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Challenges and possible mitigation of Ethiopia fishery: A review

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Abstract
This paper reviews the major existing and potential threats of Ethiopian fishery and there possible mitigation. Ethiopia has a rich diversity of Ichthyo-fauna in its lakes, rivers and reservoirs, although they are poorly known. Seven major threats to lakes of the world include: accelerated Eutrophication, invasive species, toxic contamination, overfishing, water diversion, acidification, and climate change. However in Ethiopia there are a number of challenges which affect fishery such as overfishing, wetland degradation, Dam construction for the purpose of hydropower and irrigation, deforestation and Urbanization and industrialization. The possible mitigation of the above problems has management strategies should comprise both biophysical and socioeconomic aspects with emphasis on issues like adoption of watershed/ecosystem approach at policy level, integration of income generation in conservation activities, sharing of responsibility/benefits among local stakeholders, institutional strengthening for environmentally and socioeconomically sustainable development of lakes. To protect the major challenges of fresh water are watershed protection include: reducing pollution by silt load, preventing negative water level fluctuation, eliminating overexploitation of resources, mitigation of conflict of interest in the use of water and land resources (deforestation, water logging, flooding, overgrazing, population pressure, and degradation).

Keywords: Biodiversity, challenge, ecology, fishery, mitigation, Ethiopia

Introduction
Providing adequate food for a rapidly increasing human population is one of the greatest challenges in the world. The problem is particularly acute in countries like Ethiopia where, besides population explosion, natural and manmade calamities have aggravated the problem. In addition to increase food production from land agriculture, it is necessary to sustainable exploit the aquatic ecosystem to contribute towards the effort of food security by virtue of their high productivity. Ethiopian's fish resources could undoubtedly offer one of the solutions to the problem of food shortage in the country.

Ethiopia has a rich diversity of Ichthyo-fauna in its lakes, rivers and reservoirs, although they are poorly known (Getahun & Stiassny, 1998) [23]. According to Golubtsov and Mina (2003) [2], the total number of valid species in Ethiopia inland waters is about 168 to 183 including 37 to 57 countrywide endemics. There are also 10 exotic fish species introduced from abroad into Ethiopian fresh waters (Tedla and Hyelemeske, 1981) [39]. Currently results of various studies indicate that the number of fish species could increase to 200 and above (JERBE, 2007) [29].

Fishery, livestock husbandry, small scale agriculture and wetland biomass harvesting are the main livelihood activities for communities in the African lake and river basins. The traditional lake fisheries have declined due to overfishing and environmental degradation, with Lake Victoria as a prime example. Together, these have caused a poor economic situation of rural communities who, apart from natural resources, have few alternative sources of income. Wetland crop and fish farming have become increasingly important for people living in river and lake regions.

Seven major threats to lakes of the world include: accelerated Eutrophication, invasive species, toxic contamination, overfishing, water diversion, acidification, and climate change. Institutions and institutional arrangements for addressing these issues and for implementing a watershed approach is just beginning to emerge on lakes around the world (Borre *et al*. 2001) [9]. As many other countries challenged in the world, population rise urbanization, agricultural development, industrialization and other water resource development activities have resulted

in a decrease in the species diversity of freshwater fish species (Tewabe, 2014) [43].

Major threats to wetlands in Ethiopia, include conversion to agriculture by draining, overharvesting of the resources, appearance of invasive species, introduction of perennial vegetation and overgrazing. On top of that, lack of clear awareness in general public, decision and policy makers coupled with the absence of clear policy and direction on wetlands issue are contributing to the problems mentioned before (Hailu, 2005) [27].

Potential Challenges of Fishery

Throughout Africa fishes are major sources of food accounting from some 25% to 30% of the total animal protein consumed (Rene and Kinadijan, 1994) [36]. Even when consumed in small quantities, fish often comprises a nutritionally important part of many people's diets in developing countries. It is a vital source of protein and micronutrients, and improves the quality of protein in largely vegetable and starch-based diets by providing essential amino acids. FAO (2006) [18] has estimated that fish accounts for approximately 20 percent of animal protein consumption in LIFDCs. However this is not the case of in Ethiopia where people do not include fish in their daily diet (Getahun and Stiassny, 1998) [23].

According to FAO (1973) [18], report, only about 3% of the Potential Ethiopian fishery is being exploited and despite a chronic food shortage in the country this trend appears to have changed little since the early 1970's: Therefore, which there is a growing trend in some lakes (e.g Lake Awassa, Lake Chamo, and Lake Tana) over exploitation of fish resources is a significant problems in most Ethiopia. Inland fish stocks have also been adversely affected by pollution, habitat alteration, infrastructure (dams and water management schemes) and introduction of alien species and cultured fish (Allan *et al.,* 2005) [5].

Overfishing: Inland fisheries have increased throughout the last half century reaching about nine million tons in 2002, although this trend has been accompanied in many lake and river systems by overfishing and the collapse of individual large, valuable species. "Ecosystem overfishing" has occurred as the species assemblage is fished down and fisheries use smaller nets to catch smaller and less valuable species (Allan *et al.,* 2005) [5].

In addition to stock collapses, overfishing in general has reduced revenues and economic efficiency, increased variability and reduced the resilience of stocks and catches (Hsieh *et al*., 2006) [28]. The aquatic ecosystems have been profoundly altered by fishing, with a generalized trend of "fishing down the food web" as fish from higher atrophic levels decline, leading to lower atrophic levels of harvests (Pauly *et al.,* 1998 [35]; Allan *et al.,* 2005) [5] and a range of ecosystem effects, including disturbance of sensitive habitats by destructive gears such as explosives, poisons and heavy bottom trawling equipment.

In Ethiopia all lakes, fisheries is predominantly focused on Nile tilapia (e.g. Abebe and Getachew, 1992 [1]; Bjørkli, 2004) [8]. It is only in L. Tana that *Labeobarbus* spp. are also heavily fished during a seasonal fishery (de Graaf *et al*., 2006) [13]. But some stocks (Nile perch and Tilapia) on some lakes (Chamo and Awassa) show signs of overfishing and Tilapia of lake Ziway are probably at full exploitation. Before 15-20 years Nile perch used to contribute about 20% of the total fish landings from Lakes Abaya and Chamo, however, at this moment this is reduced to a very small proportion due to overfishing and the lack of proper fisheries management (Reyntjens *et al*., 1998). It is only in L. Tana that *Labeobarbus* species are also heavily fished during a seasonal fishery (de Graaf *et al*., 2006) [13]. In Lake Tana Nile tilapia was not over fished in 2001, but several migrating *Labeobarbus* species are probably seriously over fished by a seasonal fishery (de Graaf *et al*., 2004, 2006) [13]. Half of the *Labeobarbus* species seasonally migrate into in flowing Rivers for spawning; others developed a lake spawning strategy (Nagelkerke and Sibbing, 1996 [33]; Palstra *et al*., 2004 [34]; de Graaf *et al*., 2005) [11].

According to Reyntjes and Wudneh, (1998) [47], report overfishing of tilapia was probably taking place in Lakes Chamo, Abaya, Awassa, Langano and Ziway. There is a large variation in length at first maturity in different populations of Nile tilapia within the Rift Valley Lakes (Bjørkli, 2004) [8]. Maturation at a relative small size, i.e. 'dwarfing', is considered to be an adaptation to high fisheries mortality at the adult size. In L. Awassa, L. Ziway and L. Hayek females matured at a small size (ca. 14 cm) indicating overfishing; whereas size at first maturity in L. Chamo was much larger at about 42.0 cm indicating that overfishing is unlikely (Abebe and Getachew, 1992 [1]; Teferi and Admassu, 2002 [40]; Bjørkli, 2004) [8].

In Ethiopia L. Tana, L. Ziway and L. Awassa the fish community was numerically dominated by small fish species (i.e. *Barbus* spp.) which represent a low economical value for fisheries. Due to over fishing of large-bodied fish species, there has been a gradual shift in fish capture from large and valuable carnivorous species to smaller, less valuable species that feed at lower trophic levels (Pauly *et al*., 1998) [35]. This trend has also been observed in freshwater fisheries where increasing fishing effort lead to a dramatic increase of the small (<8cm) zooplanktivorous clupeid *Clupeichthys aesarnensis* and a decrease in the densities of its main predator *Hampala macrolepidota* (Mattson *et al*., 2001) [30].

The decline of the *Labeobarbus* stock in lake Tana is thought to be recruitment over fishing by the commercial gillnet fishery that target the riverine spawners (de, Graaf *et al*, 2004) [11] and poisoning of the spawning stock in rivers using the crushed seed of Birbira (Nagelkarke and Shibbing, 1996; Ameha, 2004). According to Tewabe (2014) [43] report has stated that the composition of *Labeobarbus* species and *Varicorhinus beso* in Lake Tana significantly decline from time to time. On the other hand the composition of *Oreochromis niloticus* did not change, but *Clarias gariepinus* increased by 100% by catch composition. The most likely explanation for the total decline in abundance of fish species are the increases of illegal commercial gillnet fishery targeting their spawning aggregation in the wetlands and river mouths and that increasing trend of the degradation of spawning and nursery habitats both the lake and major tributary rivers of the catchment area. In addition to this, habitat degradation which is the alteration of breeding ground and /or separation of river from the lake which block the returning of juveniles in to the lake can be also the cause for the decline of *Labeobarbus* stock in Lake Tana((Mequaninnet, 2014 and Gebremedihn *et al.,* 2012) [19]. If things continue unabated, migratory *Labeobarbus* species of Lake Tana will be endangered like the large African cyprinids in other lakes. Hamza (2006) [26], has reported that the introduction of motorboats to Lake Tana fisheries was a

consequence of the increasing demand for fish from the capital city of Ethiopia, Addis Ababa. This introduced an additional 130 professional fishermen, which markedly negatively influenced the fish stock in the lake. In fact, the annual total catch fell to 255 metric tons in 2001 from a value of 360 metric tons in 1997. Wondie (2010) [46] has reported not only a reduction in total catch but also the percentage composition of the individual fish species yield varied between 1993 and 2001, so that the catch of *Labeobarbus* species declined by almost third in 2001 compared to 1993. Notably, the catch of Nile tilapia increased 50% in 2001 compared to 1993. This may reflect the intensive exploitation of *Labeobarbus* spp. and the superior ability of the Nile tilapia to multiply in the lake (Wondie, 2010) [46].

Deforestation: In Ethiopia the rate of degradation of the environment, mainly by deforestation and overgrazing of grasslands by cattle, is very high (Gebremariam, 2002) and leads to approximately 1.5 billion tons of soil lost every year from the highlands (Teferra, 1994) [41]. This has already resulted in a decrease in biodiversity of the fish fauna in the different drainage basins and the Rift Valley Lakes. Getahun and Stiassny (1998) [23] have compared the number of fish species in Ethiopian drainage basins in the northern and central highlands, the eastern highlands, the Ethiopian Rift Valley and Afar lowlands and the Rift Valley Lakes during the period 1835 to 1995 on the basis of literature with the results from their own surveys in 1995-1997. They reported a reduction in species numbers for each of the drainage basins varying from 40-85% and a reduction of species numbers for the Rift Valley Lakes as a whole of 65 percent. The water of most lakes in the Rift Valley contains a high sediment load which reduces light transparency and is expected to reduce primary productivity and the carrying capacity for the fish community. This is the direct result of the deforestation of the surrounding mountains in the catchments of these lakes (Getahun and Stiassny, 1998) [23]. Similarly in Lake Tana sediment load and siltation which is critical problems.

Wetlands degradation: Globally, wetlands cover between 2 to 4 per cent of the land surface. Wetlands of Ethiopia are distributed throughout the country covering approximately (22,600 km^2) of its total surface area (EPA, 2004) [16]. Their ecosystems provide significant provisioning, regulating, supporting, and cultural and amenity services to Ethiopia. In addition, they have critical importance for the wellbeing of human and natural environment.

The role of wetlands include, of food crops through agriculture by draining and recession, important sites for dry season grazing, resource extraction, raw materials, papyrus supply, fish harvesting, source of medicinal plants and sites for tourist attraction and various traditional ceremonies. In addition to a direct benefitted Carbon sequestration potential of wetlands as indirect use benefits. The capability of wetlands sequester carbon is largely a result of their productivity, their ability to act as sediment traps for runoff and sinking organic matter from the water column. They are also part of the rural people's economy as they traditionally play an important role for rural communities through the provision of water, and other materials, for both humans and livestock (EPA, 2003) [15]. Wetlands also provide tradable goods and livelihoods. Papyrus and cattail are the main wetland products used for fuel, thatching (dwelling house, pest watching tukul, granary, livestock shelter), as raw material for crafting (raincoat, mat, broom, basket, boat, carpet, etc.), ceremonial (floor covering during festivals), for mulching in nursery, compost making and fodder (Barbier *et al*. 1997) [7]. As reported by Sisay (2010) [38], natural wetlands treating domestic and municipal wastewater can remove up to 80% suspended solids, 60% to 80% of organic matter, and 20% to 60% of nitrogen, 20% to 80% of phosphorus. According to Tessema *et al.* (2014) [42], reported Chefa Wetland of Ethiopia has a potential source of fish production. He has investigated four species (*Clarias gariepinus, Gara dembecha, Labeobarbus intermedius* and, *Labeobarbus nedgia*). Wondie (2010) [46] has also reported the main feeder rivers to Lake Tana are considered as part of the lake because they constitute spawning grounds for the *Labeobarbus* species during the wet months.

In the last 2 decades with an increase of population pressure and limitation of resources (land and water) farming shifted to wetlands including river banks, channel banks and shoreline of lakes (Abunie, 2003) [2]. However, poverty related pressures, encroachment and misguided development schemes have led to environmental degradation that has compromised basic ecosystem services (e.g. fish habitat, climate control, nutrient retention, groundwater recharge). If this trend continues, the future livelihoods and food security of millions of people will be at risk. Aquatic farming policies, often aimed at development and economic growth, have frequently been ineffective due to lack of understanding of the links between poverty and the environment and an incomplete understanding of the limits of ecosystem functioning. According to Wondie (2010) [46], reported the most outstanding threats of the shoreline and riparian wetlands stability are agriculture, industrial pollution, and drainage activities and overharvesting of wetland resources. Major threats to wetlands in Ethiopia, include conversion to agriculture by draining, overharvesting of the resources, appearance of invasive species, introduction of perennial vegetation and overgrazing. According to Tessema *et al*. (2014) [42], reported that the watershed of Chefa wetland was degrading more rapidly. On top of that, lack of clear awareness in general public, decision and policy makers coupled with the absence of clear policy and direction on wetlands issue are contributing to the problems mentioned before (Hailu, 2005) [27]. In addition to the above effect climate change and population increase effects on wetlands by the following causes: Decreased water volume in dying wetlands such as Lake Haramaya (Alemaya), Eastern Ethiopia and decomposing vegetation; Increasing population growth leading to more diverse claims, more and quality water requirements.; Increased pollution beyond the assimilative potentials of wetlands. As a result wetlands are subject to frequent alteration, destruction, reconstruction, and excessive utilization of their biodiversity. Wetlands in degraded area can share biological, chemical and physical problems. For example, if the vegetation covers of a catchment drain to a wetland decline, sediment loads will be increased. This can also alter the biological chemical and physical features of wetlands and then this in turn modifies species composition, distribution, abundance and the activities of organisms that rely on these aquatic ecosystems (Abebe and Geheb, 2003) [2]. For example, among wetlands which have been converted to dry lands due to siltation and unregulated water abstraction is Lake Alemaya so that the wetlands which were associated with it (EWNRA, 2008) [17].

Habitat degradation due to Dam Construction and irrigation*:* The natural resource base in Ethiopia such as land, wildlife and water are vital sources of domestic and national income. Such provide the basis for farming, fishing, energy production and tourism. However, these resources have been degraded due to high demand for agricultural land and home energy use resulting from high population pressure. Hence, environmental degradation has been and will remain a major cause of low agriculture production. Generally, the major causes of biodiversity destruction are poor methods of farming systems which result in soil erosion, loss of mainland and soil fertility. This in return leads to low agricultural yields hence farmers become both agents and victims of environmental degradation (Yitaferu *et al*. 2004) [44].

In Ethiopia there has been a great increase in the extent of irrigation schemes in recent years (Getahun and Stiassny, 1998; Getahun *et al*., 2008 [24]; Almayehu *et al*., 2009) [3]. Water is being removed directly from the lakes and/or diverted from rivers that feed the lakes. This has created considerable water level declines in several Rift Valley Lakes (e.g. L. Ziway, L. Abijata) which damaged the breeding grounds of fish species that spawn in shallow parts of the lakes, such as Nile tilapia (*O. niloticus*) (Gebremariam and Dadebo, 1989) [22] and this has caused reduced tilapia stocks in L. Ziway (Gebremariam, 2002) [21].

The upriver spawning migrations of seven endemic *Labeobarbus* species of Lake Tana are also affected by development activities such as small-scale irrigation and dam construction at the in flowing Rivers (Anteneh *et al*., 2008 [24]; Getahun *et al*., 2008 [24]; Almayehu *et al*., 2009 [3]; McCartney *et al*., 2010). Increased soil erosion brings excess sediment load and causes low oxygen content and mud cover on the gravel beds in the in flowing rivers and wetlands and flood plains are converted to agriculture. This habitat degradation seriously affects the recruitment of these endemic *Labeobarbus* species and threatens the biodiversity of Lake Tana (Dejen, 2008) [24]. Lake Tana ecosystem has undergone substantial changes; especially the area covered by papyrus (multifunctional plant for local communities) is reduced to one tenth and limited to the southern gulf of the lake during the last 2 decades (Wondie, 2008) [24].

Urbanization and industrialization: Historically, human settlement follows river banks and lake shore areas. Wetlands degradation in Ethiopia is closely linked to the development of urban centers countrywide. The composition of storm water varies greatly, depending on the surrounding land use. Most municipal wastes and industrial wastewater in Ethiopia are directly discharged to the receiving water bodies. For example, urban runoff may contain soil particles, dissolved nutrients, heavy metals and petroleum products. A variety of industrial wastes coming from e.g. food processing, slaughtering, chemical manufacturing, and landfill leachates, are amenable to wetland ecosystems. Growing urbanization and unplanned tourism development activities around the lake in absence of adequate infrastructural facilities have negatively affected the lake's recreational values. Location of industries within the wetlands such as in Addis Ababa, Bahir Dar, Awassa and Arba Minch industrial areas greatly affects their normal functioning impairing its capability to clean wastewater and reduce siltation of streams (Gebremariam, 1994) [20]. Location of industry within the city due to poor urban planning leads to discharge of very toxic chemicals into wetlands bringing a serious threat to the biodiversity.

Possible mitigation measures of Fishery

Utilization of aquatic resources sustainably, especially the fishery resources 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 (Wudneh, 1998) [47]. Even though Ethiopia is a landlocked country, there are a number of lakes and rivers with important fish resources. Lake Tana is the largest lake in the country constituting almost half of the freshwater (Reyntjes *et al*., 1998 [37]; de Graaf *et al*., 2004) [34]. Illegal fishing activities (like use of monofilaments, Seeds of Birbira tree (*Millettia ferruginea*) with Malathion and fencing) must be totally prohibited. An increase in public awareness of the environmental degradation and waste problem should be induced, as acceptance of the problem and behavioral changes by householders. Shoreline and river bank residents should be mindful of trash, phosphate soaps and detergents, paints, and other hazardous materials that could leach through the soil and contaminate nearby water bodies should be prohibited. An integrated watershed management approach of the lake and its surroundings should be developed, rather than focusing only on the lake itself. Conservation of the lake requires covering of watershed and ecosystem basis. Inlets and outlets of the lake and its river basins should be kept clear for passage of fish species between the watersheds and areas further downstream. Especially riverine fishery should be taken in consideration during the construction of dam for hydropower and irrigation purpose.

Appropriate wastewater management system (especially in urban and sub-urban areas including big cities like Addis Ababa, Arbaminech, Awassa, Ziway, Bahir Dar and Gondar Cities) should be developed, instead of direct dumping to the receiving water bodies. The waste stabilizing ponds at the municipal level should work for recycling. Restoration of lake water quality should be obtained through either development of constructed wetland or establishment of waste treatment plant. The role of protection should be reinforced by proper legislation inducing development and plans implementation. Similarly Wondie (2010) [46], Management strategies should comprise both biophysical and socioeconomic aspects with emphasis on issues like adoption of watershed/ecosystem approach at policy level, integration of income generation in conservation activities, sharing of responsibility/benefits among local stakeholders, institutional strengthening for environmentally and socioeconomically sustainable development of lakes. It is, therefore, important for the government to exercise watershed management approach to arrest this alarming degradation of the catchments of the water bodies. A forestation, soil conservation, controlled grazing and prohibiting of hill side crop farming are some of the measures that should be exercised urgently.

Conclusion and Recommendation

Wetlands in Ethiopia Lakes and river catchment are now threatened from sedimentation (silt load) as a result of upstream intensive agricultural activities and deforestation as well as overgrazing. The major challenges fisheries in Ethiopia include: reducing pollution by silt load, preventing negative water level fluctuation, eliminating overexploitation of resources, mitigation of conflict of interest in the use of water and land resources (deforestation, water logging, flooding, overgrazing, population pressure, and degradation). Inadequate, hydrological knowledge and monitoring insufficient consideration of highland to lowland interactions

and lack of watershed management results a successive degradation of water quality. Therefore, integrated management is a proactive approach towards sound water management. Wetlands are of value because they play an important role in maintaining environmental quality, sustaining livelihoods and supporting biodiversity. Many wetland functions effectively "work" for the benefit of people. It is generally accepted that wetlands with rich biodiversity sequester carbon more efficiently and release reduced amounts of green house gas. However, social and economic factors often result in pressure to make wetlands work harder, for example, through their utilization for agriculture. Generally, the major causes of biodiversity destruction are poor methods of farming systems which result in soil erosion, loss of mainland and soil fertility. Mitigation mechanisms are a forestation program should be in place around the wetland. An increase in public awareness of the environmental degradation and waste problem should be induced, as acceptance of the problem and behavioral changes by householders. The realization of the importance of wetlands, adjacent to lake ecosystems, has resulted in the fact that drainage of wetlands has ceased in many countries and that even previously drained wetlands are restored. It is also considered to construct artificial wetlands to cope with the diffuse pollution originating from agriculture, septic tanks and other sources. This application of "soft" technology seems particularly advantageous for developing countries due to its moderate cost. To protect the major challenges of fresh water are watershed protection include: reducing pollution by silt load, preventing negative water level fluctuation, eliminating overexploitation of resources, mitigation of conflict of interest in the use of water and land resources (deforestation, water logging, flooding, overgrazing, population pressure, and degradation). In addition to water shead management there should be a need for urgent development of a management plan focusing on ensuring sustainable utilization of a resources by fishing effort, gear mesh size and gear type restrictions, and controlling the spawning grounds during the breeding seasons of different fish species of lakes and rivers.

References

1. Abebe E, Getachew T. Seasonal changes in the nutritional status of *Oreochromis niloticus* Linn. (Pisces: Cichlidae) in Lake Ziway, Ethiopia Arch Hydrobiol 1992; 124:109-122.
2. Abebe Y, Geheb K. Wetlands of Ethiopia. Proceedings of a seminar on the resources and status of Ethiopia's wetlands, IUCN, Switzerland, 2003, 116.
3. Abunie L. The distribution and Status of Ethiopian Wetlands: an overview. Proceeding of a seminar on the resources and status of Ethiopia's Wetlands IUCN, 2003.
4. Almayehu T, Mc, Cartney M, Kebede S. Simulation of water resource development and environmental flows in the Lake Tana Sub basin. In: S.B, 2009.
5. Allan JD, Abell R, Hogan Z, Revenga C, Taylor W, Welcome R and Winemiller K. Overfishing of Inland waters. Bioscience 2005; 55:12.
6. Anteneh W, Getahun A, Dejen E. The spawning migration of *Labeobarbus* species of Lake Tana (Ethiopia) to Ribb River. In: 4th International Conference of the Pan African Fish and Fisheries Association (PAFFA). The Department of Biology, Addis Ababa University, the Ethiopian Fisheries and Aquatic Sciences Association, Addis Ababa, Ethiopia, 2008.
7. Barbier EB, Acreman M, Knowles D. Economic valuation of wetlands: a guide for policy makers and planners. Ramsar Convention Bureau, Gland, Switzerland, 1997.
8. Bjørkli SG. The fisheries in Lake Awassa, Ethiopia; estimation of annual yield. M.Sc. Thesis. Norwegian University of Life Sciences (UMB), Aas, 2004.
9. Borre L, Barker DR, Duker LE. Institutional arrangements for managing the great lakes of the world: Results of a workshop on implementing the watershed approach Lakes and Reservoirs: Research and Management 2001; 6:199-209.
10. FAO. State of World Fisheries & Aquaculture 2006. Food and Agriculture Organization, Rome, 2006.
11. De Graaf M, Machiels MAM, Tesfaye W, Sibbing FA. Declining stocks of Lake Tana's endemic Barbus species flock (Pisces; Cyprinidae): natural variation of human impact? *Biological Conservation* 2004; 116:277-287.
12. De Graaf M, Nentwich ED, Osse JWM, Sibbing FA. Lacustrine spawning new reproductive strategy among 'large' African cyprinid fishes? J Fish Biol. 2005; 66:1214-1236.
13. De Graaf M, PAM van-Zweiten, MAM Machiels, E Lemma, E Dejen, FA Sibbing. Vulnerability to a small scale commercial fishery of Lake Tana's (Ethiopia) endemic Labeobarbus compared with African catfish and Nile tilapia: an example of recruitment-overfishing? Fisheries Research 2006; 82:304-318.
14. Dejen E. Wetlands and fishery resources: the impact of wetland degradation on fishery resources. In: Proceedings of the National Stakeholders' Workshop on Creating National Commitment for Wetland Policy and Strategy Development in Ethiopia, Ethio-Wetlands and Natural Resources Associations (EWNRA), Addis Ababa, 2008, 60-71.
15. EPA. State of the Environment Report for Ethiopia, Environmental Protection, 2003.
16. EPA. Proceedings of the "National Consultative Workshop on the Ramsar Convention and Ethiopia, the environmental protection Authority in collaboration with the Ramsar Bureau, Addis Ababa, Ethiopia, 2004.
17. EWNRA. Proceedings of the National Stakeholders' Workshop on Creating National Commitment for Wetland Policy and Strategy Development in Ethiopia, 7 - 8 August 2008, Addis Ababa, 2008.
18. FAO. Abrief review of the current status of the inland fisheries of Africa, 1973.
19. Gebremedihn S, Mingist M, Getahun A, Anteneh W. Spawning migration of Labeobarbus spp. (Pisces: Cyprinidae) of Lake Tana Lake Tana to Arno-Garno River, Lake Tana Sub-basin, Ethiopia SINET: Ethiop J Sci. 2012; 35(2):95-106.
20. Gebremariam Z. Long term changes in indices of chemical and productive status of a group of tropical Ethiopian lakes with differing exposure to human influences Arch Hydrobiol 1994; 132:115-125.
21. Gebremariam Z. The Ethiopian Rift Valley lakes: major threats and strategies for conservation. In: C. Tudorancea & W.D. Taylor (Eds.) Ethiopian Rift Valley Lakes. Biology of Inland Waters Series, Backhuys Publishers, Leiden, the Netherlands, 2002, 259-271.
22. Gebremariam Z, Dadebo E Water resources and fisheries management in the Ethiopian Rift-Valley Lakes. SINET: Ethiop J Sci. 1989; 12:95-109.

23. Getahun A, Stiassny MLJ. The freshwater biodiversity crisis: the case of the Ethiopian fish fauna SINET: Ethiop J Sci. 1998; 21:207-230.
24. Getahun A, Dejen E, Anteneh W. Fishery studies of Rib River, Lake Tana Basin, Ethiopia. A report submitted to World Bank 2008; 2(1573)116.
25. Golubtsov AS, Mina MV. Fish species diversity in the main drainage System of Ethiopia: Current status of Knowledge and research perspectives, Ethiop J Natu Reso 2003; 5(2):281-318.
26. Hamza W. Estuary of the Nile. In: Wangersky P. (Ed.), *Estuaries;* Hdb. Env. Chem. Springer Verlag Publisher, 2006; 5H:149-173.
27. Hailu A. Ethiopian wetlands distribution, benefits and threats. Proceedings of the second Awareness Creation Workshop on Wetlands in Amhara Region. Bahir Dar, 2005.
28. Hsieh C, Christian SR, Roger P, Hewitt and George S. Spatial analysis shows that fishing enhances the climatic sensitivity of marine fishes, 2006.
29. Joint Ethio-Russian Biological Expedition (JERBE). Fish diversity in the main drainage systems of Ethiopia. Addis Ababa, 2007.
30. Mattson NS, Balavong V, Nilsson H, Phounsavath S, Hartmann WD. Changes in fisheries yield and catch composition at the Nam Ngum Reservoir, Lao PDR. In: S.S. De Silva (Ed.) Reservoir and Culture-Based Fisheries: Biology and Management, ACIAR Publication, Vol. 98. Canberra, Australia, 2001, 48-55.
31. McCartney M, Alemayehu T, Shiferaw A, Awulachew SB. Evaluation of current and future water resources development in the Lake Tana Basin, Ethiopia. IWMI Research Report. International Water Management Institute, Colombo, Sri Lanka 2010; 134:39. DOI: 10.3910/2010.204.
32. Mequaninnet D. Spawning migration of *Labeobarbus* species of Lake Tana to Gilgel Abay River and its Tributaries, Blue Nile Basin, Ethiopia. MSc Thesis. Bahir Dar University, Ethiopia, 2012.
33. Nagelkerke LAJ, Sibbing FA. Reproductive segregation among the large barbs (*Barbus intermedius* complex) of Lake Tana, Ethiopia. An example of intralacustrine speciation? J Fish Biol. 1996; 49: 1244-1266.
34. Palstra AP, de Graaf M, Sibbing FA. Riverine spawning in a lacustrine cyprinid species flock, facilitated by homing? *Anim Biol* 2004; 54(4):393-415.
35. Pauly D, Christensen V, Dalsgaards J, Froese R, Torres Jr. Fishing down marine webs. Science 1998; 279:860-863.
36. Rene F, Kinadijan L. Aquaculture in Africaine, maisouest done passee la rentabilite? Equinoxe 1994; 51:4-11.
37. Reyntjes D, Tarekegn M, Wudneh T, Palin C. Fisheries development in Ethiopia–which way now? *European Union Bulletin* 1998; 11(1):20-22.
38. Sisay E. Ecological and socio-economic role of wetlands in Bahir Dar city and Abay Millennium Park (AMP). M.Sc. thesis. Bahir Dar University. Bahir Dar. Ethiopia, 2010.
39. Tedla S, Hayilemeskel F. Introduction and transplantation of freshwater fish species in Ethiopia. SINET: Ethiop J Sci 1981; 4:69-72.
40. Teferi Y, Admassu D. Length-weight relationship, body condition and sex ratio of tilapia (*Oreochromis niloticus*) in Lake Chamo, Ethiopia. SINET: Ethiop J Sci 2002; 25:19-26.
41. Teferra S. Basic facts about the population of Ethiopia and its needs. In: Panel on Population Resource Balance, the Biological Society of Ethiopia, Faculty of Science, Addis Ababa University, 1994, 20-29June.
42. Tessema A, Mingist M, Dejen E. A survey on Fishes in Chefa wetland around Kemisse, Oromia zone, Ethiopia 2014; 2(3):28-32.
43. Tewabe D. Spatial and Temporal distributions and some biological aspects of commercially important fish species of Lake Tana Ethiopia, 2014.
44. Yitaferu B, Hurni H, Zeleke G. Processes of land degradation in the Lake Tana Basin (LTB), Amhara Region, Ethiopia. Proceeding of the Symposium on Lake Tana watershed management. Bahir Dar University. September 24-25, 2004. Bahir Dar, Ethiopia, 2004, 5-12.
45. Wondie A. Current Land Use Practices and Possible Management Strategies in Shore Area Wetland Ecosystem of Lake Tana: towards improving livelihoods, productivity, and biodiversity conservation. Journal of Ethiopian Fishery and other aquatic sciences Associations 3, 1-12, Addis Ababa, Ethiopia, 2008.
46. Wondie A. Improving management of shoreline and riparian wetland ecosystems: the case of Lake Tana catchment. Bahir Dar University, Bahir Dar, Ethiopia 2010; 10(2-4):123-132.
47. Wudneh T. Biology and management of fish stock in Bahir Dar Gulf, Lake Tana, Ethiopia, PhD Thesis, Wageningen Institute of Animal Science, Wageningen Agricultural University, the Netherlands, 1998.