



Original Research Article

Social, economic and management status of small-scale fisheries in Omo River Delta and Ethiopian side of Lake Turkana, southern Ethiopia



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ABSTRACT

Ethiopia's inland fisheries offer an alternative livelihood for the riparian communities. One of these inland fisheries, the Omo-Turkana fisheries, have not been properly studied and managed. The main purpose of this study, therefore, was to assess social, economic aspects and related problems of fisheries in the Lower Omo River and Ethiopian side of Lake Turkana for better management and sustainable use of the resources. Various instruments including structured questionnaires, focus group discussions, key informant interviews, personal observations, and secondary sources were used to gather data on the socio-economics and management problems of the fisheries. The fisheries support a considerable number of the local communities, who have much less other livelihood options apart from pastoralism. However, development of fisheries in these localities is marred by lack of material and technical support to the fishers cooperatives, lack of government commitment to capacitate the institutions that work on fisheries management and development, and the continued conflicts between Ethiopian and Kenyan fishers in an apparent competition over a fertile fishing ground. For comprehensive insight, we developed a fisheries value chain and discussed major issues arising out of it. To sustain the fisheries contributions to community livelihoods, it is recommended that due attention be given to conflict resolution between the Ethiopian Daasanach and the Kenyan Turkana fishers. Additionally, the co-management arrangement by the two countries is urgently needed to regulate illegal fishing in the lake as well as the Omo River Delta.

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1. Introduction

Ethiopia, a Horn of African nation, has a population of more than 100 million (UN, 2017). It has an economy that relies heavily on agriculture, which accounts for more than 85% of employment (MEDaC, 1999). However, the country

often suffers risks of food insecurity largely due to a recurring drought that affects its crop productions. The nation's freshwater system consists of 8,065 km length of rivers and 13,637 km² area of lakes and reservoirs (Tesfaye and Wolff, 2014). Its freshwater system supports small-scale fisheries that sustain the livelihoods of a considerable number of its people. The Omo-Turkana is one of the country's drainage basins that traverses an extensive part in southwestern Ethiopia and northern Kenya with a catchment area of 131,000–145,500 km² (Feibel, 2011;

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Velpuri et al., 2012). The studies on fish diversity of Lake Turkana were started in the 1930s by Cambridge University and have continued to present time (Worthington, 1931, 1932; Worthington and Richardo, 1936; Pellegrin, 1935; Hamblyn, 1962; Mann, 1964; Hopson and Hopson, 1982; Kolding, 1989; Wakjira and Getahun, 2017). The Ethiopian Daasanach community (also referred to as Merille by some) is the major inhabitant occupying lower Omo River to the Delta, northern and northeastern shore of the Ethiopian side of the lake. The population generally constitutes a pastoralist livelihood with sub-livelihood systems. Those residing along Omo River are semi-pastoralists who used to depend on recession farming. The community living in the northeastern part of Lake Turkana is entirely dependent on Lake Turkana fishing with no other alternative means of livelihood (USAID, 2006). Personal observations by the authors, during various field visits since 2014, show that fisheries in the Omo River Delta at the junction with Lake Turkana are important sources of livelihood and income for the local community particularly the youth. Moreover, the first preliminary report by Wakjira (2016) indicated that fisheries potential is high in the Lower Omo River and the Ethiopian part of Lake Turkana with considerable socio-economic returns. However, while fisheries development in the main lake on the Kenyan side has received foreign supports (Hopson, 1982; Kolding, 1989), socioeconomic and management conditions of fisheries on the Ethiopian side are not well addressed. Moreover, there exist considerable numbers of development activities including hydropower dams and irrigation weirs in the Omo River Basin. A hydrological impact assessment conducted, for the African Development Bank (AfDB), remarked on the potential impacts of these development activities on the basin fish fauna and the downstream fisheries communities (Avery, 2010). Appraisal of any future positive or negative impacts of these development activities on the basin fisheries requires baseline scientific information on fisheries socioeconomic and related characteristics for appropriate intervention and management plan. The main purpose of this study is to understand the basic socioeconomic status and related problems of fisheries in the Lower Omo River and Ethiopian side of Lake Turkana for better management and sustainable use of the resources. Therefore, the specific objectives of this study include:

- assessing the socio-demographic characteristics of the fishers,
- identifying and documenting the commercially important fish species,
- describing fish production, consumption, and income,
- identifying marketing and value chain of the fisheries, and
- identifying actual and potential conflicts and possible management measures at the study sites

2. Study Area

The study area is located in southern Ethiopia at the border with northern Kenya approximately 860 km south-

west of the capital Addis Ababa (Fig. 1). Lake Turkana is the world's largest permanent desert lake located in the eastern arm of the East African Great Rift Valley roughly at geographic coordinates of 02°27'–04°40' N, 035°50'–36°40' E. The lake is 257 km long, 13–44 km wide, and with a surface area of 7,560 km², a volume of 237.36 km³ and a mean depth of 31.4 m. The largest part of the lake lies in northern Kenya while it receives more than 90% of its total inflow from Omo River that originates in the Ethiopian highlands at an elevation of about 2,200 m above sea level. The major tributaries of Omo River include Gibe, Gojeb, Gilgel Gibe, Amara, Alanga, Denchiya, Mui, Zigina-Shoshuma, Mantsa, and Usno (with sub-tributaries Mago and Neri). The area has an average elevation of 373.3 m above sea level in a lowland agroecological zone. It has an annual temperature range of 30–40°C (mean 34.5°C) with a mean annual rainfall of about 350 mm. Its wet season extends from April to November receiving a relatively higher amount of rainfall between April and May and September to November. Despite its bimodal pattern, the rainfall generally remains low and erratic (EEPCO, 2009).

3. Methods

Qualitative and quantitative data were collected using structured questionnaires, focus group discussion, key informant interview, and personal observations in April 2019. The questionnaires were designed to generate data from the fisher respondents in order to reach a large number of respondents more easily and economically. Major issues addressed in the questionnaires included sociodemographic characteristics of the fishers, fishing and livelihood, conservation problems, and fisheries management. Items of the questionnaire were tested and refined (by removing irrelevant questions) based on preliminary information obtained from fishers and fish traders before the commencement of the actual data collection. The questionnaire data were collected from a sample of forty fishers with the assistance of trained enumerators. Focus group discussion (FGD) was held with fishers' representatives, fish traders, and experts from the Livestock and Fisheries as well as the Cooperatives Office of the District. The focus group discussion points consisted of items about the fisher communities and fishing, fish marketing, and those related to conservation problems and fisheries management. The FGD was important to obtain in-depth perspectives in order to complement data collected via the structured questionnaire as well as to generate pertinent information that otherwise would have been missed in the questionnaire. Data was also collected from Heads of the Livestock and Fisheries, Cooperatives, and Revenue offices who were key informants. The items of key informant interview were largely similar to those of FGD and were meant for in-depth comprehension and verification of data. Moreover, the investigators took personal observation on most of the issues collected via both questionnaire and FGD to ensure authenticity. The methods which involved the above techniques ensure the comprehensive and robust nature of the data collected. Additionally, secondary data related to the

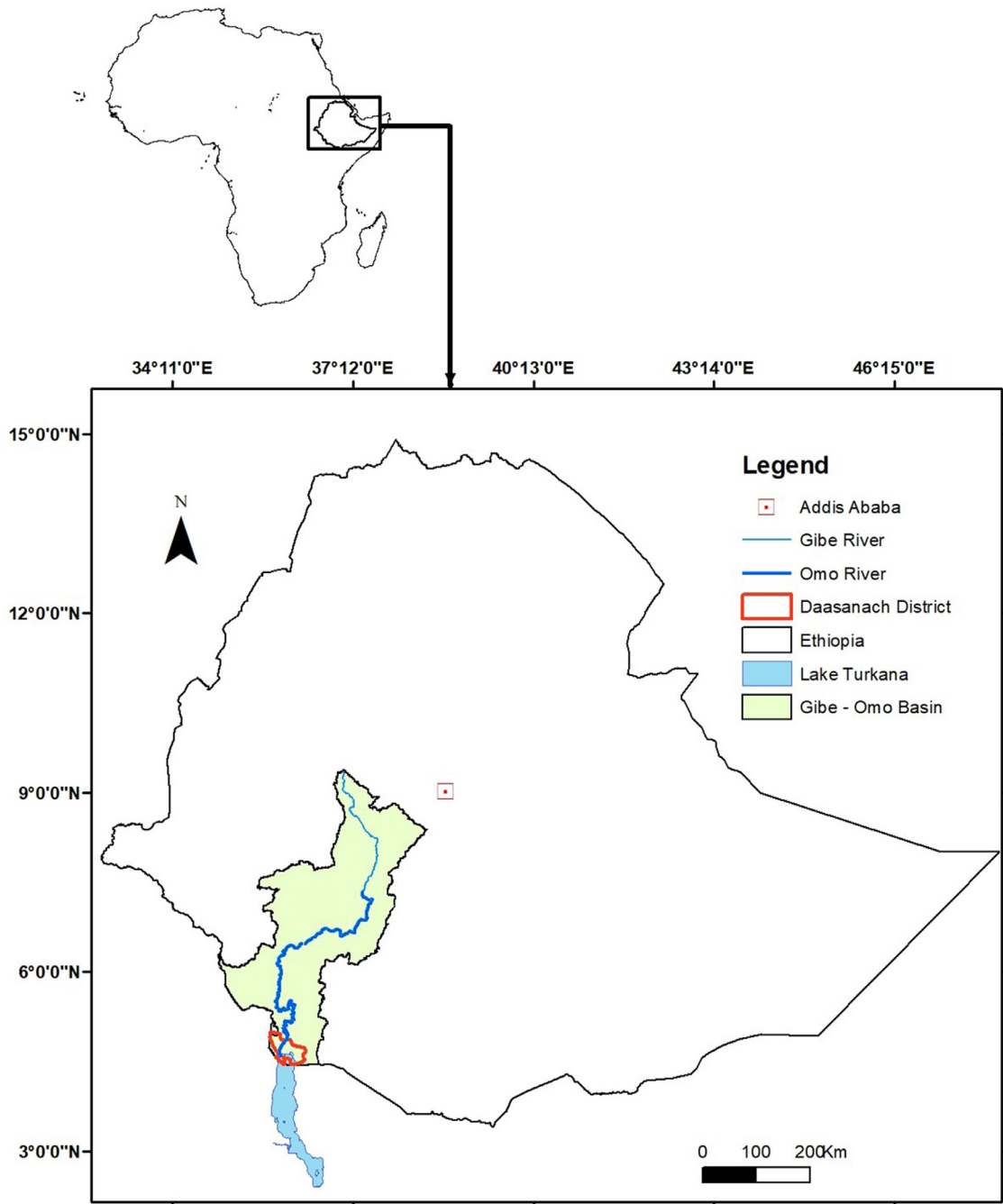


Fig. 1. The study area: Lower Omo River and Lake Turkana, Ethiopian side (Daasanach District).

fishers' income, fish consumption, gear and boat holding were used from other sources (Bayley, 1982; KMFRI, 2007; Wakjira, 2016). Quantitative data were analyzed using descriptive statistics such as means, ranges, and percentages computed in Excel 2013 while qualitative data were presented and narrated.

4. Results

4.1. Sociodemographic characteristics

All the forty participants in our present survey, 30 from Lake Turkana and 10 from Omo River, are male in-

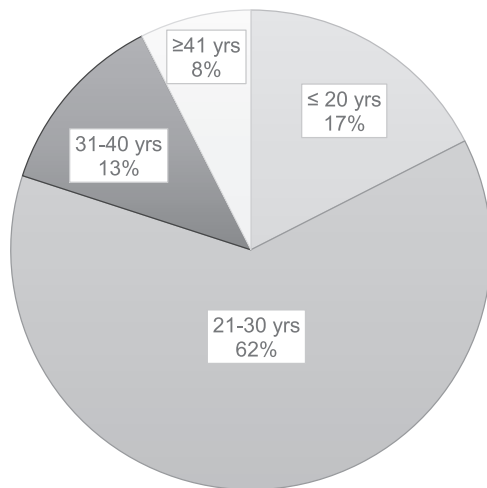


Fig. 2. Age composition of the fisher respondents during the present study (n = 40).

dividual fishers, from Daasanach ethnic group that reside along the bank of the Lower Omo River and the northern shore of Lake Turkana. They practice indigenous traditional beliefs and have no formal education. They are all married, heading families of 2–10 persons with an average of four persons. In terms of age composition, majorities of the study participants (62%) are youth in the age range of 21–30 years (Fig. 2). Most of these fishers have come from a fishing background (67.5%) while a considerable proportion (32.5%) also comes from pastoralists.

4.2. Fisheries and Fish Marketing

The list of commercially important fish species in the Lower Omo River and the Ethiopian side of Lake Turkana, with their local names in Daasanach and relative abundance in percentage by number (Wakjira, 2016), is provided in Table 1. Genera comprising the commercially important species, from the highest to the lowest species richness, include *Labeo*, *Synodontis*, *Schilbe*, *Auchenoglanis*, *Bagrus*, *Hydrocynus*, *Alestes*, *Citharinus*, *Distichodus*, *Lates* and *Oreochromis*.

All the fishers who participated in the present survey rely only on fishing for their livelihood and they fish largely for subsistence (78%). The majority of these fishers (45%) have fished for 10–15 years while considerable numbers (37.5%) have also fished up to ten years (Table 2).

The value chain for the fisheries of lower Omo River and Ethiopian side of Lake Turkana, as determined from the present survey, is presented in Fig. 3.

4.3. Conflicts and Fisheries Management

Conflicts between the Ethiopian Daasanach and the Kenyan Turkana tribesmen often occur at the border on the northwest end of Lake Turkana near Omo Delta. The major conflict-related issues identified through the focus group discussion are provided in Table 3. Moreover, there

Table 1

Summary of commercially important fish species in the fisheries of lower Omo River and Ethiopian side of Lake Turkana with their relative abundance by number; the total number of fish samples (n = 4265); n/a = data not available.

Fish species	Local name (Daasanach)	% Relative Abundance
<i>Alestes baremoze</i>	Lamete	24.78
<i>Synodontis schall</i>	Dir	23.70
<i>Schilbe uranoscopus</i>	lyinte	11.25
<i>Lates niloticus</i>	Iji	8.32
<i>Oreochromis niloticus</i>	Kelle	7.39
<i>Distichodus nefasch</i>	Gollo	6.12
<i>Labeo niloticus</i>	Karitach	4.97
<i>Citharinus citharus</i>	Nakurach	3.38
<i>Hydrocynus forskahlii</i>	Kornech	2.77
<i>Bagrus bajad</i>	Nyarabomos	1.99
<i>Synodontis filamentosus</i>	Dir	1.52
<i>Auchenoglanis occidentalis</i>	Dir	1.41
<i>Bagrus docmak</i>	Nyarabomos34	0.80
<i>Schilbe mystus</i>	lyinte	0.59
<i>Auchenoglanis biscutatus</i>	Dir	0.56
<i>Hydrocynus vittatus</i>	Kornech	0.26
<i>Labeo horie</i>	Karitach	0.14
<i>Labeo coubie</i>	Karitach	0.05
<i>Synodontis frontosus</i>	Dir	n/a
<i>Synodontis serratus</i>	Dir	n/a
<i>Schilbe intermedius</i>	lyinte	n/a
<i>Labeo cylindricus</i>	Karitach	n/a

Table 2

Summary of fishing experiences of the respondents (n = 40) in the present study.

Variable	Category	Response rate
Years of engagement in fishing	<10 years	37.5%
	10–15 years	45%
	>15 years	17.5%
Reason for engaging in fishing	Subsistence	68%
	Additional income	22%
Mode of engagement in fishing	Subsistence & Income	10%
	Individual fisher	100%
The extent of reliance on fishing for livelihood	Cooperative member	0%
	Very strongly (always)	100%
	Moderately	0%
Other/additional means of livelihood	Not dependent	0%
	Yes	0%
	No	100%

are no well-organized fisheries management institutions and structures in the locality. Fisheries management problems in the Lower Omo River and Ethiopian side of Lake Turkana, identified through the questionnaire survey, are summarized in Table 4.

5. Discussion

5.1. Sociodemographic characteristics

Fishing in lower Omo River and Ethiopian side of Lake Turkana is undertaken by both individual and organized fishers. The fishers literacy rate in the present assess-

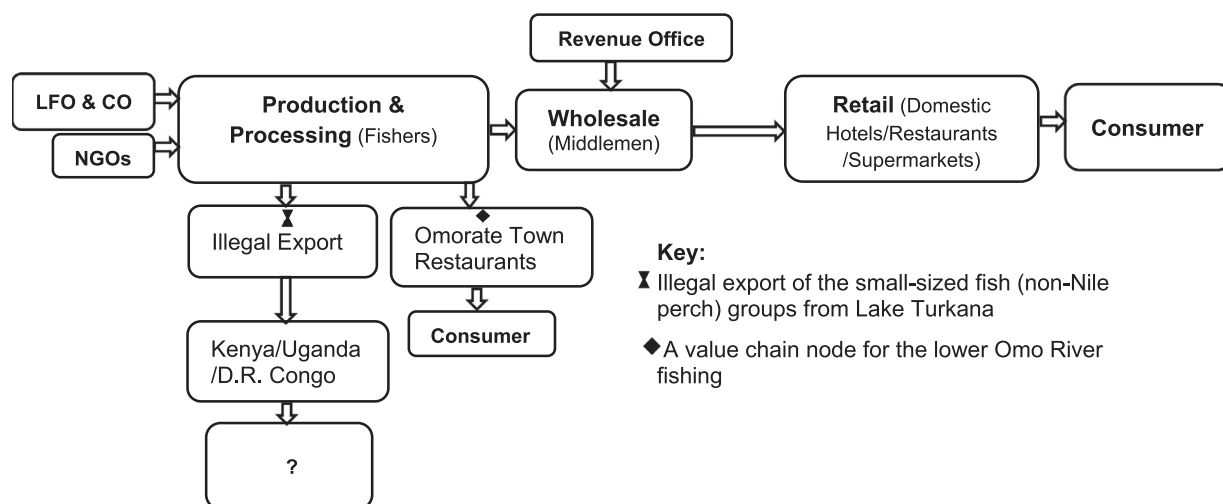


Fig. 3. The value chain of fisheries in Omo River Delta and Ethiopian side of Lake Turkana (thickness of the boxes and length of arrows are scaled, respectively, to the number of people/amount of production/entities in each stage of the chain and distance between the links; LFO & CO = Livestock and Fisheries & Cooperatives Offices, respectively, of Daasanach Wereda (a lower administrative unit equivalent to District); NGOs = Non-governmental organizations; D.R. Congo = the Democratic Republic of Congo).

Table 3

Conflicts associated with fisheries of the Lower Omo River and Ethiopian side of Lake Turkana.

Issue	Major results
Any conflict arising between the Ethiopian and Kenyan fishermen?	Conflicts are very common in the study area
Causes of the conflicts?	Competition over pasture land and fertile fishing ground are the major causes of the conflicts
Bodies who have so far involved in conflict resolution?	Non-governmental Organizations like the Catholic church and the Intergovernmental Authority on Development
Any effort by the governments of Ethiopia and Kenya to manage the conflicts and properly use the fishery resources?	Very limited; future efforts and arrangements are imperative to resolve the conflicts and improve livelihood in general

Table 4

Fisheries management problems in the Lower Omo River and the Ethiopian side of Lake Turkana.

Variable	Response category	Response rate
Any training provided on conservation and related matters?	Yes	0%
	No	100%
Any sign of overfishing in Lake Turkana or Omo River?	Yes	67%
	No	33%
Cause of overfishing	Individual fishers	17%
	Cooperative fishers	20%
	Kenyan fishers	67%
Stakeholders who should involve in the effective fisheries management	Government of Ethiopia	82%
	Local communities	93%
	Government of Kenya	85%

ment is lower compared to other fishing communities in Ethiopia, for example, Lake Zeway where the literacy rate is above 90 % (Janko and Zemedu, 2015; Kassaw, 2019). This lower literacy rate would have a negative impact on providing training to the fishers on the techniques of fishing and fish processing, fish handling, fisheries management, and effectively running their financial transactions. All the participants of the present study are male fishers, who are family heads.

5.2. Fisheries and Fish Marketing

High productivity and fish diversity in Omo Delta is attributed to freshwater and nutrient inflow from the Omo River, shallow depth, and low salinity (Wakjira, 2016). It supports high fisheries activities sustaining livelihoods of several fishers from both Ethiopia and Kenya (KMFRI,

2007; Wakjira, 2016). On the Ethiopian side, fishing is more common in the Omo River Delta at the junction with Lake Turkana and around the northern shores of the lake from west to east. The basin has the highest fish diversity only next to the Baro-Akobo Basin in Ethiopia (Golubtsov and Darkov, 2008; Getahun, 2017; Wakjira and Getahun, 2017). While 79 valid native fish species occur in the entire Omo-Turkana system, 65 species have been reported for part of the basin within the limit of Ethiopia (Wakjira and Getahun, 2017). Despite the high fish diversity in the basin, we have determined through our assessment that only 22 fish species are targets of the fisheries of the Lower Omo River and Lake Turkana in Ethiopia (Table 1). While the small-sized fish species such as *Alestes baremoze* and *Synodontis schall* have the highest relative abundance by number (the two accounting for 48.48% relative abundance),

fisheries in the Ethiopian side of Lake Turkana largely target *Lates niloticus* (accounting only for 8.32% relative abundance), apparently due to the fishers' preference for the large-sized individuals. Thus, in the interest of balanced exploitation and sustainability, it requires a management intervention to direct the overall fishing pressure from the large fish towards the small fish (Kolding et al., 2019).

The responsibility of organizing, follow up, and monitoring the fishers' cooperatives rests in the Wereda's Cooperative Office. The history of the formation of fishers cooperatives dates back to 2011/12 when the first groups consisting of four fishers cooperatives, with a total of 120 members, were formed by the support obtained from AgriService Ethiopia, a local NGO that provided a fishing boat, gears, and refrigerators. These cooperatives continued to effectively function for three years until 2014/15 when they were disrupted due to a conflict with the Kenyan fishers (Wakjira, 2016). Of the many landing sites surrounding Omo Delta and the lake, the six functional ones include Yerile, Koriagn Lubur, Ocholoch, Fejej, Eriker, and Bubu'a from west to east, respectively. According to a key informant from the Cooperative Office, five fishers' cooperatives are being established at these landing sites. Most members of the fishers' cooperatives are youth largely in their twenties and thirties. The cooperatives are governed by their bylaws. The establishment of four cooperatives, based at Bubu'a, Eriker, Ocholoch, and Fejej landing sites, has been facilitated by Veterinarians without Frontiers (VSF) Germany, an international NGO that provided fishing gears, boat (without engine), refrigerator and solar panels. The two cooperatives based at Ocholoch and Fejej sites have virtually become functional. Each of the cooperatives at these four landing sites consisted of 30 members and only one female member at the Ocholoch site. Although there is no cultural barrier that prevents females from being engaged in fishing activity, at present the role of females in the fishing community is limited apparently due to the harsh environmental conditions and hardship to fish as learned from the focus group discussion. This is also the case in other water bodies of the country (Kassaw, 2019). Moreover, fish processing, such as filleting and drying, is also accomplished by the male fishers. Thus, there is still a lot to be done to involve females in the fishing and processing activities. The composition of the fishers largely consisted of the indigenous Daasanach community and individuals from other parts of southern Ethiopia with previous experience in fishing at Abaya and Chamo Lakes. The fifth cooperative consisting of 50 or more members at Yerile fishing site, located at the junction of Omo River with the Lake Turkana in the Omo Delta, is under establishment. This cooperative is materially supported by a grant from Christensen Fund through Addis Ababa University. As this study came to completion, basic fishing facilities such as fishing gears, a boat, and an engine were handed over to the cooperative to make it functional. However, still more assistance from governmental and non-governmental organizations is required to fully strengthen the cooperatives. Other problems faced by the cooperatives include threat (conflict) from the Kenyan fishers and small payment provided by the traders to the fishers, often in the form of bartering.

Historically, fishing was for the poor and marginalized sector of the Daasanach community that lives essentially close to Omo River and Lake Turkana. However, that considerable proportion of fishermen, in the present assessment, comes from the pastoralist background is indicative of a relative shift from pastoralist to fishing (sedentary) livelihood. Moreover, more people are being attracted to the fishing sector due to a shift in livelihood from recession agriculture (locally, "Omoshesh") and pastoralism. A decrease in recession farming is apparently due to a decrease in the Omo River water level. The discussion held with the FGD participants indicated that the Omo River water level has decreased nowadays possibly due to the upstream development activities. In agreement with our assessment, various recent studies indicate changes in the volume and seasonality of inflows from Omo River, owing to the upstream dams and irrigation schemes, significantly impacting on the ecology of lower Omo River and Lake Turkana (Gownaris et al., 2016; Avery, 2017; Carr, 2017; Hodbod et al., 2019; Tebbs et al., 2019). For instance, Lake Turkana water level declined by 1.5 m during the filling up of the Gibe III dam that took place between January 2015 and January 2017. Moreover, these flow regulations affected the seasonal flood pulse and consequently reduced the downstream sediment transport, which in turn affected primary productivity and fisheries (Hodbod et al., 2019). Tebbs et al. (2019) evaluated the influence of altered hydrological patterns on large-scale lake phytoplankton concentrations using satellite data and found a 30% decline in Lake Turkana Chl-a during the dam filling period due to the absence of the floods in August/September. It was also predicted that future abstractions for irrigation activities would cause substantial declines in mean annual Chl-a, ranging from 19–44% depending on the magnitude of abstraction, further affecting fisheries (*Ibid*). Other scenarios also suggest that loss of flood pulse could lead to over a two-thirds reduction in fisheries yields, at any lake level, while extreme reductions in absolute lake level (i.e. 25 m) will lead to a total collapse of the lake fishery (Gownaris et al., 2016). Kolding (1995) demonstrated that change in Lake Turkana water level is a more important driver than internal factors and fishing, of fish abundance and fisheries yield. In light of this, the hydrological and ecological changes of the Omo-Turkana system could significantly affect the livelihood of the surrounding community who depend on the riverine and lacustrine fisheries for their livelihood. The FGD assessment during the present study further identified that incidences of drought also caused a shortage of grazing land and subsequent loss of livestock prompting a shift in livelihood to fishing despite the potential and actual impacts of the hydrological changes affecting the riverine and the lacustrine fisheries. On the other hand, road infrastructure has recently been improved facilitating livestock marketing, as it does the fishery marketing.

Based on an in-depth discussion with FGD participants, constraints identified from the fisheries value chain analysis (Fig. 3) are a poor capacity of the Wereda Livestock & Fisheries and Cooperatives Offices to effectively support the fishers and document the amount of catch, a limited number of NGOs for material and technical support, un-

hygienic fish processing, lack of adequate preservation facilities, and conflicts between Ethiopian and Kenyan fishers, and illegal traders from northern Kenya. The constraint that has the greatest impact on the value chain is the illegal fish trading as the practice has led to the use of destructive nets with small mesh sizes affecting the sustainability of the fisheries resource. The Wereda Offices mandated to support the fishers are limited in terms of the number of staff and facilities. When this study was conducted, the above mentioned Wereda Offices had only three personnel who were in charge, and they had no computer and related facilities to document fishing and other relevant data. Besides the support provided to the fishers' cooperative under formation at Yerile landing site, computer and printer support was provided to the two Offices with the assistance obtained from The Christensen Fund.

Maximum sustainable fisheries yield (MSY) was estimated at 30,000 tons per year during the 1972–1975 survey, using a measurement of opercular bones, length measurements of salted-dried fish and estimates from experimental gillnets (Bayley, 1982) for the Kenyan side of Lake Turkana while a recent annual catch is only 8,000 tons (KMFRI, 2007). In contrast, both the MSY and the exact annual catch are not known for the Ethiopian side of the lake and Omo River. At present, higher amounts of production originate from Nile perch fisheries than from Nile tilapia and other small-sized fish groups. A sample of 66 fishers, surveyed by Wakjira (2016), produced an average of 8.3 tons of Nile perch fillets per year from the Ethiopian side of Lake Turkana and Omo River while an average of 6.52 tons of Nile tilapia and other small-sized fish was produced by the same fishers during the same year. The fishers are estimated to have consumed 21.24 % of their total productions, mainly Nile tilapia and other smaller fishes, while they sold the rest of their productions for income (estimated at a total gross value of \$10,377 per year). Analysis by fishing locality shows that fish productions in the Lower Omo River are largely utilized for household consumption (>75 %) while only very few (<25 %) are sold to restaurants in Omorate Town for additional income (Wakjira, 2016). In contrast, fish productions along the shores of Lake Turkana are largely for commercial purposes, merchandised by both individual and organized fish traders operating at the landing sites. During the present assessment, there are two individual traders based at Bub'u'a fishing site, one individual trader at Koriagn Lubur site and one Enterprise (locally known as, Omo Wenz Comprehensive Fish Traders) at Yerile site, consisting of five members in which one is female. Therefore, major market destinations for the filleted Nile perch from Lake Turkana include Ethiopian towns of Jinka (200 km), Arba Minch (320 km), and the capital Addis Ababa (830 km) via these licensed private fish traders. Fish Production and Marketing Enterprise (FPME), Ethio-Fishery Plc. and other private fish marketing companies that used to operate in these localities are no more active (SNV, 2005). According to a key informant from the Livestock and Fisheries Office, apart from Nile perch all other fishes produced from Lake Turkana including Nile tilapia, citharinids, distichodontids, and bagrids, are bought by illegal traders, gutted, sun-dried and transported to Kenya, Uganda and Democratic Republic

of Congo (DRC). The presence of Kenyan fishers and traders in the Ethiopian side of Lake Turkana is illegal as they are not legally registered and licensed to operate within the nation's jurisdiction. The illegal traders buy fishes from the local fishers largely through bartering systems in which they provide the fishers with salt, sugar, necklace, and other ornaments in an exchange for fish. Moreover, the local fishers do not gain any benefit from the fish processing activity as it is solely accomplished by the illegal traders themselves. According to the key informant from Revenue Office, the prime focus of Ethiopian fish traders is on Nile perch and that has caused Nile tilapia and other important fishes to be illegally traded to other countries and eventually cause loss of revenue. That is to say, the Ethiopian fish traders who seem to have been interested only in filleted fish marketing have opened a loophole for illegal trading. There is no fixed tariff for tax collection from the fish sale. Nile perch is taxed per kg of fish fillet while Nile tilapia and other fishes are taxed per fish regardless of size. The Wereda Revenue Office is not fully capacitated in logistics, budget and human resources for proper follow up of the revenue collection process. This, therefore, has resulted in a loss of revenue particularly from illegal fish trading. There are also possibilities that some legal traders in Ethiopia could evade taxation.

5.3. Conflicts and Fisheries Management

Conflict in the region has existed over a long period and relates to cattle rustling, grazing land, and water (Yongo et al., 2010). There is also an emergence of competition over the productive fishing ground in Omo Delta and theft of fishing gears & boats by the fishers of both sides in recent days. Omo River Delta reportedly is a fertile fishing ground supporting a high amount of fisheries potential. There have been repeated incidences of fisheries resource use conflicts between fishers of the two countries. A recent and catastrophic incidence of conflict occurred in 2014/15 when the Ethiopian fishers in the Omo River Delta were attacked and their boats and gears were confiscated by the Kenyan fishers who came there in search of fertile fishing ground. There are also occasions when the Ethiopian fishers cross the border following a receding lake during the low lake levels due to the common understanding that the northern part of the lake is in Ethiopia, and also due to lack of clear boundary marks (SNV, 2005).

As per the information from key informants during our field visit, an Ad-hoc Committee comprising of Ethiopian and Kenyan officials from the bordering Daasanach and Turkana districts, representatives of NGOs such as Catholic Church operating in the border areas, representative of the Intergovernmental Authority on Development (IGAD) stationed at Omorate town (Ethiopian border town) and local elders has been formed to resolve any arising conflicts between the ethnic groups of the two countries. The conflict arising between the Kenyan Turkana and the Ethiopian Daasanach communities in the vicinity of Lake Turkana and Omo River Delta is just part of wider conflicts arising along the 861 km long border shared between the two countries. Therefore, achieving sustainable peace, and thus improved livelihoods, for the fishers operating at Omo

River Delta and Lake Turkana could be better dealt with by a country level arrangement. The Ethio-Kenya Joint Border Commission is one of the oldest border commissions in the Horn of Africa region dealing with border issues. As can be learned from [Fana Broadcasting Corporation \(2019\)](#), the commission together with the local administrators held its 32nd regular meeting recently in Adama town, Ethiopia in February 2019, at which an agreement was reached to establish Joint Peace Committee. IGAD and international bodies such as the EU and UNDP have also participated at various times in supporting the establishment of cross-border initiatives between the two countries with the ultimate goal of bringing sustainable peace and thus improved livelihood for the border communities of both countries.

In Ethiopia, the national and regional fisheries proclamations, regulations, and guidelines are all in place. However, there is a lack of awareness about these laws and their implementation by all stakeholders in the Daasanach Wereda including law enforcement agencies such as Police, Court, Livestock and Fisheries Office, Wereda Administration, Fishers and Fish traders. Although there is a provision restricting fishing area and season in Article 4.6 of the Southern Nations, Nationalities and Peoples Regional State (SNNP) fisheries development, management, and control Regulation #62/1999, it has not been properly enforced. Moreover, Daasanach Wereda Livestock and Fisheries Office, which is at the front line for management of the fisheries lacks sufficient resources for follow up and monitoring activities. Consequently, there are widespread fisheries management problems including the use of illegal gears and operations of illegal or unlicensed fishers in the Ethiopian part of Lake Turkana. The use of small mesh size and monofilament gillnets has become widespread and remained a major problem. Illegal traders, from Kenya, provide these gears to the fishers who will eventually sell fish to the traders at low prices and through bartering. This lack of proper fisheries management in the Ethiopian side of the lake could adversely affect the whole of Lake Turkana stocks. Effective management measures of this fishing ground, and indeed the whole of Lake Turkana, require regional collaboration between Kenya and Ethiopia ([SNV, 2005](#)). A co-management arrangement between Ethiopia and Kenya would ensure proper regulation of the fishing and associated marketing activities for sustainable socioeconomic returns to the needy local communities depending on this shared lake. This study also identified that the co-management approach should involve the local community to ensure the sustainability of small-scale fisheries of Omo River Delta and Lake Turkana, in agreement with various studies related to sustainability of small-scale fisheries in developing countries ([Evans and Andrew, 2011](#); [Gutiérrez et al., 2011](#); [Kosamu, 2015](#)).

6. Conclusions and Recommendations

6.1. Conclusions

Fisheries in Omo River Delta and the Ethiopian side of Lake Turkana, with a considerable number of commercially important fish species, is certainly a key alternative livelihood for the Daasanach community around the river

and the lake, who have much less other livelihood options apart from pastoralism. These localities reportedly represent very fertile fishing grounds in terms of the quantity and type of fish species being exploited apparently due to the freshwater inflow from Omo River.

The development of fisheries in these localities, however, has not received much support from regional as well as international bodies in facilitating the fishers' cooperatives and capacitating institutional structures that would support and regulate the fishing process. Moreover, the effective development of fisheries in these localities is marred by a lack of security due to conflicts arising between the Ethiopian and Kenyan fishers in an apparent competition over a fertile fishing ground. A solution to the development of fisheries in these localities, therefore, requires an approach that integrates conflict resolution.

From the perspective of Ecohydrology, sustainable water resource management has four major goals namely enhancement of water resources, maintenance and restoration of biodiversity, provision of ecosystem services for society, and building resilience to climate change and anthropogenic impact ([Zalewski, 2013](#)). Therefore, the present study has covered the ecosystem services component that has related fisheries productivity to a river flow regulation.

6.2. Recommendations

In the interest of developing fisheries and ensuring the sustainability of fisheries resources for the improved livelihood of the local communities, we would like to recommend the following measures:

- The Ethiopian Government should commit itself particularly to strengthening institutions related to fisheries management. The regional Government should take a prime role of organizing and capacitating institutions, such as the Wereda Livestock and Fisheries Office, Cooperatives Office, and Revenue Office, to enable them fully discharge their duties of regulating and inspecting the fishing activities within its jurisdiction.
- As no training was provided to the fishers in the past, local and international NGOs should provide continued technical and material assistance as well as training on awareness creation to the fishers' cooperatives that have already been organized and being organized on the Ethiopian side of Lake Turkana and Omo River Delta.
- It is required to strengthen the joint ad-hoc committee for conflict resolution between the fishers of the two countries. More importantly, the Joint Border Commission, besides its wider mandate to deal with the entire border issues, should handle conflicts arising between Turkana and Daasanach fisher communities specifically through, (1) setting up community elders who can play decisive roles in leading their communities and settling disputes, (2) integrating the two communities via various development programs that would reduce competition and enhance cooperation among them, and (3) co-management arrangement by the two countries in order to regulate illegal fishing in the lake as well as Omo River Delta. Furthermore, any conflict resolution

effort should focus on softening a practice of killing a person from each other's tribe to be considered brave, a long-held harmful traditional belief that exacerbates the conflicts between the fishers of the two communities.

- Policymakers should find the necessary resources (material, financial, and expertise) to implement the results of this study and the above recommendations.
- Conduct stock assessment and further in-depth studies on social and economic aspects of Lake Turkana via collaborative approach involving professionals from various institutions of the two countries (e.g. Kenya Marine and Fisheries Research Institute, National Museums of Kenya, Addis Ababa University, Jimma University, Ethiopian Institute of Agriculture Research) in order to determine the magnitude of the problem. However, this can be materialized only if the conflicts between the inter-competing fishing communities of the two counties are first resolved.
- Besides the recent studies that attempted to assess post-dam impacts of hydrological changes, the impacts on fish migration between Lake Turkana and Omo River, for breeding and feeding, as well as the environmental base flow of Omo River for maintaining fish migration should be studied.

Declaration of Competing Interest

We declare that this manuscript is original, and has not been published before nor is currently considered for publication elsewhere. We know of no conflicts of interest associated with this publication, and there has been no significant financial support for this work that could have influenced its outcome. As a Corresponding Author, I confirm that the manuscript has been read and approved for submission by all the named authors.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:[10.1016/j.ecohyd.2020.05.008](https://doi.org/10.1016/j.ecohyd.2020.05.008).

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