Effect Price on Expansion of Rice Production and Traditional Wetland Management in Fogera Wetlands, South Gondar, Northwest Ethiopia

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Abstract

Background

This study aims to investigate the impact of rice price on expansion of rice production and traditional wetland management in Fogera Wetlands, on the eastern shore of Lake Tana, northern Ethiopia. Although rice is becoming a major cash crop in the area, it has not been given due attention for sustainability of wetland which has been traditionally integrated with different indigenous agricultural activities such as, livestock rearing, cultivation different crops. The major instruments implemented in data collection were questionnaire, key informant interviews and Focus Group Discussions (FGD) of sampled farmers as well as GIS and Remote Sensing. Survey questionnaire was administered to 385 rice-producing sampled farmers.

Results

The result shows that 87% of the respondents confirm that increases in prices of rice encouraged them to shift from cultivation of conventional crops to rice farming. Subsequently, between the years 1973 and 2014, wetland areas has been reduced from 3114ha to 1060ha. Major activities being pursued in the wetlands of the study site do not consider their environmental impacts. Natural resource management and conservation policies and strategies implemented in the area didn't consider local people and their knowledge. It needs consideration to create sense of ownership of wetland resources to reduce abusive utilization of the wetland resources.

Conclusion

Therefore, the of policies, strategies and development activities implementation have to consider environmental issues togerther with rice production.

1. Introduction

Many developing countries rely on rice as a staple food, and it is estimated that the demand will increase by up to 70% over the next three decades (Katambara *et al.,* 2013). In Ethiopia, cultivation of rice was first started at the Fogera and Gambella plains in the early 1970s (Tareke 2003). The introduction of rice production leads to changes in production and the livelihood strategies. This affects human-environment interactions (IPMS 2005). Although rice has just been lately introduced to Ethiopia, knowing its significance as a food security crop and a means of income and employment opportunities, the Ethiopian government has named it the “millennium crop,” (Mohapatra 2012). Accordingly, rice production is an important means of livelihoods for farmers and ensuring food-insecurity in Fogera area (Taddess *et al.,* 2013).

Fogera *Woreda* (district) is one of the main producers of rice in Ethiopia, which contributes 58% of the rice production in Amhara region and 28% of the rice production in Ethiopia (Takele 2010). In the Woreda, rice is one of the main food crops produced by the majority of farmers (Gebremedhin and Hoekstra 2007). Rice is also considered as a major income-generating crop. It has not been given attention for sustainability of wetland areas and the integration of different previous indigenous activities such as livestock rearing, farming of different crops like teff (*Eragrostis tef*), maize *(Zea mays L.)*, noug (*Guizotia abyssinica*), finger millet (*Eleusine coracana*), chickpea *(Cicer arietinum)*, lentil *(Lens culinaris)* and grass pea *(Lathyrus sativus)*.

Similarly, agricultural growth in many parts of Africa is threatened by land degradation. Population growth increased cultivateble land, shortening fallow periods, and increasing stocking rates ahead of the carrying capacity of grazing lands. This leads to declining of yield crop and pastures (Kruseman 2000). For the centuries, farmers have been the main guardians of genetic diversity. The extinction of traditional farming systems, the aging and exodus of the rural population, globalization, and environmental degradation, have led to extinction of many cereal land races and much of this diversity has been eroded. As a result, during the previous century most of this unique cereal biodiversity is gone and the information regarding traditional plant use is very scarce (E. Lichtfouse *et al.,* 2011*)*

Due to the importance of wetland ecosystems to rural livelihoods, their sustainability needs to be ensured through understanding current utilization patterns. And local people have indigenous/traditional knowledge that helps in ensuring sustainable utilization of wetland resources. Ford and Martinez (2000, p 1249) conceptualised Traditional Ecological Knowledge (TEK) as “the knowledge held by local cultures about their immediate environments and the cultural management practices that build on that knowledge.” Berkes *et al*., (2000, p 1252) also defined TEK as a cultural transmission handed down throughout generations via adaptive methods of increasing knowledge, practice, and belief, about the association of living beings (including humans) with each other and their environment and an attribute of societies with historical continuity in resource use practice. Senos *et al*., (2006) called it a “holistic integrative approach that incorporates the metaphysical with the biophysical”. Traditional Ecological Knowledge is the cultural knowledge system that informs Traditional Resource Management (TRM) strategies. Traditional Resource Management includes species management, resource rotation, managing succession, intermediate disturbance and patch dynamics, and other ways to respond to and manage environmental uncertainty to optimize sustainable resource extraction. Many researchers also define TEK as a people-centered approach (MEA 2005); practice and innovations that are distinctively associated with many indigenous communities by customary laws (Pieroni *et al.,* 2011); the local TEK and TRM practices help better manage ecosystem services and understand socio-ecological and adaptive management systems (FAO 2014)

Studies done recently mainly focus on rice productivity and surrounding watershed issues. They emphasized on ways to increase rice yield and market profitability. For example, Taddess *et al.,*(2013) focused on the results of integrating manure and artificial fertilizers on rice growth and production. Takele (2010) examined rice profitability and the marketing chain in the Woreda.

Gebrekidan and Seyoum (2006) studied yield response of rice to different input regims and attempted to establish the optimum nitrogen and phosphorous fertilizer levels required for improved yield of rice in flooded fields. Patterns, causes, and consequences of land use/cover dynamics in the Gumara watershed of the Lake Tana Basin was conducted by Anteneh *et al.,*(2016). Amsalu and Addisu (2014) assessed grazing land and livestock feed balance in Gummara-Rib watershed. generally, the fore noted studies focused on production and marketing aspects, rather than aspects of the degradation or preservation of traditional knowledge and practices within the local environment of the study wetland. All the above mentioned studies didn't pay attention about sustainability of the wetland environemt

With this, the objectives of this study are to: 1.) identify trends in rice prices in the Fogera wetlands and to evaluate the effects of prices on rice production; 2.) how these prices of rice have impacted TRM in the Fogera Wetlands, and 3.) how the local people try to preserve and promote traditional wetland management practices and knowledge.

2. Methods

Study Area Description

Fogera Woreda is situated between 11º46' and 11º59'N and 37º 33' and 37º 52'W (figure 1) and the altitude of the Woreda ranges from 1,774 to 2,410 masl. The mean annual rainfall is approximately 1,216 mm, and the season June to September contributes 60% to 80% of the annual rainfall.

The Fogera floodplain is found within the eastern shores of the biosphere reserves (BR) of Lake Tana, a Lake which was registered as a world heritage site by the United Nation Education, Scientific and Cultural Organization (UNESCO) on 7 July 2015. Fogera Woreda is a surplus rice producing area and has strong potential for rice production. The area gets much of the flood water that accumulates around Lake Tana and the two big rivers (Rib and Gummara). The rivers bring eroded soil from their upstearm areas and deposit on the lowland plain. The soil seems relatively deep and fertile. In the study area, rice is planted at lower slopes where the water table moves to the surface for substantial period during rainy season. Rice is irrigated with water, which is diverted from the streams in the upper part of a drainage system. However, in Fogera and the nearby Woredas, the water supply to rice plant is principally provided by rainfall, run-off water, and ground water. Bunds (constructed from local soil as a barrier) are usually used for rain-fed rice production. The bunds serve to retain flood water, and rain water, which fall during the growing season (IPMS 2005; Akalu 2007).

Sampling Procedure

Lake Tana Region has 10 *Woredas* and 137 *kebeles* (the smallest administrative units in Ethiopia). Based on the preliminary assessment during a field visit and (agiricultural and environmental protection) expert interviews of the BR sites, it was found that the wetlands are highly vulnerable to environmental trade-off (encroachment of wetland resources) due to the different development activities like rice intensification, fishing, sand extraction, and illegal recession farming. Fogera is the largest of the wetlands that surround Lake Tana. The wetland is highly utilized for intensification of rice production and grazing lands.

For this study, five *kebeles* were selected (table 1). Initially, the *kebeles* that are included in the BR were identified as rice producing wetland. The sample sizes were determined using Kothari (2004) approach $n = \frac{N}{1+N(e)^2}$ -- EQ1 (Appendix 1 A) and sampled households were selected proportionally from each *kebele* (table 1 and figure 2) Using systematic random sampling approach. The list of household farmers was obtained from the kebele governmental offices.

Data type

Data was collected on market systems concerning supply and demand of rice, price of rice and of other crops, marketing flow directions, number of traders, number of brokers, price of traditionally-produced produces from wetlands, household perception on effects of rice market on wetlands, losses and gains of wetland resources, wetland management practices due to market forces, and household perception on preserving traditional practices. Landsat images were also used as data sources.

Data collection

The data were collected from households sampled farmers using structured questionnaire, semi structured interview, and discussion with focus group discussions (FGD based on intiative points One focus group discussion was established for each sampled kebele with7–9 participants. Participants for the discussion were selected based on their representativeness for their kebele. Interviewed farmers were also selected basedon their living experience and job in the wetland areas and expertise working on this field. Three households farmers were interviewed in each kebele. The information to select these three interviewed farmers provided by developing agent working with them The number of households responded for the questionnaire in each kebele were a proportion of the total number of households (table 1).Households were selected within each kebele using asystematic random sampling approach described by Kothari (2004). Household contact information was provided by the kebele offices.

The data were collected using five enumerators together with the researcher himself especially focus group discussions, interviews were facilitated by the researcher himself, and the household survey were collected by the three enumerators for each kebeles under the supervision of the researcher. The hydrological data were collected (Daily precipitation of the Amed Ber, Woereta, Addis Zemen and Yifage stations was obtained from the North West Region Bahir Dar Meteorological Agency (EMA). The dataset was not up to date and complete for all stations. Therefore, remote sensing precipitation data of the “Climate Hazards Group InfraRed Precipitation with Station Data” (CHIRPS) with 0.05 arc degree resolution were downloaded for the period from 1 January 1981 to 30 September 2019 from Google Earth Engine; cloud computing platform (Funk *et al.,* 2015). CHIRPS was chosen because it has daily data for a long record with the best resolution and performance for a long record with the best resolution and performance for this location (Funk *et al.,* 2015). The hydrology was characterized for the entire floodplain using the Rib River at the lower gaging station coordinate 1200 N and 37.716 E.which is used for generating flow data of floodplain using SWAT 2012 model. The Rib River flow data for the station were obtained from the Ministy of Water, Irrigation and Electric (MoWIE) from 1985 to 2014. Moreover, supporting data were also collected from Fogera woreda. agricultural offices and literature. LandsatThematic Mapper (TM) and multispectral scanner (MSS) imagery for the period 1973 and 2014 were down loaded from https://www.usgs.gov.

Data analysis

Data collected using questionnaires were summarized in percentages using SPSS version 21 and the qualitative data through narrative analysis. The hydrology of the wetland was analysed. The flow and rainfall of the wetland area were correlated using SPSS version 21. Flow Analysis Using Indicators of Hydrologivgical Alteration (IHA) Software, River flow statistics and indices were analyzed using IHA software version 7.1 (User’s Manual 2009). The software is developed by the Nature conservacy, Virginia, VA, USA. Setting up and completing an analysis in the IHA involved the use of hydrologic data as input, deciding analysis years and water year starting Julian date (User’s Manual 2009). Hydrological data from 1981 to 2018 were imported in CSV file format and saved as internal hydrologic file. A project was then created, linked to a single hydrologic data file and used to create and run multiple analysis. The study site (floodplain) flow data were not normally distributed (Figure 3) and hence, the non-parametric analysis like medians and coefficient of dispersion were used. The water year was set to start on January 1 and Water to end on December 31, which is suitable for floodplain flow condition. Lastly, all analyzed data that were triangulated with the MAB plan that deals with preserving and promoting traditional wetland managent practices vis-à-vis the prices of rice in Fogera Wetlands. In addition, image processing for land use analysis was done using ArcGIS10.3. Change matrixes were developed to interpret change in wetland at the years 1973 and 2014. Data from Woreda Agriculture Office were used to compare results from the land use analysis. The area covered by each land use land cover (LULC) class was calculated and subsequently the changes were compared for the periods 1973 and 2014.

Land Use Land Cover (LULC) classification schemes used in this study include the following variables, adapted from (Thompson1996):

Forest Areas: Areas dominated by trees having a height of 6 meter and above, which have a crown cover overlap of 15% and more.

Agricultural lands: these are land covers used to cultivate perennial or annual crops.

Water body: areas covered with ponds and small lakes.

Grass lands: Areas with permanent grass cover located on plain and water-logged areas.

Wetlands: "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static, or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters"

3. Results

3.1.1. Market information about price of rice

According to the respondents’ explanation, they do not spend money to get market information about the price of rice, other crops, fish, etc. Getting information does not necessarily require spending money in the study area, farmers said that they heard about the price of rice seeds by going to the market place only. All of the sampled households responded that farmers were not spending money in looking for market information to sale their crops. There is no system of informing the farmers about the price of their crops. Respondents explained that there were no crops left out of production because of lack of information about the introduction and high productivity of rice as well as its fetching higher prices than other crops except teff (*Eragrostis tef*). Because of the better market price of rice next to teff, farmers' production system was changing and rice became a dominant crop in the study site, while some crops such as green pepper (*Capsicum spp.*), maize *(Zea mays L.)*, noug (*Guizotia abyssinica*) and finger millet (Eleusine coracana) were almost out of production, except on small pocket areas of the study site.

3.1.2. Farmers' market participation

As the results of data presented in table 2 show, 87% of the farmers participated in the rice markets, where they sold portions of their rice produces; whereas 13% of the respondents said they used the rice for household consumption. The price of rice (11–13 Ethiopian Birr per kilogram) was very promising as explained by the sample respondents in winter season of 2015.

Respondents indicated that their market destinations are from their Woreda. Among the farmers that sold their rice, 33.2%, of the respondents sold their rice produces to any buyer in the market, 2.9%, to brokers, 11.4% to retailers and 39.5% to wholesellers. This means that farmers were not motivated to sell their rice produces to any single entity or group.

The distance of market from the farmers' village to the Woreda market center varies from 30 minutes to three hours walking distance.

The data presented in table 4 shows that farmers use three types of transportation: 80% of the farmers used pack animals to transport their rice produce to the market, 10.6% used vehicles, and 9.4% used human power. The vast majority, i.e. 89.4%, of the respondents didn't use vehicles for transportation because there is no road, 10.6% of respondents used vehicles during dry weather.

Sampled farmers were motivated to produce more rice than other crops (table 5). The main factors motivating farmers to produce more rice were high market price (63% of the respondents), high consumer demand (according to 20.5% of the respondents), and high demand for rice seed (15.9% of the respondents). Therefore, all market forces were driving factors for the farmers to produce more rice than other crops. Even though 13% of the farmers did not participate in selling rice, they knew the market prices that were motivating the farmers to produce more rice.

Regarding the supply of rice grain, 94.5% of the sampled households responded that there was not enough rice in the market; whereas, 5.5% said there was enough rice yield (table 6). Almost all the respondents responded that there was less supply of rice in the market, a situation which encouraged them to expand rice farming and production.

Getting informed on the market demand for their crop was very necessary for farmers to produce more rice. As the data in table 7 show, farmers have awareness about the market demand for rice crop. According to 96.4% of the respondents, there was high demand for rice in the market center of the Woreda; 3.6% said there was enough supply of rice in the market center of the Woreda. Almost all the respondents indicated that there was less supply of rice in the market and that had encouraged them to expand and intensify rice farming practices rather than use of previous practices.

The farmers generally suggested a more balanced rice marketing system where production of rice throughout wetland kebeles encourages all farmers to participate in rice production, access rice thrashing machines at village level, access improved variety of rice, improved road, and a good linkage in the input-output systems.

3.1.3. The impacts of rice of price on traditional wetland management practices

The influence of prices of rice on traditional wetland management practices

First, by traditional practices we refer to small scale agricultural activities like maize (*Zea mays L.)* and green pepper (*Capsicum spp.*) production using livestock manure, and production of noug (*Guizotia abyssinica*) (pulse crop) in the floodplains. Practes of fishes in the wetlands (floodplain) that is when water levels increase, wetlands (floodplain) are filled with water and fish available. After the water receds, the fish trapped in the wetlands used to be grown for human consumption. Wetland communities use pastures in recently flooded areas for cattle grazing. Forest and bush lands were common in floodplains and were used as a source of fuelwood. According to Nature And Biodiversity Conservation Union (NABU) office expert and FGD participants, the elderly people had indigenous knowledge of using wetland resources such as papyrus, reeds, brooms and *Butia capitata* for different purposes.

The study participants were asked also about the influence of rice market on traditional wetland management practices. The data presented in table 8 shows that 61.6% of the respondents said the increase in the prices of rice grain led to departures from traditional wetland management practices; 25.7% said the prices of rice almost eliminated the traditional wetland management practices in the study site; whereas 4.2%, of the respondents said that trends in the price of rice encouraged farmers to preserve their traditional wetland management practices; 4.9% said it helped promote traditional wetland management practices; but, for 3.6% of the respondents, rice price trends had no effect on traditional wetland management practices. About 12.7% of the respondents, were not sure of what counts as traditional knowledge/practice in the study areas; because, they said, some practices had already been lost over time (in the appendix I box 1).

Farmers’ understanding of traditionally-produced goods from wetland resources

As table 9 illustrates, 74% of the respondents explained there were no goods produced traditionally from wetland resources during this study, whereas 26% of the respondents said there were traditionally-produced goods from wetland resources and the surrounding Lake Tana areas beofore the introduction of rice.

The types of traditionally-produced goods from wetland resources

As summarized in the appendix box 1, there were very different resources used for the society in the study site. Currently, according to sampled household respondents, only fishing acticities are practiced a little as compared to the previous long years ago. Preparing local boats for fishers from papyrus has also continued but most of the papyrus has been lost because of the expansion of rice farming. Fishers have found those papyrus resources from elsewhere in the pocket areas of Lake Tana, particularly in the islands. The other resources mentioned in the appendix Box 1 have been lost few years ago because of expansion of rice farming in the wetland areas of the study kebeles. To reverse this, ’Man and Biosphere (MAB)’ plan encourages local people in preserving and promoting traditional agricultural practices and related traditional knowledge vis-à-vis the exiting rice prices for sustaining the wetland resources of study site.

Local people in the study site were interviewed regarding the absence or presence of the wetland functions and services.

According to the farmers explanation, the functions and service of wetland resources mentioned in the box 2 were available in the past but they have been reduced through time, because rice expansion occured at the expense of wetlands. Respondents also mentioned that the reduction and loss of these wetland resources are not only depriving the community from it but also contributing to the loss of their traditional practice in the past.

Regarding hydrologic function, they said that the water comes from the uplands and the whole study site gets covered by flood water during summer season. See the figure 9 in the appendix that indicate the upper stream of the two big rivers of at the two border of the study site. Therefore, during the summer season the floodplains are covered with flood water which was very important for the farmers to produce more rice in the summer season. They also indicated the level of water in the floodplain (wetlands) has dropped compared to the past. So, the hydrologic functions of study wetlands varied seasonally (figure 4). The trends of water flow and rainfall in the study wetland is increasing (figure 5). The frequency of extreme low flow, small flood and large flood has showen a decreasing trend (figure 6). The variability of rainfall and flow is also increasing. Flow and the rainfall in the stydy area indicate a significant correlation (table 10). The ideas of the farmers has also substantiated by the following seasonal flow duration curve, low flow and high flow graphs (table 3)

Farmers’ perception of the effects of rice market on wetland resources

About 57.9% of the respondents said they strongly agree that increasing market price of rice has negative effects on traditional wetland resources management; 34.6% of the respondents agree but 7.5% were undecided (table 11). However, 7.5% abstained and 92.5% of the respondents said the rice price has an effect on the resources of the wetlands in the study site.

3.1.4. Farmers’ participation in biodiversity conservation

Farmers' willingness to support the efforts of Nature and Biodiversity Conservation Union

It was found that 57.1% of the respondents demonstrated a willingness to support the effort of the NABU to implement the biosphere reserve principles in their kebeles (table 12). About 13% of the respondents indicated they were not willing to support the efforts of the NABU office, whereas 29.4% of the respondents did n't know anything about the program. About 70.1% of the respondents get information about the efforts of NABU. The none willingness of some of the respondents may be due to fear of legal framework that would not give the chance to encroach illegally the wetlands and communal grazing landusers to expand rice farming. During promotion of any development activities, participation of local farmers and stackholders is essential. Because, awareness creation creates a sense of ownership among the local community and thereby helps to sustain the development project in their local environment.

3.1.5. Wetland reduction detection

As illustrated in figure 7, wetland areas were greatly reduced in favor of rice farms between 1973 and 2014. This because the price of rice encouraged the farmers to incorporate wetlands in to their farmland to produce more rice. Therefore, there is not only intensification of rice but also extensification of the rice crop in the study wetland areas.

As shown in figures 7A and 7B, area of wetlands has declined in most categories except for agricultural land. This is because of the price of rice pushed the farmers to incorporat wetland and grazing lands through time in to their farmland. Quantitative comparisons for changes in land use are shown in (figure 8). Specifically, grazing lands were reduced from 8550 ha or 50% of land area, to 3501 ha or 20% of land area; wetlands from 3114 ha or 18% of land area to 1060 ha or 6% of land area; and forestlands from 1542 ha or 9% of land area to 907 ha or 5% of land area. Based on the map, cultivated land area increased from 3441 ha or 20% of land area, to 11550 ha or 67% of land area, and water surface area from 502 ha or 3% of the study area, to 907 ha or 5% of the area.

Previous to the massive introduction of rice production, the shoreline of Lake Tana was covered by papyrus and long grass has been cleared out and exposed to sunlight and visible for the remote sensing. In the previous time, the border of Lake Tana and wetlands were covered by the vegetation such as reeds, Butia Capitata (palm tree) long grasses, papyrus but today, the vegetation has been removed around the shorelineof the Lake and the wetlands because of recession farming and for the dry season small scale irrigation (figure 9) due to population dynamics.

According to interviewed and FGD participants', some traditional farming systems/practices are near extinction. For instance, farmers tried to practice different traditional farming activities like manuring of their farmyard using their livestock waste matter by leaving them in coral or byre for night time. manure was cultivated and mixed with soil. increasing the fertility of the soil. So, that this practice is extinct. The local people practiced also fishing in the wetlands but currently fishing is rarely practiced in the wetlands. They also practiced flooding pastures in the style of transhumance, where most of the local people used practiced a pastoralist community style which they were then flooded pastures for cattle grazing specially in the dry season.

4. Discussion

4.1. Market information about price of rice

All of the sampled households responded that farmers were not spending money in looking for market information to sale their crops. Based on the result, farmers participate in the market to sale their produce. They shift from different production practices in the wetland to rice crop production system because of better price of the crop. This idea is supported by (laura 2009) saying that subsistences farmers placed more weight on the taste and while commercial oriented farmers were more influenced by the market price of the crop. IPMS (2005) also mentioned that the rice production area had increased and farmers in seasonally flooded areas wanted to increase their rice acreage and production due to the price of rice was tripled, which further stimulated the interest in rice production. Considering traditional knowledge or practices is paramount for sustainability of local wetland resources of the environment. Indigenous people frequently have tremendous knowledge about the natural resources they use and over time, gained knowledge through experiments and experiences over generations, becoming a valuable and unique resource. Where indigenous peoples have depended on local environments for long periods of time, they are often aware that biological diversity is a crucial factor in generating the ecological services and natural resources upon which they depend (Gadgil *et al.,* 1993; Poole 1993).

4.2. Farmers' market participation

As the results of data presented in table 2 show, 87% of the farmers participated in the rice markets, where they sold portions of their rice produces; whereas 13% of the respondents said they used the rice for household consumption. The price of rice (11–13 Ethiopian Birr per kilogram) was very promising as explained by the sample respondents in winter season of 2015. This idea is supported that farmers' motivation to produce more rice was because of better price, yield, and demand of rice crop. Yalfal *et al.,*(2014) also mentioned that increased demand for rice in the local market was creating an environment for farmers and investors to produce more rice. As indicated in the results of the study, the price of rice leads to expansed into the wetland areas. Takele (2010) also explaind that the production trends of rice was increased from year to year.

According to choice of market destination, farmers in the study area preferred to different traders such as: any customer,brokers, retailers and whole sellers as mentioned in (table 4) above. This showed that farmers have right to choose their market outlet. This was also supported by (Zuniga-Aria and Ruben 2007). The choice for a marketing outlet is the farmers' decision on where to or not to sell their products and the price they receive from their sales. Here, it is clear that if the price of one agricultural product is good, changes in crop products and practes could affect the previous traditional practices of the farmer in the study areas. Considering NRM is important because it can keep environment. Participants of the FGDs, DAs and interviewed farmers indicate the indigenous activities have been lost except fishing by some fishers because of rice expansion and its intensification (Appendix 1 figure 11).

4.3. The impacts of rice of price on traditional wetland management practices

The influence of prices of rice on traditional wetland management practices

First, by traditional practices we refer to small scale agricultural activities like maize (*Zea mays L.)* and green pepper (*Capsicum spp.*) production using livestock manure, and production of noug (*Guizotia abyssinica*) (pulse crop) in the floodplains. Practes of fishes in the wetlands (floodplain) that is when water levels increase, wetlands (floodplain) are filled with water and fish available. After the water receds, the fish trapped in the wetlands used to be grown for human consumption. Wetland communities use pastures in recently flooded areas for cattle grazing. Forest and bush lands were common in floodplains and were used as a source of fuelwood. According to Nature And Biodiversity Conservation Union (NABU) office expert and FGD participants, the elderly people had indigenous knowledge of using wetland resources such as papyrus, reeds, brooms and *Butia capitata* for different purposes.

The above idea is also substantiated by Alemu *et al.,* (2018) in that the introduction of a cultivated rice variety shifted the dominant land use activity from cattle grazing to rice cultivation As the rice cultivation expanded, the land used for grazing of the Fogera cattle and production of other crops began to shrink, resulting in significant changes in local farming systems. He also revealed that, others crops has been shown a significant decline in the production of niger seed, chickpea, wheat, and oats in the wetlands. Teff production also declined dramatically, but still exists in pocket areas, given the traditional attachment to the crop and the relatively high price it fetches in local markets (Alemu *et al.,* 2018). Therefore, there is a need to harmonize this trade-offs of the resources based on institutional coordination. Indigenous activities have also been supported by various MAB programs that have sought to study these indigenous knowledge systems. The value of this knowledge is recognized by the biosphere reserve program (UNESCO 1993; Martin and Semple 1994).

Regarding the effort of the NABU office, there was lack of awareness creation and showing a clear vision of the (BR) and the significance of benefits to the community. Utsala (2011) suggested sustainable wetland management has received most thought within the role of community participation and the value of wetlands can olny be sustained if managed and utilized with sound knowledge and cooperation between/among communities.

4.4. Local people in the study site were interviewed regarding the absence or presence of the wetland functions and services.

According to the farmers explanation, the functions and service of wetland resources mentioned in the box 2 were available in the past but they have been reduced through time, because rice expansion occured at the expense of wetlands. Respondents also mentioned that the reduction and loss of these wetland resources are not only depriving the community from it but also contributing to the loss of their traditional practice in the past.

The interviewed and FGD participants report were summarized that there were reduction of water level in the wetland, fish, loss of papyrus and other different grass species, drying of wetland, hippopotamus in number, birds, etc in the wetlands. Generally, the fauna, flora and hydrology of the study site have been affected because of rice farming. As a result of the rice expansion in to the wetlands, the new lands were created at the land/swamp interface resulting into a massive devastation of wetland ecosystem. Several studies have also reported a progressive shift of farming system enterprises from terrestrial to wetland-based production by households in close vicinity to wetlands (Kairu, 2001; Kipkemboi, 2006). Apart from changes in land use practices, other anthropogenic activities which increased in intensity include overgrazing by livestock and over-harvesting of macrophytes that play a synergistic role in setting inertia of degradation likely to interfere with the hydrological cycle and macroclimate regulation in the area. Over-exploitation and destruction of wetland vegetation also restrict the filter function of wetlands as pollutants and nutrients are carried directly into the lake when the vegetation of wetland macrophytes is destroyed (Odada et al., 2004; Raburu and Okeyo-Owuor, 2005). Increasing turbidity resulting from distruction of ecotone or buffer zone area brings about shalowing of euphotic zone in the littorial areas lakes and implies sharp decline in water quality. This directly posed negative impacts on attraction of the local torism-based economy Ayalew 2010.

Conclusion

The wetlands in Fogera comprise various natural resources, which make a significant contribution to income, food, and employment of local community. Most of the community depends on arable land for agriculture especially for rice production and very small-scale fisheries in the wetlands were source of food security and employment to the rural communities living in the area.

Farmers are trying to maximize production in wetlands because of the high demand for and limited supply of rice in the market. So, agriculture is the economic anchor that is traditionally shaping the landscape. To preserve it, environmentally friendly, non-intensive production practices and marketing of regional products should be further encouraged. The farming style is not in harmony with the local environment because of a current damage of the wetland resources. Local farmers in the study wetland have shifted from their previous traditional agricultural practices to rice production system because of the better price for rice. This current rice agricultural production system is not compatible with wetland resources or the preserve with TEK of wetland. To sustain the traditional knowledge/practice and wetland resources, biosphere reserve administration should be better integrated and promte the local tourist marketing system.

Designation of Lake Tana as a BR for the registration and implementation by UNESCO was very necessary. As mentioned in the above, the involvement of local people and their knowledge in the course of sustainable development should be acknowledged and broadly used. The traditional knowledge research community should undertake more studies at the national or regional level to develop a better TEK framework and policy. Therefore, policy-makers and stakeholders need to work together on wetland management and intensification of rice production should take into consideration.

Abbreviations

BR: Biosphere reserve; CSA: Central Statistics Agency; FAO: Food and Agricultural Organization of the United Nations; FGD: Focus Group Discussion; FWAO: Fogera Woreda Agriculture Office; GIS: Geographic information system; IPMS: Improving Productivity and Market Success; LULC: Land use/land cover; MAB: Man and Biosphere; MEA: Millennium Ecosystem Assessment; MoWEM: Ministry of Water, Energy, and Minerals; NABU: Nature And Biodiversity Conservation Union; NRM: Natural Resource Management; TEK: Traditional Ecological Knewoldge; UNCCD: United Nations Convention to Combat Desertification; UNESCO: United Nations Educational, Scientific, Cultural Organization

Declarations

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The data can be accessed from the corresponding author via the following address mare.addis@eiabc.edu.et or mareaddis2005@gmail.com. The data can be also accessed for research purposes.

Authors' contributions:

Mare Addis Desta is the corresponding author who designed the research, developed the data collection tools, collected the data, analyzed the data, and participated in writing the paper. Dr. Gete is my advisor for this paper. He is 2nd c-author that contributed for guiding and shaping the research. He has also high contribution for editing the paper. William A. Payne is a professor that he has contributed for this paper by giving a chance of visting scholar in USA. He gave me a comuter and office with its equipment to facilitate this research. He has also contributed for editing the paper. Mengistie is a PhD holder that contributed for this paper in editing the manuscript. Generally, all co-authors contributed in guiding the researcher and editing the paper. All authors read and approved the final manuscript.

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Tables

Table 1: Selected kebeles including the sample population from each selected kebele.

No.	Name of Kebele	Total Household*	Sample**
1	Nabega	2283	87
2	Shina	2136	81
3	Kidis Hana	1790	69
4	Shaga	1515	57
5	Wagetera	2398	91
Total		10,122	385

*CSA, 2007 (the total population was taken from CSA)

** sample for each kebele has been found based on calculation using the formula (Appedix 1 A)

Table 2: Farmers' participation in the rice market

Kibele	No of Respondents	Yes	%	No	%
kidest hana	69	68	98.5	1	1.5
Shina	81	73	90.1	8	9.9
Shaga	57	48	84.2	9	15.8
Wagetera	91	76	83.5	15	16.5
Nabega	87	70	80.5	17	19.5
Total	385	335	87	50	13

Table 3: To whom farmers sold their rice

Kebele	No of Respondents	No sale	%	Any customers	%	For brokers	%	Retailers	%	Whole sellers	%
Kidest hana	69	1	1.5	33	47.8	0	0	9	13	26	37.7
Shina	81	8	9.9	35	43.2	1	1.2	3	3.7	34	42
Shaga	57	9	15.8	14	24.6	2	3.5	9	15.8	23	40.3
Wagetera	91	15	16.5	22	24.2	5	5.5	14	15.4	35	38.4
Nabega	87	17	19.5	24	27.6	3	3.5	9	10.3	34	39.1
Total	385	50	13	128	33.2	11	2.9	44	11.4	152	39.5

Table 4: Means of transportation services farmers used to transport their rice produces to market places

Kebele	No of Respondents	No sale	%	Any customers	%	For brokers	%	Retailers	%	Whole sellers	%
Kidest hana	69	1	1.5	33	47.8	0	0	9	13	26	37.7
Shina	81	8	9.9	35	43.2	1	1.2	3	3.7	34	42
Shaga	57	9	15.8	14	24.6	2	3.5	9	15.8	23	40.3
Wagetera	91	15	16.5	22	24.2	5	5.5	14	15.4	35	38.4
Nabega	87	17	19.5	24	27.6	3	3.5	9	10.3	34	39.1
Total	385	50	13	128	33.2	11	2.9	44	11.4	152	39.5

Table 5: Motivating factors for farmers to produce rice

Kebele	No of Respondents	High consumer demand	High demand for rice seed	High market price of rice
Kidest hana	69	13(18.8%)	8(11.6%)	48(69.6%)
Shina	81	16(19.8%)	12(14.8%)	53(65.4%)
Shaga	57	11(19.3%)	6(10.5%)	40(70.2%)
Wagetera	91	21(23.1%)	19(20.9%)	51(56%)
Nabega	87	18(20.7%)	16(18.4%)	53(60.9%)
Total	385	79(20.5%)	61(15.9%)	245(63.6%)

Table 6. Farmers understanding of market supply of rice in the study kebeles

Kebele	No of respondents	enough supply of rice for market	
		Yes	No
Kidest hana	69	4(5.8%)	65(94.2%)
Shina	81	3(3.7%)	78(96.3%)
Shaga	57	5(8.8%)	52(91.2%)
Wagetera	91	5(5.5%)	86(94.5%)
Nabega	87	4(4.65)	83(95.4%)
Total	385	21(5.5%)	364(94.5%)

Table 7: Farmers' awareness of rice market demand in the study kebele

Kebele	No of Respondents	Awareness of market demand for rice	
		Yes	no
Kidest hana	69	69(100%)	0
Shina	81	78(96.3%)	3(3.7%)
Shaga	57	52(91.2%)	5(8.8%)
Wagetera	91	89(97.8%)	2(2.2%)
Nabega	87	83(95.4%)	4(4.6%)
Total	385	371(96.4%)	14(3.6%)

Table 8: The influence of rice market on traditional practice/knowledge

Kebele	Respondents(N)	Impacts of increase in rice grain prices				
		Encourages preserves traditional practices/ knowledge	Encourages promote traditional practices/ knowledge	Hinders traditional practices/ knowledge	Leads to abandonment of traditional practices/ Knowledge	No change
Kidest hana	69	4(5.8%)	1(1.4%)	61(88.4%)	3(4.3%)	0
Shina	81	4(4.9%)	5(6.2%)	49(60.5%)	20(24.7)	3(3.7%)
Shaga	57	3(5.3%)	4(7.0%)	32(56.1%)	13(22.8%)	5(8.8%)
Wagetera	91	2(2.2%)	4(4.4%)	50(54.9%)	31(34.1%)	4(4.4%)
Nabega	87	3(3.4%)	5(5.7%)	45(51.7%)	32(36.8%)	292.3%)
Total	385	16(4.2%)	19(4.9%)	237(61.6%)	99(25.7%)	14(3.6%)

Table 9: Traditionally-produced goods from wetland resources

Kebele	No. of respondents	Yes	No
Kidest hana	69	6(8.7%)	63(91.3%)
Shina	81	14(17.3%)	67(82.7%)
Shaga	57	10(17.5%)	47(82.5%)
Wagetera	91	32(35.25)	59(64.8%)
Nabega	87	38(43.75)	49(56.3%)
Total	385	100(26%)	285(74%)

Table 10 the correlation between monthly average flow and rainfall

Correlations			
		Monthly Average Flow	Monthly Average Rainfal
Monthly Average Flow	Pearson Correlation	1	.868**
	Sig. (2-tailed)		.000
	N	35	35
Monthly Average Rainfal	Pearson Correlation	.868**	1
	Sig. (2-tailed)	.000	
	N	35	35
**. Correlation is significant at the 0.01 level (2-tailed).			

Table11: Farmers' perception on effects of rice market on wetland resource

Kebele	Respondents	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Kidest hana	69	45(65.2%)	19(27.5%)	5(7.3%)	0	0
Shina	81	48(59.3%)	27(33.3%)	6(7.4%)	0	0
Shaga	57	31(54.4%)	23(40.4%)	3(5.2%)	0	0
Wagetera	91	50(54.9%)	33(36.3%)	8(8.8%)	0	0
Nabega	87	49(56.3%)	31(35.6%)	7(8.1%)	0	0
Total	385	223(57.9%)	133(34.6%)	29(7.5%)	0	0

Table 12 The interest of farmers about intervention of NABU office in wetlands

Kebele	Respondent	I need support	I don't need support	I don't know
Kidest hana	69	39(56.5%)	6(8.7%)	24(34.8%)
Shina	81	44(54.3%)	11(13.6%)	26(32.1%)
Shaga	57	30(52.6%)	7(12.3%)	20(35.1%)
Wagetera	91	54(59.3)	15(16.5%)	22(24.2%)
Nabega	87	53(60.9%)	13(14.9%)	21(24.1%)
Total	385	220(57.1%)	52(13.5%)	113(29.4%)

Figures

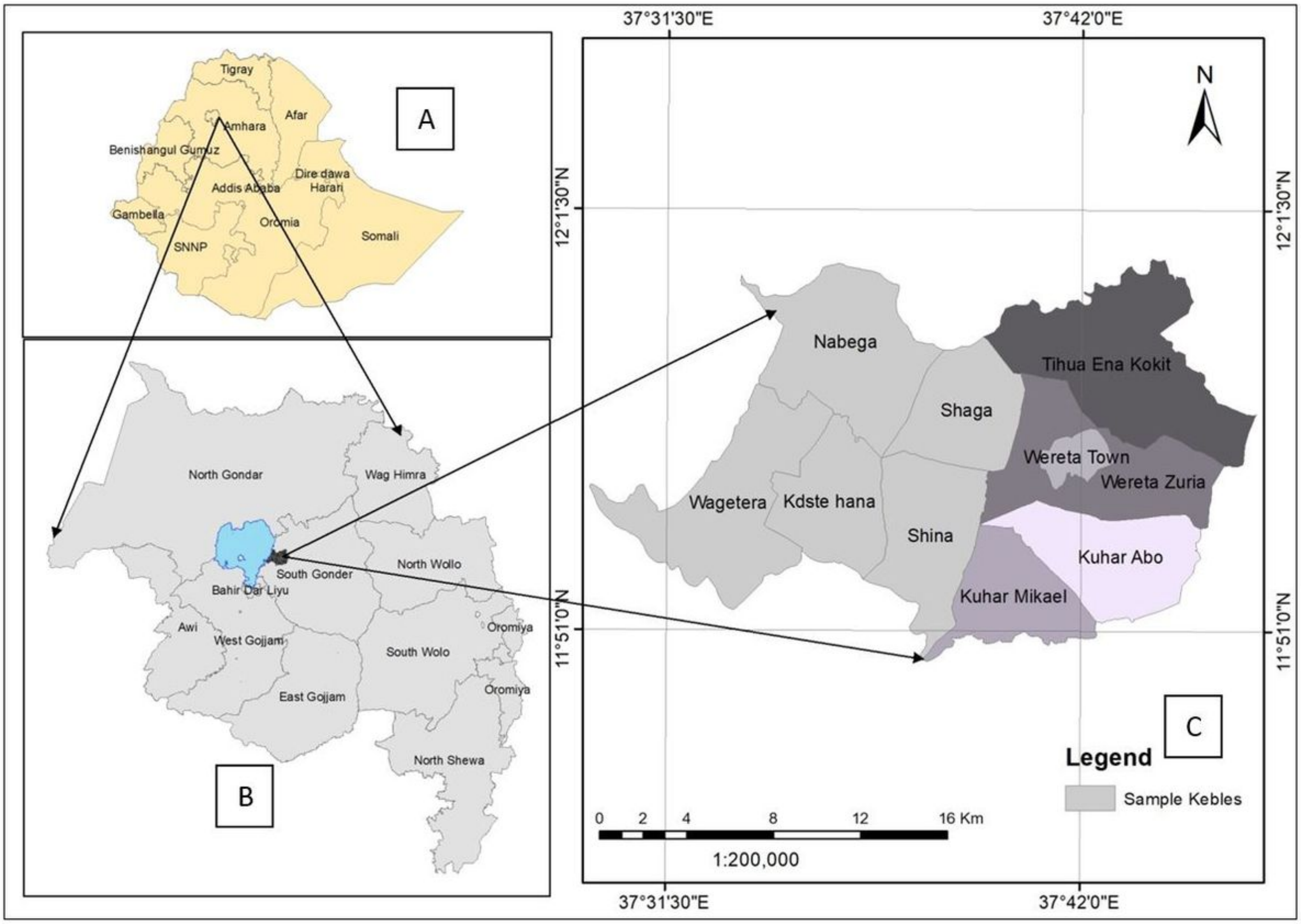

Figure 1

Map of Fogera Woreda, including its biosphere reserve The top figure (A) in the left shows the map of Ethiopia with regional boundaries and the bottom figure (B) in the left shows the Amhara region where the BR and Lake Tana are located. The figure (C) in right shows the districts of Fogera and study sample kebeles. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

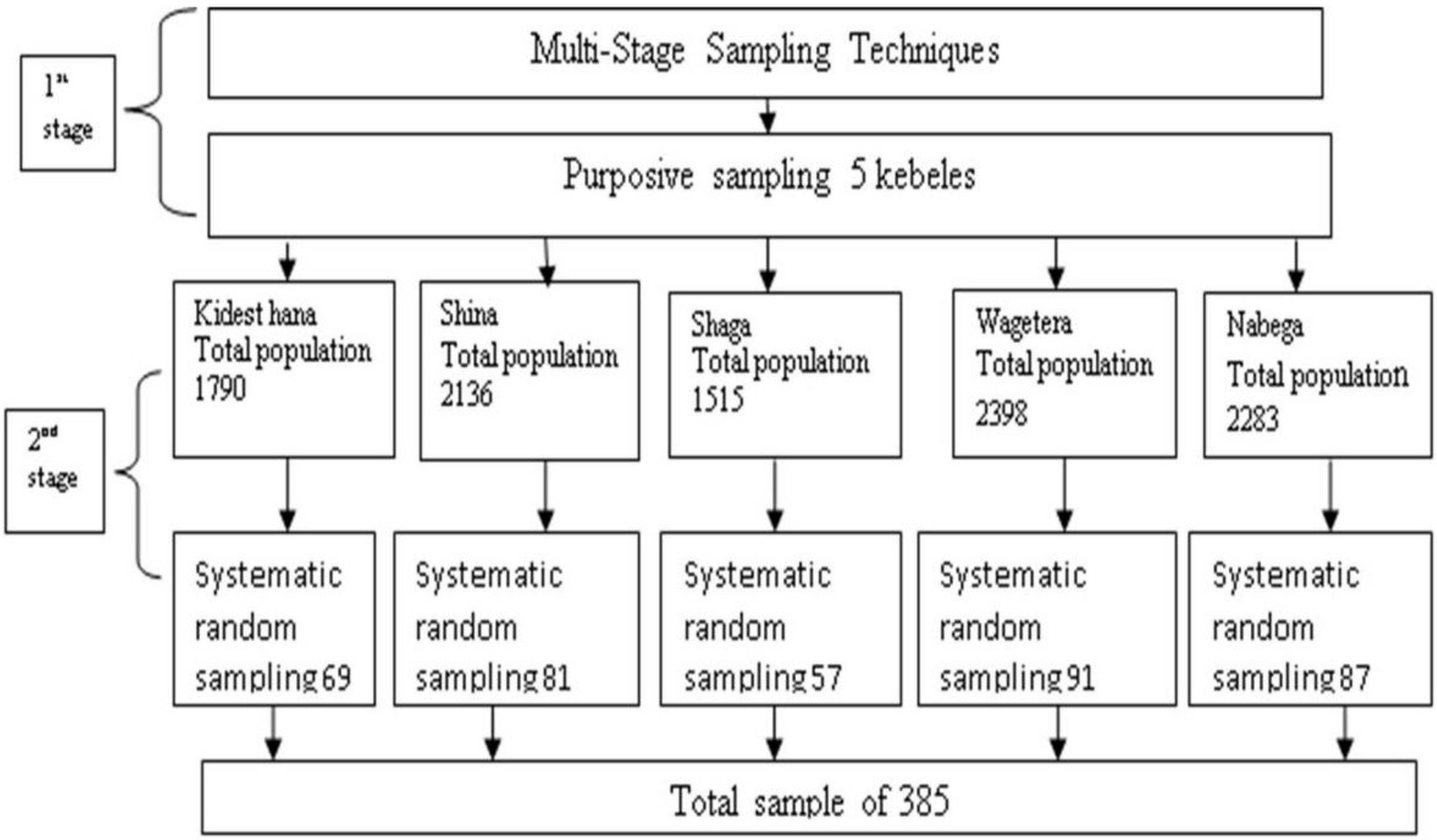

Figure 2

Schematic presentation of the sampling technique

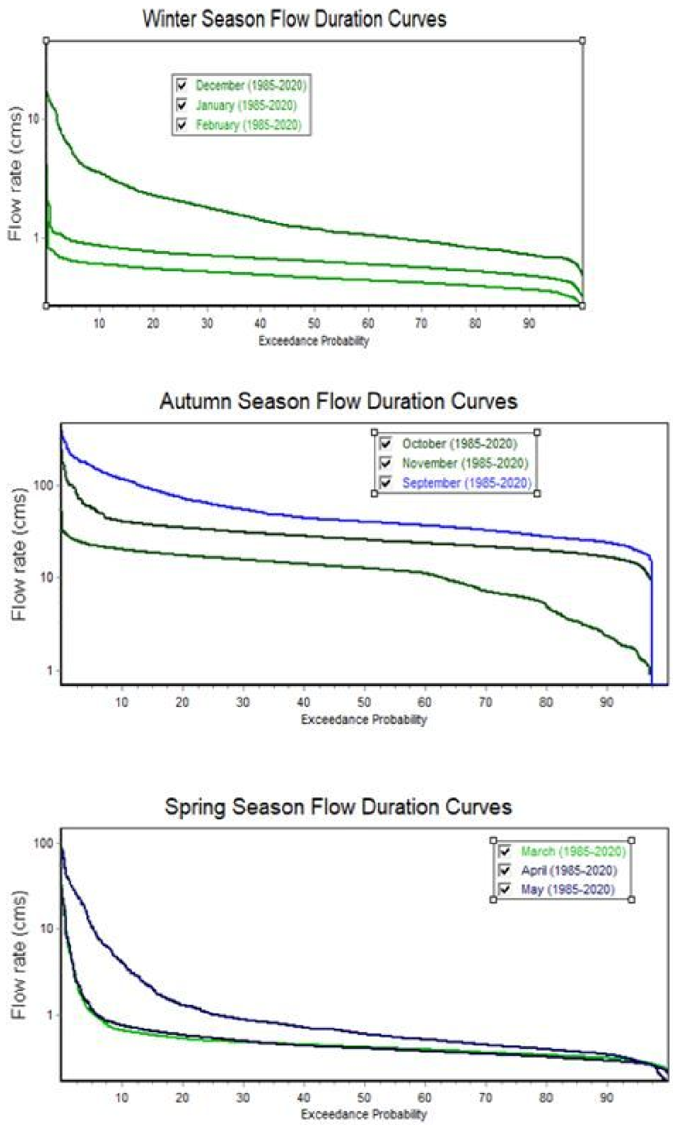

Figure 3

seasonal flow, low flow, high flow and annual flow duration curve graphs.

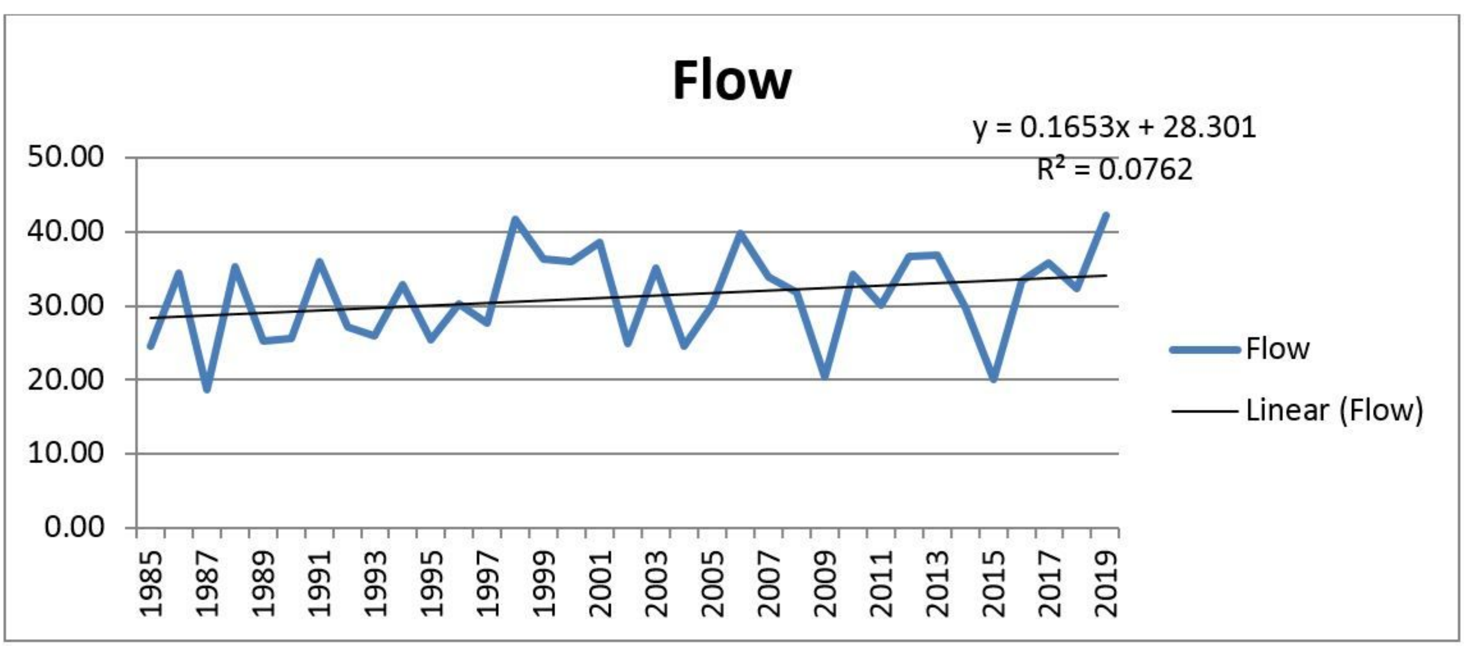

Figure 4

The water flow trend

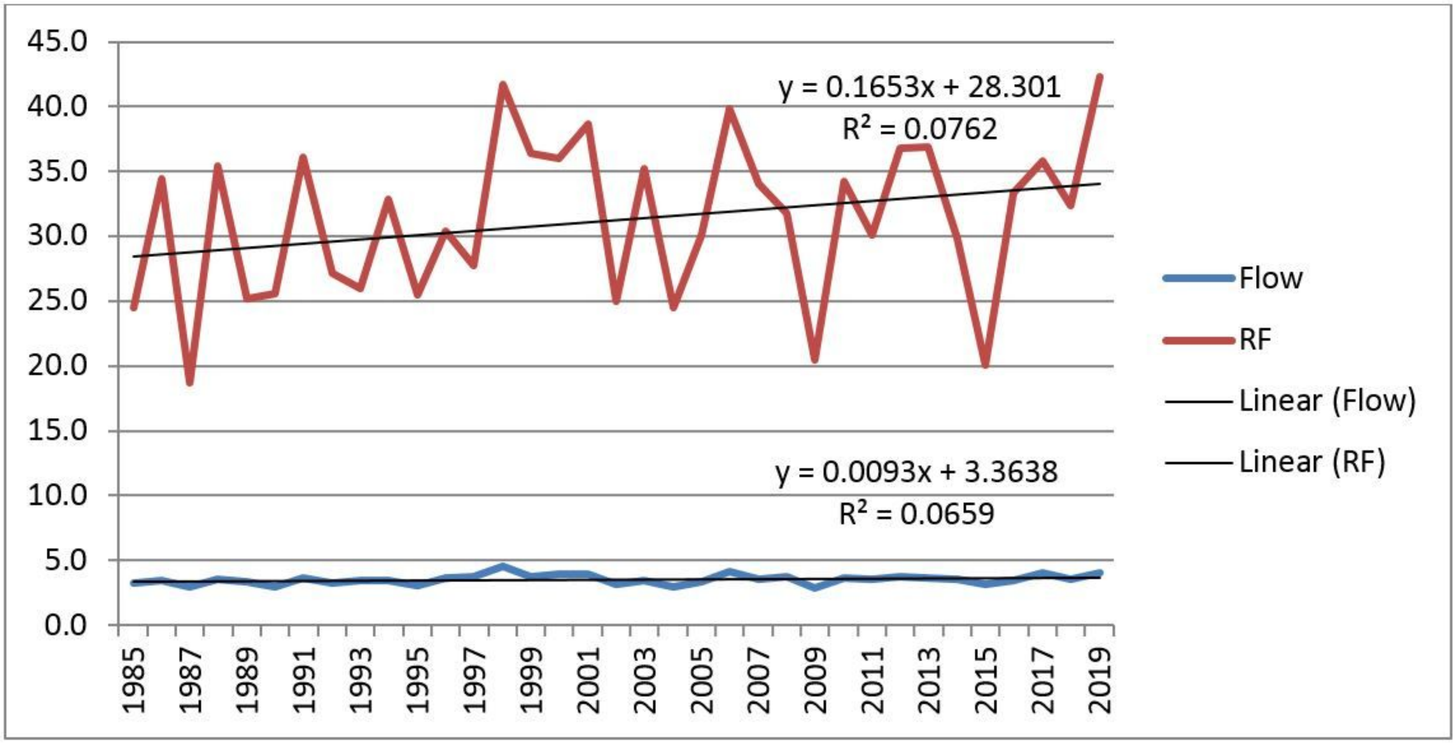

Figure 5

The flow and rainfall graphs indicating trend analysis

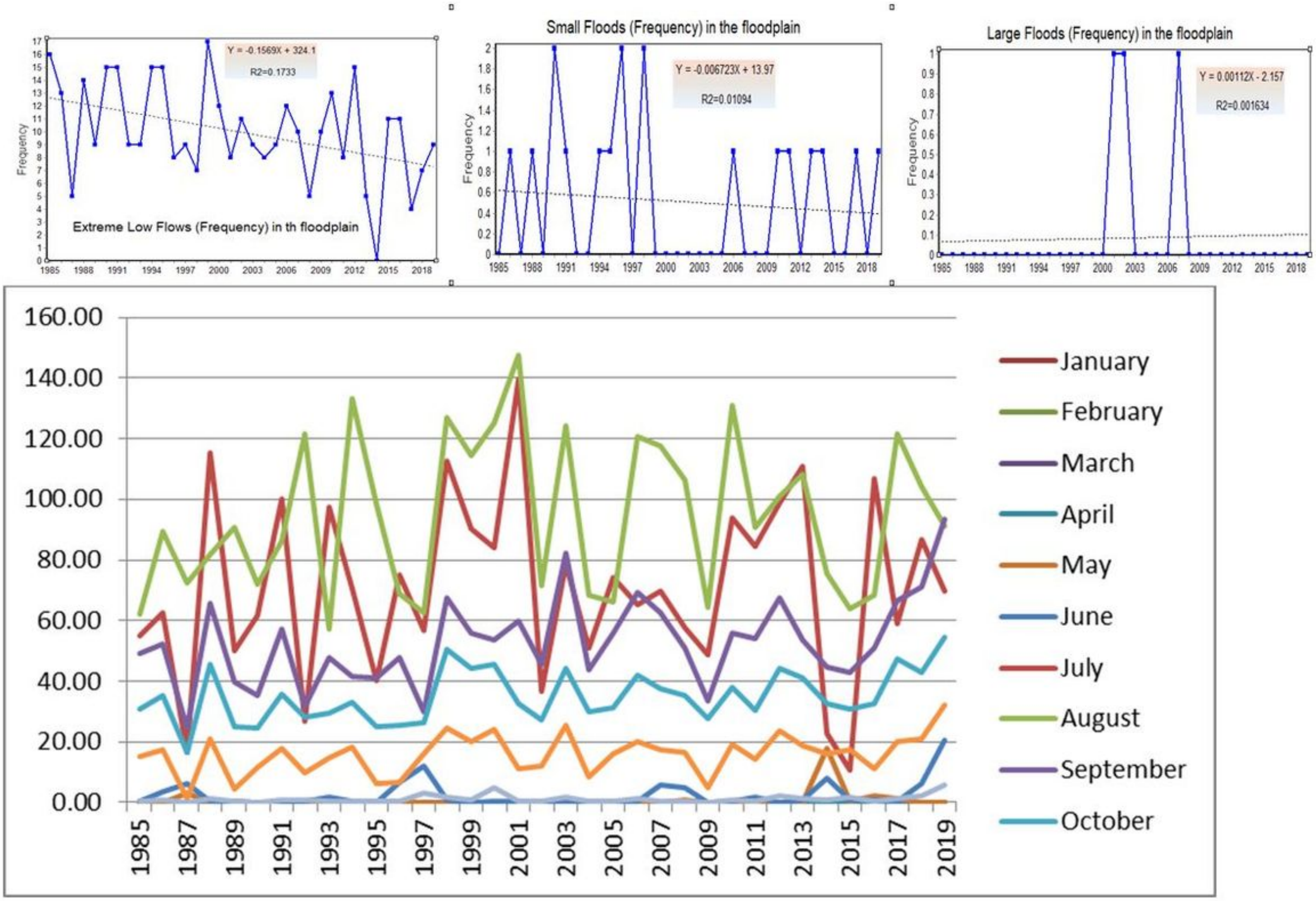

Figure 6

Extreme low flow, small flood, large flood frequency and monthly flow in floodplain

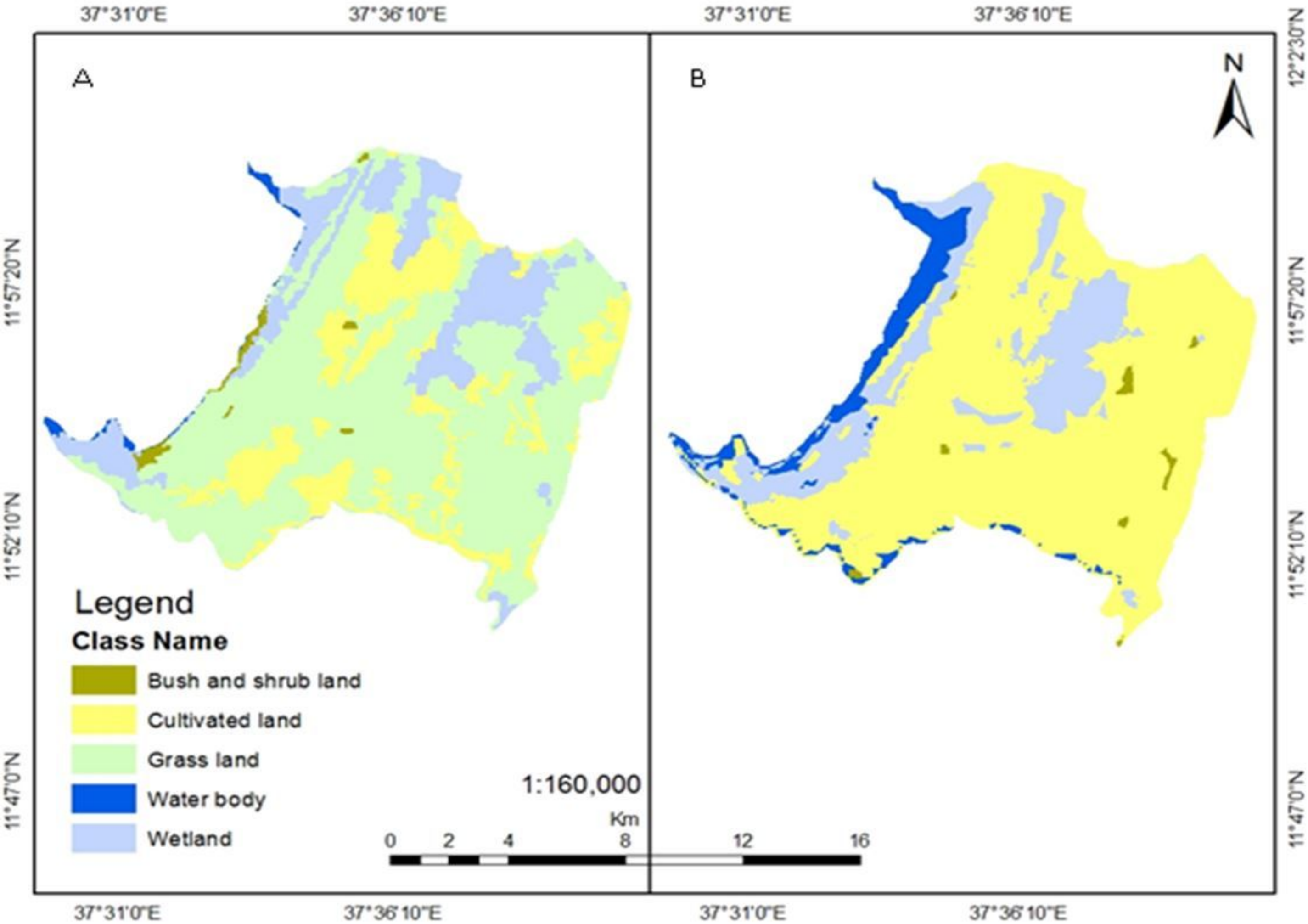

Figure 7

Land use land cover map of the study site. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

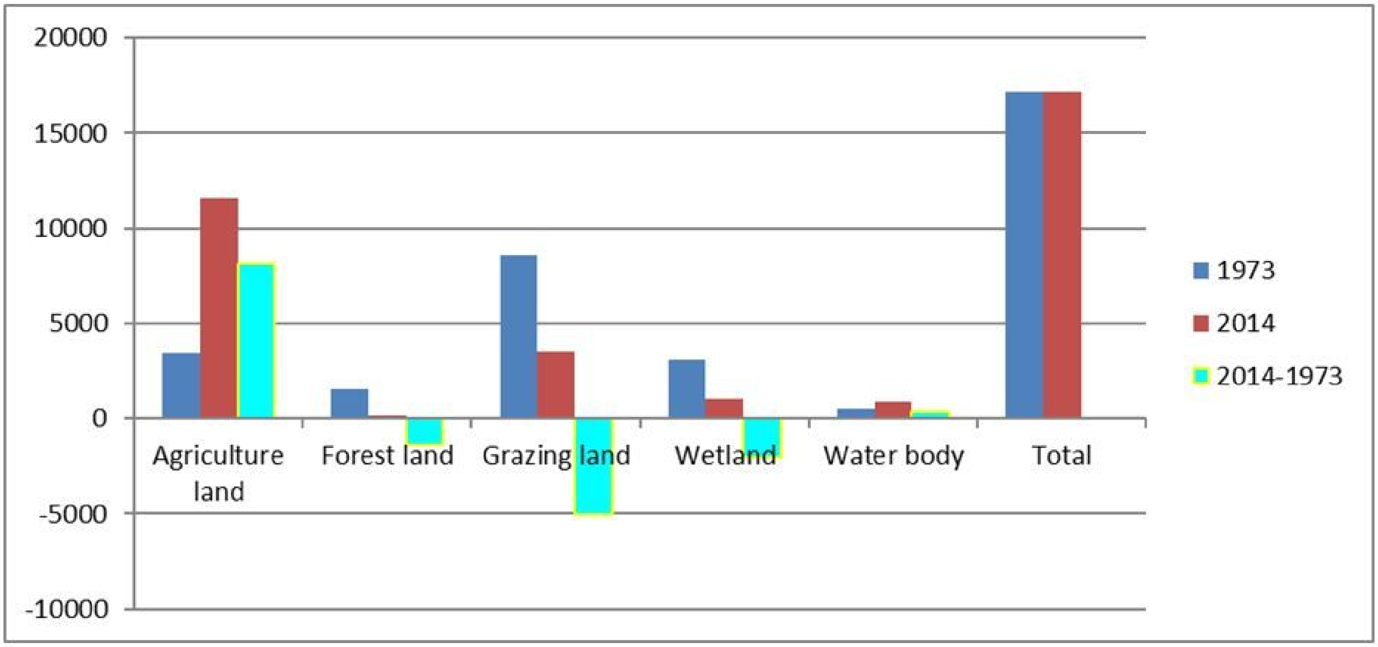

Figure 8

Land use land cover change of study site map in the year 1973 and 2014

Figure 9

A is Recession farming and B is small scale irrigation near Lake Tana and wetlands on the study site

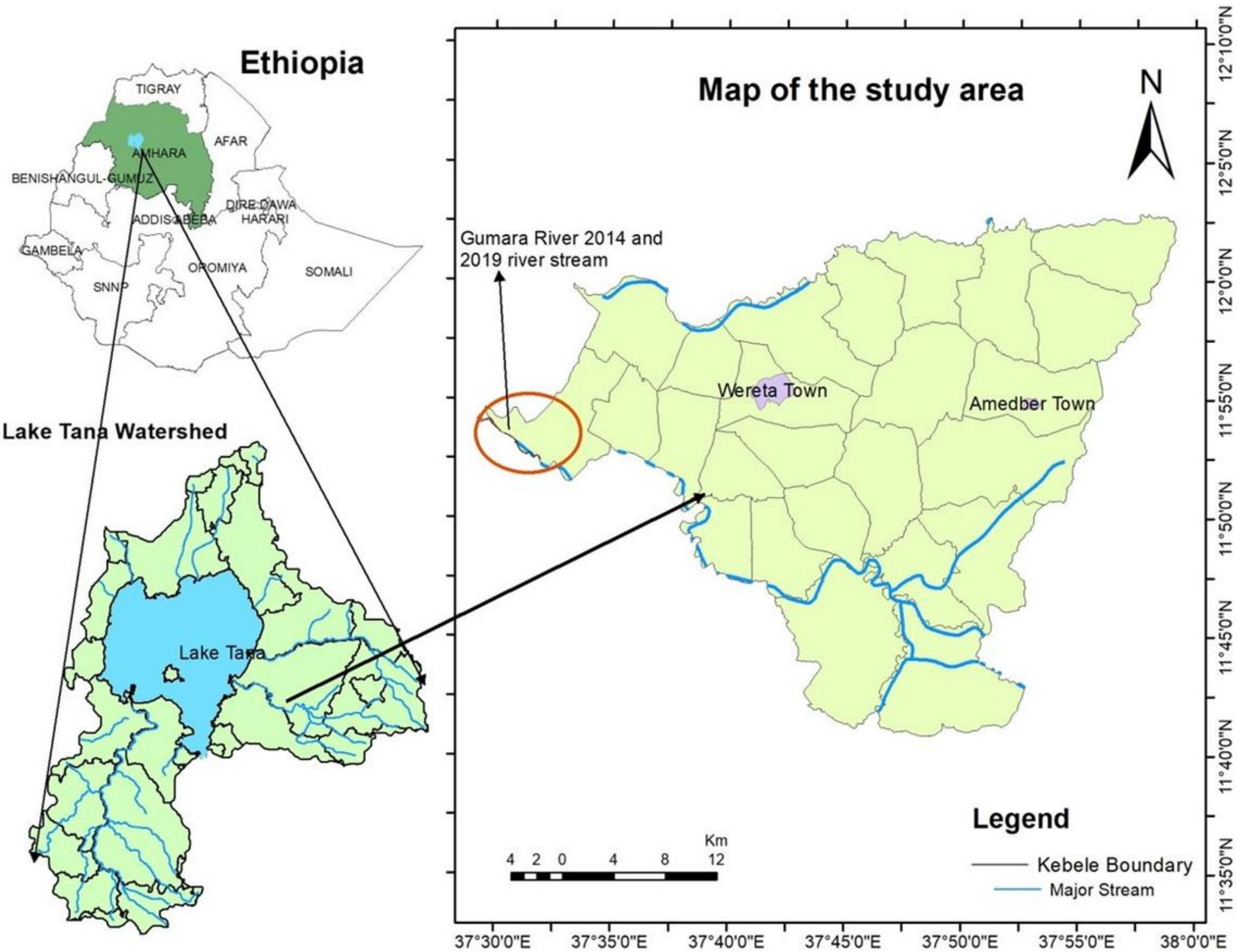

Figure 10

map of study area showing the two big Rivers (Rib and Gummara). Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

Figure 11

Small boat made from papyrus plants used for transportation for fishing and others.