Journal of Biodiversity, Bioprospecting and Development

Tewabe, J Biodivers Biopros Dev 2014, 1:3
DOI: 10.4172/2376-0214.1000131

Review Article Open Access

Impacts of Furrow Irrigation on Shesher and Welala Natural Reservoirs of Lake Tana Sub Basin, Ethiopia

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Received date: Sep 08, 2014, **Accepted date:** Oct 15, 2014, **Publication date:** Oct 20, 2014

Abstract

The survey was conducted from March 2012 to March 2013 based on field observations and samples. Shesher is natural reservoir of Lake Tana found at coordinates of 0350300 and 1322162 UTM and at altitudes 1805 a.s.l. Welala natural reservoir is found at UTM coordinates of 0348348 and 1326081 with altitude of 1804 a.s.l. The area of Shesher and Welala was estimated about 500 ha and 110 ha respectively, which are impounded by open water for extended period of a year and both with maximum depth of 3 m during rainy season. Both reservoirs filled their capacity during the rainy season through the inflow river of Ribb and the surrounding flood plain. But during pick dry season of March, 2012 and March 2013 the survey showed unexpected, amazing and sudden death of a home for many biodiversity that both Shesher and Welala natural reservoirs dried up totally. Birds fetch their food from remnants small shrink wet mud spot and it is not uncommon to see remnant dead fishes eaten by birds. This is due to several and unlimited human encroachments mainly for crop cultivation, without any rules and regulations. Major crops cultivated by drained two reservoirs using gravitational force were *Eragrastis teff*, Cheak pea, Grass pea, Lentils and Safflower. During dry season no one could be able found drinking water even for their animals and humans, inhabitants started digging well to fetch water from the middle of Shesher and Welala reservoirs. The drainage system was carried out at every 50 m intervals by making large furrows in both sides of two reservoirs until their water totally vanished. These reservoirs should be properly and sustainably exploited by designing appropriate interventions without land use change, for instance it could be serve for fisheries, ecotourism and livestock sectors.

Keywords: Eco-tourism, *Eragrastis teff*; Fisheries; Floodplain and Intervention

Introduction

Direct effects of climate change on wetlands are likely to be accentuating by human induced changes that will increase stress on wetland ecosystems. Up to 60% wetlands have been destroyed in the last 100 years due to drainage, conversion, infrastructure development and pollution. These changes could have been responsible for most of the loss in freshwater biological diversity in the United States in recent decades [1]. Water demand is projected to increase steadily during the coming decades. However, climate change is expected to lead to a decrease in water availability, especially in arid and semi-arid areas. To address this problem, many countries will need to continue efforts to increase reservoir storage capacity to meet the increasing demands for freshwater.

Nowadays in most parts of Ethiopia, watersheds are facing extreme degradation due to intensive cultivation, overgrazing, increased population, increased deforestation and other human actions [2]. In highlands of Ethiopia, there is a serious degradation of land which also affects the wetlands providing significant contribution to food production. This increased pressure upon the wetlands is leading to environmental degradation, and crop yields have declined by 50 to 65% in the past 20 years. Water bodies are vulnerable to climate change due to rainfall variability, inappropriate land and water use. Water management programs are not developed in most developing countries, where they are most needed. Furthermore, the cost for managing water supplies are increasing compared to limited financial resources [3].

Given the fragility of wetlands, its importance for water supply and the growing pressures to convert them to agriculture uses, there is an urgent need for sustainable use of wetlands. This requires management regimes, which help to maintain some of the natural characteristics of wetlands while also allowing partial conversion to allow activities, which can meet the economic needs of communities. A balance has to be made between the environmental functioning of the two wetlands and their use for livelihood purposes. The purpose of this survey is therefore, to evaluate the current encroachment status of Shesher and Welala natural reservoirs in Lake Tana sub basins.

Objective

To evaluate the current status of Shesher and Welala natural reservoirs with respect to anthropogenic activities and able to propose possible solutions

Materials and Methods

Study area

The study was conducted in the north eastern part of Lake Tana (source of the Blue Nile). The lake is the largest one (3150 km^2) in Ethiopia, comprising 50% of the total freshwater resources of the country. It is a shallow lake with a mean depth of 8 m and maximum depth of 14 m, situated 1800 m above sea level. Seven large, permanent rivers and about 40 small seasonal rivers feed the lake. The trophic

status of Lake Tana is oligotrophic to mesotrophic [4,5]. Shesher and Welala natural reservoirs are found just at the boundary of the lake in fogera floodplains of Fogera woreda of South Gondar zone (Figure 1). These are breeding sites mainly for *Clarias gariepinus* fish species but not endemic Labeobarbus species of Lake Tana [6]. Fishing activities during the breeding seasons (rainy seasons) and post rainy seasons are immense than ever, fishermen used spears and seining as fishing gear during these seasons respectively.

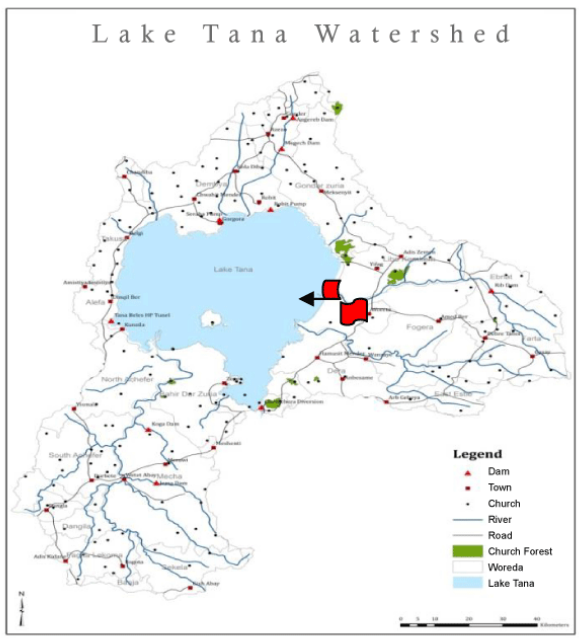

Figure 1: Map of study area red spots just at the boundry of eastern lake Tana are Shesher and Welala reservoirs with empty of water during dry seasons.

Two natural reservoirs were assessed from March 2012 to March 2013 based on field observations and samples. Interviews with the surrounding inhabitants and repeated personal observations were made and coordinates using GPS was taken both during pick rainy seasons and following the decreasing of water volume due to furrow irrigation during pick dry seasons. The possible flooded hectares of the two reservoirs were calculated. Field crops cultivated using water drained from reservoirs by gravitational forces was identified and evaluated. On top of these livestock production system versus crop production using furrow irrigation were monitored and evaluated.

Results and Discussion

Shesher natural reservoir

Shesher is natural reservoir of Lake Tana found at coordinates of 0350300 and 1322162 UTM and at altitudes 1805 a.s.l, which filled its capacity during the rainy season through the inflow river of Rib and the surrounding flood plain. This reservoir is estimated with an area of 500 hectares filled with water and free from vegetation cover due to its high relative depth that estimated of maximum depth 3m during the pick rainy season (Figure 2). According to [6], the surface area of Shesher shirked by 91% to 136 hectares from what it was 1557 hectares in 1987. The whole boundary of this reservoir was cultivated by the inhabitants with rice production at all water logged areas during the rainy seasons. Most of their livestock are transferred to the neighboring upland community settlements until the harsh flooding condition passed away. Few numbers of cattle mostly oxen and milked cows left to the surrounding fed by collecting weeds from their rice farm. Fishing was the most farming practice during the flooded periods, using predominantly of spears followed by beach seines during post rainy seasons. *Clarias gariepinus* is the most abundant fish species because its reproductive biology is favored by this natural reservoir of Shesher wetlands.

Figure 2: Shesher reservoir during rainy season, and joining Lake Tana from left to right (Photo: Dereje Tewabe, 2012).

During pick dry season of March, 2012 the survey showed unexpected, amazing and sudden death of a home for many biodiversity and life full of Shesher natural resource dried up totally and birds fetch their food from remnants small shrieked wet mud spot (Figure 3). This happened due to several and unlimited human encroachments for different activities mainly for crop cultivation, with out any rules and regulations. Major crops cultivated by drained Sheshers water using gravitational force were *Eragrastis teff*, Cheak pea, Lentils and Safflower (Figure 4). It seems the community lacks knowledge and awareness about Shesher reservoir wetland of sustainable use other than exploiting beyond its maximum limit. During the dry seasons the inhabitants could not be able found

drinking water even for their animals and themselves, they started digging well to fetch water from the Shesher reservoir.

Figure 3: Total dried up of Shesher reservoir with shrieked mud aggregated by birds at the center.

Figure 4: Major crops cultivated by draining water through furrow irrigation system from Shesher reservoir of Lake Tana wetland.

Un studied water use that is extensive use of irrigation to all directions of the reservoir causes shortage or even loss of whole available water which leads to wilt and dried of crop prior its ripening periods, there has been a lot of clues such as cracking of soil at early stage of *Eragrastis teff* and its color also indicates its future negative fate that might end up with non ripe seeds (Figure 5).

Figure 5: Lack of irrigable water that shows cracked soil and poor plant color of *Eragrastis teff* that might lead to wilt and death of a plant prior to ripe.

Such type of irrigation system in Shesher reservoir could not be recommended practice because it is not well studied and high pressure was imposed from four kebele inhabitants of its surrounding without calculating its carrying capacity, it drained until the water lost from the area by making furrows even followed its small shrinkage (Figure 6).

Water could not be found even for drinking of their animals and for themselves, as a result they started digging of the ground to fetch water for themselves and their animals (Figure 7).

Figure 6: Uncontrolled drainage of Shesher reservoir for irrigation purpose until it totally dried up from the area.

Figure 7: Digging ground water (Well) at the center of Shesher reservoir for their animals after complete dried up of the reservoir.

Figure 8: Furrows of Welala reservoir with 50 m intervals at both sides of farm lands to irrigate their crops.

Welala natural reservoir

Welala wetland is found at UTM coordinates of 0348348 and 1326081 with altitude of 1804 a.s.l. The surface area of Welala is estimated about 110 ha, which is impounded by open water for along period of a year with maximum depth of 3m during rainy season. According to [6] its surface area was 159 hectares shirked by 47% from

what it was 298 ha in 1987. Welala wetland was imposed by one kebele only, Nabega Giorgis that has bylaw, to be assigned only for communal grazing land in contrast to Shesher wetland. But human encroachment is defined here by draining water in both directions for crop cultivation on neighboring lands other than Welala territories. The drainage system carried out at every 50 m intervals by making large furrows in both sides of Welala (Figure 8), as a result the volume decreased very rapidly and becomes unable of supporting the biota of Welala ecosystems.

Especially fishes and birds are seriously affected during the pick dry seasons of the area and it is not uncommon to see remnant dead fishes eaten by birds (Figure 9). If Welala wetland could be protected from several imposed activities from the inhabitants it might be properly exploited by designing appropriate interventions for instance it can serve for fisheries and ecotourism activities (Figure 10).

Figure 9: Highly populated birds and reminant dead fishes eaten by birds in the highly shrinked and almost dried Welala wetlands.

Figure 10: Ecotourism and fisheries are assumed to be an apropriate intervention in Welala wetlands of lake Tana.

Livestock production system in Welala wetland became totally dependent on leftovers and residues of crop production because during the rainy season cattle left the area due to high volume of flooding problem and during the dry seasons the area was shifted to crop cultivated land.

The only area considered for communal grazing land by the community was the open water of Welala during its drainage period assuming the area becomes devoid of water. But there has not been observed any foraging types, it was free from vegetation cover and livestock of the surrounding waiting for watering systems from underground water and feeds from supplements probably of crop residues (Figure 11). The area is known for breeds of Fogera with their high performance traits.

According to the 100 interviewed respondents from Shesher and Welala surrounding villages, replied that 100% of them were engaged in fishing especially during pick and post rainy seasons of a year. About 95% from Shesher and 75% from Welala responded that they were using the wetlands for cattle grazing throughout the year in the previous years. According to the Intergovernmental Panel on Climate Change (IPCC).The new knowledge enables IPCC to improve their methodological guidance for monitoring greenhouse gas emissions from wetlands significantly. In the current IPCC guidelines (2006), considerable gaps exist with regard to emissions of wetlands, and particularly with respect to rewetting of drained peatlands. Peatlands drained for practices such as agriculture or forestry are significant sources of emissions, which can be reduced by rewetting (increasing the water table) [7].

Figure 11: A paradox, cattle production system awaiting for watering from the well and supplimented feed stuffs from crop residues.

According to [8] a total of 274 benthic macro-invertebrate individuals belonging to 5 families were collected, 32,699 individual birds belonging to 62 species were enumerated and 13 species of macrophytes were identified. Based on qualitative assessment of the Present Ecological state of these two reservoirs modifications have reached at critical level which means less than 20% from its reference (Table 1).

Category	Description	Score (%)
A	Unimpaired (Natural). High diversity of taxa with numerous sensitive taxa. No discernable change from reference/close to reference.	90–100
B	Slightly impaired. High diversity of taxa, but with fewer sensitive taxa. Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-90
C	Moderately impaired. Moderate diversity of taxa. Moderate modification from reference. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely impaired. Mostly tolerant taxa present. Large modification from reference, but general conditions still sustainable.	4-59
E	Severely impaired. Only tolerant taxa present. Severe modification from reference. The loss of natural habitat, biota and basic ecosystem functions is extensive. Unsustainable.	20-39
F	Critically impaired. Very few tolerant taxa present. Extreme modification from reference. Modifications have reached a critical level	<20

Table 1: A qualitative assessment of the Present Ecological state of these aquatic habitats were made, where the Present Ecological State refers to the extent to which conditions have deteriorated from natural (reference) state.

Conclusion

The two wetlands were shrinked and finally dried up at an alarming rate starting from November to the end of March, mainly because of unsustainable agricultural farming practices; farming practices by draining water through furrow irrigation system. Fishery recruitment of Lake Tana and other biodiversities like bird population have been adversely impacted by the present irrigation activity. Nowadays lack of communal grazing lands due to the dried up of these two wetlands through excessive furrow irrigation, Fogera cattle breeds are displaced by low performed upland breeds (personal communication and observation). In focus group discussions in both villages, all came to the consensus that all of them benefitted from the wetlands in fishing, cattle grazing and aesthetic values than converted to farm lands for crop production. During the last 20 years, Shesher Wetland shrinked from 1,557 hectares to 500 hectares and Welala shrinked from 298 hectares to 110 hectares. In the present study, during the dry seasons the two wetlands shrieked to 100% (totally dried up). From field observations it was clear that Shesher Wetland dries earlier in the dry season than Welala wetland.

During pick dry season of March 2012 and March 2013 the survey showed unexpected, amazing and sudden death of a home for many biodiversity wetlands, Shesher and Welala natural reservoirs dried up totally. Birds fetch their food from remnants small shrink wet mud spot and it is not uncommon to see remnant dead fishes eaten by birds. This is due to several and unlimited human encroachments mainly for crop cultivation by furrow irrigation system, without any rules and regulations made by respective actors.

Recommendations

- Environmental friendly developmental activities have to be in place, as a result appropriate and sustainable exploitation of Shesher and Welala reservoirs would be achieved and natural resources of Fogera flood plain sustained.
- An integrated landscape approach to these catchment and wetland rehabilitation is required in order to reverse the trend towards desertification of these wetlands and improve livelihoods and well-being of the community. We suggest that it may still be possible to avoid the most catastrophic impacts of encroachment and land use change.
- Particularly *Clarias gariepinus* fish stock of lake Tana would be seriously affected by recruitment overfishing, if these two wetlands could not be properly utilized and conserved with out land use change.
- It needs further multidisciplinary investigations and developed management plans

Acknowledgment

I am greatly obliged to the Ethiopian Institute of Agricultural Research (EIAR) and Amhara Regional Agricultural Research Institute (ARARI) for financing this research project. I would also like to thank some individuals for their special contribution; Endalamaw Asres and Ayenew Gedif (boat drivers), Biniam Hayilu research assistant.

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