

Threats of Nile Crocodile in Lake Chamo and the Risk Factors for Arba Minch Crocodile Ranch, Gamo Zone, Arba Minch, Ethiopia

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Abstract

This study was conducted in Arba Minch, Gamo Zone, South Ethiopia to assess threats of Nile crocodile in Lake Chamo and risk factors for Arba Minch crocodile ranch. Data collection was carried out from July 2021 to August 2022 using questionnaire surveys, interviews, focus group discussion and personal observation of the study area. The primary sources of data were collected from Gamo zone, Arba minch Zuria district of three Kebeles: namely, Genta kanchamo, Elgo and Wozeka which bordering lake Chamo. In addition experts from Arba Minch crocodile ranch and Nech Sar National Park were also part of interviewed to generate primary source of data. A secondary source of data includes published reports, websites, action plans, records, folders and brochures of the ranch were also used. The result revealed that deforestation, lake side farming, illegal fishing, huma-crocodile conflict, livestock grazing; nest site distraction, invasive weed, pollution and siltation were the major Nile crocodile threats in Lake Chamo. On the other hand nest site distraction, expansion of Lake Abaya, shortage of facilities for workers and lack of crocodile skin market were the main risk factors for Arba Minch crocodile ranch. Most of respondents agreed that the species of Nile crocodile in Lake Chamo were under great threats due to the above mentioned anthropogenic causes. Therefore, awareness creation programs should be organized in the community who bordering the lake. Moreover, the local government and the concerned stalk holders should be committed to delineate the buffer zone on the shore area of Lake Chamo. Effective management actions will help to reduce Nile crocodile threats and to sustain the existing resource. More research is needed on the population status and distribution patterns of Nile crocodile in the lake.

Keywords: Lake Chamo; Nile crocodile; Ranch; Threats

Introduction

The Nile crocodile (*Crocodylus niloticus*) is an apex predator and keystone species across Africa. It is widely spread in south of Sahara and the second largest extant reptile in the world, after the saltwater crocodile [1]. As a top predator, crocodiles are a valuable ecosystem component but also a source of management concern due their potential economic and social benefits to humans.

Nile crocodile in Ethiopia is the only crocodile species and distributed in lakes Abaya, Chamo, Beseka, Chew Bahir and different river basins of Ethiopia such as Abay, Baro-Akobo, Wabishebele, Awash and Omo-Gibe. Beginning in 1960s and 1970s crocodiles in Ethiopia were extensively hunted for their skins by French company. Fueled by European demand for crocodile skins, this well-organized commercial harvest devastates quickly crocodile population from their aquatic habitats of Ethiopia. Following this by 1971 the head of the wildlife conservation department had already considered the Nile crocodile to be seriously depleted. Subsequently, in 1972 commercial hunting of crocodiles was prohibited in Ethiopia and this was one of the driving forces for the establishment of crocodile ranch in the country.

A ranching program for Nile crocodiles (*Crocodylus niloticus*) was implemented in Ethiopia in 1984 with the government establishment of the Arba Minch Crocodile Ranch [2]. The purpose of Arba Minch Crocodile Ranch is conservation of Nile crocodile by crocodile egg collection and rearing the hatchlings up to three years of old for restocking of the depleted water bodies of Ethiopia. In addition the ranch has been doing crocodile egg collection and rearing the young for skins and meat to earn valuable foreign exchange. Currently, the ranch is also a major tourist attraction area playing a role in tourism industry.

The survival of Nile crocodiles in both protected areas and communal areas has been associated with an increasingly uncertainty

due to a combination of natural and anthropogenic threats [3]. Especially, Nile crocodile is exploited for their valuable skin, which supports an international trade worth. They are also heavily affected by habitat loss and the pollution of aquatic habitats. Loss of any species of Crocodylian would represent a significant loss of biodiversity, economic potential and ecosystem stability.

Currently, Nile crocodile and its habitat (Lake Chamo) are vulnerable to many factors such as deforestation of trees in the lake watershed, lakeside farming, nest site distraction and illegal fishing which affect Nile crocodile resources directly or indirectly. On the other hand, the Arba Minch crocodile ranch is facing challenges like shortage of crocodile seed to stock in the ranch. Collection of important data on Nile crocodile threats and searching a solution for the conservation and sustainable utilization of the Lake Chamo crocodile resource is urgent issue. All these issues have led to the formulation of the objective of this study.

Research Methodology

Description of the study area

Lake Chamo: Lake Chamo is the third largest lake in surface area

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from lakes in Ethiopia with 551 km² and the second in Ethiopian Rift valley lakes (Figure 1). It has the maximum depth of 16m, located at 5°42' to 5°58' N latitude and 37°27' to 37°38' E longitude and lies at an altitude of 1,108 masl [4]. The Lake is located at about 455 km to south of Addis Ababa, 10 km south of Arba Minch, Zonal administrative town of Gamo. Amaro, Gamo and Gujie zones are bordering the lake South, West and East of the lake, respectively. The lake is fed by one main river: Kulfo, and less important rivers, such as Segeo, Sile, Wozeka and the forty springs of Arba Minch.

The lake ecosystem has varied phytoplankton, zooplankton, fish species, reptiles, amphibians, birds, and mammals. According to Golubtsov and Habteselassie [5], Lake Chamo is known for its diversified ichthyofauna of about 18 fish species. These are *Lates niloticus*, *Oreochromis niloticus*, *Clarias gariepinus*, *Bagrus docmak*, *Mormyrus caschive*, *Hydrocynus forskahlii*, *Barbus kerstenii*, *Barbus stigmatopygus*, *Barbus sp.*, *Garra hirticeps*, *G. quadrimaculata*, *Labeo cylindricus*, *L. horie*, *L. niloticus*, *Labeobarbus bynni*, *L. intermedius*, *Synodontis schall* and *Aplocheilichthys antinorii*. In addition, the Nile crocodile (*Crocodylus Niloticus*) and the aquatic mammal, Hippopotamus Amphibious is the other fauna habituating in the Lake.

Arba minch crocodile ranch: The Arba Minch Crocodile Ranch (AMCR) is the only ranch in Ethiopia and it is under the state of South Nations Nationalities and People of Ethiopia and administered under Regional Bureau of Culture and Tourism. It is located southwest of Lake Abaya adjacent to Arba Minch Airport 3.8 Km far from Arba Minch town, which is 505 km from the capital city of Ethiopia (Addis Ababa). The primary purposes of the ranch were conservation of Nile crocodile in Lakes Abaya and Chamo, commercializing crocodile skin and meat to the global market, creating good environment for scientific studies on Nile crocodiles and tourism in the country.

Currently, Arba Minch Crocodile ranch has been rearing only 2,700 Nile crocodiles, although it resides in 8 hectare of land with a capacity to accommodate 8,500 crocodiles in 46 ponds and a potential to export 2,000 skins per annum. Besides skin, crocodile by-products (meat and teeth) could be exported to major international markets. Furthermore, the ranch serves as a major tourist attraction, which on

average visited by 36,500 tourists and earned 905,000 Ethiopian birr per years. Arba Minch Crocodile Ranch is a must for all domestic and international tourists who came to Arba Minch town.

Methods of data collection

The data collection was carried out in Gamo zone, Arba minch Zuria district of three Kebeles: namely, Genta kanchamo, Elgo and Wozeka bordering lake Chamo. Primary sources of data were gathered via household survey, focus group discussion (FGD), in depth interview and observation to find out information related to factors that influence Nile crocodile resources and conservation practices within and surrounding the Lake. A secondary source of data includes published reports, websites, action plans, records, folders and brochures of the ranch were used.

A household questionnaire survey was conducted. It was containing both closed and open ended items. The close ended items were used to help a researcher examine respondents' response about the threats for Nile crocodile conservation, while open ended questions were particularly essential for identifying the reasons why respondents hold some kind of view on related issues. For household surveys, 25 respondents were selected purposively from each of the three Kebeles, because the Lake resources are highly available and adjacent at these respondents.

The experts from 3 Kebeles of Arba Minch Zuria District (Wozeka, Elgo and Genta Kanchama) were selected purposively based on the responsibilities they have, experience, and relevance to issues under study. For that reason, from each Kebele Agriculture offices (1 Animal science expert, 1 Plant science expert, 1 Natural Resource expert and 1 Kebele chief administrator a total of 12 experts were participated for the in-depth interview. In addition, 1 crocodile expert from Arba Minch Crocodile Ranch and 1 Chife warden from Nech Sar National Park were included in interview. In addition, a total of 5 fishery cooperatives organized on Lake Chamo were considered for data collection. From each cooperative 10 fishermen were selected randomly for interview. The sample size was determined using the Israel, 1992 [6] sample size determination formula:

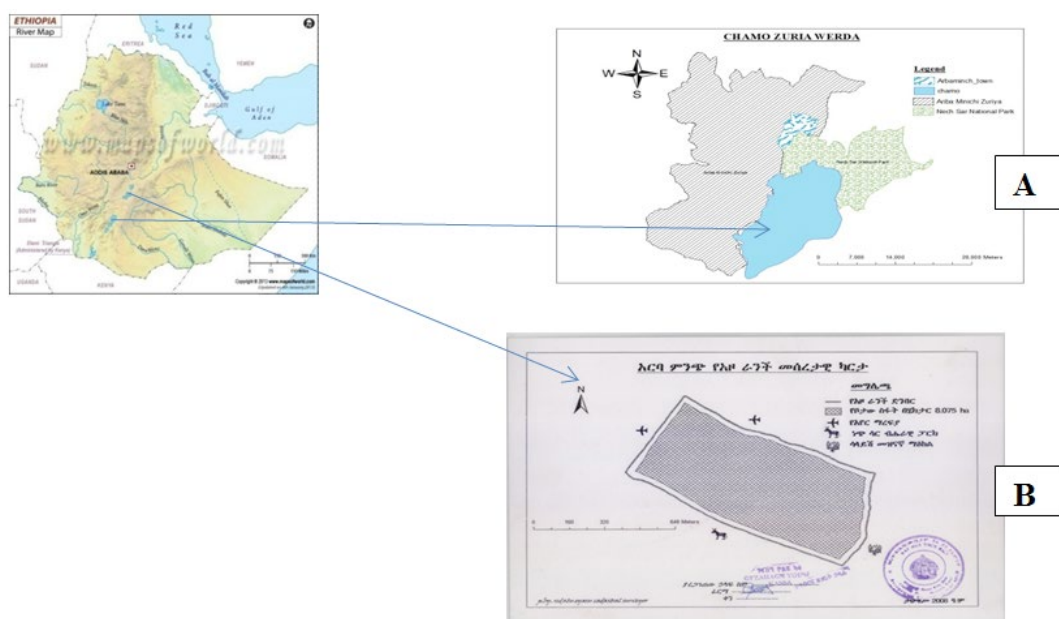


Figure 1: Map of Lake Chamo (A) and Arba Minch Crocodile Ranch (B).

$$nT = \frac{N}{1+N(e^2)}$$

Where, n is number of sampled households, „N“ is total target population, nT is total number of household, and e is level of precision. Hence, according to the formula, sample size determined at 5% precision and 95% of confidence level will be 50 respondents from fishermen and 75 from kebele, a total of 125 households.

Data analysis

Statistical package of social science (SPSS) version 20.0 was used to analyze the data. Quantitative data were presented using descriptive statistics such as percentages, frequencies and means.

Results and Discussion

Socio-demography characteristics of respondents

A total of 125 responses were received and suitable for analyses. The results of socio-demographic characteristics showed that 91.2% were males and 8.8% were found to be females. Age of respondents were grouped into youth (18-35), adult (36-50) and elders (>50). According to the survey, youth consist of 10.4%, adult 68% and elders 21.6% as shown in Table 1.

The educational status of the respondents was classified into four categories namely: uneducated, elementary, secondary and college. Majority of the respondents 92(73.6%) were elementary school. On the other hand 17(13.6%) were found to be secondary school and 16 (12.8%) were uneducated. There were no respondents found in college educational status. Regarding to household economy of the respondents, 50 (40%) were fishing, 69 (55.2%) agriculture and 6 (4.8%) were mixed system.

Threats of Nile crocodile in Lake Chamo

The study showed that all of the selected interviewed respondents have feeling of threat towards Nile crocodile due to the increase in deforestation (15.72%), lake side farming (14.29%), Siltation (12.86%), pollution (8.57%), invasive weed (4.27%), livestock grazing (10%), illegal fishing (12.86%), Nest site distraction (10%) and human-crocodile conflict (11.43%) as indicated in Table 2.

Deforestation: Based on field observations and respondent information of this study, the major threats of the Nile crocodile in and around Lake Chamo were destruction of upper and lower catchment of the lake. Deforestation of the catchment areas of the lakes leads to high

Table 1: Background of the respondents who were involved in questionnaire survey.

Demographic Characteristics of the Respondents	Background of the Respondents	No. of Respondents	Proportion (%)
Sex	Male	114	91.2
	Female	11	8.8
Age	Youth (18-35)	13	10.4
	Adult (36-50)	85	68
	Elders (>50)	27	21.6
Educational status	Uneducated	16	12.8
	Elementary	92	73.6
	Secondary	17	13.6
	College	0	0
Household economy	Fishing	50	40
	Agriculture	69	55.2
	Mixed	6	4.8

Table 2: Threats of Nile crocodile in Lake Chamo.

Threats	Frequency	Percent (%)
Deforestation	11	15.72
Lakeside farming	10	14.29
Siltation	9	12.86
Pollution	6	8.57
Invasive weed	3	4.27
Livestock grazing	7	10
Illegal fishing	9	12.86
Human-Crocodile conflict	8	11.43
Nest site distraction	7	10
	70	100

soil erosion and result in major perturbations of nutrient availability, water temperature, turbidity, pH, and water level of the lake. Consequently, the fish and other aquatic organisms are the final victim of the change in the water quality and quantity of the whole process of the system [7]. The change and disturbance of aquatic organisms in the lake directly or indirectly affect the survival and reproduction of Nile crocodile in Lake Chamo.

In addition, on the shore area of lake chamo submerged reeds (emergent macrophytes and woody vegetation) were cleared for various purposes (fish camp, animal feed, boat raft, fire wood, house furniture such as small locally made setting materials the so called ‘Kursi’, and floor decoration ‘Cheffe’). This vegetation which could serves as a refuge and breeding site of certain fish species had been cleared in alarming rate. Due to the devastation of the shore vegetation and the increasing of farming activities the lake was exposed to high siltation. All of farmer respondents who cultivate their crop near Lake Chamo claimed that the lake has been expanding and covering their farming land from year to year.

Lake Side farming: The establishment and expansion of investment, especially commercial agriculture, around the lake has played a role in the destruction of aquatic biodiversity including Nile crocodile and unsustainability risks in the resource [8]. The Nile crocodiles are strongly threatened by the expansion of Lake Side farming and the chemicals used. During field observation, the basking area and nest sites of crocodiles on the shore area of Lake Chamo were totally damaged and replaced by Banana farm which directly affect Nile crocodile reproduction and survival. The reason for this might be due to the government giving less attention to conservation of Nile crocodile and other aquatic animals in the country.

Pollution: During the survey, 55.2% of the respondents who engaged of Lake Side farming were used inorganic fertilizers, pesticides and herb sides to increase their crop production. All this inorganic chemicals and domestic wastes in the area were merging with the lake through flooding. The application of chemicals on the farm land resulted in lake pollution, algal blooming and mass fish kill in aquatic ecosystem [9]. These phenomena directly affect the Nile crocodile in Lake Chamo. In addition, the reported data in the Arba Minch crocodile ranch and the filed observation data revealed that the most known cause of pollution for Lake Chamo is the destructive human activities conducted in the Kulfo River. Since, Kulfo River is passing through Arba Minch town, cloth washing, bathing and Car washing are the routine activities of the local people. More importantly, all the refugees from petrol stations, slaughterhouses, market centers and hospitals were mixing with Lake Chamo during rainy season. The result of the current study agreed with Gashaw Tesfaye 2010 [7] who reported that the pollutants (both organic and inorganic chemicals)

from agriculture, urbanization and industrialization affecting the Ethiopian Rift Valley lake ecosystems.

Invasive weed: The respondents' information and the field observation report showed that the invasive weed, Water hyacinth (*Eichhornia crassipes*) from Lake Abaya was introduced to Lake Chamo due to the current overflow condition of Lake Abaya to Lake Chamo. The introduction of this exotic weed is a great fear of jeopardizing Lake Chamo biodiversity and the lake itself. According to Degsera Aemro, 2017 [10] water hyacinth affect aquatic ecosystems through complete block of waterways, fish catch reduction, displaces native aquatic plants and increases water losses from the lake. Not only these reasons but also the expansion of water hyacinth will invade the nesting sites of Nile crocodiles and affects their reproduction.

Livestock grazing: Another threat of Lake Chamo is grazing which cause the devastation of wetland grasses (the lake lung). Due to the increase in livestock grazing, many shore areas previously used by crocodiles for basking and nesting have been devastated. Romulus, 2007 [11] reported that forcing crocodiles to suboptimal habitats can have catastrophic effects on the population as a whole leading to increased nest predation, denying crocodile hatchlings the habitats required for their survival.

Illegal fishing: Fishing activities are one of the serious threats on Lake Chamo. I observed higher number of fishermen who owned destructive fishing gears, mono-filament and Gancho net in and around the lake which devastate the fish resource. Many crocodile habitats are surrounded by fishing Camps and the crocodile in these environments are potentially impacted by motor boat activity, noises, garbage, plastics and discarded fishing tools. According to Romulus, 2007[11] lack of regulation enforcement, illegal fishing gear and unsustainable growth of the fishing industry has resulted in overfishing, the declining of the main target species to almost non-viable levels and the apparent extinction of one of them. The use of gill nets is death to crocodiles, especially the tough-cord 'Gancho' net which can drown even the biggest crocodiles, and does.

Human-crocodile conflict: Human-crocodile conflict also a big challenge and threats in and around Lake Chamo. Based on the information collected from the respondents, People in and around Lake

Chamo have to make use of lake water for fishing, irrigation, livestock watering, washing clothes and bathing. As a result of this, many people and their livestock are exposed almost daily to the risk of being attacked by a Nile crocodile. This might be due to the loss of habitat and food shortage (low fish population in the lake) has increased humans and livestock predation by Nile crocodile [12].

The human- crocodile conflict on Lake Chamo does not restricted to damages caused by Crocodiles, the people in turn killing crocodiles and destroying their eggs for revenge. Majority of the respondents consider crocodiles as dangerous problem animals to their overall activities. Surprisingly, many crocodiles around Lake Chamo were killed during egg laying and basking from their natural home. Botha, 2010 [13] reported that Nile crocodile survival is threatened by pollution, extensive water extraction for irrigation and domestic use, over harvesting of fish and this has led to a rise in human crocodile conflicts.

The amazing result on the current study also showed that fishermen start feeding of crocodile eggs. Formerly, crocodile meat and egg does not eaten by Ethiopian people due to religious and cultural dogmatism. However, such kind of new feeding habit might be due to the depletion of fish stock in the lake, extreme poverty and inflation currently occurred in the country. The new feeding habit adopted by the fishermen will affect the reproduction and jeopardize the survival of Nile crocodile in the lake. The result of the current study agreed with Shacks 2006 [14] who reported that human crocodile conflicts mainly arises as fishermen and livestock farmers retaliate by damaging Nile crocodile nest and eggs as well as killing them in an attempt to reduce or eradicate them. During filed observation a long and deep ditch was constructed along with the near shore area of the lake to prevent the movement of crocodile and hippopotamus which caused the death of many crocodile in the area (Figure 2).

Risk factors for arba minch crocodile ranch

Nest site distraction in Lake Chamo: Arba Minch Crocodile Ranch obtain crocodile Hatchlings by harvesting from the shore area of Lake Chamo annually. Crocodile hatchlings harvested from the lake shore are allowed to grow in the ranch and have been sold before they reach to reproduction age. Based on field observation and the report



Figure 2: Major threats of Nile crocodile around Lake Chamo (field photo).

of the ranch, the main risk factor of Arba Minch crocodile Ranch is distraction of crocodile breeding site (Nest site) in the shore area of Lake Chamo. Majority of the basking area and nest sites of crocodiles on the shore area of Lake Chamo were totally disappeared and replaced by farm land, fish camp and animal grazing which directly affect Nile crocodile reproduction and absence of crocodile seed for Arba Minch Crocodile Ranch. This is the largest concern and sustainability risk for Arba Minch crocodile Ranch. Unless buffer zone demarcation and other management measures are taken by the concerned body, the country will lose its unique crocodile ranch. This problem might lead to social, economic and political fail in Ethiopia.

Expansion of Lake Abaya: According to the collected data and report of the ranch, the former Arba Minch Crocodile Ranch was flooded and totally submerged including offices by lake Abaya during 1997 and relocated new ranch on 2004. Currently, the Lake continues its expansion year to year and only 0.2 km is left to disrupt the ranch. The reason for this might be due to destruction of forest and improper farming methods on the shore area of the lake which resulted in soil erosion, sedimentation and increase Lake level expansion [7]. Unless all possible precautions will take and relocate the site free from any likelihood of flooding, the ranch could have the possibility of getting the previous hazard of flood.

Shortage of facilities for workers: one of the main challenge and risk factor mentioned by the Arba Minch crocodile ranch office were high turnover of workers due to lack of ideal transportation service. Both the workers and the crocodile feed (fish offal and abattoir offal) were transported through ISUZU Car due to the absence formal public transportation Car for the ranch. In addition, lack of incentives in motivating the conservation experts and inadequate salary payment made the workers disappoint on their job. The reason for this problem might be due to less attention given by the government and NGOs (non-governmental organizations) to conserve the Nile crocodile in the country.

Lack of crocodile skin market: Majority of the ranch workers claimed that crocodile skin marketing is always a problem for the ranch. In an effort to sale crocodile skin, the ranch mainly uses tender notice. Based on the ranch experience tender notice is too procedural and susceptible to price fixation or manipulation by bidders. Matthew et al., 2014 [2] reported that the last attempted sale of skins in the ranch was done on a tender basis and, ultimately, not sold because only a single bid was received (i.e., not the requisite three). This problem might be due to the ranch is not an independent business entity, run as a government department with all decisions made and a budget provided, by the SNNPRS Culture and Tourism Bureau in Hawassa which create complex marketing system.

Conclusion and Recommendations

Conclusively, the major threats to the conservation of Nile crocodile resources in Lake Chamo were deforestation, lake side farming, illegal fishing, huma-crocodile conflict, livestock grazing; nest site distraction, invasive weed, pollution and siltation. On the other hand nest site distraction, expansion of Lake Abaya, shortage of facilities for workers and lack of crocodile skin market were the main risk factors for Arba Minch Crocodile Ranch. Unless buffer zone demarcation and other

management measures are taken by the concerned body, the country could lose its unique crocodile ranch.

Based on the findings of the current study, the following recommendations and suggestions were made for the sustainable utilization of Nile crocodile, minimizing threats and the coexistence of crocodile and local people: awareness creation programs should be organized in the community who bordering the lake. Moreover, the local government and the concerned stalk holders should be committed to delineate the buffer zone on the shore area of Lake Chamo. Effective management actions will help to reduce Nile crocodile threats and to sustain the existing resource. The Government should give a great attention to Arba Minch Crocodile Ranch and solve the existing problems for the continuity of the Ranch. More research is needed on the population status and distribution patterns of Nile crocodile in the lake.

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