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Towards sustainable Utilization of Lake Chamo Biodiversity Resources:

Geospatial analysis of lake level Changes, Challenges and Opportunities, Ethiopia.

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Introduction

Lake Chamo is among diversified, productive and economically important lakes of Ethiopian rift valley. The lake-wetland ecosystem provides services for feeding, nesting, basking, and prey-catching. The lacustrine vegetation also provides hydrological and ecological functions. This ecotone plays a significant role in maintaining water quality, ground water recharge, flood control, input flow regulation, nutrient cycling, erosion control, sediment traps, and microclimate stabilization. However, the lake-wetland ecosystem is in peril because of human induced local and global effects. Pressures on lake-wetland biodiversity resource, emanate from extended fishery, cultivation, grazing and deforestation. At present, human induced effects are challenging the healthy ecological functioning of the lake-wetland ecosystem. This calls for understanding the role of wetland vegetation distribution pattern and designing spatially oriented environmental planning.

Objectives

- Analyze long-term lake level changes and its repercussions
- Examine the floristic composition and role of the outskirt vegetation cover under natural and impacted condition
- Explore threats of lake-wetland ecosystem utilization traditions
- Suggest an environmentally friendly spatial oriented environmental planning for sustainable utilization and management.

Study Area

Location: Lake Chamo is one of the rift valley lakes wholly situated in Ethiopia (Fig.2). Its watershed covers an area of about 2205 sq. km. The lake watershed is situated at an altitude ranging from 1,105 m ASL (lake level) to 3,546 m ASL with in a distance of 39.94 km suggesting its small watershed to Lake Ratio of 7.2. : 1(Fig.5a,b and c). In lake Chamo watershed, the climate type varies from semi-arid to afro-alpine. The rainfall pattern is bimodal type characterized by two peak rainy seasons(Fig.4). The Lake Chamo is typically eutrophic. The lake also harbours hundreds of *Hippopotamus amphibious* populations, thousands of the giant crocodile, *Crocodylus niloticus and* variety of bird species including migratory ones*(Fig.6)*.

Methods

oreline reconstruction from Aerial photographs and satellite ageries to assess the long-term *(last 45 years)* lake level changes condary data was collected to analyze temporal change on water emistry from 1938 to 2010.

oristic Composition Analysis on disturbed and undisturbed portions of e lake outskirt was conducted

wo pairs of transects were selected

he rivers selected for this purpose were

Kulfo (untouched portion of the sampling process)

Sille (encroached portion of the sampling process)

Quadrants (20 meters by 20 meters) were laid every 100 meter distance (from the lake margin (shore).

Best samples of leaves, flowers, and fruits of plant species were collected for identification

The samples were pressed on-site using standard plant press with ample information

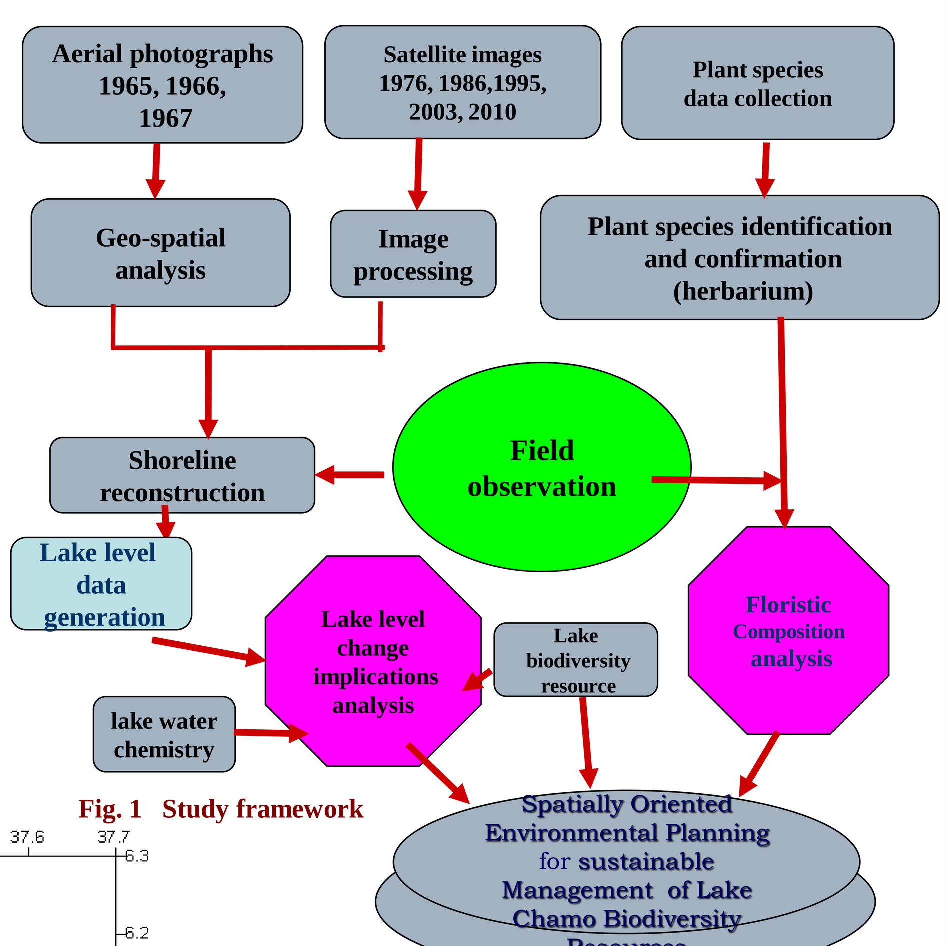

Fig. 1 Study framework

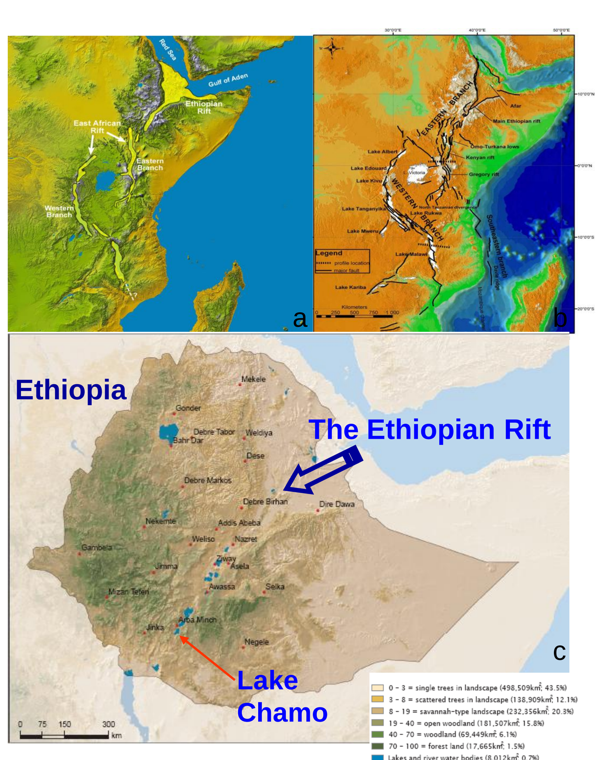

Fig.2 Location of the Study area

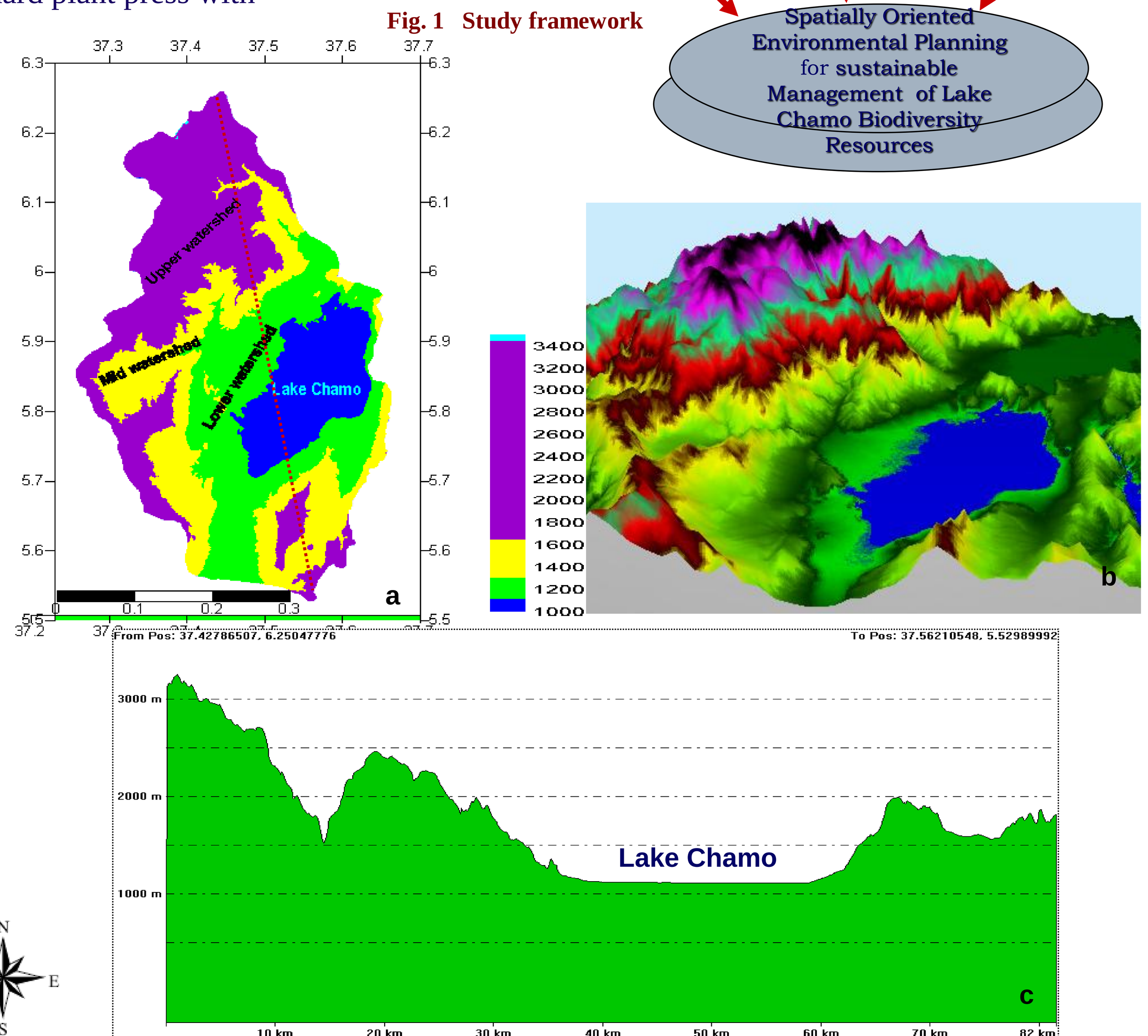

Fig. 5a,b &c Relief profile of the study watershed

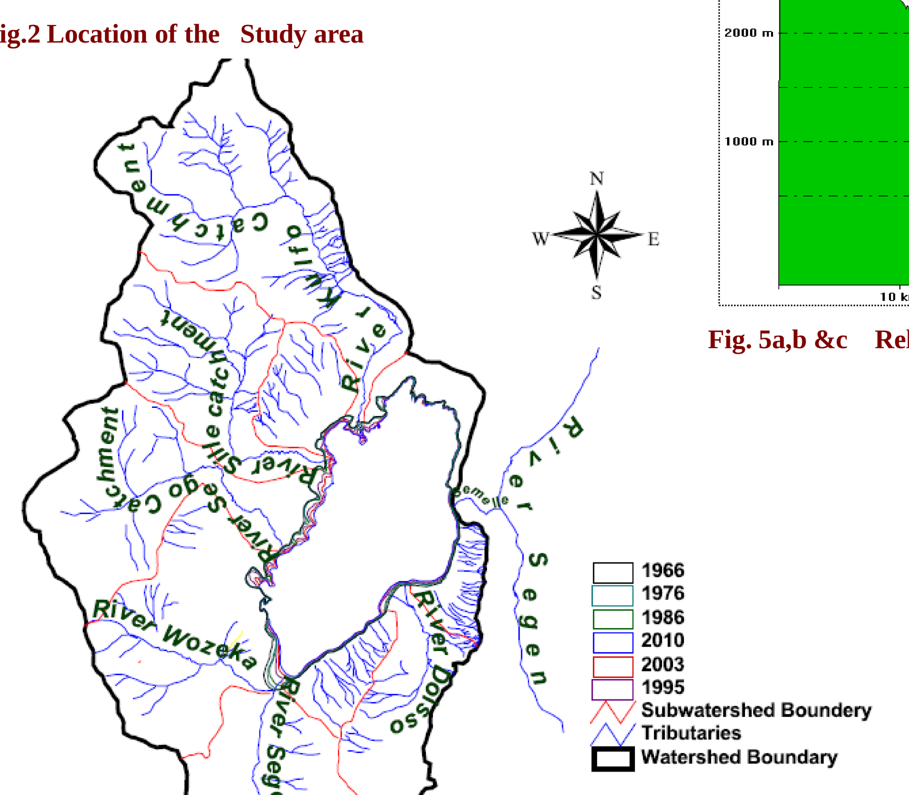

Fig. 3 Study Watershed and tributaries

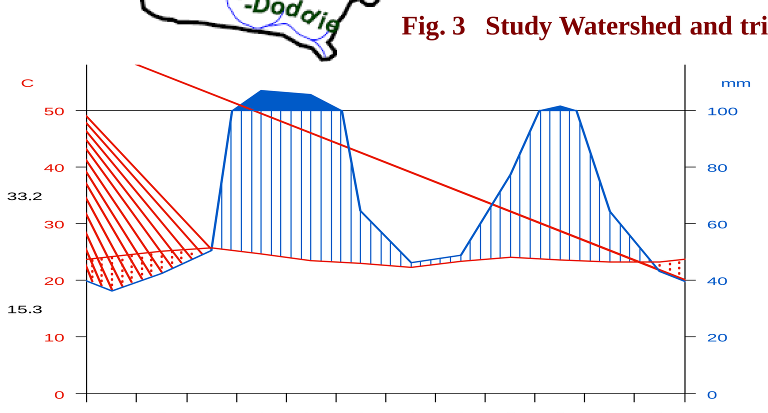

Fig. 4 climate diagram of the study area

Fig. 6 Faunal resources of Lake Chamo and surrounding

Results and Discussion

I. Lake Level changes and environmental repercussions

- The change in the level of lake Chamo for the last 45 years is found to be significant (Fig 7).
- The lake has shrunk by 14.42% (50.12 sq. km) of the lake surface area that was in 1965.
- Surface area of the lake during the study period (2010) is 297.45 sq. km
- The paradox, general shrunk with the introduction of eroded sediment nveils the aggravated loss of this freshwater resource.
- The lake area earlier covered with water is now converted to: Grazing ground, farm land and site to dig special type of clay used as salt lick.

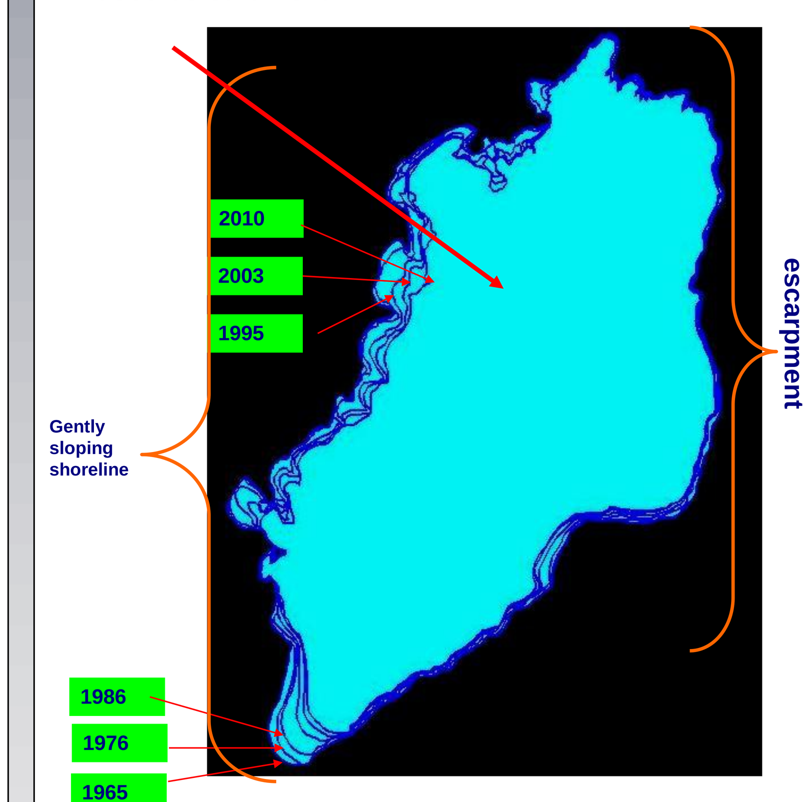

Fig. 7 reconstructed shorelines of lake Chamo(since 1965)

A. Possible cause of lake level shrinkage:

1. Water withdrawal from main rivers

Rivers have been diverted and used to irrigate

Arba Minch state farm (1200 hectares) ……...Kulfo

Sille state farms (1300 hectares)……………..Sille

Argoba irrigation scheme (80 hectares) …...Sego and Wozeka

2. Cessation of overflow from Lake Abaya

- In the past thirty years the Kulfo river deposited **a levee of 2 km** in length across the transition of lake Abaya and Chamo.
- This hindered the drainage of lake Abaya into lake Chamo.
- This has been **indirectly indicated** by the rise in the level of lake Abaya in contrary to the existing size of lake Chamo.

3. Rise in temperature

- The area experiences moist sub-humid to semi-arid climate with evapo-transpiration exceeding rainfall (Makin et al. 1975)
- The rise in temperature at local level might have enhanced evapo-transpiration rates contributing to water loss

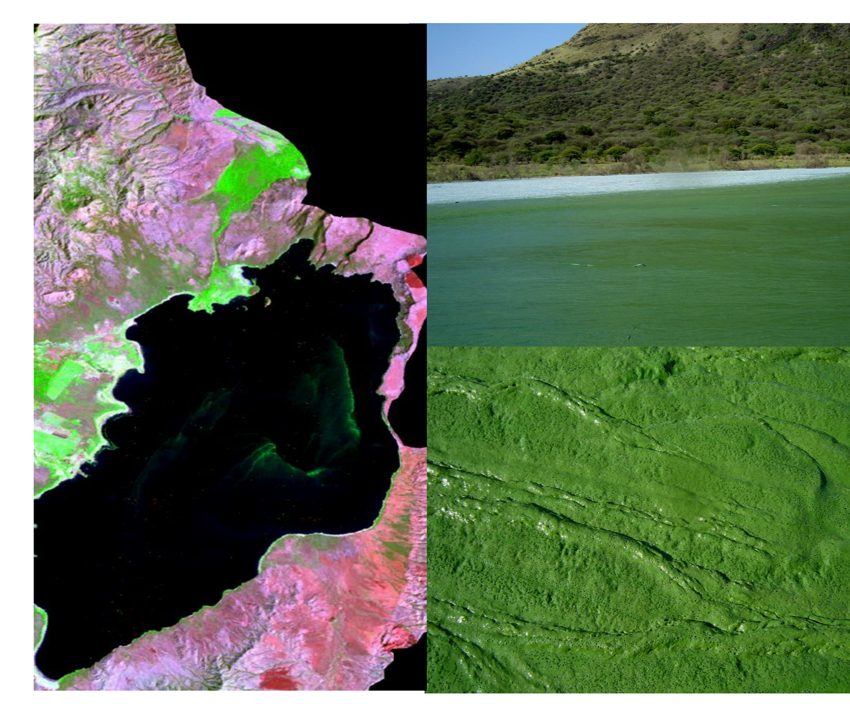

Fig. 8 Algal blooming events of 1986 and 2007

B. Consequences of lake shrinkage

❖ Former fertilization lake side zones are deserted
- -Loss of breeding grounds of *Oreochromis niloticus*
- -Complete female fish catching practice on lake shores

❖Fragmentation of grazing, basking and nesting grounds
- -Hippo grazing fields are converted in to cattle grazing and farm land
- -Surprisingly, You can find the foot prints in agricultural fields

❖Increased in ionic concentration and nutrient loading with:
- 206% increase in conductivity, 1938-2009 (80years)
- 43% raise in salinity, 1938-2004 (65 years)
- 56% boost in alkalinity, 1966-2009 (43 years)
- a slight increase in chlorophyll-a concentration
- a decrease in silica deposition.
- This has resulted in huge algal deposition.

In consequence, recurrent algal blooms proliferate causing mass fish kills and death of zebras which use lake water for drinking.

Blooming 1978 reported by Belay and Wood 1982
Blooming 1986 from satellite image
Blooming 2007 observed in person (Fig. 8).

II. Floristic composition analysis

- Definite pattern of the vegetation distribution
- The vegetation composition in the park (protected portion) was categorized into three belts:
- **Herbaceous belt:** species such as *Typha domingensis, Echinochloa pyramidalis, Cynodon dactylon* and *Cyperus articulate.*
- **Legume belt:** *Aeschynomene elaphroxylon and Sesbania sesban*
- **Bushes, shrubs and small trees belt**: *Acacia polyacantha, A. seyal, A. tortilis, Balanaites aegyptiaca, Maytenus senegalensis, Ficus sur*

On the other hand, the encroached portions of the lake outskirt have lost the vegetation cover because of farming, grazing and clearance of the vegetation cover (Fig. 9)

The established vegetation belts collectively act as different-sized sieve screen system and calm down the pace of incoming foreign matter.

Fig. 9 Status comparison of Kulfo and Sille rivers

Accordingly, a buffer zone demarcation with this vegetation pattern has been recommended to restore the entire lake outskirt (Fig 10).

Hence, the vegetation distribution pattern has to be duplicated through out the lake outskirt

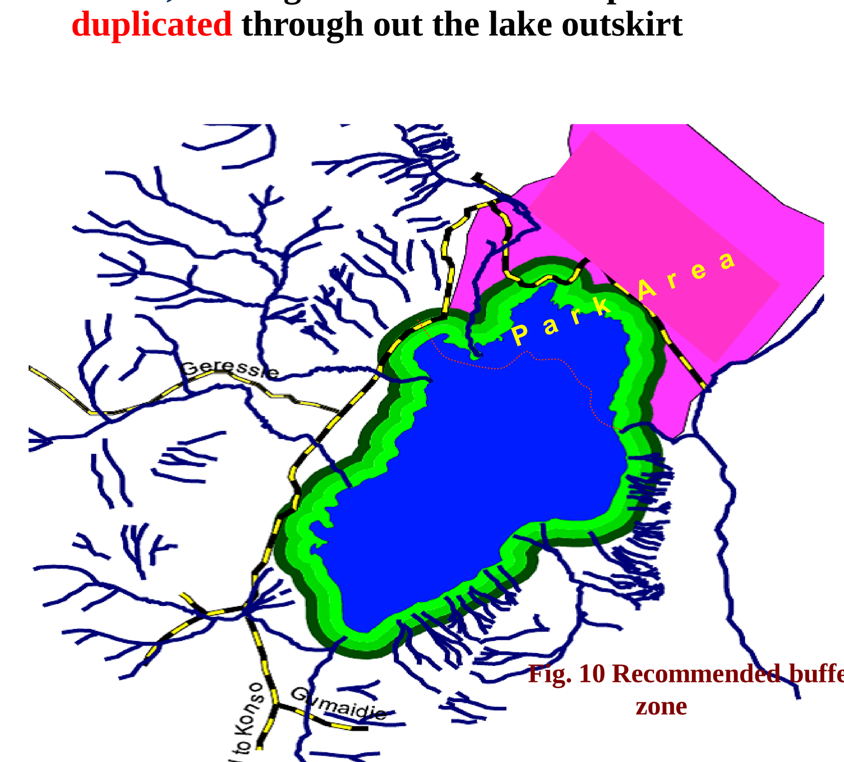

Fig. 10 Recommended buffer zone

III. Other threats to the lake

1. Lakeside waste management

- -Lake side filleting is another problem by fishermen (Fig. 11).
- –Depletion of dissolved oxygen and toxic gas secretion up on decomposition.

2. Over-fishing and Destructive fishing

- Non-sustainable fishing practices prevailed in the lake
- The number of gears deployed were larger than the recommended.
- The average mesh size of nets is below the minimum recommended size which leads to destructive fishing.

3. Car Washing

- Vehicle washing practices along Kulfo river.
- The grease and detergents along with dirt have significant pollution potential to the lake.

Fig.11 Lake side waste damping practice of fishermen

Conclusion & Recommendations

- The rich biodiversity resources of lake Chamo is at risk hence, spatially oriented participatory environmental planning has to be implemented
- To address the current problems of fishery activities, appropriate fishing tools has to be applied.
- Car washing activities has to be banned as they are potential threats of the aquatic ecosystem.
- The lake-wetland resource could be taken as a fertile ground to establish well studied aquaculture and crocodile ranching for commercial fishing.
- This would potentially reduce the pressure on natural lake resource, reduce overexploitation, and promote sustainable utilization.
- The resource from fish processing (fillet) considered as 'waste' could be used as a cheap source of protein to feed people under proper sanitation.
- It may also be used as feed for poultry and crocodile ranching establishments as **win-win principle of eco-sanitation**.