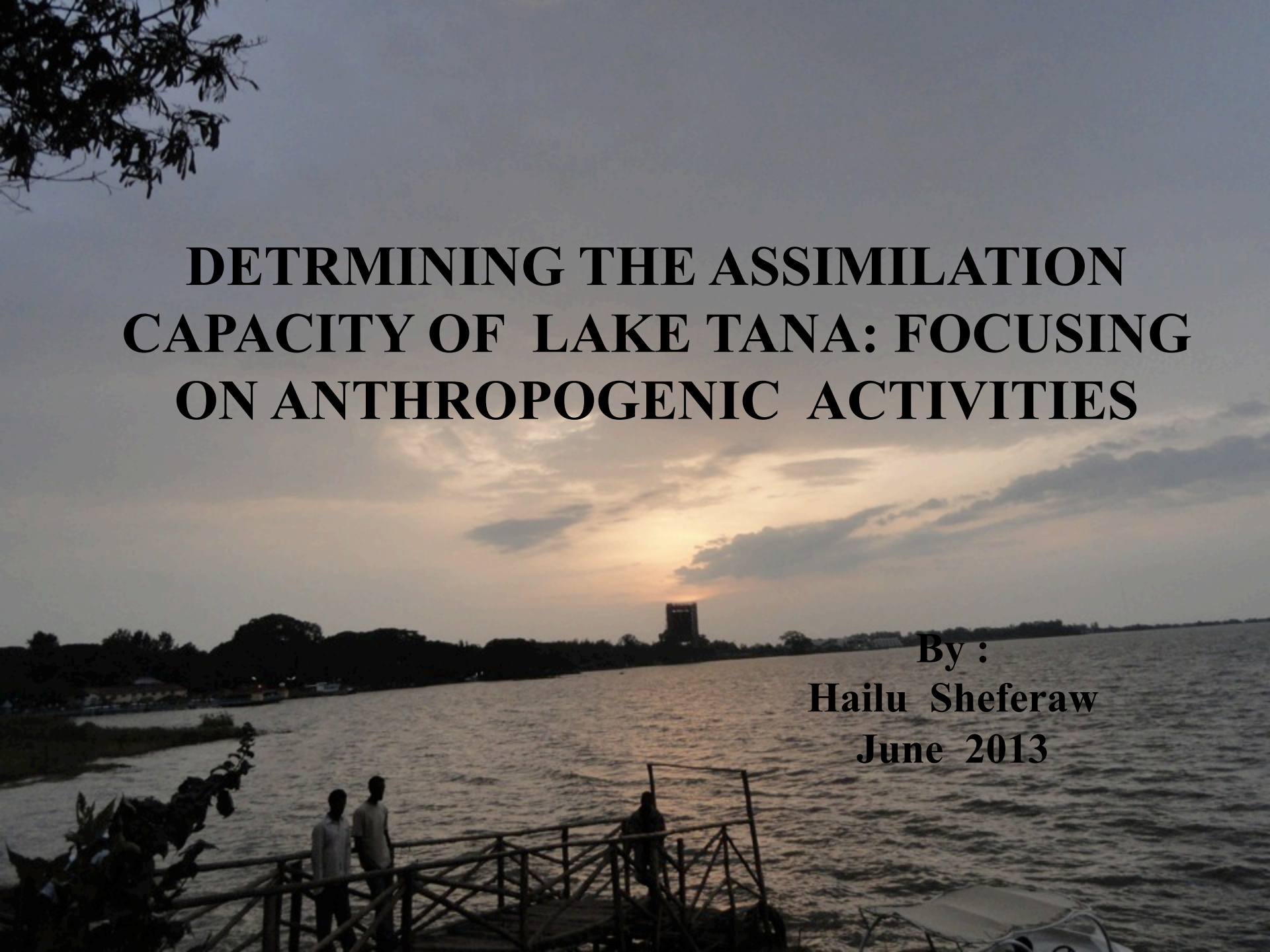

DETRMINING THE ASSIMILATION CAPACITY OF LAKE TANA: FOCUSING ON ANTHROPOGENIC ACTIVITIES

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I.BACK GROUND OF THE PROBLEM

- Lake Tana is located North western range of Ethiopian high lands at 12 º00'N, 37º 15ºE with altitude of 1840 m

  (Wale, 2008)
- Surface area (3060 to 3150 km^2)
- Catchment area approximately 15,000 km^2
- Depth mean 9m and maximum 14m
- Volume 28 km^3 at 1786m amsl (Hadush, 2008)

CONTINUED

- Maximum length 84 km and maximum width 64 km
- Major influent river Gilgel Abay, Ribb, Gumera & Megeche
- Effluent river Blue Nile (Hadush, 2008)
- **The** lake is home town of 2 million population in its catchment and wet lands (Gardone, 2007)

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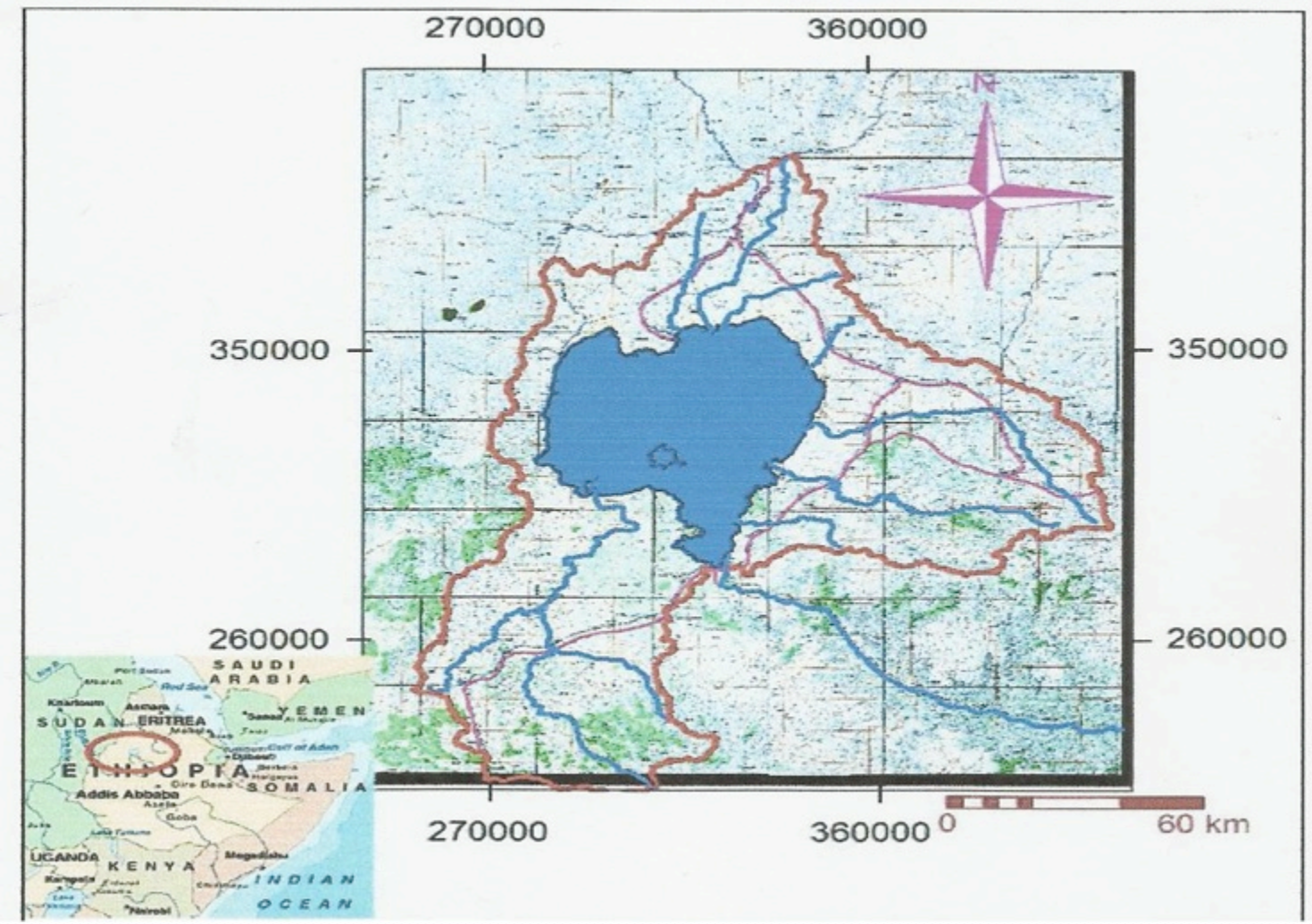
Figure 1: Map location of Lake Tana



Source (Hadush, 2008)

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- **Lake** pollution Wasn't a major problem Until large centre of population developed (Mirolav & Vladimir, 2006)
- Pollution of surface water (lake) α related to anthropogenic activities and growing population(Zmek *et al*, 2005)
- **Lake** Tana feed by streams from different catchment area HL1.pptx
- The lake used as a basket for dumping of industrial & domestic wastes from Bahir-Dar city (Goraw et al., 2010)
- There is continues loading of pollutant in to the lake and its concentration varies in the shore line specially in Bahir -Dar gulf (Mengistu, 2003)

CONTINUED

- Lakes pollution become a problem when the waste load in to a lake; exceeds itself purification mechanis**m**

- No research have been done in lake Tana in estimating its waste holding capacity (Assimilation capacity)

- To kept the lake property of carrying waste material without adverse effects on the environment or on users of its resources?

- A great attention should be given in estimating the assimilation capacity of Lake Tana

II. OBJECTIVE

- Scope:-
  - Aimed on estimation of transfer function in order to estimate the relative assimilative capacity in terms of different water quality parameters
- Objectives:-
  - Determine the concentration of various WQP in the different inflow streams entering the lake and in the lake
  - Determine the temporal variations of WQP concentration in the inflow streams joining the lake and in the lake
  - Develop a test to check whether there is a difference in the transfer function estimation respective to each WQP across time interval

III. HOW ?

- Sampling :-
  - Gelgele Abay, Gelda , Gumera, Ribb, & Megech are selected covers 93% of the inflow to the lake
  - Bahir-Dar City sources because of its anthropogenic
    - One sampling point was selected on each river
  - 15 sampling points from the open lake were taken based on their importance :
    - at a place from where water is discharged from the lake
    - at a place where feeder tributary meets the lake
    - at a central place of the lake
  - 5 sampling points were taken on the out late river

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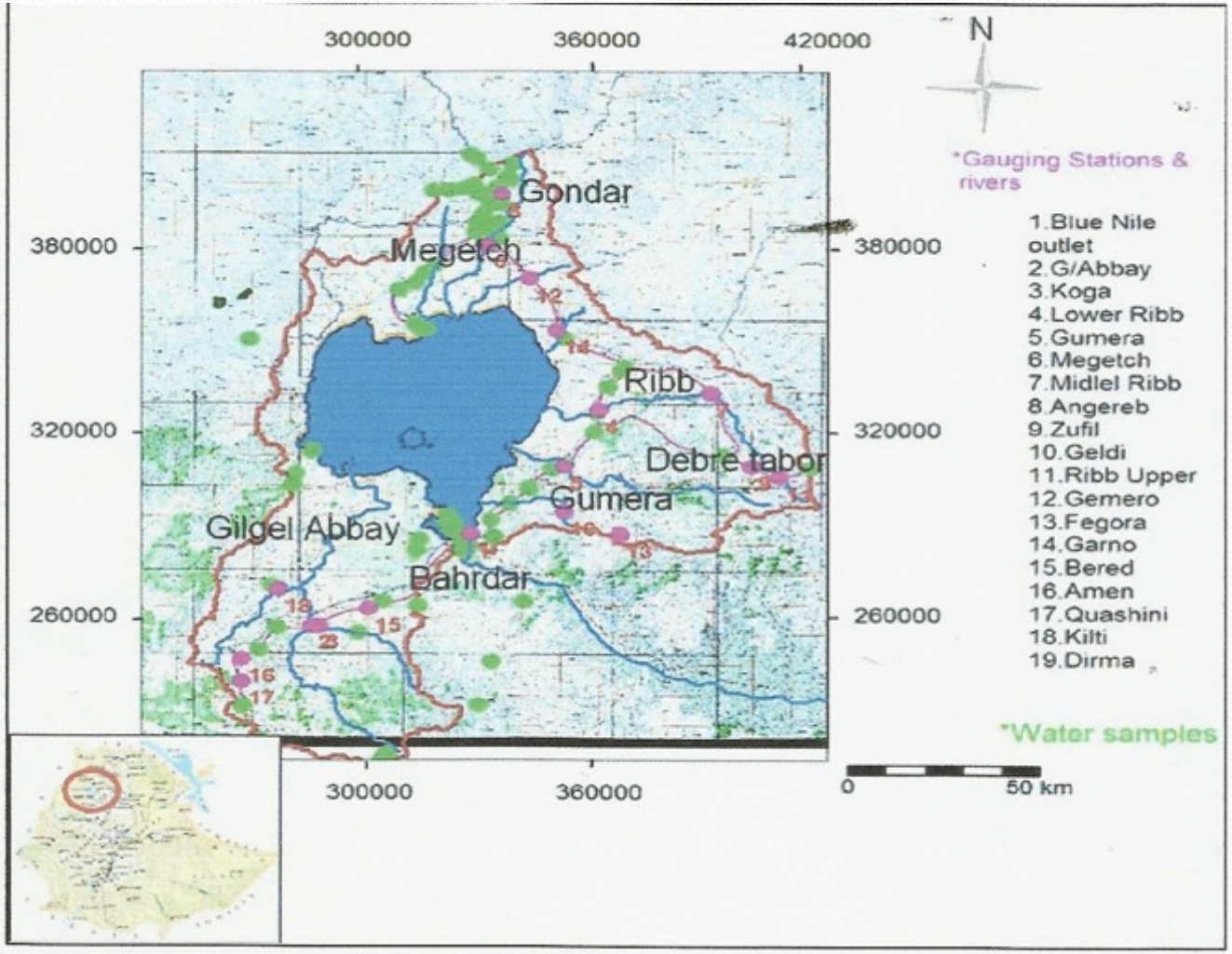
Figure 2. Study area location



Source (Hadush, 2008)

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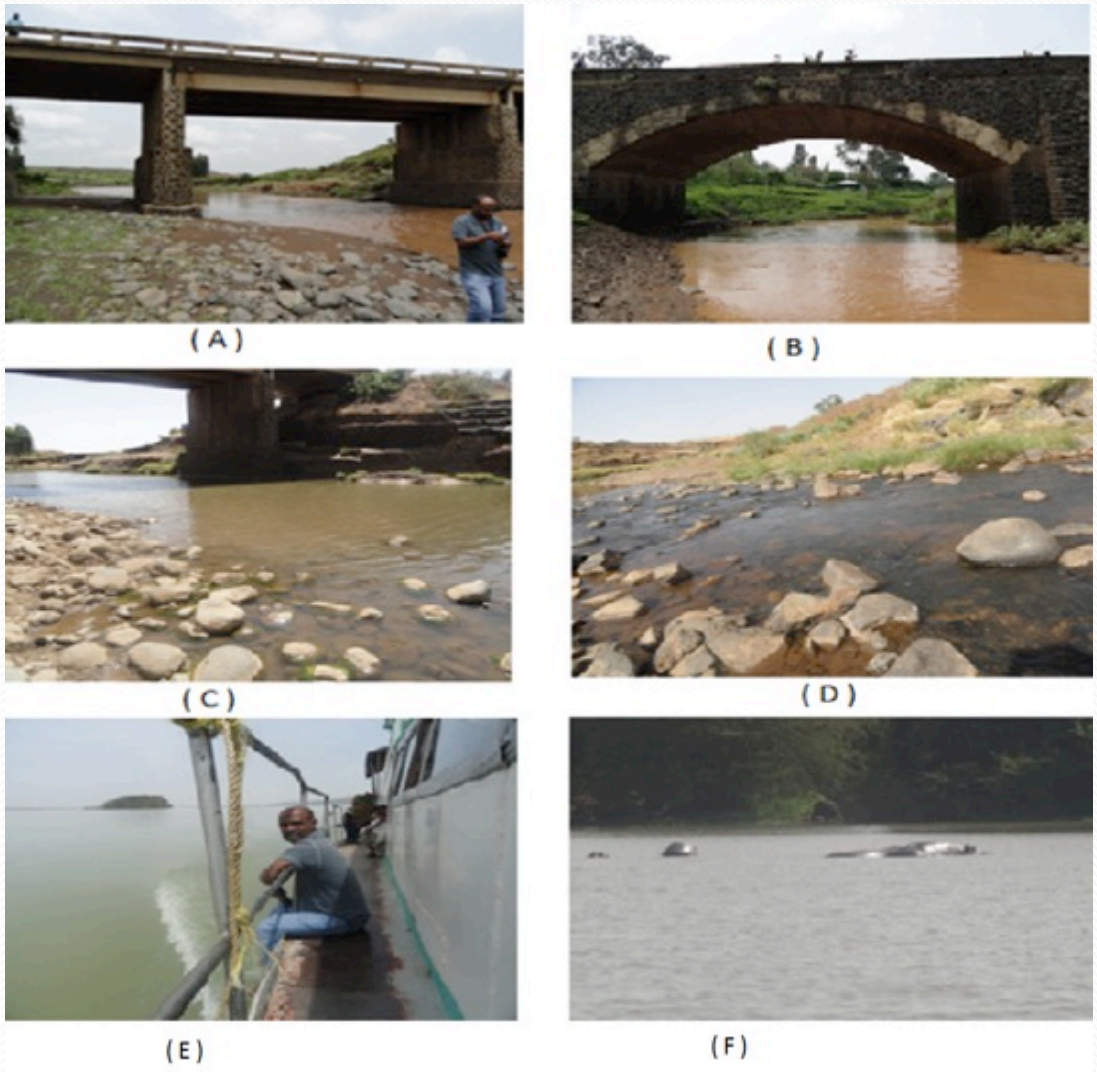
Figure3. sampling site



(a)= Megech (b) Gumera (c) Gilgele Abay

(d) Gelda (e) Lake Tana (f) Blue Nile

CONT'D

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- Sampling procedure:
  - Samples were taken 1 time per month for 3 months from inflow stream , open lake and the out late river. HL2.docx
  - Samples were taken using PVC plastics bottle
  - Sample from the lake were taken in the morning session when ratification of lakes were absent
  - Composite sample were taken from the bank and middle part of the rivers
- Data Type:
  - Secondary data from review of literature physical facts and figures of lake Tana
  - Primary Data from measurement of WQP in situ and chemical analysis in Laboratory

CONTINUED

- Procedure of analysis:-
  - WQP pH, Turbidity, EC, TDS, Temperature, Salinity, DO_2, BOD, measured with Digital instruments in situ and in the laboratory
  - NO_3^-, PO_4^{3-} determined with 5000 photometer
  - SO_4^{2-} determined with UV visible specterophoto meter
  - Cl^- and HCO_3^- with titration experiment

CONTINUED

Figure 4. Laboratory instruments used for Analysis

(a) Turbidity meter (b) Photometer (c) pH meter

(d) DO2 meter (e) Conductivity meter (f) UV spectrophoto metere

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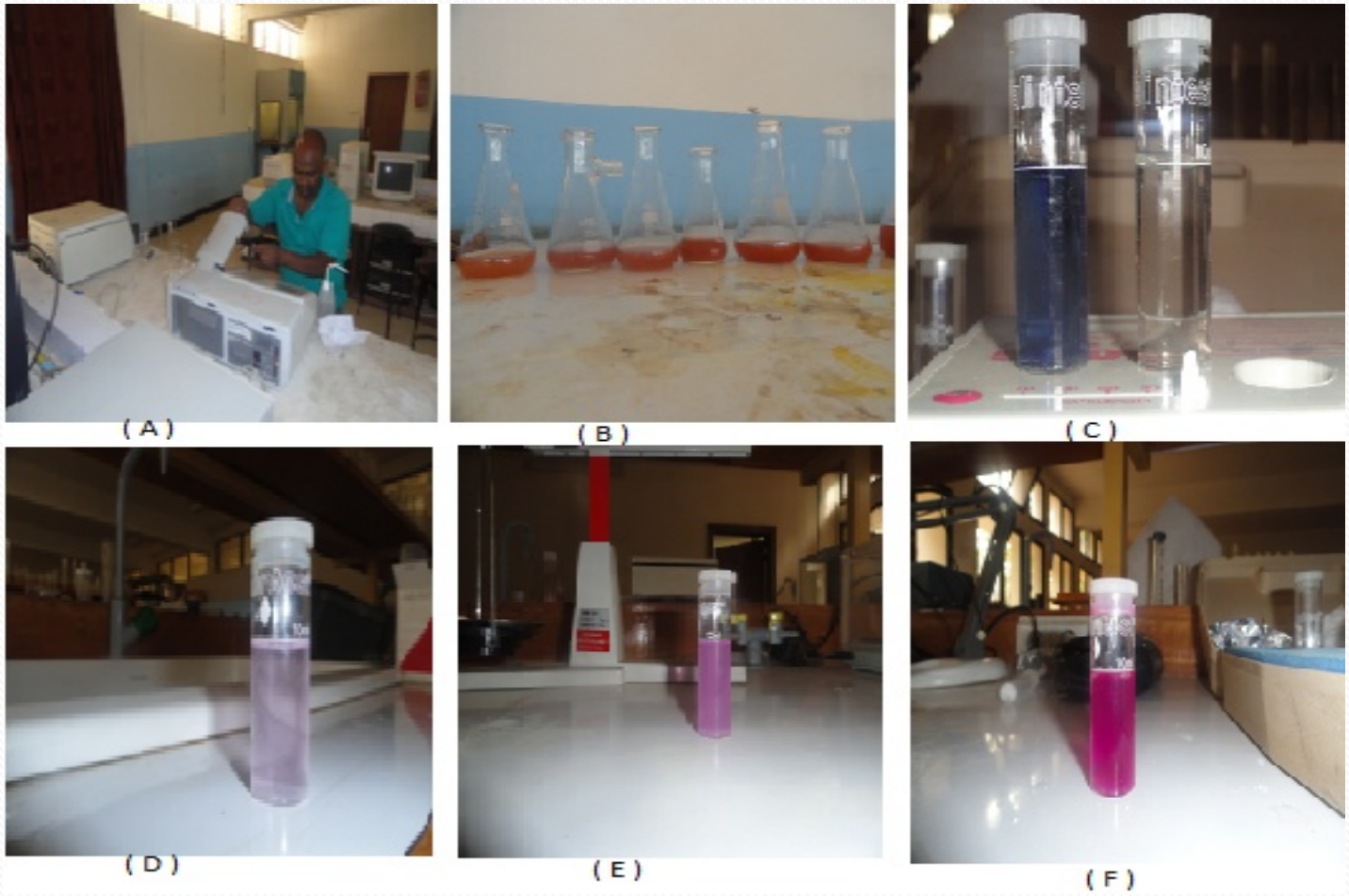
Figure 5. photo of chemical analysis were going in the lab and their out puts



(a) SO_4^{2-} (b) Cl^- (c)More [ ] PO_4^{3-}

(d) less [ ] PO_4^{3-} (e) More [ ] NO_3^- (f) less [ ] NO_3^- [ ] = concentration

CONTINUED

- Estimation of transfer function

β = C in lake/ C inflow

$\beta << 1$ = the lake has good assimilation capacity

$\beta \rightarrow 1$ = the lake waste removal mechanism are weak

where β = transfer function

C in lake = in lake concentration of WQP

C inflow = concentration of WQP inflow stream

(Chapra, 1996)

CONTINUED

- Out put data analysis:-
  - An independent two sampled T- test
  - Pearson correlation and scatter plot graph between BOD and DO_2 and EC and TDS
  - One way ANOVA was employed

IV. RESULT & DISCUSSION

I. General characteristics of the lake:

- No significant difference was observed between the in lake and the out late WQP concentrations except SO_4^{2-}

Table 1. Comparison between the in lake and out late WQP

Month	TDS in mg/l	BOD in mg/l	PO_4^{3-} in mg/l	NO_3^- in mg/l	Cl^- in mg/l	SO_4^{2-} in mg/l
February	0.368	0.230	0.405	0.010*	0.041	0.005*
March	0.053	0.968	0.074	0.121	0.013*	0.000*
April	0.123	0.456	0.073	0.151	0.012*	0.000*
Average	0.114	0.471	0.118	0.147	0.243	0.000*

$P < 0.025$ (*)= significance difference

P> 0. 0.025 = no significance difference

CONTINUED

- The correlation between EC and TDS and BOD and DO_2 are strong both in the inflow and in the in lake water bodies

Table 2. Correlation between EC& TDS and BOD &DO2 HL3.docx

Month	Inflow stream		In lake	
	TDS &EC (+ve)	BOD &DO2 (-ve)	TDS &EC (+ve)	BOD &DO2 (-ve)
February	1.00	0.996	0.803	0.764
March	1.00	0.958	0.747	0.782
April	0.995	0.982	0.656	0.662
Average	0.999	0.992	0.770	0.828

r > o.75 implies strong correlation

O.5< r < 0.75 implies medium correlation

r < 0.5 implies weak correlation (Hoshamand, 1998)

CONTINUED

- The above two findings clearly showed that lake Tana is a complete mixed system reactor type of lake in which the out late and in lake concentration equal and homogeneity of chemical species exist

- This finding is similar to the definition given for a complete mixed system lake by Chapra (1996) HL4.pptx

- But contrast results was found by Goraw (2007) regarding homogeneity of WQP concentration & by Megsitu (2003) concentration of pollutants varies in the shore line specially in 8 km Bahir -Dar gulf

CONT'D

II. Temporal Variations

- Significance difference was observed in NO_3^- and SO_4^{2-} concentrations in the inflow stream because of the temporal variations
- No significance difference is observed in all WQP concentration in the in lake because of the temporal variations
- See the summarized out put of the ANOVA analysis below

CONTINUED

Table 3. Temporal variation as independent variable

	Water quality parameters					
	TDS	BOD	PO_4^{3-}	NO_3^-	Cl^-	SO_4^{2-}
P-Value (inflow)	0.210	0.179	0.09	0.013*	0.159	0.003*
P- Value (in lake)	0.398	0.374	0.407	0.189	0.260	0.141

P< 0.025 (*) = Significance difference

P> 0.025 = no significance difference

- **The** significance difference which is observed in the SO_4^{2-} and NO_3^- in case of the inflow may be attributed to the sudden emission of these pollutants from Bahir-Dar city sources

(HL5.pptx 5.1 & HL2.docx (table 1,4,7)

CONTINUED

- These finding is similar to the finding of Goraw et al. (2010) the lake used as a natural basket for dumping municipal and domestic waste from Bahir-Dar city and its surrounding settlements

- No significance difference observed in all WQP in the in lake concentration this may be attributed to :

  - the complete mixed nature of the lake i.e. the potential to keep pollutants as their natural setting across the time interval

CONT'D

III. Estimation of transfer function

- The transfer function estimated on the average concentration of the study period showed that the lake have good assimilating capacity to all of the WQP (i.e. $\beta << 1$)

CONTINUED

Table 4. Transfer function

Month	Water quality parameters					
	TDS	BOD	PO_4^{-3}	NO_3^-	Cl^-	SO_4^{-2}
February	0.440	0.890	0.234	0.777	0.555	0.452
March	0.498	0.871	1.50*	1.32*	0.768	0.669
April	0.526	0.897	0.964	1.31*	0.893	0.668
Average	0.485	0.886	0.523	0.859	0.718	0.751

$\beta \rightarrow 1$ lake has poor assimilation capacity (*)

$\beta << 1$ lake has good assimilation capacity (Chapra, 1996)

- The finding implies the lake has a potential to self purified to all of WQP until the inflow concentrations equal to the in lake (Chapra, 1996)

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- See the graph below to see the pollutant concentration reduction capacity of Lake Tana

Graph 1. pollutant concentration reduction capacity

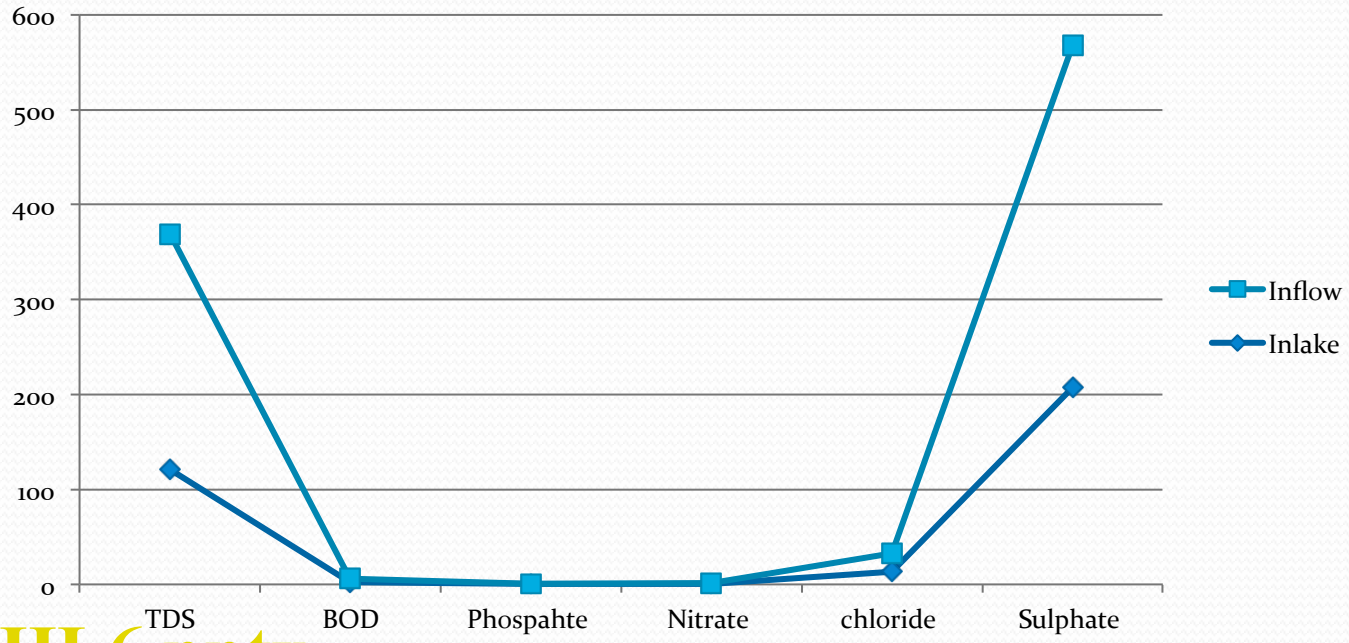

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Table 5. One-way ANOVA using sampling period as an independent variable

	Water quality parameters					
	TDS	BOD	PO_4^{3-}	NO_3^-	CL^-	SO_4^{2-}
P- value	0.207	0.834	0.272	0.010*	0.238	0.003*

P< 0.025 (*) significance P> 0.025 No significance difference

- significance difference in transfer function was observed only in NO_3^- & SO_4^{2-} because of temporal variation
- Could these difference directly attributed to the difference which is observed on these WQP in the inflow streams HL7.pptx
- Yes

CONTINUED

- The general trend observed here is:
- As there is temporal variation in concentration of WQP in the inflow water stream there is also transfer function value variation
  - but this need additional investigation i.e. simple or multiple regression to check which one has more contribution to the variation of transfer value????

V. CONCLUSION

- Lake Tana is a complete mixed system reactor type of lake in which the out late and in lake concentration equal and homogeneity of chemical species exist
- There is variation in NO_3^- and SO_4^{2-} concentrations in the inflow stream because of the temporal variations
- No significance difference is observed in all WQP concentration in the in lake because of the temporal variations
- The lake have good assimilating capacity to all of the WQP (i.e. $\beta << 1$) in the study period
- As there is temporal variation in concentration of WQP in the inflow water stream there is also transfer function value variation

VI. RECOMMENDATION

- To reduce pollution of surface water bodies; emission from the environment should be fall in the range of permissible limit

VII. LIMITATIONS

- Accessibility of sampling points in the inflow water stream
- Determination of sedimentation rate and reaction constant
- Determination of atmospheric flux
- Determination of ground water discharge contribution
- The project needs at least 1 year to see the complete assimilative property of Lake Tana in the four season

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