

*Full Length Research Paper*

# Identification of possible causes of fish death in Lake “Lake Kabo”

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Any adverse change in the environmental conditions affects the life of aquatic organisms in water. Fish death was suddenly observed in Lake Kabo. To investigate its cause and look for solution, a research team started to consider the Lake. The present study was conducted to identify the reason for the fish deaths that accidentally occur in the lake. To achieve the objective samples were collected from four different sampling sites on the lake from October 2017 to August 2018. The four sampling stations on the lake were selected based on criteria and were coded. Sample collection was made every month. Data were analyzed using SPSS version 23. Experimental activities were carried out both on the spot and in laboratory. The results analyzed were compared with permissible limits prescribed by WHO, FAO, BIS and other references. In this study, the pH (6.1-8.7), total dissolved solid (TDS) (60-251.3 mg/L) and total alkalinity (101-195 mg/L) of the lake followed the prescribed limits set by WHO (1993) and BIS (1991). Critical dissolved oxygen (DO) value (2.8-4.7 mg/L) and temperature (T°) (25-30°C) of the lake were found below the specified limit for tilapia Fish. In this study, the reasons for the sudden death of tilapia fish in the lake include: highly fluctuated values of T°, DO and pH value of the lake water especially in rainy season. The study concluded that tilapia fish could not tolerate the fluctuation of DO value which is less than 3 mg/L. The result from secchi-disk also supported the less value of DO. The mean nutrients values for Ca<sup>++</sup>, PO<sub>4</sub><sup>-3</sup> and (Cl) of the lake were 7.6 ± 2.6, 0.1039±0.15 and 1.5102±0.7 mg/L, respectively. The reduced level of DO and extreme fluctuation of pH were the expected reasons for the sudden fish death in the lake during rainy season.

**Key words:** Lake Kabo, pH, dissolved oxygen (DO), total dissolved solid (TDS), Secchi-disk.

## INTRODUCTION

This research was conducted in Majang Zone, Gambela Regional State, Ethiopia. The Lake ‘Bishan Waka’ is an alternative local name for Lake Kabo, a kind of natural lake created by volcano phenomenon. The name, Bishan Waka means the gift of God. The maximum depth of the

lake was 20.5m during the study period. It is located about 651 km from Addis Ababa and is situated very far from the government. Local people benefit from the lake through traditional fishing activity. We encountered dead fish floating on the lake during preliminary survey and

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were interested in finding the reason for their sudden death. Water quality is the totality of physical, biological and chemical parameters that affect the growth and welfare of organisms. Quality of water is an indispensable factor to be considered when planning to produce fish (Mallya, 2007).

The chemistry of natural surface waters is complex, and is based on the equilibrium reached with the normal physical, chemical and biological characteristics of the surrounding (Bronmark and Hansson, 2005). The life and growth of fish depend on pH of the water. pH value of the water will rise during the day as the amount of carbonic acid is reduced; on the other hand dissolved oxygen concentrations rise during the day. At night, the level of carbon dioxide rises, leading to reduction in pH, and the level of dissolved oxygen also falls (Svobodová et al., 1993). Algae require a pH of about 7, and a slightly lower (alkaline) pH of 6.5 favors good zooplankton (tiny animals in the pond water on which fishes feed) and fish growth.

Fish have a limited ability to adapt to changes in these factors, if they occur sufficiently slowly; rapid changes can be harmful. Water pH also has a significant influence on the toxic action of a number of other substances (e.g. ammonia, hydrogen sulphide, cyanides, and heavy metals) on fish. The suitable water temperature for carp culture, for example, is between 24 and 30°C. In their natural environment, fish can easily tolerate the seasonal changes in temperature, e.g. a decrease to 0°C in winter and increase to 20-30°C (depending on species). Increase in temperature can cause stress and expose them to disease. Fish kill can be caused by a variety of factors including dissolved oxygen depletion, extreme water temperatures, fish diseases or introduction of pollutants. Most fish kills are natural events.

Secchi disc is an all white or a black and white metal disc which can easily be made by hand. The disc is attached to a cord that is marked every 5 cm along its length (Assiah et al., 2004). Turbidity is the decreased ability of water to pass on light caused by suspended particulate matter and phytoplankton. Secchi disk transparency from 30 to 40 cm shows optimum productivity of lake and 50 cm is high. Algae, microscopic aquatic animals, water color, and suspended sediment interfere with light penetration and lessen water clarity. Hence, secchi transparency is considered an indirect measurement of how much algae and sediment is in the water (Tushar, 2012).

Cyprinids types of fish species have less demand than other fishes; they can succeed in water containing 6-8 mg/L DO and show signs of suffocation only when the oxygen concentration falls to 1.5-2.0 mg/L. Increase in water temperature from 10 to 20°C doubles the oxygen demand; a higher total weight of fish per unit volume of water can lead to increased activity and increased respiration as a result of overcrowding (Svobodová et al., 1993). Tilapia fish prefer >5 mg/l and tolerate 3-4 mg/L of

DO level (Lloyd, 1992). Alkalinity is the total sum of ions reacting to neutralize hydrogen ions when an acid is added to water. The ideal value for fish is 50-300 mg/L (Santhosh and Singh, 2007). With low levels of oxygen in the water, lower concentrations non-dissociated ammonia can kill fish.

Fish populations are highly dependent on the variations of physicochemical characteristics of their aquatic habitat which supports their biological functions (Mushahida-Al-Noor and Kamruzzaman, 2013; Blaber, 2000; Furhan et al., 2004; Koloanda and Oladimeji, 2004; Ojutiku and Kolo, 2011). The availability of good water quality is important for all fish farming systems but water quantity is even of greater importance for fish farming systems. Right through the century's fish has been vital element of humans' food. The need to improve fish yield by farming became a critical matter (Carballo et al, 2008). Phytoplankton produces carbohydrate using sunlight and releases oxygen. This is the major source of energy and oxygen in the ecosystem. Zooplanktons living on the phytoplankton form major source of food for fishes (Santhosh and Singh, 2007).

In winter, fish are commonly killed by suffocation in polluted storage ponds and in summer this often happens in polluted water courses with high temperatures and low flow rates. Oxygen deficiency causes asphyxiation and fish will die, depending on the oxygen requirements of the species and to a lesser extent on their rate of adaptation. Fish exposed to oxygen deficient water do not take food, collect near the water surface, gasp for air (cyprinids), gather at the inflow to ponds where the oxygen levels are higher, become torpid, fail to react to irritation, lose their ability to escape capture and ultimately die (Svobodová et al., 1993). The dissolved oxygen (DO) is the most important source of the aquatic atmosphere and photosynthetic process for the green plants and also a determining factor of the water quality of an aquatic ecosystem (Rajeev and Ajay, 2010).

Generally, phytoplankton development in waters is determined by the same physical and chemical parameters like temperature, light availability, nutrients. Chlorophyll-a concentration is also determined as a measure of phytoplankton biomass (Hötzel and Croome, 1999). A Secchi disk is used to estimate phytoplankton density and the fertility of lake. This study aims to study the physicochemical characteristics of the Lake and provides reason for sudden fish death.

Physicochemical feature of water has direct effect on survival, growth, reproduction and distribution of fishes. Any improper environmental characters threaten the life of fish. Quality of water is, therefore, an indispensable factor to be considered when planning the production of fish (Mallya, 2007). The chemistry of natural surface waters is complex and is based on the equilibrium reached with the normal physical, chemical and biological characteristics of the surrounding (Bronmark and Hansson, 2005). Therefore, the present study was

conducted to find out the information about the Physico-chemical parameters of Kabo Lake water for the first time and find out possible reasons for sudden fish death. So, the result of this study may provide primary data about the lake for further scientific study, help to extend sustainable lake management, monitoring of water quality, indicate the problem of the lake identified and recommend accordingly and point out possible solutions.

## MATERIALS AND METHODS

### Description of the study area

Lake Kabo is a small, circular and natural lake located in Ethiopia in Gambela Regional State, Majang zone, Godere worada, Gubeti kebele (Ethiopia). It is located about 651 km from Addis Ababa and 40 km far from Teppi town. It lies at Latitude: 7°18'10.36"N and Longitude: 35°16'5.42" E, at an elevation of 1397 m above mean sea level.

### Sampling technique and sample collection methods

Four sampling stations on the lake were taken to identify and analyze the problem of the Lake. These selected sites were according to the iterance of water to the lake, the exit site of water out of the lake and area mostly preferred by fish or traditional fishing activity performed. Samples were taken from all four selected stations every month starting from October 2017 to August 2018 in the morning by direct immersing of polyethylene vessels (PVC) just below the surface of the lake at the depth of 50 cm. Sites on the lake's body coded SS1 for entering of small river into the lake, SS2 (exit site of the lake), SS3 (at the center of the lake) and SS4 (sites of fishery activities performed by local society traditionally).

### Experimental methods and procedures

One liter of water sample from each sampling station was taken and placed in a polyethylene bottle, coded and transferred cold to the laboratory for analysis as per the standard methods suggested by APHA (1992). The samples were analysed in triplicate. Samples for pH, temperature ( $T^{\circ}$ ), transparency, TDS (total dissolved solid and electrical conductivity (EC) were analyzed *in situ* using a portable standard laboratory pH meter (pH 600, range 0.0/14 pH, accuracy + 0.1); electrical conductivity (EC) was determined by portable EC meter (conductivity meter cc-101, Elmron I P67 model). Water samples for DO and total alkalinity were analyzed in the Teppi National Soil Laboratory. All field meters and equipment were checked and calibrated according to the manufacturer's specification. Total alkalinity was estimated titrimetrically using 0.02N, HCl with Bromocresol Green and DO was measured titrimetrically based on Winkler method/procedure. The transparency of the lake was determined with the aid of the Secchi disc. The disc was lowered into the water and the depth at which it disappeared was observed and recorded. It was there after gradually withdrawn from the water and the depth at which it became visible was noted and recorded. The transparency of the water body was calculated as the mean of the two readings.

The Lake water was analyzed for its minerals following AOAC (1990). Sample (0.5 L) was digested by using HNO<sub>3</sub> and perchloric acid at ratio of 7:3 on hot plate until solution turned colorless. Digested sample was diluted for mineral analysis. Sodium, potassium and calcium were calculated on Flame Photometer-410

(Sherwood Scientific Ltd., Cambridge); on the other hand, copper, iron, magnesium and phosphorus were determined through Atomic Absorption Spectrophotometer (Varian AA240, Australia).

### Statistical analysis

Comparison of physicochemical characteristics of the lake water was made with WHO standards (1993), BIS standards (1991) and other related documents. The data were exposed to descriptive statistical analysis. Statistical package for social sciences (SPSS version 19) was used to govern the mean, standard deviation and range values. Pearson correlation was performed using simple Pearson correlation method. The results of water parameters were also compared with water quality standards to check whether the lake water is within the acceptable range to fish or not.

## RESULTS

Monthly physicochemical analysis was made in different parameters. The maximum pH was registered in March (8.7), TDS (251.3 mg/L) in June, TA (195 mg/L) in August and February, EC (191 mg/L) in August, DO (4.7 mg/L) in June and the maximum temperature was 24.6°C in the month of April (Table 1). The annual mean temp., pH, TDS, total alkalinity, EC and DO of the lake were 23°C, 7.65, 205.64, 173.3 and 4.34 mg/L respectively (Table 2). The annual mean DO value of the Lake Kabo was 3.033±0.18 to 4.2 ± 0.24 mg/L. The least value was 2.8 mg/L while 4.7 mg/L was the maximum DO value (Table 2). The annual mean values of PO<sub>4</sub><sup>-3</sup>, Chlorides and Ca<sup>++</sup> were 0.1, 1.5 and 7.6 mg/L respectively (Table 3).

## DISCUSSION

Most waters are suitable for fish production, although tolerance to different water quality parameters varies among fish species. The physicochemical characteristic of water is important determinant of the aquatic system. Their characteristic is greatly influenced by climatic vegetation and general composition of water. The lake was surrounded with larger natural forest trees and the location of the lake can be the reason for preventing sun ray to reach water surface.

pH regulates most of the biological processes and biochemical reactions. The pH showed fluctuation throughout the study period showing monthly range of 6.1-8.7 and annual mean of 7.65 ± 0.835) (Table 1). The maximum value of pH was recorded at sampling station SS4 (site from River entry, in the month of July) which is 8.7 and the minimum value of pH was recorded at sampling station S1, (recorded 6.1 in the month of August). The maximum mean value of pH was recorded at the SS1 (7.71 ± 0.9) and the minimum value was 7.6140 ± 0.9 at SS3. The result of this study revealed that the pH value for all analyzed samples was within the range of the acceptable limits set by BIS (1991) for different fish species. The pH showed strong positive

**Table 1.** Monthly value of physicochemical parameters of the Lake (Oct 2017-July 2018 G.C)

Par	T°				pH at 25 °C				TDS at 180 °C			
Month	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4
Oc	21	22	19	18	7.8	7.55	7.2	7.6	155	170	175	185
N	23.6	22.6	20	19	7.7	7.5	7.54	7.7	157	175	188	193
D	23	2	22	21	8.3	8.0	8.4	8.2	160	160	170	165
F	23.6	22.8	21	20	8.3	8.4	8.5	8.4	180	169	162	168
M	23	23	20	21	8.6	8.5	8.6	8.7	100	60	80	120
A	24.6	23.7	19	18	8.4	8.4	8.3	8.4	201	198	195	205
M	24	22	19	19	8.2	8.1	8.0	8.0	220	210	222	201
J	23	22.1	22.8	18.6	7.5	7.34	7.1	6.5	251.3	242	251	250
J	21	22.5	22	20	6.2	6.4	6.3	6.5	198	210	170	251
A	20	19	19	20	6.1	6.2	6.2	6.4	170	160	210	230

Month	Talk				EC at 25°C				OD			
S	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4
Oc	178	169	183	179	98	103	120	155	2.9	3.0	4.0	4.2
N	182	101	182	192	101	119	132	139	3.0	3.5	4.5	4.0
D	180	172	184	172	107	106	110	104	2.9	3.0	3.5	4.5
F	175	170	195	190	115	120	115	108	3.1	3.5	4.3	4.0
M	170	181	172	189	105	90	98	103	3.3	3.0	3.9	4.2
A	168	167	191	193	103	121	120	128	2.8	2.9	4.2	4.0
M	151	158	162	170	119	129	130	98	2.9	3.0	4.3	4.2
J	159	161	153	150	171	160	178	170	2.9	3.0	3.4	4.7
J	183	162	172	189	135	165	133	171	3.3	3.0	3.0	4.5
A	180	173	179	195	130	121	191	168	3.3	3.8	4.0	4.2

**Table 2.** The annual minimum, maximum and mean value of DO of the Lake **Kabo** based on sampling site (2017/2018)

Sampling stations	N	Minimum (mg/L)	Maximum (mg/L)	Mean (mg/L)	Std. Deviation
SS1	10	2.800	3.300	3.033	±0.177525
SS2	10	2.900	3.800	3.1416	±0.287492
SS3	10	3.000	4.500	3.8416	±0.503548
SS4	10	4.000	4.700	4.2083	±0.239159

**Table 3.** Annual physicochemical value (mg/L) of Lake **Kabo** (2017/2018 G.C)

Parameter	Mean value	Minimum and Maximum Value (mg/l)
T (°C)	23± 1.57928	(19.00-25.10)
pH	7.6508±0.83468	(6.10-8.70)
TDS	183.43± 64.89287	(60.00-320)
TA	172.85±16.87693	(101.00-195.00)
EC (µS/cm)	127.22±41.01139	(90.00-191.00)
DO	3.5800± 0. 59191	(2.80-4.70)
Ca <sup>++</sup>	7.6112±2.59149	(2.00-11.80)
PO <sub>4</sub> <sup>-3</sup>	0.1039±0.14598	(0.02-0.99)
Chloride (Cl <sup>-</sup> )	1.5102±0.67688	(0.89-3.00)

correlation with T° (0.727) p value < 0.01 and negatively correlated with EC (-0.601) and TDS (-0.832) significantly

at 0.01. The range obtained in this investigation was in line with the value suggested by Assiah et al. (2004).

**Table 4.** Pearson Correlation statistics of different parameters of Lake water (Lake Kabo/ 2016/2017).

Parameter	pH	T <sup>o</sup>	T.al	DO	EC	TDS
pH	1	0.727**	0.078	0.243	-0.601**	-0.832**
T <sup>o</sup>	0.727**	1	-0.109	0.399*	-0.614**	-0.574**
T.al	0.078	-0.109	1	0.197	0.103	-0.087
DO	0.243	0.399*	0.197	1	-0.289	-0.184
EC	-0.601**	-0.614**	0.103	-0.289	1	0.569**
TDS	-0.832**	-0.574**	-0.087	-0.184	0.569**	1

\*\*Correlation is significant at the 0.01 level (2-tailed). \* Correlation is significant at the 0.05 level (2 tailed).

In present study, the lowest value of water temperature was found in the month of August (19°C) and highest in May (25.1°C); while the annual average temperature was  $\sim 23 \pm 1.6^\circ\text{C}$  (Table 4). Sampling stations SS1 and SS4 scored maximum annual mean value (23.16°C) than the rest two sampling sites. The result was found below permissible limit for aquatic life as recommended by BIS (1991) (30-35°C) and Dennis et al. (2009) for tilapia fish (25-32°C) but it agreed with the report presented by Assiah et al. (2004) for fish (20- 30°C). However, the variations in water temperature may be due to different timings of collection, influence of the season and the effect of atmospheric temperature (Rajeev and Ajay, 2010).

Electrical conductivity estimates the amount of total dissolved salts (TDS), or the total amount of dissolved ions in the water. The conductivity is proportional to the amount of salts dissolved in water. In the present investigation, the lowest value of EC was obtained in October (98  $\mu\text{s}/\text{cm}$ ) and highest values (235  $\mu\text{s}/\text{cm}$ ) registered in July (Table 2), with the annual mean value of 150.59  $\mu\text{s}/\text{cm}$  (Table 5). The maximum average result was registered in August (206  $\mu\text{s}/\text{cm}$ ) and the lowest in February (108  $\mu\text{s}/\text{cm}$ ). The result of electric conductivity and total dissolved solid positively correlated with TDS ( $r=0.569$ ). The increase in electric conductivity was completely associated with the amount of dissolved solid in the analyzed sample waters. The EC level annual mean of SS4 was significantly greater than the rest three sampling sites ( $158.60 \pm 43.653$ ). The result obtained during the study period was low when compared with the value specified by BIS (1991) permissible limit for aquatic life. The lower value of total alkalinity and TDS directly correlated with  $\text{Na}^+$  and  $\text{Ca}^{++}$  concentration of the lake.

In natural water, dissolved solids are composed mainly of carbonates, bicarbonates, chlorides, sulphates, phosphates, nitrates, calcium, magnesium, sodium, potassium, Iron and manganese etc. (Esmaeili and Johal, 2005). Total dissolved solids indicate organic and inorganic matter in the sample. They originate from dissolution or weathering of the rocks and soil, including dissolution of lime, gypsum and other slowly dissolved soil minerals. It is aggregated amount of the entire floating suspended solids present in water sample. The

annual average TDS value registered in the lake was  $183.43 \pm 64.89287$  mg/L and ranged from 60 to 320 mg/L (Tables 1, 3 and 5). The highest value was registered in August (320 mg/L) and the lowest was 60 mg/L in the month of March (Table 1). SS4 had the highest value and SS2 recorded the lowest annual mean value,  $213.80 \pm 64.82935$  and  $199.7 \pm 68.3$  respectively. The TDS value of Lake Kabo agreed with the specified limit set by WHO (max 1000 mg/L) and BIS standard max 500 mg/L for drinking water quality standard. When the sample has low measurement of conductivity, the TDS is also consistently low at all stations.

Total alkalinity of water is the quality of water and kinds of components present in water such as bicarbonate, carbonate and hydroxide. Annual range was 101-195 mg/L with annual mean of  $172.85 \pm 16.87693$  (Table 3). The lowest value was registered in April (101 mg/L) and highest value obtained in the month of February (195 mg/L). The value obtained in this investigation agreed with the permissible limit set for aquatic life by BIS (1991) (max 200 mg/L) and with the document prepared by Dennis et al. (2009) for tilapia fish (100-250 mg/L). SS4 had the highest annual mean value ( $181.90 \pm 14.25521$  mg/L) and SS 2 registered the lowest value ( $161.40 \pm 22.25$  mg/L).

Fish obtain the oxygen that they require for their metabolic processes from the gas dissolved in water. The solubility of oxygen in water is low and depends on the temperature; at 5, 15 and 25°C the dissolved oxygen concentration is 12.8, 10.0 and 8.4 mg per liter respectively. Dissolved oxygen is an important limnological parameter indicating level of water quality and organic production in the lake. Fish exposed to deficient oxygen or fluctuation water do not take food, collect near the water surface, gasp for air (cyprinids), gather at the inflow to ponds where the oxygen levels are higher, become torpid, fail to react to irritation, lose their ability to escape capture and ultimately die (Svobodová et al., 1993).

Annual DO value ranged from 2.80- 4.70 mg/L with annual mean of  $3.5800 \pm 0.6$  mg/L. The lowest DO value was observed in April (2.8 mg/L) at SS1 and the highest were 4.7 mg/L at SS4 in June (Tables 1 and 3). This result was found to be below minimum permissible limit set by BIS (1991) for aquatic life (5-7 mg/L). Largest DO

**Table 5.** Annual minimum, maximum and mean values of parameters at each sampling stations (2016/2017)

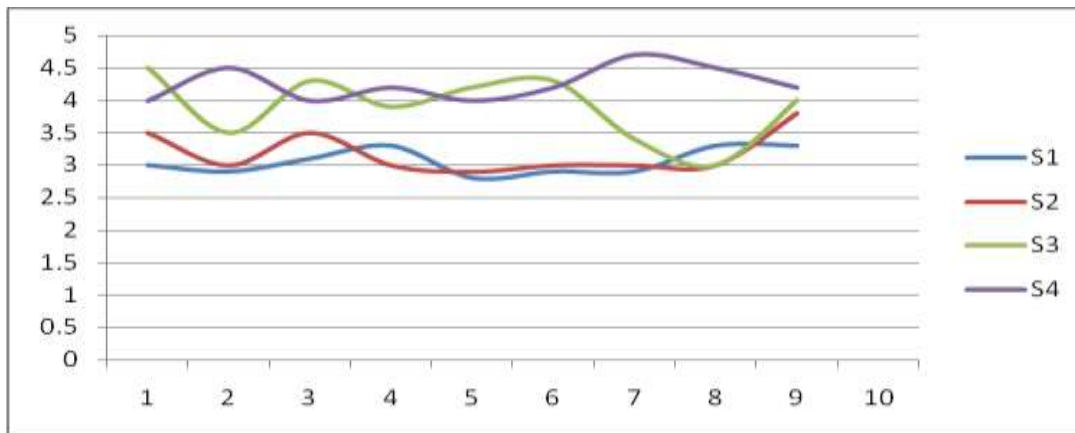
Sampling	Parameter	N	Descriptive statistics			
			Minimum	Maximum	Mean	Std. Deviation
SS1	T°	10	20.00	24.90	23.12	±1.59778
	PH	10	6.10	8.60	7.71	±.89001
	TDS	10	100.00	251.300	179.23	±4.1495
	T.al	10	151.00	183.00	172.60	±10.64790
	EC	10	98.00	171.000	118.400	±52.37907
	DO	10	2.800	3.300	3.03333	±0.177525
SS2	T°	10	19.00	24.90	22.791	±1.56678
	PH	10	6.20	8.50	7.6390	±0.81410
	TDS	10	60.00	242.000	175.40	+68.27729
	T.al	10	101.00	181.00	161.40	+22.2471
	EC	10	90.00	165.000	123.40	+36.53370
	DO	10	2.900	3.800	3.14167	±0.287492
SS3	T°	10	19.00	25.00	22.922	±1.66998
	PH	10	6.20	8.60	7.6140	±0.89204
	TDS	10	80.00	251.00	182.30	±70.43723
	T.al	10	153.00	195.00	177.30	±12.84134
	EC	10	98.000	191.000	132.700	±34.19231
	DO	10	3.000	4.500	3.84167	±0.503548
SS4	T°	10	20.00	25.10	23.16	±1.70633
	PH	10	6.40	8.70	7.64	±0.87331
	TDS	10	120.00	251.000	196.800	±64.82935
	T.alk	10	150.00	195.00	181.90	±14.25521
	EC	10	98.000	171.000	134.400	±43.65318
	DO	10	4.000	4.700	4.20833	±0.239159

value was recorded at sampling site coded as SS3 and SS4 (Table 2). These sites were identified as sites where fish are abundantly located on the lake. The annual DO mean value and monthly value of the Lake Kobo at SS1 and SS2 were below the minimum permissible limit for fish and aquatic life as suggested by WHO (1993)/BIS (1991). The only fish species inhabiting the lake was tilapia type of fish and other fish inhabit the lake not found at the time of study. Tilapia fish prefer >5 mg/L and tolerate 3-4 mg/L of DO level (Lloyd, 1992). Values lower than this can put fishes to stress and levels reaching less than 2 mg/L may result to death. The dissolved oxygen (DO) is the most important source of the aquatic atmosphere and photosynthetic process for the green plants and also a determining factor of the water quality of an aquatic ecosystem (Rajeev and Ajay, 2010). In this finding the less DO level registered (<4 mg/L) in 75% of lake sites was suggested problem for fish death on Lake Kobo. The reduced level of DO is due to the stirring effect of the in-coming flood towards the lake resulting in the mixing of surface waters to reduce pH (Figure 1).

Clarity of lake water is affected by algae, soil particles, and other materials suspended in the water. However,

Secchi disk depth is primarily used as an indicator of algal abundance and general lake productivity. Although it is only an indicator, Secchi disk depth is the simplest and one of the most effective tools for estimating a lake's productivity. The Secchi disk values can help to estimate the low concentration of chlorophyll, algae and TSS present in the lake. The Secchi disk value obtained in this study ranged from 35-66 cm and annual average value was 48.32 cm which is above the specified limit (25-30 cm) proposed by Assiah et al. (2004).

Pearson Correlation was made among the parameters identified in the study. TDS has a strong negative correlation with PH and T<sup>0</sup> which were  $r = -.832$  and  $r = -.574$ , respectively; positive correlation with EC and vs. EC have negative correlation with PH and T<sup>0</sup> while positive with TDS. Temperature has strong positive correlation with pH (0.727) at 0.01 significance level (Table 4). Biological properties are essential to determine the lake's condition and in making informed lake management decisions. In this study direct measurement of Biological parameters (Phytoplankton and zooplanktons) was not studied instead indirect estimations were conducted. Algae, microscopic aquatic



**Figure 1.** Fluctuation of dissolved oxygen (DO) in the Lake Kabo from the month of October to August 2016/2017 G.C.

animals, watercolor, and suspended sediment interfere with light penetration and reduce water clarity. Hence, secchi transparency is considered an indirect measurement of how much algae and sediment is the water. The water transparency of the Lake Kabo (Secchi depths ranged from 35-66 cm) which is the indication of very clear water deficient of microscopic organisms. The Secchi disc values obtained in this investigation indirectly showed us the low concentration of chlorophyll and algae, which can be indirect indicator for low level of DO in the lake due to their less abundance.

Calcium is an essential component for fish, and moderate calcium levels in water help in fish osmoregulation during stressful periods. The annual range of  $\text{Ca}^{++}$  registered at the study time was 2.00 -11.80 mg/L with mean value of 7.6112 + 2.59149. Most results were under the desirable value (>20 mg/L) and similar with the acceptable range > 5 mg/L.  $\text{PO}_4$  is a component of most waters; it recorded value obtained in this study ranged from 0.02-0.99 mg/L with annual mean of 0.1039 + 0.14598 mg/L, and for Chloride, it ranged from 0.89-3.00 mg/L with annual mean value of 1.5102 ± 0.67688 mg/L (Table 5).

## Conclusion

From the result obtained during the study period, major conclusions were drawn. The Physicochemical water quality of Lake Kabo at the study time revealed that water dissolved oxygen (mg/l), temperature and pH level fluctuation were found as the reasons for the sudden death of the fish.

## RECOMMENDATIONS

The critical problem of the lake was fluctuation of DO and

pH level. So, it is recommended that the level of phytoplankton in the lake should be enhanced through wise use of minerals for their growth and farther production of oxygen. Forest canopy that prevents the penetration of sun light should be avoided.

## CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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