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HABITATS CHARACTERIZATION OF HAPLOCHROMINES IN LAKE KIVU

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ABSTRACT
Living conditions of *Haplochromis kamiranzovu* Snoeks 1984 and *Haplochromis insidiae* Snoeks 1994 in Lake Kivu was characterized in order to know the preferred habitats for the species as this has a lot of effect on the survival of the species in terms of food availability and reproduction. For this purpose, a CTD probe **(**Sea & Sun Technology, CTD60M-Probe) was used to measure five prime physico-chemical parameters in each fish sampling locations in the littoral and pelagic zones of the Northern and Southern parts of the lake. The water temperature (°C), dissolved oxygen (OxyGd), turbidity (FTU), dissolved oxygen (DO-mg) and salinity (g/L) were measured at all fish sampling site. All these parameters were then analyzed with the software packages Excel and Ocean Data View (for interpolations). Physico and chemical parameters were found to vary in all fish sampling locations which imply that Lake Kivu is composed of heterogeneous habitats. Aquatics plants sampled in those locations in Lake Kivu were identified and were found to be useful for protection and reproduction of the studied species. Due to the sampling at different habitats in the study area, it was observed that both species of haplochromines studied occur preferentially in the sandy and rocky habitat.

KEY WORDS: Characterization, Habitat, Haplochromis, Lake Kivu.

INTRODUCTION

Water as a habitat for fish must carry dissolved useful gases, minerals and other substances of sorts and in such amounts that are not harmful to fish (Adeyemi & Ipinjolu, 1999; Adeyemi, 2011). The habitat also consists of physical features, basically the contours of the lake basin with depths, high ridges, rocks, gravel beds, silt areas, mud deposits, stumps, and fallen trees. Also growths of submerged aquatic plants, filamentous algae and shoreline vegetation are part of the physical habitat as well as of the biological environment (Adeyemi & Ipinjolu, 1997). Other parts of the biological environment include bacteria, plankton, fungi, aquatic invertebrate fauna, aquatic birds and a few kinds of vertebrates other than fish (Adeyemi *et al.,* 2009). Some of these organisms provide food, some are enemies and others change with time, being enemies of small fish at first and later as these same fish grow become their food supply (Adeyemi *et al*., 2007). Limnological parameters of the aquatic environment have been found to influence yields and production from lakes. Rawson (1952) demonstrated that it was possible to estimate fish yields for a particular lake from the lake's mean depth. Ryder (1965) later introduced the effect of Lake Fertility, which is indicated by the total dissolved solids and with that developed the now well- known Morpho-Edaphic Index (MEI) which has become an empirical concept. Recently, Janjua *et al*., (2008) predicted a high fish production from Shahpur dam, Pakistan, using MEI derived from physico-chemical parameters, while Kantoussan *et al.,* (2007) used it as indicator in evaluating fish yield in two tropical lakes of Mali, West Africa. Rivers, lakes, dams and estuaries are continuously subjected to a dynamic state of change with respect to the geological age and geochemical characteristics (Adefemi *et al*., 2007). Temperature plays a very important role in the aquatic environment. Certain organisms including fish are very sensitive to water temperatures. According to de Graaf *et al*. (1995) the maturation of *Clarias gariepinus* is influenced by annual changes in water temperature and periodicity. Schlesinger and Regier (1982) used it in conjunction with MEI to predict fish yields. Bouton *et al.,* (2000) found that the head shapes of Haplochromines of Lake Victoria are correlated with eight environmental variables. The same type of correlation was also studied in the case of some Haplochromines from Lake Malawi (Kassam *et al*., 2003a, 2004). Marginal F-statistics for the more complex models revealed that breeding type and water depth also have a significant effect on shape; the most important ecological variable for predicting shape of the fish was the feeding preference followed by water depth in Lake Tanganyika (Clabaut *et al*., 2007). It was also stated that the abiotic environmental conditions may have an impact on feeding performance of fish (Witte *et al.,* 2007). Furthermore, the size of the mandibles muscle is known to be influenced by dissolved oxygen (DO) of cichlid fish (Chapman *et al.,* 2000); Chapman *et al.,* 2008). Pharyngeal jaw traits may also be modified by indirect effects from the abiotic environment through architectonic interdependency and interaction with the gill arches and muscles of the head (Mallatt, 1996; Smits *et al*., 1996b).

The main purpose of the study was to characterize the habitat condition of the studied haplochromines species in Northern, Southern parts, littoral and pelagic zone of the Lake Kivu in order to indicate their preferential habitat as this has a lot of effect on the survival of the species in terms of food availability and reproduction. This was done by determination of physico-chemical properties of water at Northern, Southern, pelagic and littoral sampling locations of the lake, identification of aquatic and

terrestrial plants surrounding the sampling site, determination of substrate nature of the sampling point and identification of aquatic birds

MATERIAL & METHOD

Study area

The study was undertaken in Lake Kivu**.** The Lake Kivu is situated in the Albertine Rift Valley between the Republic of Rwanda and the Democratic Republic of Congo. It covers a surface of 2370 km² out of which 1370 km² belongs to the Congolese territory (Villanueva et *al*., 2008). Some physical characteristics of the lake makes it a peculiar ecosystem: it stands at the highest point of Rift valley with an altitude of 1463 meters of altitude between 1°30' and 2° 30' of Southern latitude and between 28° 50' and 29° 23' of longitude in the North 4790 ft above sea level. Its position in the Rift also makes it exceptionally deep (480m), ranking as the 15th deepest lake in the world (Bernacsek, 1990). The lake reaches a depth of 70 m in its Southern part, with an average of 240 m depth at the Northern part. It is also home to the worlds tenth-largest in land Island, Idjwi, while settlements on its shore include Bukavu, Kabare, Kalehe, Sake and Goma in Congo and Gisenyi, Kibuye and Cyangugu in Rwanda. Largely influenced by two active volcanoes, the Nyiragongo and the Nyiramulagira, Lake Kivu contains about 60 km^3 of methane and about 300 km^3 of carbon dioxide, which are dissolved below 270 m depth (Bernacsek, 1990). The gas content in the lower strata of Lake Kivu was first reported in 1937 by H. Damas (Bernacsek, 1990). Lake Kivu is the only lake worldwide which contains a high level of dissolved methane, in addition to CO_2. Being much larger than Lakes Monoun and Nyos in Cameroon, which contain CO_2 only, the volume of gas in Lake Kivu is much higher (Bernacsek, 1990). The lake is further characterized by a relatively poor fish species variety, comprising about 29 species (Snoeks *et al*., 1997; Snoeks, 2000; Nshombo & Lushombo, 2010). The most diversified fish groups in Lake Kivu are the Haplochromines, most of which are endemic (Snoeks, 1994).

Locations

Some areas were chosen for physical and chemical measurements (Fig.1) taking into account the following three criteria: abundance of the studied haplochromines species in the site, site accessibility, the presence of similar physical habitat and suitable water velocity. These sampling areas were Littoral North, Pelagic North, Littoral South and Pelagic South. The most important location in Littoral North is called Paradise Motel bay. It is located about 300 meters away from the Bralirwa Brewery bay of Gisenyi. The most important Littoral South is named Nyamasheke bay. It is situated about 5 km away from the Kamiranzovu River where *H. kamiranzovu* Snoeks 1984 species was sampled by Snoeks for the first time. In each littoral zone, both species were present. Before the fishing took place, the depth, salinity, temperature and dissolved oxygen of the sampling site were measured. So also the water transparency was measured using the Secchi disc. (Tab.1). Aquatic and terrestrial plants in those localities were also identified. All fish specimens of both species sampled were adults based on minimal standard length of more than 50 cm. A Lake Kivu haplochromine fish is considered to be adult when it is sexually active; females individuals with mature eggs while males specimens display colour patterns (Snoeks, 1994). From June to July 2014, a physical and chemical survey was conducted in two (North and South) parts and zones (littoral and pelagic) of the Lake Kivu. In total, 15 profiles with a CTD probe was taken and the aquatic plants, where fish hide themselves, were identified under the guidance of a botanist expert in the National Herbarium of Rwanda. Many species of fish rely on aquatic plants at some point during their lives and often move to different habitats based on their growth stage. Many juvenile and some adult fish prefer habitats with aquatic vegetation. Figs.1, 2 and 3 are maps of Lake Kivu showing the study area. Identification of aquatic birds was done by ornithologist expert of Royal Museum for Central Africa/Tervuren (Belgium).

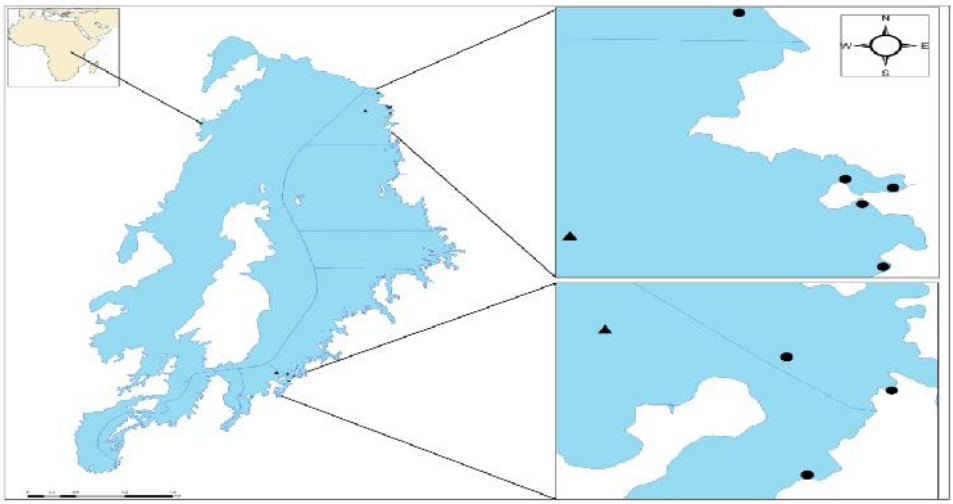

FIGURE1. Map of Lake Kivu and physico and chemical measurements locations in Rwanda part. Dots, triangle (●), (▲) represents the fish sampling location in the littoral and pelagic zones, respectively.

During the fieldwork activities the CTD probe **(**Sea & Sun Technology, CTD60M-Probe) Fig.2, was the key instrument and was submerged in water at a maximum depth of the biozone at different sampling sites in the Northern and Southern parts of the lake. This probe has sensors for conductivity, temperature, oxygen, pressure, pH and turbidity for in situ data collection. The water temperature (°C), dissolved oxygen (OxyGd), turbidity (FTU), dissolved oxygen (DO-mg) and salinity (g/L) were measured at fish sampling site using a CTD probe. All these parameters were downloaded and then analyzed with the software packages Excel and Ocean Data View (for interpolations).

FIGURE 2. Photos of CTD probe

Sampling zones and conditions

Overall 15 profiles were taken: Six from littoral zone Gisenyi (Sebeya, Kigufi, Bralirwa and near Kp1), four profiles were taken in Nyamasheke District and five profiles taken in Rusizi. The sampling conditions were good. In Rusizi sampling sites, the Secchi disc could not be used for the transparency of the water due to bad weather conditions. Many aquatic plants were also collected for laboratory identification at National Herbarium of Rwanda. The coordinates and fish sampling location are given in Tables (1 and 2). It was important to sample both biotic and abiotic aquatic parameters within each different shoreline habitat in order to characterize the complete fish assemblage and food base at each site.

RESULTS & DISCUSSION

Physico-chemical properties of water at Northern, Southern and Pelagic and Littoral sampling locations of the lake was determined, so also aquatic plants surrounding the sampling site was identified, substrate nature of the sampling point was determined in addition to the identification of aquatic birds and the determination of the habitat nature was down as shown in Tables 1a & 1b, Tables 2a & 2b and Table 3.

TABLE1a. Characteristics of fish sampling site at Northern part of Lake Kivu

Site No	Profile name	Latitude S	Longitude E	Max dept (m)	Habitat	Transparency Appearance/ Disappearance
1	Mouth of Sebeya	-1.70623	29.26040	14	Sandy Muddy Rocky	2m/1.70 m
2	Pelagic around KP1	-1.74315	29.24158	70	Muddy	5.50m/5.40m
3	Kigufi bay	-1.74834	29.27643	24	Sandy Rocky	4.5m/4.3m
5	Mashyuza bay	-1.73746	29.27402	24	Muddy	4m/3.7m
6	Bralirwa bay	-1.73724	29.27752	15	Muddy Rocky	2m /1.7m
7	Paradise Motel bay	-1.73470	29.27205	24	Sandy Rocky	3.80m/3.6m

TABLE1b. Characteristics of fish sampling site at Northern part of Lake Kivu

Site No.	Profile name	Identified aquatic plants	Abundance	Role
1	Mouth of Sebeya	Macroscopic algae	40%	Target place for fish feeding
		Pennisetum clandestinum Hochst	50%	
		Echinochloa sp	10%	
2	Pelagic around KP1	Phytoplankton	100%	Target place for fish feeding and reproduction
3	Kigufi bay	Macroscopic algae	30%	Target place for fish feeding
		Phragmites mauritianus Kunth	70%	
5	Mashyuza bay	Macroscopic algae	40%	Target place for fish feeding and reproduction
		Cyperus margaritacusVahl	50%	
		Phragmites mauritianus Kunth	10%	
6	Bralirwa bay	Macroscopic algae	40%	Target place for fish feeding
		Pennisetum clandestinum Hochst	50%	
7	Paradise Motel bay	Macroscopic algae	40%	Target place for fish feeding and reproduction
		Phragmites mauritianus Kunth	50%	
		Potamogeton pectinatus L.	10%	Target place for fish hiding

TABLE 2a. Characteristics of fish sampling site at Southern part of Lake Kivu (Nyamasheke and Rusizi)

Site No.	Profile name	Latitude S	Longitude E	Max dept (m)	Habitat types	Transparency Appearance/Disappearance
1	Karundura mouth	-2.30591	29.13442	10	Muddy	1.6m/1.5m
2	Kubuhabwa littoral	-2.29646	29.14163	30	Sandy, Rocky	2.45m/2.65m
3	Kubuhabwa littoral	-2.29114	29.13269	40	Sandy, Rocky	-
5	Kubuhabwa pelagic	-2.29309	29.11994	80	Muddy	2.61m/2.98m
6	Budijye A	-2.47586	28.87065	10	Muddy	-
7	Budijye B	-2.47458	28.90630	3	Muddy	-
8	Kamarari littoral	-2.44330	28.88289	25	Muddy, Rocky	-
9	Kamarari pelagic	-2.45082	28.87537	60	Muddy	-
10	Ex-Marine Island bay	-2.47688	28.89182	7	Muddy	-

TABLE 2b. Characteristics of fish sampling site at Southern part of Lake Kivu (Nyamasheke and Rusizi)

Site No	Profile name	Identified aquatic plants	Abundance	Role
1	Karundura mouth	Macroscopic algae	40%	Target place for fish feeding
		Pennisetum clandestinum Hochst	50%	
		Echinochloa sp	10%	
2	Kubuhabwa littoral A	Macroscopic algae	50%	Target place for fish feeding and reproduction
		Cyperus margaritacusVahl	30%	
		Phragmites mauritianus Kunth	20%	
		Schoenoplectus subulatus Vahl		
3	Kubuhabwa littoral B	Macroscopic algae	30%	Target place for fish feeding and reproduction
		Phragmites mauritianus Kunth	50%	
		Schoenoplectus subulatus Vahl	20%	
5	Kubuhabwa pelagic	Phytoplankton	100%	Target place for fish feeding and reproduction
6	Budijye A,B	*Echinochloa sp*	20%	Target place for fish feeding
		Phragmites mauritianus Kunth,	40%	
		Schoenoplectus subulatus Vahl	40%	
8	Kamarari littoral	Macroscopic algae	10%	Target place for fish feeding and hiding
		Schoenoplectus subulatus Vahl	50%	
		Echinochloa sp	20%	
		Potamogeton pectinatus L.	20%	
9	Kamarari pelagic	Phytoplankton	100%	Target place for fish feeding and reproduction
10	Ex Marine island bay	*Schoenoplectus subulatus Vahl*	-50%	Target place for fish feeding and reproduction
		Cyperus margaritacusVahl	-50%	

Vertical profiles

A CTD profile in the bio-zone area at a maximum depth of 60m was also sampled and it was observed that organisms including the Haplochromines fish population were present. However in Rusizi and several other places, the sampled area was shallow and the CTD probe could not touch the bottom. The 15 profiles taken from different places, excluding profile number 6 in RUSIZI because of its short depth (2.8m), were treated with ODV software, showing the vertical profiles from the surface up to 70 deep for; temperature, turbidity, salinity and oxygen parameters. The following Figures 3, 4 and 5 illustrate parameter values measured up to the bottom at Northern part of the Lake Kivu.

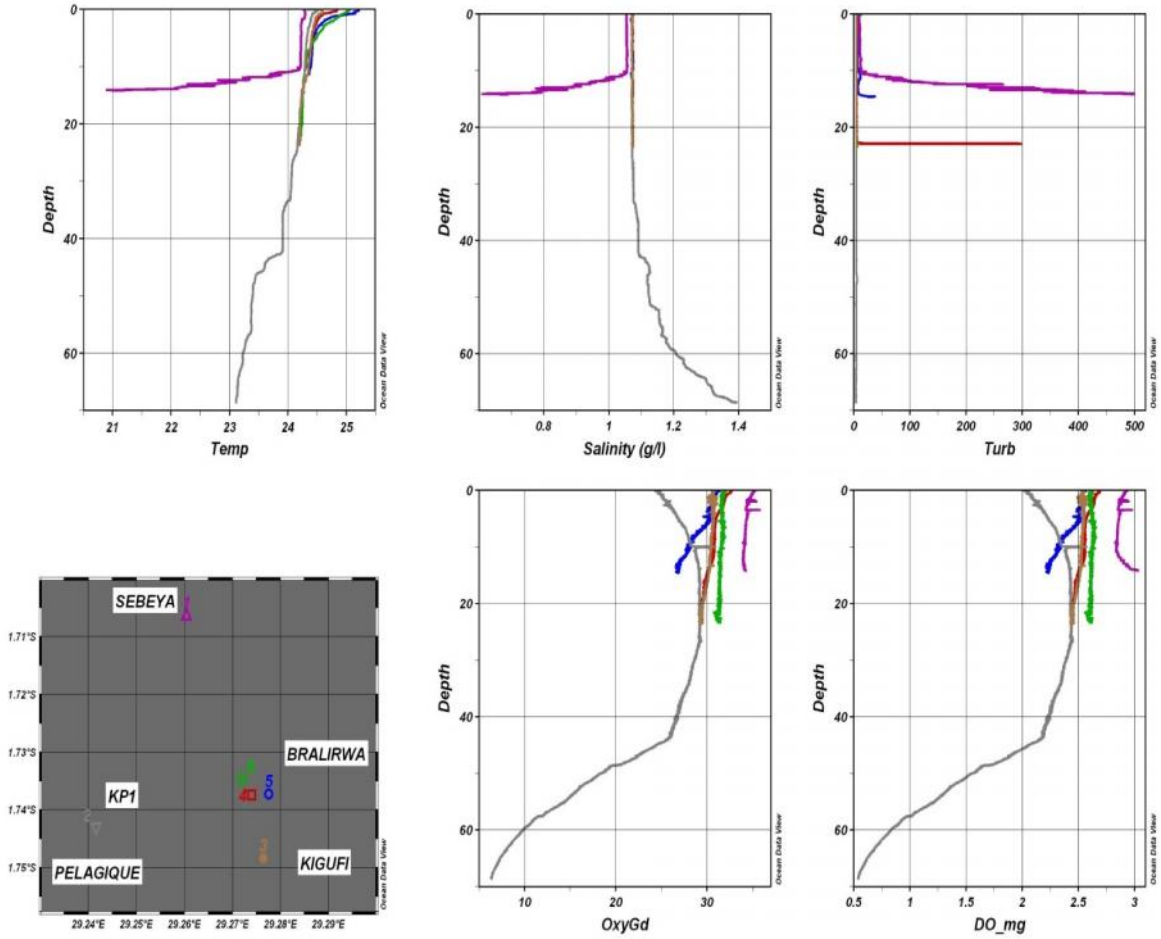

FIGURE 3. Temperature (°C), turbidity (FTU), dissolved oxygen (Do-mg) and salinity (g/l) for Gisenyi zone

The above graphs represent data taken at 4 sites in Gisenyi (Northern part of the Lake Kivu). All parameters were measured in the littoral and pelagic zones. The temperature was highest at the surface (0-2m) with a maximum of 25.5°C at Kigufi. The temperature slowly decreases down to 20 meters deep with a maximum of 24.4°C at Kigufi site. The lowest temperature at the water surface was 17°C at the Sebeya mouth. This could be due the Sebeya water input. From the littoral zone at 42 meters deep, the water temperature in pelagic zone decrease slightly. The salinity gradually decreased from (1.03 g/l) the surface water to 18 meters deep in littoral zone and increased continuously from (1.4g/l) at 42m till down in pelagic zone. The decrease of the salinity was paralleled to the dissolved oxygen in the pelagic zone. The following Figure 4, Kibogora in Nyamasheke District illustrates parameter values of physical and chemical parameters. This part of the lake is considered a southern part of Lake Kivu in this study. A visible decrease was seen in the temperature from 33.57m to 43.76m deep in a range of 23.84°C to 23.49°C with a difference of 0.35°C at Nyamasheke sampling site. In a pelagic zone at 71.43meters deep, the temperature decreased till 23.14°C. The salinity was 1.05 g/l at the water surface, appeared to be stable till 40.52 meters deep, from there, it decreased gradually with 1.50 g/l at 71.46 meters deep in pelagic zone. The turbidity at Karundura mouth was higher till 7.83 meters deep with 74.80 FTU and could be considered to be homogeneous in littoral zone. The turbidity at a certain point in pelagic zone to the 68.64 meters deep was 15.68 FTU; the CTD probe touched the sediment. The dissolved Oxygen gradually decreased from the water surface. At 0.25 meters deep, the dissolved Oxygen was 19.05 DO_mg. At the 35.06 meters deep, the dissolved Oxygen was 11.42 DO_mg. From 35.06 to 48.59 meters deep, the dissolved oxygen decreased from 11.64 DO-mg to 3.21 DO-mg.

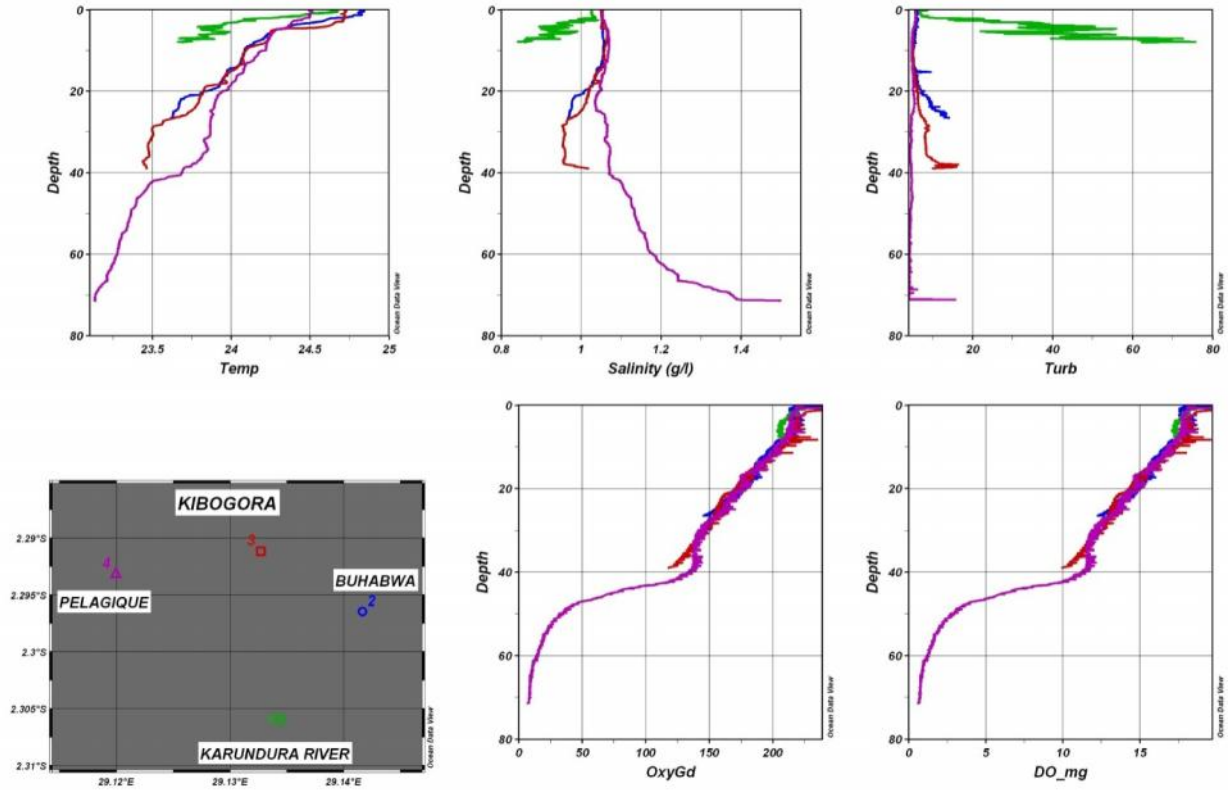

FIGURE 4. Temperature (°C), turbidity (FTU), dissolved oxygen (DO-mg) and salinity (g/L) for Nyamasheke zone.

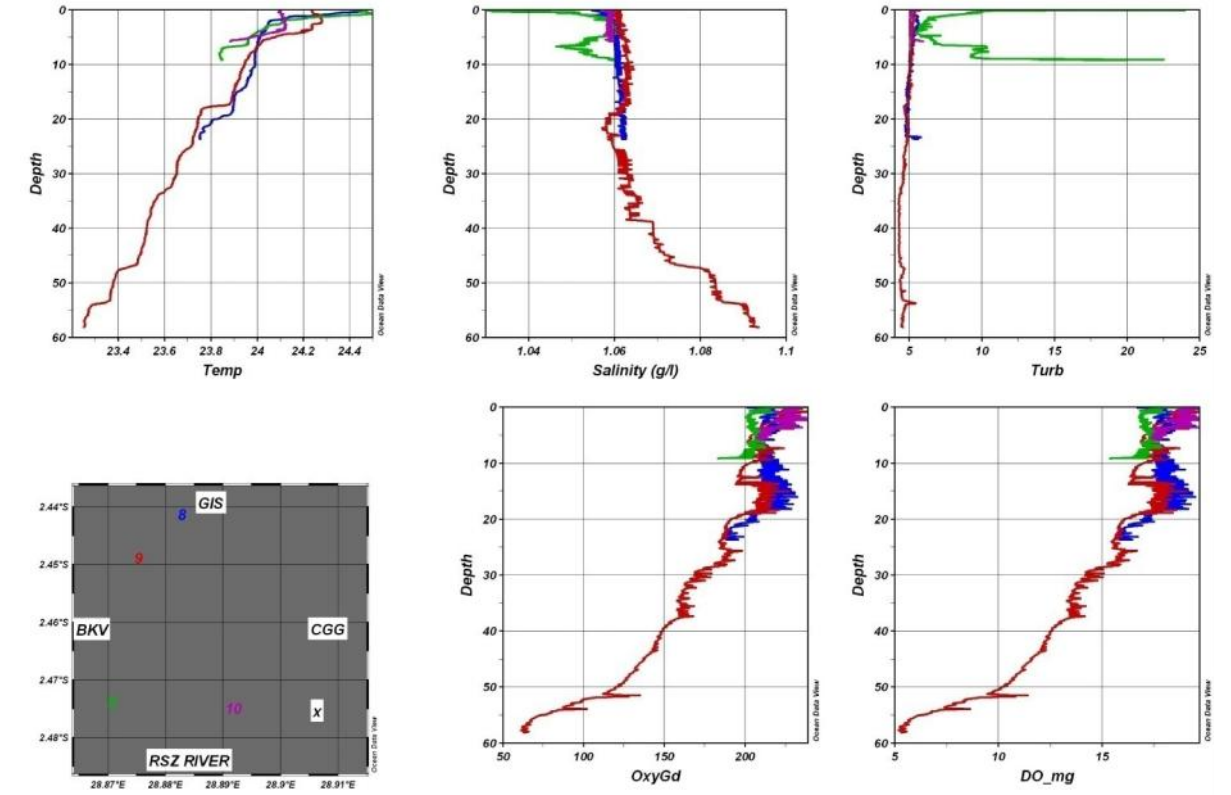

FIGURE 5.Temperature (°C), turbidity (FTU), oxygen (DO-mg) and salinity (g/L) for Rusizi zone.

The following Figure 7 illustrates the Temperature (°C), turbidity (FTU), oxygen (DO-mg) and salinity (g/L) values for Rusizi zone. The Rusizi area is an extreme southern part of the Lake Kivu. The water temperature (0-

4meters) had a range of 24.1°C – 24.4°C. From 4 meters deep, the water temperature and the dissolved oxygen decreased slightly. From 51.20 meters deep, the dissolved oxygen was 9.55DO_mg/l but at 51.47 meters deep, an increase of dissolved oxygen with 11.43 DO _mg (a positive peak) was observed. The salinity of the water surface decreased about 1.03 g/L to 1.06g/L. At 6.56 meters deep, the salinity gets a negative peak with 1.05 g/L at Budijye sampling site. The pelagic zone (60 meters deep) had salinity of 1.09 g/L. At this sampling location, the turbidity was 22.52 FTU at 9.13 meters deep.

Figs. 3, 4 and 5 present 15 profiles taken in 3 sampled zones (Gisenyi, Nyamasheke and Rusizi) and show that the lake was ordinarily stratified. The temperature looked normal in the biozone, warmer at the surface and cooling gradually downwards with the rivers inputs which made exception in neighborhood. Similarly, there were large differences in their turbidity; near the mouth of rivers had around 400 FTU (Sebeya), and lastly oxygen concentrations in Gisenyi zone were not quite homogenous compared to Nyamasheke and Rusizi. The horizontal interpolation is shown as follow Figs 6, 7and 8.

Horizontal interpolation

Water temperature in the Lake Kivu appears to be more or less uniform in the two parts and zones of the lake Fig.6. The difference of the temperature does not exceed (± 3°C) to all water levels considered. This reflects the prevailing weather conditions. This favors the performance of its function as a regulator of the physiological and ecological parameters of the fish (Body & Lichtkoppler, 1979). It enhances both the production of food for fish as well as influences the spawning time and year class strengths. These agree with the study of Alabaster and Downing (1966) and Mills and Mann (1985) that showed field and Laboratory Investigation of heated effluents on fish.

In general, we argue that the temperature of water may not be as important in pure water as in Lake Kivu, because of the wide range of the temperature tolerance in aquatic life, but in polluted water, temperature can have profound effects on dissolved oxygen (DO) and biological oxygen demand (BOD) (Verkatesharaju *et al*., 2010). Noted that the fluctuation in water temperature usually depends on the season, geographical location, sampling time and temperature of the effluents entering in the lake (Ahipathy, 2006). It was also experimented that water temperature is one of the most influencing environmental factors affecting pond dynamics and both the metabolism and growth of fish (Weatherley and Gill, 1983, Herzing and Winkler, 1986 and Body, 1990). Body (1990) mentioned that water temperature in fish ponds is related to solar radiation and air temperature. In the present study, water temperature was favorable for fish growth.

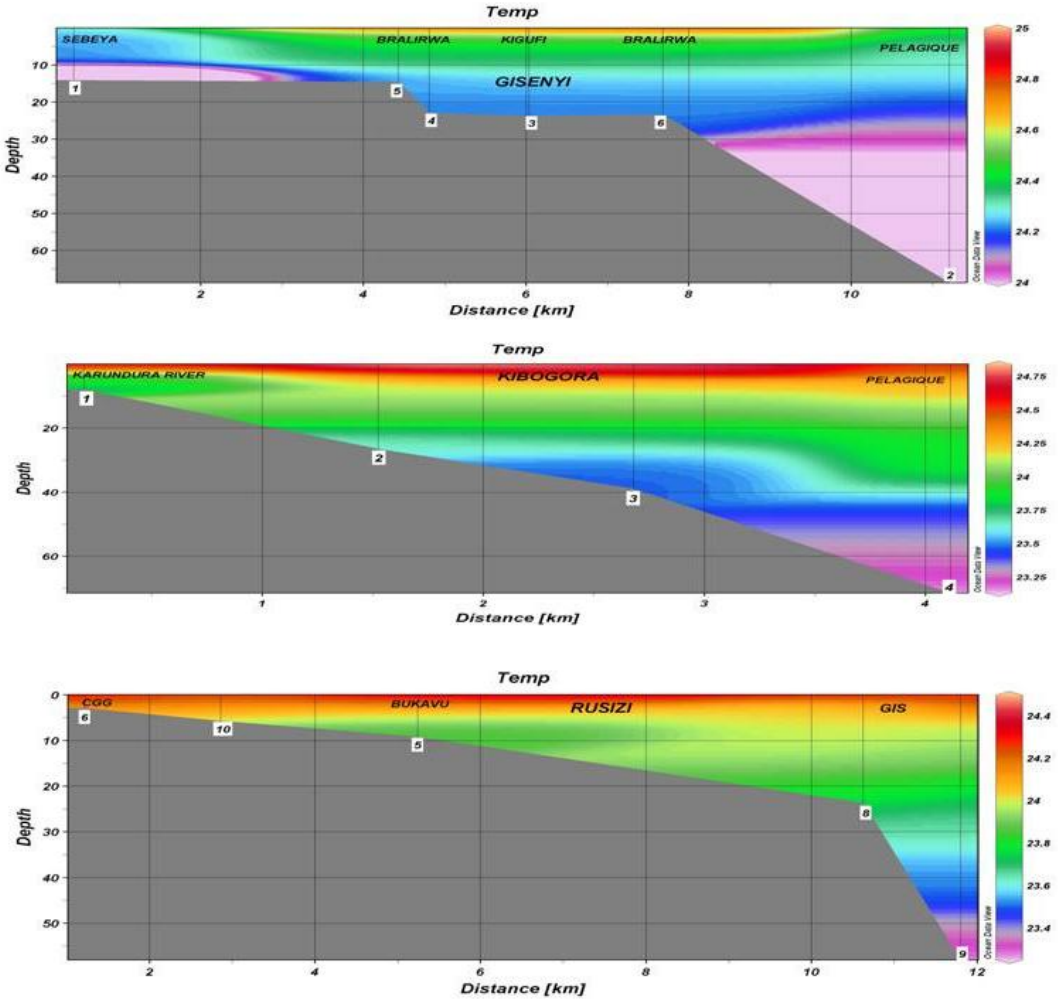

FIGURE 6. Temperature (°C) interpolated in all 3 zones.

Salinity fluctuation values were observed in the present study. This was due to the total concentration of all ions in different level of water, and fluctuation in total solids (Body and Tucker, 1998) Fig.8. Salam et *al*., (2000) also observed the fluctuation trend in salinity.

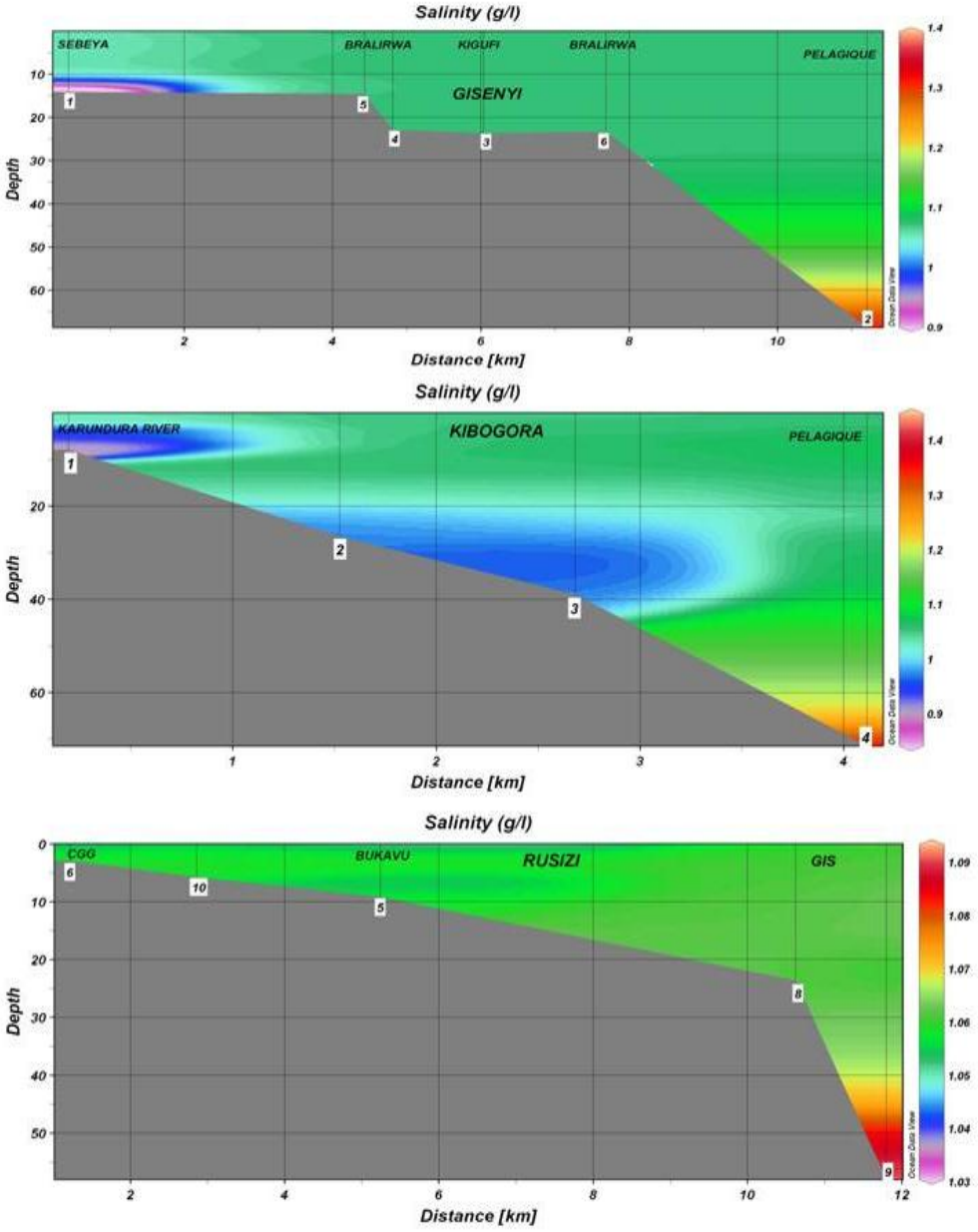

FIGURE 7. Salinity (g/L) interpolated in all 3 zones

Turbidity has quantitative and qualitative effect on light penetration and thus on phytoplankton production (Barnabe, 1990). Light penetration showed an increase to July and probably then, decreased till November due to the rain season. The clarity of natural body of water is an important determinant of its condition and productivity (Venkatesharaju *et al*., 2010). Turbidity in water is caused by suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, and plankton and other microscopic organisms. The Secchi disc visibility test indicated that the turbidity of the water which is usually caused by suspended soil particles and/or plankton abundance (Body, 1990). The present results showed higher visibility in the pelagic than in the littoral zones. This could be due to the lower abundance of phytoplankton in pelagic zone in northern part of the Lake Kivu. We could not make this test in southern part of the lake due to the bad weather conditions Tables 1 & 2.

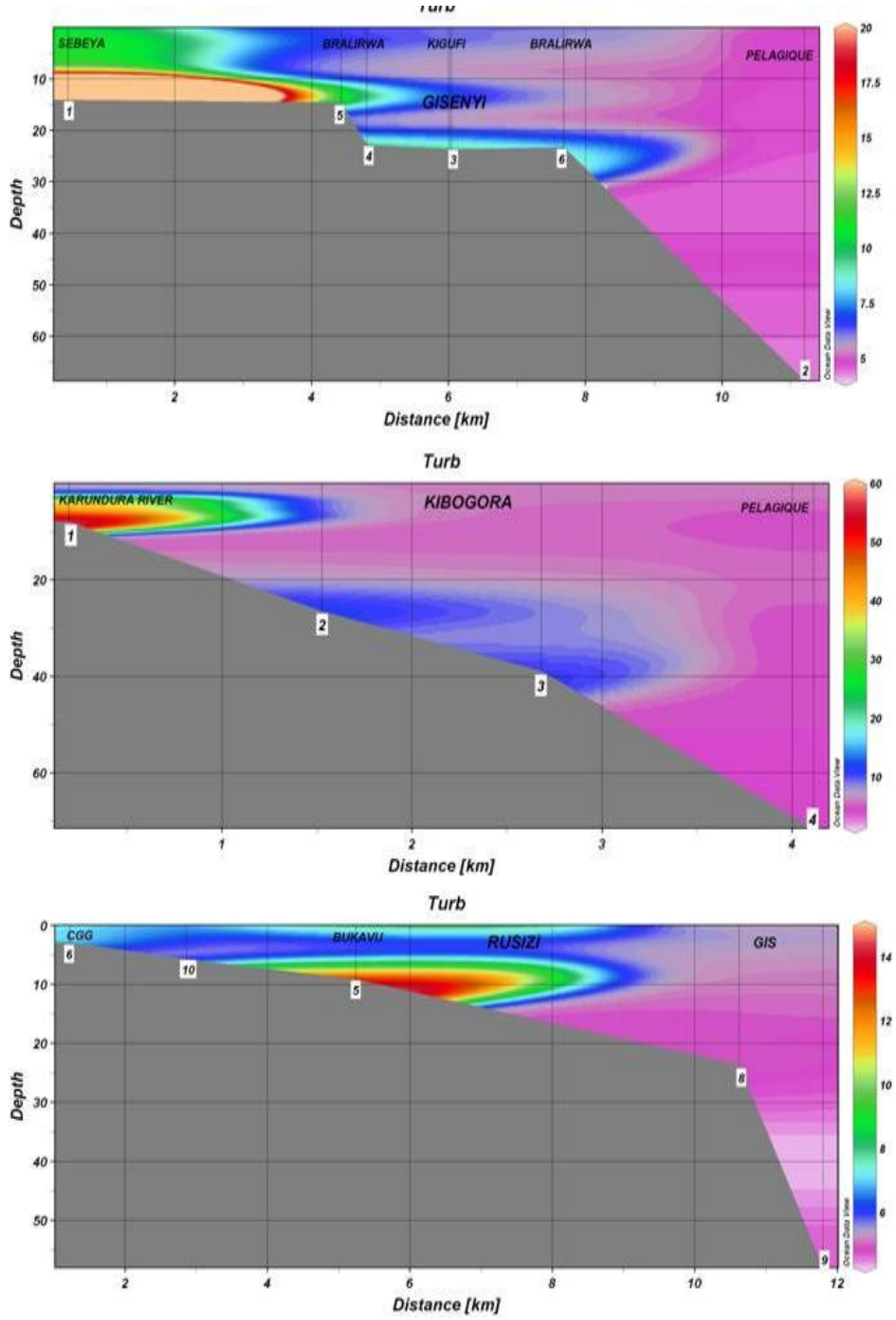

FIGURE 8. Turbidity (FTU) interpolated in all 3 zones

Dissolved oxygen is one of the most important factors in Lake Health. It is the single most important gas for most aquatic organisms; free oxygen (O_2) or DO is needed for respiration. DO levels below 1ppm will not be supported by fish; levels of 5 to 6 ppm are usually required for most of the fish population. DO fluctuation might be due to natural turbulence and higher algal productivity produces O_2 by photosynthesis in the rainy period and active utilization in bacterial decomposition of organic matter. Its deficiency directly affects the ecosystem of the lake. Down 70 meters deep in the Lake Kivu, there are no living organisms. The oxygen content in water measured Figure 11 depends on a number of physical, chemical, biological and microbiological processes (Verkatesharaju *et al.*, 2010).

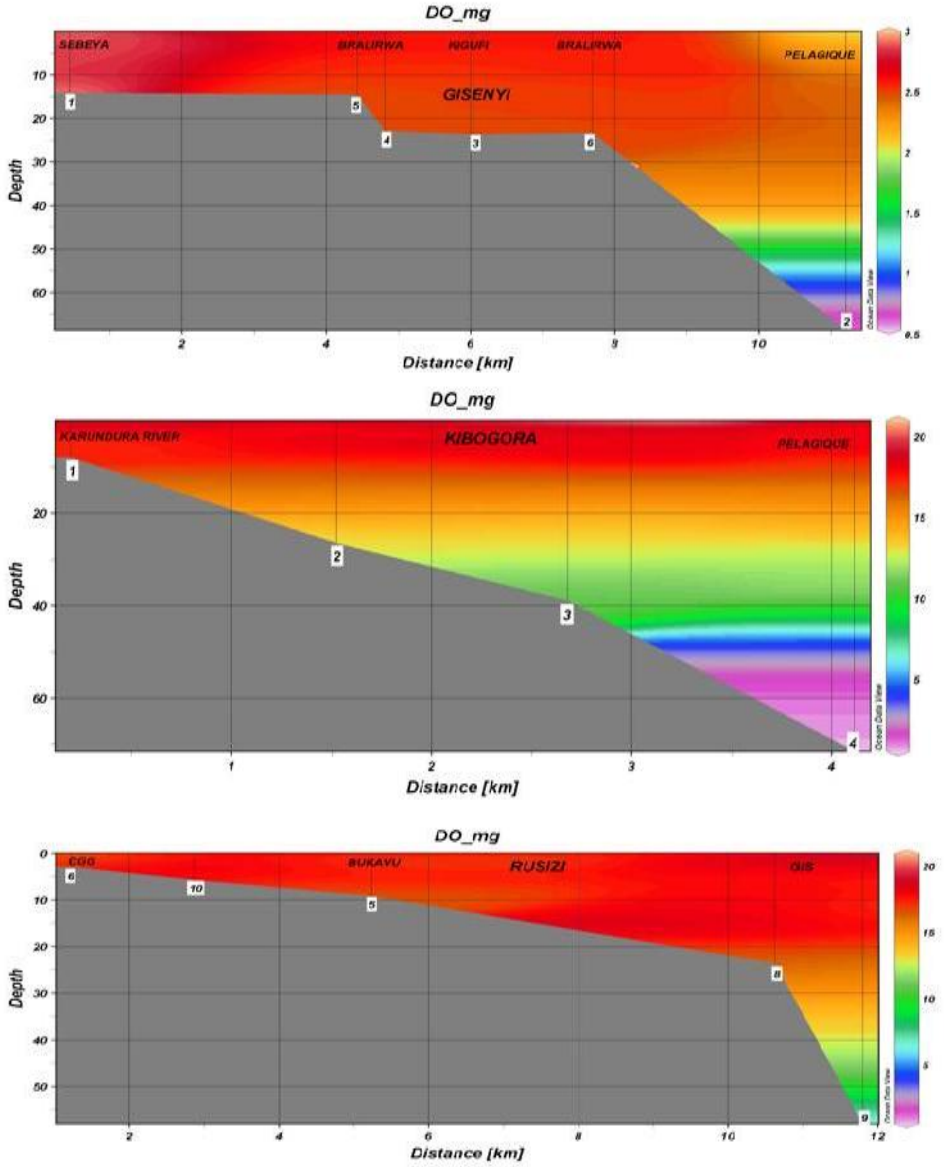

FIGURE 9. Oxygen (Do-mg) interpolated in all 3 zones

Temperature was homogeneous to the bio-zone of the lake, however the rivers inputs cooled the lake and increased the turbidity that was the case of Sebeya (North) and Karundura (South). The oxygen and salinity were homogeneous to the biozone of the lake with a small difference from the area next to the rivers mentioned above. pH is an important factor that determines the suitability of water for various purposes, including toxicity to animals and plants. In the present study, pH was found faintly alkaline in all 15 sites. It might be due to increased draining of domestic effluent water to the lake and microbial activities.

Aquatic birds

Fifteen aquatic bird species were found in Lake Kivu. They were identified by ornithologist expert of Royal Museum for Central Africa/Tervuren (Belgium). All of them were found in Southern and the Northern parts of the Lake Kivu Table 3. Aquatic birds can be influenced by the same environmental features of the lakes which affect fish and invertebrates, and can interact with these organisms directly as predators, competitors or prey (Paszkowski *et al.*, 2000). Further studies could assess concordance between the communities of fish, aquatic birds and other organisms on Lake Kivu. However, there is growing recognition that aquatic birds are members of lake ecosystems and can be influenced by the same physical and chemical features of lakes which affect other vertebrate and invertebrate organisms , and can interact with these organisms directly (Kerekes, 1994).

TABLE 3. Summary of Physical and Chemical characteristics of locations measured in Lake Kivu

Physico-chemical differences in fish sampling locations			
Regions	Habitat variables	Pelagic	Littoral
NORTH			
	Temperature (°C)	25 – 23	24 – 21
		24.33 - 23.11	25.20 - 21.19
		24.76 - 23.18	25.92 - 23.39
	Salinity (g/l)	1.09 - 1.4	1.09 - 0.2
		1.06 - 1.31	1.06 - 1.07
		1.07 - 1.38	1.07 - 1.68
	D- Oxygen (mg/l)	2.25 - 0.5	3 - 2.5
		7.07 - 1.48	7.74 - 3.63
		2.05 - 0.54	2.23 - 2.03
	Turbidity (FTU)	0.1	1.0
		11.72 - 5.53	10.53 - 6.20
		6.04 - 4.31	25.43 - 10.94
	Depth (m)	70	1- 24.00
	Transparency	5.50 - 5.40	2 - 4.5 and 1.70 - 4.3
	Habitat	Muddy	Rocky, Sandy
			Hydrothermal springs
	Dimension	Wide (500 m)	Short (50 m)
	Latitude S	-1.74315	-1.70623
			-1.74834
	Longitude E	29.24158	29.24158 and
			29.27752
	Predators	Birds	Birds
		Lamprichthys	
		tanganicanus	*L. tanganicanus*
			H. vittatus
SOUTH			
	Temperature (°C)	23.75 - 22.75	24.75 – 23
		24.81 - 23.14	24.81 - 23.45
		23.00 - 23.7	23.49 - 23.7
	Salinity (g/l)	1.01 - 1.5	1.01 - 0.8
		1.06 -1.1	1.05 - 1.06
		1.07 - 1.12	1.06 - 1.08
	D- Oxygen (mg/l)	5	10- 20.00
		0.53 - 2.69	3.01 - 24.48
		5-10.00	10.42 - 19.05
	Turbidity (FTU)	1 -18.00	11 - 75.00
		15.67 - 1.29	192.16 - 23.95
		4.00 - 4.25	5.25 - 4.5
	Depth (m)	50 -70	3 - 40.00
	Transparency	2.61 - 2.98	1.6 - 2.61 and 1.5 - 2.98
	Habitat	Muddy	Muddy, sandy, rocky
	Dimension	Short (about 20 m)	Short (50m)
	Latitude S	-2.29309	-2.29114
			-2.47688
	Longitude E	20.11994	28.87537
			29.14163
	Predators	Birds	Birds
		Lamprichthys	*Lamprichthys*
		tanganicanus	*tanganicanus*

TABLE 3. Aquatic birds species identified in Lake Kivu

N°	ID CODE	French name	Scientific name
1	880	Black Kite	*Milvus migrans*
2	580/1018	Reed Cormorant	*Phalacrocorax africanus*
3	1022	Common Sandpiper	*Actitis hypoleucos*
4	355/874	Pied Kingfisher	*Ceryle rudis*
5	533	Cattle Egret	*Bubulcus ibis*
6	397	Cattle Egrets and 1 Pied Crow	*Corvus albus*
7	1069	Great Cormorant	*Phalacrocorax carbo*

8	1034	Black-headed Heron	*Ardea melanocephala*

CONCLUSION

The study compared the physical and chemical parameters between Southern, Northern part and Littoral and Pelagic zones of Lake Kivu. Characterization of the bio-zone habitats preference of Haplochromis species was carried out using 15 profiles CTD probe in different parts of the Lake at Gisenyi and Cyangugu zones. The Ocean data view tool was used to observe the interpolation data. It was observed that the littoral zones of Northern part of Lake Kivu could be grouped into two different groups considering the chemical and physical values of pH, turbidity, salinity, dissolved oxygen and temperature. The first group composed of Brewery bay of Gisenyi and Mashyuza, which had more anthropogenic influences and also higher salinity, higher turbidity and less dissolved oxygen. The second group composed of Paradis Motel and Gapfunuka which were more preserved by macrophytes. The both studied haplochromines were found to occur preferentially in a sandy and rocky habitat.

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