# A BASELINE FISH SURVEY AND WATER QUALITY ASSESSMENT OF BUTIABA-WANSEKO AREA ON LAKE ALBERT

**Prepared for Environmental Assessment Consult Limited (EACL) by the National Fisheries Resources Research Institute (NaFIRRI)**

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## Introduction

Oil and gas exploration in the Albertine Graben are on-going activities by Tullow Oil Plc, and Heritage Oil and Gas (Heritage). Part of the activities involve 2-D TZ seismic surveys in exploration area Block 2 (Butiaba-Wanseko area) in Buliisa District. A study of the transition zone (basically along the shoreline was undertaken by National Fisheries Resources Research Institute (NaFIRRI) on behalf of Environmental Assessment Consult Ltd (EACL) during September 2007. A major objective of the study was to carry out a baseline survey of the fisheries and water quality of the lake shore between Wanseko and Butiaba prior to the proposed 2-D Seisimic investigation.

This report gives the baseline information specifically on water quality (physical/chemical, nutrient and phytoplankton biomass status) of the open part of the lake, a river flowing into the lake and a lagoon, within Butiaba-Wanseko area.

## Specific objectives of the study

1) To determine the physical-chemical characteristics of the waters in selected sites within the transition zone,
2) To determine and relate nutrient and phytoplankton biomass (chl-a) concentrations in the waters as an indicator of the productivity of the waters,
3) To determine the concentrations of oil and grease and total suspended solids as some of the major constituents suspected to contaminate the waters during the exploration/exploitation activities,
4) To search for evidence of entry of any contaminants from the catchment into the lake area of focus,
5) To search for evidence of water movement patterns that may indicate how contaminants might spread from the focus area.

## Study area

The study was conducted on Lake Albert along the shore between Butiaba and Wanseko fish landings (Fig. 1). Inshore stations were established at about 1 km from the shoreline. The offshore stations were established at a distance further away from the inshore stations towards open water but most importantly at water depths of at least 10m. The sampling stations were: Wanseko offshore (N02.13370$^o$, E031.33978$^o$), Wanseko inshore (N02.15640$^o$, E031.37234$^o$), River Waiga area offshore (N01.98545$^o$, E031.36533$^o$), River Waiga area inshore (N01.98604$^o$, E031.39238$^o$), River Waiga mouth (N01.98096$^o$, E031.40604$^o$), River Waiga up stream (N01.99221$^o$, E031.47591$^o$), Butiaba offshore (N01.84148$^o$, E031.21618$^o$), Butiaba inshore (N01.83873$^o$, E031.31240$^o$) and Butiaba lagoon, Boma (N01.81726$^o$, E031.34648$^o$).

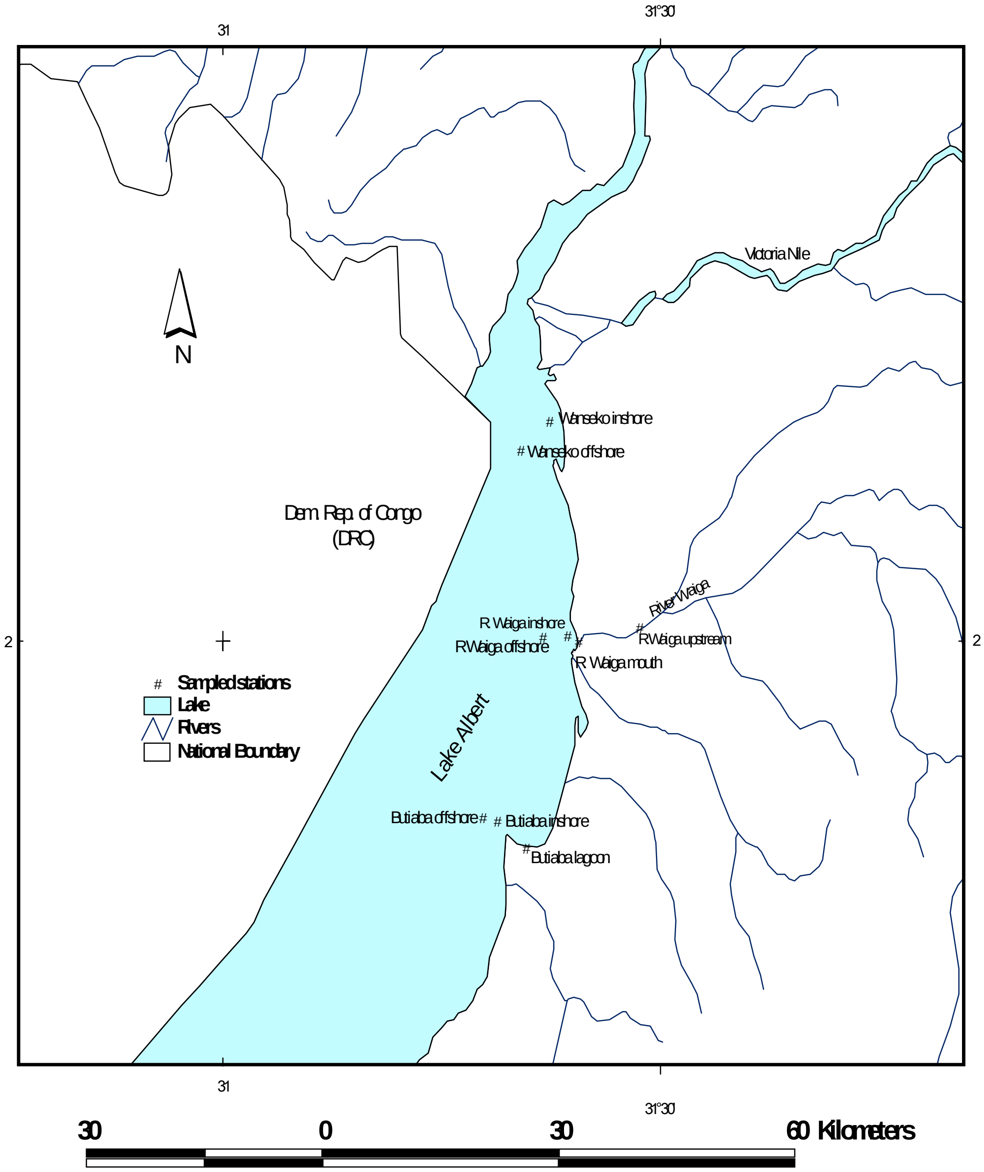



Figure 1: Sampling stations for water quality on Lake Albert between Butiaba and Wanseko

Wanseko stations are along a transect within 1 km to the south of Wanseko fish landing (a delta zone) where the Victoria Nile flows into Lake Albert. Wanseko stations were 11.6 and 4.4m deep at offshore and inshore waters, respectively. River Waiga stations are along a transect within 1 km to the south of Lubolwa fish landing, and it is the point where River Waiga from the east, flows into Lake Albert. Stations at River Waiga area were 11, 2.3, 0.5 and 0.3m deep at offshore, inshore, river mouth and river upstream, respectively. Butiaba stations are along a transect within 1 km to the north of Butiaba fish landing and their water depths, for offshore and inshore, were 38.9 and 26.2m, respectively. Butiaba lagoon was generally shallow (0.7m) with charactericistic emergent (mainly *Typha* spp) and submerged macrophytes close to some of the homesteads of Butiaba fish landing.

## Materials and methods

### Sampling procedures

Sampling at Butiaba-Wanseko area was conducted in September 2007. This period was wet. Physical variables namely dissolved oxygen (mg/L), temperature ($^{o}C$), pH and water conductivity (µs/cm) at the stations were measured *in situ*, using well-calibrated standard portable meters (Wagtech 983-030, WTW PH330 and HI 9033 multi-range). The variables were measured as depth profiles at all the stations except at the stations of River Waiga mouth and upstream, and Butiaba lagoon (Boma), which were very shallow (< 1 m). Water transparency and water depth (m) at all the sites were measured using standard Secchi disc and echo sounder, respectively.

Water samples for analyses of nutrients (total nitrogen, TN; nitrates, $NO_3$-N; ammonium, $NH_4$-N; total dissolved nitrogen, TDN; total phosphorus, TP; total dissolved phosphorus, TDP; and soluble reactive phosphorus, SRP), phytoplankton biomass (Chl-a), total suspended solids (TSS), and oil and grease, were collected using a Van Dorn sampler. Water samples were collected from 1 m below the water surface and at < 1m at shallow stations e.g. Butiaba lagoon (n=1 at each station). Water was transferred from the Van Dorn sampler to clean plastic sample bottles, which were placed in cool boxes containing ice blocks. Some of the water samples were filtered using Whatman GFC filter papers (47 mm, pore size 0.7µm). The papers were gently folded using fine forceps and covered in petri dishes containing silica gel. The Petri dishes were wrapped with aluminium foils to keep the samples in dark. Filter papers and water samples (filtered and unfiltered) were taken for extraction of chlorophyll a, and analyses for nutrients and suspended solids, respectively, at NaFIRRI in Jinja. The water samples (unfiltered) for oil and grease were transported to the laboratory of National Water and Sewage Corporation (NWSC) in Bugolobi, in Kampala, for analyses.

### Sample analyses

Nutrients and chlorophyll a (Chl-a) were determined following the methods of Stainton *et al*., 1977. Total suspended solids, and oil and grease in water were determined in accordance with methods of Greenberg *et al*. (1987).

### Data processing

Data was processed using MS excel program. The physical-chemical variables (dissolved oxygen, temperature, pH and water conductivity) at the stations were plotted as depth profiles, except those of River Waiga mouth, River Waiga upstream and Butiaba lagoon (Boma). Individual values of concentrations of oil and grease, total Suspended Solids, nutrients and Chl a, in water and sechhi depths, were tabulated.

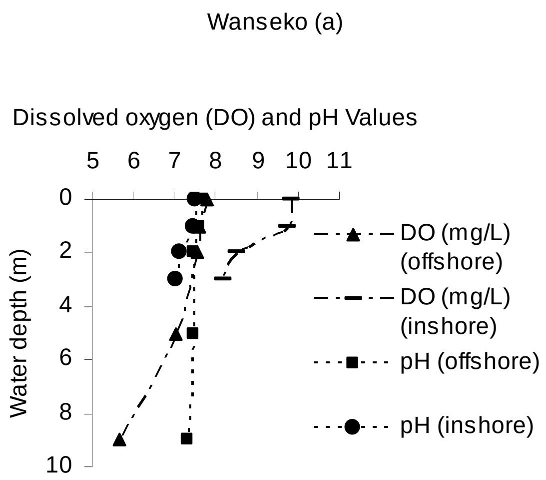
## Results

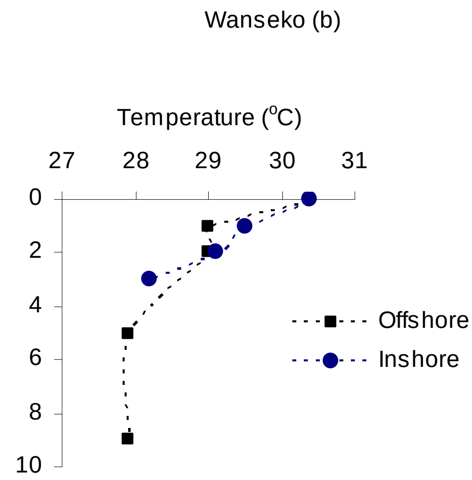
### Physical variables

The profiles of the physical-chemical variables namely dissolved oxygen (DO), pH, temperature and conductivity along the water column of the stations of Wanseko, River Waiga area and Butiaba were (fig. 2 and 3). Dissolved oxygen of more than 7mg/L was recorded in the epilimnion (upper water column, approx. 5m deep) of both inshore and offshore sites (Fig. 2a). In deeper waters (> 10m), e.g. at Butiaba, concentrations of DO, 6mg/L or less) were observed. At River Waiga mouth, 6.8 mg/L of DO was recorded while at an upstream station, 4.0 mg/L of DO was registered. At Butiaba lagoon, the mean value of DO was 9.3 mg/L. The concentration of DO at most stations, including the shallow Butiaba lagoon, was close to saturation.

The values of pH ranged from 7 to 9, with some slight decrease towards the bottom waters, in both offshore and inshore stations (Fig. 2a). The pH values of the shallow stations of River Waiga mouth, River Waiga upstream and Butiaba lagoon were about 7, 4 and 9, respectively.

Temperature values (Fig. 2b) were in the range of 27-30 $^{o}$C in waters of all the open lake stations. The upper layers (5m deep or less) of both offshore and inshore waters were generally warmer (28-30 $^{o}$C) as compared to deeper layers (about 27 $^{o}$C), as shown in the profiles (Fig. 2b). The temperature values of the shallow stations of River Waiga mouth, River Waiga upstream and Butiaba lagoon, were within the range of 29-30 $^{o}$C.



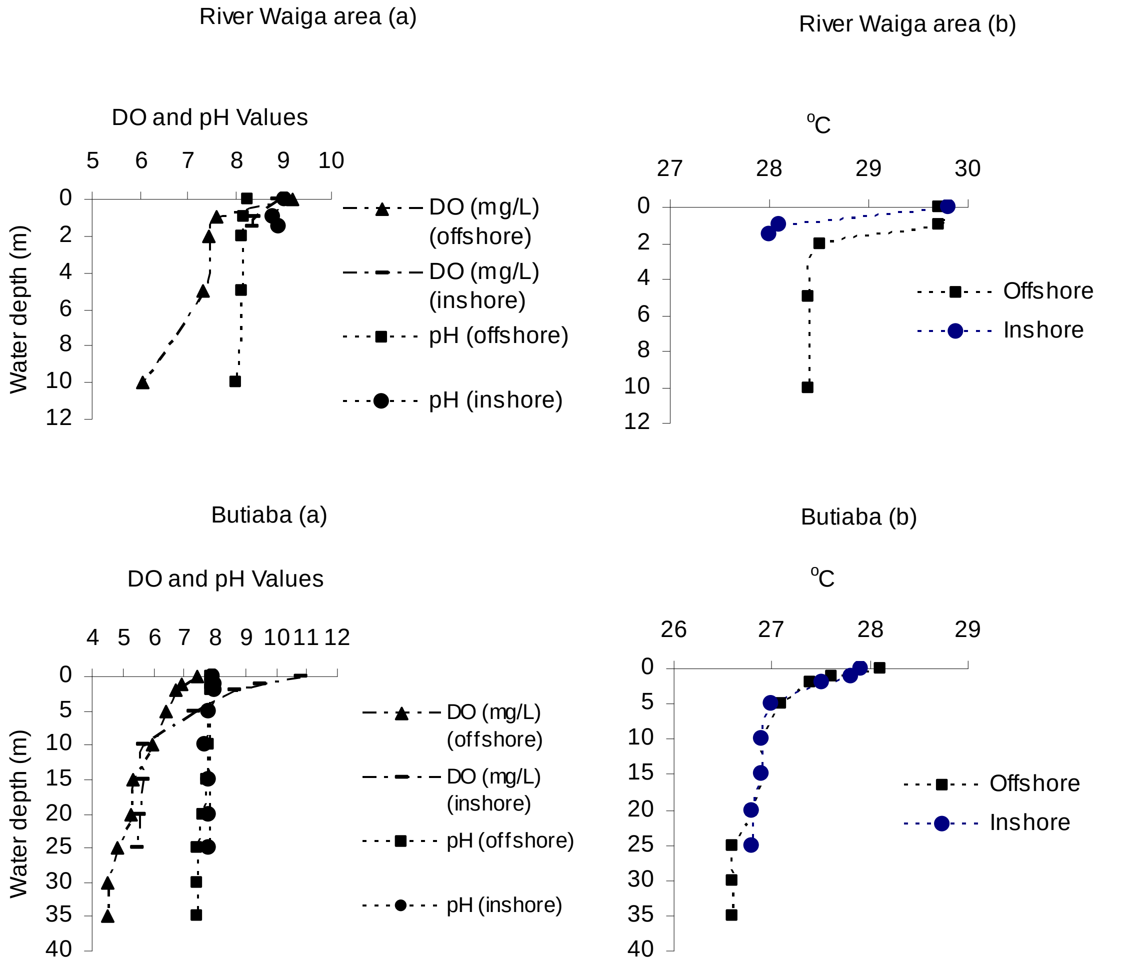



Figure 2: Profiles of dissolved oxygen (DO), pH and temperature at the sampling stations

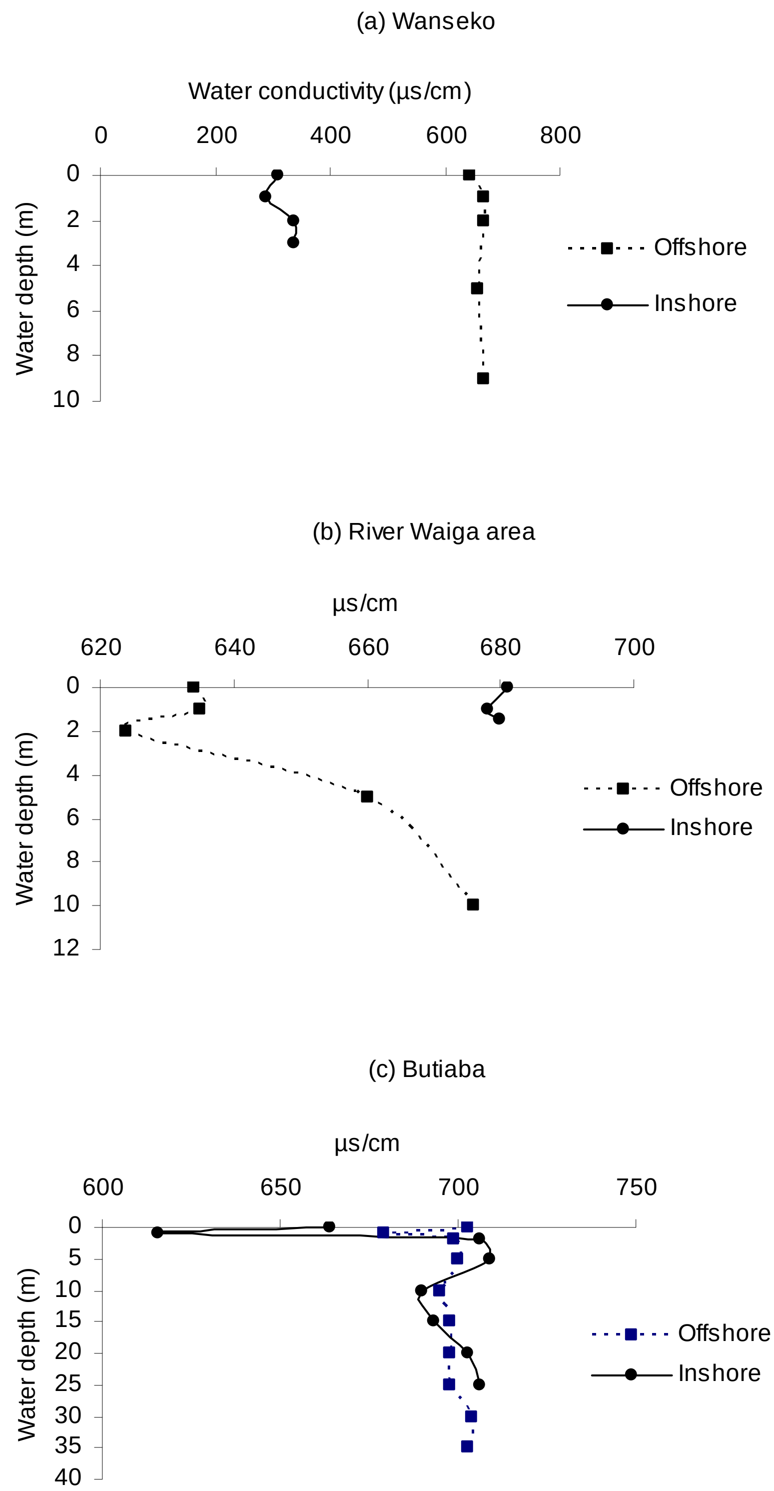



Figure 3: Profiles of water conductivity at the sampling stations

Conductivity values within the water column of both inshore and offshore open lake stations, ranged from about 615 to 700 µs/cm (Fig. 3). The inshore station of Wanseko however, recorded relatively low values (280-340 µs/cm). A slight increase in conductivity was noticeable towards the bottom portions of the waters. The water conductivity values of the shallow stations of River Waiga mouth, River Waiga upstream and Butiaba lagoon, were 344, 178 and 733 µs/cm, respectively.

**Oil and grease and total suspended solids**

The concentrations (µg/L) of total suspended solids (TSS) and oil and grease in waters of the sampling stations, are presented (Table 1). The values of TSS are significantly higher (30-50 µg/L) at Wanseko inshore, mouth of River Waiga and Butiaba lagoon as compared to the rest of the stations (1-7µg/L). The concentrations of oil and grease in the waters of all the stations are generally low (0-9 µg/L). However, within the mentioned range of concentrations of oil and grease, contamination by oil and grease seem to be becoming prominent at the upstream, mouth and inshore area of River Waiga and Butiaba inshore as compared to other stations.

**Nutrient concentrations and phytoplankton biomass as chlorophyll a**

The concentrations of TN at Wanseko inshore and offshore, and Butiaba offshore waters ranged from 685 to 760 µg/L (Table 2). At the stations of River Waiga, Butiaba inshore and Butiaba lagoon, relatively high values greater than1000 µg/LTN were recored, the highest value of 1660 µg/L being registered in the lagoon (Table 2).

Total Dissolved Nitrogen (TDN) values were in a range of 610 to 835 µg/L at all stations except in Butiaba lagoon, a value of 1035 µg/L was recorded. The values of $NO_3$-N were within 17-34 µg/L range at most stations but in Butiaba lagoon and Wanseko, 49.5µg/L and 64-67µg/L were registered respectively. The values of $NH_4$-N were within 25-39µg/L range at most stations except at the upstream of River Waiga, a high value of 60.6 µg/L was recorded.

Total Phosphorus (TP) values were lower (37.4- 41.7 µg/L) in Butiaba open lake waters compared to Butiaba lagoon concentrations of 66.0 µg/L. At inshore and offshore stations of Wanseko and River Waiga, TP values were comparable (46.0-58.9µg/L). Exceptionally high concentrations, 184.6-224.6 µg/L were measured at mouth of River Waiga as well as at site further upstream. Similarly, concentrations of Total dissolved phosphorus (TDP) were much higher at the upstream site and mouth of River Waiga, recording 170-189 µg/L as compared to 23-52 µg/L at other stations.

Soluble Reactive Phosphorus (SRP) was undetectable at Butiaba lagoon and very low at inshore and offshore stations of River Waiga, measuring up to 1.8 µg/L and 6.8 µg/L at Butiaba inshore. Wanseko inshore and offshore and Butiaba offshore waters recorded relatively much higher values, 10.2-21.8 µg/L SRP. The highest values of 171.8-221.8µg/L SRP were recored at the upstream and mouth of River Waiga. Chlorophyll a concentrations, are within the range of 10.2 to 13.9µg/L in most of the stations except at upstream, mouth and inshore of River Waiga and Butiaba offshore. Sechhi values are lower at Butiaba lagoon and Wanseko inshore as compared to other stations. At upstream and mouth of River Waiga, the sechhi values are equal to those of water depth (shallow areas).

Table 1: Concentrations of total suspended solids (TSS) and oil and grease at the sampling stations

| Station | Water depth (m) | Sample depth (m) | TSS | Oil and grease |
|---|---|---|---|---|
| Wanseko offshore | 11.6 | 1 | 3 | 0 |
| Wanseko inshore | 4.4 | 1 | 38 | 0 |
| River Waiga offshore | 11 | 1 | 7 | 2 |
| River Waiga inshore | 2.3 | 1 | 4 | 6 |
| River Waiga mouth | 0.5 | 0 | 51 | 7 |
| River Waiga Upstream | 0.3 | 0 | 5 | 9 |
| Butiaba offshore | 38.9 | 1 | 2 | 4 |
| Butiaba inshore | 26.2 | 1 | 1 | 7 |
| Butiaba lagoon | 0.7 | 0 | 32 | 2 |
| | | | Unit: µg/L | |

Table 2: Nutrient concentrations and phytoplankton biomass as chlorophyll (Chl-a) at the sampling stations

| Station | Water depth (m) | Sample depth (m) | Secchi (m) | TN | TDN | $NO_3$-N | $NH_4$-N | TP | TDP | SRP | Chl-a |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Wanseko offshore | 11.6 | 1 | 1.4 | 985 | 660 | 66.6 | 25.6 | 58.9 | 51.7 | 21.8 | 13.9 |
| Wanseko inshore | 4.4 | 1 | 0.9 | 685 | 610 | 64.1 | 37 | 50.3 | 46 | 11.8 | 13.0 |
| River Waiga offshore | 11 | 1 | 1.6 | 1185 | 735 | 27.8 | 27 | 53.1 | 46 | 1.8 | 12.2 |
| River Waiga inshore | 2.3 | 1 | 1.1 | 1035 | 860 | 17.8 | 38.8 | 46.0 | 23.1 | 1.8 | 0.9 |
| River Waiga mouth | 0.5 | 0 | 0.5 | 1010 | 835 | 27.8 | 25.9 | 224.6 | 188.9 | 171.8 | 5.6 |
| River Waiga Upstream | 0.3 | 0 | 0.3 | 1135 | 785 | 33.3 | 60.6 | 184.6 | 170.3 | 221.8 | 2.8 |
| Butiaba offshore | 38.9 | 1 | 1.7 | 760 | 535 | 18.25 | 27.4 | 37.4 | 30.3 | 10.2 | 3.7 |
| Butiaba inshore | 26.2 | 1 | 1.4 | 1085 | 835 | 24.1 | 25.6 | 41.7 | 24.6 | 6.8 | 10.2 |
| Butiaba lagoon | 0.7 | 0 | 0.5 | 1660 | 1035 | 49.5 | 31.6 | 66.0 | 36 | 0.0 | 11.1 |
| | | | | Unit: µg/L | | | | | | | |

## Discussion

High concentrations of dissolved oxygen, especially within the upper layers of the waters, in most of the stations, could be attributed to light attenuation, photosynthetic activities and mixing of water. The oxygen and temperature profiles (Figure 2) indicate more of mixing than persistent stratification of the lake during the time of the year

(September). In comparison, a more stratified condition within the lake waters were observed during May 2007, when a similar work was conducted around Kaiso (NaFIRRI 2007). This shows that the rate of vertical movement of any contaminants within the lake during exploration and exploration activities would depend on the season. Relatively low concentrations of DO at the upstream and mouth of River Waiga mouth could be attributed to low Chl-a content as shown (Table 3). The shedding effect especially at the upstream of the river and the strong currents, in spite of availability of nutrients e.g. SRP (Table 2), do not favour the growth of phytoplankton. Significantly high value (9.3mg/L) of DO at Butiaba lagoon concurs with the phytoplankton biomass and nutrient availability e.g. TN and TP (Table 3) and presence of submerged macrophytes. The concentrations of DO in most of the stations were close to saturation because samplings were conducted mainly in the afternoons that were generally very sunny. The pH values indicate alkaline conditions of the lake and seem to increase with the photosynthetic activities within the water column, as indicated by its low values at upstream and mouth of River Waiga where Chl-a was low.

High conductivity values (615-700µs/cm) in most of the open lake stations indicate high levels of dissolved salts and are typical characteristic of Lake Albert waters. Low conductivity values at Wanseko inshore and at River Waiga mouth, are results of dilution effects from Victoria Nile and River Waiga, respectively. Significantly higher conductivity at Butiaba lagoon than at the rest of the stations is because of it being enclosed part of the lake, with shallow depth and poor flushing effects.

Significant value of TSS at Wanseko inshore is a result of presence of phytoplankton biomass (Table 3) and sediment particles brought in the area by Victoria Nile. High TSS at River Waiga mouth could be mainly sediment particles but not Chl-a as shown in Table 3. At Butiaba lagoon, TSS is high because of presence of both Chl-a, sediment debris arising from shallow depth, and poor flushing effect. Presence of high concentrations of TSS at Wanseko inshore and Butiaba lagoon is reflected by the low secchi values (Table 3). The pattern of distribution of TSS indicates that River Waiga, which lies within the focus zone, could contribute to transfer of contaminants e.g. sediments into the lake, if there would be any during seismic or other exploration or exploitation activity.

Low concentrations of oil and grease in the lake waters indicates there is no serious contamination at this focus zone by the mentioned constituent and gives opportunity of detecting its elevation, if any, during the forthcoming seismic or other exploration or exploitation activities. As shown (Table 2), it is River Waiga and inshore waters of Butiaba, which seem to contain slightly more oil and grease, and this is probably as a result of activities like cleaning and depositing contaminated items into such waters by the communities.

High values of chlorophyll a, TSS and DO in the Butiaba lagoon indicate high productivity that is promoted by the high levels of nutrients e.g. TN and TP. It is a productive environment and may be an important nursery and feeding area for young fishes. The distinctive chemical composition e.g. very high TN, TDN and TP as well as water conductivity at Butiaba lagoon shows that water exchange between this area and the open lake is slow and it is likely that any contaminants coming into the lagoon are likely to be flushed out very slowly. Such observations were also made on the lagoon at Ngassa area of Lake Albert (NaFIRRI 2007). The poor content of SRP (Table 3) in the waters of Butiaba lagoon could be a result of higher demand by various organisms (phytoplankton, bacteria and submerged macrophytes) as compared to other stations.

Relatively high values of nutrients e.g. TN, $NO_3$-N, $NH_4$-N, TP, TDP and SRP at the upstream and at the mouth of River Waiga, could be attributed to inputs from activities like washing, bathing, animal grazing and others that are conducted by the communities within the catchment. This river, which is situated within the focus zone, would transport any nutrients generated from such areas during the exploration/exploitation activities, into the lake. In spite of high amounts of nutrients (TN and TP), low phytoplankton biomasses (Table 3) are seen in the waters of this area of focus. This could be related to light limitation for phytoplankton because of frequent mixing especially in the deeper waters. Addition of any nutrients to this local environment would be quite difficult to detect unless it is really of significant concentrations relative to the current ones in the lake waters.

This baseline information gives a clue on the current status of water quality of the Butiaba-Wanseko focus zone, on which monitoring could be based. However, more sampling, especially to be conducted during a different season (dry) from the one of present (wet) sampling, would be of relevance.

**References**

Greenberg A. E. C., Lenore L. S., and Eaton A. D. (1987) Standard methods for examination of water and waste water.

NaFIRRI (2007) A baseline survey of water and sediment quality, fisheries and invertebrates at Ngassa spit, Kaiso, Lake Albert. A Report prepared for Environmental Resources Management Southern Africa (Pty) Ltd (ERM) in association with Environmental Assessment Consult Ltd (EACL), 71pp.

Stainton M. P., Capel M. J. and Armstrong F. A. J. (1977) The Chemical Analysis of Fresh Waters, 2nd Edition. Misc. Spec. Publ. Enviroment Canada 25,166pp.