Introduction

Lake Tanganyika has been classified by Kilham and Hecky (1973) a fresh lake belonging to the Sodium-Potassium-Magnesium bicarbonate type which also includes in Lake Albert, Edward and Kivu. Little sodium chloride was observed in its water by Beauchamp (1939, 1940), but high proportions of Sodium bicarbonates were found, mostly derived from surrounding volcanic rocks; (i.e. geochemistry of the catchment). He also pointed out that the inflowing rivers make up about one-third of the total water supply and are low in salt content, with the exception of the Ruzizi River, which may regulate the present ionic composition of the lake. However, small streams cannot be overlooked with regards to their contribution to the geochemistry of lake water, because they enter the lake directly compared to big rivers that passes through many swampy areas with much deposition and dilution. This paper discusses on the influence of stream flows on hydrogeochemistry of lake. Two streams will be discussed here; Mitumba in Gombe and Ngonya in Mwamgongo village. These two drain different catchments, undisturbed and disturbed by human settlement respectively.

Objectives

The objectives of research were mainly, (1) to investigate the physical - chemical nature of the streams as related to their catchment disturbances, (2) to investigate the behavior of the ionic parameters of streams as compared to those of the lake at the mixed and open waters off shore about 100m.

Materials And Methods

General remarks

The following parameters have been measured during sampling: transparency (Secchi), temperature, dissolved oxygen, pH, conductivity, Soluble Reactive Phosphorus, Ammonia (NH\(_3\)-N), Nitrite (NO\(_2\)-N), Nitrate (NO\(_3\)-N), and Turbidity. The parameters were measured by HACH DR 2010 methods, HANNA Instruments: - , conductivity meter Model HI 8033, pH meter Model HI 9023 and conductivity / D.O meter probe Model YSI 58 -230 V.

Sampling Procedure

Due to the unavailability of a GPS (Global Positioning System) instrument at the time of sampling, the exact sampling position was not recorded. Sampling was performed at two separate localities;
(1) Mitumba stream -Gombe, samples were taken at gauge station placed about 15 m before entering the lake, at the mixed area (stream and lake), and lake at about 100 m offshore where a vertical transect from surface down to 40m was taken it was not possible to sample beyond because of depth limitations. The same procedure was also done at locality no. (2): Mwamgongo -Ngonya stream.

The following parameters were measured directly from the stream & lake (using ZODIAC), water Temperature, dissolved oxygen, pH, conductivity; from water samples taken to the Lab.; Turbidity, NH\(_3\)-N, PO\(_4\)-P, NO3-N, SO4. In the lake D.O, Temperature, pH, conductivity, and turbidity were measured at 10m depth intervals from the surface down to 40m. Chloride, silica, calcium, magnesium and hardness were not done due to lack of required chemical reagents

Instrumentation And Analytical Methods

Transparency measurements, taken at the lake were done with a 20cm diameter Secchi disk. Water samples from the river were collected by scooping water from the stream directly into sample bottles, and those from the lake were collected using a 2l van Dorn bottle. Water temperature was measured using digital thermometer, coupled to an oxygen meter. Dissolved oxygen (D.O) was measured with a dissolved Oxygen meter; Turbidity measurements (NTU) were made with a HACH Turbidimeter.

Results

Tables 1,2,3 &4 show the physical-chemical parameters obtained from the two localities: Gombe & Mwamgongo.

Physical & Chemical parameters

Temperature

The temperatures in the streams were 24.8 & 27.3 (Gombe and Mwamgongo respectively). Temperatures in the lake remained at an average of 27.0 °C while at the mixed point (where rivers enter the lake) was between 27.5 & 27.8 °C. Gombe is much cooler than Mwamgongo, this could be due to thick forest covering the Mitumba stream as compared to Ngonya.

Conductivity

Conductivity ranged between 530uS/cm to 627 uS/cm with the exception of Gombe-Mitumba and Mwamgongo -Ngonya streams. Their corresponding conductivities were 26.0uS/ cm and 45 uS/cm respectively.

pH

PHs at Gombe and Mwamgongo were 7.8 & 7.94 respectively, while those in lake ranged between 8.96 and 9.05.

Dissolved Oxygen (D.O)
The Gombe-Mitumba stream was better oxygenated than Mwamgongo, both in the stream and at the lake outlet. Temperature is the primary controlling parameter for this difference in D.O (Table 5).

**Turbidity**

Mwamgongo-Ngonya stream is more turbid than both the lake and Gombe-Mituba stream; this indicates that it has more suspended matter.

**Transparency**

The Secchi depth was 8.50 and 7.60 m at Mwamgongo and Gombe respectively. However, these results might have been affected by wavy conditions during the measurements.

**Silica**

Mwamgongo has higher SiO$_2$ than other places visited, ranging from 11.50 to 17.50 (mg/L). The river has 17.50 (mg/L) as compared to 12.30 (mg/L) at Gombe-Mitumba.

**Ammonia, Nitrate, and Nitrite.**

Ammonia, Nitrate, Nitrite in both Gombe & Mwamgongo are present in proportions of NH$_4^+$ > NO$_3^-$ > NO$_2^-$, with much higher total concentrations at Gombe. This could be due to decomposition of debris or litter.

**Phosphorus**

The Mwamgongo sample had more phosphorus than either Gombe or and lake. This may result from the use of chemical fertilizers up stream.

**Sulphate**

No SO$_4^{2-}$ was detected at Gombe-Mitumba stream, but little was obtained at Mwamgongo. This could be due to climatic changes and less use of sulphate fertilizers up stream.

**Discussion**

Since the two streams; Ngonya (Mwamgongo) and Mitumba (Gombe) are small, their flows are likely to have also small influence on the hydrogeochemistry of the near shore lake and the pelagic zone. This is shown by the relative close relationship between their flows and the ammonia concentration comparisons between the stream, mixed, and lake sites. The chemical parameters vary considerably from one place to another.

At Mwamgongo (the place where catchment geology is greatly disturbed), the variation is in the order of SiO$_2$ > SO$_4^{2-}$ > PO$_4^{3-}$ > NH$_4^+$ > NO$_3^-$ > NO$_2^-$, and that of Gombe (the relatively undisturbed catchment) is SiO$_2$ > NH$_4^+$ > NO$_3^-$ > NO$_2^-$ > (PO$_4^{3-}$ & SO$_4^{2-}$). Gombe has high concentrations of most of the parameters except SO$_4^{2-}$ and PO$_4^{3-}$, which were not detected in water samples from stream. It follows that climatic changes, course of the stream (composition of substrate) and perhaps the use of chemical fertilizers especially in Mwamgongo and other villages up stream have a major influence on the ionic concentration of the stream. Physical parameters behave differently also. At Mwamgongo, temperature was high (27.3 °C) as compared to Gombe (24.8 °C). This is a reflection of direct evaporation by solar energy due to little or no forest cover along the stream course. This greatly affects the D.O concentration because D.O has an inverse relationship with temperature. Turbidity was much higher at Gombe than Mwamgongo. This could be explained by the nature of the catchment which probably has big supply of suspended matter compared to Mwamgongo. No doubt, that Gombe has a lot of humus, organic detritus, and plants. This may also have an influence to the physical parameters of the near shore lake, but needs detailed study to confirm this.

**Conclusions**

The influence of stream flow for the hydrogeochemistry of the lake is confined to shallow regions, i.e. the near shore zone whereas the deep offshore areas appear to have little or no relationship with stream flow. However, this study cannot be considered conclusive because very little data could be collected during the available research time. A more detailed study is required in order to be able to come up with correlations that are more definitive.

**References**

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