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Special Study on Sediment Discharge and Its Consequences (SedSS)

Technical Research Report Number 11

HYDROLOGY OF SELECTED WATERSHEDS ALONG THE LAKE TANGANYIKA SHORELINE

by

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2000

Pollution Control and Other Measures to Protect Biodiversity in Lake Tanganyika (RAF/92/G32)

Lutte contre la pollution et autres mesures visant à protéger la biodiversité du Lac Tanganyika (RAF/92/G32)

Le Projet sur la diversité biologique du lac Tanganyika a été formulé pour aider les quatre Etats riverains (Burundi, Congo, Tanzanie et Zambie) à élaborer un système efficace et durable pour gérer et conserver la diversité biologique du lac Tanganyika dans un avenir prévisible. Il est financé par le GEF (Fonds pour l'environnement mondial) par le biais du Programme des Nations Unies pour le développement.	The Lake Tanganyika Biodiversity Project has been formulated to help the four riparian states (Burundi, Congo, Tanzania and Zambia) produce an effective and sustainable system for managing and conserving the biodiversity of Lake Tanganyika into the foreseeable future. It is funded by the Global Environmental Facility through the United Nations Development Programme.

Burundi: Institut National pour Environnement et Conservation de la Nature
D R Congo: Ministrie Environnement et Conservation de la Nature
Tanzania: Vice President's Office, Division of Environment
Zambia: Environmental Council of Zambia

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SUMMARY

Hydrological evaluation of two contrasting watersheds of more or less the same size and located adjacent to each other has been undertaken. The chemical, isotope, sediment and stream flow assessment has been conducted. The two watersheds show that the chemical character of the two streams is due to natural processes. Low values of all determined ions have been measured including those of nutrients. A magnesium bicarbonate type of water has been identified for the stream, borehole and lake waters. This supports the hypothesis that the chemical character of water in the study area is attributed to natural processes.

Hydrographic separation of stream flows using chemical and classical techniques shows that about 70% and 80% of stream component is groundwater in the Mitumba and Ngonya streams respectively. The differences in the groundwater stream components for the two streams has been attributed to strong evapotranspiration process due to the availability of heavy vegetation cover present in the pristine Mitumba watershed. But, Ngonya stream located in the impacted watershed was measured to have an order of magnitude higher suspended stream sediment load than that in the Mitumba stream. However, in both cases the stream suspended sediment load has a power function relationship with the stream discharge. Sediment analysis shows that some heavy metals emanating from the local lithology tend to form significant concentrations in the sediments. Clay minerals including smectite and kaolinite are determined to form dominant components in the stream suspended sediments.

Estimates of potential evapo-transpiration using chloride, ^{18}O and empirical formula show that about 80% of the annual rainfall is lost through this process. The evaporation process is supported by comparison of ^{18}O content of rainfall to that of the lake water. The mean $\delta^{18}O$ ‰ rainfall is determined to be - 4.5 ‰ while that of the Lake is about 3 ‰ indicating strong enrichment in the isotope due to the evaporation process. The results demonstrate that evaporation is the major process by which the lake may be losing water.

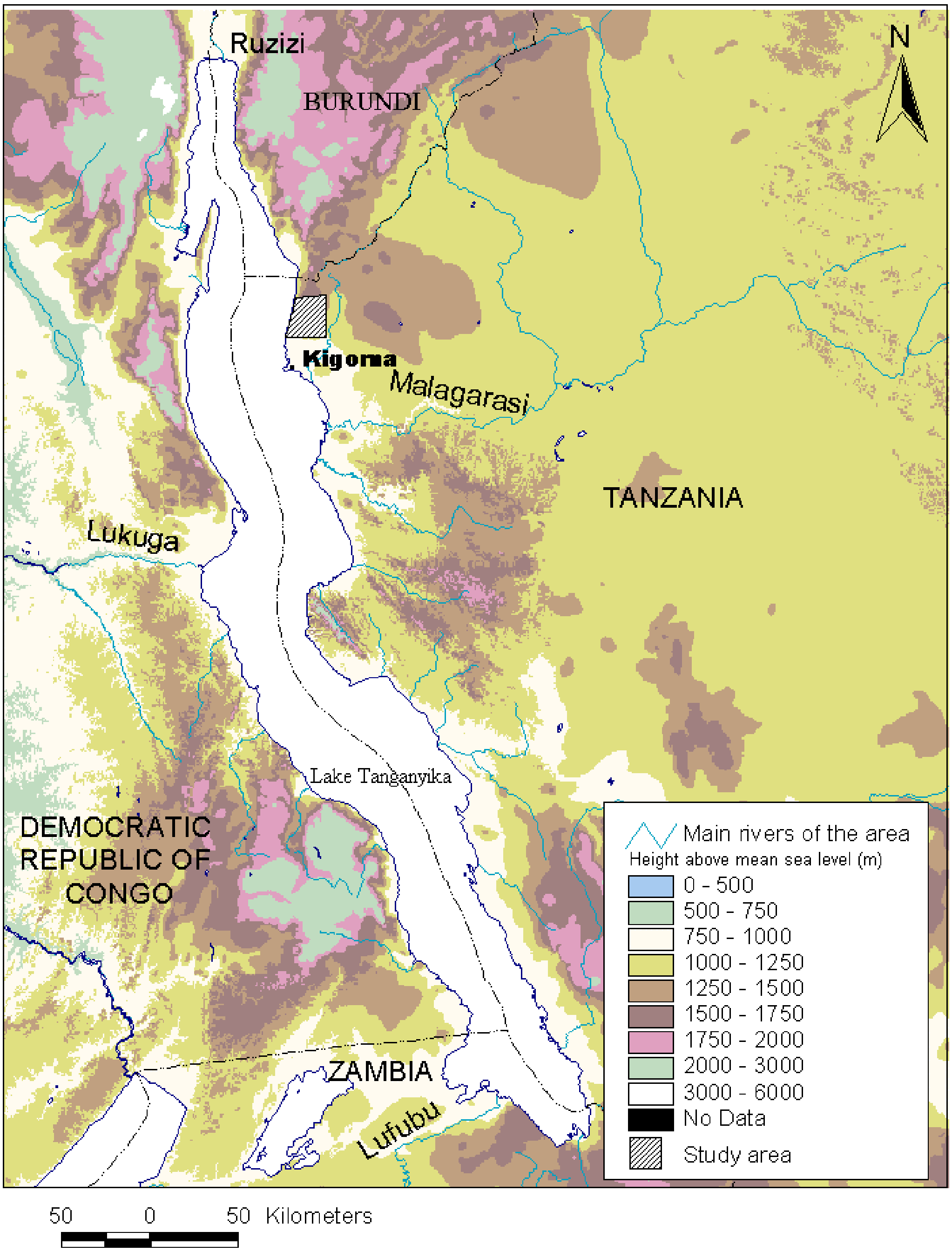
This work involved fieldwork, laboratory work, data collection and interpretation. The fieldwork included sampling of water from streams, springs, wells, and rainfall covering one water year. In addition, fieldwork involved stream sediment sampling, stream flow measurements and geological mapping. To effect stream flow measurements and rainfall collections, gauge plates and rain gauges were respectively installed in the study area.

It has been concluded that the mode of solute transport to the lake is predominantly through groundwater. It is recommended that measures to halt soil erosion through afforestation and appropriate agricultural practices be immediately undertaken in order to reduce the currently measured high sedimentation rates.

1. THE STUDY AREA

Two small contrasting watersheds were selected along the shores of Lake Tanganyika. The Mitumba watershed located at the Gombe National Park and the Ngonya watershed at the Mwamgongo village represent pristine and impacted environments respectively. The two watersheds are about the same size each with an area of about 7 km^2. The watersheds lie at 29º 41'E and 6º S (**Figure 1**).

Figure 1. The location of the study area



1.1 Climate

The study area lies in the semi humid tropical climate with mean annual rainfall and potential evapotranspiration of about 1200mm and 2000 mm respectively. The variation of rainfall amounts during the study period across the two watersheds is shown in Appendix 1a for the Mwamgongo catchment and Appendix 1b for the Mitumba catchment. The locations of the rain gauges indicated are given in Figure 3. The area experiences two seasons in each water year namely dry and wet season.

1.2 Topography

Mitumba watershed lies between altitudes of 640 m and 1450m a m s l with maximum axial length of about 5km. The Ngonya watershed lies between 640m and 1550m a. m. s. l with an axial length of 7km. Steep slopes and rocky terrain characterise both watersheds. Slopes of about 15% characterise the area.

1.3 Geology

The two watersheds are located in the Bukoban sandstones with mainly quartzitic sandstone and shales dominating the area. A few outcrops of gneissic rocks are also exposed in this area. The outcrops show a dip of less than 10^{o} (Figure 2).

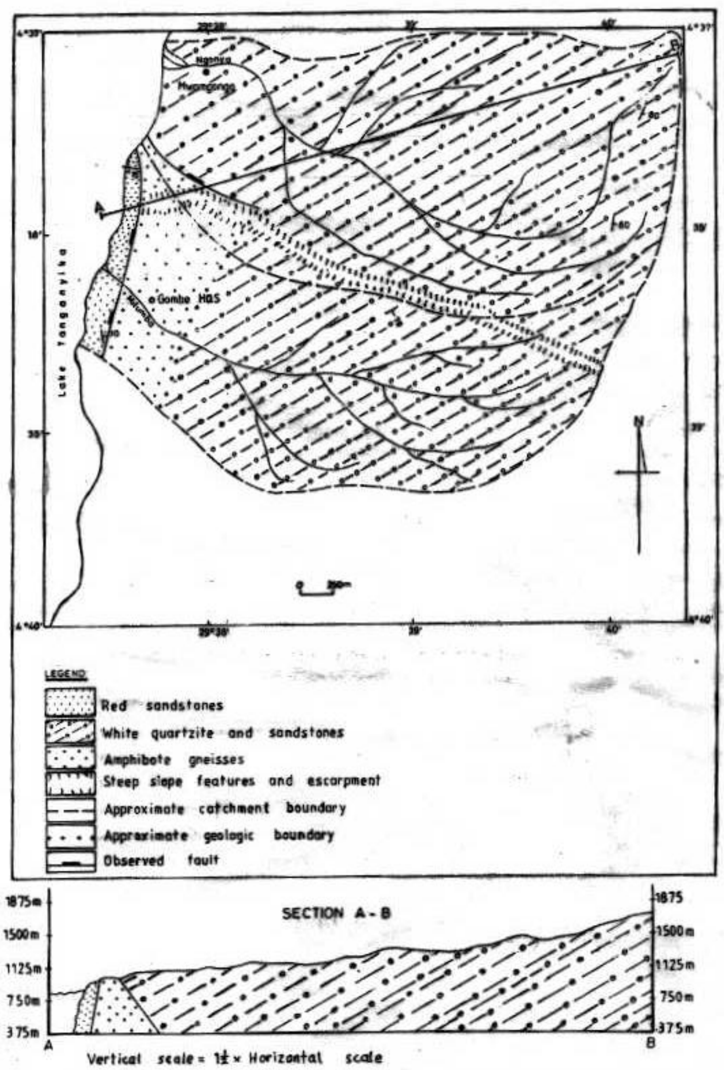


Figure 2. Location and geological Map of the study area (Mitumba and Ngonya catchments)

1.4 Objectives of the study

The primary objectives of this work may be summarised as follows:

1. To quantify the current sedimentation rates from both impacted and pristine Gombe watersheds.

2 To characterise the chemistry of natural waters and identify levels of pollutants and nutrients as delivered into the lake from both impacted and pristine Gombe watersheds.

3 To establish the mode of nutrient and pollutant transport into the lake

4 To compute the water balance of the Gombe watersheds

5 To derive a conceptual model for the management of Lake Tanganyika

In order to achieve the above objectives, several parameters were measured including suspended sediment load in the streams, the chemical and stable isotope content of surface and groundwater and the nature of rainfall pattern and stream flows.

2. MATERIALS AND METHODS

2.1 Desk study

The desk study involved mainly the collection of hydro - meteorological data and satellite information. The hydro meteorological data were collected from the Kigoma Water Department and Ubungo Directorate of Water Research for the Ministry of Water and Energy. The satellite information was obtained from the LTBP / LARST satellite station in Kigoma. The information is important in the understanding of the cloud pattern that produced the recorded rainfall as well as assessing the vegetation indices at different times of the year during the project field study period of 1997 / 98 and 1998 / 99 wet periods

2.2 Water sampling

Water samples were collected from rainfall, springs, wells, and streams in both the Mitumba and Ngonya watersheds. Duplicate water samples were collected for chemical and stable isotope determination. Additional duplicate water samples were collected from boreholes and wells, springs located in the Kigoma urban and rural districts. Furthermore duplicate water samples were obtained from the Malagarasi and Luiche rivers as well as rainfall. All samples were collected mainly in half litre polythene bottles. The sampling program started at the beginning of the 1997/98-water year up to the end of the 1998/99-water year. Except for a few months, sampling was conducted on a monthly basis. A total of about 400 samples were collected. The sampling points are as indicated on **Figure 3.**

2.3 Suspended stream sediment sampling

Stream sediment sampling was conducted on both Mitumba and Ngonya streams in order to determine total suspended stream sediment load in each stream. Samples were collected following standard procedures using a stream sediment sampler model DH 48 obtained from the Kigoma Water Department as discussed by **Norconsult 1982** Stream sediments samples were collected at the 1/6, 3/6 and 5/6 sections of the stream span as measured from either bank of the stream during taking stream flow measurements. A total of 100 samples were collected for this purpose.

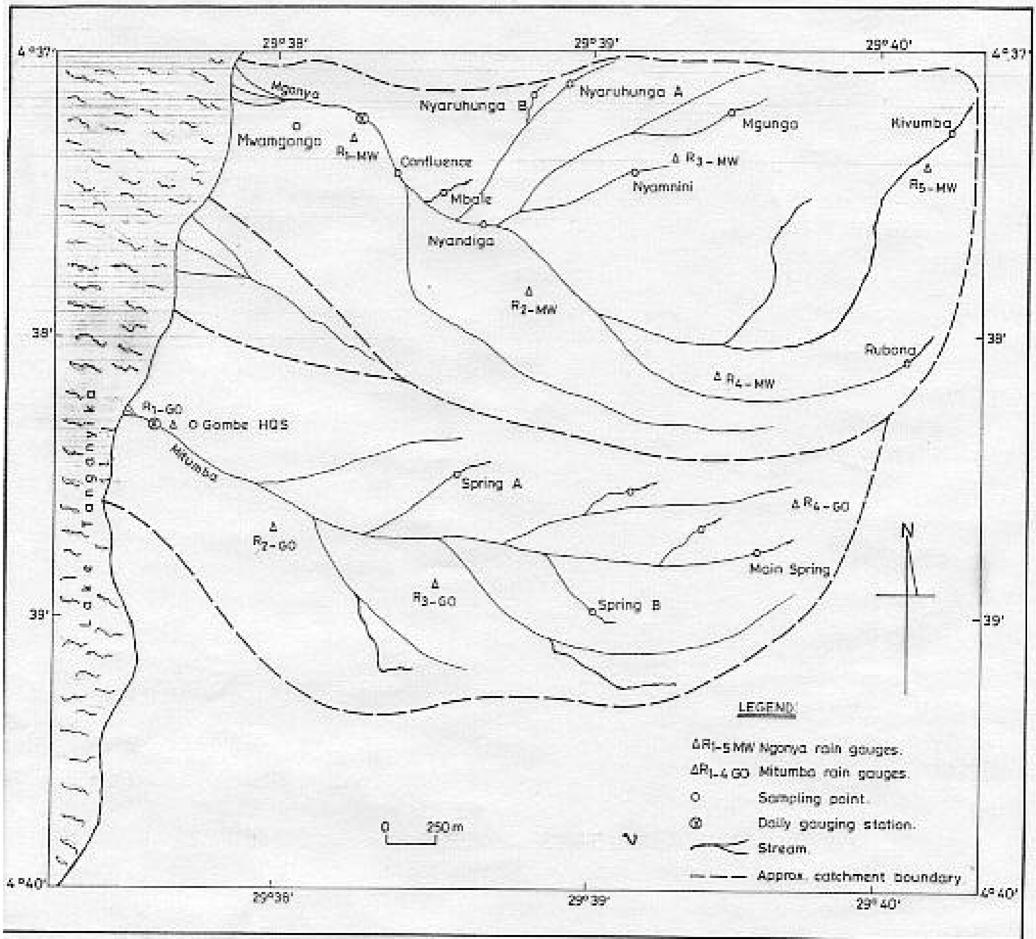


Fig.3 Map of the study area showing stream gauging point, sampling points, Rain gauge location and Catchment boundary.

Ngonya watershed was sampled in order to show how impacted watershed would highlight the hydrological effects by the current levels of deforestation in comparison to the pristine one. Sampling was conducted for two successive water years commencing with the 1997/98-water year but for the Luiche river this was undertaken for a short period during the 1998/99 -water year due to logistical reasons.

In addition, chemical and mineralogical characterisation of some selected sediment samples was undertaken. Sediment samples collected during high, medium and low flows were selected for this purpose. Sediment sample collections continued during dry season so as to be able to complete a full hydrologic cycle in order to constrain data from the last El NINO event.

2.4 Stream flow measurements

Stream flow measurements were conducted following the Area - Velocity method. Standard techniques were used in taking the flow measurement as explained by **Watson and Burnet (1995).**

However, due to the shifting nature of the Ngonya stream, surveying procedures were used in taking up flow measurement while maintaining the original zero point determined at the time of establishing the gauging station. Flow measurements were taken almost daily for the period of two complete water years except for few months due to logistical reasons. Measured stream flow amounts along with gauge heights are shown in the **Figures 4 & 5 and in Appendix 2a & Appendix 2b** for the Mitumba and Ngonya streams respectively.

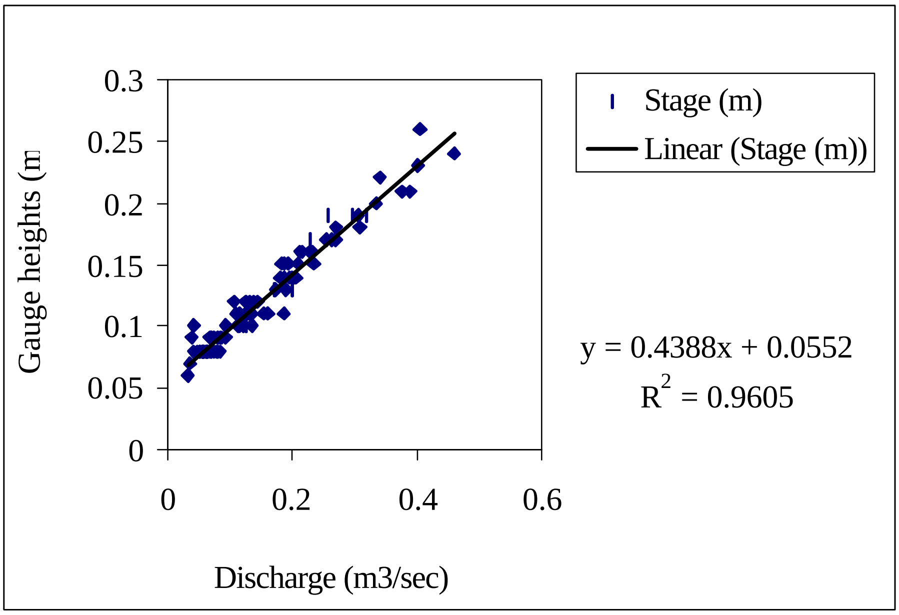


Figure 4. The Mitumba stream rating curve.

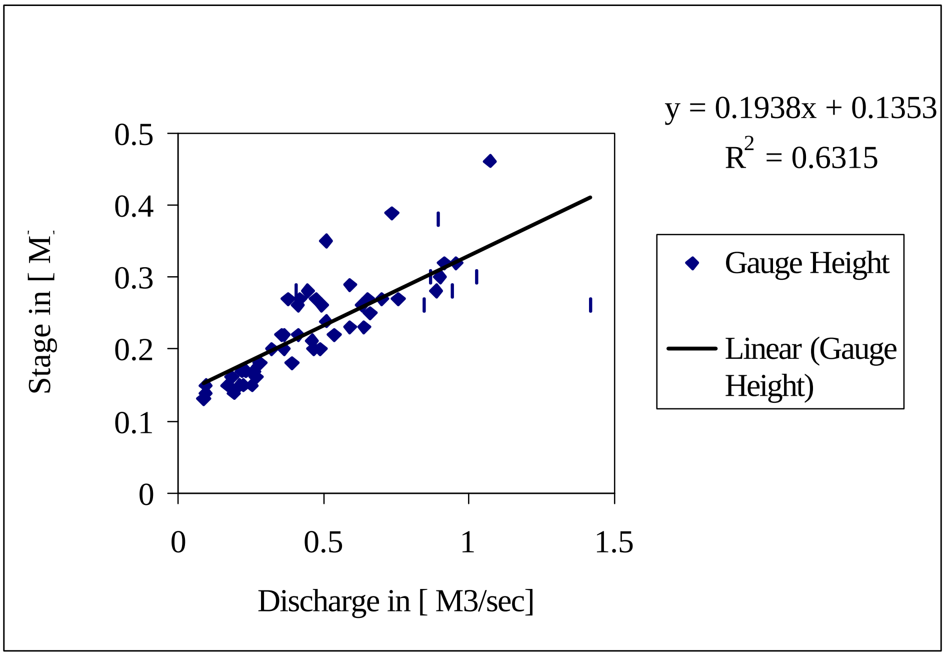


Figure 5. The Ngonya stream rating curve.

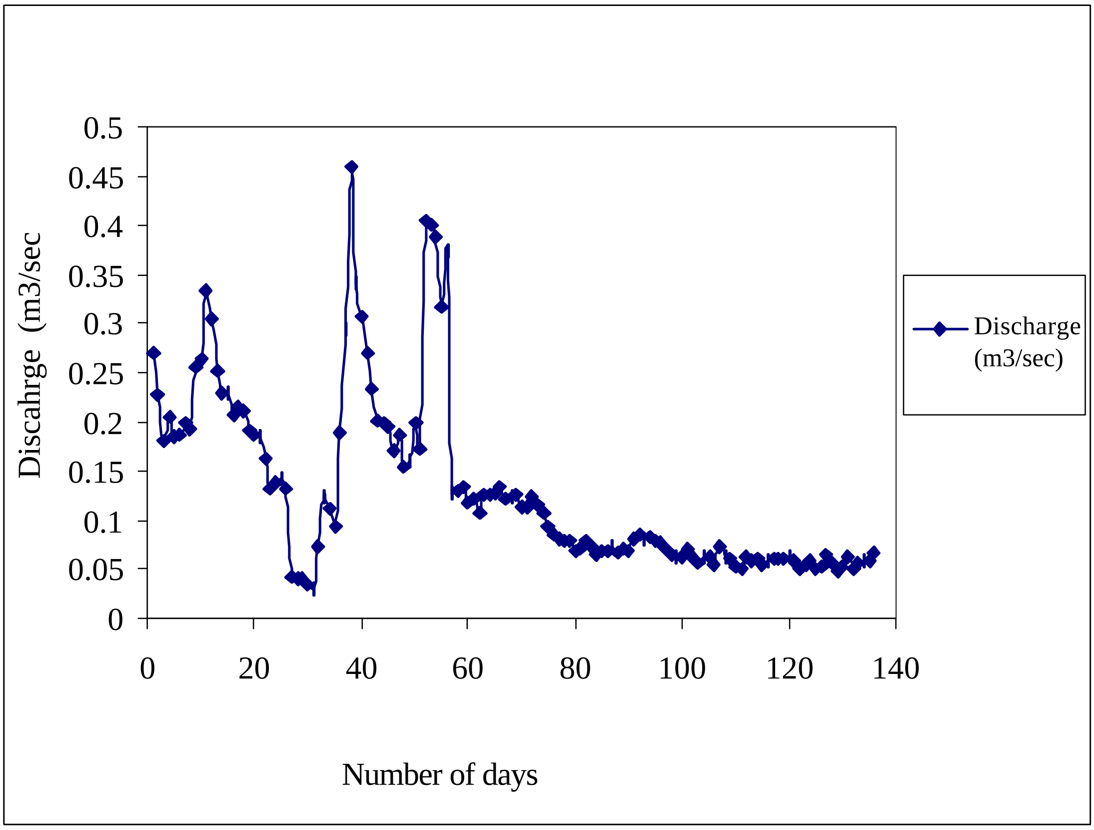


Figure 6. The Hydrograph for the Mitumba stream

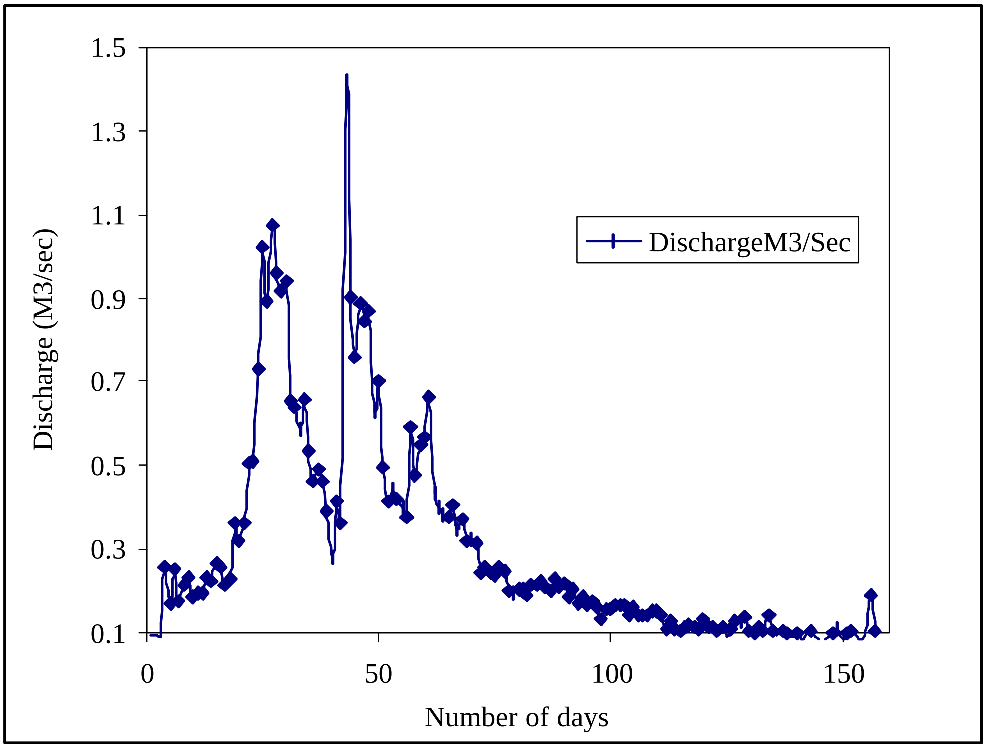


Figure 7. The Hydrograph for the Ngonya stream

In addition, the stream flow measurements were sometimes conducted to monitor the stream flow behaviour following a particular storm event that generated abnormally high flows.

The monitoring lasted in most cases for about 4 to 6 hrs until the stream water level reached pre-storm levels for the particular stream. Flow measurements were continued in order to complete a full water year. The stream flow results modified data collected during the last El Niño period and therefore in the construction of proper rating curve for each stream.

Stream flow data were used to construct the stream hydrograph for each stream and results are as shown in Figures 6 & 7 for Mitumba and Ngonya stream respectively.

3. WATER SAMPLES ANALYSIS

3.1 Water samples analysis during fieldwork

Analysis of water samples during fieldwork was undertaken following the availability of the relevant field probes. Some of the results as obtained during fieldwork are as shown in **Appendix 3.**

3.2 Laboratory analysis of water samples

3.2.1 Chemical analysis

Detailed chemical analysis of the water samples was undertaken at the chemical laboratory of Tanzania Bureau of Standards (TBS). A total of about 300 samples were analysed.

The following major inorganic ions were determined Na^{+}, Ca^{2+}, K^{+}, HCO_3^{-}, $SO_4^{2-}$and Cl^{-}. Additional analysis included the determination of NO_3^{-}, NO_2^{-}, SiO_2 and PO_4^{-}. About 300 water samples were analysed for chemical contents during the study.

The results are presented in **Appendix 4**

3.2.2 Stable isotope determination

About 200 water samples were analysed for ^{18}O and ^{2}H using Finnigan Mass Spectrometer available at the stable isotope hydrology laboratory of the Geosciences Department of the University of Arizona. Water samples from rainfall, springs, wells, boreholes streams and the lake were analysed for the stable isotopes. A list of the collected water samples, some of which were analysed, are as shown in **Appendix 5a** and the raw data in **Appendix 5b**.

3.3 Analysis of stream suspended sediments

3.3 1 Determination of stream suspended sediment concentration

Determination of stream suspended sediment concentration was undertaken at the Department of Geology of the University of Dar es Salaam. About 73 samples were analysed for the sediment load concentration from both the Mitumba and Ngonya watersheds, following the gravimetric technique and the results are as shown in **Appendix 6**. Sediment concentration results are reported in mg/l and their relationships with the stream flows measured at the time of sediment sampling are presented in **Figure 8**.

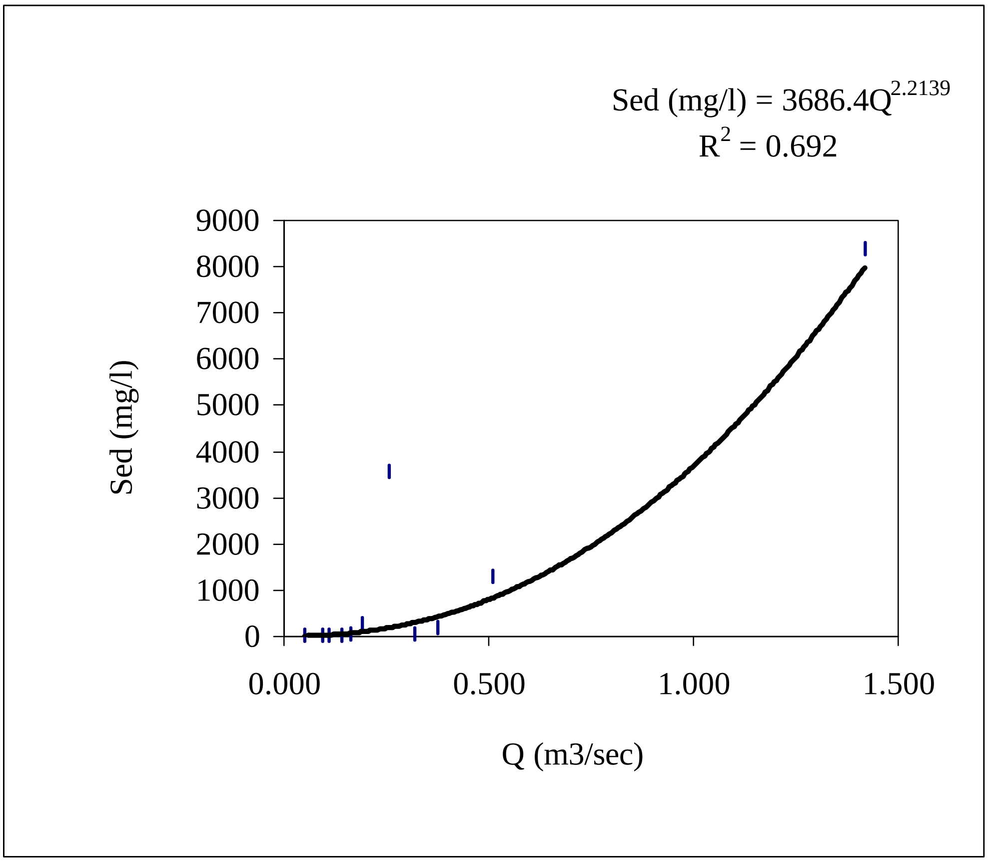


Figure 8. The relationship between stream flow and suspended sediment concentration for both streams.

3.3.2 Determination of chemical and mineral content of the stream suspended sediments

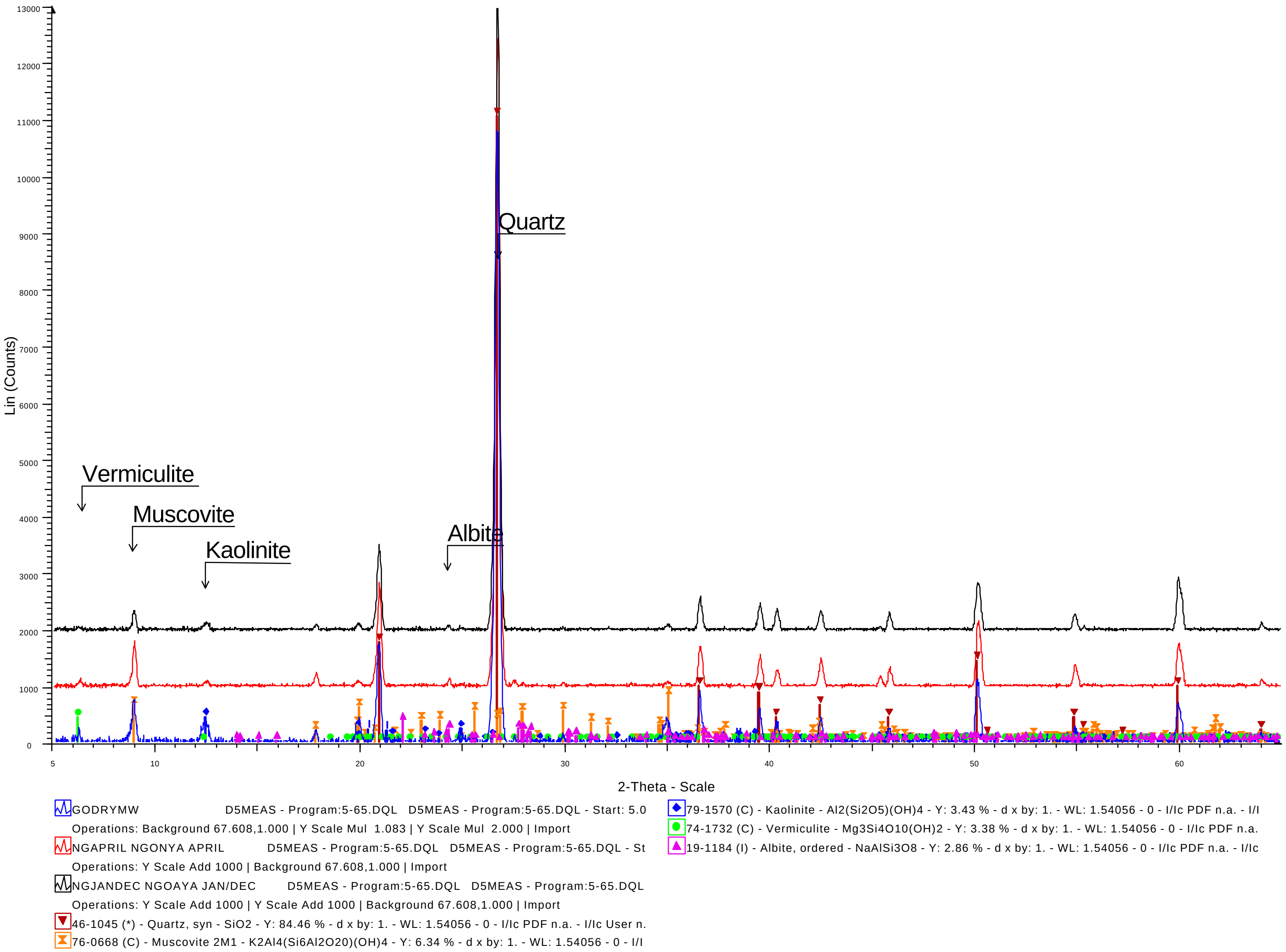
Determination of chemical and mineral content of the stream suspended sediments using ICP and XRD was conducted in the U.K. at the University of Greenwich.

Sediment samples were grouped into three major categories. Category one included those sediment samples that were sampled from high flows during the high rainfall (possible El NINO-related) event.

The other category includes those sediment samples that were collected during the stream recession period in the dry season.

The final category includes the sediment samples for Mitumba stream. The results for this work are as shown in **Appendix 7** (ICP analysis) and **Figure 9** (XRD).

Figure 9. Ngonya stream sediments XRD results (Those from Mitumba stream were very similar)



4. RESULTS AND INTERPRETATIONS

4.1 Separation of hydrograph into both groundwater and surface water

Hydrograph analysis following classical, chemical and isotope methods was conducted.

Classical method was undertaken following the formula as reported by Fetter (1995).

$$Q_t = Q_0 * e^{-at}$$

Where

Q_t is the stream flow after time t of recession

Q_0 is the initial stream flow before time t of recession

a is the recession constant.

The results show that about 70% and 80% of total stream flow is groundwater component in the Mitumba and Ngonya streams respectively. A Horton recession constant of about 0.095/day was computed implying a greater groundwater component in the total stream flow.

The relationship between $\delta\ ^{18}O$ ‰ and stream discharge for both streams shows that the stream discharge increases as the $\delta\ ^{18}O$ ‰ decreases **(Figure 10).**

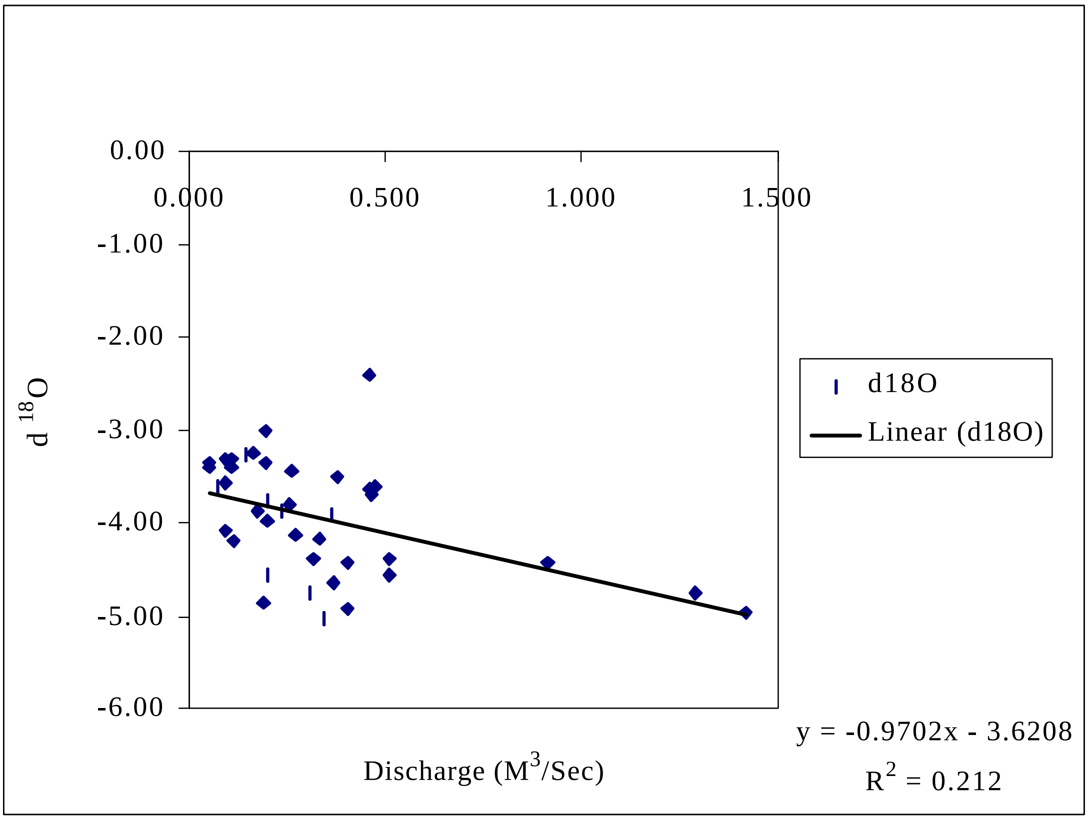


Figure 10. The relationship between δ ^{18}O ‰ and stream discharge for both streams.

The relationship implies that at high flows surface runoff forms a major component in the total stream flow. However a low positive correlation shown by the trend line implies that the amount of stream discharge does not entirely influence the δ ^{18}O ‰ of the stream flows. Mixing of different water components in the stream flows might be influencing the stable isotope character of the stream discharge.

Stream flow separation using both Cl and ^{18}O data has been undertaken for both streams.

Groundwater flow separation calculations using the formula after Jones and Pinder (1966)

$$\therefore \mathbf{Q_{gw} = Q_{tr} * \left(\frac{C_{tr} - C_{dr}}{C_{gw} - C_{dr}}\right) \%}$$ was followed.

Where:

Q_{gw} = groundwater % component

Q_{tr} = total stream flow

C_{tr} = Cl (in ppm) or ^{18}O content of total stream flow

C_{dr} = Cl or ^{18}O content of direct runoff (rainfall taken to represent direct runoff)

C_{gw} = Cl (in ppm) or ^{18}O content of base flow

Results for selected dates using ^{18}O show that the percentage of groundwater component varies from 10 % to 100 % for the Mitumba stream while it varies from 30 % to 100 % for the Ngonya stream as shown in Figures 11 & 12 respectively. The minimum groundwater percentage component of the total stream flow in both cases is obtained during high stream flows and vice versa.

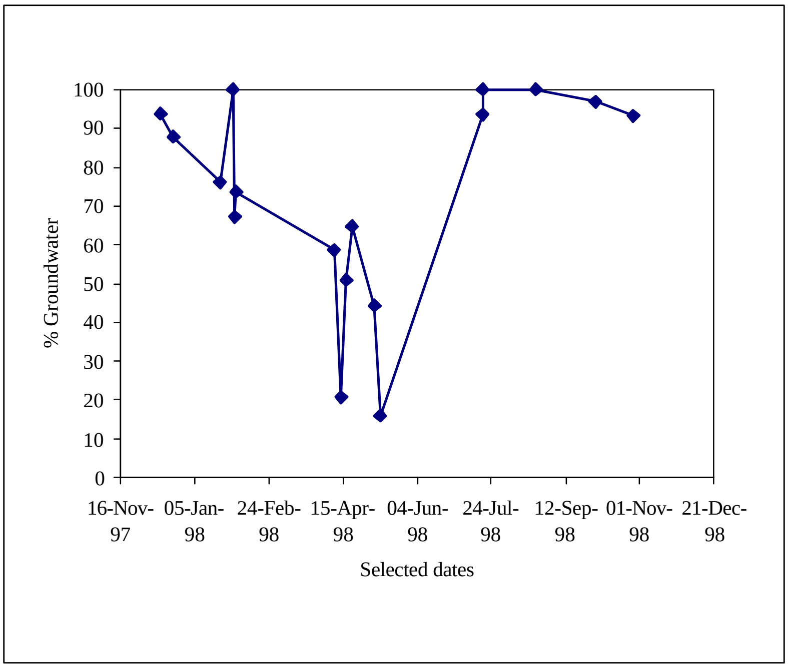


Figure 11. Stream flow separation of Mitumba stream using ^{18}O data for selected dates

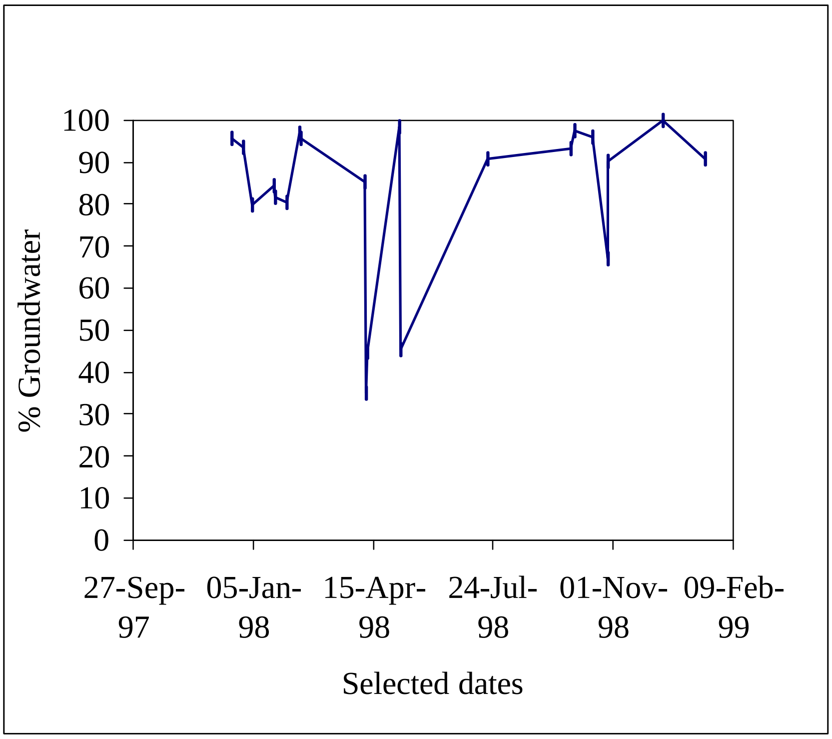


Figure 12. Stream flow separation using ^{18}O data for Ngonya stream on selected dates.

However, about 70 % and 80% of the total stream flow is dominated by groundwater for Mitumba and Ngonya streams respectively. The lower groundwater component in the Mitumba stream than Ngonya is explained to be due to high vegetal cover present in the Mitumba watershed that favours strong losses of groundwater through the process of evapo-transpiration.). This could also show the differences in the groundwater retention capacities between the two streams. The ratio of the high to low flow shows the Mitumba stream to have higher groundwater retention capacity than the Ngonya one.

The relationship between the Cl and $\delta^{18}O$ data from the springs in the Mitumba watershed show constant values in the $\delta^{18}O$ values with increasing concentration of chloride **(Figure 13).** The relationship suggests a strong transpiration process to be taking place in the study area since the phenomenon results in water losses while concentrating the solutes leaving both the ^{18}O and ^{2}H isotopes unaffected.

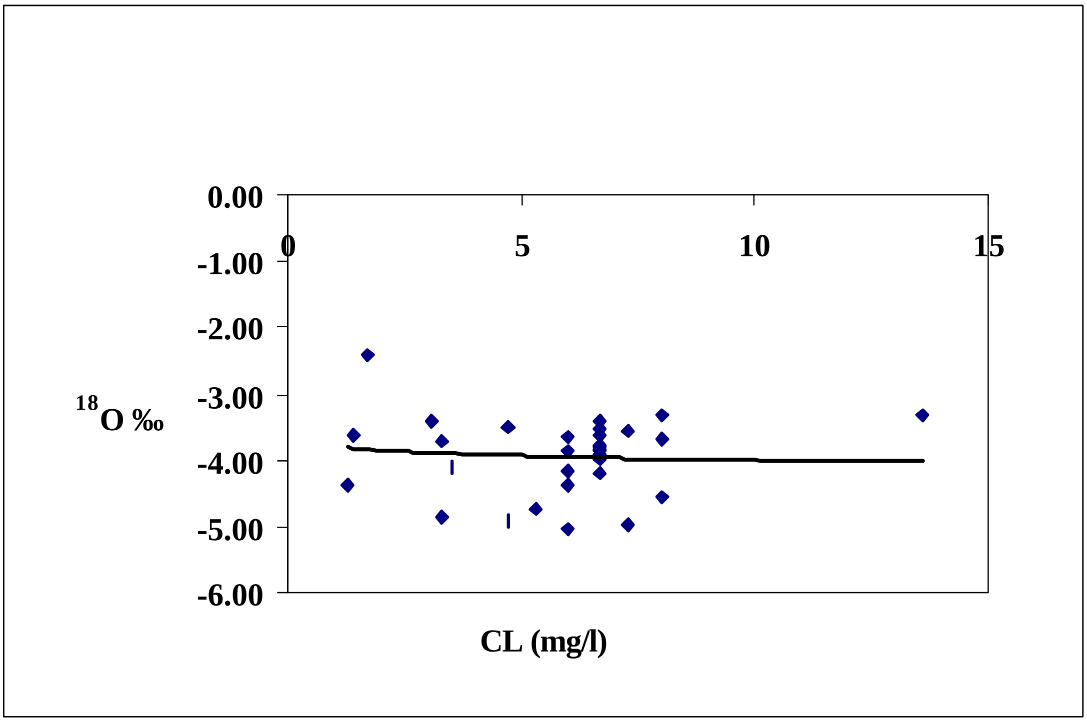


Figure 13. The relationship between δ ^{18}O and [Cl] in the springs of the Mitumba watershed.

The percentage of groundwater component results obtained from Cl and δ ^{18}O data agree well with those derived from classical stream hydrograph separation technique for both streams as shown on **Tables 1 & 2** for Mitumba and Ngonya streams respectively.

Table 1 Summary of the hydrograph separation results for Mitumba stream.

Stream flow component	**Wet season (Nov 97-May 98**		**Dry season (May 98 - Oct 98)**	
	Q $(m^3/y) * 10^6$	%Q	Q $(m^3/y) * 10^6$	%Q
Surface runoff	1.762	53	0.365	26
Groundwater Flow	1.54	47	1.015	74
Recession constant A * (day^{-1})	$5.58 * 10^{-3} day^{-1}$		$9.35 * 10^{-3} day^{-1}$	

Recession Constants	Mitumba catchment	Ngonya catchment
Horton`s constant (a) day^{-1}	9.35×10^{-3}	8.35×10^{-3}
Barnes constant K day^{-1}	1.009×10^{-3}	1.008×10^{-3}

HYDROGRAPH SEPARATION BY USING $[Cl^{-1}]$.

Table 2. Summary of the results for the Ngonya stream
.

Stream flow component	**Wet season (Nov 97 - May 98**		**Dry season (May 98 - Oct 98)**	
	Q $(m^3/y) * 10^6$	%Q	Q $(m^3/y) * 10^6$	%Q
Surface runoff	1.73	30	0.537	20
Groundwater Flow	3.46	70	2.363	80
Recession constant (a) (day^{-1})	$6.74 * 10^{-3} day^{-1}$		$8.35 * 10^{-3} day^{-1}$	

4.2 Estimation of potential evapotranspiration

Estimation of the potential evapo - transpiration in the study area is also undertaken by use of Chloride and Oxygen 18 data following the formula discussed by **Igbal (1996)** as shown below.

However, stable isotope method using ^{18}O data was undertaken following the chloride formula, because evaporation is considered to be the major process that causes fractionation of the stable isotopes as it is for the concentration of chloride content.

Similarly, ET was calculated also as shown below by use of ^{18}O data following the water balance equation.

$$P = ET + R + G + \Delta S \cong ET + Q$$

Where,

P   is precipitation input to the watershed

ET is evapotranspiration
R is surface runoff plus interflow
G is groundwater recharge
ΔS is annual change in storage
Q is measured streamflow

$$M_t = \sum_{n=1}^{nt} P_n [Cl_P]_n = \int_0^t R[Cl_R](t)\,dt$$

Where,
M_t total chloride input to the watershed per unit area in time t (mol l^{-2})
P_n amount of precipitation in each event, n(l)
$[Cl_p]$ chloride concentration in each precipitation event, n(mol l^{-1})
t integration period chosen, where it is assumed that chloride input to the watershed equals output for the period(t)
R $[Cl_R]$ (t) instantaneous product of runoff volume and chloride concentration (mol t^{-1})

$$M_t = \int_0^t R[Cl_R](t)\,dt \cong (P - ET)*[Cl_B]$$

Where
C_B is the concentration of chloride in base flow
Then

$$M_t \cong (P - ET)*[Cl_B]$$

Rearranging,

$$ET = \frac{P[Cl_B] - M_t}{[Cl_B]} = \frac{P[Cl_B] - [Cl_P]}{[Cl_B]}$$

$$P = \frac{Q}{(1 - (([Cl_B] - [Cl_P])/[Cl_B]))}$$

$$E_T = \frac{[Cl_B] - [Cl_p]}{Cl_B} * (P)$$

$$E_T = [\frac{{}^{18}O_B - {}^{18}O_P}{{}^{18}O_B}] * (P)$$

Where;

E_t = Potential Evapotranspiration.

Cl_B = Chloride concentration of Baseflow in mg/l.

Cl_p= Chloride concentration of Precipitation in mg
P = Mean annual precipitation in mm.

$^{18}O_B$ = d ^{18}O of Baseflow = -3.0%o.

$^{18}O_p$ = d ^{18}O of Precipitation = -5.0%o

P = 1300ml

$[Cl_P]$ = 5.00mg/l

$[Cl_l]$ = 26.00mg/l

$$E_T = \frac{[Cl_B] - [Cl_p]}{Cl_B} * (P)$$

$$E_T = [\frac{26-5}{26}] * 1300mm$$

The results show potential evapotranspiration in the study area to be about 1050mm. The computed E_t following the two methods is about 80% of the total precipitation.

The classical method after Turc (1955) as reported by Fetter (1994) following the formula below, resulted in the Et of about 1068mm which is 82% of the mean annual precipitation of 1300 mm

$$Et = \frac{P}{\left[0.9 + \left(P/L\right)^2\right]^{1/2}}$$

where;

Et = evapotranspiration in mm per year

P = mean annual precipitation in mm

L = 300 + 25T + 0.05T^3 (where T is the mean air temperature in ^{o}C = 25)

The results from the three methods show that potential evapo - transpiration in this area is less than the long term mean annual precipitation, implying that the area experiences a semi humid tropical climate.

4.3 Estimation of the total stream suspended sediment load
The total stream suspended sediment load was computed by use of the following Approach,

$$C_m = Q * [\frac{q_1 c_1 + q_2 c_2 + q_3 c_3 + ... + q_n c_n}{\sum (q_1 + q_2 + q_3 + q_4 + ... + q_n)}]$$

Where

q_1, q_2…qn are the stream flow amounts in m^3/s as measured at each sampling position within the river span.[Normally taken at 1/6, 1/2, and 5/6 of the stream's width as measured from either bank of the stream]. The results of the measured sediment concentration in the Ngonya and Mitumba streams are as shown in **Tables 3 & 4** respectively (where total flow is average flow for whole day).

C_1, C_2…C_n are the corresponding sediment concentration in mg/l as measured at each sampling position.

C_m is the computed weighted mean in mg/l of the total stream suspended sediment discharge at a given time. The results of the computation of the total suspended sediment load are as shown in the Ngonya stream are as shown in **Table 5.**

Sediment concentration was determined from both pristine and impacted watersheds with high sediment discharges measured as expected in the latter one.

However, the relationship between the total sediment load and stream flow for the streams in both watersheds resulted in an exponential function of discharge as shown in **Figure 8.**

According to Yang (1996), the amount of total sediment transported by a stream or river hence inflow to a reservoir depend on the amount of sediment yield produced by the upstream watershed. In addition, he summarised the factors that determine the sediment yield of a watershed as being, rainfall amount and intensity, soil type and geological formation. Furthermore, groundcover, land use, topography, upland erosion rates, drainage network density, slopes, shape size and alignment of channels are additional factors.

Finally, runoff, sediment characteristics, such as grain size and mineralogy, channel hydraulic characteristics may also determine the total amount of sediment transport in a given channel. Observation shows that in this area, the amount of sediment increases with the increase of the intensity of rainfall. In additional for the same amount of stream flow and rainfall, more suspended sediment transport was measured in the Ngonya stream draining an impacted watershed than in the Mitumba stream flowing across the heavily vegetated watershed in the Gombe national Park.

The results demonstrate the variation in the degree of erodability of the soils in each watershed with the most easily eroded soil being that in the impacted watershed and vice versa for the pristine one.

Table 3 Total sediment load for Ngonya Stream

Sample No.	Q (m^3/s)	Sediment Conc.(mg/l)	Average Sediment conc.(mg/l)	Total flow m^3/sec
97/12/01Mw	0.006	3287.63		
97/12/02Mw	0.011	2904.73		
97/12/03Mw	0.001	623.94	2905.63	0.260
97/12/04Mw	-	117.50		
97/12/05Mw	-	112.76		
97/12/06Mw	-	167.63	132.63	0.260
97/12/07Mw	0.003	100.38		
97/12/08Mw	0.016	20.85		
97/12/09Mw	0.008	80.95	47.49	0.174
97/12/10Mw	0.008	77.97		
97/12/11Mw	0.018	93.94		
97/12/12Mw	0.012	83.96	87.43	0.255
98/1/13Mw	0.026	460.00		
98/1/14Mw	0.027	-		0.509
98/1/15Mw	0.021	4020.17	1302.48	
98/1/16Mw	0.016	2416.30		
98/1/17Mw	0.036	1608.31		0.733
98/1/18Mw	0.033	1623.45	1766.28	
98/1/19Mw	0.093	4536.65		
98/1/20Mw	0.080	17544.34		1.024
98/1/21Mw	0.013	4723.35	10044.40	
98/1/22Mw	0.012	6502.68		
98/1/23Mw	0.065	7061.80	6128.09	0.892
98/1/24Mw	0.015	1782.33		
98/4/25Mw	0.107	8617.04		
98/4/26Mw	0.104	8669.75	8564.74	1.417
98/4/27Mw	0.023	7846.67		
98/4/28Mw	0.073	579.83		
98/4/29Mw	0.029	227.33	397.71	0.868
98/4/30Mw	0.024	49.64		
98/4/31Mw	0.082	2437.22		
98/4/32Mw	0.046	162.00	1346.34	0.889
98/4/33Mw	0.030	180.91		
98/4/37Mw	0.135	8252.50		
98/4/38Mw	0.026	1139.60	6430.65	0.867
98/4/39Mw	0.039	3651.59		
98/4/46Mw	0.023	39.10		
98/4/47Mw	0.013	24.59	32.48	0.175
98/4/48Mw	0.004	20.38		
98/9/49Mw	0.008	9.23		
98/9/50Mw	0.008	9.60	9.81	0.104
98/9/51Mw	0.003	11.92		
98/10/55Mw	0.008	15.91		
98/10/56Mw	0.010	8.57	11.63	0.101

98/10/57Mw	0.004	10.74		
98/10/58Mw 98/10/59Mw 98/10/60Mw	0.035 0.009 0.013	289.29 306.36 228.33	278.08	0.192
98/12/61Mw 98/12/62Mw 98/12/63Mw	0.005 0.010 0.011	1114.85 653.02 1219.35	981.43	0.107
98/12/64Mw 98/12/65Mw 98/12/66Mw	0.006 0.013 0.011	950.56 845.81 853.94	869.74	0.125
98/12/67Mw 98/12/68Mw 98/12/69Mw	0.009 0.021 0.014	6061.07 5274.72 5665.51	5559.91	0.184

Table 4 TOTAL SEDIMENT LOAD FOR MITUMBA STREAM

Sample No.	Q(m3/s)in section	Sediment conc.(mg/l)	Average sediment concentration(mg/l)	Total flow m^3/s
98/4/34GO 98/4/35GO 98/4/36GO	0.011 0.023 0.028	16.52 - 21.79	12.77	0.318
98/4/40GO 98/4/41GO 98/4/42GO	0.014 0.025 0.036	72.00 47.71 66.33	61.18	0.375
98/4/43GO 98/4/44GO 98/4/45GO	0.003 0.004 0.010	20.00 11.37 12.94	13.82	0.094
98/4/52GO 98/4/53GO 98/4/54GO	0.006 0.003 0.004	8.39 17.00 10.00	10.87	0.059

Fluctuations of total suspended sediment load have been observed and are attributed to the following reasons:

(i) Erratic supply from catchment

(ii) Fluctuation of a dominant factor (i.e. Unit stream power) within the stream water flow system.

(iii) Inconsistency in taking and calculating the stream discharges, mean velocity, cross-sectional area, channel width, mean depth at verticals where suspended sediment samples were taken (According to the modified Einstein procedure of sediment concentration determination (Yang, 1996)

(iv) Different catchment conditions at the time of storm events and measurements e.g. differential sediment coherence.

Table 5 COMPUTED TOTAL SEDIMENT LOAD FOR NGONYA STREAM.

No	Sample No.	Average Discharge m^3/s	Average Sediment Concentration mg/l
I	98/10/58Mw 98/10/59Mw 98/10/60Mw	0.192	278.08
II	98/10/67Mw 98/10/68Mw 98/10/69Mw	0.184	5559.91
III	98/10/55Mw 98/10/56Mw 98/10/57Mw	0.101	11.63
IV	98/10/61Mw 98/10/62Mw 98/10/63Mw	0.107	981.43
V	98/10/19Mw 98/10/20Mw 98/10/21Mw	1.024	10044.40
VI	98/10/25Mw 98/10/26Mw 98/10/27Mw	1.417	8564.74

4.4 Analysis of chemical data

The chemical data were computed for the ion balance in order to determine the degree of accuracy of the laboratory work before further interpretations were carried out.

The results show that ion imbalance varied from 1 to 10 %. However, water samples having low ion concentration have higher values of ion imbalance than 10 % implying to be the most inaccurate ones. This is attributed to poor detection limits by the measuring instruments. Low concentration determined for the nutrients including NO_3^-, SiO_2 and PO_4^- indicate lack of significant anthropogenic sources **(Appendix 4)**, possibly implying natural sources of these key plant nutrients.

The chemical data obtained were interpreted in order to determine the factors that bring about the chemical character of both surface and groundwater in the study area including Lake Tanganyika.

Data analysis using Piper trilinear diagram indicates Magnesium Bicarbonate type of water to be the most dominant in both surface and groundwater. **Figures 14, 15, 16 & 17.**

Figure 14. Piper trilinear diagram Streams - wet season (Jan., Feb., Mar., Apr., May, Nov., Dec)

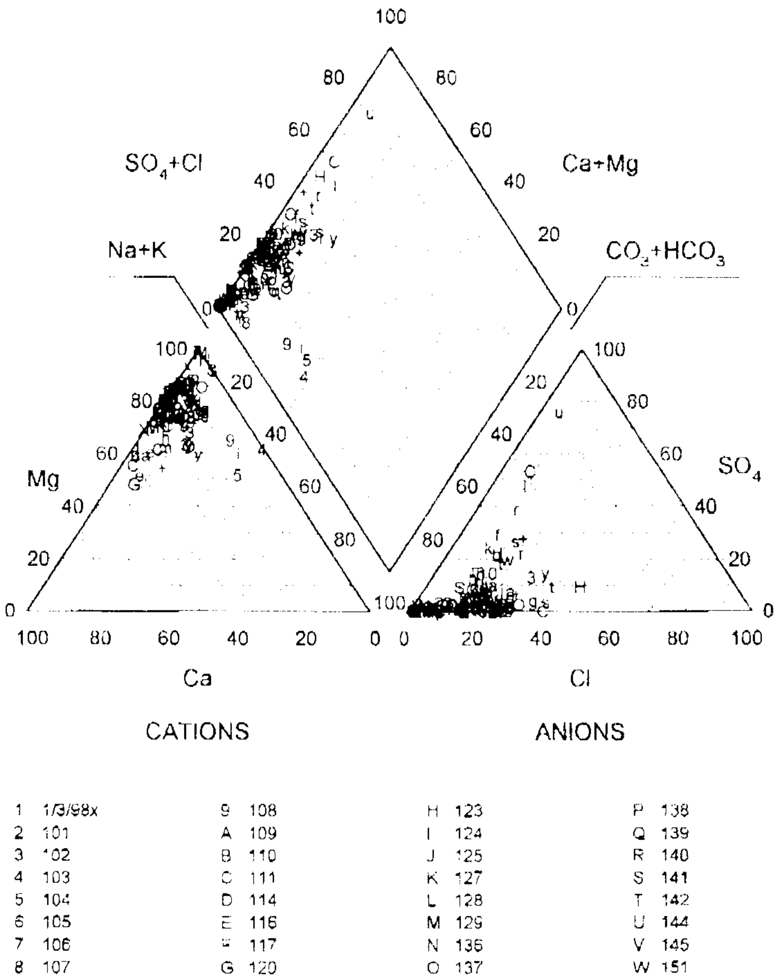


Figure 15. Piper trilinear diagram for Streams - dry season (Jul., Aug., Jan., Feb., Oct.)

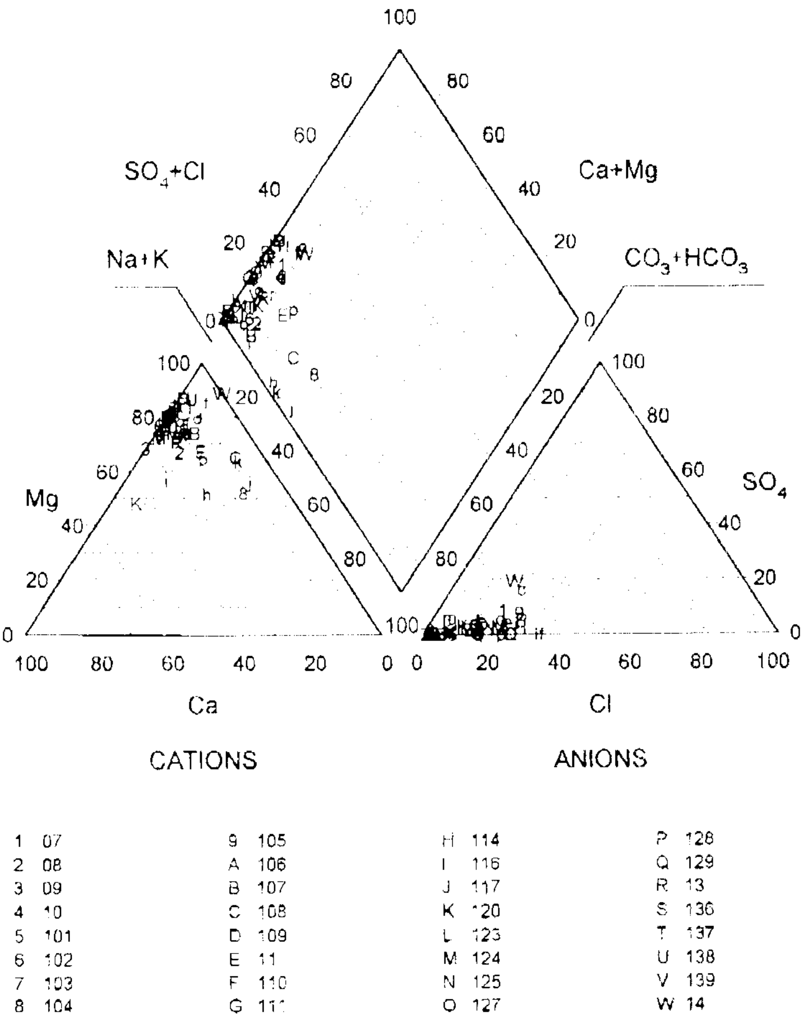


Figure 16. Piper trilinear diagram for lake water

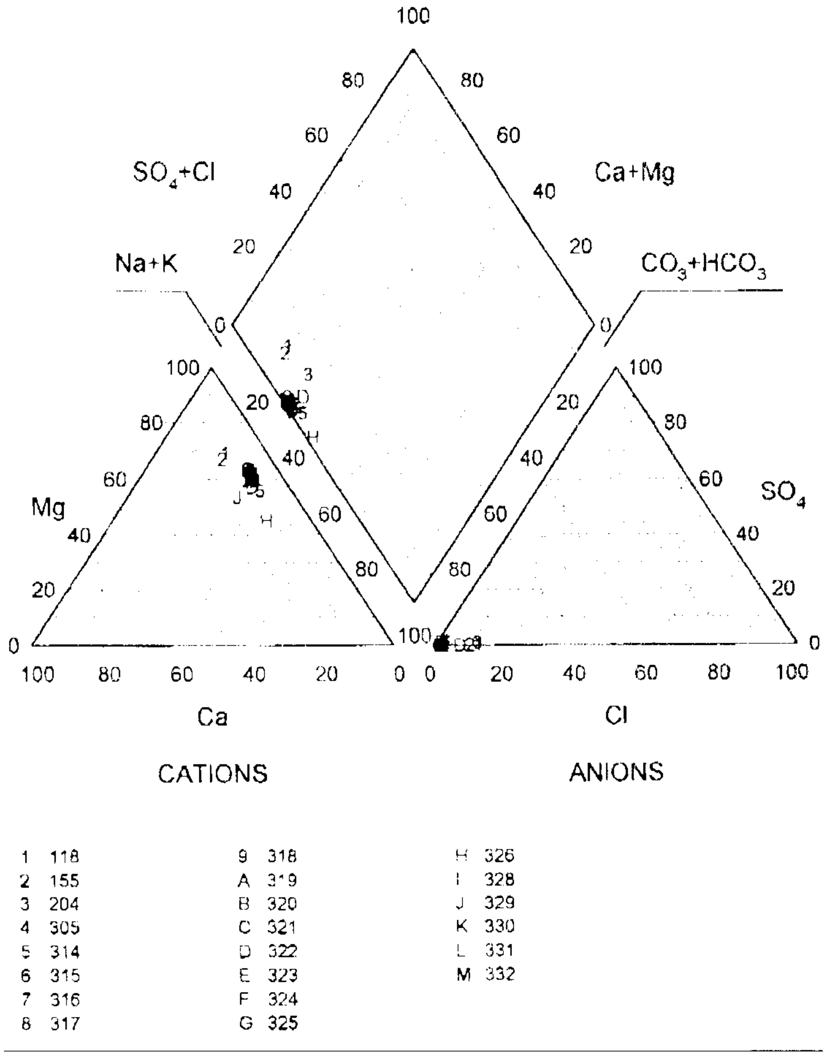
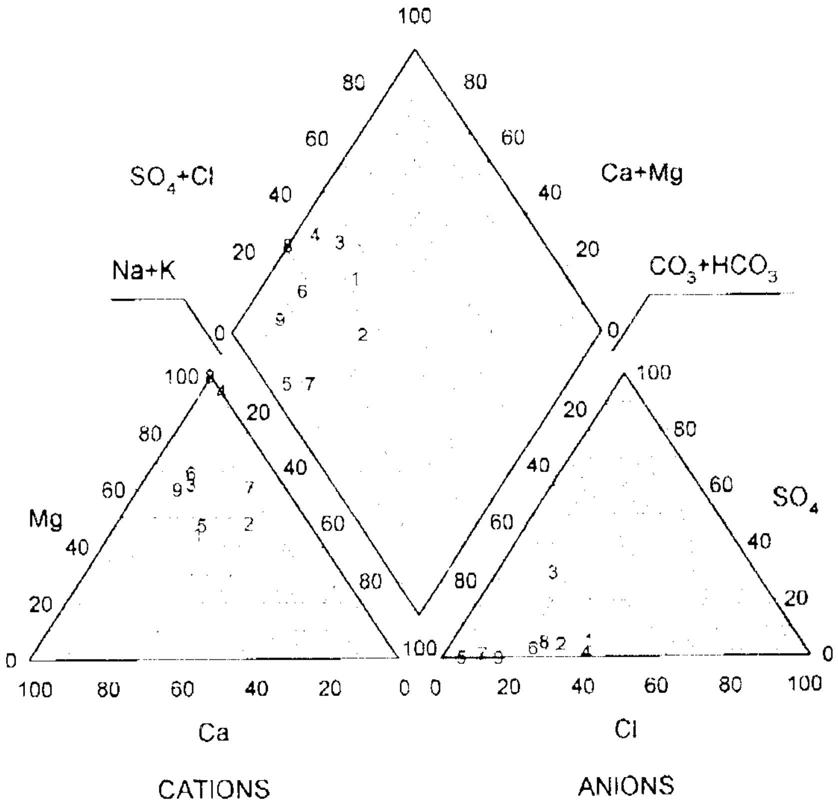


Figure 17. Piper trilinear diagram for shallow wells



1 242
2 243
3 244
4 245
5 247
6 249
7 252
8 292
9 296

The results show that the chemical character of water in the Lake Tanganyika reflects that of the inflowing streams and rivers. However, Cohen. *et. al.* (1997) explained that the chemical character of water in Lake Tanganyika is due to the waters coming from the hot springs located in some places on the lake bed. This may be unlikely because the contribution of water by the hot springs located on the lake bed to the total volume of water into the lake is insignificant in comparison to that coming from rivers and streams.

4.5 Correlation analysis

Correlation analysis using multivariate statistics shows salinity of both surface and groundwater to be highly positively correlated with Na^+, K^+, and HCO_3^- but to a lesser extent with Mg^{2+}, and Cl^- (**Table 6).** The correlation results suggest that the chemical character of water in this area is caused by water - rock interaction. The reaction of albite minerals that were determined in the sediment samples could indicate one of the possible minerals that are reacting to form the well correlating ions as per the following chemical reaction:

$$2.33\ NaAlSi_2O_8 + 8.64H_2O + 2CO_2 = Na0.33Al_2.33SiO_3.67O_{10}.(OH)_2 + 2Na^+ + 2HCO_3^- + 3.32H_2SiO_4.$$

Similarly Na^+, K^+, and HCO_3^- correlate very well, indicating that these ions have a common source and/or the same process influences the concentrations in the stream.

Silica was determined to be the most dominant nutrient in comparison to phosphates and nitrates. The results show that anthropogenic factors do not influence the chemical character of the water in this area, because silica is a product of the reaction of silicate minerals with water. However, only a few samples were analysed for silica and hence could not be used in the correlation analysis. The concentration of the Na^+, & K^+, tends to be smaller than Mg^{2+} in waters, this is attributed to the cation exchange process that depletes the Na^+, and K^+ ions from solution in favour of the Mg^{2+} enrichment from the soil matrix.

Table 6 Correlation matrix for chemical data

Variable	Temp	pH	EC	Cl	Ca	Mg	SO4	HCO3	Fe	K	Na
Temp	**1.00**										
pH	0.16	**1.00**									
EC	0.11	0.76	**1.00**								
Cl	0.15	0.21	0.37	**1.00**							
Ca	0.13	0.31	0.26	0.19	**1.00**						
Mg	0.15	0.37	0.31	0.21	0.77	**1.00**					
SO4	0.12	-0.01	0.09	0.22	0.00	-0.06	**1.00**				
HCO3	0.13	0.77	0.95	0.27	0.29	0.37	-0.00	**1.00**			
Fe	0.08	-0.09	-0.10	0.02	-0.07	-0.09	0.71	-0.10	**1.00**		
K	0.11	0.75	0.94	0.26	0.20	0.3	-0.01	0.95	-0.06	**1.00**	
Na	0.10	0.75	0.94	0.42	0.25	0.33	0.01	0.92	-0.1	0.93	**1.00**

4.6 Ion Ratios

The Na^+:Cl^- ratios were determined from various water sources and resulted in decreasing values that are lower than 1.0 with increasing chloride concentrations **(Figures 18 & 19)**. The chloride concentration is apparently taken as a measure of salinity due to its conservative nature. The ratio results indicate that chloride is being added to the aquatic system much faster than Na^+. Alternatively, Na^+ could be decreasing in the system through cat ion exchange processes, as salinity of water increases.

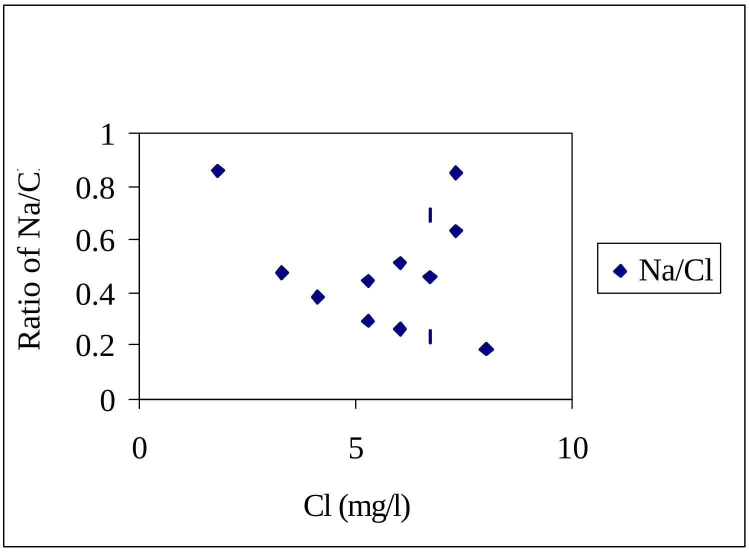


Figure 18 Variation of Na/Cl with Cl in springs

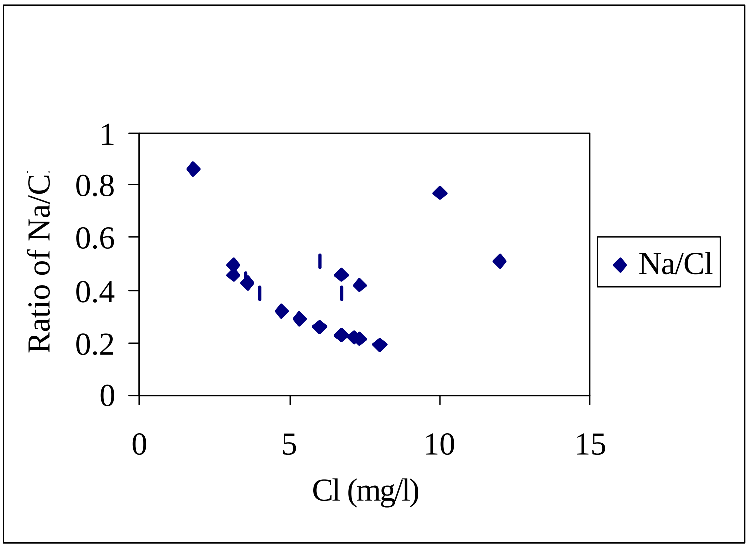


Figure 19 Variation of Na/Cl with Cl in streams

However, the ratio of Na^+ / Cl^- for the Lake Tanganyika waters is determined to vary from more than 5.0 to lower values than 3.0 at low and high concentrations of chloride respectively **(Figure 20)**.

The results suggest that at low chloride concentration addition of Na^+ probably resulting from the dissolution of plagioclase minerals brought about into the lake as stream sediments may be taking place. Sediment analysis using XRF and ICP techniques result in high concentration of albite minerals whose sodium content is high **(Figure 9 and Appendix 7)**

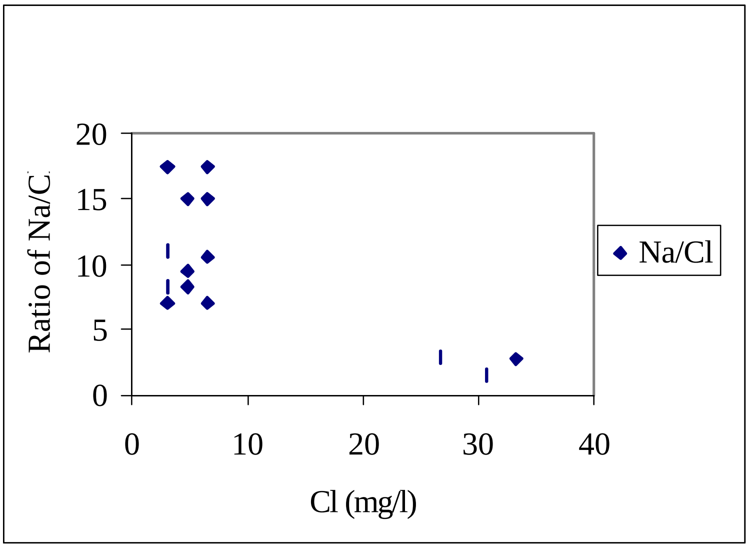


Figure 20 Variation of Na / Cl with Cl for Lake Tanganyika

However, at high chloride concentrations of the lake water, cation exchange processes may be predominantly taking place thus resulting in decreased values of Na^+, hence the low calculated ratios.

The cation exchange process may further be supported by the ratio of the Mg^{2+} / Na^{+} which has almost constant values at various chloride concentrations as determined from various water sources **(Figures 21 and 22).** The constant values suggest that the same processes regulating the concentration of the two ions operate at all levels of salinity as reflected by chloride concentrations and at all times of the year.

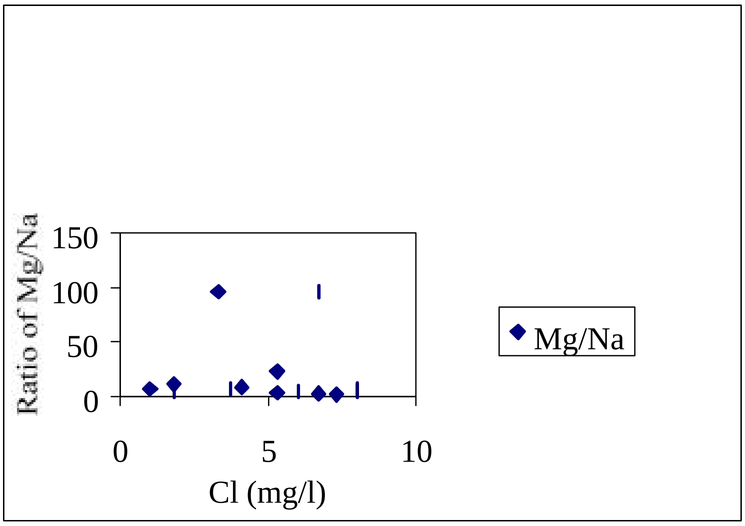


Figure 21 Variation of Mg / Na (y axis) with Cl in the springs

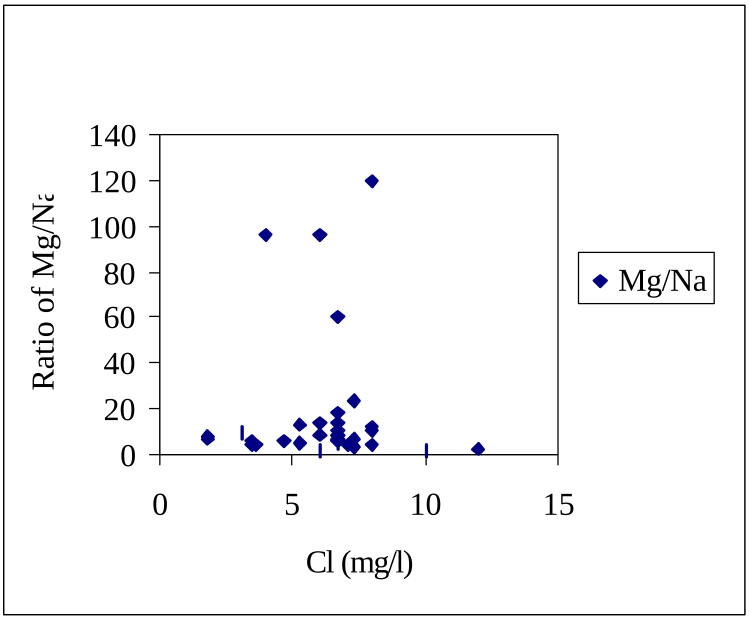


Figure 22 Variation of Mg / Na with Cl in the Streams

However, the higher ratio of Mg^{2+} / Na^{+} than 1.0 from the lake water indicates that $[Mg^{2+}]$ increases in the lake as $[Na^{+}]$ decreases, possibly due to cation exchange processes **(Figure 23).**

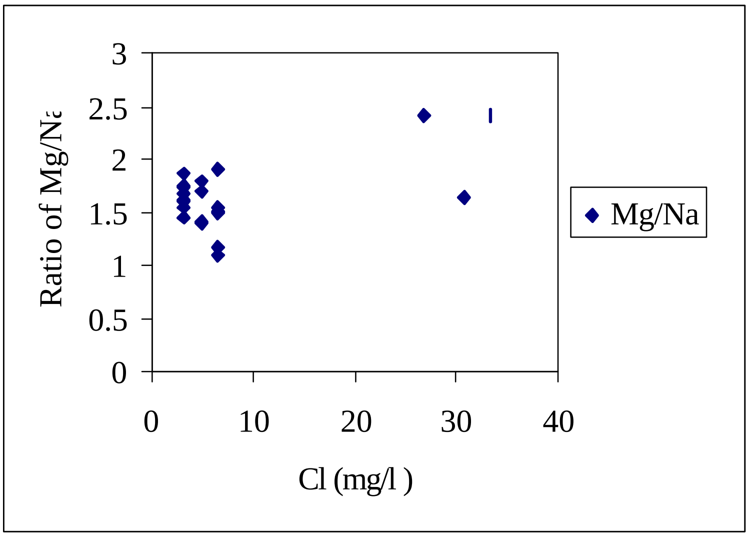


Figure 23 Variation of Mg / Na with Cl for Lake Tanganyika.

The results demonstrate further that natural processes may be responsible for the overall chemical character of the water in the study area.

The ratio of Mg^{2+} / Ca^{2+} for all the water samples collected from various water sources resulted in higher values than 1.0, sugesting that Mg^{2+} rich minerals are dissolving in the water in this area **(Figures 24, 25 & 26)**. This is supported by the underlying geology in this area being dominated by dolomitic limestone.

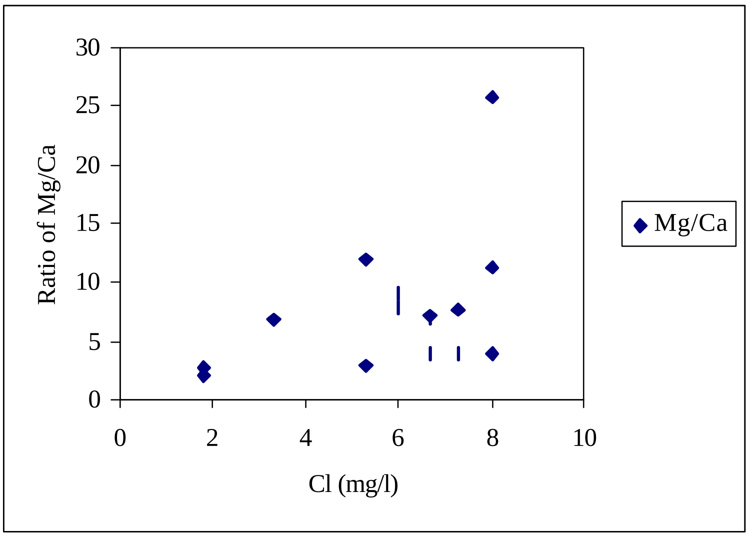


Figure 24. Variation of the Mg / Ca with Cl for the Springs.

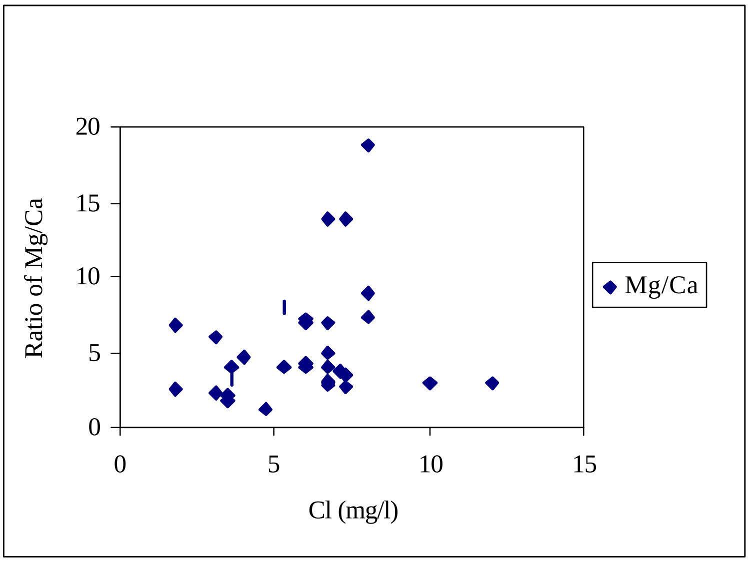


Figure 25. Variation of Mg / Ca with Cl for the Streams

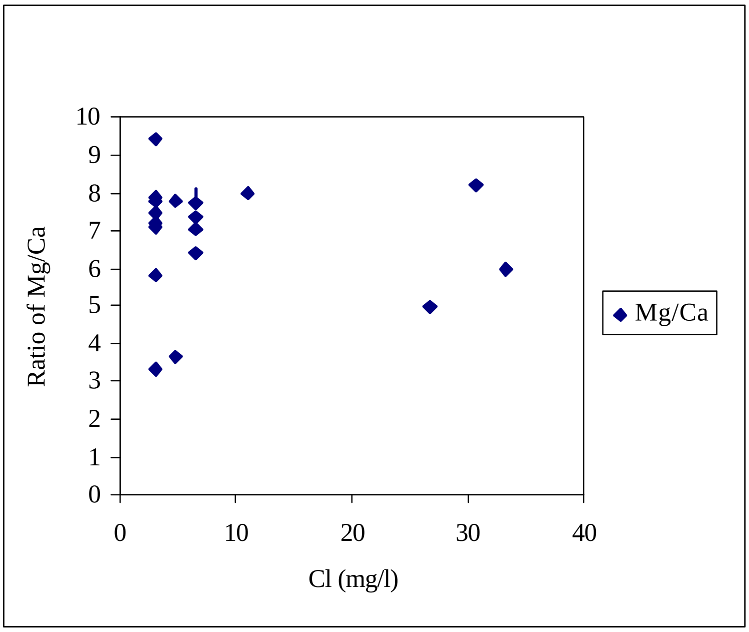


Figure 26. Variation of the Mg / Ca with Cl for Lake Tanganyika

Similarly, the ratio of [Mg^{2+} + Ca^{2+}] / HCO_3^- in various water sources resulted in values higher than one **(Figures 27, 28 & 29).** The results show that dissolution of dolomitic limestone is not the only source of Mg^{2+} and Ca^{2+} into the natural water in this area. Therefore, dissolution of amphiboles might also be contributing a significant amount of the ions into the water along with cation exchange process. The amphibole gneisses have been identified to form part of the geology of the study area **(Figure 2).** These rocks have significant content of amphiboles that could be dissolving to form the observed chemical character of the water as per thefollowing chemical reaction:

$$Ca_2\,Mg_5Si_8O_{22}(OH)_2 + 14\,CO_2 + 22H_2O = 2Ca^{2+} + 5\,Mg^{2+} + 14HCO_3^- + 8\,Si(OH)_4$$

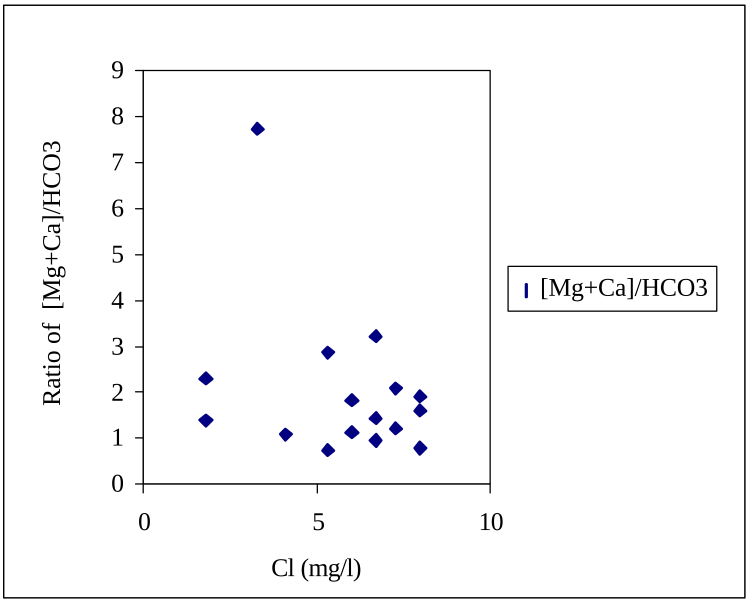


Figure 27. Variation of the (Mg + Ca)/HCO_3 with Cl for the springs

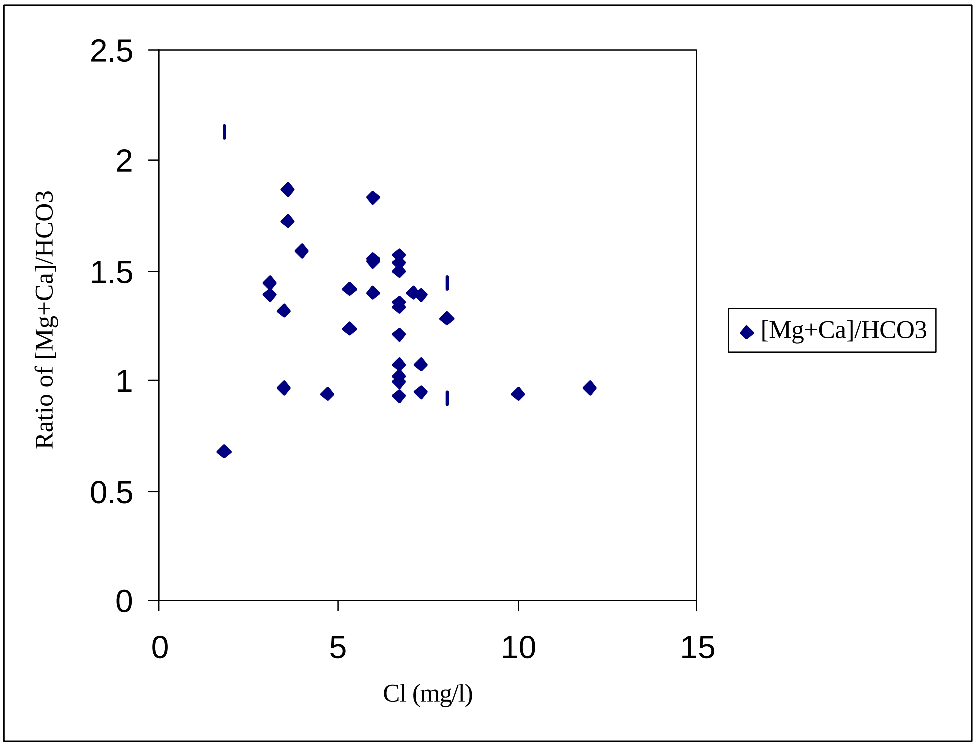


Figure 28 Variation of the (Mg + Ca)/HCO_3 with Cl for the streams

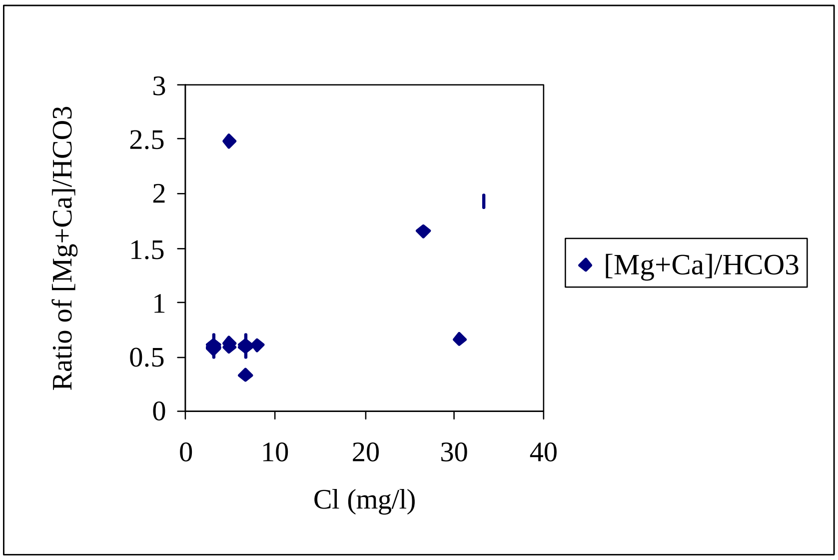


Figure 29 Variations of [Mg + Ca] / HCO_3 with Cl for Lake Tanganyika.

It may be summarised that the ratios show that the chemical character of the water in the study area is mainly due to natural processes.

4.7 Trend surface maps

These were plotted and show that the chemical content of stream flow varies insignificantly with the catchment topography. This is because there is minor, if any, anthropogenic causes of chemical character of the stream surface runoff. These maps are available from the author.

In addition, streams flow fast enough in this area (at least higher in the watershed) that no water rock interaction would take place along the stream channel.

Mean monthly variation of chemical composition of water in the Mitumba and Ngonya watersheds show the chemical composition to have similar trends in the two watersheds **(Figures 30 & 31)**. In general, TDS is observed to decrease during the months in which stream flow increases as this is the period of high rainfall. Rapidly flowing fluxes of surface runoff generated by high rainfall results in decreased water rock contact time. The increase of TDS in the period of decreased rainfall, that results in decreased runoff is attributed to the increase in contact time between the rock and the water thus enabling effective dissolution process to take place and also evaporation effect to be significant.

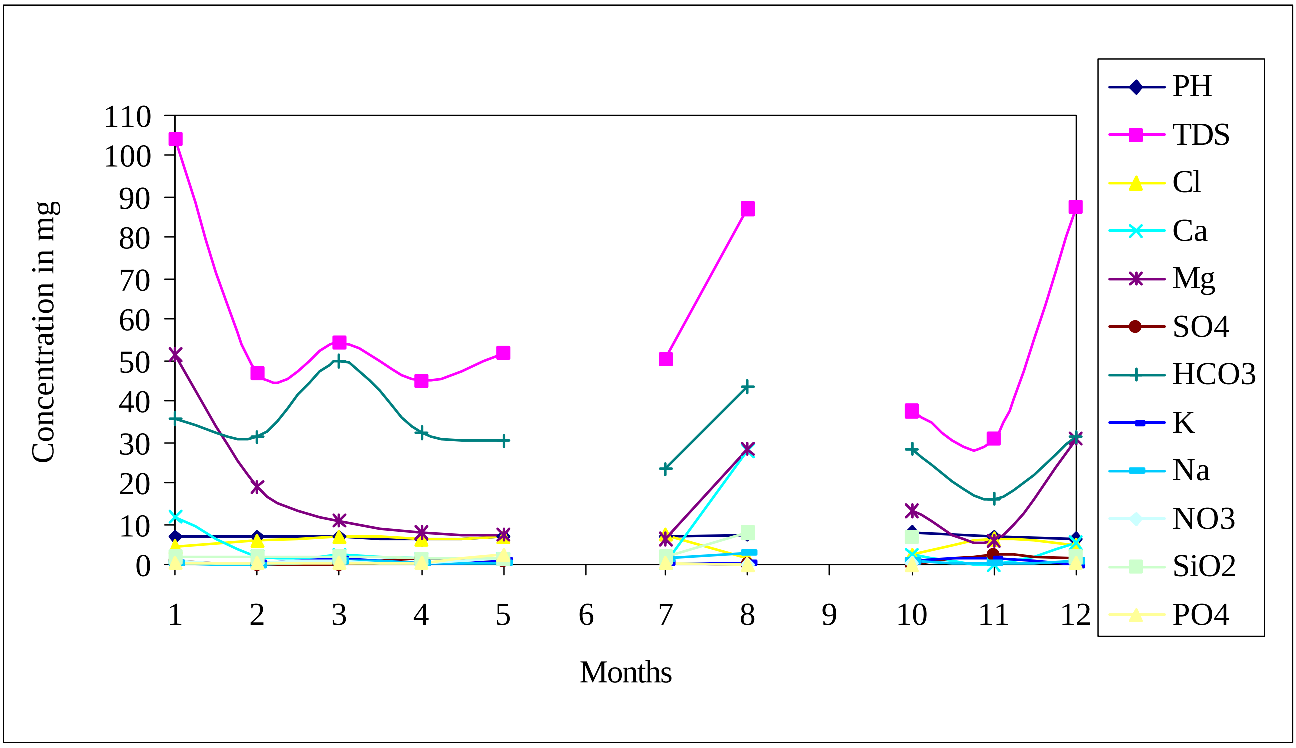


Figure 30. Mean monthly variation in the chemical composition of the Mitumba stream. Concentrations in mg/l.

However, waters from the Ngonya watershed are higher in concentration of various ions than waters from the Mitumba watershed. The difference in concentration is attributed to the degree of vegetal cover. Vegetation stabilises the soil and prevents physical erosion. Vegetation cover also causes fresh rocks not to be exposed at the surface, thus causing less contact between the rainwater and the rocks, hence resulting in decreased chemical weathering.

Therefore, as a consequence of deforestation, the rocks in the Ngonya watershed are always exposed at the surface and therefore easily interacting with rainwater. This explains why there is high concentration in various ions in the Ngonya stream waters compared to that in the Mitumba watershed, which is well covered by plant litter.

Magnesium is observed to be the most dominant cation along with the bicarbonate anion during the entire water year **(Figures 30 & 31)**. This implies that natural processes are responsible for the chemical character of the water in the two watersheds as there are no anthropogenic sources of Mg in this area and the ions are naturally being introduced into the aquatic environment independent of seasonal variation.

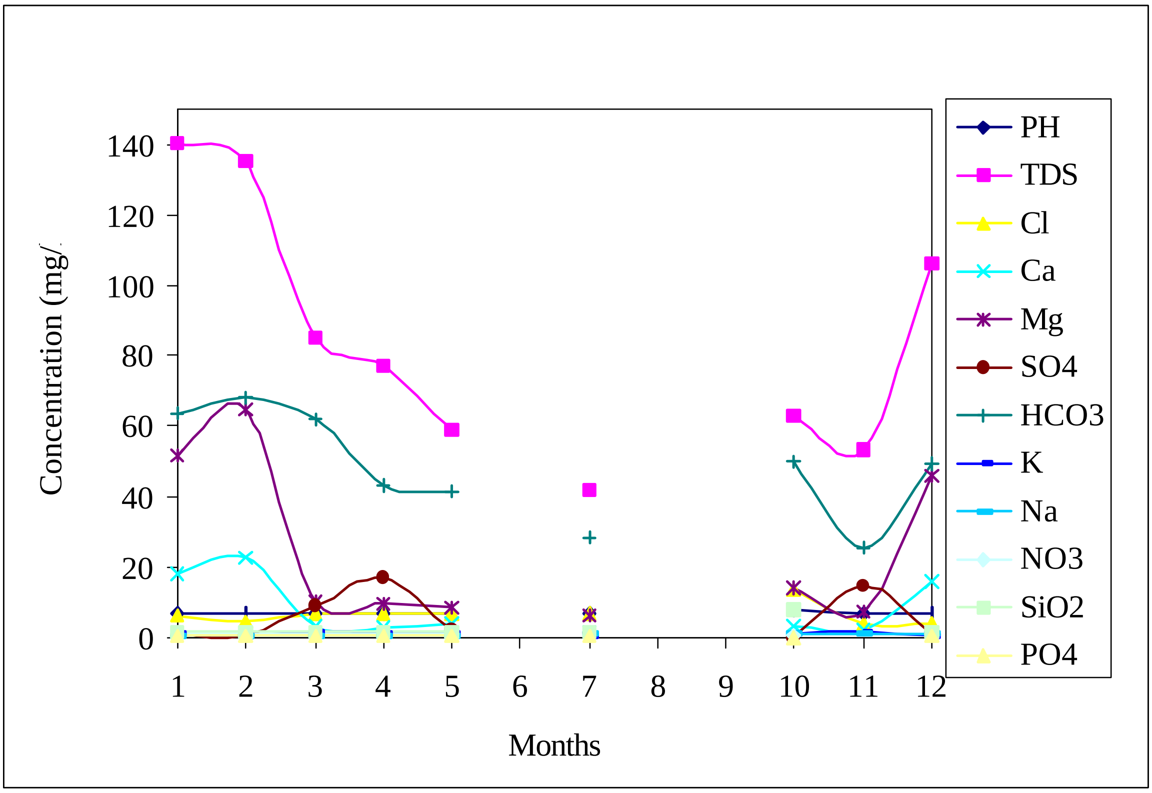


Figure 31. Mean monthly variation in the chemical composition of the Ngonya stream. Concentrations in mg/l.

5. ISOTOPE HYDROLOGY

The isotope data are reported according to Craig (1961) and reported using the V SMOW standard as shown below.

$$d\,^{18}O_{SMOW} = [\frac{(^{18}O/^{16}O_{sample} - ^{18}O/^{16}O_{standard})}{(^{18}O/^{16}O_{standard})}] * 10^{3}$$

The relationship between $\delta\,^{18}O$ and $\delta\,^{2}H$ of precipitation resulted in the local meteoric equation of $\delta\,^{2}H = 7.499\,\delta\,^{18}O + 12.11$. Similar results have been obtained for the rainfall collected in the Mitumba and Ngonya watersheds as shown in the **Figures 32 & 33**.

The slope of the equation indicates that precipitation in this area has undergone evaporation process implying that either precipitation originates from a distant place accompanied by strong winds and or from high placed clouds. Satellite data indicate that the clouds forming the precipitation during the study period are predominantly Cumulus, broken clouds that normally form at an altitude of about 3000 m - 10,000 m above sea level. These types of clouds form high intensity rainfall accompanied with strong winds.

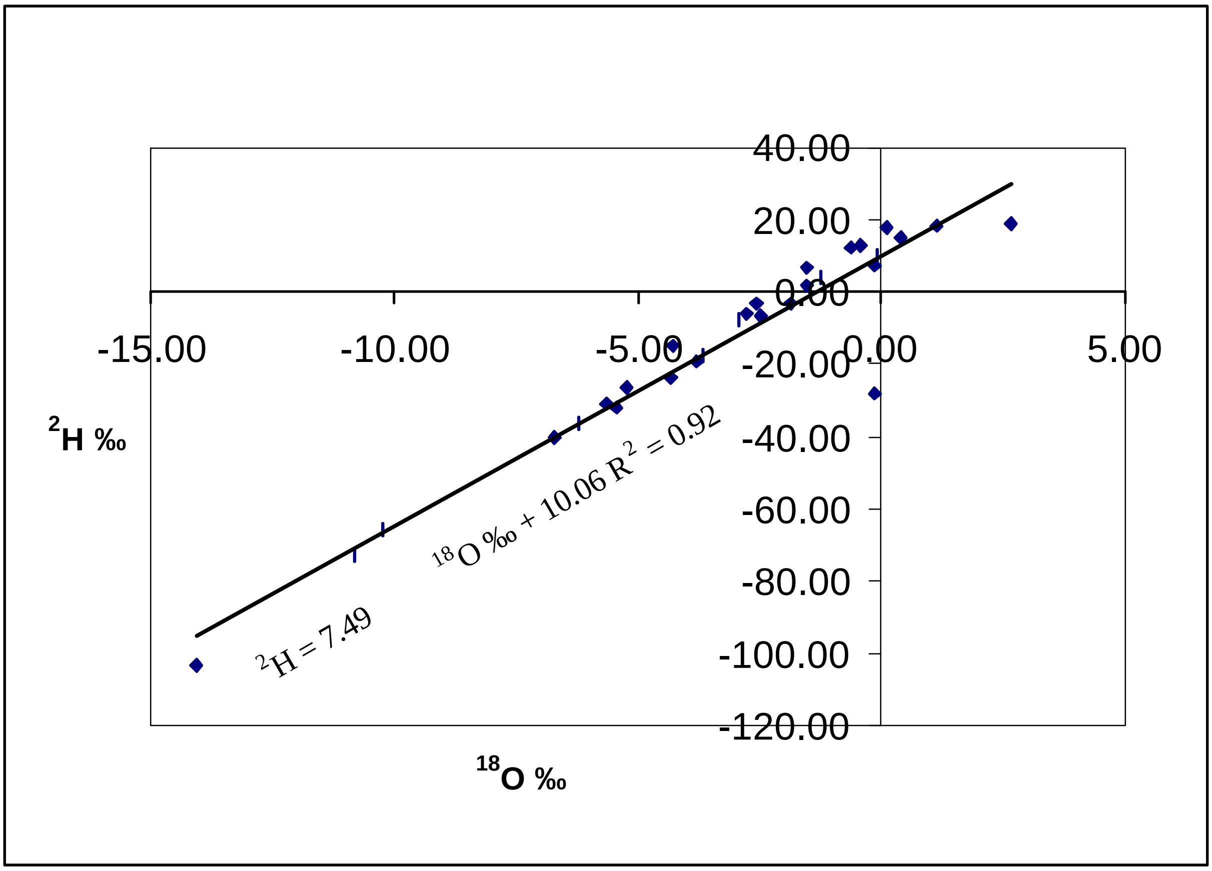


Figure 32 The relationship between δ ^{18}O (y-axis) and δ ^{2}H (x-axis) for the rainfall in the Mitumba watershed.

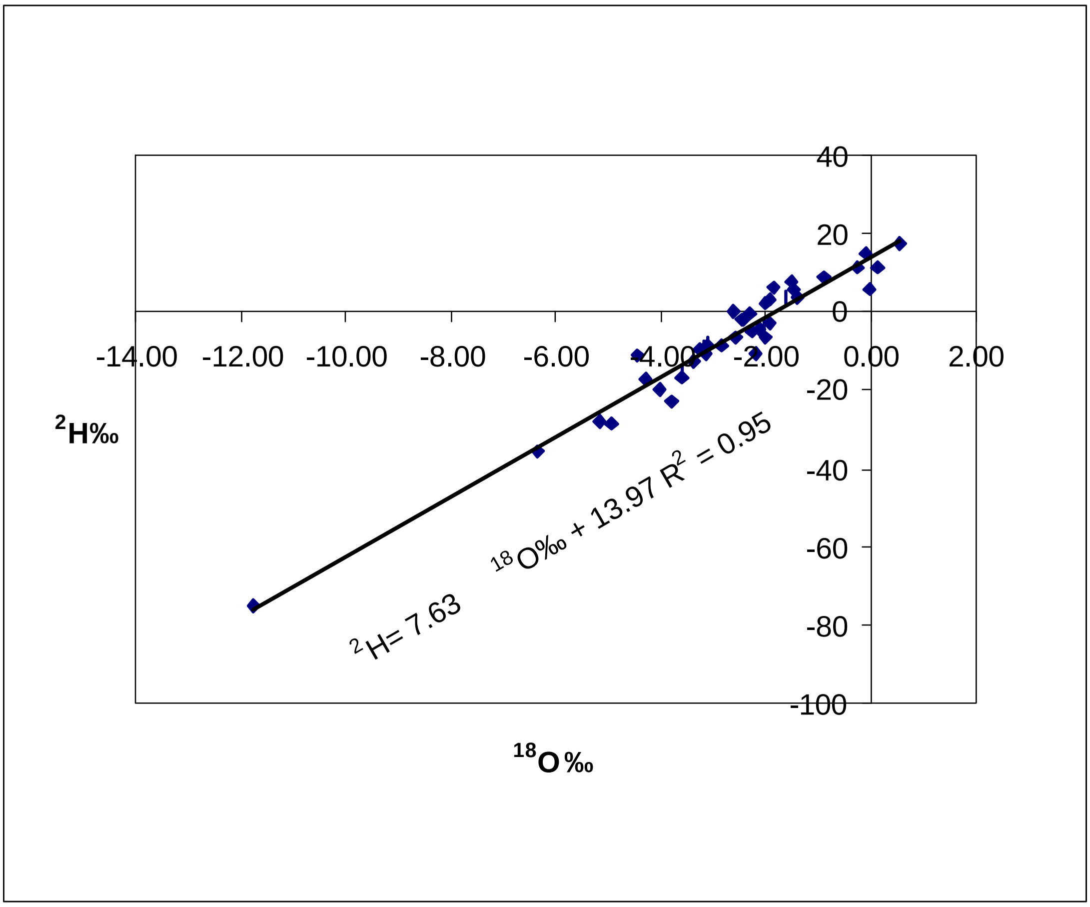


Figure 33 The relationship between δ ^{18}O (y-axis) and δ ^{2} H (x-axis) for the rainfall in the Ngonya watershed.

Isotope content of precipitation ranges from -3.5‰ to -5.5‰ for **δ ^{18}O**. The mean deuterium excess of about 13‰ shown in **Table 7** computed for the precipitation indicates a high moisture deficit, i.e. low relative humidity in the atmosphere just above the ocean from which the vapours forming the precipitation was formed.

Table 7 The mean deuterium excess for the Ngonya and Mitumba rainfall.

Source of mean rainfall values	δ ^{18}O ‰	δ ^{2} H ‰	δ ^{2} H ‰ Excess
Gombe	-3.25	-14.30	11.7
Mwamugongo	-2.69	-6.59	15.0
Mean for both rainfall sources	-2.92	-9.70	13.6

Comparison of the mean stable isotope content of precipitation and stream waters to that of the lake water suggests that strong evaporation may account for a big percentage in the water losses from the lake. Computation of the actual evapo - transpiration for the lake using ^{18}O data resulted in about 1080mm. This is about 90% of mean annual precipitation of 1200mm, implying that evaporation is the major mechanism by which the lake water is lost. In addition, the isotope data show that evaporation process may also significantly contribute to the observed chemical character of the lake.

Since the mean residence time of water in the lake Tanganyika is about 1000 years (Cohen *et. al.* 1997), then enrichment in ^{18}O data from water samples collected in the hypolimnion indicate that about 1000 years ago the lake experienced a dry climate. The isotope content of shells collected from the cores dated with same age support this observation (Marcel 1992, Cohen *et al*. 1997).

6. INSTALLATION OF EQUIPMENT AND PERFORMANCE MONITORING

New manual rain gauges were installed at different altitudes in the Study areas. Four and five rain gauges were installed at Mitumba and Ngonya watersheds respectively. Several rain gauges were installed in each watershed in order to monitor variability of rainfall amounts with altitude.

Two automatic tipping bucket rain gauges were installed one in each watershed adjacent to the first manual rain gauge in each watershed in order to track the rainfall intensity in this area. However, the automatic rain gauges for some reason recorded abnormally high rainfall in a day and/or in a single event that is equivalent to an amount collected in several years. Thus indicating that something was wrong in the recording by these gauges, consequently collected data have been discarded in the interpretation.

Furthermore, gauge plates obtained from the Kigoma Water Department were installed at the zero level position (deepest point on stream bed) in each stream about 50m upstream of the Lake confluence with each stream. Gauge plates were installed in order to monitor changes in the stream water levels in order to deduce the stream flow rates from the stream constructed rating curves.

7. TRAINING

Mr. C. Rubabwa was shown how to conduct stream flow measurements along with sediment sampling; Mr Rubabawa continues to be trained at the University of Dar - es - Salaam where he is conducting his M.Sc. studies.

Dr David Dettman systematically explained how to use Delta S Finnigan Mass Spectrometer to Hudson Nkotagu during the determination of ^{2}H and ^{18}O from water samples at the University of Arizona.

The Assistants obtained from the Mwamugongo and Gombe village were taught how to take gauge readings and rainfall data. The training was successful as they managed to take some of the data used in this work without supervision.

8. MANPOWER

The following staff members were involved in different capacities during the project.

(1) Mrs. K. Mbwambo	Analytical chemist [Tanzania Bureau of Standards]
(2) Mr. C. Rubabwa	Geologist (M Sc. student at UDSM) [Ministry of Water]
(3) Mr. T. Mpyalimi	Technician (Hydrology) [Ministry of Water]
(4) Mr. H. Mdangi	Gombe Ranger [Gombe National Park / TANAPA]
(5) Mr. S. Shemudoe	Gombe Ranger [Gombe National Park / TANAPA]
(6) Mr. S. Haruna	Mwamugongo village resident [Mwamugongo village]
(7) Mr. Chale	R/V Echo Captain [TAFIRI]
(8) Mr. Chata	R/V Echo Crew [TAFIRI]
(9) Mr. Ibrahim	R/V Echo Crew [TAFIRI]
(10) Dr. G. Patterson	Sediment special study Co-ordinator [NRI / U.K.]
(11) Mr O. Drieu	Sediment special study Facilitator [LTBP/Mpulungu]
(12) Dr. D. Dettman	Stable isotope Geochemist [University of Arizona]
(13) Dr. H. Nkotagu	Hydrologist [University of Dar Es Salaam]

9. SUMMARY

The main findings of this work may be summarised as follows;

- The impacted watershed has an order of magnitude higher than the pristine environment in the current suspended sediment transport rates.
- Groundwater forms about 70% and 80% of the total stream flow in form of base flow for the Mitumba and Ngonya streams respectively.
- Low levels of nutrients and chemical pollutants are at the moment being transported by the two streams.
- Groundwater plays a dominant role in the mode of nutrient and chemical pollutant transport into the lake on a long term basis through the base flow component, that forms a major part of the stream flows.
- Significant concentrations of nutrients are also transported during high flows.
- The interplay between the watershed lithology and vegetal cover forms a major role in determining the chemical character of the natural water in both watersheds.
- Insignificant anthropogenic causes, if any, are observed to influence the water quality in this area.
- From the study area, suspeneded sediments may be considered as the lake's major pollutant and possibly carriers of pollutants.

10. RECOMMENDATIONS FOR FUTURE WORK

Monitoring and future research

<u>High Priority</u>

Research

Find out to what extent sediments act as carriers of pollutants and sinks for nutrients in the lake

Establish a water quality numerical model for the lake, focused on nutrients and pollutant mass balance hydrodynamics.

Find out the relationship between current sedimentation rates and the species (Benthic and Pelagic) productivity.

Investigate to what extent the Malagarasi wetland up stream of the Malagarasi delta acts as a sink or buffer of both sediments and pollutants to the lake. Mass flux of both sediments and pollutants into the wetland then can be monitored accordingly.

Monitoring

Current sedimentation rates for major rivers of Malagarasi and Luiche.

Monitor water quality variations with season from major rivers including Malagarasi, Luiche and Lugufu.

Monitor the hydro meteorological parameters around the Malagarasi wetland.

Variability in land use patterns in the lake Tanganyika watershed.

<u>Medium Priority</u>

Research

To what extent does fire outbreak enhance sedimentation rates?

Quantify contributions of sediments from each sediment source to the lake.

Monitoring

Monitor the hydro - meteorological conditions in the Lake Tanganyika watershed

Monitor various pollutants (e.g. heavy metals) and general water quality from major rivers of Malagarasi, Luiche and Lugufu rivers and the lake itself.

<u>Low Priority</u>

Monitoring

Chemical character of precipitation above the onto the lake surface as well as in the whole catchment. The rainfall pattern in the study area originates from the Atlantic Ocean across the Congo forests. Therefore, any activity in the Congo that could result in atmospheric pollution should be monitored through chemical characterisation of rainfall.

11. MANAGEMENT ACTIONS

11.1 Appropriate farming practices enhancement.

Farming involving ridges across the slopes should be practised in the attempt to control erosion by slowing down the surface runoff. In addition, stream bank cultivation should be avoided for halting accelerated erosion.

11.2 Afforestation

This should be considered as an important management intervention, because trees slow down surface runoff, in turn reducing its erosive powers. Afforestation should be undertaken in the upstream section of the watershed. The upstream section of the watershed is a highly energetic environment where maximum erosion normally occurs. However, appropriate tree species should be planted that do not consume a lot of water per day for their growth requirement. Lack of appropriate tree species may result in the depletion of groundwater resources that sustain surface water flows during the dry season. This is supported by the contribution of groundwater component to the stream flow, which is high in the impacted watershed and slightly less in the Gombe National Park as a consequence to high evapo - transpiration losses.

It may be summarised that soil conservation methods in preventing or reducing sediment inflow to a reservoir such as Lake Tanganyika may include structural and nonstructural measures. Structural measures may involve the construction of sedimentation basin to store sediments; drop inlets and chutes to reduce gully erosion; stream bank revetment to reduce bank erosion; and sill and drop structures to stabilise the stream bed.

Nonstructural measures including watershed land treatment to reduce sheet erosion; the use of proper tillage methods, strip cropping, terracing and crop rotation; and trapping and retention of sediment by vegetative screen (reforestation) may be undertaken.

Additional benefits

Control of deforestation and actions in favour of afforestation would lead to obvious benefits in terms of production of wood and other products, land conservation, water control and conservation of forest biodiversity (including regional endemic species).

11.3 Community based interventions

For the control of sedimentation action to prevent the primary causes should be highly encouraged.

Additional comments

The LTBP has put much emphasis on the lake itself with relatively little scientific input on what is going on in the lake's catchment.

A scientific study for example on the Malagarasi wetland that potentially acts as a buffer to the lake (with an area of about 10,000 km^2) would have assisted very much in achieving proper management strategies for the lake. To what extent does such a huge wetland connected to one of the lake's major inflow rivers act as a sediment and pollutant sink?

In addition, could there be any species relationship between those of the lake and those in the wetland? If so in what ways?

It is strongly recommended that the data collected during the project be stored in form of a data bank electronic or otherwise so that they are easily accessible to any stakeholders. In this case it is suggested that for future research purposes and teaching, the University of Dar Es Salaam be the most suitable candidate for holding the Lake Tanganyika Environmental Data Bank.

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Appendix 1 Rainfall data

Appendix 1a RAINFALL OBSERVATIONS AT MWAMGONGO

1997

Date	J	F	M	A	M	J	J	A	S	O	N	D
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												39.1
18												0.3
19												20.6
20												5.0
21												NIL
22												0.4
23												NIL
24												22.9
25												1.1
26												6.3
27												NIL
28												16.9
29												2.4
30												NIL
31												4.5
Total												**119.5**
Total to date												**119.5**
No. of days												**11**
average												**10.9**

1998

Date	J	F	M	A	M	J	J	A	S	O	N	D
1	21.6	TR	24.6	6.0	1.0							
2	NIL	NIL	NIL	NIL	TR							
3	4.8	NIL	1.3	8.2	6.3							
4	3.7	NIL	13.2	4.1	1.3							
5	NIL	NIL	TR	1.9	3.5							
6	4.2	1.3	34.2	11.7	1.6							
7	NIL	16.8	NIL	NIL	21.6							
8	14.1	6.2	9.7	42.8	12.5							
9	1.8	19.4	5.8	NIL	37.7							
10	3.3	5.3	2.7	10.2	NIL							
11	9.9	1.2	1.4	54.3	NIL							
12	20.2	1.9	TR	2.8	NIL							
13	60.1	NIL	45.6	31.6	NIL							
14	NIL	10.2	NIL	4.4	4.4							
15	NIL	NIL	4.6	6.2	NIL							
16	27.2	NIL	7.4	11.7	NIL							
17	TR	NIL	5.0	18.0	NIL							
18	NIL	NIL	NIL	11.7	NIL							
19	64.9	1.8	NIL	NIL	NIL							
20	TR	NIL	TR	NIL	NIL							
21	NIL	51.0	22.3	NIL	NIL							
22	0.4	10.7	5.2	NIL								
23	3.4	NIL	NIL	NIL								
24	44.2	TR	NIL	NIL								
25	7.8	43.1	24.8	32.6								
26	TR	17.6	2.1	NIL								
27	23.7	5.8	13.7	NIL								
28	27.1	9.7	1.8	1.6								
29	35.2	-	17.1	2.3								
30	26.9	-	36.3	1.5								
31	33.8	-	14.4	-								
Total	**438.3**	**202.0**	**293.2**	**263.6**								
Total to date	**438.3**	**640.3**	**933.5**	**1197.1**								
No of days	**21**	**15**	**21**	**19**								
average	**20.9**	**13.5**	**14.0**	**13.9**								

No rain gauge in October to December therefore no rainfall data

Appendix 1b RAINFALL OBSERVATIONS AT MITUMBA

1997

Date	J	F	M	A	M	J	J	A	S	O	N	D
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												16.0
17												26.4
18												0.2
19												28.7
20												14.3
21												1.1
22												0.2
23												0.2
24												38.1
25												2.2
26												5.2
27												TR
28												1.4
29												7.3
30												0.4
31												7.2
Total												**148.9**
Total to date												**148.9**
No. of days												**15**
average												**9.93**

Collected immediately after rain gauge installation.

1998

Date	J	F	M	A	M	J	J	A	S	O	N	D
1	23.4	NIL	24.4	7.8	1.8							
2	NIL	TR	0.9	4.9	1.0							
3	3.6	NIL	NIL	NIL	12.8							
4	2.1	NIL	8.5	8.7	13.9							
5	NIL	NIL	1.3	3.7	32.5							
6	2.2	0.1	47.4	0.9	NIL							
7	2.0	20.3	NIL	6.9	33.9							
8	11.1	8.6	4.8	NIL	33.9							
9	4.1	12.5	NIL	33.9	51.9							
10	2.1	3.4	4.7	NIL	NIL							
11	10.3	1.1	0.9	76.4	NIL							
12	12.6	2.0	2.4	3.1	NIL							
13	48.3	NIL	63.0	13.1	NIL							
14	1.4	9.5	NIL	5.0	NIL							
15	NIL	0.5	NIL	6.7	NIL							
16	30.5	NIL	1.7	27.4	NIL							
17	0.6	NIL	1.9	8.4	NIL							
18	0.1	NIL	NIL	NIL	NIL							
19	52.6	24.4	NIL	NIL	NIL							
20	4.4	NIL	NIL	NIL	NIL							
21	1.9	33.3		NIL	NIL							
22	2.8	17.0		NIL	NIL							
23	6.8	NIL	33.7	NIL								
24	40.9	NIL	NIL	NIL								
25	NIL	38.6	NIL	43.3								
26	17.5	0.5	20.1	NIL								
27	25.6	NIL	2.4	1.5								
28	18.4	1.6	20.5	1.2								
29	24.8	-	4.4	8.3								
30	29.8	-	31.8	1.8								
31	NIL	-	26.7	-								
Total	**386.2**	**173.4**	**301.5**	**263.0**								
Monthly cum Totals	**386.2**	**559.6**	**861.1**	**1124.1**								
No. of days	**26**	**15**	**21**	**19**								
Mean monthly rainfall	**14.9**	**11.6**	**14.4**	**13.8**								

No rain gauge in October to December therefore no rainfall data

APPENDIX 2a: Mitumba Stream Discharge Measurements at Gombe National Park Hqs.

Serial No.	Date of Measurements	Gauge height [m]	Discharge [Q] Measured in M^3/sec
1.	31.10.97	0.10	0.043
2.	04.11.97	0.09	0.040
3.	09.11.97	0.08	0.041
4.	12.11.97	0.07	0.034
5.	13.11.97	0.06	0.031
6.	13.12.97	0.09	0.073
7.	21.12.97	0.11	0.124
8.	22.12.97	0.10	0.112
9.	23.12.97	0.10	0.094
9.	22.01.98	0.13	0.190
10.	30.01.98	0.19	0.294
11.	31.01.98	0.24	0.459
12.	01.02.98	0.22	0.341
13.	02.02.98	0.18	0.307
14.	03.02.98	0.18	0.271
15.	04.02.98	0.15	0.234
16.	05.02.98	0.14	0.201
17.	06.02.98	0.14	0.200
18.	07.02.98	0.14	0.196
19.	08.02.98	0.13	0.170
20.	12.02.98	0.11	0.187
21.	13.02.98	0.11	0.154
22.	14.02.98	0.11	0.160
23.	20.03.98	0.13	0.200
24.	08.04.98	0.13	0.172
25.	09.04.98	0.26	0.405
26.	14.04.98	0.23	0.401
27.	15.04.98	0.21	0.388
28.	17.04.98	0.19	0.318
29.	18.04.98	0.21	0.375
30.	21.04.98	0.17	0.270
31.	23.04.98	0.16	0.228
32.	02.05.98	0.14	0.180
33.	03.05.98	0.14	0.205
34.	04.05.98	0.15	0.185
35.	05.05.98	0.14	0.187
36.	06.05.98	0.13	0.199
37.	07.05.98	0.15	0.194
38.	08.05.98	0.19	0.256
39.	09.05.98	0.17	0.264
40.	10.05.98	0.20	0.334
41.	11.05.98	0.19	0.305
42.	13.05.98	0.17	0.253
43.	14.05.98	0.17	0.229
44.	15.05.98	0.16	0.230
45.	16.05.98	0.15	0.208
46.	17.05.98	0.16	0.216
47.	18.05.98	0.16	0.212
48.	19.05.98	0.15	0.196
49.	20.05.98	0.15	0.186
50.	21.05.98	0.15	0.184
51.	07.06.98	0.11	0.162
52.	08.06.98	0.11	0.133

53.	09.06.98	0.12	0.138
54.	10.06.98	0.12	0.143
55.	11.06.98	0.11	0.133
56.	12.06.98	0.11	0.129
57.	13.06.98	0.12	0.131
58.	14.06.98	0.11	0.134
59.	15.06.98	0.10	0.117
60.	17.06.98	0.10	0.121
61.	18.06.98	0.12	0.107
62.	19.06.98	0.12	0.126
63.	20.06.98	0.12	0.126
64.	21.06.98	0.11	0.129
65.	22.06.98	0.10	0.134
66.	23.06.98	0.10	0.122
67.	24.06.98	0.10	0.124
68.	25.06.98	0.11	0.126
69.	26.06.98	0.10	0.113
70.	27.06.98	0.11	0.114
71.	28.06.98	0.11	0.124
72.	29.06.98	0.11	0.115
73.	30.06.98	0.11	0.108
74.	18.07.98	0.09	0.094
75.	19.07.98	0.09	0.086
76.	23.07.98	0.09	0.082
77.	24.07.98	0.09	0.080
78.	25.07.98	0.09	0.079
79.	26.07.98	0.09	0.070
80.	28.07.98	0.09	0.071
81.	29.07.98	0.09	0.079
82.	30.07.98	0.09	0.073
83.	31.07.98	0.09	0.066
84.	01.08.98	0.09	0.070
85.	02.08.98	0.09	0.069
86.	03.08.98	0.09	0.073
87.	04.08.98	0.09	0.068
88.	23.08.98	0.09	0.072
89.	24.08.98	0.09	0.069
90.	25.08.98	0.09	0.081
91.	26.08.98	0.09	0.085
92.	28.08.98	0.08	0.081
93.	29.08.98	0.08	0.084
94.	30.08.98	0.08	0.080
95.	31.08.98	0.08	0.077
96.	01.09.98	0.08	0.071
97.	02.09.98	0.08	0.065
98.	05.09.98	0.08	0.064
99.	06.09.98	0.08	0.063
100.	07.09.98	0.08	0.071
101.	08.09.98	0.08	0.063
102.	17.09.98	0.08	0.057
103.	18.09.98	0.08	0.064
104.	19.09.98	0.08	0.063
105.	20.09.98	0.08	0.055
106.	21.09.98	0.08	0.073
107.	22.09.98	0.08	0.062
108.	23.09.98	0.08	0.061
109.	24.09.98	0.08	0.052
110.	25.09.98	0.08	0.051

111.	26.09.98	0.08	0.063
112.	27.09.98	0.08	0.058
113.	28.09.98	0.08	0.060
114.	29.09.98	0.08	0.054
115.	30.09.98	0.08	0.059
116.	01.10.98	0.08	0.061
117.	02.10.98	0.08	0.061
118.	03.10.98	0.08	0.060
119.	04.10.98	0.08	0.062
120.	08.10.98	0.08	0.059
121.	09.10.98	0.08	0.051
122.	10.10.98	0.08	0.055
123.	11.10.98	0.08	0.058
124.	12.10.98	0.08	0.051
125.	13.10.98	0.08	0.052
126.	14.10.98	0.08	0.066
127.	15.10.98	0.08	0.056
128.	22.10.98	0.08	0.049
129.	23.10.98	0.08	0.053
130.	24.10.98	0.08	0.064
131.	25.10.98	0.08	0.050
132.	26.10.98	0.08	0.056
133.	27.10.98	0.08	0.059
134.	28.10.98	0.08	0.059
135.	29.10.98	0.09	0.067

APPENDIX 2b : Ngonya Stream Discharge Measurements at Mwamugongo gauging station:

Serial No.	Date of Measurements	Gauge height [m]	Discharge [Q] Measured in m^3/sec
1	03.11.97	0.14	0.093
2	09.11.97	0.15	0.096
3	13.11.97	0.13	0.091
4	14.12.97	0.17	0.260
5	16.12.97	0.15	0.174
6	17.12.97	0.15	0.255
7	18.12.97	0.15	0.175
8	19.12.97	0.15	0.213
9	20.12.97	0.17	0.234
10	21.12.97	0.16	0.188
11	22.12.97	0.14	0.194
12	23.12.97	0.14	0.194
13	27.12.97	0.17	0.234
14	28.12.97	0.17	0.222
15	29.12.97	0.16	0.266
16	30.12.97	0.17	0.259
17	31.12.97	0.15	0.215
18	01.01.98	0.15	0.228
19	02.01.98	0.20	0.362
20	03.01.98	0.20	0.320
21	04.01.98	0.22	0.364
22	22.01.98	0.24	0.506
23	23.01.98	0.35	0.509

24	23.01.98	0.39	0.733
25	29.01.98	0.30	1.024
26	30.01.98	0.38	0.892
27	31.01.98	0.46	1.076
28	01.02.98	0.32	0.958
29	02.02.98	0.32	0.915
30	03.02.98	0.28	0.940
31	04.02.98	0.27	0.652
32	05.02.98	0.23	0.641
33	06.02.98	0.23	0.589
34	07.02.98	0.25	0.660
35	08.02.98	0.22	0.536
36	12.02.98	0.21	0.461
37	13.02.98	0.20	0.490
38	14.02.98	0.20	0.465
39	15.02.98	0.18	0.393
40	20.03.98	0.18	0.282
41	07.04.98	0.22	0.414
42	08.04.98	0.22	0.361
43	09.04.98	0.26	1.417
44	15.04.98	0.30	0.901
45	16.04.98	0.27	0.760
46	16.04.98	0.28	0.889
47	17.04.98	0.26	0.845
48	17.04.98	0.30	0.867
49	22.04.98	0.26	0.632
50	23.04.98	0.27	0.703
51	02.05.98	0.26	0.496
52	03.05.98	0.26	0.414
53	04.05.98	0.28	0.446
54	05.05.98	0.27	0.420
55	06.05.98	0.28	0.403
56	07.05.98	0.27	0.376
57	07.05.98	0.29	0.593
58	08.05.98	0.27	0.476
59	08.05.98	0.28	0.550
60	09.05.98	0.25	0.567
61	10.05.98	0.27	0.664
62	11.05.98	0.26	0.435
63	13.05.98	0.25	0.399
64	14.05.98	0.27	0.382
65	15.05.98	0.27	0.379
66	16.05.98	0.27	0.405
67	17.05.98	0.25	0.348
68	18.05.98	0.27	0.371
69	19.05.98	0.26	0.322
70	20.05.98	0.26	0.325
71	21.05.98	0.26	0.317
72	07.06.98	0.25	0.245
73	08.06.98	0.25	0.257
74	09.06.98	0.25	0.243
75	10.06.98	0.25	0.240
76	11.06.98	0.25	0.259
77	12.06.98	0.25	0.248
78	13.06.98	0.24	0.200
79	14.06.98	0.23	0.194
80	15.06.98	0.24	0.205
81	17.06.98	0.24	0.204

82	18.06.98	0.25	0.193
83	19.06.98	0.24	0.216
84	20.06.98	0.24	0.213
85	21.06.98	0.24	0.226
86	22.06.98	0.24	0.208
87	23.06.98	0.24	0.201
88	24.06.98	0.24	0.229
89	25.06.98	0.23	0.211
90	26.06.98	0.24	0.220
91	27.06.98	0.24	0.187
92	28.06.98	0.22	0.206
93	29.06.98	0.23	0.173
94	30.06.98	0.23	0.187
95	17.07.98	0.25	0.165
96	18.07.98	0.25	0.175
97	19.07.98	0.25	0.162
98	23.07.98	0.24	0.133
99	24.07.98	0.24	0.158
100	25.07.98	0.20	0.158
101	26.07.98	0.22	0.168
102	27.07.98	0.22	0.165
103	28.07.98	0.21	0.165
104	29.07.98	0.20	0.142
105	31.07.98	0.19	0.163
106	01.08.98	0.19	0.141
107	02.08.98	0.18	0.145
108	03.08.98	0.19	0.145
109	04.08.98	0.20	0.151
110	23.08.98	0.20	0.152
111	24.08.98	0.21	0.143
112	25.08.98	0.20	0.109
113	26.08.98	0.20	0.131
114	28.08.98	0.20	0.109
115	29.08.98	0.20	0.105
116	30.08.98	0.20	0.116
117	31.08.98	019	0.118
118	01.09.98	0.19	0.115
119	02.09.98	0.18	0.108
120	05.09.98	0.17	0.135
121	06.09.98	0.17	0.116
122	07.09.98	0.17	0.115
123	08.09.98	0.15	0.106
124	17.09.98	0.15	0.113
125	18.09.98	0.15	0.091
126	19.09.98	0.14	0.110
127	20.09.98	0.14	0.129
128	21.09.98	0.14	0.131
129	22.09.98	0.14	0.139
130	23.09.98	0.14	0.103
131	24.09.98	0.14	0.101
132	25.09.98	0.14	0.112
133	26.09.98	0.14	0.104
134	27.09.98	0.14	0.141
135	28.09.98	0.14	0.107
136	29.09.98	0.14	0.095
137	30.09.98	0.14	0.107
138	01.10.98	0.14	0.100
139	02.10.98	0.14	0.090

140	03.10.98	0.14	0.098
141	04.10.98	0.14	0.088
142	08.10.98	0.13	0.091
143	09.10.98	0.13	0.103
144	10.10.98	0.13	0.090
145	11.10.98	0.12	0.087
146	12.10.98	0.12	0.087
147	13.10.98	0.12	0.090
148	14.10.98	0.12	0.101
149	15.10.98	0.13	0.109
150	22.10.98	0.12	0.086
151	23.10.98	0.12	0.102
152	24.10.98	0.12	0.107
153	25.10.98	0.12	0.089
154	26.10.98	0.12	0.086
155	27.10.98	0.12	0.096
156	28.10.98	0.17	0.192
157	29.10.98	0.14	0.105

Appendix 3 SAMPLE FIELD NOTES

Sample No.07/10/1997 GOTZ
Date: 29/10/97
Location: Mitumba stream bridge
Time: 1345hrs, During the rain season
S: $04^{0}38.401$
E: $29^{0}37.851$
Altitude: 600m above sea level
Chemical data:
$[CL^{-1}]$, mg/l = 8.0
pH:
Temp. ^{0}C = 24.0
Remarks:
****
Sample No.08/10/1997 MWTZ
Date: 29/10/97
Time: Mwamgongo - Ngonya stream
S: $04^{0}37.392$
E: $029^{0}38.317$
Altitude: 670m above sea level
Chemical data:
$[CL^{-1}]$, mg/l = 6.0
pH:
Temp. ^{0}C = 24.2
Remarks: Quite disturbed area; villagers washing, bathing, agricultural activities.
The stream has shifting behaviour
****
Sample No.09/10/1997 GOTZ
Date: 30/10/97
Location: Kakombe stream at the bridge
N.B. Received pH, DO, EC probes from pollution group.
Received from RV Echo Captain Mr. Chata
pH standardisation done according to the standard manual
Time: 0900hrs, During the rain season
S:
E:
Altitude:
Chemical data:
$[CL^{-1}]$, mg/l = 8.0
EC at 25 ^{0}C, µscm^{-1} = 191.0
pH: 7.61
Temp. ^{0}C = 22.3
DO (O_2) probe not working properly
Remarks:
****
Sample No.10/10/1997 GOTZ
Date: 30/10/97
Location: Mitumba stream at the bridge
Time: 1135hrs
S:
E:
Altitude:
Chemical data:
$[CL^{-1}]$, mg/l = 6.0
EC at 25^{0}C, µscm^{-1}
pH: 7.33
Temp. ^{0}C = 24.2
Remarks:
****
Sample No.11/10/1997 MWTZ
Date: 30/10/97
Location: Nyamnini tributary of Ngonya stream
Time: 1420hrs, during the rain season
S:
E:
Altitude: 780m above sea level
Chemical data:
$[CL^{-1}]$, mg/l = 6.0
EC at 25^{0}C, µscm^{-1} = 16.1
pH: 5.62
Temp. ^{0}C = 24.3
Remarks: pH reduced may be because of humus litter around reducing environment
****
Sample No.12/10/1997 MWTZ
Date:30/10/97
Location: Mbale spring, tributary of Ngonya
Time: 1540hrs, rain season
S:
E:
Altitude: 720m
Chemical data:
$[CL^{-1}]$, mg/l = 8.0
EC at 25^{0}C, µscm^{-1} 29.2
pH: 5.88
Temp. ^{0}C = 24.8
Remarks: Reducing environment
****
Sample No.13/10/1997 MWTZ
Date:30/10/97
Location: Ngonya stream
Time: 1605hrs
S:
E:
Altitude:
Chemical data:
$[CL^{-1}]$, mg/l = 10.0
EC at 25^{0}C, µscm^{-1} = 43.6
pH: 7.50
temp. ^{0}C = 26.7
Remarks: Variation of EC and pH at this point compared to previous day may be due to dilution factor - rainfall and water - seepage/washing from soils/mountains
****
Sample No.1/10/1997 GOTZ
Date:3/10/97
Location: Mitumba western tributary
Time: 1215hrs, rain season
S:
E:
Altitude: 880m above sea level
Chemical data:
$[CL^{-1}]$, mg/l = 2.0
EC at 25^{0}C, µscm^{-1} = 9.5
pH: 5.16
temp. ^{0}C = 22.7
O_2, % = 62.5
Remarks: The tributary is full of stones, logs
-Reducing environment a lot of litters

****
Sample No.15/10/1997 GOTZ
Date: 31/10/97
Location: Mitumba spring
Time: 1350hrs
S:
E:
Altitude: at 790m above sea level
Chemical data:
[CL^{-1}], mg/l = 2.0
EC at 25^0C, μscm^{-1} = 12.5
pH: 5.50
Temp. ^{0}C = 22.8
O_2, % = 35.5
Remarks: The spring is about 30m from the main stream.
Variations of pH may be due to CO_2 by organisms (bacterial activities)
****
Sample No.16/10/1997 GOTZ
Date: 31/10/97
Location: Mitumba confluence
Time: 1440hrs, during the rain season
S:
E:
Altitude: 670m above sea level
Chemical data:
[CL^{-1}], mg/l = 6.0
EC at 25^0C, μscm^{-1} = 23.7
pH: 7.08
Temp. ^{0}C = 23.7
O_2 % = 45.1
Remarks:
****
Sample No.17/10/1997 GOTZ
Date: 31/10/97
Location: Mitumba stream at the bridge
Time: 1600hrs
S:
E:
Altitude:
Chemical data:
[CL^{-1}], mg/l = 6.0
EC at 25^0C, μscm^{-1} = 24.3
pH: 7.33
Temp. ^{0}C = 25.0
O_2 = % = 38.2
Remarks:

****
Sample No.18/11/1997 MWTZ
Date: 1/11/97
Location: Nyaruhunga
Time: 1200hrs
S:
E:
Altitude: 860 above sea level
Chemical data:
[CL^{-1}], mg/l = 4.0
EC at 25^0C, μscm^{-1} = 17.0
pH: 6.94
temp. ^{0}C = 26.9
O_2 % = 32.6
Remarks: unstable and land slide
****
Sample No.19/11/1997 MWTZ
Date: 1/11/97
Location: Nyaruhunga spring(b)
Time: 1230hrs
S:
E:
Altitude: 880m above sea level
Chemical data:
[CL^{-1}], mg/l = 4.0
EC at 25^0C, μscm^{-1} = 31.0
pH: 7.40
Temp. ^{0}C = 28.0
O_2, % = 40.3
Remarks: 1.very clear water
2. A lot of weeds, rocks, logs mushrooms
****
Sample No.20/11/1997 MWTZ
Date: 1/11/97
Location: Nyaruhunga (main)
Time: 1330hrs, rain season
S:
E:
Altitude: 940m above sea level
Chemical data:
[CL^{-1}], mg/l = 4.0
EC at 25^0C, μscm^{-1} = 33.3
pH: 7.44
Temp. ^{0}C = 29.3
O_2 % = 28.3
Remarks: -Milky colour
-A lot of stones, rocks, land slide.

****
Sample No.21/11/1997 MWTZ
Date: 1/11/97
Location: Mgunga tributary
Time: 1400hrs
S:
E:
Altitude: 915m above sea level
Chemical data:
[CL^{-1}], mg/l = 4.0
EC at 25^0C, μscm^{-1} = 20.3
pH: 4.77
Temp. ^{0}C = 24.0
$O_{2,}$ % = 36.9
Remarks: Stones reducing environment
Banana plants around
****
Sample No.22/11/1997 MWTZ
Date: 1/11/97
Location: Kivumba tributary
Time: 1600hrs, rain season
S:
E:
Altitude: 1045m above sea level
Chemical data:
[CL^{-1}], mg/l = 4.0
EC at 25^0C, μscm^{-1} = 22.2
pH: 7.29
Temp. ^{0}C = 23.1
$O_{2,}$ % = 26.2
Remarks: A lot of stones rocks, weeds water
Not very clear, yellowish
A lot of suspended matter

****
Sample No.23/11/1997 MWTZ
Date: 1/11/97
Location: Nyandinga confluence
Time: 1700hrs
S:
E:
Altitude: 780m above sea level
Chemical data:
$[CL^{-1}]$, mg/l = 8.0
EC at 25^0C, µscm^{-1} = 35.9
pH: 7.19
Temp. ^{0}C = 24.6
$O_{2,}$ % = 21.5
Remarks: A lot of weeds water, pebbles, gravestones
Reducing environment
Colour of water-slightly milky
****
Sample No.24/11/1997 GOTZ
Date: 02/11/97
Location: Kakombe tributary
Time: 1025hrs
S:
E:
Altitude: 825m above sea level
Chemical data:
$[CL^{-1}]$, mg/l = 4.0
EC at 25^0C, µscm^{-1} = 24.2
pH: 5.43
Temp. ^{0}C = 23.3
$O_{2,}$ % = 28.3
Remarks: A lot of humus
Stone
Bushy environment
Clear water
****
Sample No.25/11/1997 GOTZ
Date: 2/11/97
Location: Kakombe (c) -Main tributary
Time: 1210hrs
S:
E:
Altitude: 950m above sea level
Chemical data:
$[CL^{-1}]$, mg/l = 4.0
EC at 25^0C, µscm^{-1} = 4.3
pH: 6.18
Temp. ^{0}C = 20.8
$O_{2,}$ % = 26.4
Remarks: There is waterfall about 40m high
A lot of stones, logs
Bushy environment
The river is rocky and very rough
Clear water
****
Sample No.26/11/1997 GOTZ
Date: 2/11/97
Location: Kakombe spring (d)
Time: 1345hrs
S:
E:
Altitude: 880m above sea level
Chemical data:
$[CL^{-1}]$, mg/l = 4.0
EC at 25^0C, µscm^{-1} = 8.2
pH: 5.95
Temp. ^{0}C = 22.8
$O_{2,}$ % = 13.0
Remarks: Rocky, bushy environment
A lot of humus
Clear water
****
Sample No.54/12/1997 MWTZ
Date: 13/12/97
Location: Ngonya stream
Time: 1635hrs, during the rain season
S:
E:
Altitude:
Chemical data:
$[CL^{-1}]$, mg/l = 10.0
EC at 25^0C, µscm^{-1} = 51.5
pH: 7.48
Temp. ^{0}C = 25.5
DO, $O_{2,}$ % = 98.6
Remarks: Two samples were collected for isotopes and chemical data
****
Sample No. 55/12/1997 GOTZ
Date: 13/12/97
Location: Mitumba bridge
Time: 1720hrs
S:
E:
Altitude:
Chemical data:
$[CL^{-1}]$, mg/l = 6.0
EC at 25^0C, µscm^{-1} = 24.5
pH: 7.44
Temp. ^{0}C = 23.8
DO, $O_{2,}$ % = 95.4
Remarks: Two samples were collected for isotopes and chemical data
****
Sample No.56/12/1997 GOTZ
Date: 14/12/97
Location: Mitumba stream
Time: 0900hrs
S:
E:
Altitude:
Chemical data:
$[CL^{-1}]$, mg/l = 4.0
EC at 25^0C, µscm^{-1} = 9.9
pH: 5.81
Temp. ^{0}C = 21.7
DO, $O_{2,}$ % = 84.3
Remarks: 1) Two samples were collected for isotopes and chemical data
2) Water quantity has increased, raining

****
Sample No.57/12/1997 GOTZ
Date: 14/12/97
Location: Mitumba tributary
Time: 1235hrs
S:
E:
Altitude:
Chemical data:
$[CL^{-1}]$, mg/l = 4.0
EC at 25^0C, μscm^{-1} = 9.3
pH: 5.41
Temp. ^0C = 22.2
DO, O_2, % = 82.7
Remarks: 1). The tributary was usually dry during the dry season
2). Two samples were collected for isotopes and chemical data
3). Raining
4). A lot of reducing environment rocky
****
Sample No.58/12/1997 GOTZ
Date: 14/12/97
Location: Mitumba spring(790)
Time: 1300hrs
S:
E:
Altitude:
Chemical data:
$[CL^{-1}]$, mg/l = 4.0
EC at 25^0C, μscm^{-1} = 14.6
pH: 5.47
Temp. ^0C = 22.4
DO, O_2, % = 96.0
Remarks: 1) Two samples were collected for isotopes and chemical data
2) Very clear water, stones, bushy
****
Sample No.59/12/1997 MWTZ
Date: 14/12/97
Location: Mitumba tributary(after 670m.a.s.l)
Time: 1345hrs
S:
E:
Altitude:
Chemical data:
$[CL^{-1}]$, mg/l = 4.0
EC at 25^0C, μscm^{-1} = 13.1
pH: 5.85
Temp. ^0C = 22.5
DO, O_2, % = 92.9
Remarks: 1) Two samples were collected for isotopes and chemical data
2) Rocky, litters
****
Sample No.60/12/1997 GOTZ
Date: 14/12/97
Location: Mitumba western spring
Time: 1430hrs
S:
E:
Altitude:
Chemical data:
$[CL^{-1}]$, mg/l = 2.0
EC at 25^0C, μscm^{-1} = 17.6
pH: 5.66
Temp. ^0C = 23.0
DO, O_2, % = 97.9
Remarks: 1) Two samples were collected for isotopes and chemical data
2) Rocky and bushy
****
Sample No.61/12/1997 GOTZ
Date: 14/12/97
Location: Mitumba confluence
Time: 1520hrs
S:
E:
Altitude: 670m above sea level
Chemical data:
$[CL^{-1}]$, mg/l = 6.0
EC at 25^0C, μscm^{-1} = 21.6
pH: 7.04
Temp. ^0C = 23.0
DO, O_2, % = 97.7
Remarks: 1) Two samples were collected for isotopes and chemical data
2) Rocky and bushy
****
Sample No.62/12/1997 MWTZ (01)
Date: 14/12/97
Location: Ngonya gauging station, sample 01- During peak flash flood Relative height 0.2m(Gauge height)
Time:
S:
E:
Altitude:
Chemical data:
$[CL^{-1}]$, mg/l = 16.0
EC at 25^0C, μscm^{-1} = 38.7
pH: 6.7
Temp. ^0C = 24.5
DO, O_2, % = 36.9
Remarks: 1) Analysed after 19hrs of collection divided into two samples (isotopes + chemical)
****
Sample No. 63/12/1997 MWTZ (02)
Date: 14/12/97
Location: Ngonya gauging station, sample 02- Two hrs after the peak flash flood (Gauge height 0.18m)
Time:
S:
E:
Altitude:
Chemical data:
$[CL^{-1}]$, mg/l = 6.0
EC at 25^0C, μscm^{-1} = 45.5
pH: 7.43
Temp. ^0C = 24.3
DO, O_2, % = 92.8
Remarks: 1) Analysed after 17hrs of collection
2) Divided into two samples (isotopes +chemical)
****
Sample No.64/12/1997 MWTZ (03)
Date: 14/12/97
Location: Ngonya gauging station, sample 03- Four hrs after the peak flash flood (Gauge height 0.16m)
Time:
S:
E:
Altitude:
Chemical data:
$[CL^{-1}]$, mg/l = 4.0
EC at 25^0C, μscm^{-1} = 45.6
pH: 7.33
Temp. ^0C = 24.1
DO, O_2, % = 93.9
Remarks: 1) Analysed after 15hrs of collection
Measurement probes were with Mrs Mbwambo at the hills during the time of these three sample's collection
2) Divided into two samples(isotopes + chemical)

****
Sample No.65/12/1997 GOTZ
Date: 15/12/97
Location: Kakombe bridge during rain season
Time: 1130hrs
S:
E:
Altitude:
Chemical data:
[CL^{-1}], mg/l = 6.0
EC at 25^0C, µscm^{-1} = 63.7
pH: 7.71
Temp. ^{0}C = 22.3
DO, $O_{2,}$ % = 94.8
Remarks: 1) One sample taken for chemical analysis, NO sample taken for isotope
2) Quantity of water has increased
3) Clear water

NOTE:
****
Sample No.66/12/1997 GOTZ
Date: 15/12/97
Location: Mitumba rain gauge
Time:
S:
E:
Altitude:
Chemical data:
[CL^{-1}], mg/l =
EC at 25^0C, µscm^{-1} =
pH:
Temp. ^{0}C =
DO, $O_{2,}$ % =
Remarks:
****
Sample No.67/12/1997 MWTZ
Date: 15/12/97
Location: Nyamnini spring
Time: 0410hrs
S:
E:
Altitude: 780m above sea level
Chemical data:
[CL^{-1}], mg/l = 4.0
EC at 25^0C, µscm^{-1} =19.2
pH: 5.63
Temp. ^{0}C = 23.7
DO, $O_{2,}$ % = 92.3
Remarks: 1) Two samples collected (isotopes + chemical)
2) Banana plantation, litters
****
Sample No.68/12/1997 MWTZ
Date: 15/12/97
Location: Nyandinga confluence
Time: 1700hrs
S:
E:
Altitude: 780m above sea level
Chemical data:
[CL^{-1}], mg/l = 6.0
EC at 25^0C, µscm^{-1} = 30.8
pH: 6.95
Temp. ^{0}C = 23.1
DO, $O_{2,}$ % = 99.2
Remarks: 1) Two samples collected (isotope + chemical)
2) Stones, reducing environment
****
Sample No.69/12/1997 MWTZ
Date: 16/12/97
Location: Kivumba tributary
Time: 1330hrs
S:
E:
Altitude: 950m above sea level
Chemical data:
[CL^{-1}], mg/l = 4.0
EC at 25^0C, µscm^{-1} = 13.5
pH: 7.30
Temp. ^{0}C = 21.2
DO, $O_{2,}$ % = 97.9
Remarks: 1) Falls quantity of water has increased
2) Rocky water not clear
3) Two samples collected (isotopes + chemical)
****
Sample No.70/12/1997 MWTZ
Date: 6/12/97
Location: Mgunga tributary
Time: 1525hrs
S:
E:
Altitude: 915m above sea level
Chemical data:
[CL^{-1}], mg/l = 4.0
EC at 25^0C, µscm^{-1} = 20.1
pH: 4.91
Temp. ^{0}C = 23.2
DO, $O_{2,}$ % = 97.2
Remarks: 1) Two samples collected (isotopes + chemical)
2) Very clear water
3) Banana plantation around, a lot of stones
****
Sample No.71/12/1997 MWTZ
Date: 16/12/97
Location: Nyaruhunga main
Time: 0415hrs
S:
E:
Altitude: 940m above sea level
Chemical data:
[CL^{-1}], mg/l = 4.0
EC at 25^0C, µscm^{-1} = 42.8
pH: 7.40
Temp. ^{0}C = 24.2
DO, $O_{2,}$ % = 98.1
Remarks: 1) Water not clear
2) A lot of stones
3) Two samples collected (isotopes + chemical)
****
Sample No.72/12/1997 MWTZ
Date: 16/12/97
Location: Nyaruhunga spring(b)
Time: 0440hrs
S:
E:
Altitude: 880m above sea level
Chemical data:
[CL^{-1}], mg/l = 4.0
EC at 25^0C, µscm^{-1} = 71.3
pH: 7.72
Temp. ^{0}C = 22.9
DO, $O_{2,}$ % = 95.2
Remarks: 1) Very clear water Grassy, stones
2) Two samples collected (isotopes + chemical)

****
Sample No.73/12/1997 MWTZ
Date: 16/12/97
Location: Nyaruhunga spring(a)
Time: 0510hrs
S:
E:
Altitude: 860m above sea level
Chemical data:
[CL^{-1}], mg/l = 2.0
EC at 25^0C, µscm^{-1} = 21.8
pH: 7.54
Temp. ^{0}C = 23.1
DO, $O_{2,}$ % = 97.1
Remarks:
1) Two samples collected (isotopes + chemical)
2) Grassy

NOTE: -
****
Sample No.43-53/12/1997 GOTZ
66/12/97 GOTZ
Location: Rain water from Kakombe

NOTE: -
Rain water sample for chemical analysis
31/11/1997 GOTZ
37/11/1997 GOTZ
43/11/1997 GOTZ
47/11/1997 GOTZ
****
Sample No.74/12/1997 MWTZ
Date: 16/12/97
Location: Ngonya Gauging station
Time:
S:
E:
Altitude:
Chemical data**: NOT MEASURED**
[CL^{-1}], mg/l =
EC at 25^0C, µscm^{-1} =
pH:
Temp. ^{0}C =
$O_{2,}$ % =
Remarks:
****
Sample No.75/12/1997 MWTZ
Date: 17/12/97
Source: Ngonya stream (WL 0.15m)
Remarks: Collected at 4.30 after shower
****
Sample No.77/12/1997 MWTZ
Date: 18/12/97
Source: Ngonya stream (WL 0.15m)
Remarks: Rainless day
****
Sample No.78/12/1997 MWTZ
Date: 19/12/97
Source: Ngonya stream(WL 0.15)
Remarks: Collected at 12.35 after shower
****
Sample No.80/12/1997 MWTZ
Date: 20/12/97
Source: Ngonya stream
Remarks: Collected at 10.50 after shower
****
Sample No.83/12/1997 GOTZ
Date: 21/12/97
Source: `Mitumba stream (WL 0.11)
Remarks:
****
Sample No.82/12/1997 GOTZ
Date: 21/12/97
Source: Mwamgongo (Ngonya stream) (WL 0.16)
Remarks:
****
Sample No.84/12/1997 MWTZ
Date: 22/12/97
Source: Ngonya stream (WL 0.14)
Remarks:
****
Sample No.85/12/1997 GOTZ
Date: 22/12/97
Source: Mitumba stream (WL 0.10)
Remarks:
****
Sample No.86/12/1997 MWTZ
Date: 23/12/97
Source: Ngonya stream (WL 0.14)
Remarks:
****
Sample No.87/12/1997 GOTZ
Date: 23/12/97
Source: Mitumba stream (WL 0.10)
Remarks:
****
Sample No.88/12/1997 MWTZ
Date: 27/12/97
Source: Ngonya stream (WL 0.17)
Remarks:
****
Sample No.89/12/1997 MWTZ
Date: 28/12/97
Source: Ngonya stream (WL 0.17)
Remarks:
****
Sample No.91/12/1997 MWTZ
Date: 29/12/97
Source: Ngonya stream (WL 0.14)
Remarks:
****
Sample No.93/12/1997 MWTZ
Date: 30/12/97
Source: Ngonya stream (WL 0.17)
Remarks:
****
Sample No.94/12/1997 MWTZ
Date: 31/12/97
Source: Ngonya stream (WL 0.15)
Remarks:
****
Sample No.96/1/1998 MWTZ
Date: 1/1/98
Source: Ngonya stream (WL 0.15)
Remarks:
****
Sample No.98/1/1998 MWTZ
Date: 2/1/98
Source: Ngonya stream (WL 0.20m)
Remarks:
****
Sample No.99/1/1998 MWTZ
Date: 3/1/98
Source: Ngonya stream
Remarks:
****
Sample No.101/1/1998 MWTZ
Date: 4/1/97
Source: Ngonya stream (WL 0.19m)
Remarks:

****
Sample No.102/1/199 GOTZ
Date: 22/1/98
Source: Mitumba stream
Remarks:
****
Sample No.103/1/1998 GOTZ
Date: 22/1/98
Source: Mitumba confluence
Remarks:
****
Sample No.104/1/1998 GOTZ
Date: 22/1/98
Source: At the lake - zero Revs (mixing point about 15m in lake)
Remarks:
****
Sample No.105/1/1998 MWTZ
Date: 22/1/98
Source: At Ganging station - Ngonya stream
Remarks:
****
Sample No.106/1/1998 MWTZ
Date: 22/1/98
Source: At the main confluence - Ngonya stream
Remarks:
****
Sample No.107/1/1998 MWTZ
Date: 22/1/98
Source: At zero Revs (8.30m in the lake mixing point)
Remarks:
****
Sample No.108/1/1998 GOTZ
Date: 23/1/98
Source: Water lake near Mitumba
Remarks:
****
Sample No.109/1/1998 MWTZ
Date: 23/1/98
Source: Kivumba 1st waterfalls 950m.a.s.l
Remarks:
****
Sample No.110/1/1998 MWTZ
Date: 23/1/98
Source: Ngonya stream
Altitude: 910m.a.s.l
Remarks:
****
Sample No.111/1/1998 MWTZ
Date: 23/1/98
Source: Nyamhunga main stream
Altitude 940m.a.s.l
Remarks:
****
Sample No.112/1/1998 MWTZ
Date: 23/1/98
Source: Nyamhunga (b) spring
Altitude 880m.a.s.l
Remarks:
****
Sample No.113/1/1998 MWTZ
Date: 23/1/98
Source: Nyamhunga (a) spring
Altitude 860m.a.s.l
Remarks:
****
Sample No.114/1/1998 MWTZ
Date: 23/1/98
Source: Main confluence-Ngonya-Nyandiga
Altitude 780m.a.s.l
Remarks:
****
Sample No.115/1/1998 MWTZ
Date: 23/1/98
Source: Mbale spring
Altitude 730
Remarks:
****
Sample No.116/1/1998 MWTZ
Date: 23/1/98
Source: Ngonya stream
Altitude
Remarks:
****
Sample No.117/1/1998 MWTZ
Date: 23/1/98
Source: At gauging station, Ngonya stream
Altitude
Remarks:
****
Sample No.118/1/1998 MWTZ
Date: 23/1/98
Source: Lake water in lake Mwamgongo
Altitude 150m.a.s.l
Remarks:
****
Sample No.120/1/1998 MWTZ
Date: 24/1/98
Source: Ngonya stream
Altitude
Remarks: Peak floods at gauging station
****
Sample No.121/1/1998 MWTZ
Date: 24/1/98
Source: Ngonya stream
Remarks: Peak floods
****
Sample No.123/1/1998 MWTZ
Date: 29/1/98
Source:
Remarks:
****
Sample No.124/1/1998 GOTZ
Date: 30/1/98
Source: Mitumba stream
Remarks:
****
Sample No.125/1/1998 MWTZ
Date: 30/1/98
Source: Ngonya stream
Remarks:
****
Sample No.127/1/1998 MWTZ
Date: 31/1/98
Source: Ngonya stream
Remarks:
****
Sample No.128/1/1998 GOTZ
Date: 31/1/98
Source: Mitumba stream
Remarks:
****
Sample No.129/2/1998 GOTZ
Date: 1/2/98
Source: Mitumba stream
Remarks:
****
Sample No.136/2/1998 MWTZ
Date: 5/2/98
Source: Ngonya stream
Remarks:

****
Sample No.137/2/1998
Date: 6/2/98
Source: Ngonya stream
Remarks:
****
Sample No.138/2/1998
Date: 7/2/98
Source: Ngonya stream
Remarks:
****
Sample No.139/2/1998
Date: 8/2/98
Source: Ngonya stream
Remarks:
****
Sample No.140/2/1998
Date: 12/2/98
Source: Ngonya stream
Remarks:
****
Sample No.141/2/1998 MWTZ
Date: 13/2/98
Source: Ngonya stream
Remarks:
****
Sample No.142/2/1998 MWTZ
Date: 14/2/98
Source: Ngonya stream
Remarks:
****
Sample No.144/2/1998 MWTZ
Date: 15/2/98
Source: Ngonya stream
Remarks:
****
Sample No.153/3/1998 GOTZ
Date: 20/3/98
Source: Mitumba stream at Gauging station
Altitude: 630m.a.s.l
Remarks:
****
Sample No.154/3/1998 GOTZ
Date: 20/3/98
Source: Mitumba stream/ L. Tanganyika mixing point
Altitude:
Remarks:
****
Sample No.155/3/1998 GOTZ
Date: 20/3/98
Source: L. water at Mitumba
Altitude:
Remarks:
****
Sample No.156/3/1998 MWTZ
Date: 20/3/98
Source: Ngonya stream at Gauging station
Altitude: 640m.a.s.l
Remarks:
****
Sample No.157/3/1998 MWTZ
Date: 20/3/98
Source: Nyamunini spring
Altitude: 800m.a.s.l
Remarks:
****
Sample No.158/3/1998 KGM-TZ
Date: 21/3/98
Source: Nyakageni spring (Kigoma town)
Altitude: 640m.a.s.l
Remarks:
****
Sample No.1/3/1998
Date: 20/3/98
Source: Kavusindi stream
Altitude:
Remarks:
****
Sample No.151/3/1998 MWTZ
Date: 13/3/98
Source: Ngonya stream
Altitude:
Remarks:
****
Sample No.145/2/1998 MWTZ
Date: 21/2/98
Source: Ngonya stream
Altitude:
Remarks:
****
Sample No.163/3/1998 MWTZ
Date: 25/3/98
Source: Ngonya stream
Altitude:
Remarks: Sampling time 07hr00
****
Sample No.167/3/1998 MWTZ
Date: 29/3/98
Source: Ngonya stream
Altitude:
Remarks: Sampling time 16hr15
****
Sample No.185/4/1998 GOTZ
Date: 9/4/98
Location: Mitumba stream
Altitude:
Remarks: Peak floods, sampling time 14hr30
****
Sample No.189/4/1998 GOTZ
Date: 12/4/98
Location: Mitumba stream
Altitude:
Remarks:
****
Sample No.192/4/1998 MWTZ
Date: 16/4/98
Location: Ngonya stream
Altitude:
Remarks: Taken at the right bank 0.10m from right bank, velocity 0.442m/s
****
Sample No.193/4/1998 MWTZ
Date: 16/4/98
Location: Ngonya stream
Altitude:
Remarks: at 0.9m max flow, velocity 1.253m/s
****
Sample No.194/4/1998 MWTZ
Date: 16/4/98
Location: Ngonya stream
Altitude:
Remarks: (the left bank) at 6.30m from right bank velocity 0.285m/s
****
Sample No.195/4/1998 MWTZ
Date: 16/4/98
Location: Ngonya stream
Altitude:
Remarks:

****
Sample No.196/4/1998 MWTZ
Date: 16/4/98
Location: Ngonya stream
Altitude:
Remarks: at 4.50mb 2nd high flow point, velocity 1.091m/s
****
Sample No.197/4/1998 MWTZ
Date: 16/4/98
Location: Ngonya stream
Altitude:
Remarks: A composite sample, taken at every 40cm from left edge to right edge after rainfall
****
Sample No.198/4/1998 MWTZ
Date: 16/4/98
Location: Ngonya stream
Altitude:
Remarks: velocity = 0.351m/s(after rains) at 0.10 from right edge
****
Sample No.199/4/1998 MWTZ
Date: 16/4/98
Location: Ngonya stream
Altitude:
Remarks: At 0.90 from right edge, velocity 1.377m/s
****
Sample No.200/4/1998 MWTZ
Date: 16/4/98
Location: Ngonya stream
Altitude:
Remarks: At 4.50 from right bank/edge velocity 0.976m/s
****
Sample No.201/4/1998 MWTZ
Date: 16/4/98
Location: Ngonya stream
Altitude:
Remarks: At 40cm from left edge, velocity 0.0m/s
****
Sample No.203/4/1998 MWTZ
Date: 16/4/98
Location: Water lake mixed with Ngonya
Altitude:
Remarks:
****
Sample No.204/4/1998 MWTZ
Date: 16/4/98
Location: Fresh water lake
Altitude:
Remarks:
****
Sample No.205/4/1998 GOTZ
Date: 17/4/98
Location: Mitumba stream
Altitude:
Remarks: A composite sample, taken at every 40cm with 3.10m span of stream
****
Sample No.206/4/1998 GOTZ
Date: 17/4/98
Location: Mitumba stream
Altitude:
Remarks: Taken at 25cm from left edge, velocity = 0.153m/s
****
Sample No.207/4/1998 GOTZ
Date: 17/4/98
Location: Mitumba stream
Altitude:
Remarks: Taken at 10cm from right edge, velocity = 0.0m/s
****
Sample No.208/4/1998 GOTZ
Date: 17/4/98
Location: Mitumba stream
Altitude:
Remarks: Taken at 2.60m of max. Revolutions, velocity = 0.903m/s
****
Sample No.209/4/1998 GOTZ
Date: 17/4/98
Location: Mitumba stream
Altitude:
Remarks: Taken at 1.20m from left bank edge, velocity = 0.803m/s
****
Sample No.210/4/1998 GOTZ
Date: 17/4/98
Location: Mixing point of Mitumba and the Lake
Altitude:
Remarks:
****
Sample No.212/4/1998 MWTZ
Date: 17/4/98
Location: Ngonya stream
Altitude:
Remarks: Taken at 20cm from left edge after rainfall, velocity = 0.634m/s
****
Sample No.213/4/1998 MWTZ
Date: 17/4/98
Location: Ngonya stream
Altitude:
Remarks: Taken at a point of max. Revolutions 80cm right edge, Velocity = 1.875m/s
****
Sample No.214/4/1998
Date: 17/4/98
Location: Ngonya stream
Altitude:
Remarks: Taken at 40cm from left edge, after rainfall. Velocity = 0.799m/s
****
Sample No.215/4/1998 MWTZ
Date: 17/4/98
Location: Ngonya stream
Altitude:
Remarks: A composite sample taken after rainfall at 50cm intervals
****
Sample No.216/4/1998 MWTZ
Date: 17/4/98 at GH station
Location: Ngonya stream
Altitude:
Remarks: Taken at a point of min revolutions 660cm from right edge, velocity = 0.097m/s
****
Sample No.217/4/1998 MWTZ
Date: 18/4/98
Location: Rubona tributary (Ngonya)
Altitude: at 1245m.a.s.l
Remarks:
****
Sample No.218/4/1998 MWTZ
Date: 18/4/98
Location: Kivumba (Ngonya) main spring
Altitude: at 1340m.a.s.l
Remarks:

****
Sample No.219/4/1998 MWTZ
Date: 18/4/98
Location: Nyaruhunga stream
Altitude: 980m.a.s.l
Remarks:
****
Sample No.220/4/1998 MWTZ
Date: 18/4/98
Location: Nyamunini spring at the intake
Altitude: 780m.a.s.l
Remarks:
****
Sample No.221/4/1998 GOTZ
Date: 18/4/98
Location: Mitumba stream at G.H gauge
Altitude:
Remarks:
****
Sample No.222/4/1998 GOTZ
Date: 19/4/98
Location: Mitumba spring source
Altitude: 960m.a.s.l
Remarks: It is where Mitumba stream starts
****
Sample No.223/4/1998 GOTZ
Date: 19/4/98
Location: Spring North of Mitumba (flowing into Mitumba)
Altitude: 670m.a.s.l confluence with Mitumba is at 950m.a.s.l
Remarks:
****
Sample No.224/4/1998 GOTZ
Date: 19/4/98
Location: A spring (3m south)
Altitude: 850m.a.s.l
Remarks: Meets MitumbaTaken at an Alt 850m.a.s.l
****
Sample No.225/4/1998 GOTZ
Date: 19/4/98
Location: A spring North of Mitumba about 20m
Altitude: 780m.a.s.l
Remarks: Meets MitumbaTaken at an Alt 775m.a.s.l
****
Sample No.226/4/1998 GOTZ
Date: 19/4/98
Location: A spring North of Mitumba about 15m from Mitumba
Altitude: 765m.a.s.l (sampling)
Remarks: Meets MitumbaTaken at an Alt 770m.a.s.l
****
Sample No.227/4/1998 GOTZ
Date: 19/4/98
Location: A spring North of Mitumba
Altitude: 770m.a.s.l
Remarks: Meets MitumbaTaken at an Alt 765m.a.s.l
****
Sample No.228/4/1998 GOTZ
Date: 21/4/98
Location: Kakombe spring 1 (source)
Altitude: 1190m.a.s.l
Remarks:
****
Sample No.229/4/1998 GOTZ
Date: 21/4/98
Location: Kakombe source spring 2 (on 2nd ridge)
Altitude: 1170m.a.s.l
Remarks:
****
Sample No.230/4/1998 GOTZ
Date: 21/4/98
Location: Kakombe source spring 3
Altitude: 1130m.a.s.l
Remarks:
****
Sample No.231/4/1998
Date: 21/4/98
Location: Mitumba gauge station
Altitude:
Remarks: Position min right bank 5+3.1m, velocity = 0.00m/s
****
Sample No.232/4/1998 GOTZ
Date: 21/4/98
Location: Mitumba stream
Altitude:
Remarks: Composite sample 10cm interval
****
Sample No.233/4/1998 GOTZ
Date: 21/4/98
Location: Mitumba gauging station
Altitude:
Remarks: At 1.2m from left bank, velocity = 0.128m/s
****
Sample No.235/4/1998 GOTZ
Date: 21/4/98
Location: Mitumba gauge station
Altitude:
Remarks: Position at 2.60m from left edge bank, max. velocity = 0.803m/s
****
Sample No.236/4/1998 GOTZ
Date: 22/4/98
Location: Kakombe stream (near waterfall No. 1) spring 4
Altitude: 750m.a.s.l
Remarks:
****
Sample No.237/4/1998 GOTZ
Date: 22/4/98
Location: Kakombe stream, spring 5
Altitude: 815m.a.s.l
Remarks:
****
Sample No.238/4/1998 GOTZ
Date: 22/4/98
Location: Ngonya stream
Altitude:
Remarks:
****
Sample No.239/4/1998 GOTZ
Date: 22/4/98
Location: Ngonya stream composite
Altitude:
Remarks:
****
Sample No.240/4/1998 KGM
Date: 25/4/98
Location: Mwamgongo intake w/s, collection chamber
Altitude: 835m.a.s.l
Remarks: 1210pm
****
Sample No.241/4/1998 KGM
Date: 27/4/98
Source: Luiche river at the bridge - G. station
Altitude: 640m.a.s.l
Remarks:
****
Sample No.242/4/1998 KGM
Date: 27/4/98
Source: SW (shallow well Simbo)
Altitude: 735m.a.s.l****
Remarks:

****
Sample No.243/4/1998 KGM
Date: 27/4/98
Source: SW (shallow well Kasuku)
Altitude: 760m.a.s.l
Remarks:
****
Sample No.244/4/1998 KGM
Date: 27/4/98
Source: BH (Bore hole -Kasuku) RC church
Altitude:
Remarks:
****
Sample No.245/4/1998 KGM
Date: 28/4/98
Source: BH (Bore hole) NORAD compound
Altitude: 770m.a.s.l
Remarks:
****
Sample No.246/4/1998 KGM
Date: 28/4/98
Source: Nyakageni spring
Altitude: 740m.a.s.l
Remarks:
****
Sample No.247/4/1998 KGM
Date: 28/4/98
Source: BH (Bore hole - Msimba)
Altitude: 760m.a.s.l
Remarks:
****
Sample No.248/4/1998 KGM
Date: 28/4/98
Source: Kabemba spring - Msimba
Altitude: 740m.a.s.l
Remarks:
****
Sample No.249/4/1998 KGM
Date: 28/4/98
Source: SW (15m deep) - Msimba
Altitude: 750m.a.s.l
Remarks:
****
Sample No.250/4/1998 KGM
Date: 28/4/98
Location: Malagarasi River (Ilagala) left Bank of the river
Altitude: 760m.a.s.l
Remarks:
****
Sample No.250/4/1998 KGM
Date: 28/4/98
Location: Malagarasi River (Ilagala) right Bank of the river
Altitude: 760m.a.s.l
Remarks:
****
Sample No.250/4/1998 KGM
Date: 28/4/98
Location: Malagarasi River (Ilagala) in the middle Bank of the river
Altitude: 760m.a.s.l
Remarks:
****
Sample No.251/4/1998 KGM
Date: 28/4/98
Location: Northern Malagarasi tributary
Altitude: 770m.a.s.l
Remarks:
****
Sample No.159/3/1998 KGM
Date: 23/3/98
Location: Rutare spring
Altitude:
Remarks:
****
Sample No.160/3/1998 MWTZ
Date: 21/3/98
Location: Ngonya stream
Altitude:
Remarks: Sampling time 1200hrs
****
Sample No.161/3/1998 MWTZ
Date: 21/3/98
Location: Ngonya stream
Altitude:
Remarks:
****
Sample No.162/3/1998 MWTZ
Date: 21/3/98
Location: Ngonya stream
Altitude:
Remarks: Sampling time 1700hrs
****
Sample No.164/3/1998 MWTZ
Date: 25/3/98
Location: Ngonya stream
Altitude:
Remarks:
****
Sample No.165/3/1998 MWTZ
Date: 27/3/98
Location: Ngonya stream
Altitude:
Remarks: Sampling time 1400hrs, peak floods
****
Sample No.166/3/1998 MWTZ
Date: 27/3/98
Location: Ngonya stream
Altitude:
Remarks: Sampling time 1700hrs, 1430hrs after floods
****
Sample No.168/3/1998 GOTZ
Date: 30/3/98
Location: Mitumba stream
Altitude:
Remarks:
****
Sample No.169/3/1998 MWTZ
Date: 30/3/98
Location: Ngonya stream
Altitude:
Remarks: Sampling time 1505hrs, Peak floods
****
Sample No.170/3/1998 MWTZ
Date: 30/3/98
Location: Ngonya stream
Altitude:
Remarks: Sampling time 1750hrs
****
Sample No.171/3/1998 MWTZ
Date: 30/3/98
Location: Ngonya stream
Altitude:
Remarks: Sampling time 1930hrs
****
Sample No.172/3/1998 MWTZ
Date: 30/3/98
Location: Mwamgongo rainfall
Altitude:
Remarks:

****
Sample No.176/4/1998 MWTZ
Date: 7/4/98
Location: Ngonya stream
Altitude:
Remarks:
****
Sample No.177/4/1998 MWTZ
Date: 8/4/98
Location: Mitumba stream
Altitude:
Remarks:
****
Sample No.178/4/1998 MWTZ
Date: 8/4/98
Location: Ngonya stream
Altitude:
Remarks:
****
Sample No.179/4/1998 MWTZ
Date: 8/4/98
Location: Mwamgongo rainfall sample
Altitude:
Remarks:
****
Sample No.180/4/1998 MWTZ
Date: 9/4/98
Location: Ngonya stream
Altitude:
Remarks: Peak floods, sampled at 1900pm
****
Sample No.181/4/1998 MWTZ
Date: 9/4/98
Location: Ngonya stream
Altitude:
Remarks: Floods sampling time 1030hrs
****
Sample No.182/4/1998 MWTZ
Date: 9/4/98
Location: Ngonya stream
Altitude:
Remarks: Sampling time 1330hrs
****
Sample No.183/4/1998 MWTZ
Date: 9/4/98
Location: Ngonya stream
Altitude:
Remarks: Sampling time 1830hrs
****
Sample No.186/4/1998 MWTZ
Date: 10/4/98
Location: Ngonya stream
Altitude:
Remarks:
****
Sample No.187/4/1998 MWTZ
Date: 11/4/98
Location: Ngonya stream
Altitude:
Remarks:
****
Sample No.190/4/1998 GOTZ
Date: 12/4/98
Location: Mitumba stream
Altitude:
Remarks:
****
Sample No.191/4/1998 GOTZ
Date: 14/4/98
Location: Mitumba stream
Altitude:
Remarks:
****
Sample No.252/4/1998 GOTZ
Date: 30/4/98
Location: Mitumba stream
Altitude:
Remarks: 730m.a.s.l
****
Sample No.253/4/1998 GOTZ
Date: 25/4/98
Location: Mwamgongo rainfall
Altitude:
Remarks:
****
Sample No.254/4/1998 MWTZ
Date: 25/4/98
Location: Ngonya stream
Altitude:
Remarks: collected at 1310hrs
****
Sample No.255/4/1998 MWTZ
Date: 25/4/98
Location: Ngonya stream
Altitude:
Remarks: collected at 1435hrs
****
Sample No.256/4/1998 GOTZ
Date: 25/4/98
Location: Mitumba rainfall
Altitude:
Remarks:
****
Sample No.257/4/1998 GOTZ
Date: 26/4/98
Location: Mitumba stream
Altitude:
Remarks:
****
Sample No.258/4/1998 GOTZ
Date: 30/4/98
Location: Mitumba stream
Altitude:
Remarks:
****
Sample No.262/5/1998 GOTZ
Date: 4/5/98
Location: Mitumba stream
Altitude:
Remarks:
****
Sample No.266/5/1998 GOTZ
Date: 6/5/98
Location: Mitumba stream
Altitude:
Remarks:
****
Sample No.267/5/1998 GOTZ
Date: 6/5/98
Location: Mitumba rainfall
Altitude:
Remarks:
****
Sample No.269/5/1998 MWTZ
Date: 7/5/98
Location: Ngonya stream
Altitude:
Remarks: Collected at 1350hrs

****
Sample No.270/5/1998 MWTZ
Date: 7/5/98
Location: Ngonya stream
Altitude:
Remarks: Collected at 1700hrs
****
Sample No.271/5/1998 MWTZ
Date: 7/5/98
Location: Mwamgongo rainfall
Altitude:
Remarks:
****
Sample No.272/5/1998 MWTZ
Date: 8/5/98
Location: Ngonya stream
Altitude:
Remarks: Collected at 1213hrs
****
Sample No.273/5/1998 MWTZ
Date: 8/5/98
Location: Ngonya stream
Altitude:
Remarks: Collected at 1513hrs
****
Sample No.275/5/1998 MWTZ
Date: 8/5/98
Location: Mitumba rainfall
Altitude:
Remarks: Two days rainfall 7&8/5/98
****
Sample No.277/5/1998 MWTZ
Date: 8/5/98
Location: Mitumba stream
Altitude:
Remarks: Collected at 1430hrs
****
Sample No.276/5/1998 GOTZ
Date: 8/5/98
Location: Mitumba stream
Altitude:
Remarks: Collected at 1230hrs
****
Sample No.278/5/1998 MWTZ
Date: 9/5/98
Location: Mwamgongo rainfall
Altitude:
Remarks:
****
Sample No.279/5/1998 MWTZ
Date: 10/5/98
Location: Ngonya stream
Altitude:
Remarks:
****
Sample No.280/5/1998 MWTZ
Date: 10/5/98
Location: Ngonya stream
Altitude:
Remarks: Collected at 1030hrs
****
Sample No.281/5/1998 GOTZ
Date: 9/5/98
Location: Mitumba rainfall
Altitude:
Remarks:
****
Sample No.282/5/1998 GOTZ
Date: 10/5/98
Location: Mitumba stream
Altitude:
Remarks: Collected at 1615hrs
****
Sample No.283/5/1998 GOTZ
Date: 10/5/98
Location: Mitumba stream
Altitude:
Remarks: Collected at 1300hrs
****
Sample No.285/7/1998 MWTZ
Date: 17/7/98
Location: Ngonya/ Mwamgongo
Time:
S:
E:
Altitude: 770m.a.s.l
Chemical data:
pH: 8.13
Temp. ^{0}C = 22.8
EC at 25^{0}C, µscm^{-1} = 4
DO, $O_{2,}$ % = 96.5
Remarks:
****
Sample No.286/7/1998 MWTZ
Date: 17/7/98
Location: Rubona spring
Time:
S:
E:
Altitude: 1345m.a.s.l
Chemical data:
pH: 4.97
Temp. ^{0}C = 22.2
EC at 25^{0}C, µscm^{-1} = 21.3
DO, $O_{2,}$ % = 49.2
Remarks: reducing environment
****
Sample No.287/7/1998 MWTZ
Date: 17/7/98
Location: Kivumba spring(Ngonya)
Time:
S:
E:
Altitude: 1440m.a.s.l
Chemical data:
pH: 5.62
Temp. ^{0}C = 22.0
EC at 25^{0}C, µscm^{-1} = 9.4
DO, $O_{2,}$ % = 84.6
Remarks: The original spring is dry but water continues to deep down at about 15m down
****
Sample No.288/7/1998 MWTZ
Date: 17/7/98
Location: Nyamunini spring(Ngonya)
Time:
S:
E:
Altitude: 1015m.a.s.l
Chemical data:
pH: 4.78
Temp. ^{0}C = 23.3
EC at 25^{0}C, µscm^{-1} = 15.9
DO, $O_{2,}$ % = 113.3
Remarks: Algae a lot of humus

****
Sample No.289/7/1998 MWTZ
Date: 17/7/98
Location: Nyamunini spring
Time:
S:
E:
Altitude: 880m.a.s.l
Chemical data:
pH: 5.45
Temp. ^{0}C = 24.3
EC at 25^{0}C, µscm^{-1} = 13.4
DO, $O_{2,}$ % = 45.0
Remarks: Sample taken from a protected
****
Sample No.290/7/1998 GOTZ
Date: 18/7/98
Location: Mitumba stream
Time:
S:
E:
Altitude: 730m.a.s.l
Chemical data:
pH: 7.21
Temp. ^{0}C = 21.5
EC at 25^{0}C, µscm^{-1} =21.4
DO, $O_{2,}$ % = 91.2
Remarks: Reducing environment (weeds, plants)
****
Sample No.291/7/1998 GOTZ
Date: 18/7/98
Location: Mitumba spring source
Time:
S:
E:
Altitude: 1060m.a.s.l
Chemical data:
pH: 5.19
Temp. ^{0}C = 22.6
EC at 25^{0}C, µscm^{-1} = 10.2
DO, $O_{2,}$ % = 90.5
Remarks: Spring source (eye spring)
****
Sample No.292/7/1998 GOTZ
Date: 18/7/98
Location: Mitumba spring A
Time:
S:
E:
Altitude: 1070m.a.s.l
Chemical data:
pH: 5.25
Temp. ^{0}C = 23.0
EC at 25^{0}C, µscm^{-1} =12.7
DO, $O_{2,}$ % = 74.0
Remarks: Reducing environment (rocky and algae)
****
Sample No.293/7/1998 GOTZ
Date: 18/7/98
Location: Mitumba spring B
Time:
S:
E:
Altitude: 870m.a.s.l
Chemical data:
pH: 5.50
Temp. ^{0}C = 23.5
EC at 25^{0}C, µscm^{-1} =20.6
DO, $O_{2,}$ % = 97.8
Remarks: Reducing environment & rocky
****
Sample No.294/7/1998 MWTZ
Date: 19/7/98
Location: Nyamunini spring
Time:
S:
E:
Altitude: 880m.a.s.l
Chemical data:
pH: 7.02
Temp. ^{0}C = 21.5
EC at 25^{0}C, µscm^{-1} =20.9
DO, $O_{2,}$ % = 95.3
Remarks: A protected spring
****
Sample No.295/7/1998 MWTZ
Date: 19/7/98
Location: Ngonya stream
Time:
S:
E:
Altitude: 770m.a.s.l
Chemical data:
pH: 7.66
Temp. ^{0}C = 24.6
EC at 25^{0}C, µscm^{-1} = 38.8
DO, $O_{2,}$ % = 95.5
Remarks: At gauging station
****
Sample No.296/7/1998 KGTZ
Date: 21/7/98
Location: Matyazo
Altitude:
Remarks: Water from bore hole of 66m depth Q = 10m^3
****
Sample No.296/7/1998 KGTZ
Date: 21/7/98
Location: Matyazo
Altitude:
Remarks: Water from bore hole of 66m depth Q = 10m^3
****
Sample No.297/7/1998 KGTZ
Date: 21/7/98
Location: Nyaza salt mines
Brine from BH-Nyamsunga
RH 250m depth
****
Sample No.298/7/1998 KGTZ
Date: 21/7/98
Location: Maji yard rainfall
Altitude:
Remarks: rainfall (20.3mm)
****
Sample No.299/7/1998 UVZ-KGTZ
Date: 29/8/98
Location: Nyamsunga BH- Uvinza
Altitude:
Remarks: BH depth = 250m
****
Sample No.300/8/1998 UVZ-KGTZ
Date: 20/8/98
Location: Nyamsunga BH- Uvinza
Altitude:
Remarks: depth 500ft
****
Sample No.301/8/1998 UVZ-KGTZ
Date: 20/8/98
Location: Nyamsunga BH- Uvinza
Altitude:
Remarks: depth 500ft

****
Sample No.302/8/1998 UVZ-KGTZ
Date: 20/8/98
Location: Malagarasi River at Uvinza
Altitude:
Remarks:
****
Sample No.303/8/1998 GOTZ
Date: 23/8/98
Location: Mitumba stream
Altitude:
Remarks: Composite sample
****
Sample No.305/8/1998 MWTZ
Date: 23/8/98
Location: 1.142Km off shore Ngonya
Altitude:
Remarks:
****
Sample No.314/8/1998 MWTZ
Date: 25/8/98
Location:3.087Km off shore Ngonya
Altitude:
Remarks: Sample taken 0m (Lake surface)
****
Sample No.315/8/1998 MWTZ
Date: 25/8/98
Location: 3.087Km off shore Ngonya
Altitude:
Remarks: Sample taken at 10m (from Lake surface)
****
Sample No.316/8/1998 MWTZ
Date: 25/8/98
Location: 3.087Km off shore Ngonya
Altitude:
Remarks: Sample taken 50m below Lake surface
****
Sample No.317/8/1998 MWTZ
Date: 25/8/98
Location: 3.087Km off shore Ngonya
Altitude:
Remarks: Sample taken 70m (below Lake surface)
****
Sample No.318/8/1998 MWTZ
Date: 25/8/98
Location: 3.087Km off shore Ngonya
Altitude:
Remarks: Sample taken 70m below Lake surface
****
Sample No.319/8/1998 MWTZ
Date: 25/8/98
Location: 3.087Km off shore Ngonya
Altitude:
Remarks: Sample taken 100m below Lake surface
****
Sample No.320/8/1998 MWTZ
Date: 25/8/98
Location: 300m off shore Ngonya
Altitude:
Remarks: Sample taken 0m (Lake surface)
****
Sample No.321/8/1998 MWTZ
Date: 25/8/98
Location: 300m off shore Ngonya
Altitude:
Remarks: Sample taken 10m below Lake surface
****
Sample No.322/8/1998 MWTZ
Date: 25/8/98
Location: 300m off shore Ngonya
Altitude:
Remarks: Sample taken 50m below Lake surface
****
Sample No.323/8/1998 MWTZ
Date: 25/8/98
Location: 300m off shore Ngonya
Altitude:
Remarks: Sample taken 70m below Lake surface
****
Sample No.324/8/1998 MWTZ
Date: 25/8/98
Location: 300m off shore Ngonya
Altitude:
Remarks: Sample taken 90m below Lake surface
****
Sample No.325/8/1998 MWTZ
Date: 25/8/98
Location: 300m off shore Ngonya
Altitude:
Remarks: Sample taken 100m below Lake surface
****
Sample No.326/8/1998 GOTZ
Date: 26/8/98
Location: off shore Mitumba
Altitude:
Remarks: Sample taken 0m below Lake surface
****
Sample No.327/8/1998 GOTZ
Date: 26/8/98
Location: off shore Mitumba
Altitude:
Remarks: Sample taken 10m below Lake surface
****
Sample No.328/8/1998 GOTZ
Date: 26/8/98
Location: off shore Mitumba
Altitude:
Remarks: Sample taken 50m below Lake surface
****
Sample No.329/8/1998 GOTZ
Date: 26/8/98
Location: off shore Mitumba
Altitude:
Remarks: Sample taken 70m below Lake surface
****
Sample No.330/8/1998 GOTZ
Date: 26/8/98
Location: off shore Mitumba
Altitude:
Remarks: Sample taken 90m below Lake surface
****
Sample No.331/8/1998 GOTZ
Date: 26/8/98
Location: off shore Mitumba
Altitude:
Remarks: Sample taken 100m below Lake surface
****
Sample No.332/8/1998 GOTZ
Date: 26/8/98
Location: off shore Mitumba
Altitude: 278m
Remarks: Sample taken 0m below Lake surface
****
Sample No.357/10/1998 MWTZ
Date: 15/10/98
Location: Ngonya stream / Mwamgongo
Altitude:
Remarks:

****
Sample No.358/10/1998 GOTZ
Date: 26/10/98
Location: Kakombe stream
Altitude:
Remarks: Flash floods
****
Sample No.359/10/1998 GOTZ
Date: 26/10/98
Location: Kakombe stream
Altitude:
Remarks: 2 hours after flash floods
****
Sample No.362/10/1998 GOTZ
Date: 27/10/98
Location: Mitumba stream
Altitude:
Remarks:
****
Sample No.366/10/1998 GOTZ
Date: 28/10/98
Location: Mitumba stream
Altitude:
Remarks:

10 Samples of Rainwater
Rain gauge No.--
****
Sample No. -
Date of collection
R_1-370/11/98MW-23/11/98
R_2 371/11/98MW-23/11/98
R_3-372/11/98MW-23/11/98
R_4-376/11/98MW-23/11/98
R_5-377/11/98MW-23/11/98
R_2-410/12/98MW-20/12/98
R_3-408/12/98MW-20/12/98
R_4-407/12/98MW
20/12/98
$R_5$408/12/98MW-20/12/98

$R_1$420/01/98MW-09/01/98

Appendix 4 : LIST OF CHEMICAL DATA

Sample No.	Temp ^0C	pH	EC (µscm/1)	Cl^- (mg/l)	Ca^{2+} (mg/l)	Mg^{2+} (mg/l)	SO_4^{2-} (mg/l)	HCO_3^- (mg/l)	Fe (mg/l)	K^+ (mg/l)	Na^+ (mg/l)	NO_3^- (mg/l)	SiO_2 (mg/l)	PO_4^{3-} (mg/l)
01	25	6.6	31.0	5.3	1.96	4.70	0.29	21.4	0.05	0.01	1.0			
02	25	6.8	50.0	5.3	1.96	5.90	1.15	27.5	0.08	1.0	2.0			
03	25	6.8	31.0	3.6	1.96	7.15	4.03	21.4	0.02	0.01	1.0			
04	25	6.8	29.0	5.3	1.96	5.96	0.86	27.5	0.08	0.01	0.01			
05	25	6.5	53.0	1.8	1.96	8.34	0.58	33.6	0.01	1.0	1.0			
06	25	6.5	51.0	3.6	3.93	7.15	1.15	42.7	0.01	1.0	1.0			
07/10/97GOTZ	24.0	6.5	58.5	3.6	1.96	5.96	2.30	24.4	0.01	0.01	1.0			
08/10/97MWTZ	24.2	6.9	65.0	1.8	5.89	5.30	0.58	36.6	0.01	1.0	1.0			
09/10/97GOTZ	22.3	7.1	60.0	3.6	5.89	7.74	1.15	39.7	0.01	0.01	0.01			
10/10/97GOTZ	24.2	7.2	27.0	3.6	1.96	4.76	0.58	21.4	0.01	0.01	1.0			
11/10/97MWTZ	24.3	6.1	28.0	2.7	1.96	4.76	0.58	18.3	0.01	2.0	1.0			
12/10/97MWTZ	24.8	6.3	29.2	3.6	3.96	4.76	1.15	24.4	0.07	0.01	0.01			
13/10/97MWTZ	26.7	7.3	53.0	3.6	3.93	7.74	0.58	36.6	0.01	1.0	1.0			
14/10/97GOTZ	22.7	7.5	13.2	1.8	0.01	4.17	2.88	12.2	0.01	0.01	1.0			
15/10/97GOTZ	22.8	7.2	19.2	5.3	0.01	4.76	1.73	18.3	0.01	0.01	0.01			
16/10/97GOTZ	23.7	7.6	31.0	1.8	0.98	6.56	2.02	21.4	0.01	1.0	0.01			

17/10/97GOTZ	25.0	7.4	32.0	3.6	0.98	4.17	1.44	24.4	0.01	1.5	0.01			
18/11/97MWTZ	26.9	7.2	98.1	5.3	1.96	8.30	72.58	27.5	0.99	4.0	4.0			
19/11/97MWTZ	22.8	7.1	65.0	1.8	0.98	8.93	0.86	27.5	0.01	0.01	0.01			
20/11/97MWTZ	29.3	7.1	48.0	3.6	0.98	8.34	11.1	30.5	0.18	1.0	0.01			
21/11/97MWTZ	24.0	7.3	90.1	3.6	3.93	7.15	0.32	12.2	0.01	0.01	0.01			
22/11/97MWTZ	23.1	6.9	62.5	5.3	0.01	5.96	1.73	21.4	0.01	3.5	2.0			
23/11/97MWTZ	24.6	7.1	48.0	3.6	5.89	4.76	2.88	33.6	0.01	1.0	0.01			
24/11/97GOTZ	23.3	7.0	59.0	7.1	0.01	7.15	4.32	24.4	0.01	3.0	1.0			
25/11/97GOTZ	20.8	6.9	27.4	7.1	0.01	4.76	2.02	12.2	0.01	1.0	0.01			
26/11/97GOTZ	22.8	6.7	27.0	5.3	0.01	5.96	0.86	12.2	0.01	1.0	0.01			
31/11/97	25	6.3	13.5	0.01	0.01	0.01	0.01	61.02	0.01	0.5	0.01			
37/11/97	25	6.3	8.1	0.01	0.01	0.01	0.32	61.02	0.01	0.01	0.01			
49/11/97	25	7.1	6.1	0.01	0.01	0.01	0.01	61.02	0.01	0.5	0.01			
43/12/97	25	7.0	4.1	0.01	0.01	0.01	2.30	61.02	0.01	0.01	0.01			
54/12/97MWTZ	22.5	6.7	46.0	1.8	3.93	5.96	0.01	62.0	0.01	0.5	1.0			
55/12/97GOTZ	23.8	6.7	22.2	3.5	4.91	5.36	2.02	30.0	0.01	0.01	1.0			
56/12/97GOTZ	21.7	6.6	10.2	3.5	0.01	5.96	0.01	24.0	0.01	0.01	1.0			
57/12/97GOTZ	22.2	6.3	8.2	3.5	0.01	4.76	1.73	18.0	0.01	0.01	0.01			
58/12/97GOTZ	22.4	6.4	15.0	7.1	0.01	4.76	1.44	22.0	0.01	0.01	1.0			
59/12/97GOTZ	22.5	6.4	15.3	5.3	1.96	4.76	0.68	14.0	0.01	0.01	1.0			
60/12/97GOTZ	23.0	6.3	17.1	5.3	1.96	3.57	2.30	16.0	0.01	0.01	1.0			
61/12/97GOTZ	23.0	6.4	21.3	3.5	1.96	4.76	0.49	22.0	0.01	0.01	1.0			
62/12/97MWTZ	24.5	6.4	34.0	5.3	3.93	7.15	7.49	24.0	2.89	1.0	3.0			
63/12/97MWTZ	24.3	6.6	43.0	5.3	3.93	7.15	1.68	30.0	0.17	0.5	3.0			

64/12/97MWTZ	24.1	6.5	46.0	1.8	4.91	7.15	1.15	36.0	0.01	0.5	1.0			
65/12/97MWTZ	22.3	7.0	61.0	0.01	4.91	10.12	2.02	46.0	0.01	0.01	1.0			
67/12/97MWTZ	23.7	6.5	18.3	0.01	1.96	7.15	0.86	22.0	0.01	0.01	1.0			
68/12/97MWTZ	23.1	6.5	33.0	1.8	1.96	5.96	1.44	28.0	0.01	0.5	1.0			
69/12/97MWTZ	21.2	6.6	15.0	1.8	0.98	5.36	1.44	20.0	0.01	1.0	1.0			
70/12/97MWTZ	23.2	5.5	14.7	1.8	0.98	4.76	2.30	12.0	0.01	0.01	0.01			
71/12/97MWTZ	24.2	6.7	41.0	1.8	5.89	5.96	1.73	12.0	0.06	0.01	1.0			
72/12/97MWTZ	22.9	6.9	68.0	1.8	6.87	11.32	1.44	34.0	0.01	0.01	1.0			
73/12/97MWTZ	23.1	6.7	22.8	1.8	3.93	4.76	0.86	26.0	0.01	0.01	1.0			
74/12/97MWTZ	25.0	6.8	49.0	3.5	4.91	6.55	6.34	36.0	0.02	1.5	1.0			
75/12/97MWTZ	25.0	7.3	54.0	3.3	3.2	9.62	0.01	124.9	0.01	1.0	0.01	1.056	1.760	0.350
77/12/97MWTZ	25.0	6.4	55.0	6.0	5.9	6.00	0.01	49.9	0.01	0.5	0.01	1.122	1.760	0.295
78/12/97MWTZ	25.0	6.6	53.0	4.7	7.9	6.00	0.01	43.7	0.18	0.1	1.0	0.924	1.760	0.265
80/12/97MWTZ	25.0	7.4	58.0	3.3	39.7	96.20	0.01	62.4	0.01	0.5	0.01	0.968	1.760	0.370
82/12/97GOTZ	25.0	6.8	54.0	3.3	39.7	72.20	0.01	62.4	0.01	0.01	0.01	0.792	1.760	0.360
83/12/97GOTZ	25.0	6.7	27.9	6.7	39.7	96.2	0.86	62.4	0.01	0.01	0.01	0.814	1.760	0.360
84/12/97MWTZ	25.0	6.9	51.0	6.7	39.7	96.2	0.01	62.4	0.03	0.5	1.0	1.078	1.760	0.410
85/12/97GOTZ	25.0	6.8	28.8	6.7	ND	144.4	1.15	62.4	0.01	1.5	1.0	0.968	1.760	0.350
86/12/97MWTZ	25.0	7.7	50.0	6.7	39.7	96.0	0.01	62.4	0.01	0.1	1.0	0.704	1.760	0.310
87/12/97GOTZ	25.0	6.9	25.2	6.0	2.0	7.2	1.73	31.2	0.01	0.5	1.0	0.528	1.760	0.345
88/12/97MWTZ	25.0	7.3	52.0	6.7	39.7	120.0	0.86	62.4	0.01	0.5	0.01	0.902	1.760	0.330
89/12/97MWTZ	25.0	6.8	50.0	6.7	39.7	96.0	0.86	62.4	0.01	0.5	1.0	0.682	1.760	0.355
91/12/97MWTZ	25.0	7.3	56.0	3.3	39.7	96.0.0	0.58	62.4	0.01	0.5	1.0	1.012	1.760	0.365
93/12/97MWTZ	25.0	7.3	53.0	6.7	39.7	144.4	0.29	124.9	0.01	0.5	1.0	1.254	1.760	0.370

94/12/97MWTZ	25.0	6.6	52.0	4.7	5.6	0.01	0.01	49.9	0.02	0.5	0.01	0.924	1.760	0.425
96/01/98MWTZ	25.0	6.7	68.0	5.3	4.8	23.6	0.29	49.9	0.05	1.0	1.0	0.660	1.760	0.275
98/01/98MWTZ	25.0	6.8	53.0	4.0	2.4	23.8	2.59	49.9	0.49	1.0	1.0	1.078	1.760	0.410
99/01/98MWTZ	25.0	6.6	52.0	5.3	6.0	19.3	0.01	56.2	0.05	0.5	0.01	1.584	1.760	0.320
101/01/98MWTZ	25.0	7.5	52.0	6.7	39.7	96.2	0.01	62.4	0.01	0.5	1.0	1.342	1.760	0.555
102/01/98GOTZ	25.0	7.3	23.7	3.3	39.7	144.4	0.01	62.4	0.01	0.01	2.0	0.836	1.760	0.430
103/01/98GOTZ	25.0	6.7	22.7	4.7	3.2	20.2	1.15	25.0	0.04	0.5	0.01	0.968	1.760	0.380
104/010/98GOTZ	25.0	8.0	440.0	23.3	9.9	44.5	0.58	312.2	0.01	17.5	22.0	0.528	1.760	0.200
105/01/98 MWTZ	25.0	6.5	53.5	6.0	7.1	18.5	0.86	56.2	0.01	1.0	0.01	1.518	1.760	0.330
106/01/98 MWTZ	25.0	6.6	55.0	6.7	6.0	20.5	0.01	43.7	0.09	1.0	0.01	1.584	1.760	0.465
107/01/98 MWTZ	25.0	8.0	31.0	16.7	39.7	120.3	0.86	187.3	0.01	14.0	26	1.144	1.760	0.295
108/01/98 GOTZ	25.0	8.0	600.0	34.0	11.9	59.0	6.62	430.8	0.01	24.0	32	0.330	1.256	0.100
109/01/98 MWTZ	25.0	7.0	12.6	6.7	0.01	96.2	1.73	62.4	0.01	0.5	0.01	0.594	1.760	0.245
110/01/98 MWTZ	25.0	6.8	15.6	10.0	0.01	96.2	0.01	62.4	0.01	ND	0.01	1.936	1.760	0.275
111/01/98 MWTZ	25.0	7.2	22.8	6.7	0.01	120.3	0.01	62.4	0.01	ND	0.01	1.188	1.760	0.245
112/01/98 MWTZ	25.0	6.6	64.0	8.0	13.9	4.8	0.58	62.4	0.03	ND	0.01	0.682	1.760	0.245
113/01/98 MWTZ	25.0	6.8	18.9	6.7	0.01	120.3	0.01	62.4	0.03	ND	0.01	0.748	1.760	0.380
114/01/98 MWTZ	25.0	7.1	32.0	6.7	2.0	19.3	0.86	31.2	0.08	0.5	0.01	1.496	1.760	0.235
115/01/98 MWTZ	25.0	7.4	62.0	5.3	3.2	23.2	0.01	43.7	0.11	2.0	1.0	0.440	1.760	0.385
116/01/98 MWTZ	25.0	7.0	50.0	3.3	39.7	96.2	1.44	62.4	0.01	0.5	0.1	0.616	1.760	0.315
117/01/98 MWTZ	25.0	7.4	52.0	6.7	39.7	120.3	0.01	62.4	0.01	0.5	0.1	0.283	1.760	0.260
118/01/98 MWTZ	25.0	8.5	610.0	33.3	39.7	144.4	2.02	437.0	0.03	27.0	60	0.264	1.228	0.135
120/01/98 MWTZ	25.0	7.0	154.5	7.3	23.8	15.6	3.17	112.4	0.13	6.0	1.0	0.836	1.760	0.280
121/01/98 MWTZ	25.0	7.9	180.0	6.7	79.4	96.2	0.58	187.3	0.16	8.5	1.0	0.572	1.760	0.245

123/01/98MWTZ	25.0	7.2	50.0	6.7	39.7	96.2	1.73	62.4	0.01	1.0	0.l1	1.936	1.760	0.275
124/01/98GOTZ	25.0	6.7	24.3	4.7	ND	20.5	0.86	31.2	0.04	0.5	0.1	0.704	1.760	0.355
125/01/98MWTZ	25.0	7.2	52.0	6.7	39.7	120.3	0.01	62.4	0.63	1.0	2.0	1.760	1.760	0.395
127/01/98MWTZ	25.0	6.5	53.0	5.3	7.9	20.5	1.73	49.9	0.30	1.0	0.01	1.760	1.760	0.415
128/01/98GOTZ	25.0	6.9	23.7	1.7	4.0	20.5	1.44	25.0	0.08	0.5	0.01	0.748	1.760	0.370
129/02/98GOTZ	25.0	6.7	21.9	6.0	2.0	19.3	0.01	31.2	0.01	0.5	0.01	0.616	1.760	0.365
136/02/98MWTZ	25.0	7.4	42.0	6.7	39.7	96.2	0.86	62.4	0.13	0.5	1.0	1.452	1.760	0.375
137/02/98MWTZ	25.0	7.2	42.0	3.3	39.7	96.2	0.01	124.9	0.01	0.5	0.1	1.584	1.760	0.305
138/02/98MWTZ	25.0	6.9	43.0	4.7	4.0	21.3	0.01	37.5	0.20	1.5	1.0	1.254	1.760	0.275
139/02/98MWTZ	25.0	6.7	41.0	4.7	6.0	22.9	1.44	43.7	0.23	1.0	1.0	1.254	1.760	0.020
140/02/98MWTZ	25.0	6.5	41.0	6.0	7.1	18.5	0.58	43.7	0.05	0.5	1.0	0.792	1.760	0.225
141/02/98MWTZ	25.0	6.6	41.0	6.7	6.0	20.5	0.86	43.7	0.04	0.5	0.1	1.144	1.760	0.255
142/02/98MWTZ	25.0	7.1	56.0	3.3	39.7	120.3	0.01	62.4	0.01	0.1	0.1	0.924	1.760	0.445
144/02/98MWTZ	25.0	6.8	0.01	3.3	39.7	120.3	0.58	124.9	0.01	0.5	1.0	1.012	1.760	1.135
159/03/98KGTZ	25.0	7.0	42.0	8.0	2.0	8.4	0.86	25.0	0.01	0.5	1.0			
160/03/98MWTZ	25.0	6.9	47.0	8.0	3.2	17.3	0.01	0.01	1.21	1.5	1.0			
161/03/98MWTZ	25.0	7.2	48.0	6.7	2.0	8.4	13.47	49.9	0.46	1.0	1.0			
162/03/98MWTZ	25.0	7.7	49.0	4.7	4.0	9.6	4.32	43.7	0.30	1.0	0.01			
163/03/98MWTZ	25.0	6.4	45.0	6.7	4.0	9.6	0.29	124.9	0.20	1.0	0.01			
164/03/98MWTZ	25.0	7.0	48.0	7.3	2.0	8.4	2.59	56.2	0.26	1.0	0.01			
165/03/98 MWTZ	25.0	6.5	45.0	5.3	2.0	10.8	19.30	49.9	3.43	2.0	0.11			
166/03/98 MWTZ	25.0	7.3	54.5	8.0	4.8	9.6	3.46	62.4	0.39	1.0	0.1			
167/03/98 MWTZ	25.0	7.0	50.0	4.7	2.0	8.4	6.92	49.9	1.23	1.5	1.0			
168/03/98 GOTZ	25.0	6.9	141.0	6.7	2.4	10.6	0.01	0.01	0.29	16.5	1.0			

169/03/98 MWTZ	25.0	6.8	45.0	8.0	2.0	10.8	16.70	56.2	3.09	2.5	1.0			
170/03/98 MWTZ	25.0	7.0	71.0	6.0	6.0	10.8	18.35	62.4	2.60	2.0	0.1			
171/03/98 MWTZ	25.0	6.8	70.0	8.0	6.4	12.0	6.73	62.4	2.20	1.5	1.0			
172/03/98 MWTZ	25.0	6.9	11.1	8.0	2.4	0.01	0.01	0.01	0.01	0.5	0.1			
176/04/98 MWTZ	25.0	6.9	46.0	6.7	3.2	14.4	0.01	0.01	0.24	1.0	1.0			
177/04/98 GOTZ	25.0	7.7	24.6	5.3	1.6	13.5	0.86	31.2	0.01	0.5	1.0			
178/04/98 MWTZ	25.0	6.6	48	6.7	2.0	8.4	0.58	49.9	0.06	1.0	2.0			
179/04/98 MWTZ	25.0	6.9	12.6	5.3	1.6	11.1	1.73	25.0	0.02	0.5	0.1			
180/04/98 MWTZ	25.0	6.7	39.0	7.3	2.4	10.6	105.98	43.7	10.20	4.0	1.0			
181/04/98 MWTZ	25.0	6.9	43.0	8.0	2.4	11.6	2.02	37.5	6.70	3.0	2.0			
182/04/98 MWTZ	25.0	8.2	39.0	6.0	2.0	8.4	27.07	43.7	4.64	2.5	0.1			
183/04/98 MWTZ	25.0	6.5	44.0	7.3	2.0	8.4	15.26	43.7	1.74	2.0	2.0			
185/04/98 GOTZ	25.0	6.5	20.4	10.0	0.01	9.6	3.46	25.0	0.21	1.0	1.0			
186/04/98 MWTZ	25.0	6.7	47.0	5.3	4.0	18.0	100.00	49.9	9.00	3.0	1.0			
187/04/98 MWTZ	25.0	6.5	50.0	7.3	2.4	14.0	5.04	0.01	1.37	1.0	1.0			
189/04/98 GOTZ	25.0	6.1	26.3	6.7	2.0	8.4	9.50	37.5	1.68	1.5	1.0			
190/04/98 GOTZ	25.0	6.9	21.9	0.01	2.0	3.6	3.76	31.2	0.01	0.5	2.0			
191/04/98 GOTZ	25.0	7.3	23.4	4.7	2.0	8.4	1.73	31.2	0.08	0.5	0.1			
192/04/98 MWTZ	25.0	6.5	40.0	6.7	2.4	10.6	3.17	49.9	0.06	1.0	0.1			
193/04/98 MWTZ	25.0	6.3	40.0	4.7	4.0	9.6	0.24	49.9	0.05	1.0	1.0			
194/04/98 MWTZ	25.0	6.7	41.0	6.7	4.0	9.6	23.54	43.7	0.14	1.0	0.1			
195/04/98 MWTZ	25.0	7.2	41.0	3.3	2.0	10.8	2.88	43.7	0.07	1.0	1.0			
196/04/98 MWTZ	25.0	6.7	42.0	9.3	2.0	8.4	2.59	43.7	0.16	0.5	0.1			
197/04/98 MWTZ	25.0	6.9	40.0	5.3	2.0	8.4	2.30	49.9	0.21	1.0	1.0			

198/04/98 MWTZ	25.0	7.2	43.0	7.3	2.0	8.4	8.35	49.9	0.80	1.0	0.1			
199/04/98 MWTZ	25.0	6.9	44.0	8.0	4.0	9.6	6.62	43.7	1.02	1.0	0.1			
200/04/98 MWTZ	25.0	7.0	43.0	8.7	2.0	8.4	1.72	37.5	0.88	1.0	1.0			
201/04/98 MWTZ	25.0	7.7	39.0	6.0	7.9	7.2	4.03	43.7	0.56	1.0	0.1			
203/04/98 MWTZ	25.0	8.4	410.0	25.3	9.5	35.1	3.46	293.4	0.01	15.5	35.0			
204/04/98 MWTZ	25.0	8.8	570.0	30.7	9.9	49.3	4.03	418.3	0.01	25.0	30.0			
205/04/98 GOTZ	25.0	6.9	23.4	8.0	0.01	12.0	2.02	31.2	0.01	0.5	1.0			
206/04/98 GOTZ	25.0	6.4	21.0	1.3	2.0	6.0	0.29	37.5	0.01	0.5	1.0			
207/04/98 GOTZ	25.0	6.5	21.8	9.3	2.4	8.2	1.73	37.4	0.04	0.5	1.0			
208/04/98 GOTZ	25.0	8.1	21.9	6.7	2.0	8.4	1.15	31.2	0.03	0.5	1.0			
209/04/98 GOTZ	25.0	6.6	22.5	7.3	2.0	8.4	0.58	31.2	0.01	0.5	0.1			
210/04/98 GOTZ	25.0	8.4	425.0	22.0	0.8	42.8	5.18	318.4	0.01	17.0	40.0			
212/04/98 MWTZ	25.0	7.1	38.0	6.7	2.4	20.2	28.51	43.7	3.62	1.5	0.01			
213/04/98 MWTZ	25.0	6.4	39.0	10.7	2.0	13.2	20.74	49.9	2.80	1.5	0.01			
214/04/98 MWTZ	25.0	6.9	40.0	6.7	4.0	7.2	54.43	49.9	5.68	2.0	0.01			
215/04/98 MWTZ	25.0	6.8	42.5	6.7	2.0	8.4	43.78	49.9	5.29	2.0	1.0			
216/04/98 MWTZ	25.0	6.6	40.0	8.0	4.8	9.1	7.20	43.7	1.68	1.0	0.1			
217/04/98 MWTZ	25.0	6.4	15.9	6.0	0.01	7.2	0.58	31.2	0.01	1.0	0.1			
218/04/98 MWTZ	25.0	7.6	4.4	6.7	0.01	9.6	0.58	25.0	0.04	0.01	0.01			
219/04/98 MWTZ	25.0	6.8	22.5	4.7	2.4	10.6	1.72	31.2	0.01	0.5	0.01			
220/04/98 MWTZ	25.0	6.9	22.5	8.0	2.0	6.0	5.44	31.2	0.05	1.0	0.01			
221/04/98 GOTZ	25.0	6.9	24.0	6.0	2.0	6.0	0.20	31.2	0.17	0.5	1.0			
222/04/98 GOTZ	25.0	6.4	13.7	8.7	0.01	7.2	0.01	43.7	0.01	0.5	0.01			
223/04/98 GOTZ	25.0	7.1	4.4	8.0	0.01	4.8	0.29	31.2	0.01	0.01	1.0			

224/04/98 GOTZ	25.0	6.5	12.6	4.7	0.01	4.8	0.01	18.7	0.01	0.5	0.01			
225/04/98 GOTZ	25.0	6.5	15.3	8.0	0.01	7.2	0.58	25.0	0.01	0.5	0.01			
226/04/98 GOTZ	25.0	6.8	16.2	5.3	1.6	8.7	2.02	25.0	0.03	0.5	0.01			
227/04/98 GOTZ	25.0	6.6	26.4	6.0	1.6	8.7	4.32	43.7	0.01	1.0	2.0			
228/04/98 GOTZ	25.0	7.6	4.8	8.0	0.01	7.2	0.01	25.0	0.01	0.01	0.01			
229/04/98 GOTZ	25.0	7.7	4.5	5.3	0.01	9.6	2.59	18.7	0.01	0.01	0.01			
230/04/98 GOTZ	25.0	6.9	6.1	6.0	0.01	7.2	0.43	31.2	0.01	0.01	0.01			
231/04/98 GOTZ	25.0	6.9	21.9	6.7	1.6	11.1	0.58	37.5	0.03	0.5	1.0			
232/04/98 GOTZ	25.0	8.0	22.2	6.0	ND	9.6	0.32	37.5	0.01	0.5	ND			
233/04/98 GOTZ	25.0	7.2	22.2	6.0	2.0	8.4	0.58	31.2	0.01	0.5	1.0			
235/04/98 GOTZ	25.0	6.5	2.2	5.3	2.0	8.4	2.59	31.2	0.01	0.5	ND			
236/04/98 GOTZ	25.0	7.6	213.0	6.0	19.1	31.8	2.59	199.8	0.04	0.5	1.0			
237/04/98GOTZ	25.0	6.7	18.9	5.3	0.8	11.6	0.14	31.2	0.01	1.0	1.0			
238/04/98 MWTZ	25.0	6.5	39	6.0	3.2	14.0	2.02	43.7	0.07	0.5	1.0			
239/04/98 MWTZ	25.0	6.8	41.0	6.7	2.0	10.8	1.44	43.7	0.09	0.5	2.0			
240/04/98 KGTZ	25.0	6.5	14.7	4.7	0.01	7.2	1.15	31.2	0.05	0.5	1.0			
241/04/98 KGTZ	25.0	7.1	145.5	7.3	15.1	14.9	4.03	49.9	0.56	1.0	6.0			
242/04/98 KGTZ	25.0	6.4	234.0	33.3	19.8	16.8	7.20	87.4	0.01	4.0	15.0			
243/04/98 KGTZ	25.0	7.4	75.0	15.3	4.0	7.2	3.17	56.4	0.31	0.5	10.0			
244/04/98 KGTZ	25.0	7.4	810.0	36.0	50.0	75.6	95.32	220.0	0.01	2.0	20.0			
245/04/98 KGTZ	25.0	6.5	26.7	9.3	0.01	14.4	0.58	25.0	0.05	1.0	1.0			
246/04/98 KGTZ	25.0	6.8	24.0	6.7	0.01	7.2	0.72	25.0	0.04	0.5	3.0			
247/04/98 KGTZ	25.0	7.9	320.0	0.01	25.8	25.3	0.58	268.4	0.01	0.5	24.0			
248/04/98 KGTZ	25.0	6.9	29.7	7.3	0.8	0.01	8.93	31.2	0.72	0.5	4.0			

249/04/98 KGTZ	25.0	7.8	67.5	9.3	7.1	12.5	1.73	49.9	0.08	0.5	4.0			
250R/04/98 KGMTZ	25.0	6.6	87.0	10.0	4.0	14.4	4.04	74.9	0.63	0.5	3.0			
250L/04/98 KGMTZ	25.0	7.0	86.0	8.0	7.9	9.6	3.44	68.7	0.57	0.5	2.0			
250M/04/98 KGMTZ	25.0	6.5	85.0	10.0	6.0	10.8	3.74	68.7	0.53	0.5	5.0			
251/04/98 KGTZ	25.0	6.9	87.0	12.0	6.0	0.01	3.46	74.9	0.59	1.0	4.0			
252/04/98 KGTZ	25.0	8.5	580.0	29.3	11.9	45.7	35.18	418.3	0.01	23.0	30.0			
253/04/98 MWTZ	25.0	6.8	14.7	10.0	0.8	6.0	0.01	25.0	0.01	0.5	1.0			
254/04/98 MWTZ	25.0	7.1	37.0	9.3	4.8	9.6	3.84	43.7	0.01	0.5	0.01			
255/04/98 MWTZ	25.0	7.1	41.0	7.3	4.0	6.0	0.01	43.7	0.01	0.5	0.01			
256/04/98 GOTZ	25.0	6.4	7.5	8.7	2.0	6.0	0.01	25.0	0.01	0.01	0.01			
257/04/98 GOTZ	25.0	6.8	13.5	8.0	2.0	4.8	1.28	25.0	0.01	0.5	1.0			
258/04/98 GOTZ	25.0	6.6	23.1	6.7	0.8	9.1	1.44	31.2	0.03	0.5	1.0			
262/05/98 GOTZ	25.0	6.6	12.6	6.7	1.6	6.3	0.01	31.2	0.01	0.5	0.01			
266/05/98 GOTZ	25.0	6.9	27.6	8.0	2.0	4.8	2.88	31.2	0.24	1.5	0.01			
267/05/98 GOTZ	25.0	6.8	10.8	1.7	0.01	4.8	0.01	18.7	0.01	0.5	0.01			
269/05/98 MWTZ	25.0	6.7	42.0	6.7	4.0	7.2	0.32	37.5	0.24	1.5	1.0			
270/05/98 MWTZ	25.0	7.2	38.0	13.3	2.0	8.4	0.01	37.5	0.04	1.0	0.01			
271/05/98 MWTZ	25.0	6.4	5.7	8.0	0.01	0.01	0.01	0.01	0.01	0.01	1.0			
272/05/98 MWTZ	25.0	7.2	58.0	6.0	2.0	12.0	5.28	43.7	1.13	2.0	0.01			
273/05/98 MWTZ	25.0	6.8	42.0	6.7	2.0	8.4	0.01	37.5	0.06	1.0	0.01			
275/05/98 GOTZ	25.0	6.5	5.3	0.01	0.01	8.4	0.01	25.0	0.01	0.01	1.0			
276/05/98 GOTZ	25.0	6.8	24.6	0.01	0.01	9.6	0.96	31.2	0.15	1.0	1.0			
277/05/98 GOTZ	25.0	6.5	26.1	6.7	0.8	6.7	0.80	25.0	0.16	0.5	1.0			
278/05/98 MWTZ	25.0	6.8	8.3	8.0	4.8	3.1	1.12	18.7	0.01	0.01	1.0			

279/05/98 MWTZ	25.0	6.7	58.0	3.1	5.6	9.9	1.92	43.7	1.72	1.0	1.0			
280/05/98 MWTZ	25.0	6.9	56.0	5.8	7.1	6.5	4.32	49.9	0.90	1.0	0.01			
281/05/98 GOTZ	25.0	6.6	5.5	20.0	4.0	3.6	0.16	12.5	0.01	3.0	0.01			
282/05/98 GOTZ	25.0	7.0	27.9	6.0	3.2	8.9	2.56	31.2	0.43	1.0	0.01			
283/05/98 GOTZ	25.0	8.6	30.0	7.3	2.0	7.2	0.01	31.2	0.31	0.5	2.0			
285/05/98 MWTZ	25.0	6.8	26.7	0.01	4.0	7.2	2.08	43.7	0.01	0.5	0.01			
286/07/98 MWTZ	25.0	6.7	18.6	6.7	0.01	6.0	0.32	31.2	0.01	1.5	2.0			
287/07/98 MWTZ	25.0	6.8	9.0	7.3	0.01	6.0	1.28	18.7	0.01	0.5	0.01			
288/07/98 MWTZ	25.0	6.9	24.6	6.7	4.0	4.8	0.01	18.7	0.01	0.5	0.01			
289/07/98 MWTZ	25.0	6.9	9.0	3.7	0.01	7.2	0.16	25.0	0.01	0.01	0.01			
290/07/98 GOTZ	25.0	6.8	7.4	7.3	0.8	6.7	0.01	25.0	0.01	0.5	1.0			
291/07/98 GOTZ	25.0	6.4	11.4	8.0	0.01	6.0	0.01	18.7	0.01	0.01	1.0			
292/07/98 GOTZ	25.0	6.9	7.2	5.3	0.01	6.0	1.60	25.0	0.01	0.01	0.01			
293/07/98 GOTZ	25.0	6.8	25.8	8.0	2.0	7.2	0.64	25.0	0.01	0.5	0.01			
294/07/98 MWTZ	25.0	6.9	13.2	7.3	0.01	6.0	1.92	25.0	0.01	0.01	3.0			
295/07/98 MWTZ	25.0	6.7	38.0	0.01	4.0	8.4	3.84	37.5	0.01	0.5	0.01			
296/07/98 KGTZ	25.0	7.2	117.0	10.0	13.9	7.2	0.01	93.6	0.01	1.5	5.0			
297/07/98 MWTZ	25.0	7.2	0.01	133200	0.01	0.01	4384.0	99.9	0.01	2400	60000			
298/07/98 KGTZ	25.0	7.0	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01			
299/07/98 UVZ-GTZ	25.0	7.1	$60*10^4$	12472.0	1825.3	1972.9	4144.0	118.6	0.01	3100	37500			
300/08/98 UVZ-GTZ	25.0	6.8	$54*10^4$	12472.0	1904.6	1876.7	3840.0	118.6	0.01	3250	40000			
301/08/98 UVZ-GTZ	25.0	7.1	$54*10^4$	13166.8	2301.4	1780.4	3856.0	106.1	0.01	3250	40000			
302/08/98 UVZ-GTZ	25.0	7.8	186.0	3.1	14.3	19.3	0.01	137.3	0.04	2.0	17.0			
303/08/98 GOTZ	25.0	7.5	52.0	1.4	27.8	28.4	0.01	43.7	0.01	0.5	3.0			

305/08/98 MWTZ	25.0	8.5	630.0	4.9	11.1	53.9	4.16	511.9	0.01	30.5	30.0			
314/08/98 MWTZ	25.0	8.5	670.0	6.6	13.5	52.5	5.76	505.7	0.01	31.0	45.0			
315/08/98 MWTZ	25.0	8.8	580.0	6.6	11.9	57.3	0.01	501.9	0.01	30.5	30.0			
316/08/98 MWTZ	25.0	8.5	620.0	3.1	14.3	50.5	0.01	505.7	0.01	30.0	30.0			
317/08/98 MWTZ	25.0	8.8	590.0	6.6	11.1	52.0	0.01	511.9	0.01	30.0	35.0			
318/08/98 MWTZ	25.0	8.7	630.0	3.1	11.9	52.0	0.01	524.4	0.01	30.5	30.0			
319/08/98 MWTZ	25.0	8.7	630.0	6.6	11.9	52.9	0.01	536.9	0.02	30.5	35.0			
320/08/98 GOTZ	25.0	8.4	580.0	3.1	11.1	52.5	5.76	511.9	0.01	30.0	30.0			
321/08/98 MWTZ	25.0	8.8	580.0	3.1	11.9	51.0	0.48	511.9	0.01	30.0	35.0			
322/08/98 MWTZ	25.0	8.7	590.0	4.9	14.3	48.6	0.01	115.9	0.02	30.0	35.0			
323/08/98 MWTZ	25.0	8.7	610.0	3.1	11.9	55.8	0.01	518.2	0.01	31.0	30.0			
324/08/98 MWTZ	25.0	8.3	610.0	3.1	11.9	51.0	0.01	524.4	0.01	31.0	35.0			
325/08/98 MWTZ	25.0	8.3	600.0	3.1	12.7	57.3	0.16	511.9	0.01	30.5	35.0			
326/08/98 GOTZ	25.0	8.8	600.0	6.6	11.9	26.5	0.01	511.9	0.01	30.0	30.0			
327/08/98 GOTZ	25.0	8.8	640.0	4.9	11.1	52.9	0.01	505.7	0.01	30.5	30.0			
328/08/98 GOTZ	25.0	8.8	640.0	3.1	9.5	54.4	0.01	511.9	0.01	30.0	35.0			
329/08/98 GOTZ	25.0	8.8	610.0	4.9	24.6	49.6	0.01	524.4	0.01	31.0	35.0			
330/08/98 GOTZ	25.0	8.5	630.0	6.6	12.7	54.4	3.04	524.4	0.01	30.5	35.0			
331/08/98 GOTZ	25.0	8.5	670.0	3.1	11.9	56.3	0.80	530.7	0.01	34.0	35.0			
332/08/98 GOTZ	25.0	8.4	630.0	4.9	13.5	51.0	0.01	518.2	0.01	30.5	30.0			
357/10/98 MWTZ	25.0	7.9	78.0	13.6	3.2	14.0	0.01	49.9	0.01	1.0	1.0			
358/10/98 GOTZ	25.0	7.8	54.0	1.4	3.2	16.8	2.56	56.2	0.02	1.5	0.01			
359/10/98 GOTZ	25.0	8.0	54.0	1.4	3.2	15.9	0.01	56.2	0.03	1.0	0.01			
362/10/98 GOTZ	25.0	7.9	35.0	0.01	3.2	14.4	0.01	37.5	0.01	0.5	1.0			

366/10/98 GOTZ	25.0	7.9	58.0	3.1	1.6	12.0	0.01	18.7	0.06	1.5	1.0			
370R_1/11/98 MWTZ	25.0	6.0	14.7	5.21	1.6	11.1	1.44	37.5	0.01	0.01	0.01			
371R_2/11/98 MWTZ	25.0	5.9	19.5	5.2	1.6	11.1	0.58	74.9	0.01	0.5	0.01			
372R_3/11/98 MWTZ	25.0	6.4	7.6	5.21	ND	10.6	7.49	31.2	0.01	0.5	0.01			
376R_4/11/98 MWTZ	25.0	6.1	15.6	7.3	ND	12.5	0.29	37.5	0.01	1.0	0.01			
377R_5/11/98 MWTZ	25.0	6.3	10.5	5.2	ND	11.1	0.86	34.3	0.01	1.0	0.01			
410R_2/12/98 MWTZ	25.0	6.2	6.5	7.3	ND	10.6	0.86	37.5	0.10	0.10	0.01			
408R_3/12/98 MWTZ	25.0	6.5	6.9	7.3	ND	8.7	0.86	28.1	0.01	0.01	0.01			
407R_4/12/98 MWTZ	25.0	6.5	5.0	8.7	ND	10.6	2.02	31.2	0.01	0.01	0.l0			
409R_5/12/98 MWTZ	25.0	6.3	15.6	5.9	ND	10.6	0.29	46.8	0.l	0.01	0.01			
420R_1/01/99 MWTZ	25.0	6.1	7.3	5.9	ND	11.1	0.01	28.1	0.01	0.01	0.01			
1/3/98	25.0	8.0	186.0	6.7	39.7	96.2	0.01	187.2	0.01	0.5	1.0			
145/02/98MWTZ	25.0	7.0.	0.01	6.7	39.7	120.3	0.01	62.4	0.17	3.5	0.01			
151/03/98MWTZ	25.0	6.9	67.0	6.7	39.7	120.3	0.01	62.4	3.72	3.5	1.0			
153/03/98GOTZ	25.0	7.1	21.9	6.7	0.8	144.4	0.01	62.4	0.01	0.01	0.1			
154/03/98GOTZ	25.0	6.8	279.0	16.7	39.7	168.4	0.01	249.7	0.01	15.0	24.0			
155/03/98GOTZ	25.0	8.9	600.0	26.7	39.7	120.3	0.01	437.0	0.04	29.0	50.0			
156/03/98MWTZ	25.0	7.3	44.5	3.3	39.7	168.4	0.01	62.4	0.1	0.5	0.01			
157/03/98MWTZ	25.0	7.2	20.1	6.7	39.7	96.2	0.01	62.4	0.03	0.01	0.01			
158/03/98KGTZ	25.0	7.8	20.1	3.3	0.01	96.2	0.01	62.4	0.02	0.01	1.0			

Appendix 5a LIST OF ISOTOPE SAMPLES

Sample	Date	Source	Remarks
28/11/97GOTZ	6/11/97	GOMBE	Gombe Hostel rainfall
30/11/97GOTZ	10/11/97	GOMBE	-
29/11/97GOTZ	8/11/97	GOMBE	-
33/11/97GOTZ	13/11/97	KAKOMBE	GAUGING STATION
39/11/97GOTZ	19/11/97	GOMBE	-
35/11/97GOTZ	14/11/97	GOMBE	-
38/11/97GOTZ	18/11/97	KAKOMBE	GAUGING STATION
32/11/77GOTZ	12/11/97	MITUMBA	
36/11/97GOTZ	15/11/97	GOMBE	-
34/11/97GOTZ	13/11/97	GOMBE	-
27/11/97GOTZ	5/11/97	GOMBE	-
41/11/97GOTZ	24/11/97	GOMBE	-
51/12/97GOTZ	7/12/97	GOMBE	-
40/11/97GOTZ	20/11/97	GOMBE	-
66/12/97GOTZ	15/12/97	GOMBE	-
44/11/97GOTZ	26/12/97	GOMBE	-
45/11/97GOTZ	30/12/97	GOMBE	-
46/12/97GOTZ	1/12/97	GOMBE	-
50/12/97GOTZ	6/12/97	GOMBE	-
47/12/97GOTZ	2/12/97	GOMBE	-
48/12/97 GOTZ	3/12/97	GOMBE	-
52/12/97GOTZ	8/12/97	GOMBE	-
70/12/97MWTZ	16/12/97	MGUNGA	Alt. 915m.a.s.l.
73/12/97MWTZ	16/12/97	NYAMHUNG	Tributary Alt.860m.a.s.l.
53/12/97GOTZ	11/12/97	GOMBE	
42/11/97GOTZ	26/12/97	KAKOMBE BRIDGE	
54/12/97MWTZ	13/12/97	NGONYA STREAM	
67/12/97MWTZ	15/12/97	NYAMNINI	Alt. 780m.a.s.l
56/12/97GOTZ	14/12/97	MITUMBA	Alt. 880m.a.s.l
60/12/97GOTZ	14/12/97	MITUMBA(W. SPRING)	
58/12/97GOTZ	14/12/97	MITUMBA	Alt. 790m.a.s.l.
55/12/97GOTZ	13/12/97	MITUMBA STREAM	Gauging station
71/12/97GOTZ	16/12/97	NYAMHUNGU	Alt. 940m.a.s.l
61/12/97GOTZ	14/12/97	MITUMBA	Alt 670m.a.s.l
74/12/97MWTZ	16/12/97	NGONYA STREAM	At gauge station
72/12/97MWTZ	16/12/97	NGONYA SPRING	Alt. 880m.a.s.l.
64/12/97MWTZ	14/12/97	NGONYA STREAM.	4hrs after (03) after peak flash floods
62/12/97MWTZ	14/12/97	NGONYA STREAM.	During peak flash floods
63/12/97MWTZ	14/12/97	NGONYA STREAM.	2hrs after peak flash floods
224/4/98G0TZ	19/4/98	MITUMBA SPRING	Alt 850m.a.s.l
218/4/98MWTZ	18/4/98	KIVUMBA SPRING NGONYA STREAM MAIN SOURCE	Alt.1440m.a.s.l
241/4/98KGM	27/4/98	LUICHE RIVER AT THE BRIDGE G	Alt 640m.a.s.l

243/4/98KGM	27/4/98	SW (SHALLOW WELL) (KASUKU). (ISOTOPE)	Alt 660m.a.s.l Sample bottle broken
242/4/98KGM	27/4/98	SW (Shallow well-Simbo)	Alt 635m.a.s.l
213/4/98MWTZ	14/4/98	NGONYA STREAM lake confluence point	Taken at a point of max. Revs. 80cm from Right edge. Velocity 1.875 m/s. at gauging station.
191/4/98GOTZ	14/4/98	MITUMBA STREAM	Gauging station
166/3/98MWTZ	27/03/98	NGONYA STREAM	sampled at Peak floods at 5.00PM
247/4/98KGM	28/4/98	MSIMBA BORE HOLE	760masl
169/3/98MWTZ	30/3/98	NGONYA STREAM	Peak flash floods sampled at 3.05pm
174/3/98MWTZ	31/3/98	NGONYA STREAM	Taken at 2.00PM
203/4/98MWTZ	16/04/98	LAKE SAMPLE	Ngonya stream lake confluence point
244/4/98KGM	27/4/98	KASUKU BORE HOLE (SIMBO R.C)	810m.a.s.l
229/4/98GOTZ	21/4/98	KAKOMBE spring2.	Alt. 1270masl
194/4/98GOTZ	16/4/98	NGONYA STREAM -	(At the left Bank) Right Bank 40cm from left edge Velocity 0.285 m/s Taken at 40cm from left edge
217/4/98MWTZ	18/4/98	RUBONA Tributary NGONYA	Alt. 1245m.a.s.l
146/2/98MWTZ	21/2/98	NGONYA RAINFALL (MWAMGONGO)	51.0 mm
222/4/98GOTZ	19/4/98	Mitumba spring	Alt 960m.a.s.l
212/4/98MWTZ	17/4/98	Ngonya Stream	Taken at 20am from right edge, after rain fall v=0.634 m/s
215/4/98MWTZ	17/4/98	Ngonya Stream	Taken after Rainfall 50cm interval across the span of the stream
202/4/98MWTZ	16/4/98	Ngonya Stream	Taken after rainfall (at the Gauge station)
204/4/98MWTZ	16/4/98	Lake sample	Lake surface near Ngonya stream
245/4/98KGM	28/4/98	NORAD Compound Bore hole at Kigoma station	Alt: 780m.a.s.l
237/4/98GOTZ	22/4/98	Kakombe Spring	Alt:815m.a.s.l
192/4/98MW	16/04/98	Ngonya Stream	Taken at the right Bank 0.1 from right Bank edge v=0.441 m/s
175/4/98MW	3/4/98	Ngonya Stream	Sampled at 2.40pm
317/8/98MWTZ	25/8/98	Lake sample	3.087km off shore Ngonya 70m below lake surface

308/8/98MWTZ	23/8/98	Ngonya spring	
361/10/98GOTZ	26/10/98	Mitumba Rain Fall	
358/10/98GOTZ	26/10/98	Kakombe stream	Gauging station
343/8/98GOTZ	27/08/98	Kakombe stream	Gauging station
359/10/98GOTZ	26/10/98	Kakombe Stream,	2hrs after flash floods
313/8/98GOTZ	24/08/98	Spring (b) Mitumba	Alt. 1070m.a.s.l
366/10/98GOTZ	28/10/98	Mitumba Stream	Gauging station
306/8/98MWTZ	23/08/98	Rubona Spring	Alt. 1345m.a.s.l
302/8/98UVTZ	20/08/98	Malagarasi River at Uvinza	
230/4/98	21/4/98	Kakombe spring3	Alt 1130m.a.s.l
211/4/98MWT	17/4/98	Ngonya Stream	Gauging station
226/4/98GO	19/4/98	Mitumba spring	A spring(north) about 15m from Mitumba Alt. 880m.a.s.l
186/4/98MW	11/4/98	Mwangongo Rainfall	R_1 740m.a.s.l 54.3mm
196/04/98MW	16/04/98	Ngonya Stream	At 4.50m 2nd high flow point v=1.091 m/s
337/8/98MWTZ	26/08/98	Nguka spring.	
303/8/98GOTZ	23/8/98	Mitumba Stream	Gauging station
336/8/98MWTZ	26/8/98	Kashoko spring	
307/8/98MWTZ	23/8/98	Kivumba spring.	Alt. 1440m.a.s.l
339/8/98MWTZ	25/08/98	Confluence (Nguka & Confluence Mpemba)	
315/8/98MWTZ	25/8/98	3.087km offshore Ngonya stream	Sample taken at 10m below Lake Surface
317/8/98MWTZ	25/8/98	3.087Km off shore Ngonya stream	70m below lake surface
300/8/98KGM	20/8/98	Nyamsunga BH (UVINZA) Salt mine	Brine Bore hole 500 ft deep
392/11/98MW	27/11/98	NGONYA stream	Gauging station
412/12/98MW	27/12/98	Mwamgongo Rainfall	R_2 Alt 950m.a.s.l 21mm
406/12/98G0	20/12/98	Mitumba Rainfall	R_1
408/12/98MW	20/12/98	Mwamgongo Rainfall	R_3 Alt. 1110m.a.s.l 23.3mm
396/11/98MW	27/11/98	Mwamgongo Rainfall	R_4 Alt. 1350m.a.s.l 26.8mm
385/11/98MW	25/11/98	Mwamgongo Rainfall	R_3 1110m.a.s.l
419/1/99MW	3/1/99	Mwamgongo Rainfall	R_3 1110m.a.s.l 22.7mm
416/1/99MW	2/1/99	Mwamgongo Rainfall	R_4 Alt. 1350m.a.s.l 38.8mm
417/1/99MW	2/1/99	Mwamgongo Rain	R_3 1110m.a.s.l 25.3mm
402/12/98GO	6/12/98	Mitumba Rain (R_2)	R_2
401/12/98	6/12/98	Mitumba Rain (R_1)	R_1
430/1/99 KG	19/1/99	Luiche River	-
370/11/98 MW	23/11/98	Mwamgongo Rainfall	R_1 740m.a.s.l 49.0mm
384/11/98 MW	25/11/98	Mwamgongo Rainfall	R_1 740m.a.s.l 23.9mm
387/11/98 MW	25/11/98	Mwamgongo Rainfall	R_5 1580m.a.s.l 24.3mm
393/11/98 MW	27/11/98	Mwamgongo Rainfall	R_1 740m.a.s.l 20.2mm
429/1/99 GO	16/1/99	Mitumba Rainfall	R_3
382/11/98 MW	25/11/98	Ngonya Stream	-
371/11/98 MW	23/11/98	Mwamgongo Rainfall	R_2 980m.a.s.l 26.9mm
415/12/98MW	28/12/98	Mwamgongo Rainfall	R_4 1350m.a.s.l 26.1mm
372/11/98 MW	23/11/98	Mwamgongo Rainfall	$R_3$1110m.a.s.l 25.2mm
427/1/99 GO	12/1/99	MITUMBA Rainfall	R_1

397/11/98 MW	27/11/98	Mwamgongo Rain	R_5 1580m.a.s.l 22.5mm
376/11/98 MW	23/11/98	Mwamgongo Rain	R_4 1350m.a.s.l 30.2mm
413/12/98 MW	28/12/98	Mwamgongo Rain	R_5 1580m.a.s.l 21.1mm
407/12/98 MW	20/12/98	Mwamgongo Rain	R_4 1350m.a.s.l 19.9mm
377/11/98 MW	23/11/98	Mwamgongo Rainfall	R_5 1580m.a.s.l 25.9mm
395/11/98 MW	27/11/98	Mwamgongo Rainfall	$R_3$1110m.a.s.l 18.0mm
423/1/99 GO	5/1/99	Mitumba Stream	-
398/12/98 MW	6/12/98	Mwamgongo Rain	$R_1$740m.a.s.l 34.1mm
374/11/98 GO	23/11/98	Mitumba Rainfall	R_4
386/11/98 MW	25/11/98	Mwangongo Rainfall	R_4 1350m.a.s.l 25.1mm
379/11/98 GO	25/11/98	Mitumba Rainfall	R_1
375/11/98 GO	23/11/98	Mitumba Stream	-
400/12/98 GO	6/12/98	Mitumba Stream	-
399/12/98 MW	6/11/98	Ngonya Stream	-
380/11/98 GO	25/11/98	Mitumba Rainfall	R_2
368/11/98MW	16/11/98	Mwamgongo Rainfall	$R_1$740m.a.s.l 11.7mm
411/12/18MW	23/12/98	Ngonya Stream	-
422/12/98G0	23/12/98	Mitumba Rainfall	R_1
389/11/98G0	25/11/98	Mitumba Rainfall	R_3
404/12/98MW	12/12/98	Ngonya Stream	-
369/11/98MW	23/11/98	Ngonya Stream	-
405/12/98MW	20/12/98	Ngonya Stream	-
69/12/97MWTZ	16/12/97	Kivumba Tributary	Alt. 1060m.a.s.l
59/12/97GOTZ	14/12/97	Mitumba	Alt. 670m.a.s.l
68/12/97MWTZ	15/12/97	Nyandiga Confluence point.	780m.a.s.l
57/12/97GOTZ	14/12/97	Mitumba tributary (intermittent)	880m.a.s.l
23/11/97MWTZ	1/11/97	Nyandiga Confluence	780m.a.s.l
19/11/97MWTZ	1/11/97	Nyaruhunga (b) Spring	980m.a.s.l
25/11/97GOTZ	2/11/97	Kakombe(b) spring	1050m.a.s.l
07/10/97GOTZ	29/10/97	Mitumba Stream	Gauging station
22/11/97MWTZ	1/11/97	Kivumba Tributary spring	1145m.a.s.l
10/10/97GOTZ	30/10/97	Mitumba Stream	Gauging station
17/10/97GOTZ	31/10/97	Mitumba Stream (Gauging station)	Alt. 740m.a.s.l
18/11/97GOTZ	1/11/97	Nyaruhunga tributary	900m.a.s.l
09/10/97GOTZ	30/10/97	Kakombe Stream	Gauging station
21/11/97MWTZ	1/11/97	Mgunga Spring	1015m.a.s.l
13/10/97MWTZ	30/10/97	Ngonya Stream	Gauging station
15/10/97GOTZ	31/10/97	Mitumba Upper Spring	890m.a.s.l
16/10/97GOTZ	31/10/97	Mitumba confluence	770m.a.s.l
12/10/97MWTZ	30/10/97	Mbale Spring	830m.a.s.l
26/11/97GOTZ	2/11/97	Kakombe Spring. (d)	980m.a.s.l
24/11/97GOTZ	2/11/97	Kakombe Tributary	925m.a.s.l
08/10/97MWTZ	29/10/97	Ngonya Stream	Gauging station 740m.a.s.l
11/10/97MWTZ	30/10/97	Nyamunini Spring	880m.a.s.l
20/11/97MWTZ	1/11/97	Nyaruhunga stream	1040m.a.s.l
14/10/97GOTZ	31/10/97	Mitumba West	980m.a.s.l

		tributary	
86/12/97MWTZ	23/12/97	Ngonya Stream	Gauging station 740m.a.s.l
89/12/97MWTZ	28/12/98	Ngonya Stream	Gauging station 740m.a.s.l
84/12/97MWTZ	22/12/97	Ngonya Stream	Gauging station 740m.a.s.l
77/12/97MWTZ	18/12/97	740m.a.s.l	Gauging station 740m.a.s.l
91/12/97MW	29/12/97	Ngonya Stream	Gauging station 740m.a.s.l
98/04/28MWTZ	16/4/97	Ngonya Stream	(Taken at 1/6 of stream span from R/Edge 1.117m River span = 6.70m Sediment at 1.117m from R/Bank
85/12/97GOTZ	22/12/97	Mitumba Stream	Gauging station
80/12/97MWTZ	20/12/97	Ngonya Stream	Gauging station
87/12/97 GOTZ	23/12/97	Mitumba Stream	Gauging station
82/12/97MWTZ	21/12/97	Ngonya Stream	Gauging station
75/12/97MWTZ	17/12/97	Ngonya Stream	Gauging station
83/12/97GOTZ	21/12/97	Mitumba Stream	Gauging station
88/12/97MWTZ	27/12/97	Ngonya Stream	Gauging station
253/4/98	25/4/98	MWAMGONGO RAINFALL	R_1 740m.a.s.l 32.6mm
254/4/98/MW	25/4/98	NGONYA STREAM	Gauging station
283/4/98/GO	10/5/98	MITUMBA STREAM	Gauging station
263/98/MW	4/5/98	MWAMGONGO RAINFALL	R_1 740m.a.s.l 1.3mm
284/5/MW	14/5/98	MWAMGONGO RAINFALL	R_1 740m.a.s.l 4.4mm
268/5/MW	6/5/98	MWAMGONGO RAINFALL	R_1 740m.a.s.l 1.6mm
281/5/98GO	9/5/98	MITUMBA RAINFALL	R_1
269/5/98/MW	7/5/98	NGONYA STREAM	Gauging station
279/5/98/MW	10/5/98	MITUMBA RAINFALL	R_1
261/5/98/GO	3/5/98	MITUMBA RAINFALL	R_1
270/5/98/MW	7/5/98	NGONYA STREAM	Gauging station
298/7/98/KGTZ	21/7/98	KGM. MAJI YARD	Rainfall = 20.3mm
278/5/98/MW	9/5/98	MWAMGONGO RAINFALL	R_1 740m.a.s.l 37.7mm
265/5/98/GO	5/5/98	MITUMBA STREAM	Gauging station
259/5/98/MW	1/5/98	MWAMGONGO RAINFALL	R_1 740m.a.s.l 1.0mm
264/5/98/MW	5/5/98	MWAMGONGO RAINFALL	R_1 740m.a.s.l 3.5mm
271/5/98MW	7/5/98	MWAMGONGO RAINFALL	R_1 740m.a.s.l 21.6mm
277/5/98GO	8/5/98	MITUMBA STREAM	Gauging station
272/5/98MW	8/5/98	NGONYA STREAM	Gauging station
275/5/98GO	8/5/98	MITUMBA STREAM	Rainfall
256/4/98GO	25/5/98	MITUMBA STREAM	Gauging station
276/5/98GO	8/5/98	MITUMBA STREAM	Gauging station
282/5/98GO	10/5/98	MITUMBA STREAM	Gauging station

260/5/98MW	3/5/98	MWAMGONGO RAINFALL	R_1 740m.a.s.l 6.3mm
273/5/98MW	8/5/98	NGONYA STREAM	Gauging station
267/5/98GO	6/5/98	MITUMBA STREAM	Gauging station
274/5/98MW	8/5/98	MWAMGONGO RAINFALL	R_1 740m.a.s.l 12.5mm
266/5/98GO	6/5/98	MITUMBA STREAM	Gauging station
296/7/98KGM	21/5/98	MATYAZO KALINZI	66m deep bore hole
293/7/98GOTZ	18/5/98	MITUMBA STREAM	Reducing environ.
297/7/98UVZ/KGM	21/7/98	NYAZA SALT	Brine bore hole 500ft deep from Nyamsunga
291/7/98GOTZ	18/7/98	MITUMBA SPRING SOURCE	Alt 1060m.a.s.l
292/7/98GOTZ	18/7/98	MITUMBA SPRING (A)	Alt 1070m.a.s.l
290/7/98GOTZ	18/7/98	MITUMBA STREAM	Alt 740m.a.s.l Reducing environ.(Rocky Algae)
295/7/98MWTZ	19/7/98	NGONYA STREAM	Reducing environ.(Weeds Plants at Gauging station 770m.a.s.l)
294/7/98MWTZ	19/7/98	NYAMUNINI SPRING	Alt 880m.a.s.l Protected spring
186/4/98/MWTZ	10/4/98	NGONYA STREAM	Gauging station
178/4/98/MWTZ	8/4/98	NGONYA STREAM	Gauging station
36/12/97/MW	18/12/97	MWAMGONGO RAINFALL	$R_1$740m.a.s.l No rain gauge
5/1/98/MWTZ	1/1/98	MWAMGONGO RAINFALL	$R_1$740m.a.s.l No rain gauge
181/4/98/MWTZ	9/4/98	NGONYA STREAM	Gauging station
92/12/97/MWTZ	30/12/97	NGONYA STREAM	Gauging station
161/3/98/MWTZ	21/3/98	NGONYA STREAM	Gauging station
100/1/98/MWTZ	4/1/98	NGONYA STREAM	Gauging station
187/4/98/MWTZ	11/4/98	NGONYA STREAM	Gauging station
79/12/97/MWTZ	20/12/97	NGONYA STREAM	Gauging station
162/3/98/MWTZ	21/3/98	NGONYA STREAM	Gauging station
180/4/98/MWTZ	9/4/98	NGONYA STREAM	At peak flash flood
190/4/98/GO/TZ	12/4/98	MUTUMBA RAINFALL	
171/3/98/MWTZ	30/3/98	NGONYA STREAM	Gauging station
72/12/97/GOTZ	17/12/97	GOMBE (RAIN)	
179/4/98/MWTZ	8/4/98	MWAMGONGO (RAINFALL)	$R_1$740m.a.s.l 42.8mm
170/3/98/MWTZ	30/3/98	NGONYA STREAM	Gauging station
81/12/97/MWTZ	21/12/97	NGONYA STREAM	Gauging station
172/3/98/MWTZ	30/3/98	MWAMGONGO RAIN FALL	$R_1$740m.a.s.l 36.3mm
160/3/98/MWTZ	21/3/98	NGONYA STREAM	Gauging station
103/01/98/GOTZ	22/01/98	MUTUMBA CONFLUENCE	
112/01/98/MWTZ	23/01/98	NYARUHUNGA (B) SPRING	Alt 980m.a.s.l
117/01/98/MWTZ		NGONYA(GAUGIN	

		G STATION)	
115/01/98/MWTZ	23/01/98	MBALE SPRING	Alt. 830m.a.s.l.
114/01/98/MWTZ	23/01/98	NGONYA –MAIN CONFLUENCE	
105/01/98/MWTZ	22/01/98	NGONYA	Gauging station
104/01/98/GOTZ	22/01/98	AT THE LAKE SURFACE	Zero stream flow velocity after the lake stream confluence
111/01/98/MWTZ	23/01/98	NYARUHUNGA MAIN	Alt. 960m.a.s.l
108/01/98/GOTZ	23/01/98	LAKE MITUMBA STREAM CONFLUENCE	
118/01/98/MWTZ	23/01/98	LAKE SURFACE	150m offshore Ngonya stream
102/1/98/GOTZ	22/01/98	MITUMBA AT THE GAUGING STATION	
107/01/98/MWTZ	22/1/98	LAKE NGONYA STREAM MIXING POINT	AT 8.30m offshore Ngonya stream at zero stream velocity
90/12/97/MWTZ	28/12/97	NGONYA STREAM	Gauging station
119/01/98	23/01/98	NGONYA-	Gauging station
168/3/98/GOTZ	30/3/98	MITUMBA STREAM	Gauging station
176/4/98/MWTZ	7/4/96	NGONYA STREAM	Gauging station
110/01/98/MWTZ	23/01/98	MGUNGA CHINI SPRING.	Alt 1010m.a.s.l
106/01/98/MWTZ	22/01/98	NGONYA STREAM	Confluence point
113/01/98/MWTZ	23/01/98	NYARUHUNGA (A) SPRING.	Alt 960m.a.s.l
112/1/98/MWTZ	23/01/98	NYARUHUNGA (B)	Alt 980m.a.s.l
127/1/98/MWTZ	31/1/98	NGONYA STREAM	Gauging station
144/2/98/MW	13/2/98	NGONYA STREAM	Gauging station
137/2/98/MW	6/2/98	NGONYA STREAM	Gauging station
138/2/98/MW	7/2/98	NGONYA STREAM	Gauging station
136/2/98/MW	5/2/98	NGONYA STREAM	Gauging station
128/1/98/GOTZ	31/1/98	MITUMBA STREAM	Gauging station
126/1/98/GOTZ	30/1/98	MITUMBA RAINFALL	
139/2/98/MW	8/2/98	NGONYA STREAM	Gauging station
135/2/98/MW	4/1/98	NGOYA STREAM	Gauging station
129/2/98/GOTZ	1/2/98	MITUMBA STREAM	Gauging station
140/2/98/MW	12/2/98	NGONYA STREAM	Gauging station
125/1/98/MWTZ	30/1/98	NGONYA STREAM	Gauging station
134/2/98/MW	3/2/98	NGONYA STREAM	Gauging station
130/2/98/MW	1/2/98	MITUMBA STREAM	Gauging station
124/1/98/GOTZ	30/1/98	NGONYA STREAM	Gauging station
141/2/98/MW	13/2/98	MITUMBA STREAM	Gauging station
133/2/98/GO	3/2/98	NGONYA STREAM	Gauging station
131/2/98/MW	2/2/98	NGONYA STREAM	Gauging station
132/2/98GO	2/2/98	MITUMBA STREAM	Gauging station
123/1/98/MW	29/1/98	NGONYA STREAM	Gauging station
142/2/98/GO	14/2/1/98	NGONYA STREAM	Gauging station
122/2/98/GOTZ	24/1/98	MITUMBA STREAM	Gauging station
143/2/98/GO	15/2/98	MITUMBA RAINFALL	

346/9/98/GOTZ	29/9/98	MITUMBA RAIN FALL	
335/8/98/GOTZ	26/8/98	LAKE SURFACE	8.3m Offshore Mitumba at 30m.below lake surface
343/9/98/MWTZ	27/9/98	NGONYA STREAM	Gauging station
351/10/98/GOTZ	2/10/98	MITUMBA STREAM	Gauging station
334/8/98/GOTZ	26/8/98	LAKE SAMPLE.	Sample taken 278m offshore Mitumba at depth 30below lake surface
350/10/98/GOTZ	1/10/98	MITUMBA RAIN FALL	
365/10/98/MW	28/10/98	MWAMGONGO RAINFALL	$R_1$740m.a.s.l 40.5mm
341/09/98/GOTZ	26/9/98	MITUMBA RAINFALL	
352/10/98/MW	13/10/98	RAIN FALL MW	
363/10/98/MW	28/10/98	NGONYA STREAM	Gauging station
319/8/98/MWTZ	15/8/98	NGONYA STREAM	Gauging station
367/10/98/GOTZ	28/10/98	MITUMBA RAIN FALL	
364/10/98/MW	28/10/98	NGONYA STREAM	2hrs after flash floods
318/8/98/MWTZ	25/8/98	LAKE SAMPLE	3.087 km off shore Ngonya stream 90m below Lake surface
320/8/98/MWTZ	25/8/98	NGONYA STEAM	Gauging station
326/8/98/GOTZ	26/8/98	MITUMBA STREAM	Gauging station
334/8/98/GOTZ	26/8/98*	LAKE SAMPLE	Sample taken 278m off shore Mitumba
353/10/98/GOTZ	26/8/98	LAKE SAMPLE	Sample taken 278m
321/8/98/GOTZ	25/8/98	LAKE SAMPLE	Sample taken at 10m below Lake surface
325/8/98/MWTZ.	25/8/98	LAKE SAMPLE	300m.Ngonya off shore. Sample taken below Lake surface
324/8/98/MWTZ.	25/8/98	LAKE SAMPLE	300m. off shore Ngonya 90m below Lake Surface
349/9/98/MWTZ	30/9/98	NGONYA STREAM	Gauging station
342/9/98/GOTZ	27/9/98	MITUMBA STREAM	Gauging station
329/8/98/GOTZ	26/8/98	MITUMBA STREAM	Gauging station
332/8/98/GOTZ	26/8/98	LAKE SAMPLE	Sample taken 278m offshore Mitumba at the lake surface
336/10/98/MW	29/10/98	MWAMGONGO RAIN FALL	$R_1$740m.a.s.l 2.4mm
355/10/98/GOTZ	14/10/98	MITUMBA STREAM	
338/8/98/MWTZ	25/8/98	MBALE SPRING.	Alt 830m.a.s.l
344/9/98/GOTZ	27/9/98	MITUMBA RAIN FALL	
305/8/98/MWTZ	23/8/98	LAKE SAMPLE	1.142 km offshore Ngonya stream
328/8/98/GOTZ	26/8/98	LAKE SAMPLE	Sample taken offshore Mitumba at 50m.below lake surface
348/9/98/MW	29/9/98	MWAMGONGO	$R_1$740m.a.s.l 3.5mm

		RAINFALL	
331/8/98/GOTZ	26/8/98	LAKE SAMPLE	Sample taken offshore Mitumba at 100m below lake surface
333/8/98/GOTZ	26/8/98	LAKE SAMPLE	Sample taken 278m offshore Mitumba
330/8/98/GOTZ	26/8/98	LAKE SAMPLE	Sample taken 278m offshore Mitumba at 90m below lake surface
316/8/98/MWTZ	26/8/98	LAKE SAMPLE	Sample taken at 3.087Km offshore Ngonya at 50m below lake surface
345/9/98/GOTZ	28/9/98	MITUMBA STREAM	Gauging station
347/9/98/GOTZ	30/9/98	LAKE SAMPLE	Confluence (Ngonya Stream & Lake)
340/8/98/MWTZ	26/8/98	LAKE SAMPLE	Confluence (Ngonya Stream & Lake)
354/10/98/GO	13/10/98	MITUMBA RAINFALL	
322/8/98/MWTZ	25/8/98	LAKE SAMPLE	offshore Ngonya taken at 50m below lake surface
327/8/98/GOTZ	26/8/98	LAKE SAMPLE	Offshore Mitumba taken at 10m below lake surface
342/9/98/GOTZ	27/9/98	MITUMBA STREAM	Gauging station
356/10/98/MW	15/10/98	MWAMGONGO RAINFALL	$R_1$740m.a.s.l 7.8mm
314/8/98/MWTZ	25/8/98	LAKE SAMPLE	3.087km off shore Ngonya at Lake surface
134/2/98/MWTZ	3/2/98	NGONYA STREAM	Gauging station
223/4/98/GOTZ	19/9/98	SPRING NORTH OF MITUMBA	Alt 1070m.a.s.l
152/3/98/MWTZ	13/3/98	MWAMGONGO RAINFALL	$R_1$740m.a.s.l 45.6mm
135/2/98/MWTZ	4/2/98	NGONYA STREAM	Gauging station
148/2/98/MWTZ	25/2/98	NGONYA STREAM	Gauging station
132/2/98/GOTZ	2/2/98	GOMBE STREAM	Gauging station
158/3/98/KGM	21/3/98	NYAKAGENI SPRING(KIGOMA TOWN)	740m.a.s.l
159/3/98/KGM	23/3/98	RUTARE SPRING	300m East of the Lake
234/4/98/GOTZ	21/4/98	MITUMBA STREAM	Gauging station
195/4/98/MWTZ	16/4/98	NGONYA STREAM	A composite sample taken at gauging station
246/4/98/KGM	28/4/98	NYAKAGENI SPRING	Alt 740m.a.s.l
221/9/98/GOTZ	18/4/98	MITUMBA STREAM	Gauging station
149/2/98	25/2/98	MWAMGONGO RAINFALL	$R_1$740m.a.s.l 43.1mm
248/4/98/KGM	28/4/98	KABEMBA SPRING	At Msimba Alt 740m.a.s.l
250/4/98/KGM	28/4/98	MALAGARASI RIVER	Sample taken in the middle of the river Alt 760m.a.s.l
165/3/98/MWTZ	27/3/98	NGONYA STREAM	Sample taken at gauging station during peak flash

			floods
193/4/98/MWTZ	16/4/98	NGONYA STREAM	At 0.90m of Max flow velocity of 1.253m/sec
216/4/98/MWTZ	17/4/98	NGONYA STREAM	Taken at a point of Min Revolutions 6.60m from Right bank at velocity 0.097m/sec
207/4/98/GOTZ	17/4/98	MITUMBA STREAM	Taken at 10cm from right bank of stream at velocity 0.0m/s
183/4/98/MWTZ	9/4/98	NGONYA STREAM	Gauging station
251/4/98/KGM	28/4/98	NORTHERN MALAGARASI	Branch Alt 770m.a.s.l
214/4/98/MWTZ	17/4/98	NGONYA STREAM	Taken at 40cm from left edge after Rain fall velocity 1.799m/s
184/4/98/GO	9/4/98	MITUMBA STREAM	At peak flash floods sampled at gauging station
249/4/98/KGM	28/4/98	SHALLOW WELL (SW)	15m depth Msimba Alt.750m.a.s.l
182/4/98/MW	9/4/98	NGONYA STREAM	Gauging station
206/4/98GO	17/4/98	MITUMBA STREAM	Taken at 25cm form left edge v=0.153 m/s
227/4/98/GO	19/4/98	MITUMBA SPRING	50m north of Mitumba main stream at 865m.a.s.l
205/4/98/GO	17/4/98	MITUMBA STREAM	Gauging station
219/4/98/MWTZ	18/4/98	NYARUHUNGA-TRIBUTARY	Alt 980m.a.s.l
225/4/98/GOTZ	19/4/98	MITUMBA SPRING	20m north of Mitumba main stream station at 880m.a.s.l
131/2/98/MWTZ	2/2/98	NGONYA STREAM	Gauging station
220/4/98/GOTZ	18/4/98	NYAMUNINI SPRING	At the intake Alt 880m.a.s l protected spring
228/4/98/GOTZ	21/4/98	KAKOMBE SPRING1.	Alt 1290m.a.s.l
153/3/98/GOTZ	20/3/98	MITUMBA STREAM	Gauging station
173/3/98MWTZ	31/3/98	NGOYA STREAM	Gauging station
130/2/98/MWTZ	1/2/98	NGOYA STREAM	Gauging station
177/4/98/GOTZ	8/4/98	MITUMBA STREAM	Gauging station
150/3/98MWTZ	1/3/98	NGONYA STREAM	Gauging station
252/4/98KG	30/4/98	LAKE SAMPLE	(Close to NORAD compound.) Alt 730m.a.s.l
133/2/98	3/2/98	MITUMBA STREAM	Gauging station
210/4/98GOTZ	17/4/98	LAKE SAMPLE	Mixing point of Mitumba & the lake
157/3/98/MWTZ	20/3/98	NYAMUNINI SPRING	Alt 880m.a.s.l protected spring
312/8/98//GOTZ	24/8/98	MITUMBA SPRING	
362/10/98/GOTZ	27/10/98	MITUMBA STREAM	Gauging station
309/8/98MWTZ	23/8/98	LAKE SAMPLE	Ngonya stream lake confluence
357/10/98/MW	15/10/98	NGONYA STREAM	Gauging station
344/9/98GOTZ	27/9/98	MITUMBA RAINFALL	R_1
341/8/98/GOTZ	27/8/98	KAKOMBE SPRING	

360/10/98 GOTZ	26/10/98	KASEKELA RAINFALL	
310/8/98MWTZ	23/8/98	NYAMUNINI SPRING.	Alt 880m.a.s.l protected spring
311/8/98 GOTZ	24/8/98	MITUMBA SPRING	
345/8/98GOTZ	27/8/98	LAKE SAMPLE	KAKOMBE(Confluence with lake)
299/7/98UVI-KGTZ	29/7/98	NYAMSUNGA BH-UVINZA	Brine bore hole 500ft deep
301/8/98UVITZ	20/8/98	NYAMSUNGA BH-UVINZA	Brine bore hole 500ft deep
421/1/99MW	12/1/99	MWANGONGO RAINFALL(R_{1})	$R_1$740m.a.s.l 59.6mm
381/11/98MW	25/11/98	NGONYA STEAM	Gauging station
390/11/98GO	27/11/98	MITUMBA RAINFALL	R_1
424/1/98GO	9/1/99	MITUMBA RAINFALL(R_3)	
383/11/98MW	25/11/98	MWANGONGO RAINFALL	R_2 950m.a.s.l 52.2mm
378/11/98GO	25/11/98	MITUMBA STREAM	Gauging station
394/11/98MW	27/11/98	MWANGONGO RAINFALL	R_2 950m.a.s.l 18.7mm
415/12/98	28/12/98	MWANGONGO RAINFALL	$R_4$1350m.a.s.l 26.1mm
418/1/98MW	2/1/99	MWANGONGO RAINFALL	R_5 1580m.a.s.l 27.4mm
403/12/98GO	6/12/98	MITUMBA RAINFALL	R_3 Cumulative rainfall Alt. 1260m.a.s.l
428/1/98GO	16/1/99	MITUMBA RAINFALL	R_3 Cumulative rainfall Alt. 1260m.a.s.l
4261/1/98MW	17/1/99	NGONYA STEAM	Gauging station
388/11/98GO	25/11/98	MITUMBA RAINFALL	R_4Cumulative rainfall Alt. 1530m.a.s.l
409/12/98	20//12/98	MWANGONGO RAINFALL	R_5 1580m.a.s.l 23.1mm
410/12/98MW	20/12/98	MWANGONGO RAINFALL	$R_2$950m.a.s.l 26.1mm
425/1/99GO	9/1/99	MITUMBA RAINFALL	R_2 Cumulative rainfall Alt. 930m.a.s.l
373/11/98GO	23/11/98	MITUMBA RAINFALL	R_1 Cumulative rainfall Alt. 790m.a.s.l
391/11/98GO	27/11/98	MITUMBA RAINFALL	R_4Cumulative rainfall Alt. 1530m.a.s.l

Appendix 5b Stable Isotope Data

Sample numbers as labelled during sampling (Field Sample I. D)	Source of the samples	Average reference standard Sample gsdi for $d^{18}O$	GSDI= -8.5 Water sample d^{18} O content with reference to the reference standard (gsdi)	Calculated water sample d^{18} O content with reference to SMOW (Standard Mean Oceanic Water)	Average reference standard Sample gsdi for d^2H	Water sample deuterium (d^2H) content with reference to the gsdi	Calculated water sample d^2 H content with reference to SMOW (Standard Mean Oceanic Water)
.			measured	SMOW	avg gsdi	Deuterium measured	Deuterium calculated
	#	#	#	#	#		
			d18-O	d18-O smow			
			-12.325	-8.52	-12.3005		
			-12.342	-8.54			
			-12.296	-8.50			
			-12.239	-8.44			
30/3/98/MW	Rainfall		-7.409	-3.61		-6.48	-15.41
1/MAY/98/MW	,,		-3.82	-0.02		13.59	5.82
26/OCT/98/GO	,,		-3.413	0.39		24.32	14.98
6/MAY/98/MW	,,		-5.992	-2.19		-1.66	-10.69
1/OCT/98/MW	,,		-2.665	1.14		27.57	18.19
8/MAY/98/GO	,,		-7.486	-3.69		-8.89	-17.83
5/MAY/98/MW	,,		-7.417	-3.62		-7.74	-16.70
13/OCT/98/MW	,,		-1.284	2.52		29.52	20.12
14/MAY/98/MW	,,		-3.249	0.55		26.76	17.39
26.SEPT/98/GO	,,		-3.938	-0.14		16.68	7.43
12/APR/98/GO	,,		-9.433	-5.63		-22.16	-30.94
28/OCT/98/MW	,,		-5.812	-2.01		2.8	-6.28
13/MARCH/98/MW	,,		-5.178	-1.38		12.77	3.57
3/MAY/98/MW	,,		-7.599	-3.80		-13.9	-22.78
26/OCT/98/KASKELA	,,		-5.028	-1.23		13.39	4.18
25/APR/98/MW	,,		-8.74	-4.94		-19.7	-28.51
3/MAY/98/GO	,,		-8.112	-4.31		-15.06	-23.93
9/MAY/98/MW	,,		-8.094	-4.29		-8.02	-16.97
8/APR/98/MW	,,		-10.147	-6.35		-26.99	-35.72
21/JULY/98/KGM	,,		-5.869	-2.07		11.71	2.52

#	#	#	#	#	#		
3CC	8 HRS			d18-O smow			
			-12.197	-8.47	-12.2235		
			-12.256	-8.53			
			-12.191	-8.47			
			-12.25	-8.53			
29-SEPT-98-MW	Rainfall		-3.593	0.13		20.84	11.54
29-SEPT-98-GO	,,		-3.808	-0.08		19.12	9.84
5-MAY-98-GO	,,		-7.755	-4.03		-10.89	-19.81
13-OCT-98-GO	,,		-1.06	2.66		28.27	18.88
#	#	#	#	#	#		
3CC	8 HRS			d18-O smow			
			-12.548	-8.45	-12.59475		
			-12.572	-8.48			
			-12.675	-8.58			
			-12.584	-8.49			
24-Jan-98	Rainfall		-10.807	-6.71		-32.2	-40.12
30-Jan-98	,,		-14.312	-10.22		-57.68	-65.66
15-Feb-98	,,		-10.313	-6.22		-28.62	-36.52
25-Apr-98	,,		-9.329	-5.23		-18.58	-26.45
6-May	,,		-9.533	-5.44		-24.16	-32.04
9-May-98	,,		-8.376	-4.28		-7.21	-15.04
27-Sep-98	,,		-4.209	-0.11		-20.1	-27.97
28-Oct-98	,,		-5.936	-1.84		4.48	-3.32
18-Dec-97	,,		-15.863	-11.77		-67.04	-75.05
25-Feb-98	,,		-6.078	-1.98		10.2	2.42
11-Apr-98	,,		-9.256	-5.16		-20.27	-28.14
4-May-98	,,		-7.88	-3.79		-11.51	-19.35
7-May-98	,,		-8.546	-4.45		-3.37	-11.19
8-May-98	,,		-7.479	-3.38		-5.04	-12.86
15-Oct-98	,,		-4.34	-0.25		19.15	11.41
29-Oct-98	,,		-7.209	-3.11		-0.79	-8.6
3-Dec-97	,,		-14.899	-10.80		-64.97	-72.99
8-Dec-97	,,		-18.15	-14.06		-95.23	-103.35
299-07-98-UVZ-KGM			-5.054	-0.96		0.42	-7.38
245/4/98-KGM			-7.281	-3.19		-3.16	-10.98

#	#	#	#	#	#		
5CC	8 HRS			d18-O smow			
			-13.265	-8.40	-13.36375		
			-13.375	-8.51			
			-13.434	-8.57			
			-13.381	-8.52			
60/12/97			-8.148	-3.28		0.51	-8.32
420/1/99MW			-7.137	-2.27		2.59	-5.21
229/4/98/GO			-10.135	-5.27		-15.58	-23.44
292/7/98			-8.468	-3.60		-3.72	-11.54
242/4/98/KGM			-8.904	-4.04		-10.04	-17.85
297/7/98/UVZ/KGM			-4.959	-0.10		3.95	-3.84
300/8/98/UVZ/KGM			-6.399	-1.54		-0.87	-8.68
244/4/98/MW			-8.138	-3.27		-4.14	-11.96
220/4/98/MW			-8.53	-3.67		-5.4	-13.22
306/8/98/GO			-8.194	-3.33		-0.99	-8.8
226/4/98/GO			-9.046	-4.18		-9.97	-17.81
11/10/97/MW			-8.475	-3.61		-3.45	-11.27
26/11/97GO			-8.375	-3.51		-3.67	-11.49
157/3/98MW			-8.17	-3.31		-4.42	-12.24
158/3/98KGM			-8.007	-3.14		-5.31	-13.13
248/4/98/KGM			-8.492	-3.63		-9.29	-17.13
301/8/98/UVZ/KGM			-6.082	-1.22		-2.76	-10.57
296/7/98KGM			-8.718	-3.85		-6.69	-14.52
247/4/98KGM			-8.014	-3.15		-4.31	-12.13
291/7/98/GO			-8.45	-3.59		-4.87	-12.69
#	#	#	#	#	#		
5CC	8 HRS			d18-O smow			
			-12.199	-8.45	-12.249	-51.31	
			-12.329	-8.58		-51.17	
			-12.242	-8.49		-50.14	
			-12.226	-8.48		-50.501	
293/7/98 GO			-7.07	-3.32		-2.34	-10.16
380/11/98/GO			-5.279	-1.53		9.37	1.59
311/8/98/GO			-7.316	-3.57		-2.94	-10.76
313/8/98GO			-6.696	-2.95		-1.68	-20.29
112/01/98MW			-7.1	-3.35		-3.78	-11.6

110/01/98MW			-8.715	-4.97		-18.06	-25.92
307/8/98MW			-7.256	-3.51		-2.97	-10.79
310/8/98MW			-7.239	-3.49		-4.55	-12.37
294/7/MW			-7.076	-3.33		-3.07	-10.89
370/11/98MW			-5.68	-1.93		5.09	-2.7
374/11/98MW			-5.801	-2.05			
383/11/98MW			-6.193	-2.44		6.01	-1.78
413/12/98MW						14.02	6.25
415/12/98MW			-5.269	-1.52		15.8	8.04
424/1/99MW			-4.37	-0.62		19.8	12.05
418/1/99MW			-6.929	-3.18		-1.88	-9.7
397/11/98MW			-6.354	-2.61		7.85	0.06
409/12/98MW			-5.684	-1.94		11.08	3.3
374/11/98GO						1.12	-6.69
371/11/98MW			-5.856	-2.11		3.44	-4.36
#	#	#	#	#	#		
5CC	8 HRS			d18-O smow			
			-12.152	-8.49	-12.1585		
			-12.183	-8.52			
			-12.158	-8.50			
			-12.141	-8.48			
412/12/98MW			-3.747	-0.09		22.47	14.73
388/11/98MW			-5.974	-2.32		7.22	-0.57
417/1/99MW			-6.825	-3.17		-1.45	-9.26
421/1/99MW			-6.76	-3.10		-0.23	-8.04
376/11/98MW			-6.212	-2.55		1.09	-6.72
419/1/99MW			-6.808	-3.15		-2.94	-10.76
410/12/98MW		-8.388	-4.544	-0.89		16.43	8.67
427/1/99GO			-6.596	-2.94		0.16	-7.65
425/1/99GO			-4.09	-0.43		20.42	12.67
429/1/99GO			-6.228	-2.57		4.73	-3.07
422/12/98GO			-3.553	0.11		25.05	17.72
377/11/98GO			-6.503	-2.84		-0.97	-8.78
414/12/98GO			-5.17	-1.51		14.43	6.66
408/12/98MW			-5.121	-1.46		13.59	5.82
428/1/99GO			-6.42	-2.76		1.81	-5.99
113/1/98MW			-7.094	-3.44		-4.33	-12.15
407/12/98MW			-5.083	-1.42		12.64	4.87
393/11/98MW			-5.279	-1.62		11.64	3.86
416/1/99MW			-6.904	-3.25		-1.87	-9.69
387/11/98MW			-6.06	-2.40		6.01	-1.7

#	#	#	#	#	#		
5CC	8 HRS			d18-O smow			
			-12.119	-8.52	-12.10025		
			-12.06	-8.46			
			-12.135	-8.53			
			-12.087	-8.49			
142/2/98MW			-7.309	-3.71			
234/4/98GO			-7.734	-4.13			
363/10/98MW			-6.607	-3.01			
88/12/98MW			-7.468	-3.87			
312/8/98GO			-7.282	-3.68			
119/01/98			-8.152	-4.55			
141/2/98MW			-7.417	-3.82			
2/2/98MW			-8.025	-4.42			
303/8/98GO			-7.215	-3.61			
184/4/98GO			-8.031	-4.43			
77/12/97MW			-7.468	-3.87			
19/4/98GO			-8.515	-4.91			
105/01/98			-7.986	-4.39			
129/2/98GO		-12.957	-8.785	-5.18	-5.04		
364/10/98MW			-6.953	-3.35			
366/10/98G0			-6.997	-3.40			
128/1/98GO			-6.001	-2.40			
140/2/98GO			-7.243	-3.64			
#	#	#	#	#	#		
5CC	8 HRS			d18-O smow			
			-12.226	-8.54	-12.182		
			-12.222	-8.54			
			-12.137	-8.46			
			-12.143	-8.46			
102/1/98GO			-8.549	-4.87			
132/2/98GO			-8.428	-4.75			
302/8/98MW			-4.612	-0.93			
250/4/98KGM			-7.887	-4.21			
357/10/98MW			-6.997	-3.32			
290/7/98MW			-7.247	-3.57			

115/1/98MW			-8.178	-4.50			
330/8/98GO			-0.308	3.37			
266/5/98GO			-8.241	-4.56			
180/4/98MW			-8.646	-4.96			
171/3/98MW			-7.367	-3.69			
168/3/98GO			-7.667	-3.99			
186/4/98MW			-8.426	-4.74			
320/8/98MW			-0.609	3.07			
349/9/98GO			-7.075	-3.39			
282/5/98GO			-7.854	-4.17			
347/9/98GO		-9.161	-7.117	-3.44	-3.36		
277/5/98GO			-7.496	-3.81			
85/12/98GO			-7.878	-4.20			
206/4/98GO			-8.066	-4.38			
#	#	#	#	#	#		
5CC	8 HRS			d18-O smow			
			-12.226	-8.68	-12.044		
			-12.222	-8.68			
			-12.137	-8.59			
			-12.044	-8.50			
241/4/98KG			-7.263	-3.72			
426/1/99MW			-7.141	-3.60			
295/7/98MW			-6.921	-3.38			
153/03/98GO			-7.448	-3.90			
351/10/98GO			-6.969	-3.43			
162/3/98MW			-7.128	-3.58			
161/3/98MW		-12.392					
269/05/98MW		-11.869					
279/5/98MW		-6.534					
178/4/98MW	gauging station	-12.78					
343/9/98MW	gauging station	-6.802					
273/5/98MW	gauging station	-24.463					
100/1/98MW	gauging station	-14.486					
55/12/97GO	gauging station		-7.795	-4.25			
115/1/98MW	Mbale spring		-8.237	-4.69			
19/11/97MW	nyaruhunga spring		-6.866	-3.32			
72/12/97MW	ngonya spring		-7.082	-3.54			

#	#	#	#	#	#		
5CC	8 HRS			d18-O smow			
			-12.374	-8.51	-12.361		
			-12.348	-8.49			
241/4/98KG			-7.474	-3.61			
426/1/99MW			-7.296	-3.44			
295/7/98MW			-7.102	-3.24			
153/03/98GO			-7.621	-3.76			
351/10/98GO			-7.215	-3.35			
162/3/98MW			-7.369	-3.51			
161/3/98MW		-12.392	-7.282	-3.42			
269/05/98MW		-11.869	-7.376	-3.52			
279/5/98MW		-6.534	-7.672	-3.81			
178/4/98MW	gauging station	-12.78	-7.776	-3.92			
343/9/98MW	gauging station	-6.802	-7.128	-3.27			
273/5/98MW	gauging station	-24.463	-7.47	-3.61			
100/1/98MW	gauging station	-14.486	-8.505	-4.64			
55/12/97GO	gauging station		-7.956	-4.10			
115/1/98MW	mbale spring		-8.403	-4.54			
19/11/97MW	nyaruhunga spring		-7.085	-3.22			-10.36
72/12/97MW	ngonya spring		-7.253	-3.39			-11.84
			-8.903	-5.04			
			-7.219	-3.36			

Appendix 6: RESULTS FOR STREAM SUSPENDED SEDIMENT LOAD

Lab. No.	Sample No.	Volume(ml)	Sediment in (gm)	Sediment conc. in (mg/L)	Q (m^3/s)
1.	99/1/(at Luiche Bridge,19/1/99	515	0.0093	18.06	
2.	99/1/75Mw	300	0.5645	1881.67	0.48
3.	98/12/61Mw	330	0.3679	1114.85	
4.	98/5/43Mw	330	0.0573	173.64	
5.	98/5/45Mw	310	0.0611	197.10	
6.	98/12/65Mw	310	0.2622	845.81	
7.	98/4/27Mw	270	2.1186	7846.67	1.417
8.	98/4/38Mw	250	0.3349	1139.60	
9.	98/4/25Mw	270	2.3266	8617.04	
10.	98/4/26Mw	400	3.4679	8669.75	1.417
11.	98/1/18Mw	550	0.8929	1623.45	1.417
12.	98/4/37Mw	40	0.3301	8252.50	
13.	98/12/64Mw	360	0.3422	950.56	
14.	98/12/66Mw	330	0.2818	853.94	
15.	98/1/21Mw	520	2.4564	4723.85	
16.	98/12/62Mw	530	0.3461	653.02	
17.	97/12/10Mw	590	0.0460	77.97	
18.	97/12/06Mw	590	0.0989	167.63	
19.	97/12/12Mw	530	0.0445	83.96	
20.	97/12/11Mw	710	0.0667	93.94	
21.	97/12/08Mw	710	0.0148	20.85	
22.	98/1/24Mw	1370	2.4418	1782.33	
23.	97/12/02Mw	275	0.7988	2904.73	
24.	97/12/01Mw	800	2.6301	3287.63	
25.	98/1/22Mw	1495	9.7215	6502.68	
26.	98/12/63Mw	310	0.3780	1219.35	
27.	98/1/23Mw	1560	11.0164	7061.80	
28.	98/4/39Mw	345	1.2598	3651.59	
29.	98/1/19Mw	1206	5.4712	4536.65	
30.	98/04/33Mw	330	0.0597	180.91	
31.	98/12/67Mw	280	1.6971	6061.07	
32.	98/1/16Mw	540	1.3048	2416.30	
33.	98/1/17Mw	650	1.0454	1608.31	
34.	98/12/68Mw	360	1.8989	5274.72	
35.	98/12/69Mw	345	1.9546	5665.51	
36.	99/1/74Mw	355	1.1437	3221.69	
37.	98/5/44Mw	360	0.0760	211.11	0.480
38.	99/1/73Mw	345	1.9379	5617.10	
39.	98/1/20Mw	530	9.2985	17544.34	0.480
40.	98/4/32MTtz	300	0.0486	162.00	
41.	97/12/03Ngy	280	0.1747	623.94	
42.	97/12/04Mw	560	0.0658	117.50	
43.	97/12/07Mw	560	0.0562	100.38	
44.	98/1/15Mw	600	0.2413	402.17	
45.	98/1/13Mw	230	0.1058	460.00	
46.	97/12/05Mw	580	0.0654	112.76	
47.	97/12/04Mw	840	0.0680	80.95	
48.	98/10/60Mw	300	0.0685	228.33	
49.	99/1…(17/1/99, 1/2of1.55)	300	0.0040	13.33	
50.	98/5/47Mw	305	0.0075	24.59	
51.	98/4/40Mw	350	0.0252	72.00	0.375
52.	98/5/46Mw	315	0.0120	38.10	

53.	98/7/43Mw	280	0.0056	20.00	
54.	98/7/44Mw	255	0.0029	11.37	
55.	98/12/42Mw	300	0.0199	66.33	0.375
56.	98/10/56Mw	245	0.0021	8.57	0.101
57.	98/4/34GoTz	230	0.0038	16.52	
58.	99/1…(17/1/99, 5/6of 1.55m from Right Bank	300	0.0085	28.33	
59.	98/10/57Mw	270	0.0029	10.74	0.101
60.	98/04/29Mw	300	0.0682	227.33	
61.	98/4/41GOTz	350	0.0167	47.71	0.375
62.	98/9/53Go	330	0.0056	17.00	0.059
63.	98/9/49Mw	260	0.0024	9.23	
64.	98/5/48Mw	260	0.0053	20.38	
65.	98/04/30Mw	280	0.0139	49.64	
66.	98/9/50Mw	250	0.0024	9.60	
67.	98/4/36Mw	280	0.0016	21.79	
68.	98/10/58Mw	280	0.0810	289.29	
69.	98/12/59Mw	222	0.0153	68.92	
70.	98/04/31Mw	266	0.6483	2437.22	
71.	98/12/58Mw	250	0.0119	47.60	
72.	98/7/46Mw	276	0.0036	13.04	
73.	98/7/45Mw	309	0.0040	12.94	
74.	98/04/28Mw	238	0.1380	579.83	
75.	98/12/60Mw	239	0.0129	54.00	
76.	98/9/51Mw	235	0.0028	11.92	
77.	98/10/55Mw	352	0.0056	15.91	0.101
78.	98/10/59Mw	220	0.0674	306.36	
79.	98/9/52Mw	298	0.0025	8.39	0.059
80.	99/1…(17/1/99, 1/6 of 1.55mm from left bank	270	0.0062	22.96	
81.	98/9/54Mw	320	0.0032	10.00	0.059
82.	98/7/47Mw	10	0.0017	170.00	
83.	98/7/48Mw	250	0.0010	4.00	

Appendix 7: Sediment Chemical Data from ICP analysis

Locality	Sample No.	Results in oxides percent (%)				
		Al_2O_3	CaO	Fe_20_3	K_2O	MgO
Mwamgongo	99/1269	13.740	0.379	6.057	2.134	1.464
Ngonya Jan/Dec	99/1270	4.988	0.207	2.343	1.090	0.694
Ngonya Apr	99/1271	10.370	0.475	5.075	2.086	1.392
Locality	**Sample No**	**MnO**	**Na_2O**	**P_2O_5**	**SiO_2**	**TiO_2**
Mwamgongo	99/1269	0.112	0.057	0.229	59.760	0.941
Ngonya Jan/Dec	99/1270	0.039	0.046	0.072	83.390	0.423
Ngonya April	99/1271	0.091	0.061	0.191	67.330	0.891

Locality	Sample No.	Elements determined (mg/ kg)				
		Ba	Be	Ce	Cr	Cu
Mwamgongo	99/1269	348.4	2.4	112.0	93.8	18.7
Ngonya Jan/ Dec	99/1270	144.6	1.1	45.6	49.7	9.2
Ngonya April	99/1271	308.0	2.3	112.3	92.2	20.4
Locality	**Sample No.**	**La**	**Nb**	**Ni**	**Sc**	**Sr**
Mwamgongo	99/1269	63.6	70.8	50.9	10.2	56.7
Ngonya Jan/Dec	99/1270	27.6	39.6	36.4	4.1	32.9
Ngonya April	99/1271	65.5	69.4	46.3	9.6	65.2
Locality	**Sample No.**	**V**	**Y**	**Zn**	**Zr**	
Mwamgongo	99/1269	70.5	31.4	44.9	282.8	
Ngonya Jan/Dec	99/1270	14.8	15.0	21.0	202.4	
Ngonya April	99/1271	77.8	31.5	48.0	281.1	