THE WORLD BANK

LAKE VICTORIA ENVIRONMENTAL MANAGEMENT PROJECT (LVEMP)



Study on

WATER QUALITY & HUMAN HEALTH around Lake Victoria

REGIONAL SUMMARY REPORT

March 2004

PREFACE

The report in hand contains the main regional findings from the study on *Water Quality & Human Health* around Lake Victoria. One report for each of the three countries (Kenya, Tanzania and Uganda) is also prepared under separate covers. The study was initiated by the Task Manager for the Lake Victoria Environmental Management Project (LVEMP) in the World Bank and was supported by the Norwegian Consultancy Trust Fund in the Bank. The ToR for the study was formulated by the Bank and concluded with the Regional LVEMP Secretariat in Dar es Salaam. The beneficiaries of the study will, besides the Bank, primarily be the National LVEMP Secretariats in the three riparian countries as a help in the planning of activities for Phase 2 of LVEMP. The study objective was therefore to assist in making the LVEMP2 more focused towards the main goal of improved standard of living for the inhabitants in the Lake Victoria Basin, through improved human health conditions.

The study took place during the period September 2003-January 2004, with the Consultant undertaking two comprehensive field visits to the study areas in all the three countries, in addition to home office desk studies and reporting. The Consultant wants to thank the Regional LVEMP Secretariat in Dar and the National Secretariats in the three countries for their provision of useful information and data on water quality and sanitary conditions around the lake, in addition to arranging logistical support on transport and meeting arrangements. The Consultant would also commend the various institutions of the Ministry of Health in the three countries (central offices, and local health centres and dispensaries) for taking the time to provide statistics on waterborne and water-related diseases and to discuss with the Consultant and the counterparts in the three countries.

16 March 2004
Tore Laugerud
Environmental Technical Advisor
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1. BACKGROUND, METHODOLOGY AND FOCUS

Much has been achieved during LVEMP1 in terms of the countries' understanding of the Lake Victoria ecosystem, but still there is a limited knowledge of the water quality in various parts (particularly bays) of the Lake and its relationship with human health in the area. The direct or indirect measures for improving the livelihood of the inhabitants living in the Lake Region are key goals of LVEMP2 and beyond. It was therefore important to get an overview of what is known about the relationship *water quality - human health*, and "*to review the relationship between water quality and human health in the Lake region and the effects that various mitigation measures may have*".

The Consultant decided to make the Study as *practical* as possible, because the findings should hopefully lead to useful input for the planning of LVEMP2 activities to be more focused as regards the study aspects. The Study was thus *not* meant to be a scientific research or theoretical exercise, but rather trying to establish the water quality/human health relationship based on available data on which aspects seem to have the largest impact. The Study had a dual approach: a *quantitative* one (statistics and data for the last five years) and a *qualitative* one (interviews with stakeholders, field observations, etc.), focussing on the following waterborne/-related diseases: diarrhoea, dysentery, typhoid, cholera, schistosomiasis (*bilharzia*), intestinal worms and skin infections. The water quality data from the lake largely came from LVEMP1 analysis, with relatively good data basis in Tanzania. In Kenya, however, such data were scanted and in Uganda virtually non-existent from the study areas.

It is widely known that several factors interact and will jointly influence on the human health conditions. The Consultant therefore also reviewed the sanitary/waste disposal conditions in the study locations, in addition to the level of sensitisation/health education in the communities. In addition to visiting central health institutions, NGOs, donors, etc., some lakeshore communities in all the three countries were visited in order to inspect and discuss with the inhabitants the relative importance of water quality related to health, and to reveal which measures had the most significant impact on the health situation.

2. MAIN STUDY FINDINGS

The main findings from the three countries to a large extent coincide well. However, the prevalence of diseases, the sectors activities and the socio-cultural settings vary from area to area. The most salient findings can be summarised as follows:

- Detailed *national* statistics on diseases were readily available in Uganda, but not in Kenya and Tanzania.
- Disease statistics for the last five years were provided from most of the visited health centre/dispensaries.
- The health data provided at lower levels (health centres/dispensary) have gaps, are not properly quality controlled, and must therefore be cautiously used.
- The verbal information given did not coincide very well with the written statistics.
- There are no clear correlations between dispensary/health centre and district/regional statistics in the study areas.

- There are seemingly clear reductions in waterborne/water-related diseases resulting from improved sanitary conditions combined with health education (and partly improved water supply) in some visited shoreline communities.
- Bilharzia is not prevalent on the western shore of Lake Victoria (Tanzania and Uganda). The highest prevalence exists on the northern shore (Uganda) and southern shore (Tanzania).
- The worst health and sanitary conditions prevail on the lake islands.
- Very few and scanted data on water quality along the shoreline are available (especially bacteriological), and **not sufficient to establish a firm correlation between water quality and human health**. (In Mara, Tanzania, useful longer-term shorelines water quality studies are undertaken).
- LVEMP1 has not collected water quality data related to human health. Open waters analyses show no dangerous level of any chemical parameters.
- A lot of experienced NGOs have smaller water- and sanitation-related projects ongoing in some communities around the whole lake.
- Health education/sensitisation must be repeated with regular intervals in most places in order to keep up a satisfactory awareness level on hygiene practices.
- The HESAWA programme in **Tanzania** shows fairly good health effects resulting from long-term integrated water-sanitation- sensitisation interactions.
- The CARE Study on "the Safe Water System" in **Kenya** shows that the relative impact on human health of household sensitisation efforts is higher than other measures.
- The situation in Mpunge Village in **Uganda** clearly demonstrates the importance of hygiene campaigns as opposed to introduction of clean water alone ("all" households boil the polluted water, with few cases of water-borne diseases).
- There are still socio-cultural taboos in some of the communities around the lake (notably in Tanzania, southern part, the "in-law" taboo being the prevalent).
- Amongst the health and water/sanitation stakeholders interviewed, more than ¾ (in all three countries) claim that **health education/sensitisation** of people has a relatively larger effect alone on the human health than sanitation/latrines and improved water supply alone. The combination between sensitisation and improved sanitation seems to have a significant effect on the health.

3. RECOMMENDATIONS

The main objective of LVEMP is amongst others to: *" .....maximise the sustainable benefits to riparian communities from using resources within the basin to generate food, employment and income, supply safe water, and sustain a disease-free environmental ....."*.

So far, LVEMP has to a large extent concentrated on establishing a baseline, especially related to the water quality and ecosystem characteristics of the lake. LVEMP2, in all the three countries, should be much more focused towards actions that will tangibly benefit the *population* living around the lake (and in the basin). No doubt, the reduction of waterborne and water-related diseases will largely contribute to improved standard of living for the riparian communities. This could be achieved by introducing a **Human Health Component** under LVEMP. This component should have increased sensitisation/health education, combined with improvement of sanitary structures, as the main focus. Improved quality of domestic water supply in a limited number of selected locations *could be* included in such component.

However, it is strongly advised *against* embarking on any comprehensive "water supply programme" supported by the World Bank, as this will require large resources. Experience from previous donor-supported water supply and sanitation programmes in East Africa show that the *water supply infrastructure construction activities* easily will be the focus (giving "status" and some incentives to the staff involved, and tangible results to be shown by the donors), and *not* the sensitisation/awareness raising. In the case of LVEMP2 however, such "soft components", supported by minor low-cost locally initiated infrastructure development, should be the starting and focal point.

The new proposed project component could, amongst others, have the following characteristics:

- It must be run by the district, county and village health authorities (Ministry of Health), and *not* appear as a Bank-financed programme *besides* the official governmental structure. It must be an integral part of the normal government planning.
- It must be an integral part of other activities under the EAC Secretariat, covering all three countries.
- The efforts must be closely planned, coordinated and blended with other ongoing programmes (official, donor-supported and especially NGO activities), and LVEMP must draw on the human resources from these established programmes.
- The ambitions of the component must *not* be too high, but with a gradual increase in activity level to a point where local resources can sustain the activities once the external support withdraws in the future.
- The activities must primarily be concentrated in the worst-off/poorest areas, with a clear reference to statistics for the various lake districts and landing sites, and other ongoing programmes in these areas. Amongst others, the lake islands should be a target area.
- It must be focused towards changing peoples' hygiene habits and behaviour patterns (including getting rid of possible remaining socio-cultural taboos), supported by low-cost infrastructure development (merely latrines, and exceptionally small water supplies) to enable the people to practice the behavioural changes.
- It must have a long-term approach (10-15 years), as changing peoples' minds is not done overnight.

Appendix 1:
Tables and figures

Table 1.1: List of central authorities and key stakeholder institutions visited in Tanzania:

Stakeholder	Location
National Bureau of Statistics	Dar es Salaam
Ministry of Health (AFYA)	Dar es Salaam
Swedish International Development Agency	Dar es Salaam
Norwegian Agency for Development Assistance	Dar es Salaam
Regional Medical Office, AFYA	Mwanza Town, M. Region
Mwanza Medical Research Centre	Mwanza Town. M. Region
City Health Office and City Medical Office	Mwanza Town, M. Region
Urban Water & Sewerage Authority	Mwanza Town, M. Region
Ministry of Water (MAJI) laboratory	Mwanza Town, M. Region
HESAWA (Health, Sanitation and Water)	Mwanza Town, M. Region
PLAN International	Mwanza Town, M. Region
Bukoba Town Council	Bukoba Town, Kagera Region
Regional Medical Office (AFYA)	Bukoba Town, Kagera Region
Urban Water & Sewerage Authority	Bukoba Town, Region
District Development Project (DDP)	Musoma Town, Mara Region
Musoma Water & Sewerage Agency	Musoma Town, Mara Region
Regional Medical Office (AFYA)	Musoma Town, Mara Region
Town Health Office	Musoma Town, Mara Region

Table 1.2: List of locations visited in Tanzania

Region	District	Institution Name/ Type	Comments
Mwanza	Sengerema	Sengerema	District HQ, MoH Office
	Sengerema	Nyakalilo Health Centre	50,000 people in catchment area
Kagera	Bukoba Urban	Kakororo Dispensary	Serving 4,475 people officially, around 11,000 unofficially
	Bukoba Rural	Kaagya Dispensary	In Mchosi Village, serving 8,650 people
	Bukoba Rural	Igobilo Fishing Village	Around 1000 people
	Muleba	Kaigara Health Centre	Around 3.5 km from Muleba Town, serving > 10,000 people
	Biharamulo	Kibehe Dispensary	Serving around 11,400 people
	Biharamulo	Kasunguti Dispensary	In Nyamiwembe Village, serving 5,750 people
Mara	Musoma Rural	Mugango Dispensary	Serving 7,780 people
	Tarime	Kinesi Health Centre	Serving around 13,500 people

MoH: Ministry of Health

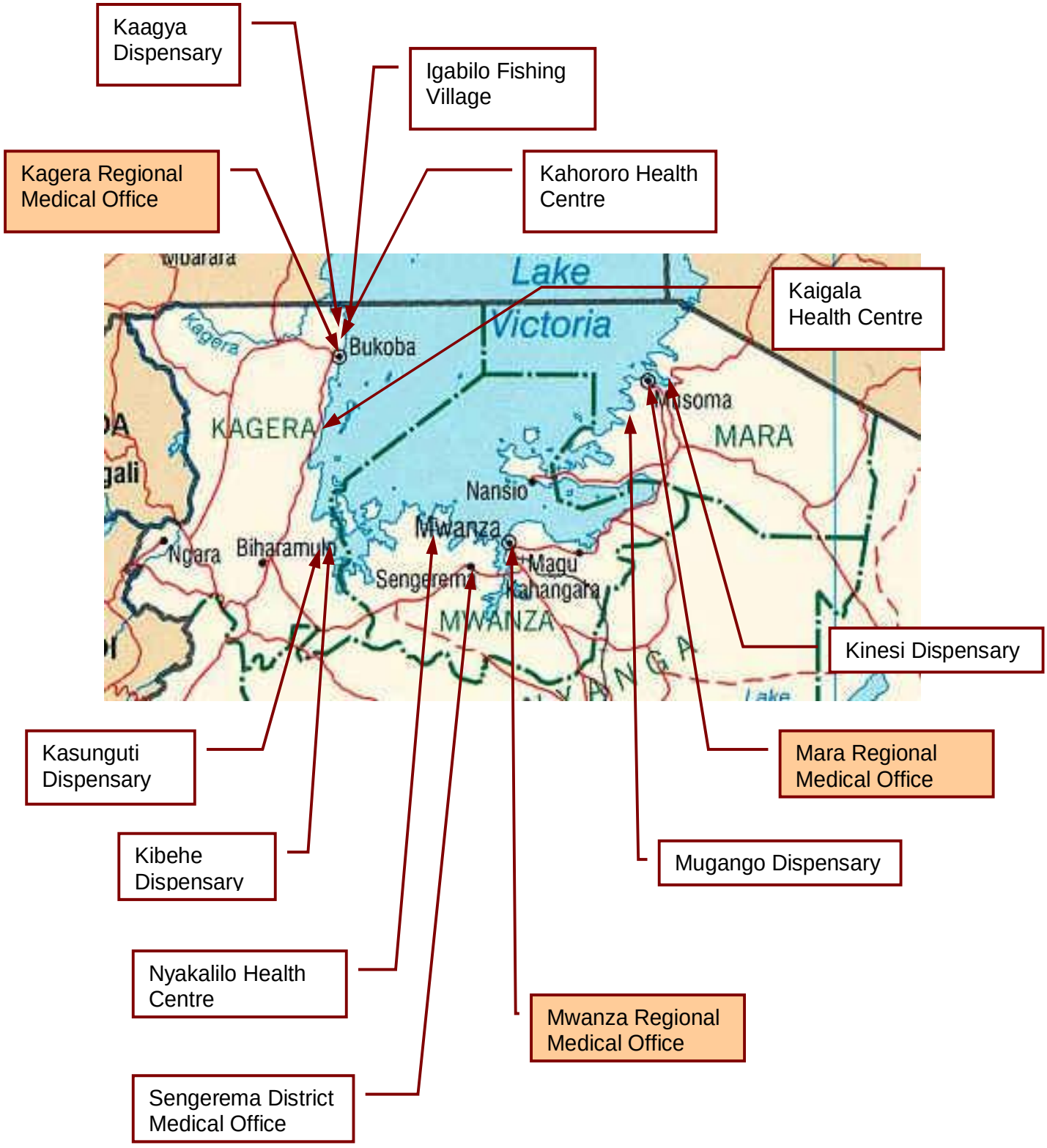


Figure 1.1: Locations visited in Tanzania

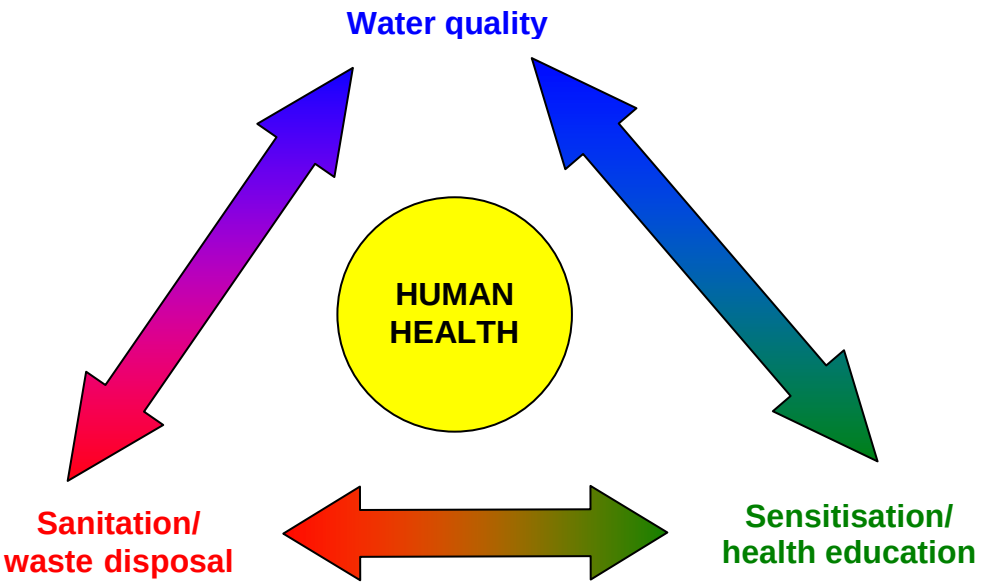


Figure 2.1: Inter-related factors effecting human health (simplified model)

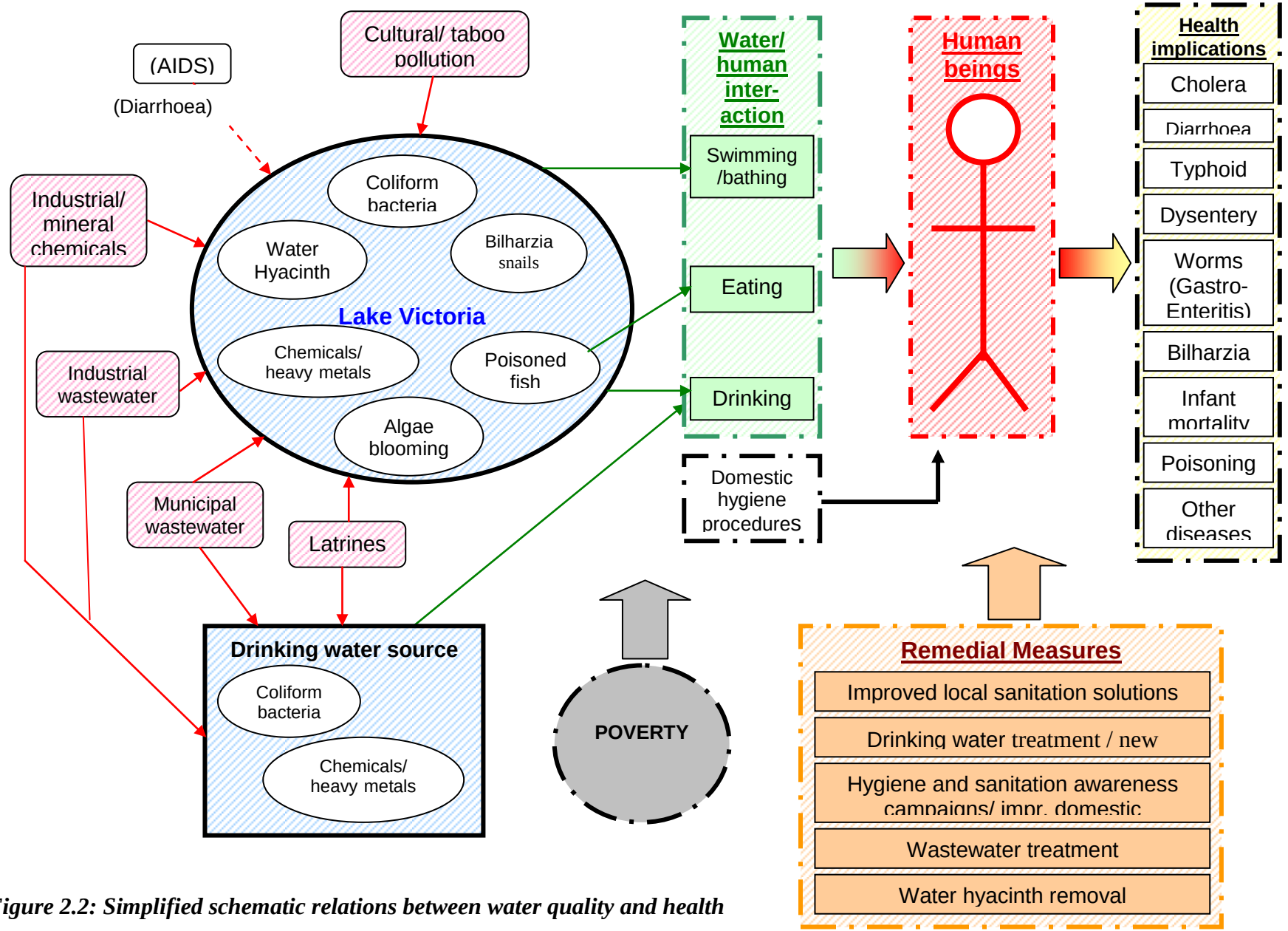


Figure 2.2: Simplified schematic relations between water quality and health

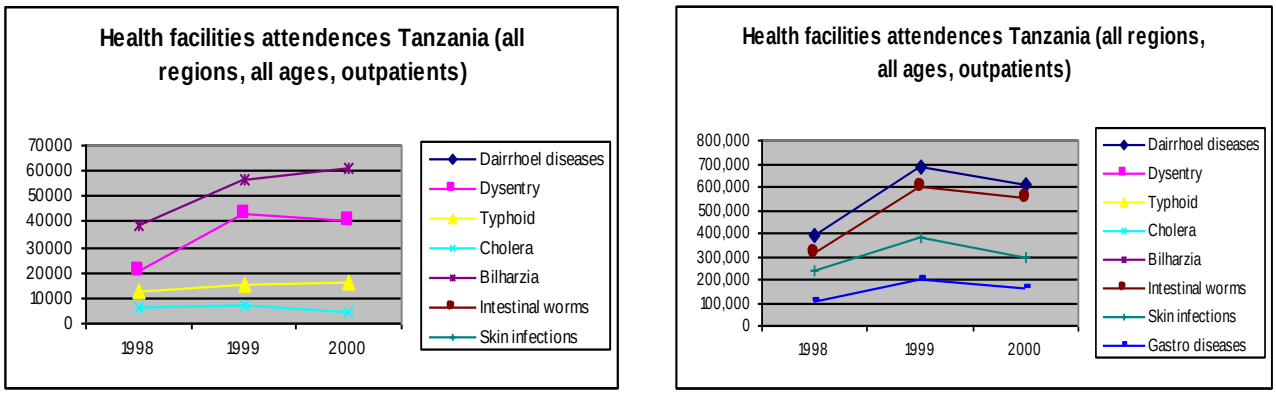


Figure 2.3: Diseases trend, Tanzania (all region and ages)

Table 2.1: Relative rate of diseases, Tanzania (number of cases and cases per 1000 inhabitants)

	Total No. of cases (Year 2000)	**No. of cases per 1000 inhabitants[1]**
Diarrhoeal diseases	611,877	17.7
Dysentery	40,079	1.2
Typhoid	16,072	0.46
Cholera	4,893	0.14
Bilharzia	61,000	1.8
Intestinal worms	554,087	16.0
Skin Infections	298,160	8.63
Gastro diseases	165,812	4.8

1) Population figures from 2002 census used

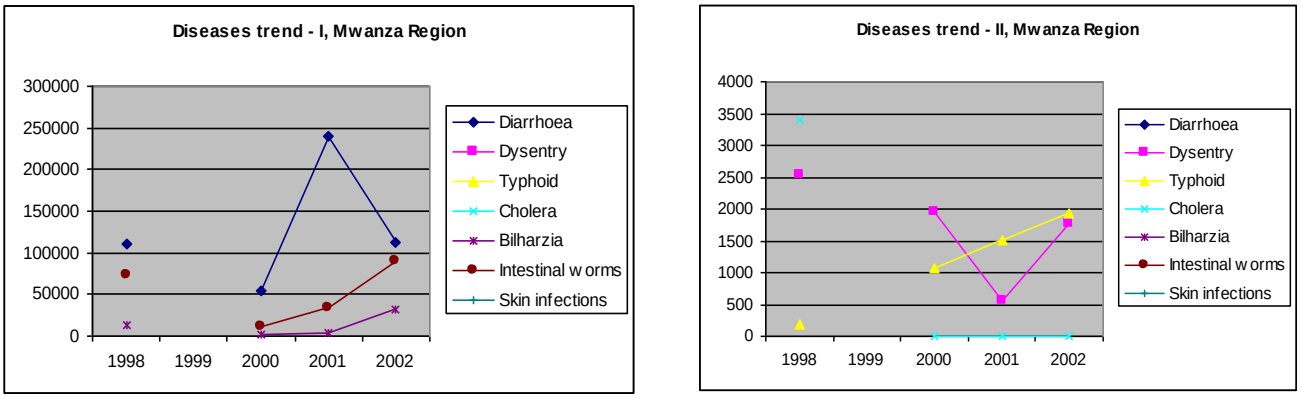
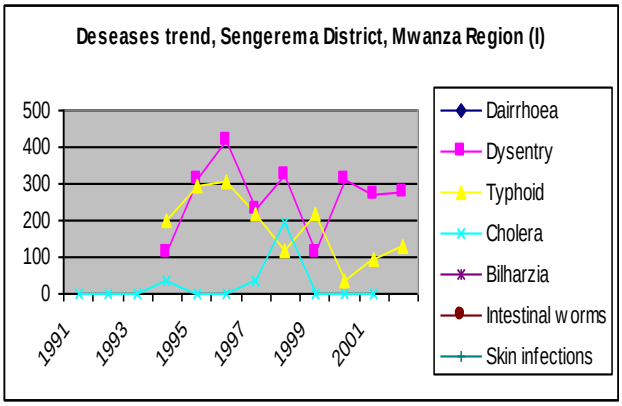


Figure 2.4: Diseases trend, Mwanza Region *(Source: Regional Health Office)*



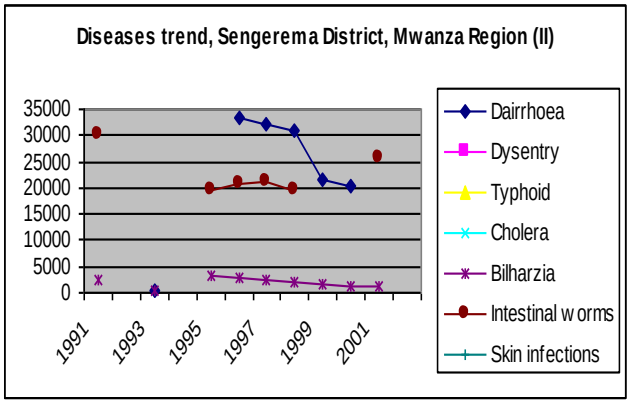


Figure 2.5: Diseases trend, Sengerema District, Mwanza Region *(Source: DMO records)*

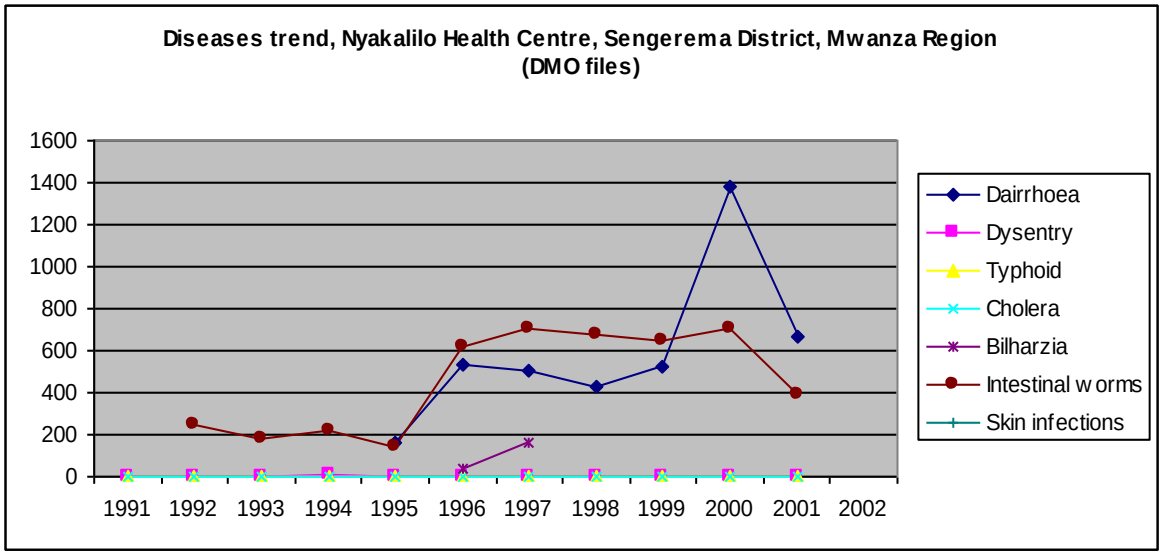


Figure 2.6: Diseases trend, Nyakaliro Health Centre (Sengerema District, Mwanza Region). *(Source: DMO records)*

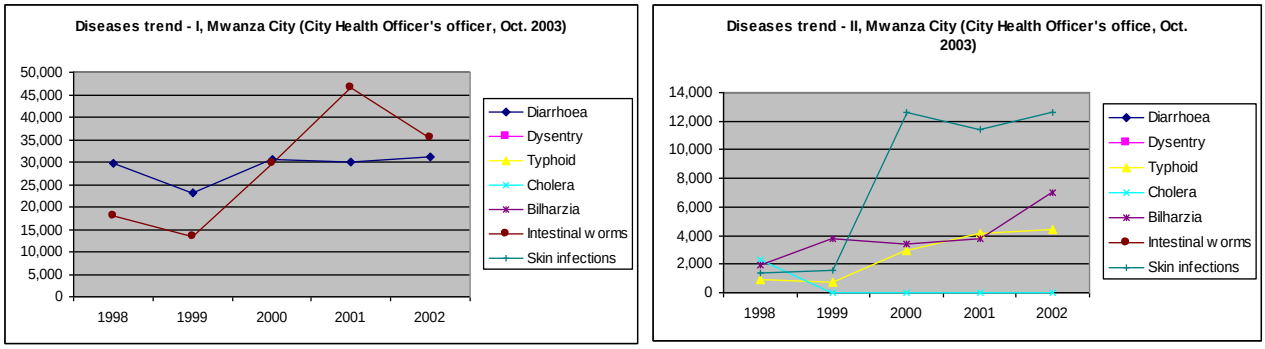
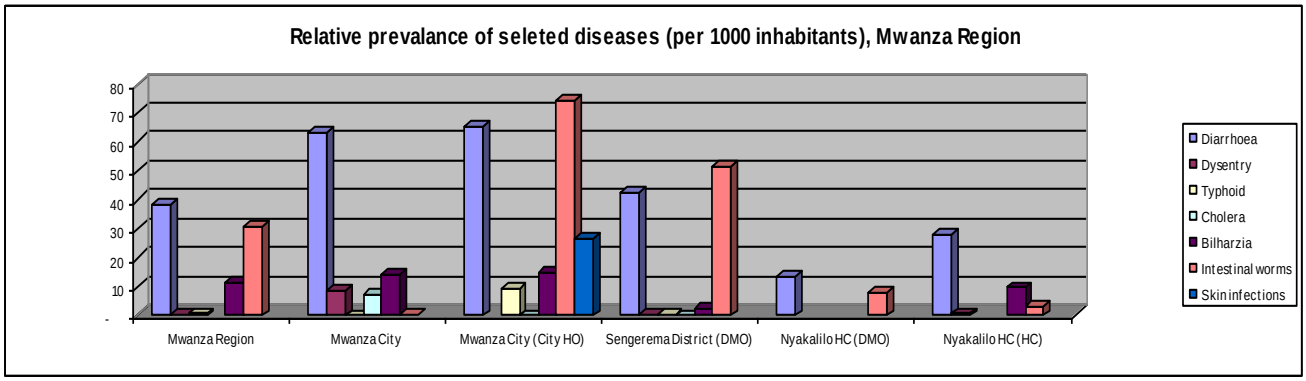


Figure 2.7: Diseases trend Mwanza City *(Source: CHO records)*



Sengerema figure for diarrhoea and bilharzia and Nyakaliro diarrhoea and intestinal worms from 2001.

Figure 2.8: Relative prevalence of diseases, Mwanza Region

Table 2.2: Lake water quality analysis from the visited and nearby locations, Mwanza Region

		Quality parameter										
Date of sampling	Sampling station	Total Alk. (mg/l)	Total Hard. (mg/l)	Calcium (mg/l)	Magnesium (mg/l)	Chloride (mg/l)	Temp. (C)	pH	EC (uS/cm)	TDS (Mg/l)	Turbidity (NTU)	FC (CFU/100 ml)
29/09/99	Nyakalilo	52.00	28.00	4.00	4.30	9.90	27.0	9.5	150.0	112.5	4.0	3000
20/07/02	Nyakalilo	60.00	31.00	4.68	2.70	6.38	26.4	9.8	111.0	50.0	6.0	1000
21/04/00	Nyamazugo	42.00	35.00	10.00	1.20	5.70	25.0	9.3	110.0	55.0	4.2	4500
20/07/02	Nyamazugo	58.00	32.00	5.85	1.70	5.67	27.2	8.7	115.0	52.0	14.0	2600
21/04/00	Nyakasungwa	68.00	51.00	8.00	1.90	16.30	26.0	9.1	160.0	80.0	10.0	4000
28/09/99	Katunguru	54.00	52.00	30.00	3.60	5.10	26.8	9.2	110.0	42.8	9.0	4500
21/07/02	Katunguru	48.00	38.00	3.27	5.80	4.96	27.8	9.0	112.0	50.4	24.0	8200
20/04/00	Bungonya	80.00	28.00	10.00	0.70	21.00	26.0	7.6	140.0	70.0	4.2	10000
22/07/02	Bungonya	54.00	23.00	2.57	2.90	4.25	27.2	9.7	105.0	47.3	6.0	1500

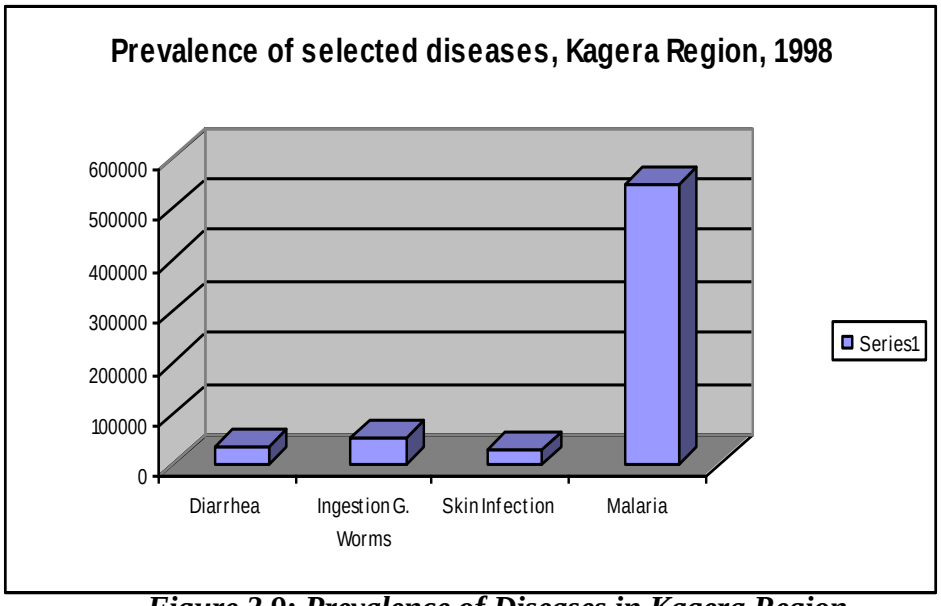


Figure 2.9: Prevalence of Diseases in Kagera Region

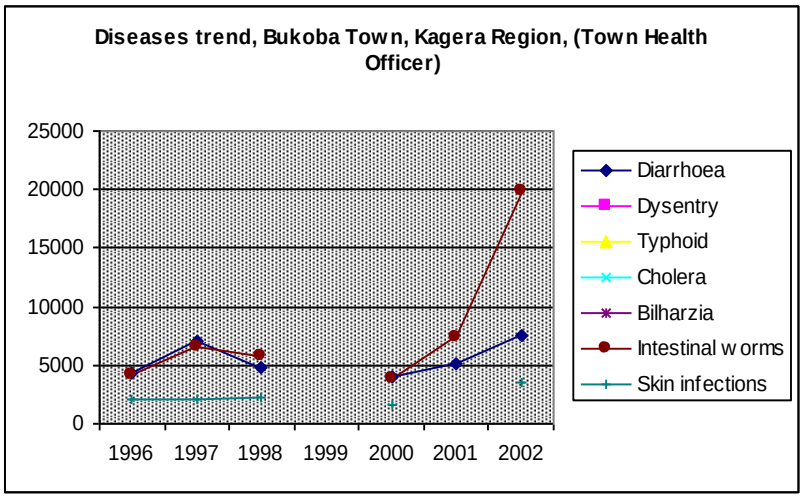


Figure 2.10: Diseases trend Bukoba Town *(Source: Town Health Officer)*

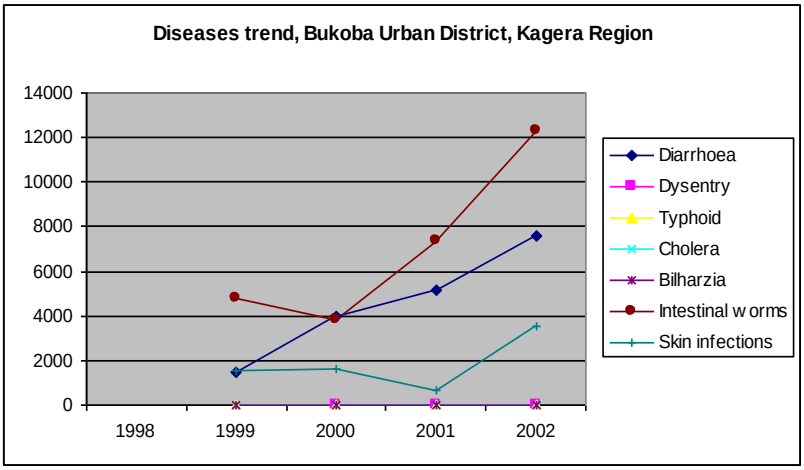


Figure 2.11: Diseases trend, Bukoba Urban District

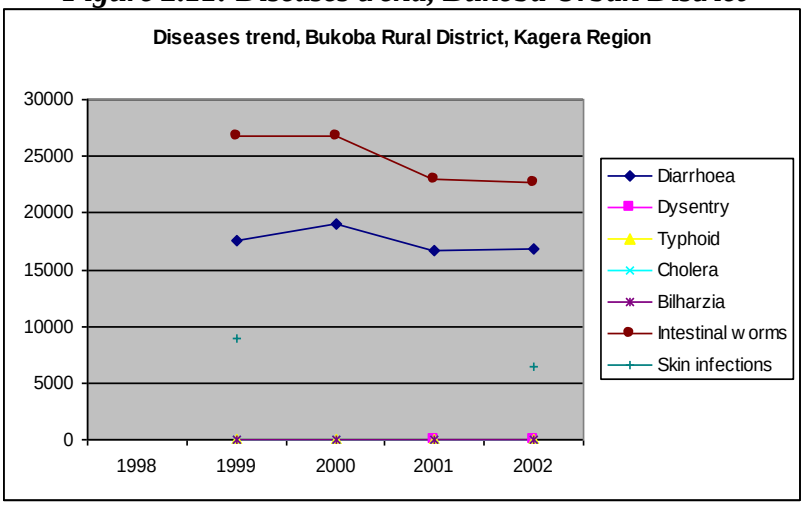


Figure 2.12: Diseases trend, Bukoba Rural District

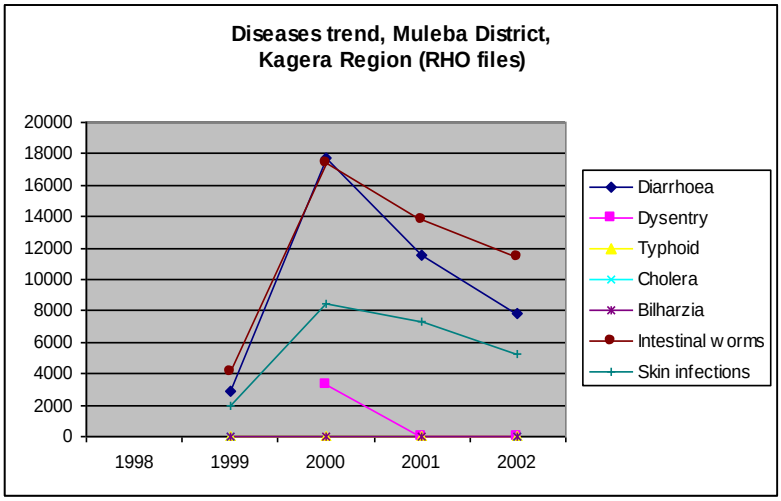


Figure 2.13: Diseases trend, Muleba District

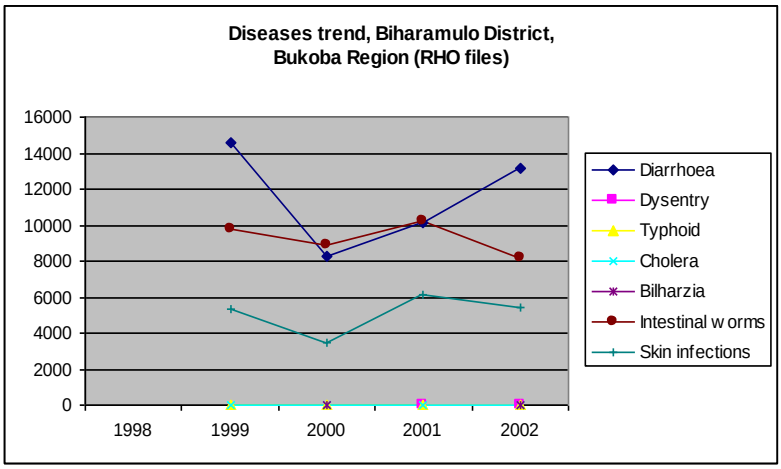
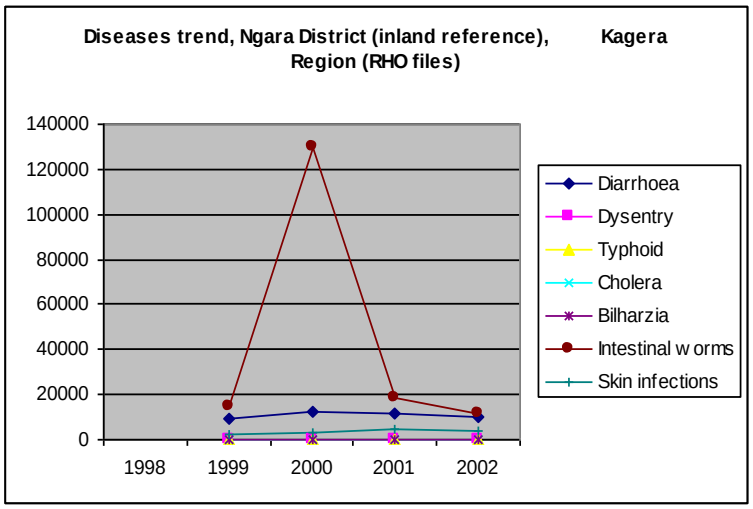
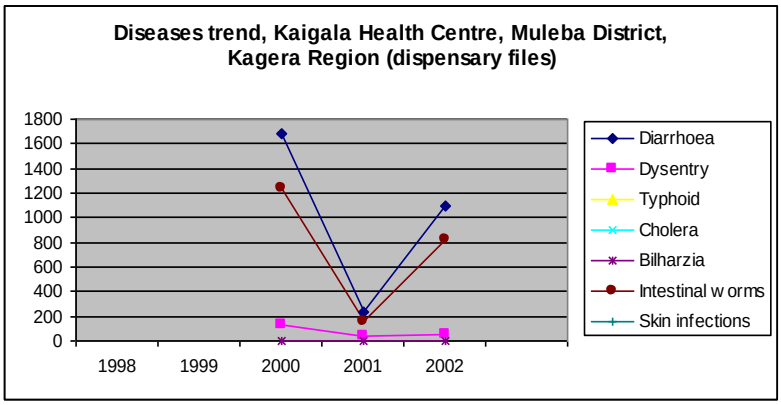


Figure 2.14: Diseases trend, Biharamulo District



Note: The 2000 figure for intestinal worms is assumed to be wrong/misprint.

Figure 2.15: Diseases trend, Ngara District *(inland reference)*



Note: The 2001 figures for intestinal worms and diarrhoea are assumed to be wrong/misprint.

Figure 2.16: Diseases trend, Kaigala Health Centre, Muleba District

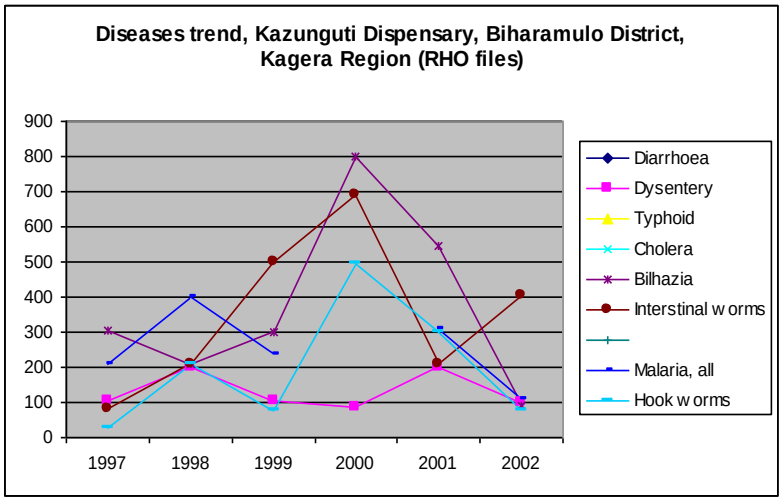


Figure 2.17: Diseases trend, Kazunguti Dispensary, Biharamulo District

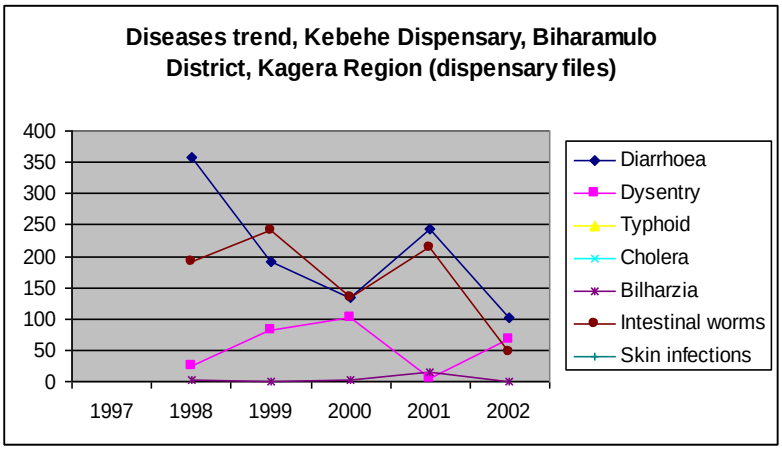


Figure 2.18: Diseases trend, Kibehe Dispensary, Biharamulo District

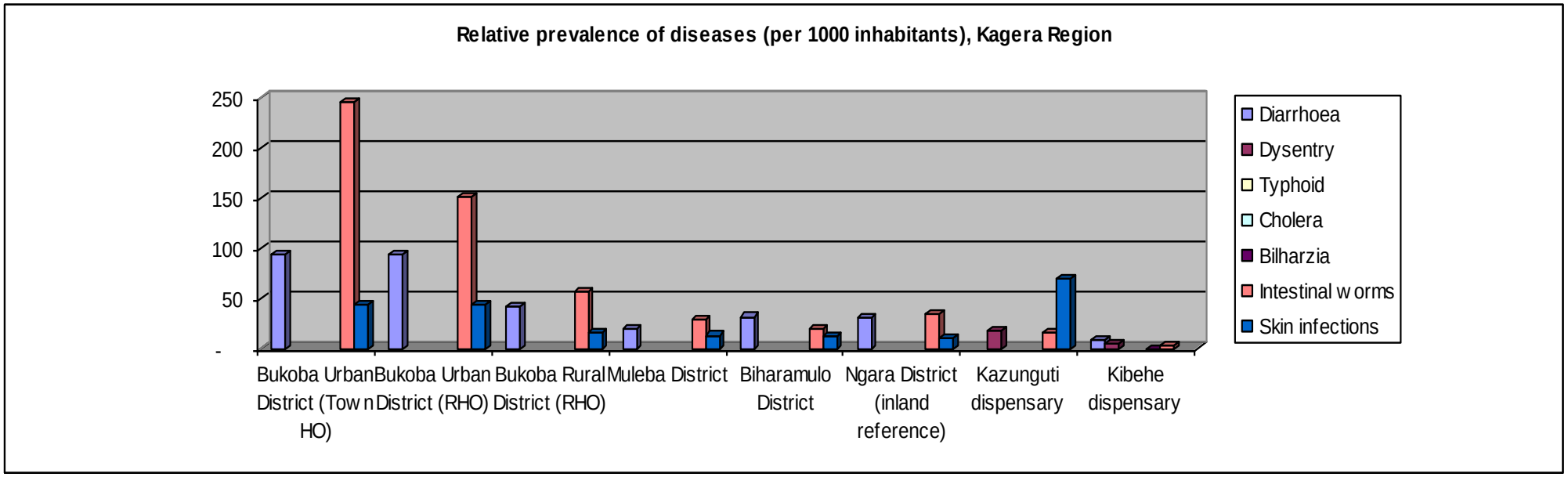
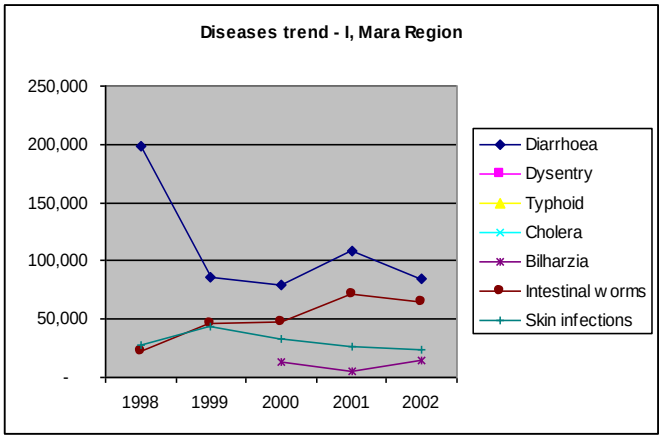


Figure 2.19: Relative prevalence of diseases, Kagera region

Table 2.3: Water quality parametres from sampling spots close to the visited locations, Kagera Region

StNo	Date	Actual E	Actual N	Temp	EC	pH	NO2 (µg/l)	NO3 (µg/l)	ALK	Chloride	Chl-a (mg/l)	Ca++	Mg+	Hardness (mgCaCO3/l)	Color	Turbidity (NTU)	TDS
Close to Kahororo Dispensary, Bukoba Urban District																	
KAISHEBO	22.10.2002	31.7648	-1.04553	25.5	92.4	7.66	0.456	140.516	55.04	58.2	12.76	2.4	23.4	15			
IGABILO	23.10.2002	31.875	-1.167	25.6	92.3	7.67	6.968	11.279	47.45		14.18	1.43	23.52	5			
LWAZI	15.11.2002	31.79915	-1.48573	25.5	87	8.09	1.621		47.45	87.3	15.59			5			
KASHA	15.11.2002	31.78458	-1.4839	25.7	91.3	8.24	1.621		37.96		12.76			5			
IZIRU	15.11.2002	31.46323	-1.75663	24.3	93.7	8.01	1.621		47.45		13.47			5			
Ntoro'B'	04.04.2003	31.860866	-1.277433		116.70	8.01	0.002		36.00	9.93		4.80	0.61	27.44	5.00	0.36	80.37
Ntoro'A'	05.04.2003	31.864183	-1.292450		25.00	7.60	0.002		31.50	5.67		5.20	0.49	25.48	5.00	0.48	17.22
Close to Kaigala Health Centre, Muleba District																	
KYAMKWIKWI	16.10.2002	31.9032	-1.6258	23.4	93.7	7.96			47.45	261.9	9.93	4.15	27.9	5			
KABONDE	22.04.2003	31.678383	-2.182800		99.20	7.80	1.796	1246.620	4.50	8.51		6.40	0.64	33.00	5.00	6.50	68.32
MISIKILO	24.04.2003	31.673780	-1.913500		75.30	7.65	0.002	326.865	22.50	7.8		4.40	0.64	28.00	5.00	2.90	51.86
KASHARU	25.04.2003	31.701950	1.837330		93.60	7.97	2.2	7.434	36.00	9.93		4.80	0.61	28.00	5.00	1.00	64.46
Close to Kasunguti Dispensary and Kibehe Health Centre, Biharamulo District																	
NYAMIREMBE	16.10.2002	3172665	-2.5085	23.3	97.8	9.02			58.84	29.1	8.51	2.62	23.4	50			
NYAMIREMBE	16.10.2002	31.72815	-2.5636	23.4	108.8	7.65			58.84		9.22	3.93	27	20			
CHATO	16.10.2002	31.77768	-2.6214	23.5	101.5	8.94			66.43	174.6	9.93	1.96	26.1	30			
BWINA	16.10.2002	31.82755	-2.62112	23.5	99.4	8.68			72.12		11.34	1.96	23.4	60			
KASAGARA	16.10.2002	31.80887	-2.64895	23.7	109	8.23			66.43	611.1		2.62	26.1	20			
BUZIRAYOMBO	16.10.2002	31.79652	-2.80867	23.7	117.5	7.87			74.02	552.9	11.34	3.5	27.9	30			
NYAKATO	16.10.2002	31.7781	-2.83552	23.7	121.8	7.42			68.33	203.7	9.93	1.96	27.9	10			
KASALA	16.10.2002	31.7838	-2.86027	23.8	156.9	7.83			81.61	29.1	10.63	2.4	27.9	30			



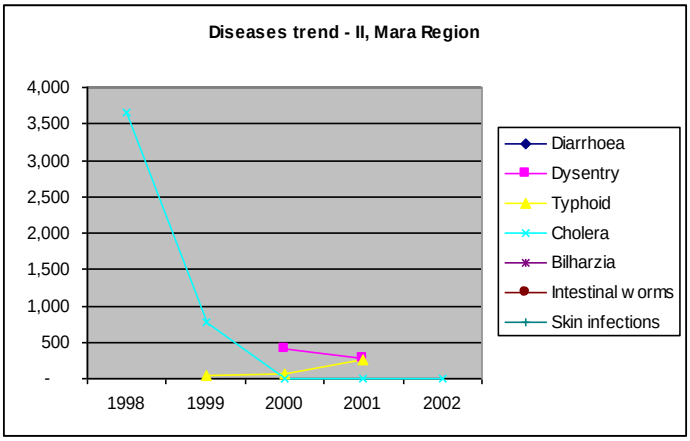
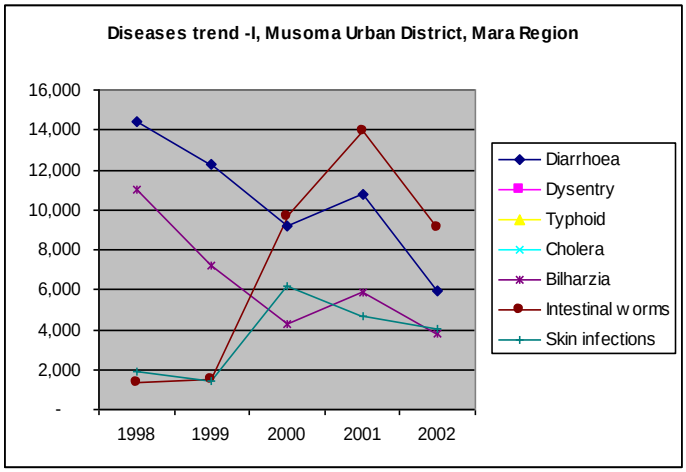


Figure 2.20: Diseases trend, Mara Region (source: RHO).



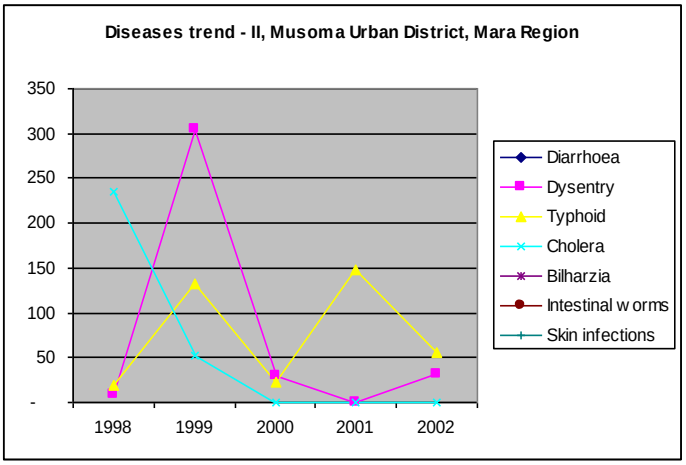
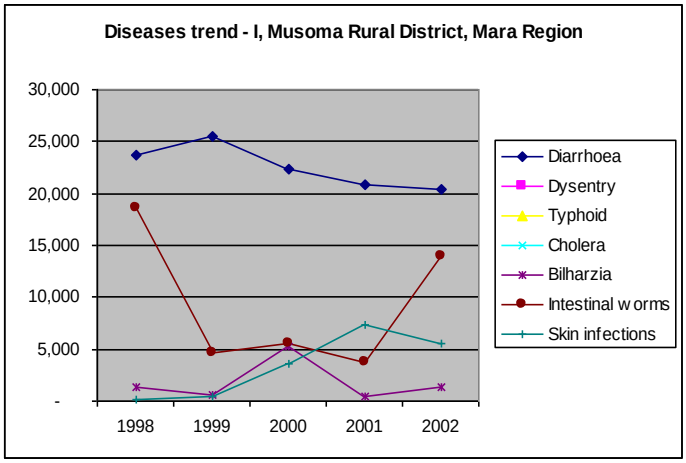


Figure 2.21: Diseases trend, Musoma Urban District (source: DHO)



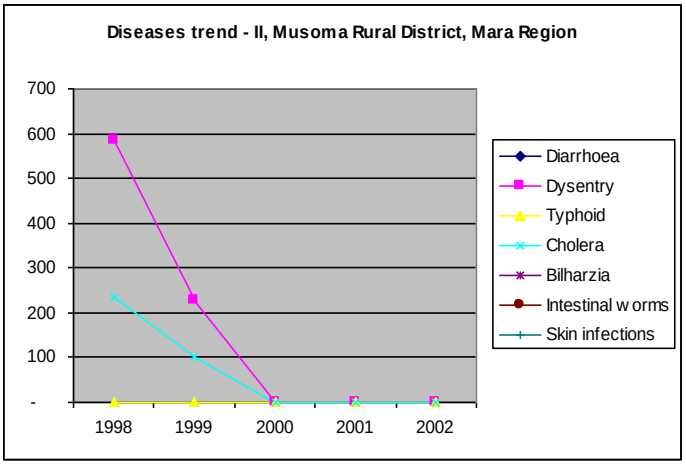


Figure 2.22: Diseases trend, Musoma Rural District (source: DHO)

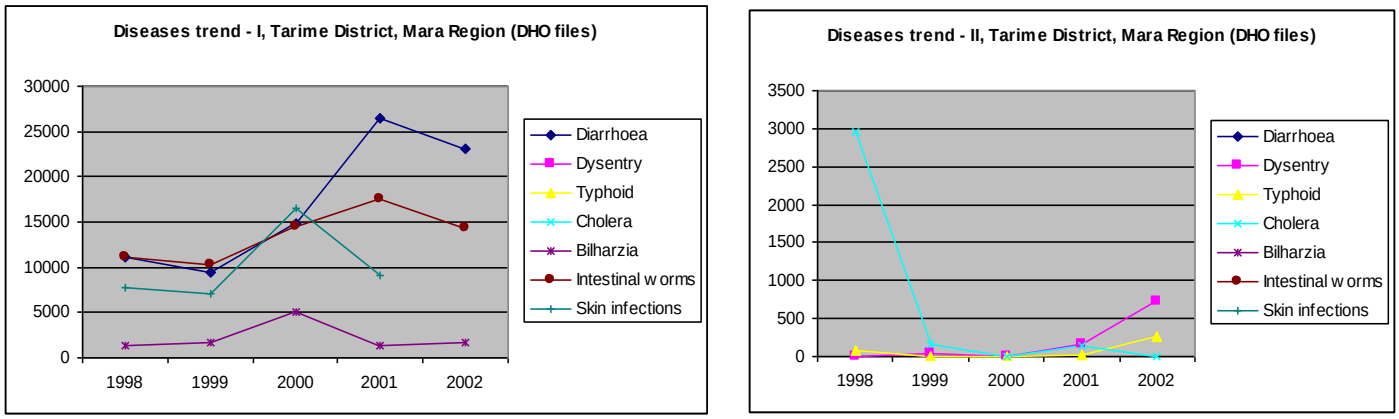


Figure 2.23: Diseases trend, Tarime District *(Source: DHO)*

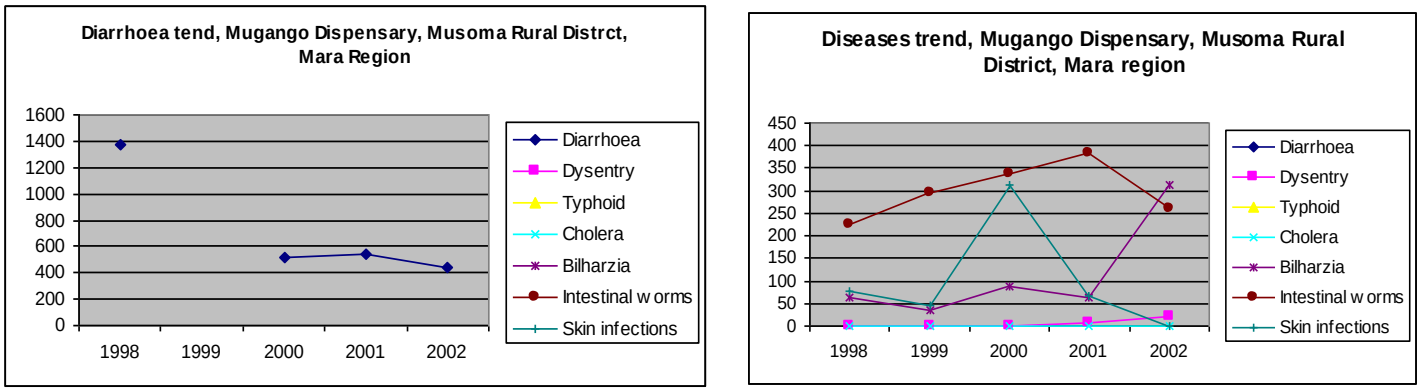


Figure 2.24: Diseases trend, Mugango Dispensary, Musoma Rural District *(Source: Dispensary)*

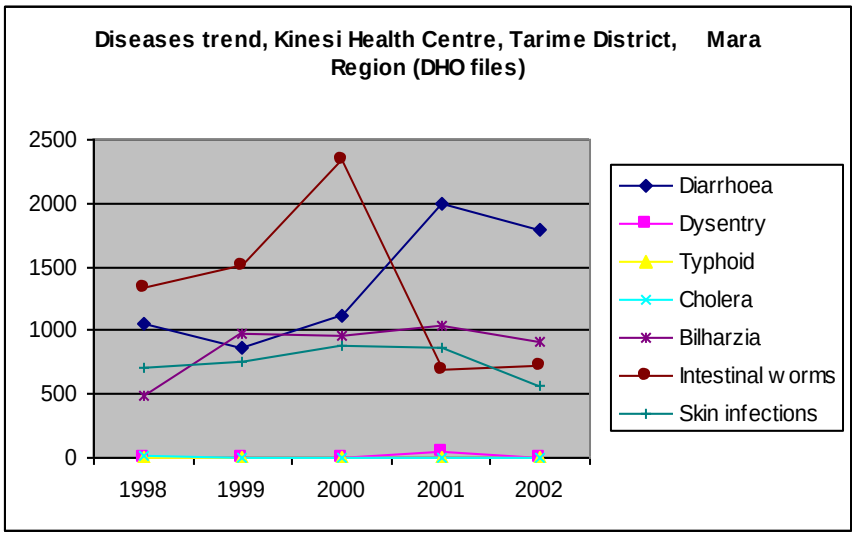


Figure 2.25: Diseases trend, Kinesi Health Centre, Tarime District *(Source: DHO)*

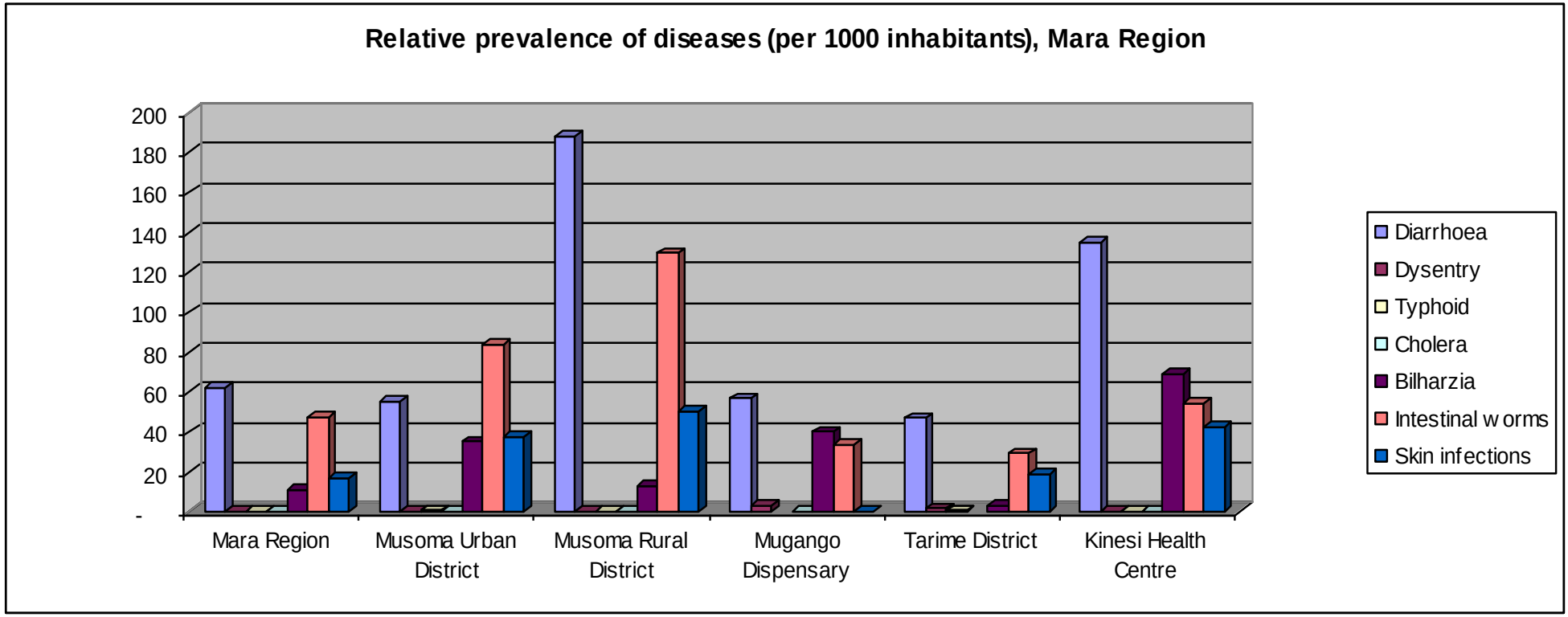


Figure 2.26: Relative prevalence of diseases, Mara Region

Appendix 2:
Outline list of field visit questions and data collection format

Lake Victoria Environment Project (LVEMP)
WATER QUALITY & HUMAN HEALTH STUDY

OUTLINE QUESTIONS

(Additional questions will be asked depending on the progress and outcome of the discussions. The below questions are just guidance)

A. INTERVIEW WITH VILLAGERS ON-SITE

1. Village name, ward and district. Village location related to the Lake.
2. Who interviewed (man/woman, age, several)
3. Where interview took place (in an office, at the road, at the water source, by the lakeshore, etc.)
4. Use of lake water for what? (Swimming/bathing, washing clothes, water supply).
5. Have you noticed any change in the lake water quality over time? How have you noticed?
6. Other potable water supply sources? (% of villagers using other sources, properly constructed). When were these developed, financed by whom? For how long have you used these, and what did you use before?
7. Quality of drinking water? Is it enough potable water for all families to use domestically?
8. Are you having any diseases in the family? Which ones and why do you get these? Any changes in frequency of diseases/human health last five years? After took the "new" potable water sources into use, if applicable? Which indicators (frequency of diseases, which diseases, etc.)?
9. Has there been any awareness campaigns in the use of water and sanitary hygiene in the villages? Has this helped changing the practices or are old taboos still valid?
10. What is the situation in the nearby villages when regards to waterborne diseases? (Water supply sources, awareness raising campaigns, etc.)
11. What are your development priorities when it comes to improved human liveliness and reduce poverty?

12. Although realising that all the three main factors: water quality, sanitation/waste disposal and sensitisation/health education *jointly* contribute to the human health, can you prioritise these factors in order of relative importance?

B. INTERVIEW AT DIPENSARIES, HEALTH CENTRES AND HOSPITALS

1. Name of location/institution, village/town, district, (ward, division/county), region/province.
2. Name and position of interviewed person(s). How long worked in the area?
3. No. of people in the "catchment area" (and service area where applicable) to the institution? Number of villages and their location related to the lake?
4. Statistics and trends of waterborne and water-related diseases say last 5 years (Cholera, dysentery, diarrhoea, worms, typhoid, schistosomiasis (bilharzia)?) Do you have any figures to show? What are the main reasons for these changes?
5. Do you know the locations where there has been improved water supply and/or sanitation situation during the last five years? Has this reduced the number of disease cases? In case not – why?
6. Have there been any awareness raising campaigns on hygiene and sanitation in any villages in the area? Does it work? How? List of these villages available?
7. How is the quality of the lake water related to the frequency of waterborne diseases? Has there been a change in the quality of the lake waters the last say five years?
8. Any cultural/religious taboos or specific habits connected to use of water and sanitation (latrines).
9. Although realising that all the three main factors: water quality, sanitation/waste disposal and sensitisation/health education *jointly* contribute to the human health, can you prioritise these factors in order of relative importance?

C. VISIT TO CENTRAL MEDICAL AND HEALTH INSTITUTIONS (REGION & DISTRICT)

1. Present the mandate of the study (linkages between WQ, sanitation and health, find out what works, etc).
2. Statistics on waterborne and water-related diseases available for 5 last years? (Can prepared such for certain villages, districts and wards? Collect later.)
3. What are the trends related to the diseases and why? Which measures work?
4. Overview of villages where awareness campaigns have been carried out.
5. Any proposal on which areas should be visited by the team, most interesting related to WQ and human health? (Villages with improved WS systems, sanitation facilities and/or awareness campaigns. Also nearby villages without such facilities).
6. Although realising that all the three main factors: water quality, sanitation/waste disposal and sensitisation/health education *jointly* contribute to the human health, can you prioritise these factors in order of relative importance?

LVEMP

WATER QUALITY & HEALTH STUDY, TANZANIA

FORMAT FOR COLLECTION OF
STATISTICS ON WATERBORNE AND WATER-RELATED DISEASES

	YEAR				
	1998	**1999**	**2000**	**2001**	**2002**
Diarrhoea (all ages)					
Dysentry (all)					
Typhoid (all)					
Cholera (all)					
Schistosomiasis (Bilharzia) (all)					
Intestinal worms (all)					
Skin infections (all)					
Malaria, above 5 yrs					
Malaria, below 5yrs					

* Please indicate (estimate) the approximate percentage (%) of diarrhoea cases, both above and below 5 years, that are **not** directly connected to malaria.

* In case of **significant** trend in number of cases (increase or decrease), please indicate the possible reasons for this.

Name of Dispensary/Health Centre/Hospital: ……

Name of District, Ward and Division: ……

Number of people in the catchment area: ……

Name, position & telephone of the informant: ……

Appendix 3:
Notes on water quality and public health implications

BRIEF NOTES ON WATER QUALITY AND ITS IMPLICATIONS ON PUBLIC HEALTH

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A. Turbidity, Chloride and Faecal coliforms

1.0 Turbidity

Significant levels of turbidity were measured in the gulfs and bays of Lake Victoria found in Mwanza, Bukoba and Musoma. The highest annual average values of 4.2 NTU were recorded at various sampling stations. Although waters with measured turbidity of 5 NTU can be acceptable by consumers, for effective disinfections turbidity levels should be less than 1 NTU (WHO, 1984).

Turbidity is caused by the presence in water of particulate matter, such as clay, silt, colloidal particles, and plankton and other microscopic organisms, and is a measure of the water's ability to scatter and absorb light. This depends on a number of factors, such as the number, size, shape, and refractive index of the particles and the wavelength of the incident light (Katz, 1986). In Lake Victoria, a two-fold decline in transparency due to high turbidity was observed over time and was associated to increase of phytoplankton productivity, most notably the blue-green algae (Cyanobacteria) which displaced diatoms (Kling *et al.,* 2001, LVEMP 2002).

Changes in chlorophyll-a concentrations have also been reported in Lake Victoria. Earlier limnological surveys indicate that *chlorophyll a* ranging from 1.2 to 5.5. mg m^{-3} in offshore and 10-15 mg m^{-3} in inshore waters (Talling, 1966; Akiyama *et al.,* 1977). While the current *Chlorophyll a* measures at 8.4 to 40 mg m-3 and 22.2 to 67.1 mg m^{-3} in the offshore and the inshore areas, respectively (Lehman *et. al.*, 1993). The higher levels of turbidity measured in this study is partly caused by the increased algal biomass reported by previous studies (Lehman *et. al.*, 1993). Soil particles, produced by the erosion of the land surface, have been found to constitute the major part of the suspended material in most natural waters (WHO, 1996). The agricultural expansion and destruction of wetlands, which are potential filters, trapping sediments, nutrients and pathogenic bacteria, acerbated pollution in Lake Victoria. In some places along the shore land in Mwanza gulf, farmers brought fertile soils from elsewhere to fertilize the shore land (Alley, 2002). This practice can also has significant impact on the pollution of waters in Mwanza gulf.

Turbidity can have a significant effect on the microbiological quality of drinking water. Its presence can interfere with the detection of bacteria and viruses in drinking-water (LeChevallier

et al., 1981); more importantly, turbid water has been shown to stimulate bacterial growth (McCoy, 1986) since nutrients are adsorbed on to particulate surfaces, thereby enabling the attached bacteria to grow more rapidly than those in free suspension. The major problem associated with turbidity is its effect on disinfections, because high levels have been shown to protect microorganisms from the action of disinfectants (LeChevallier *et al.,* 1981; APHA, 1995) and to increase the chlorine and oxygen demand (Reilly, 1983).

Coliform bacteria have been found in waters of turbidity between 4 and 84 NTU, free chlorine residuals between 0.1 and 0.5 mg/litre, and a minimum contact time of 30 min. In turbid water, *Escherichia coli* has been shown to be protected in the presence of chlorine levels of 0.35 mg/litre or greater. The adsorptive capacity of some suspended particulates can lead to the presence of undesirable inorganic and organic compounds in drinking water. Most important in this respect is the organic or humic component of turbidity. For example, herbicides such as 2,4-D, paraquat, and diquat can be adsorbed on to clay–humic particulates, the adsorption being greatly influenced by metal cations present in the humic material. In addition, the strength of the bonds in some metal – humate complexes in the turbidity fraction may complicate the measurement of trace metals in natural waters, resulting in an underestimation of the metal concentrations.

The consumption of highly turbid water may constitute a health risk, because, as mentioned above, excessive turbidity can protect pathogenic microorganisms from the effects of disinfectants, stimulate the growth of bacteria in distribution systems, and increase the chlorine demand. In addition, the adsorptive capacity of some particulates may lead to the presence of harmful inorganic and organic compounds in drinking-water (WHO, 1996). High levels of turbidity in water supplies also cause wear on equipment and water reticulation systems and can block them.

2.0 Chloride

Chloride concentrations were not exceeding the maximum acceptable levels for the Surface Water Quality Criteria for Public Water Supplies (250 mg/L) (Hammer, 1975). Although chloride occurs naturally in most waters as Cl^-, the presence of industrial activity may also increase its concentration. High concentrations of chloride gives undesirable taste to water and beverages and are corrosive to metals in the distribution systems (APHA, 1995).

3.0 Faecal coliforms (*E.coli*)

Densities of faecal coliforms (*E. coli*) greater than Surface Water Criteria for Public Water Supplies were observed throughout the course of this study at various sampling stations. The presence of faecal coliform bacteria in surface waters indicates that faecal material of humans or other warm-blooded animal has been introduced into the water at some point. Potential sources are numerous -- agricultural runoff, urban storm water, inadequate or neglected septic systems, sanitary waste from boats (less likely) and waterfowl and other wildlife. Beyond these actual sources, soils and aquatic sediments are reservoirs for faecal coliform bacteria (Heufelder, 1997; Stephenson, 1982).

Human activities like fish processing, washing cargo handling, and local boat making which carried out either at the lake shores or near the lake may contribute to faecal pollution.

Agricultural activities are carried out to the shore land in Mwanza gulf. In these areas farmers brought fertile soils to fertilize shore land and animal manures and pesticides are also used (Alley, 2002). This practice may also contribute to faecal pollution.

Pollution caused by faecal contamination is a particularly serious problem, due to the potential for contraction of disease from the pathogenic (disease-causing) organisms found in faecal matter. *Shigella* (dysentery), *Salmonella* (gastrointestinal illness), *Pseudonomas auerognosa* (swimmer's itch), and certain *E. coli* species (i.e. 0157) are examples of bacterial pathogens. Giardia and Cryptosporidium are examples of common protozoan pathogens.

In addition to implying health risks, the presence of faecal coliform bacteria in surface waters may also be an indicator of environmental concerns. Most often, faecal coliforms enter a water body through non-point source pollution (not from a single source, like a sewer pipe). This type of pollution can include silt, nutrients, organic material or toxins that are present throughout the watershed. A watershed is all the land around a stream, river, or lake that drains precipitation runoff to that water body.

Agriculture and urban runoff, and municipal raw sewage, domestic and industrial wastes are the major sources of faecal pollution in Mwanza gulf. It was further noted that agricultural activities and destruction of wetlands aggravated the situation. Other human activities like fish processing, washing cargo handling, and local boat making which carried out either at the lake shores or near the lake are also significantly cause pollution in the gulf.

B. Blue-green algae blooms and their effects on humans

The contamination of water sources and drinking water supplies by human excreta remains a major human health concern, just as it has been for centuries. By contrast the importance of toxic substances, such as metals and synthetic organic compounds, has only emerged in the latter half of the twentieth century. Although Eutrophication has been recognized as a growing concern since 1950s, only recently have algal toxins (Cyanobacteria toxins) become widely recognized as a human health problem arising as a consequence of Eutrophication. The importance of such toxins, relative to other water – health issues, can correctly only be estimated.

Blue-green algae are of concern in drinking water due to the toxins (Cyanotoxins) that they are capable of producing. Details on the four most common toxins produced by blue-green algae reported world wide are given in the Table below.

As detailed below, cases of gastroenteritis, nausea, vomiting, diarrhoea, muscle weakness and paralysis have all been associated with the consumption of, or contact with water containing high numbers of blue-green algae. In other words, algal toxins pose a severe potential health hazard causing anything from skin irritation to sub-lethal intoxication and may be most harmful through chronic uptake with drinking water leading to liver damage. Impairment of water quality for many purposes is the result of all these processes. The occurrence and severity of the symptoms are strongly related to the type of toxin, the toxin's concentration in the water and the amount of toxin consumed.

Whilst these species of blue-green algae are capable of producing toxins, toxin production in any population at any given time may vary greatly. The mechanisms for toxin production are not clearly understood at this time. However, it has been shown that the presence of these species within a water body does not necessarily indicate the presence of algal toxins.

Preriminary findings of LVEMP (Water Quality Components- Tz, Ug and Kn) and earlier studies show dominance of blue green algae species potential for producing toxins, in Lake Victoria. These species are *Microcystis aeruginosa, Microcystis flos-aquae, Anabaena circinalis* and *Cylindrospermopsis raciborskii.*

Toxin type	Potential Health Effects	Organism Producing Toxin
Hepatotoxins: Microcystins	Damages liver cells, leading to pooling of blood and finally liver failure.	*Microcystis aeruginosa Microcystis flos-aquae, Nodularia spumigena*
Neurotoxins: Saxitoxins	Interfere with the function of the nervous system. Death by paralysis of the respiratory system as a result of muscle failure.	*Anabaena circinalis*
Non-specific Toxins: Cylindrospermopsin	Relatively slow acting toxin that damages a number of organs of the body including liver, kidney, and thymus.	*Cylindrospermopsis raciborskii, Aphanizomenon ovalisporum*
Endotoxins: Dermatotoxic Lipopolysachharides	Associated with outbreaks of gastroenteritis, skin and eye irritation and hayfever in humans who come into contact with blue-green algae during recreational activities	Potentially produced by all blue-green algae

C. REFERENCES

Akiyama,T., A. A.Kajumulo and S. Olsen (1977). *Seasonal Variations of Plankton and Physicochemical Condition in Mwanza Gulf, Lake Victoria*. Bulletin of Fresh water Fisheries Research Laboratory, Vol. 27 No. 2 (1977).

Alley, S. (2002). Mazingira ya asili ya Ziwa Victoria hatarini kutoweka. Msanii Africa (Local News paper) Issue No. 669, Wednesday, 18-20, 09/2002, pp. 9.

APHA (1995). Standards Methods for Examination of Water and Wastewater. American Public Health Association, Washington D.C., 19th Edition.

Bugenyi, F.W. B., J.S. Balirwa (1989). *Human intervention in natural processes of the Lake Victoria*. The Problem. Symp. Biol. Hung. 38.

Hammer, M.J. (1975). Water and Wastewater Technology. SI Version. John Wiley & Sons, INC, New York.

Heufelder, G. (1997)..Interpreting Fecal Coliform Data: Tracking Down the Right Sources. Volunteer Monitor. Fall. 1997.

Hecky R.E., Begenyi F.W.B., Ochumba P, Talling J.F., Muggide R., Gophen M and Kaufman L. (1994). Deoxygenation of deep water of Lake Victoria. *Verhandlungen der internationale vereining für Limnologie*. **25:** 39-48.

Hecky R .E. (1993). The Eutrophication of Lake Victoria.-*Verb. Internat. Verein. Limnol.* **25:** 39-48.

Kandoro, J.W.A. and Hamza, M.M. (1998). *Heavy Metal Pollution in Lake Victoria*. Tanzania Journal of Science. **24:** 9-21.

Katz, E.L. (1986). The stability of turbidity in raw water and its relationship to chlorine demand. *Journal of the American Water Works Association.* 78(2):72-75.

Kling H.J., Mugidde R., Heckey R.E. (2001). Recent changes in the phytoplankton community of Lake Victoria in response to eutrophication. The Great Lakes of the World (GLOW). Food-web, health and integrity, pp. 47-65.

Kravitz, J.D., Nyaphisi, M., Mandel, R., and Petersen, E. (1998). Quantitative Bacterial Examination of Domestic Water Supplies in the Lesotho Highlands: Water Quality, Sanitation and Village Health. In: *Bulletin of WHO.* **77** (10): 787-860.

LeChevallier M.W., Evans T.M., Seidler R.J. (1981). Effect of turbidity on chlorination efficiency and bacterial persistence in drinking water. *Applied and environmental microbiology.* 42(1):159-167.

Lehman, J.T. and Donn K. B. (1993). Effects of nutrients on grazing on the phytoplankton of Lake Victoria. *Ver. Internat. Verein. Limnol,* 25*:* 858-855.

Lung'ayia, H.B.O., A. M'Harziz, M. Tackx, J. Gichuki and J. J. Symoens (2000). *Phytoplakton community structure and environment in Kenyan water of Lake Victoria.* Fresh water Biology. 43: 529-543.

Reilly K. (1983). Relationship of bacterial counts with turbidity and free chlorine in two distribution systems. *Journal of the American Water Works Association*. 75(6):309-312.

Stephenson, G.R. and Rychert, R.C. (1982). Bottom Sediment: a Reservoir of *Escherichia coli* in Rangeland Streams. Journal of Range Management. 35 (1): 119-123.

Talling, J. F. (1966). The annual cycle of stratification and pytoplankton growth in Lake Victoria (East Africa).-*Int. Revue ges. Hydrobiol.* **51***:* 545-621.

Tibbetts, J. (2000). Water: *Thirst or Threat. Water World 2000. Environmental Health* Perspectives, Feb.2000. **108** (2).

Verschuren, D., Edgington, D.N., Hedy, J. Kling, J. and Johnson J.C. (1998). *Silica Depletion in Lake Victoria:* Sedimentary Signals at Offshore Stations. Great Lakes Res. 24(1): 118-130.
WHO. (1996). World Health Organization***. Guidelines for drinking-water quality*****,** 2nd ed. **Vol. 2. *Health criteria and other supporting information.*** Geneva, pp. 370-373.

WHO Geneva (1984). Guidelines for Drinking- Water Quality: Vol.1 Recommendations.
WRC (1998). Water Research Commission No. TT101 (1998). Quality of domestic water supply. Volume1: Assessment Guide.

Wu, C, Maurer, C., Wang, Y., Xue, S., and Davis, D. L. (1999). Water Pollution and Human Health in China. In: *The Journal of the National Institute of Environmental Health Sciences. Environmental Health Perspectives*. **107** (4): 251-256.

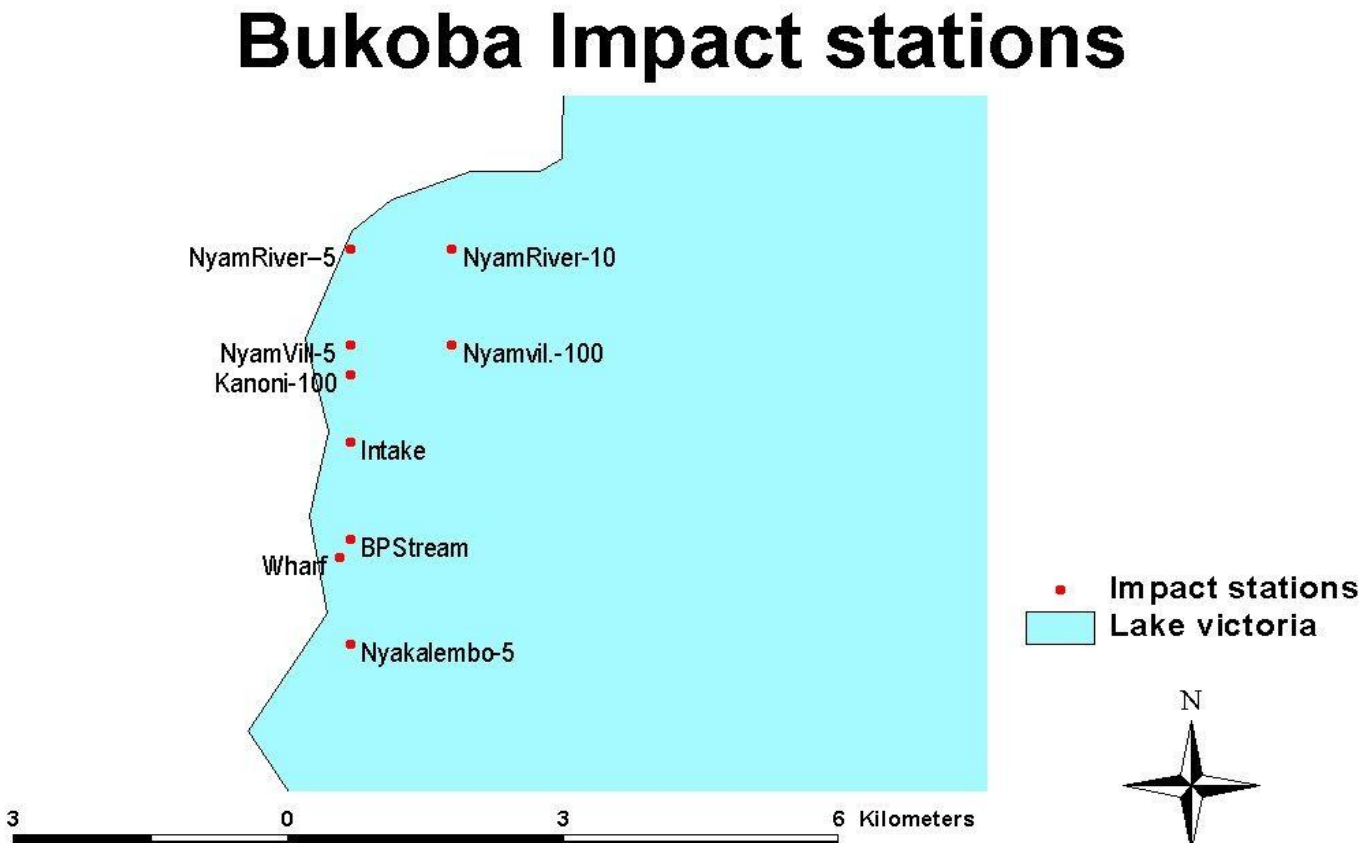
Appendix 5:
Water quality analysis from LVEMP impact stations

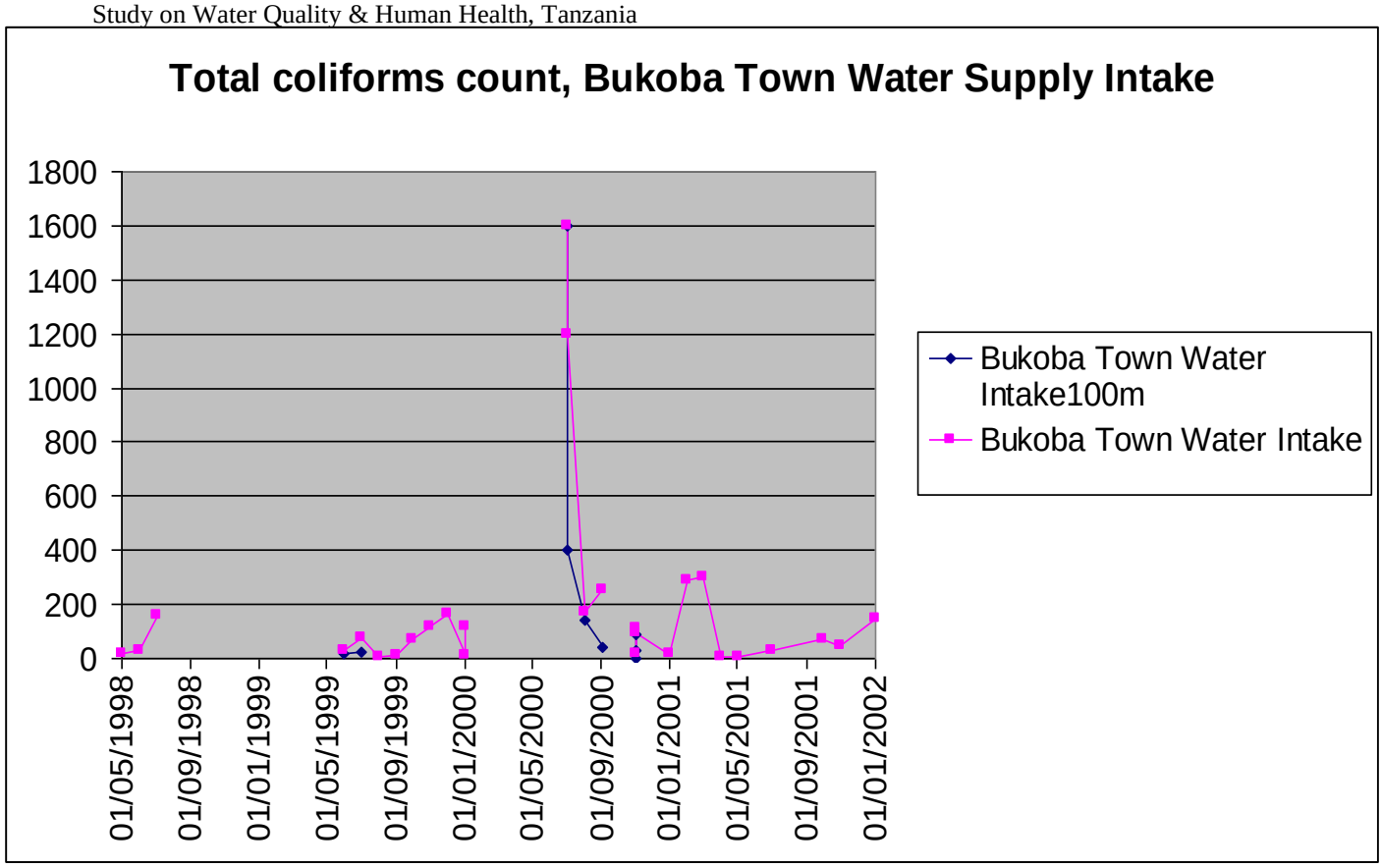
In-Lake Water Quality Monitoring: Bukoba

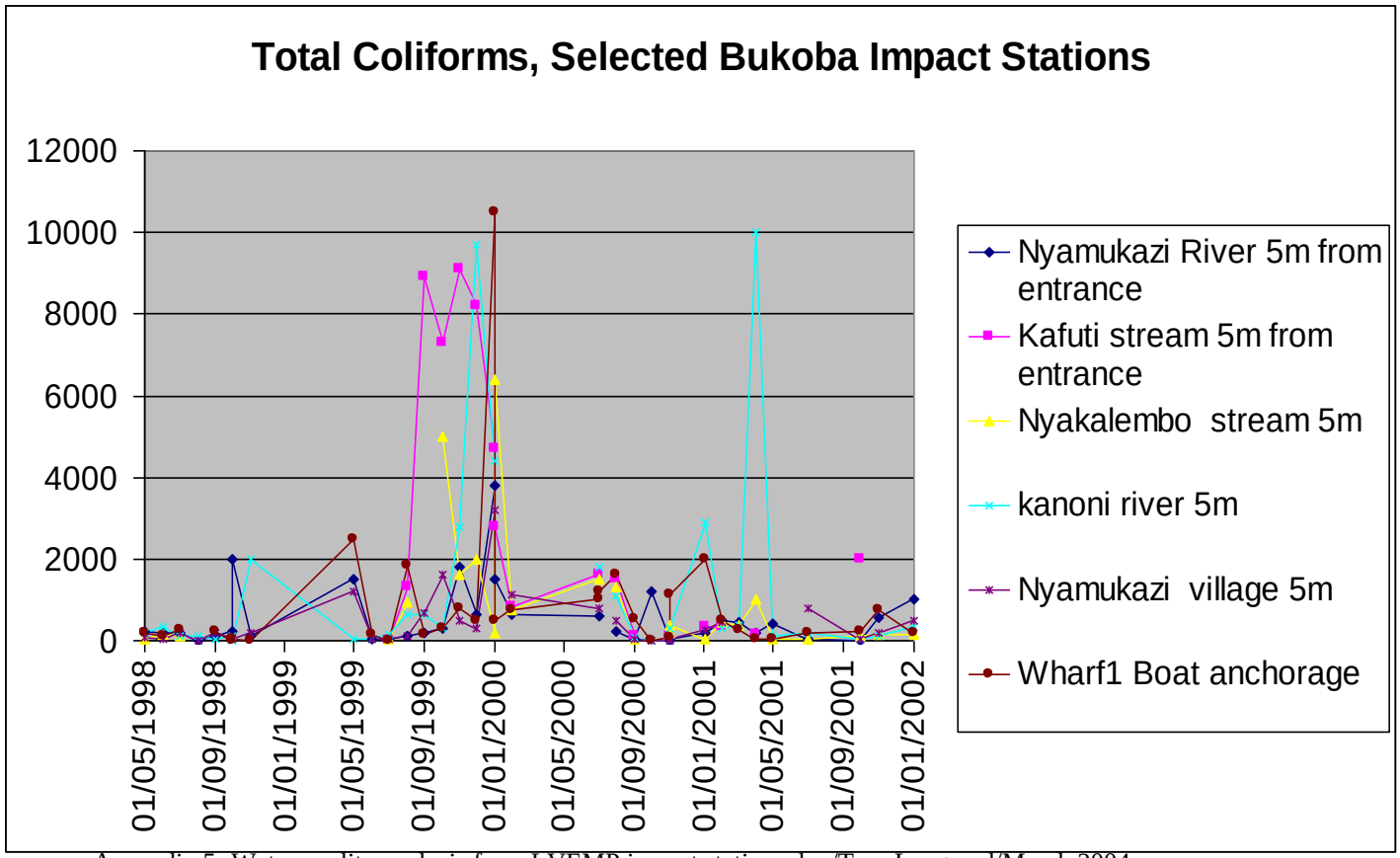
(Data collected by the LVEMP Bukoba Staff)

In-lake water quality monitoring is one of the tasks that are normally conducted by Eutrophication sub-component. The aim of this program is to provide quantitative information on the status of lake water quality.

Below follows the data from selected impact stations with long series of data outside Bukoba Town.




Total coliforms count, Bukoba Town Water Supply Intake
1800
1600
1400
1200
1000
800
600
400
200
0
01/05/1998
01/09/1998
01/01/1999
01/05/1999
01/09/1999
01/01/2000
01/05/2000
01/09/2000
01/01/2001
01/05/2001
01/09/2001
01/01/2002
Bukoba Town Water Intake100m
Bukoba Town Water Intake


Total Coliforms, Selected Bukoba Impact Stations
12000
10000
8000
6000
4000
2000
0
01/05/1998
01/09/1998
01/01/1999
01/05/1999
01/09/1999
01/01/2000
01/05/2000
01/09/2000
01/01/2001
01/05/2001
01/09/2001
01/01/2002
Nyamukazi River 5m from entrance
Kafuti stream 5m from entrance
Nyakalembo stream 5m
kanoni river 5m
Nyamukazi village 5m
Wharf1 Boat anchorage

In-Lake Water Quality Monitoring: Musoma

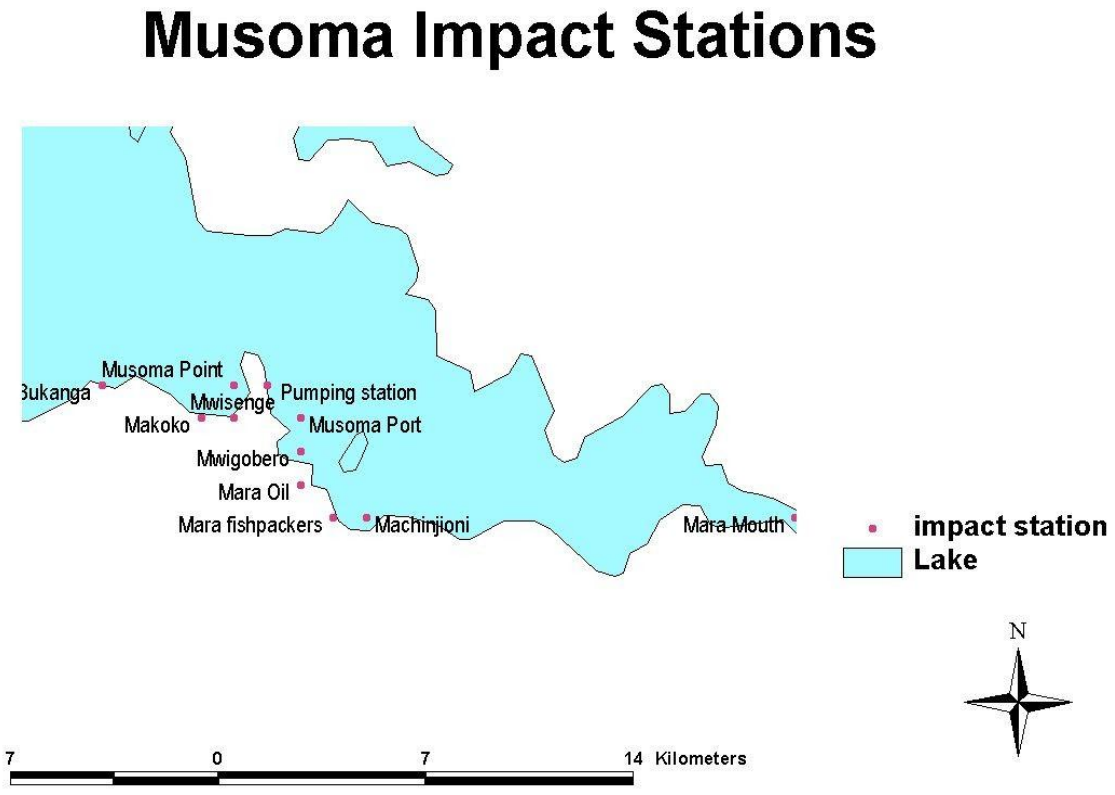
(Prepared by the LVEMP Musoma Staff)

In-lake water quality monitoring is one of the tasks that are normally conducted by Eutrophication sub-component. The aim of this program is to provide quantitative information on the status of lake water quality.

In this case water samples from selected impact stations have been collected and analysed. Two of these impact stations are Mwigobero and Machinjioni.

Mwigobero impact station is a busy place (small market) used as landing site for fish and agricultural crops from neighbouring towns. On the contrary, Machinjioni impact station is famous for receiving effluents from the slaughterhouse (Abattoir), which normally contains remains of blood, fats and some dung in combination with effluents from neighbouring Textile Industry. Following interventions put in place by the Lake Victoria Environmental Management Project (LVEMP), the trend in pollution of the lake is progressively decreasing.

According to data collected some few years back, it has been found that the bacterial counts (Total Coliform – TC and Faecal Coliform - FC), which normally originate from warm-blooded animals including man are decreasing with time. The decrease in bacterial counts (pollution indicator) has been illustrated in the attached figures (1 – 2). Samples are collected at ten metres (10 m) one hundred metres (100 m) from the shoreline.



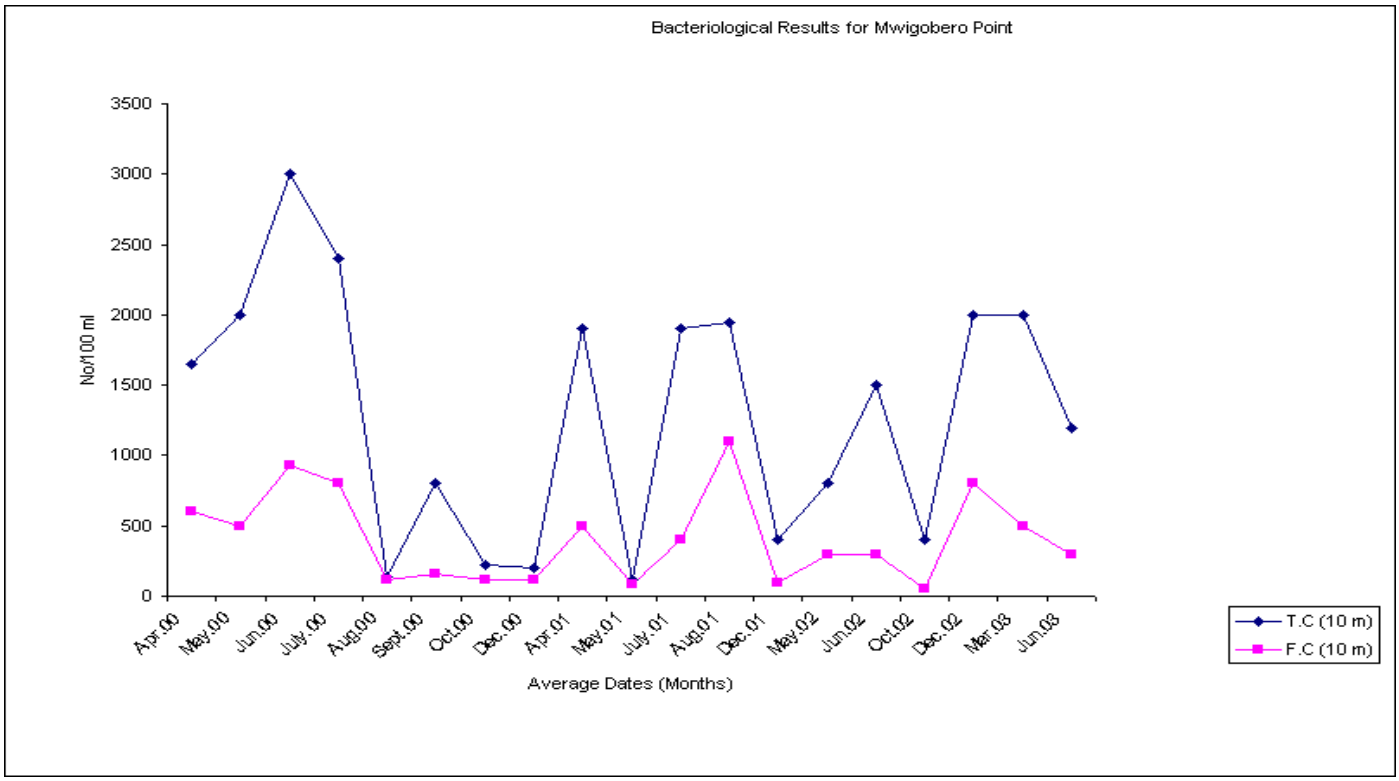


Figure 1a.

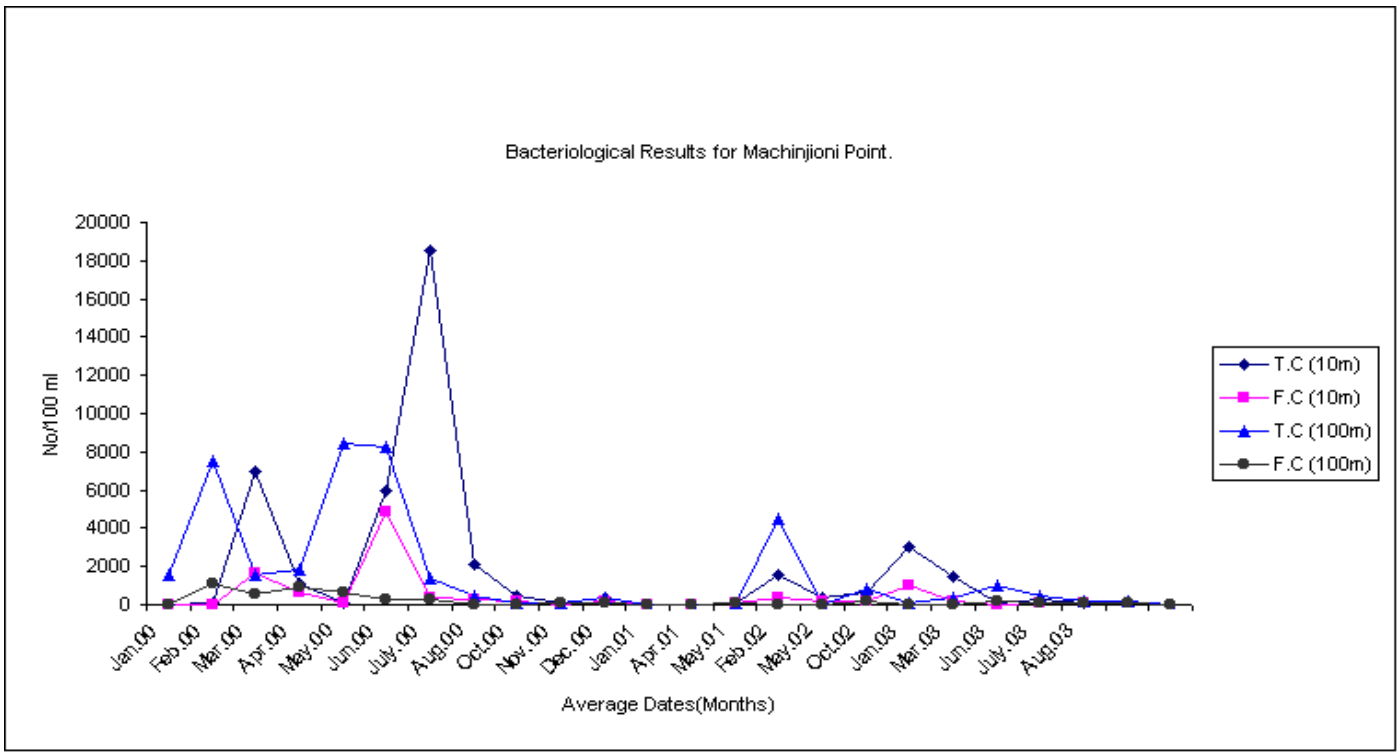


Figure 2a.

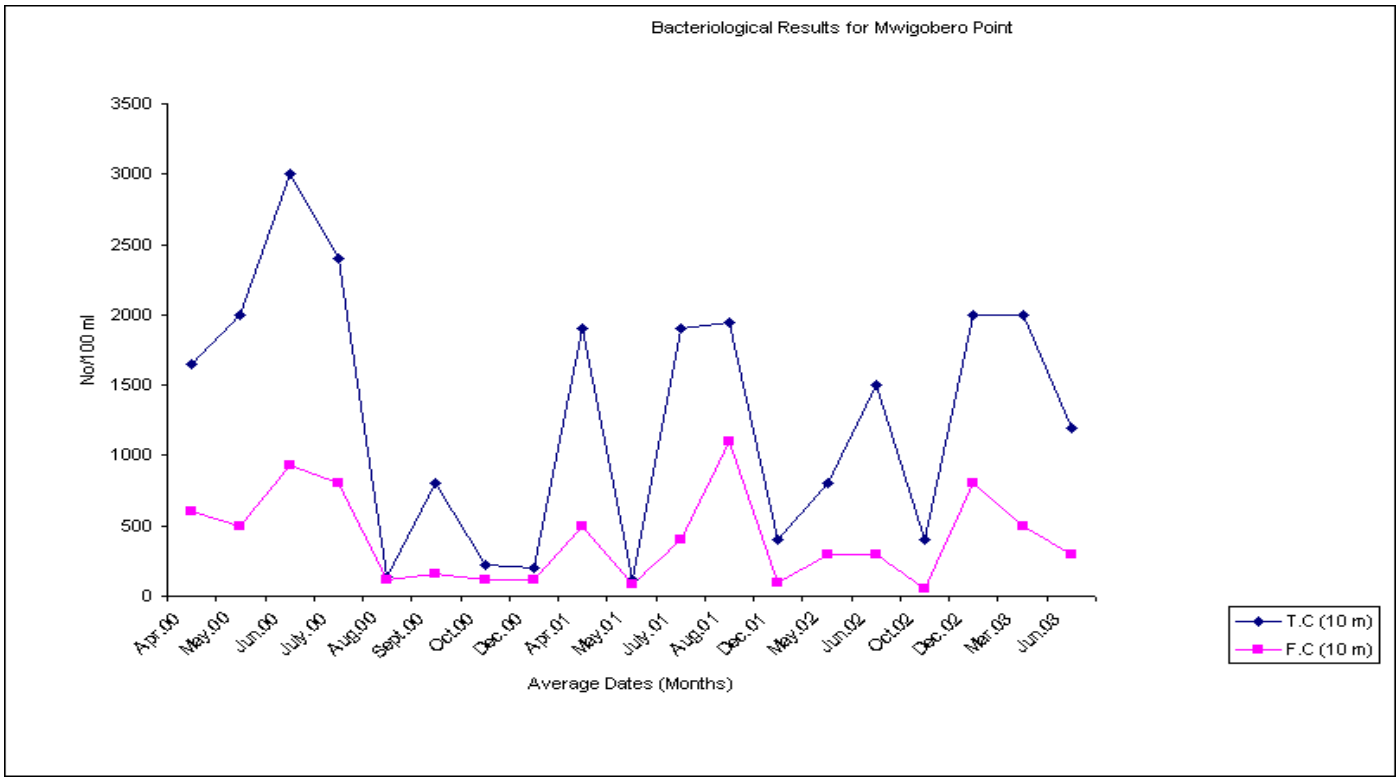


Figure 1b.

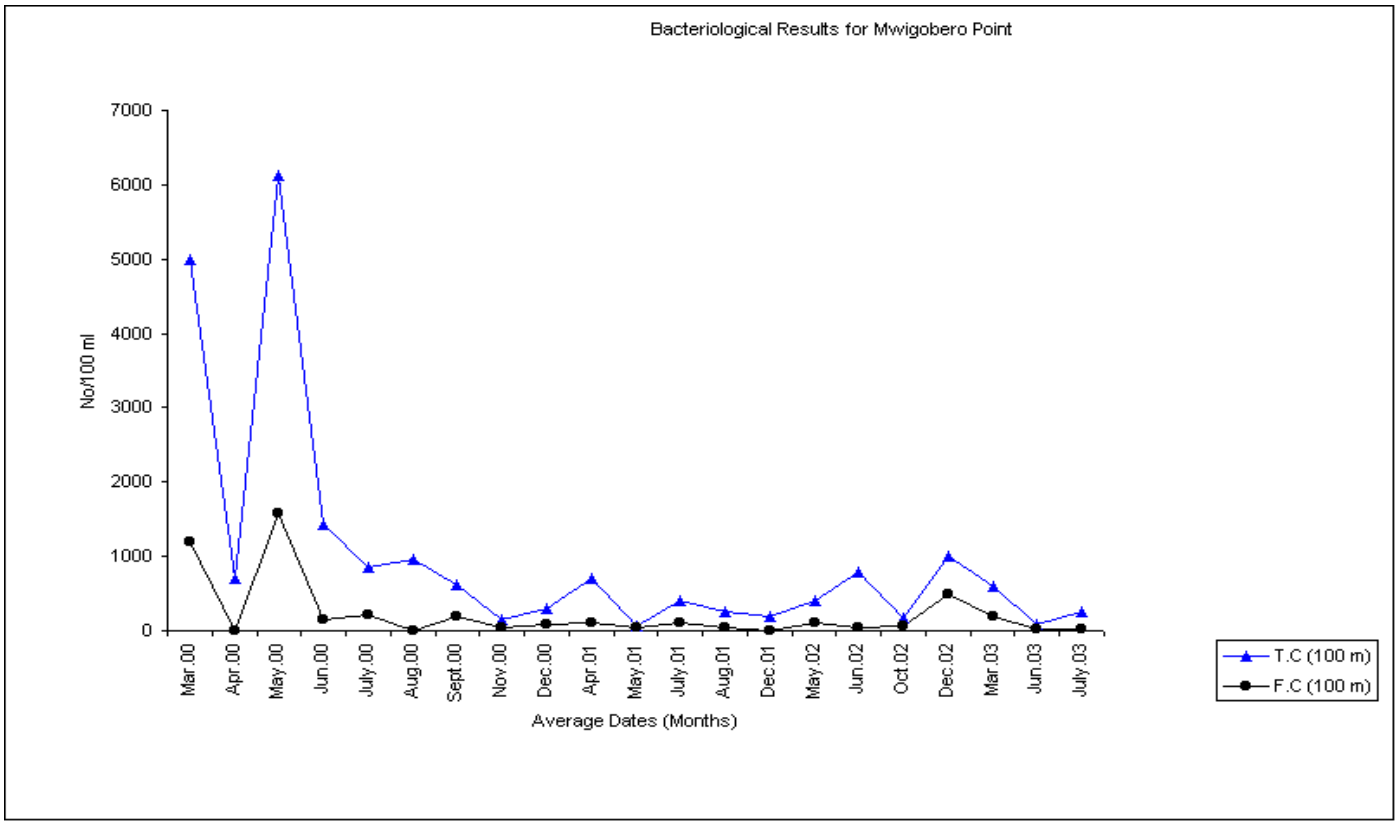


Figure 1c.

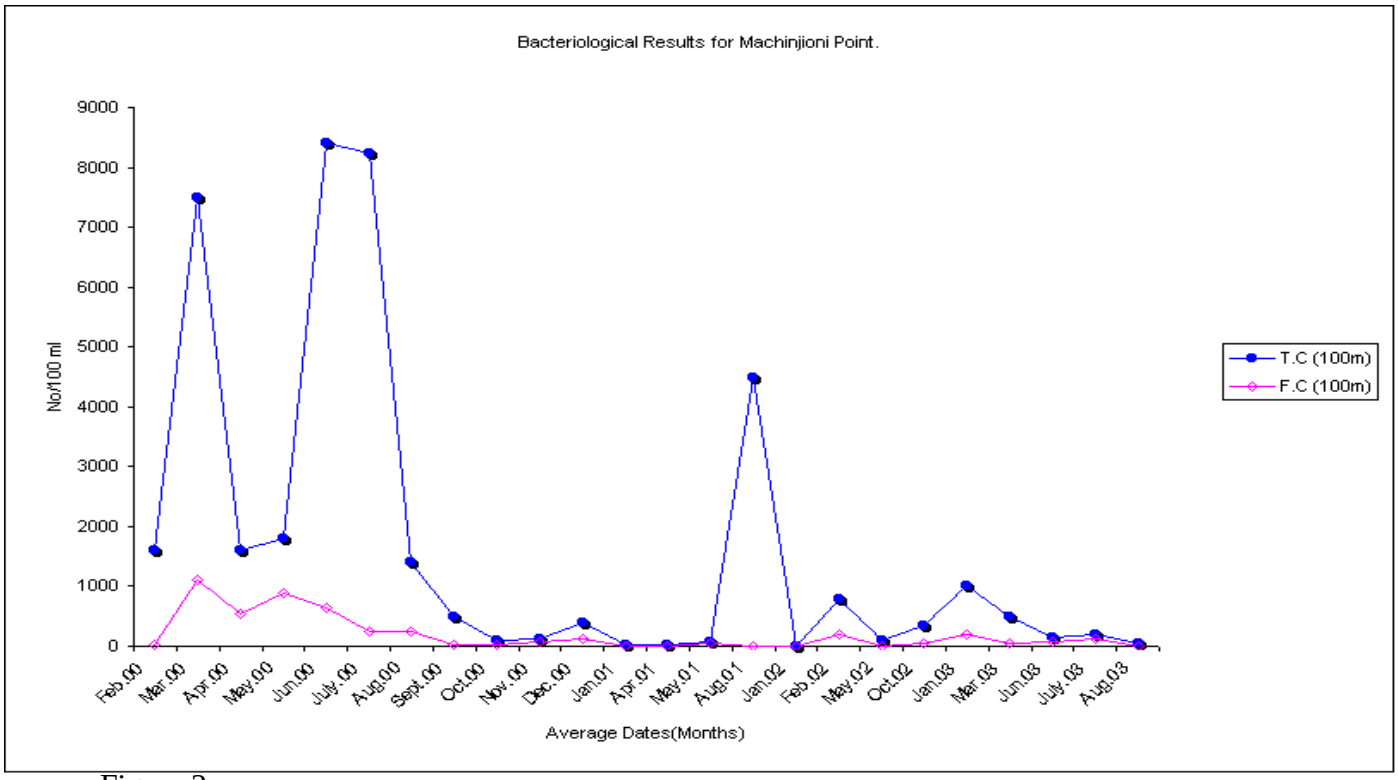


Figure 2a.

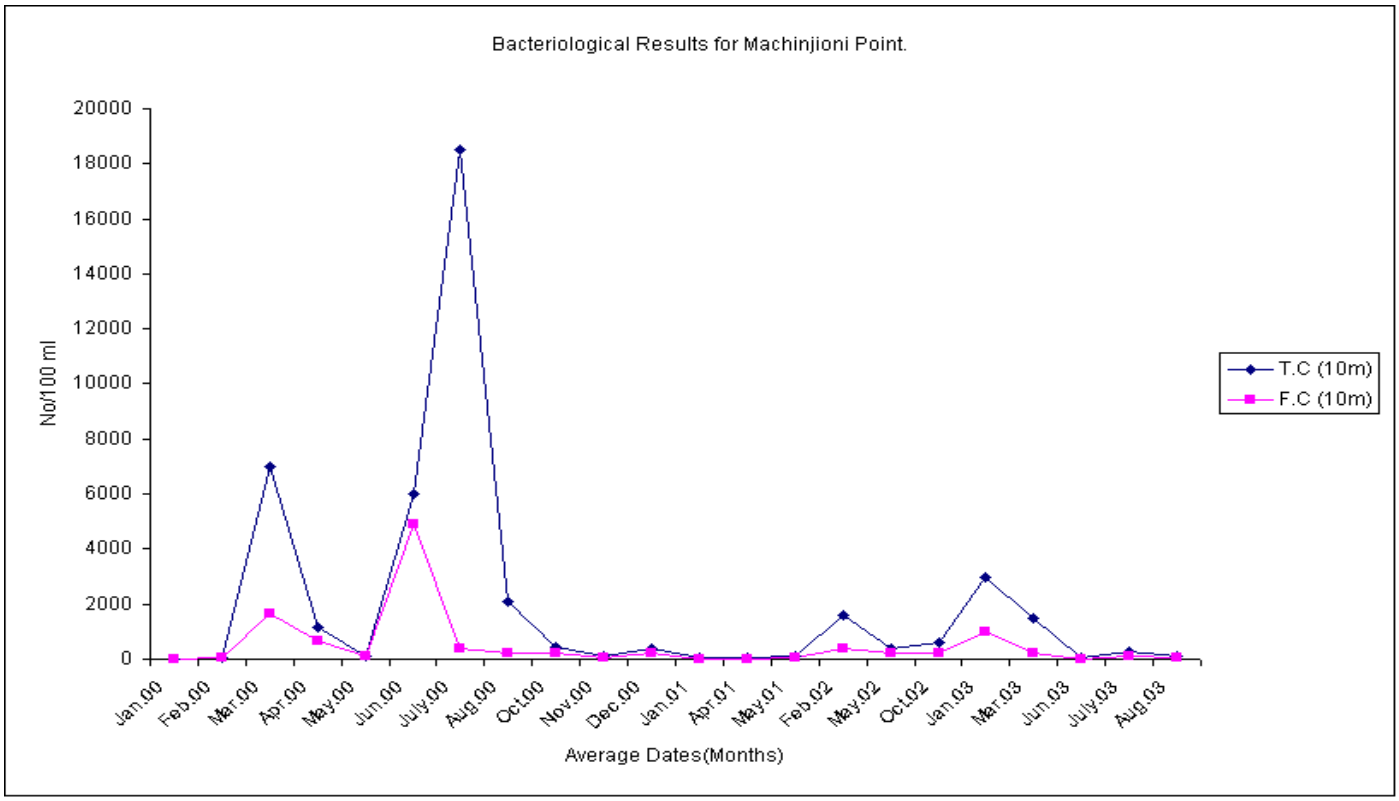


Figure 2b.

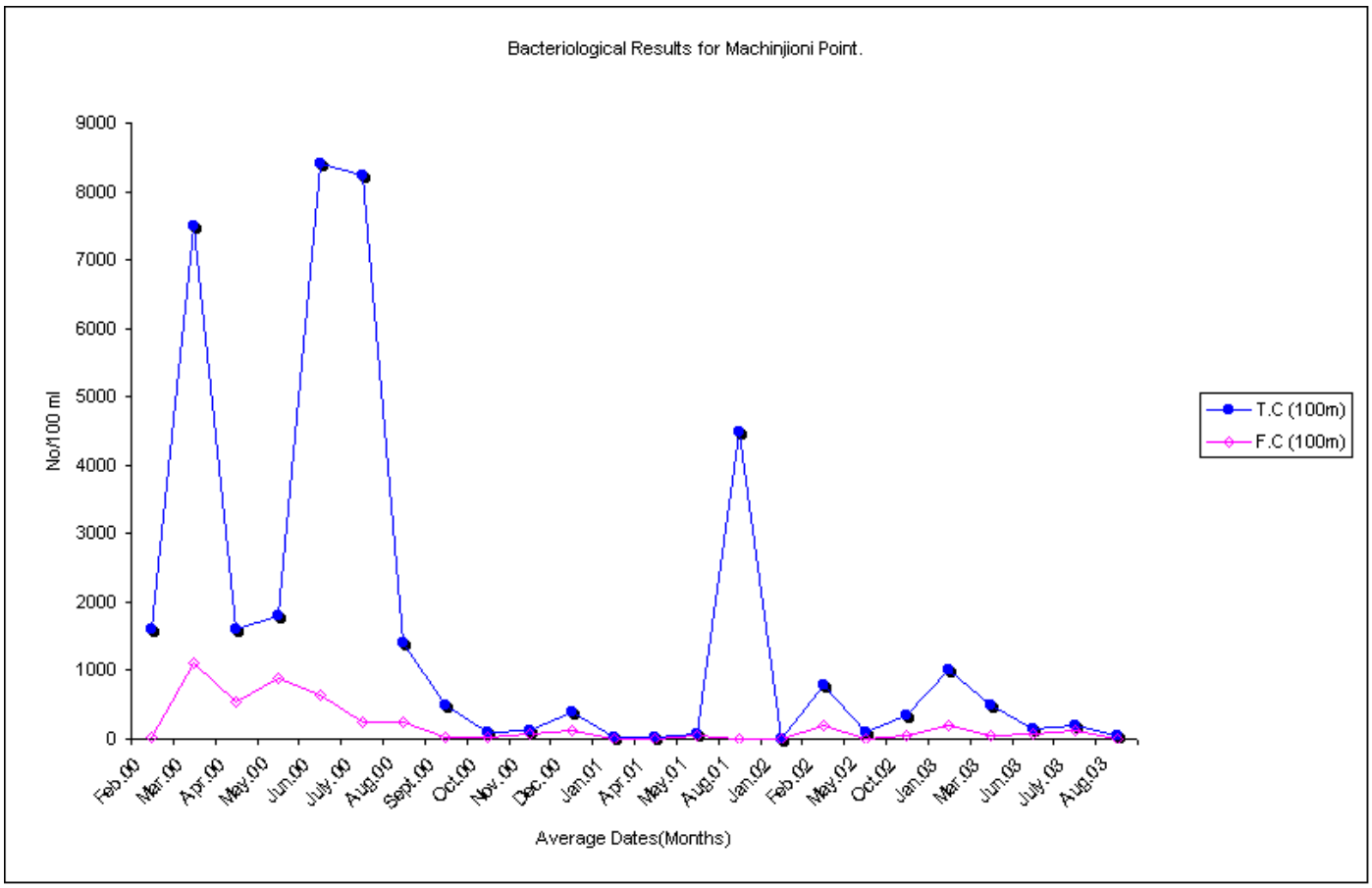

Bacteriological Results for Machinjioni Point.
No/100 ml
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Feb.00
Mar.00
Apr.00
May.00
Jun.00
July.00
Aug.00
Sept.00
Oct.00
Nov.00
Dec.00
Jan.01
Apr.01
May.01
Aug.01
Jan.02
Feb.02
May.02
Oct.02
Jan.03
Mar.03
Jun.03
July.03
Aug.03
Average Dates(Months)
T.C (100m)
F.C (100m)

Figure 2c.

Appendix 6:
Terms of Reference for the Study

Draft
September 18, 2003

Draft TORs for the **Water Quality – Human Health Study**

Study Background and Rationale

Much has been achieved during LVEMP1 in terms of the countries' understanding of the Lake Victoria ecosystem. But not much is known about water quality in various parts (particularly bays) of the Lake and its relationship with human health.

As direct or indirect measures for improving the livelihood of the inhabitants living in the Lake Region is a key objective of LVEMP2 and or future phases of the project, it is therefore important to get a grip on what is known about water quality and human health and how that may have changed over time.

Study Purpose

The main *purpose* of the Study is to review the relationship between water quality and human health in the Lake region and the effects that various mitigation measures may have.

Study methodology

The Consultant will, in addition to desk study of relevant documents, base the review on collection of statistics on relevant health-related issues and water quality parameters, where available. He will have meetings with relevant institutions and stakeholders centrally and locally in order to collect data and information related to the topics at stake, through field visits in the region. He will consult with resource persons in the National LVEMP secretariats, who will assist in logistical and transport arrangements. The Consultant intends to undertake two field visits of 2-3 weeks duration with 2-3 weeks in-between where additional data/information can be collected.

Study tasks

The Consultant will undertake the following tasks (but not necessarily limit himself to these):

- Together with representatives from the LVEMP Regional and National Secretariats, to revise/finalize the draft TOR for the study, with indications on the most suitable geographical locations to be included in the study.
- Collect, assess and analyse statistical data on water-related diseases/sickness (such as waterborne diseases (Cholera, diarrhoea, etc.); poisoning through water; bilharzia; etc.) in the relevant geographical area, collected from central and local health authorities (Ministry of Health, etc.).

- Supplement the health statistics/information through discussions with staff at local dispensaries, health centres and hospitals in the project area.
- Through interviews with selected inhabitants in sample villages, to establish a qualitative picture of the development of the health situation over time related to measures implemented or lack of measures.
- Collect information on a selected number of water quality parameters in and around Lake Victoria over a significant time-span.
- Collect information on water quality-related measures undertaken around the Lake (hereunder various infrastructure, sensitisation and awareness campaigns, etc.)
- Initiate collection of *not* readily available data/information by key informants in-between the two field visits of the Consultant.

Study Input

The LVEMP Regional and National Secretariats will support in the planning of the study, including the setting-up of meetings with relevant institutions and stakeholders. The Consultant will depend on the support from the LVEMP Secretariats in provision of vehicles and drivers for the field visits. The Consultant will pay the petrol spent at cost (but not the salary of the driver or other running vehicle costs), in addition to any other direct costs connected to the execution of the study, i.e. copying, etc.

Study Output

The Consultant will submit, by 15 December 2003 one Draft Report for each of the three countries, main text not exceeding 10 (ten) pages (not including Appendices) and one Draft Regional Summary Report of 2-3 (two-three) pages synthesising the main findings of the study.

Appendix 7:
List of persons met and contacted

List of persons met and contacted by the Senior Advisor in connection with the study in Tanzania.

(Listed in order of appearance during the study)

Name	Position/Title	Institution
In Dar es Salaam		
Saidi B. Mbwana	Senior Operations Officer	LVEMP, Mwanza (Ag. National Secretary, Dar)
G.A. Mallya	Operations Officer	LVEMP Secretariat
Sofia Nhonoly	Ass. Management Information Officer	LVEMP Secretariat
Badaka Louisa Lupogo	Secretary	LVEMP Secretariat
Eirik Janssen	First Secretary	Royal Norwegian Embassy
Anders Hagwall	Senior Regional Advisor	Embassy of Sweden
I. Mwenda	Manager. Dept. of Labour and Price Statistics	National Bureau of Statistics
Wilfred Johanna	Senior Statistician	National Bureau of Statistics
Elias Kwesi	Head, Health System Research Unit	National Bureau of Statistics
Martin Elias	Health Officer	Ministry of Health
Honest Anicetus	Environmental Health Officer	Ministry of Health
Dr. Kalinga	Heard. Epidemiological Dept.	Ministry of Health
Marie Bergstrøm	Programme Officer, Natural Resources, District Development – Lake Victoria	Swedish Embassy/ SIDA
Eirik G. Janssen	First Secretary	Royal Norwegian Embassy/NORAD
In Mwanza Region		
Dickson K. Rutagemwa	Task Leader/Senior Scientist, Industrial and Municipal Waste Management	LVEMP, Ministry of Water (MAJI)
Praxeda K. Machiwa	Senior Scientist, Industrial and Municipal Waste Management	LVEMP, MAJI
Samsom Winam	Regional Medical Officer	Ministry of Health
Venance S. Saihaul	Regional Aids Coordinator	Ministry of Health
L.R. Gasembe	Regional Health Secretary	Ministry of Health
Seraphine Lutta	Regional Reproductive Child Health Coordinator	Ministry of Health
Ngole Mabeyo	Regional Statistician	Ministry of Health
Thobias Mashiba	Regional Health Accountant	Ministry of Health
N.M. Temu	Research Scientist/Ag. Director	Mwanza Medical Research Centre
Mathias Nemes Kapizo	City Health Officer/Ag. City Medical Officer	Mwanza Town
Zephania Mihayo	Managing Director	Mwanza Urban Water & Sewerage Authority
Pazi Semili	Microbiologist	MAJI Laboratory, Mwanza Town
Gogadi Mgwatu	Environmental Engineer	MAJI Laboratory, Mwanza Town
Zaituni S. Thani	Technician	MAJI Laboratory, Mwanza Town
A.B. Bunduki	Community Dev. Officer	HESAWA, Mwanza Town
Daniel Mkare	Regional Promotion Advisor	HESAWA, Mwanza Town
Henry M. Nyamete	District Health Officer	Sengerema District
Antony Getere	Health Officer	Sengerema District
Abraham Mahiso	District Medical Officer	Sengerema District

A.S.R. Mukungu	Head of Health Centre/Clinical Officer	Nyakalio Health Centre, Sengerema District
Stephen Bihemo	Health Officer	Sengerema District
Asteria M. Gwajima	Programme Unit Manager	Plan International, Mwanza Town
Nicolata Chipa	Community Development Worker	Plan International, Mwanza Town, Igogo area
Modesta Medard	Environmental Planning & Management Officer	LVEMP Socio-Economic Component, Tanzania Fishery Research Institute (TAFIRI),
Jackson M. Ndobeji	Chairman	ECOVIC, Mwanza
In Kagera Region		
Omari Myanza	Laboratory Manager	LVEMP, Bukoba, Kagera Town
K.J.M. Kitundu	Town Director	Bukoba Town Council, Kagera Town
W.B. Rwehumbize	Town Health Officer	Bukoba Town Council, Kagera Town
Jonas Frank Kanga	Regional Health Officer	Ministry of Health, Bukoba
Pius Tubeti	Regional Medical Officer	Ministry of Health, Bukoba
W.S.J. Nkanwa	Managing Director	Urban Water and Sewerage Authority, Bukoba Town
Mwanard Mabangwa	Clinical Officer II	Kakororo Dispensary, Bukoba Urban District
Verdiana Kahalam	Senior Nurse, Midwife	Kakororo Dispensary, --"--
Amath Hassani	Nurse, Midwife I	Kakororo Dispensary, --"--
Ann John	Nurse	Kakororo Dispensary, --"--
Edith Lwakatare	Medical Assistant	Kakororo Dispensary, --"--
Devotha Katiti	Clinical Officer	Kaagya Dispensary, Bukoba Rural District
Gaspari Ugabea	Village Leader (out of 9)/Beach Management Unit	Igabilo Fishing Village, --"--
Butatondewe Simeon	Ag. Primary Health Care Coordinator	Kaigara Health Centre (near Muleba Town), Muleba District
Henry Rotahoile	Clinical Officer	Kaigara Health Centre. –"--
Mana Sophie Ruabasola	Public Health Nurse/District School Health Programme Coordinator	Kaigara Helath Centre, --"--
Batchard Rugewalila	Assistant Clinical Officer	Meninite Dispensary and Medical shop (private), Muleba Town, Muleba District
Truphina Kyaruzi	Clinical Assistant/Maternity & Child Health Aid	Kibehe Dispensary, Biharamulo District
Dibas Malai Magale	Rural Medical Aid	Kazunguti Dispensary (near Nyamuwembe village), Buharamulu District
Christopher John	Laboratory Technician	--"--
In Mara Region		
Mathayo Athuman	Water Laboratory Manager, Environmental engineer	MAJI/LVEMP, Musoma Town
Benedicta Maganga	Office Manager, Social Issues Advisor	District Development Project (DDP), Musoma
Hasse Ericksson	Team Leader, Urban Advisor	DDP, Musoma

Genes Kaduri	Managing Director	Musoma Water & Sewerage Agency (MW&SA)
William Massota	Regional Health Officer	Musoma
Elly DB. Nakuzelwa	Town Health Officer	Musoma Town
Milkrista Malsanja	Public Health Nurse	Mugango Dispensary, Musoma Rural District
Weaver Machemba Okelle	Village Executive Officer	Kinesi Village
Justina Nyambalia	Clinical Officer, in charge of Health Station	Kinesi Health Centre, Tarima District

Abbreviations/acronyms:

NORAD = Norwegian Agency for Development Cooperation
SIDA = Swedish International Development Agency

Appendix 8:
List of main reference documents

List of the Most Relevant Reports and Documents (Tanzania)

No.	Title	Author	Date
	JOINT AND MISC. DOCUMENTS		
1.	The Status of Water Quality of Lake Victoria (A Brief Prepared In response to the Document "Health of Lake Victoria", by Prof. M.W. Thring	LVEMP. P.G. Njuru, A. Matovu, L. Mwebembezi, D Rutagemwa	November 2002
2.	Integrated Water Quality/Limnology Study for Lake Victoria. Draft Final report, Part II: Technical Report (selected pages)	LVEMP	January 2002
3.	Brief notes on water quality and its implications on public health	LVEMP, Mwanza. Pazi Semili	-
	TANZANIA		
4.	Lake Water Quality Monitoring: Musoma (Selected pages)	LVEMP Water Quality and Ecosystem Management Component	2000-2003
5.	Data list of Bacteriological database , Tanzania (selected pages)	LVEMP, ---"---	-
6.	Shoreline settlement and sanitary survey laboratory results	LVEMP, ---"---	-
7.	Sanitary Conditions of the Shoreline Settlements of Lake Victoria . Draft Research Report	LVEMP. ---"---. Vitalis P. Mnyanga	January 2002
8.	Reports of Needs/Assessment fro Promotion of Participatory Hygiene and sanitation Transformation Approach in Sengerema District	Ministry of Health and UNICEF	September 1999
9.	Water Quality Monitoring: the LVEMP (Tanzania) experience	LVEMP. Dickson K. Rutagemwa	August 2001
10.	Annual report for July 2000 to June 2001 (selected pages)	Mwanza Medical research Centre	2000/2001
11.	Report on baseline study on: socio-cultural factors contributing to persistence and transmission of trachoma disease in Manyoni District	Ministry of Health	2001
12.	In-depth Study of Mugumu in Serengeti District. Final Report.	Carl Bro. SIDA	August 2002
13.	Organic Pollution of Lake Victoria. As assessment of organic pollution and treatment perspectives of waste water by domestic and industrial sources in Mwanza. Research Proposal.	Various universities in the Netherlands	-
14.	Water quality management and sustainability: the experience of LVEMP Tanzania. Journal article	LVEMP. Praxeda K. Machiwa	2003
15.	For a people centred and long lasting efforts to manage Lake Victoria. Presentation of ECOVIC	ECOVIC	-
16.	Inputs/information that can facilitate the preparation of the intended CSPD support programme aiming at improvement of health of the people through water and sanitation interventions in Mwanza Region	HESAWA Office, RHMO Mwanza	July 2002
17.	Final HESAWA Programme Progress Report. (F/Ys 1985/86-2001/02)	HESAWA. RHMO, Mwanza	August 2002

18.	Final report for the HESAWA Programme Mara Region, 1985 – 2002 (Selected pages)	HESAWA Office	2002
19.	Final Progress Report July 1985 – June 2002. Kagera Region	HESAWA Office (Min. of Comm. Dev., Women Affairs and Children)	2002
20.	Health Statistics Abstract 2002.	Ministry of Health	2002
21.	Population and housing Census 2002. WEB	Government of Tanzania	2002
22.			