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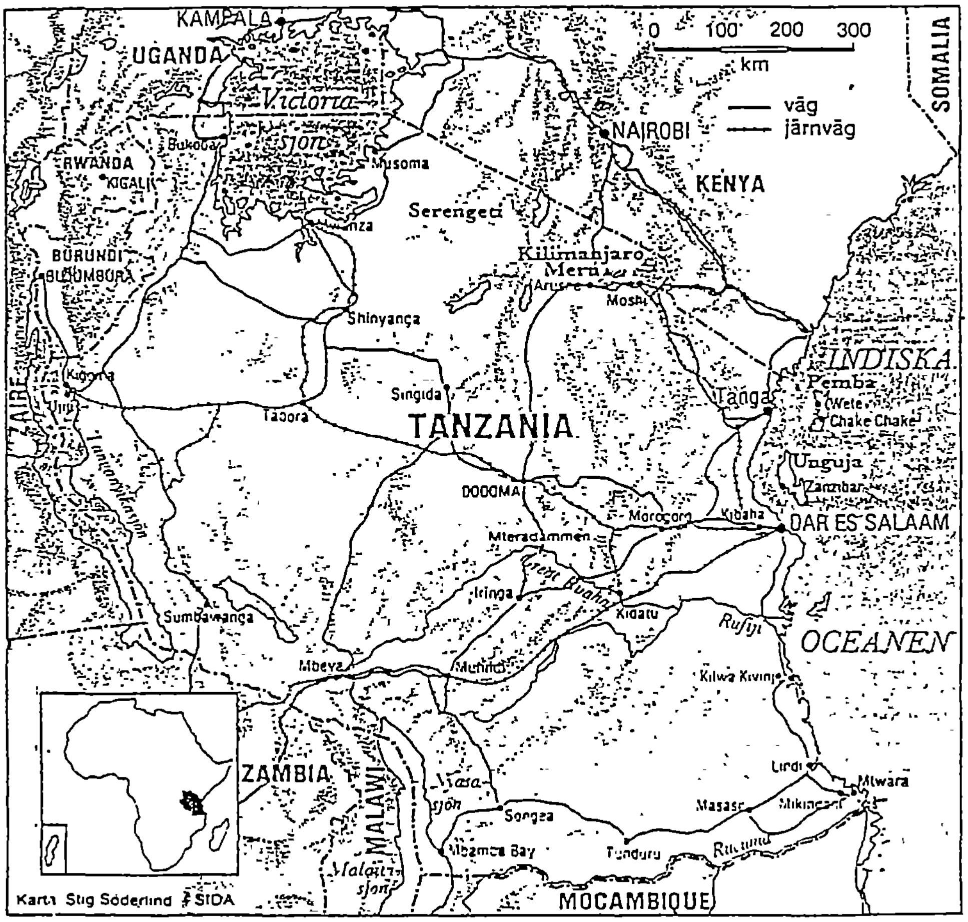
AnnKristin Rönnberg
Department of Public Health
and Environmental Studies
Umeå University



Bacteriological Water Quality Surveillance

A minor field study carried out within the Hesawa programme area in northern Tanzania.

CONTENTS

PREFACE

This study has been carried out within the framework of the Minor Field Studies (MFS) scholarship programme, which is funded by the Swedish International Development Authority (SIDA).

The MFS scholarship programme offers Swedish undergraduate students or recent graduates an oppurtunity to carry out two months field work in a third world country for their Masters theses or similar in-depth studies. The study should primarily be conducted in a country supported by the Swedish development aid programme.

The main purpose of the MFS programme is to create interest among Swedish university students to work in developing countries, providing them with an initial experience of conditions in the third world. A further purpose is to attract students to enter into professions suitable for this kind of work, thus supplying SIDA staff and widening the Swedish personnel resources for recruitment into international organisations.

The International Unit at the Royal Institute of Technology (KTH), Stockholm, administers the MFS programme for all faculties of engineereing and natural sciences in Sweden.

Sigrun Santesson
Programme Officer
MFS-programme

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The prerequisities for bacteriological Water Quality Surveillance in rural areas in northern Tanzania was evaluated through observations and interviews with responsible authorities. In addition, the bacteriological water quality and sanitary conditions of several randomly selected water sources were examined.

Routines for quality surveillance were found to be practically nonexisting in the study area. The water supply programme operating in the area (HESAWA), has so far deliberately focused its efforts on quantity rather than quality in order to solve problems associated with lack of water. There are however ideas and plans for a future surveillance programme to be developed.

Three types of water sources were included in the process of water analysis and sanitary surveys; Improved traditional water sources (8), Shallow wells (20) and boreholes (4). The number of sources included in the study are however very limited, due to lack of transportation and technical problems during analysis such as electricity failure. The conclusions drawn can therefore not be considered as statisticly relevant. A thorough study covering more sources and a greater area is recomended before implementing a surveillance programme.

The results indicate an acceptable bacteriological water quality in all boreholes and 50 % of all the shallow wells included in the study. Improved traditional water sources were usually not fully improved and only 25 % of them supplied water of acceptable quality.

Sanitary conditions at boreholes were good. Both regarding construction and surrounding factors.The shallow wells included in the study all had a similar and quite new construction, giving the source a good protection. The surroundings and human or animal contact where instead often the probable source of contamination. Traditional water sources usually had very poor sanitary standards. Some improvement had been carried out but since none of them had complete protection there was still a high contamination risk.

2.1 Water and health

It has been estimated by the World health organization that about 80 % of all the diseases in the world are associated with water. One of them is diarrhoeal disease which every year takes the lives of four and a half million children under the age of five (1).

A water-related disease is one which is in some way related to water or impurities within water. We can distinguish between infectious water-related diseases and those related to some chemical property of the water, as for instance, cardiovascular disease is associated with water softness (2) and high nitrate levels are associated with infantile cyanosis (3).

Non-infectious water-related diseases are of major importance only in industrialized countries where infectious diseases have been almost completely reduced. In developing countries it is the infectious water-related diseases listed below which are the most important (4).

Group	Disease	Transmitter
Water-borne	Cholera, Diarrhoea Typhoid, Bacillary dysentry	Fecal/ Oral
Water-washed	Scabies, Leprosy Skin sepsis, Typhus, Salmonelloses, Hookworm	Insufficient water quantity
Water-based	Schistosomiasis Bilharziosis Guineaworm, Threadworm	Insufficient protection of the water source
water-related vectors	Yellow fever, Malaria Diarrhoea, Sleeping-sickness	Insufficient water-source and storage protection
Faecal-disposal	Hookworm, Tapeworm	Defective sanitation

table 1. Infectious diseases related to water supply and sanitation practises.

Provision of clean and sufficient water at the source and also to maintain the quality during transportation and storage are consequently important interventions when trying to reduce infectious water related diseases in Developing countries. Studies i.e in Malawi does however indicate very limited impact on health from improvement of water supply only (5). Combined efforts , including health education and improved sanitation is therefore recomended.

2.2 Study area

The study was performed in the republic of Tanzania which is situated on the eastafrican coastline (app.1). Tanzania is a former British colony which gained its independence in 1964 as a union formed by Tanganyika and the island Zanzibar. It covers an area of 945 087 square kilometres and has a population of about 24 million people.

Mwanza town which came to function as a base for the study is situated on the southern shore of Lake Victoria (app.2). It is the main town of the Mwanza region which holds about 2 million people (census in 1988). A vast majority of the people (90 %) live in the villages.

The region covers an area of 19 500 square kilometres at an altitude varying between 1134 m, the level of Lake Victoria and 1400 m at the highest hills in the area. The climate is tropical with a rainy season in october/november and another one in march/april. Annual rainfall is between 800 and 1200 mm.

Northern Tanzania has since 1982 been the focus of concentrated SIDA-support to the rural water supply programme in operation.

2.3 HESAWA (Health trough sanitation and water supply)

Hesawa is the name of the SIDA-financed development cooperation programme which has been operating in the three lake regions Kagera, Mara and Mwanza since 1985 (app. 1). Through an integrated approach to health education, sanitation and water supply the programme aims to improve the welfare of the rural population, and to create better prospects for social development and economic growth.

The Hesawa programme is carried out within the existing Tanzanian government structure. It is a continuation of the development cooperation between Sweden and Tanzania in the sector of rural water supply, which started in 1965.

Preceeding the Hesawa idea, which will be more presicely explained below, was an increasing dissatisfaction with the lack of impact of past efforts and an awareness that the initiatives and skills of the local communities could be utilized more (7). High technology solutions - planned and implemented by experts on a central government level were no longer feasible and there was a need for a new strategy.

2.3.1 The Hesawa idea

The main concepts of the Hesawa philosophy can be summarized as follows;

- decentralization
- sustainability
- affordability
- replicability
- credibility
- cost efficiency

According to the Hesawa principles, planning and implementation should be the responsibility of the villages. That way local resources, physical and human as well as organizational are belived to be utilized as far as possible. Especially women are encouraged to take part at all levels of the programme. Hesawa activities includes;

<u>Human Resources Development</u>

- Village training in the fields of hygiene, environmental sanitation and water supply, including operation and maintenance.
- Management training at all levels , including training of Trainers.
- Development and upgrading of existing technical skills.
- Study groups

<u>Village Health Workers</u>

- Local level health care

Environmental Sanitation
- Latrine construction
- Waste disposal
- Water source protection
- Spillwater drainage
- Personal hygiene

Water Supply
- Well construction
- Well rehabilitation
- Pipe scheme
- Construction of washing slabs
- Rainwater harvesting

According to agreements with the Tanzanian government, Hesawa responsibilities will be left over in the hands of local Government Departments, villages and other local communities after a "phase out" period when the expatriote staff is gradually reduced. The take over is presently planned for 1993.

2.4 Water quality surveillance

Some physical and chemical analysis of drinking water are carried out in connection with well construction, at the Department of Water Affairs (MAJI) in Mwanza town.

Surveillance routines for bacteriological quality is however not enforced and bacteriological analysis had, at the time of the study, not been conducted during the past months due to lack of funds for growth media and field transportation. The Maji-laboratory is otherwise well staffed (One laboratory chief and three laboratory technicians) and educated for carrying out routine surveillance and analysis. The method currently used for bacteriological analysis is the Membrane Filter Method.

The Department of Health (AFYA) plans to conduct bacteriological testing of water sources in the future. The samples will be analysed for total coliforms in so called Aquatubes, which are incubated in a regular thermos. A number of Aquatubes have already been distributed to the department.

3 OBJECTIVES

The aim of the study was to examine the prerequisites for bacteriological water quality surveillance in a developing country. A minor surveillance programme was carried out including ; sampling, sanitary survey and bacteriological analysis. Leading to an assessment of applicable standards for bacteriological pollution and local surveillance routines.

It was also anticipated that the study , in addition to giving some base line data on the bacteriological and sanitary state of the sources included, would provide results of use for the Hesawa programme in planning future water quality surveillance in the Mwanza area.

4 BACTERIOLOGICAL CONTAMINATION

4.1 Contamination routes

Natural water vary in bacteriological quality depending on its origin and the extent of human and animal contact. The routes of contamination are plenty and hard to control. The different watersupply systems are more or less equipt to prevent the infiltration of intestinal pathogens. The routes of contamination which have been considered in the study are:

- groundwater infiltration
- human and/or animal contact
- surface water infiltration

Contamination during the handeling procedure is not included in the study due to lack of time and resources. This is however considered a major source of contamination (16).
If the contamination is recent, and if among the contributors there are carriers of communicable enteric diseases, some of the living casual agents may be present. The drinking of such water, or its use e.g. in food preparation may result in further cases of infections.

4.2 Indicator organisms

The most important parameter of domestic and drinking water in developing countries is consequently the bacteriological quality; the occurence of bacteria, viruses and parasites (8). These can of course be numerous and it is therefore not feasible to test for all possible microbial pathogens that might occur. Instead samples are examined for an indicator organism which originates in large numbers from human or animal excreta. The presence of such organisms indicate the presence of fecal material and the possible presence of pathogenic microbes.

The requirement of a good indicator bacteria is that it should be easily isolated, identified and enumerated. It should not remarkably grow or multiply in water and it should be practically absent in other sources. Examination for such indicators provides a mean for quality control of domestic- and drinking water.

Suitable indicator bacteria for fecal pollution is especially the coliform bacteria known as Escerichia coli, E.coli or presumtive E. coli. It ferments lactose at 44.5 C, and is specifically of fecal origin. When detecting fecal coliforms in a sample it is considered to provide sufficient information to assess the level of contamination of pathogens (8).

5 METHODS OF WATER SUPPLY IN THE STUDY AREA

The number of facilities built per year within the Hesawa programme has increased since the start in 1985. In march 1991 the number of improved traditional water sources had reached a total of 358 (23 in the study area), tube- and ring wells with handpumps were 1007 (103), rain water tanks 26 (1) and piped water schemes 23 (1). There has also been some rehabilitation of 242 old tube- and ring wells (49 in the study area).
About 2/3 of the population are belived to obtain water from the different types of water sources mentioned above (9). Unimproved traditional water sources and in some cases lake water is however still utilized by a minor part of the population (10).

5.1 Improved traditional water source

In its simplest form, the traditional source is little more than a water hole, hand-dug into the water table. The contamination risk from surface water drainage, users and animals is very high. But when improved by lining of the walls, raising the well head above the surrounding ground level, adding a cover and apron made from concrete, and given a fixed lifting device, it usually has potential to yield water of acceptable quality (fig. 5.1).
The improvement of traditional water sources has many social and cultural advantages. The use of traditional skills and materials makes the source cheap to construct and easy to maintain.

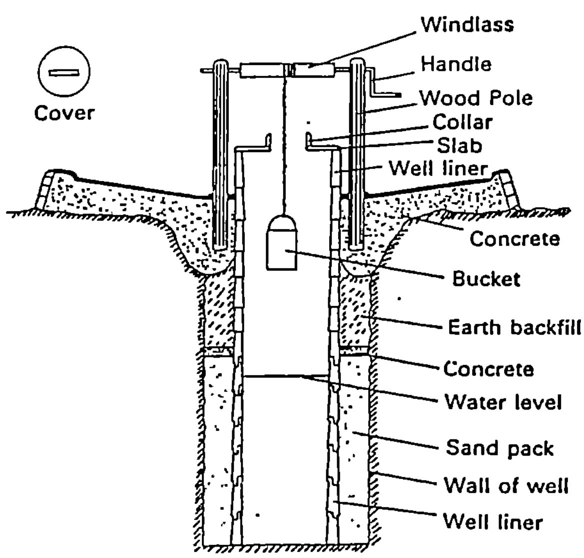
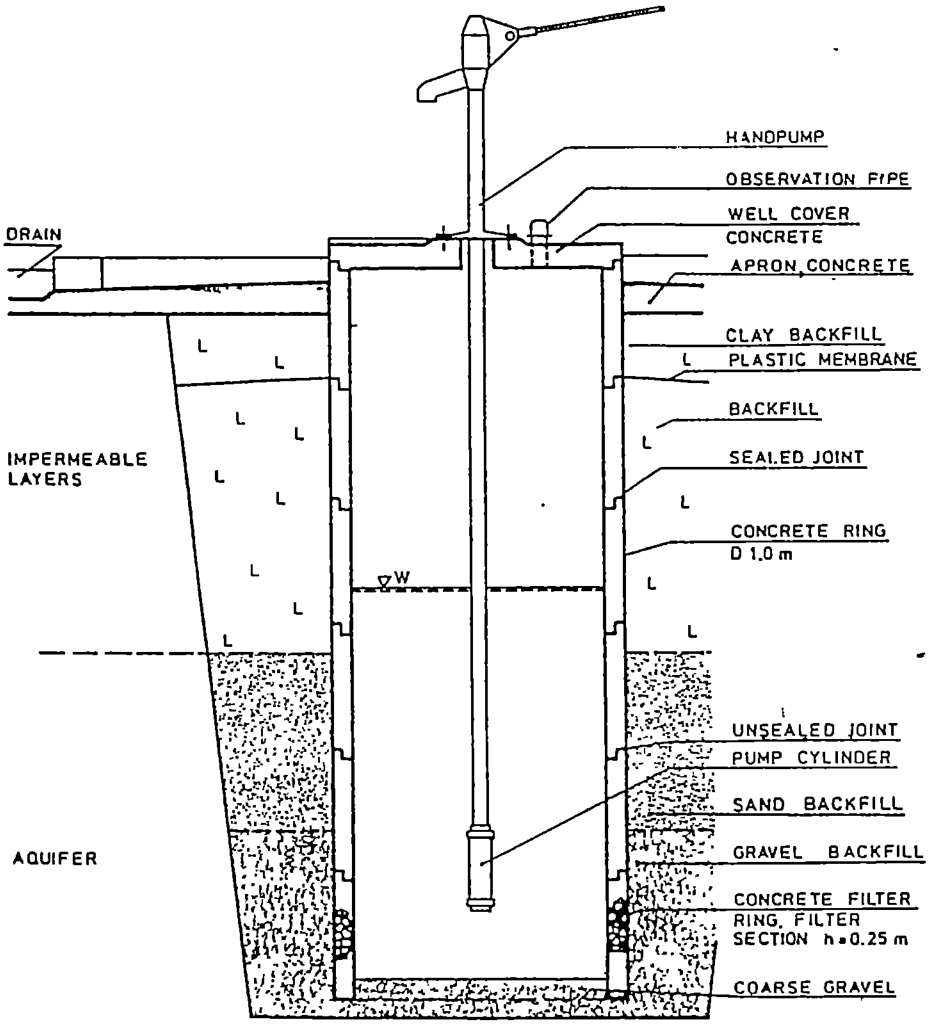


fig.5.1 Improved traditional water source

5.2 Shallow well - Ringwell with handpump

The shallow wells constructed in Mwanza municipality are lined with cement rings. Impermeable at the top to prevent surface water from infiltrating into the well and permeable rings below the groundwatertable.
The wells are all constructed with apron, soakway, and a concrete cover fitted with a handpump (Fig 5.2).Since hand-pumps installed in Developing Countries often are used by large communities there is however a recurrent problem of maintenance (11).



<u>Fig. 5.2 Shallow well - Ringwell with handpump</u>

Two types of handpumps were found on the wells included in the study;

NIRA AF 85

A Direct Action Reciprocating Pump, constructed in Finland. This pump is becoming more and more common in many rural water programmes in the world. NIRA is used exclusively on shallow wells down to about 12 metres in depth. The delivery rate varies between 15 and 25 litres per minute.

SWN 80/81 (Dutch)

A Lever Acting Reciprocating Pump which is more complex than Direct Action Pumps and therefore more difficult to maintain. The SWN 80/81 is however more robust and it is essential for all deep wells and heavy duty settings.

The concrete apron and soakway serves as a diversion of surface- and spillwater.

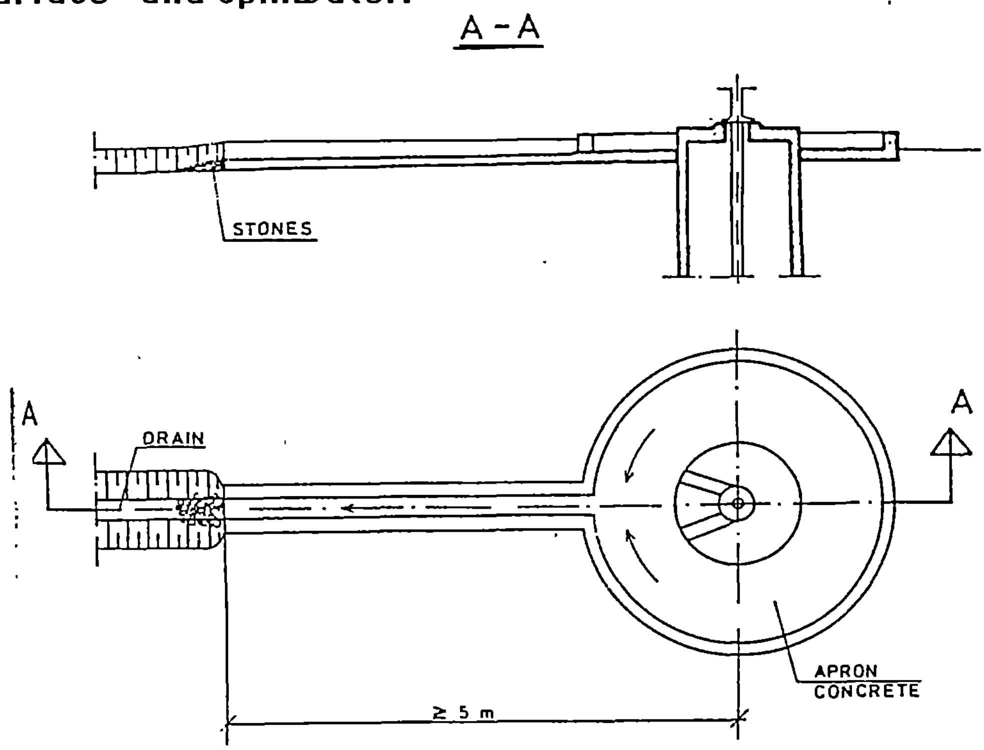


Fig. 5.3 Design of concrete apron and soakway

5.3 Borehole - Tubewell

Most boreholes drilled with mechanised rigs can be described as tubewells (Fig 5.3.), and these often penetrate into very deep aquifers where water is found in fractured rock layers. The tubewells included in the study ranged in depth between 11 and 20 metres. The handpump which was used on all of them was SWN 80/81.

Boreholes with correctly fitted and maintained pumps have an exellent potential for yielding water of good bacteriological quality, since groundwater in itself is free from bacteria and viruses. The main problem with water produced from boreholes is instead the physical/chemical constituents which often gives the water a corrosive and bad tasting nature. The taste of the water has proven to be an important factor in the users conception of quality. There are even cases where boreholes have been abandoned for heavily polluted old traditional water sources because of the sharp tasting groundwater (10).

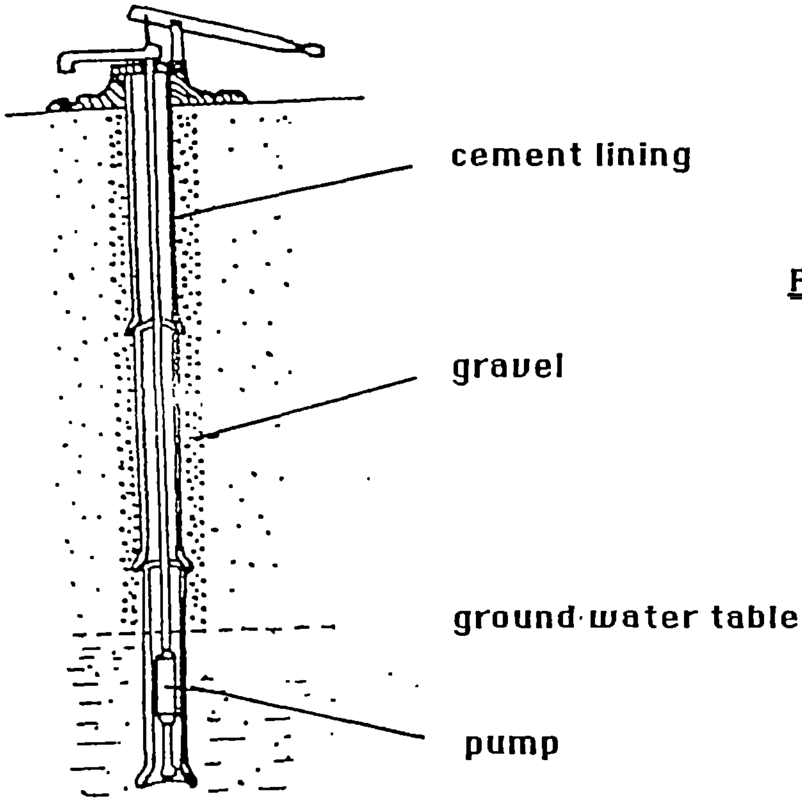


Fig. 5.4 Borehole-Tubewell

6.1 Field Procedures

Sampling for survey of bacteriological contamination was carried out from June 7th to July 8th, 1991 in Mwanza municipality. In the original plan it was anticipated that the sampling should be performed in more than one area but due to circumstances such as laboratory closing hours and lack of field transportation the plan proved to be unrealistic and the sampling area had to be limited to Mwanza municipality.

The sampling was carried out according to WHO guidelines (8). Water samples were collected in sterilized glass bottles with a glass stopper. A piece of aluminium foil was used to protect the stopper and the bottle neck from contamination. During transportation before and after sampling the bottles were stored in a coolbox to prevent any further growth of bacteria.

When collecting the water samples different techniques where used depending on the type of source. All shallow wells and boreholes included in the study had fixed hand pumps and were sampled in an identical way. The water was pumped at a maximum flow for 1-2 minutes, the flame from a cotton ball soaked in alcohol was used to sterilize the tap and finally the water was pumped at a medium flow rate to fill the bottle, leaving a small air space. The stopper was immediately fitted back on the bottle and fixed with aluminium foil.

When sampling the traditional water sources the bottle had to be attached to a stick with tape and then lowered down to the middle of the well without allowing it to touch the sides. When full, the bottle was raised and stoppered as described above.

Due to lack of space in the incubator a maximum of 6 samples could be collected during a days field trip. The time for incubation was 24 hours which limited the possible days for sampling to monday - thirsday in order to complie with laboratory working hours.

Transportation was usually possible to arrange through the Hesawa programme. But other commitments within the programme sometimes intervened and the shortage of jeeps forced us to cancel fieldtrips at short notice.

6.2 Laboratory procedures

For the bacteriological analysis the dipslide technique for detection of fecal coliform was used. The technique is suitable for field situations and it does not require any ancillary equipment other than an incubator. The dipslide consists of a sterile paddle on which is fixed a filter pad precoated with a growth medium (Fig.6.2).
In the laboratory the paddle is removed from it's plastic container, the container is filled with the water sample and the paddle replaced for about 1 min. to let the filter absorb 1 ml of the water sample.

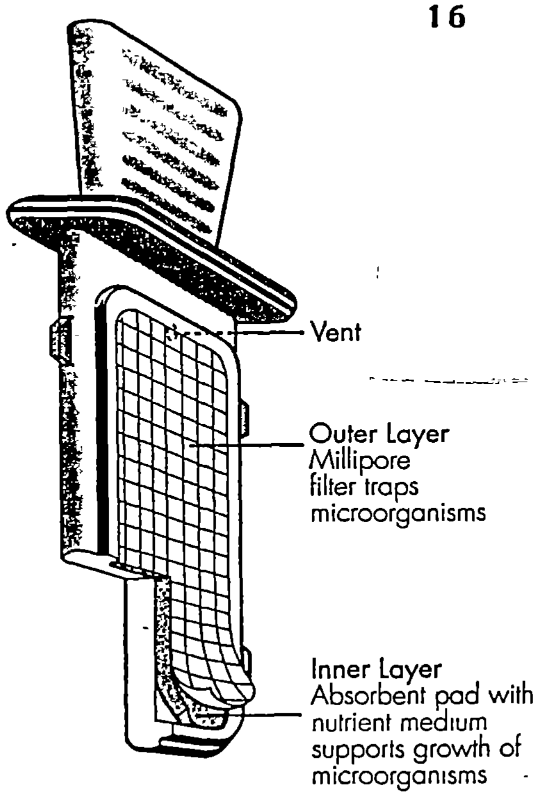


Fig. 6.2 Sampler design

After the set time the paddle is separated from the container and they are both shaken dry and put back together again. Finally the dipslide is incubated and colonies formed on the paddle can be counted at a visual inspection. The detection of fecal coliforms which was the aim of the analysis in this study, requires an incubation time of 24 hours in an exact temperature of 44.5 degrees Celsius.

6.3 Interpreting results

The result of the analysis have been determind by visual inspection of the dipslide paddle. Colonies growing on the filter surface of samplers were counted as individual organisms. The microbial colonies representing fecal coliforms are blue in colour. When using the water sample without dilution, as in this study, each colony represents 100 fecal coliforms per 100 ml. Dipslide analysis is considered highly dependable qualitywise, but as for the quantitative result the researcher are still in doubt. The results have therefore been regarded as an on/off assessment of fecal coliforms. Where the actual number of coliforms has been interpreted merely as an indication as to what extent the source is polluted.

7 SANITARY SURVEY

During the study a sanitary survey was performed on all the wells sampled for bacteriological analysis. A sanitary survey form was prepared (app. 3 & 4), based on the example provided in WHO Guidelines vol. III; 1985, and used consistently on all the water sources.
The form included the following choice of observation points;

7.1 Construction

- **Lifting device;** The device used to collect water should be kept in a hygienical way, and be well cleaned before lowered into the well.

- **Pump seal;** The quality of the seal between pump base and well head has to be good in order to prevent spillwater from entering the well. (This point was excluded in the observation of improved traditional water sources.)

- **Cover;** The cover should be intact, made from concrete and preferably locked to prevent contamination by surface water, animals or other objects.

- **Elevation;** The well should be situated in an elevated place, so that during the rainy season water will flow away from it rather than into it.

- **Apron;** The apron should cover 3 metres in diameter of the immediate surrounding of the well head. The edges should be raised and the surface sloped towards a soakway. The apron should be reinforced with steelwire to prevent from cracking.

- **Soakway;** The soakway should be between 6 and 10 metres long, made out of reinforced concrete, leading to a seepage area where preferably bananas, trees, sugar canes or vegetables are planted. The seepage area requires a lot of local care and management.

7.2 Surroundings

- **Dunghills;** The safety distance between a water source and a dunghill should be at least 30 metres, with the water source downhill.

- **Animal-presence;** Cattle kraals should be located downhill from the well site and on the same distance as latrines and dunghills (30 m).

- **Fence;** The well site should be properly surrounded by a fence to prevent animal precence in the area.

- **Latrines;** To minimize the risk of groundwater transportation of bacteriological pollution from pit latrines the well should be situated at least 30 metres uphill from the latrine.

- **Paths;** Paths leading to the water source shold preferably reach the well from the downhill side.

8 RESULTS

The results of the survey on bacteriological water quality and sanitary conditions are presented in the following chapter depending on the type of water source concerned.
During the study in Mwanza municipality 21 shallow wells, 8 improved traditional water sources and 4 boreholes were examined.
12 samples have been left out of the report since the results were judged as doubtful due to electricity failure during the incubation period. The samples were collected in 18 different villages all within the Mwanza municipality (app. 2).

8.1 Improved traditional water sources

village	ward	fecal coliforms/100 ml
1.Buswelu	Buswelu	TNTC
2.Chabakima	Igogwe	300
3.Masemere	Igogwe	200
4.Masemere	Igogwe	100
5.Kabangaja	Igombe	<100
6.Bugando	Igombe	<100
7.Nyafula	Sangabuye	100
8.Nyafula	Sangabuye	200

table 8.1 Bacteriological contamination (fecal coliforms/100 ml) in improved traditional water sources in various villages in Mwanza municipality.

8.1.1 Sanitary situation

The results of the form used to investigate the sanitary situation at the Improved traditional water sources can be summarized as follows.

	1	2	3	4	5	6	7	8
cover	-	-	-	-	-	x	x	x
elevation	-	-	x	x	x	x	x	x
lining	-	x	-	x	x	x	x	x
lifting device	-	-	-	-	-	-	-	-
fence	-	-	-	-	-	-	-	-
no latrines	x	x	x	x	x	x	x	x
no animals	x	x	x	x	x	x	x	x
no uphill paths	x	-	x	-	-	x	x	x

x = yes / functioning - = no / not functioning

8.2 Shallow wells

well no.	village	ward	fecal coliforms/100 ml
1. 21/4-34	Igombe	Bugogwa	500
2. 21/4-44	Igombe	Bugogwa	1300
3. 21/4-43	Igombe	Bugogwa	900
4. 33/2-50	Bujingwa	Buswelu	<100
5. 33/2-48	Buhira	Buswelu	<100
6. 33/2-53	Bulola	Buswelu	<100
7. 21/4-18	Bugando	Igombe	200
8. 34/1-125	Fumagila	Igoma	<100
9. 34/1-126	Fumagila	Igoma	100
10. 34/1-123	Fumagila	Igoma	300
11. 33/2-58	Igoma	Igoma	<100
12. 33/2-56	Igoma	Igoma	TNTC
13. 33/2-92	Mahina	Igoma	100
14. 33/2-41	Mahina	Igoma	<100
15. 33/2-42	Mahina	Igoma	<100
16. 33/2-67	Nyamhongolo	Buswelu	<100
17. 21/4-44	Kayenzendogo	Bugogwa	<100
18. missing	Nyamwilolelwa	Ilemela	300
19. 21/4-26	Nyamwilolelwa	Ilemela	1000
20. 21/4-49	Sangabuye	Sangabuye	<100

Table 8.2 Bacteriological contamination(fecal coliforms/100 ml) in shallow wells in various villages in Mwanza municipality.

8.2.1 Sanitary situation

Sanitary survey results from Shallow wells are summarized in the following table. Since all shallow wells were of recent construction with similar sanitary standard on pump, pump-seal, cover and lining these are not accounted for in the table.

	1	2	3	4	5	6	7	8	9	10
apron	x	x	x	-	x	x	x	x	x	x
soakway	x	-	x	-	x	-	x	x	x	x
fence	-	-	-	-	-	-	-	-	-	-
no latrine	x	x	-	x	x	x	x	x	x	x
no animals	x	-	x	x	x	x	x	x	x	x
no uphill paths	-	-	x	x	-	x	-	-	-	-
elevated	-	-	-	x	x	-	-	-	-	-

	11	12	13	14	15	16	17	18	19	20
apron	x	x	x	-	x	-	-	-	x	x
soakway	-	x	x	x	x	-	x	x	x	x
fence	-	-	-	-	-	-	-	-	-	-
no latrine	x	x	x	x	-	x	-	x	x	x
no animals	x	-	-	x	x	x	x	x	x	-
no uphill paths	x	-	x	-	x	x	-	x	-	-
elevated	-	-	-	-	x	x	x	-	-	x

x = yes / functioning
- = no / not functioning

8.3 Boreholes

reg. no.	village	ward	fecal coliforms/100 ml
1. 4/89	Buswelu	Buswelu	<100
2. 64/86	Fumagila	Igoma	<100
3. 17/80	Saba Saba ground		<100
4. 7/89	Sangabuye	Sangabuye	<100

Table 8.3 Bacteriological contamination (fecal coliforms/100 ml) in boreholes in various villages in Mwanza municipality.

8.3.1 Sanitary situation

	1	2	3	4
apron	x	x	x	x
soakway	x	x	x	x
fence	x	-	-	-
no latrines	x	x	x	x
no animals	x	x	x	x
no uphill paths	-	x	-	x
elevated	-	x	-	x

x = yes / functioning
- = no / not functioning

8.4 Water analysis - summary

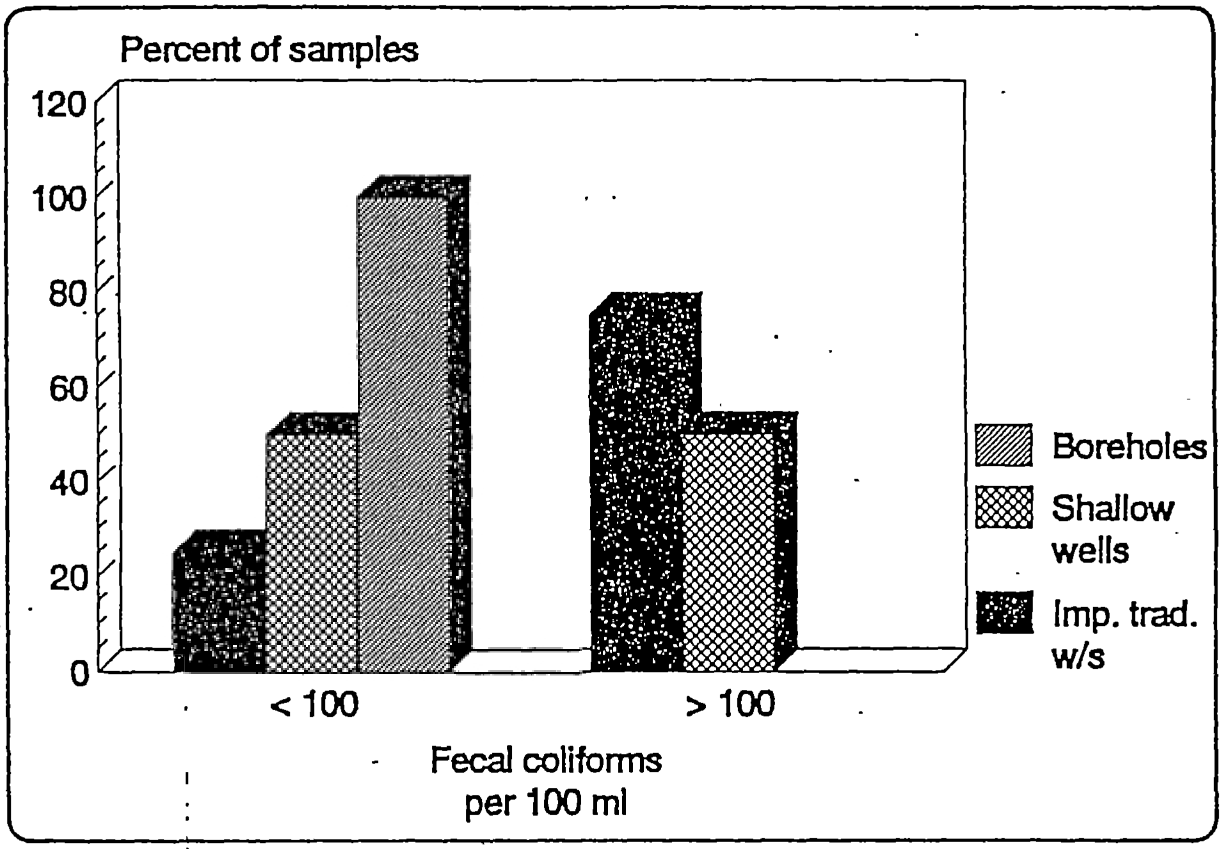


Fig. 8.4 Distribution of fecal coliform counts from untreated sources in Mwanza municipality.

9 DISCUSSION

9.1 Applicable standards

For unpiped water supplies as those concerned in this study, the World Health Organization (WHO) stipulates less than 10 coliforms and no fecal coliforms per 100 ml (8). These standards have however been questioned on the grounds of being too stringent.(12)

To enforce the international WHO standards on bacteriological water quality would be of little practical value in the Mwanza area. A majority of the sources included in the study would be rejected and since the choice of sources and opportunities for treatment are limited, the surveillance might result in forcing people to turn to unprotected traditional sources, usually heavily polluted.

In developing national standards based on the WHO guidelines it is necessary to take into consideration the local geographical, socio-economic and industrial conditions. This may lead to a national or local standard that differ appreciably from the guideline values. Urban supplies where one central source and treatment plant serves thousends of people must of course be subject to higher standards and surveillance than untreated small community supplies as those included in the study.

The following standards where recomended by the National Bacteriological Laboratory (SBL) in Sweden when establishing water quality surveillance in Botswana 1986 (13).

	Faecal coliforms	Total coliforms
Rural supplies	< 100	< 100
Urban supplies (after treatment)	< 2	< 1

The results of the study will be discussed with reference to the SBL-standards mentioned above since they are considered more applicable to local conditions.

9.2 Water quality - Sanitary situation

The results of bacteriological analysis and sanitary surveys at traditional water sources included in the study indicates that a major part of the sources (75 %) yield water of unacceptable quality. According to the sanitary survey many of the sources are improved with some protective features, but since none of them are built with all the features combined they still yield water of poor quality.

Inspite of adequate measures of sanitary protection, which was the case at most of the shallow wells, 50 % of the sources still supply water of unacceptable quality. It is evident that there is an external pollutant with greater effect in well pollution, outweighing the well protection.

All the boreholes tested in the study supplied water of acceptable quality. The sanitary situation at the source was judged as fairly good both construction- and locationwise. The utilization of a few boreholes and also some shallow wells was however questioned since the smell of sulphurhydrogen was detected when pumping water, indicating "standing water" in the pipes.

9.3 Bacteriological water quality surveillance

In order to reach improvement in the area of water quality there has to be a surveillance system striving for a realisticly set standard. An effective surveillance system is however difficult to organize. It requires trained staff for sampling and sanitary surveys, laboratory facilities for bacteriological analysis and routines for remedial and preventive actions at the water source.

9.3.1 Laboratory analysis - Sanitary survey

Bacteriological analysis on its own can never give a complete picture of the sanitary situation at the source. The results are only inicative of the contamination level. Since it is usually not possible to do a repeated series of samples, the results indicate a momentary situation only, without any diurnal or seasonal variations.

Complementary to the sampling of the water source there should therefore be a sanitary survey of the construction and surroundings of the source. Conducted by a trained sanitary inspector this could provide a range of information on potentially hazardous conditions which later may be verified by the results of water analysis.

When combining these two methods of quality surveillance the health risks due to bacteriological contamination are largely covered and the results can be followed up by remedial and preventive actions such as operation and maintenance programmes and rehabilitation of water sources.

9.3.2 Responsibilities

The MAJI Water quality laboratory is well staffed but not equipt to carry out bacteriological surveillance. The presently used Membrane Filter method is acceptable for sampling shallow wells and boreholes, traditional water sources are however often high on organic material and should be tested by i.e. the Multiple Tube method. The requirements for one years sampling by M-F mehtod are listed in app. 5. The analysis for total coliforms intended by the Department of Health (AFYA), with so called Aquatubes was tested during the study and found to be extremely unreliable and not relevant for a future surveillance programme.

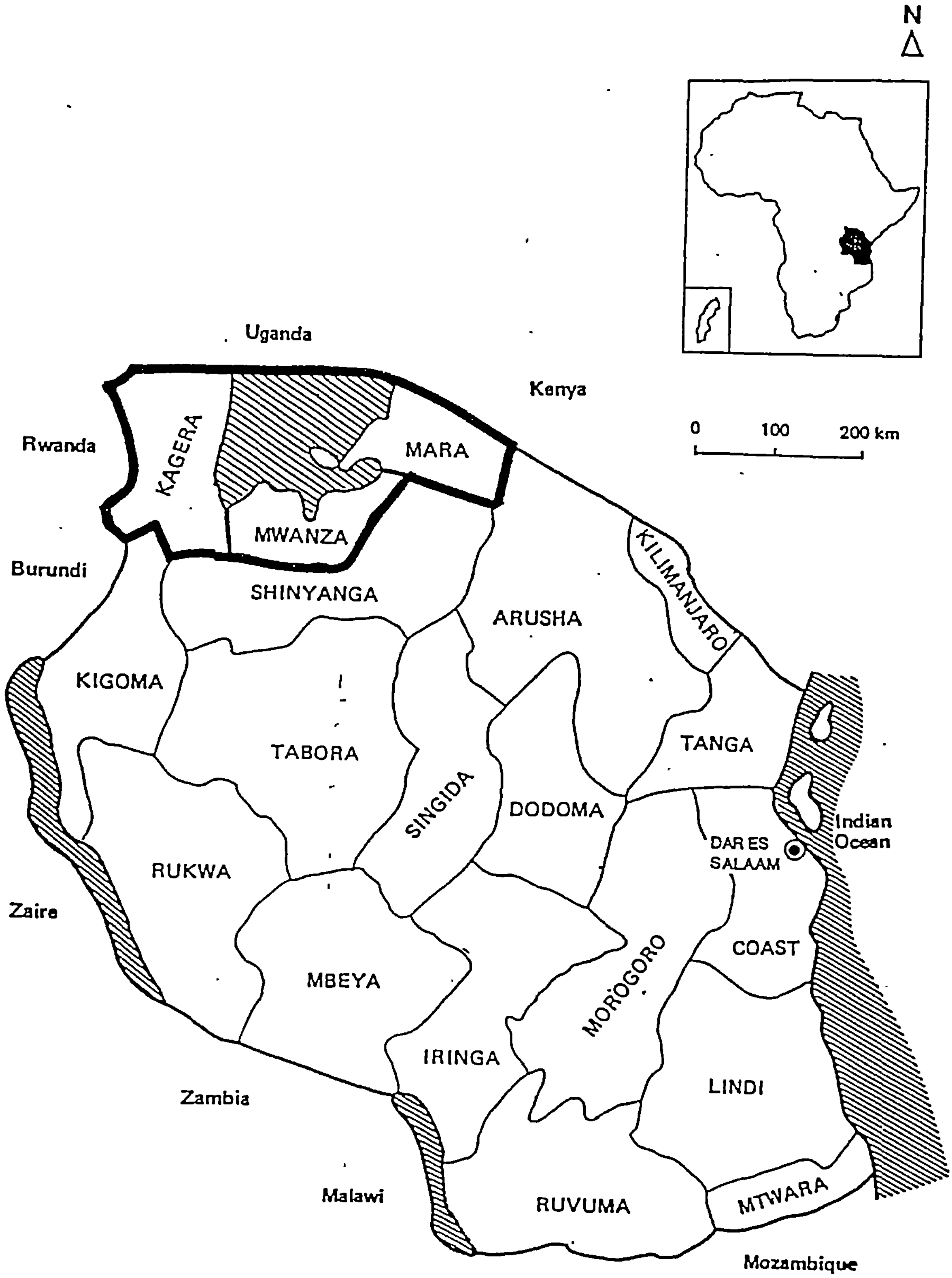
The sanitary survey should be performed by a trained health inspector i.e. in combination with other field work. To prevent any conflict of interest the survey is preferably carried out by the Department of Health (AFYA), who is not involved in the construction of water sources. The quality surveillance does however require a close cooperation between involved authorities in order to reach quick and reliable desicions regarding remedial and preventive actions (app. 6).

Knowledge of the potential hazards of poor protection of a water point should also be taught to local communities, so that they themselves may be in a position to detect and improve weaknesses in the supply.

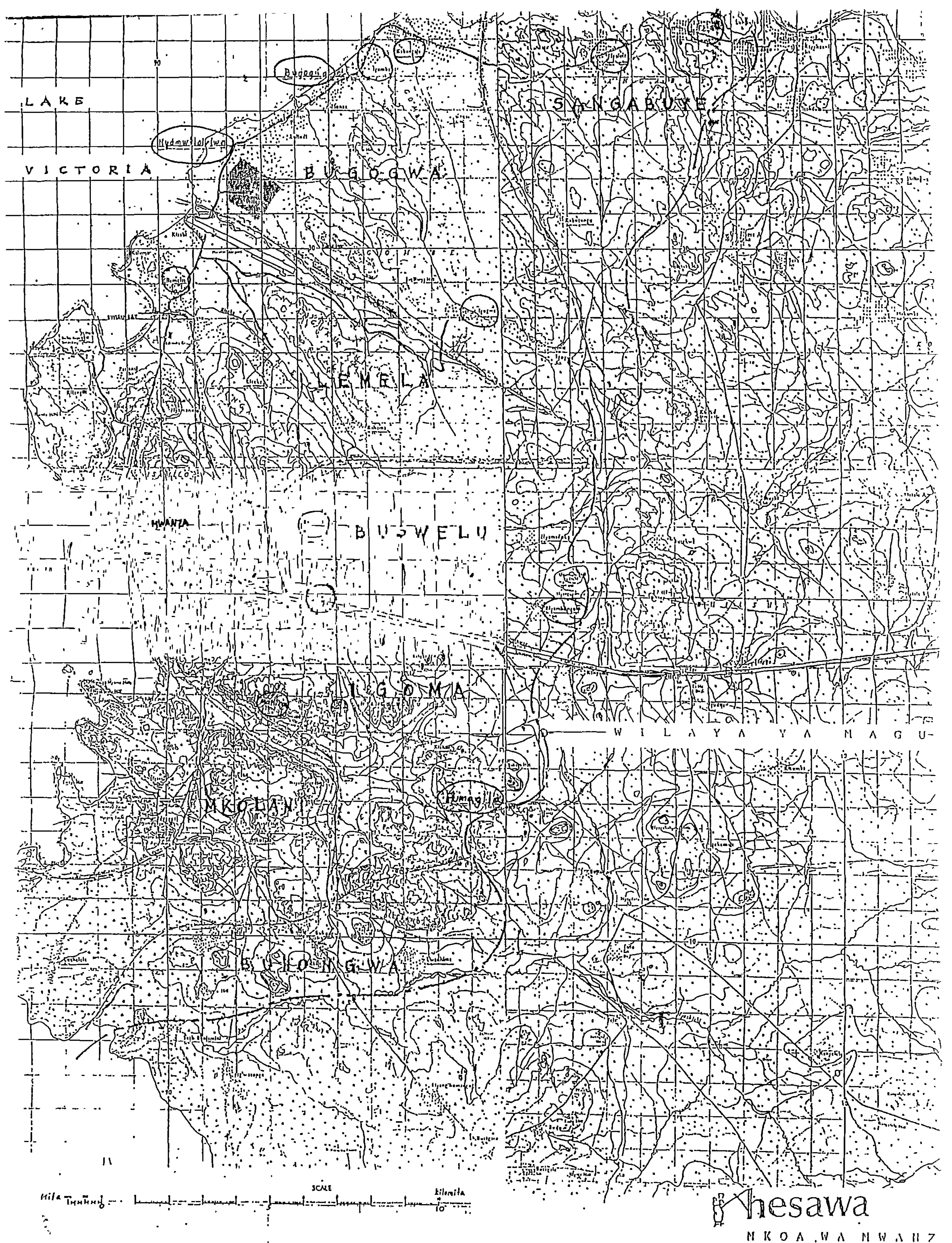
9.3.3 Inspection frequency

The surveillance should be continous and frequent enough to allow statistically significant conclusions, contrary to the indicative ones in this study. Each source should be sampled during the constructional phase and after that at least two times a year. Since the quality of water deteriorates during the rainy season (14,15), an increased number of inspections should be carried out during this time.

app. 1



TANZANIA - ADMINISTRATIVE BOUNDARIES (REGIONS)



○ = VILLAGES INCL DED

APPEND 2

Thesawa

MKOA WA MWANZ

WILAYA YA MWANZA

Ramani ya eneo la teule

GENERAL RISKASSESSMENT I

Village name:

Well no. :

Fecal coliforms:

WELL CONSTRUCTION	YES	NO	QUALITY
PUMP			
PUMP SEAL			
COVER			
LINING			
LINING DEPTH			
APRON			
SOAKWAY			
LIFTING DEVICE			
DEPTH			
WIDTH			

QUALITY CLASSIFICATION: (1-5)

1. Very good
2. Good
3. Acceptable (functioning)
4. Poor
5. Very poor (not functioning at all)

GENERAL RISKASSESSMENT II

Village name:

Well no. :

Fecal coliforms:

WELL SURROUNDINGS	NOTES
USAGE	
FENCE	
CATTLE	
PIT LATRINES	
DUNG HILLS	
BIRDS, WILD ANIMALS	
PATHS	
SOIL	

LABORATORY REQUIREMENTS

1.General materials for Total and Fecal coliform analysis for 1 year (about 1000 samples).

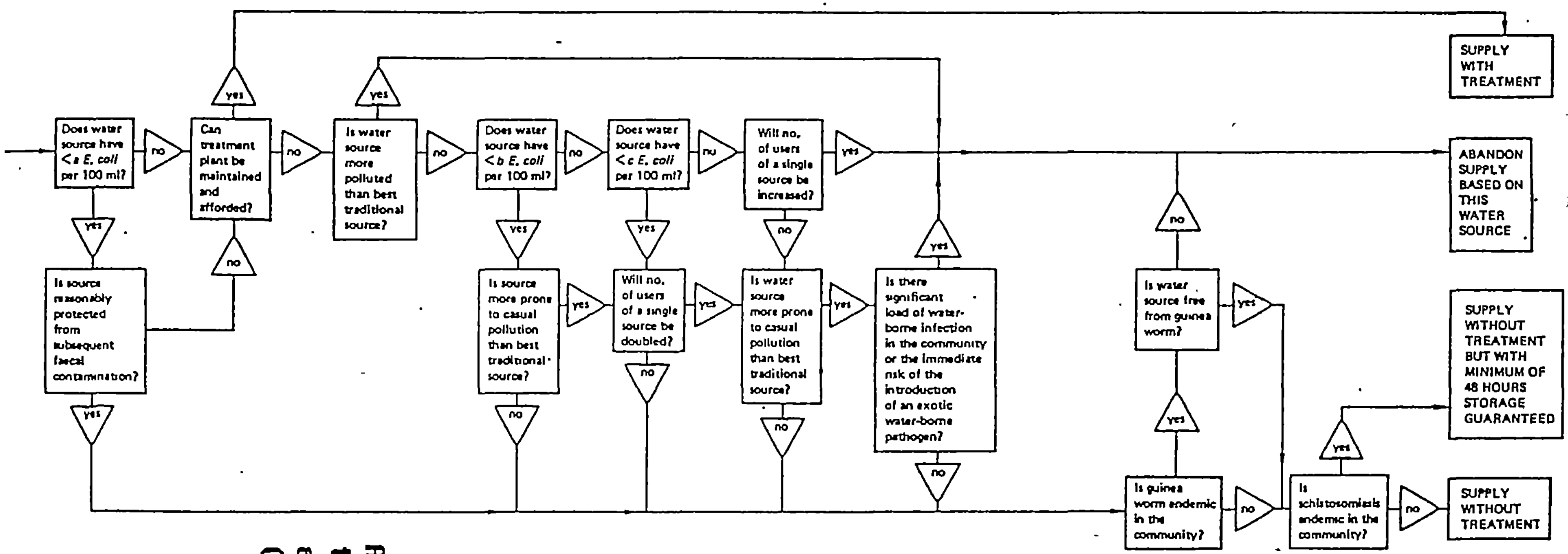
	Quantity
1. Air/filter pump (vacuum at least 400 mm Hg for membrane filtration)	2
2. Colony counter and magnifier lens	2
3. Incubator (laboratory and portable)	2
4. Membrane filter holders	2
5. Water test kit (for field use)	1
6. Autoclave	1
7. Aluminum foil	30 m
8. Bleach	1 litre
9. Buffer soulution	1 litre
10. Cotton wool	2 kg
11. Phosfate buffer (Sodium hydroxide and Sodium Thiosulfate)	12 kg
12. Spirit, methylated	1 litre
13. Wax pencils	10 pieces

2. Specific materials for 1000 Total coliform (T.C) tests.

	Quantity
1. M-endo (including 20 % wastage)	115 g
2. Ethyl alcohol	2 litres
3. Membrane filters and pads	1000

3. Specific materials for 1000 Fecal coliform (F.C) tests.

	Quantity
1. M-FC broth (including 20 % wastage)	100 g
2. Resolic acid	0.2 litres
3. Bags (polythene)	100
4. Membrane filters and pads	1000



Possible values of water pollution constants:
a = 10
b = 100
c = 1000

An algorithm of the decision to treat, not to treat or to abandone a particular source (4).