

824 TZZA92

LIBRARY

REF. INCL.

Y. AND

S:

ZANZIBAR URBAN WATER SUPPLY PROJECT

ENVIRONMENTAL REPORT

Based on the short term consultancy
of Jaana Pasanen 22.1. - 4.3. 1992

PLANCENTER LTD
May 1992

824-TZZA92-9869

TABLE OF CONTENTS

1.	EXECUTIVE SUMMARY	1
2.	INTRODUCTION	1
3.	PRESENT SITUATION	2
3.1.	Laboratory work in the project	2
3.2.	Environmental work in the project	3
3.2.1.	Environmental assessment of water intakes (pit-latrines study)	3
3.2.2.	Protection of ground water intakes	3
3.2.3.	Environmental education	3
4.	PLANS AND RECOMMENDATIONS	4
4.1.	Laboratory work in the project	4
4.1.1.	Water quality control programme for March-August 1992	4
4.1.2.	Job descriptions for the laboratory personnel	5
4.1.3.	The new laboratory	6
4.1.4.	A laboratory unit in Pemba	7
4.2.	Environmental work in the project	8
4.2.1.	Environmental assessment of water intakes (pit-latrines study)	8
4.2.2.	Protection areas around water intakes	8
4.2.3.	Environmental education	8
4.2.4.	Pesticide study	8
5.	A LIST OF PERSONS CONSULTED	9

LIBRARY, INTERNATIONAL CONFERENCE
CENTRE FOR COMMUNITY WATER SUPPLY
AND SANITATION
P.O. Box 27180, 1117 AD The Hague
Tel: (070) 814011 ext. 141/142

LSW 9869

LO: 824 T22A92

- ANNEX 1: TOR for environmental study**
- ANNEX 2: Bacteriological and chemical analyses since September 1990**
- ANNEX 3: Results of the water analyses in 1992**
- ANNEX 4: Summary of the laboratory excursion in Dar es Salaam**
- ANNEX 5: Results of the environmental assessment study**
- ANNEX 6: Detailed work programme of the water laboratory**
- ANNEX 7: Preliminary protected area plan around water intakes**
- ANNEX 8: A summary about pesticides and fertilizers used in Mwanyanya tree nursery**

1. EXECUTIVE SUMMARY

The environmental work in the Zanzibar Urban Water Supply Project was started in 1990 during the planning phase of the project by making an environmental assessment and starting water quality monitoring work. As a result, a Preliminary EIA Report was prepared.

During 1990-1991 the environmental monitoring was continued by:

- laboratory work
- environmental assessment of water intakes
- some protection measures of water intakes
- some environmental education activities

In the beginning of 1992 a short term consultancy was made to the project by Ms. Jaana Pasanen to assess the present situation regarding the environmental monitoring work. The following plans and recommendations were born during the visit (presented more detailed in this report):

- water quality monitoring should be done more systematic way
- the new water laboratory, which is scheduled to be ready in August-September 1992, should be developed as central water laboratory of Zanzibar, serving both urban, rural and waste water development
- the equipment of the existing water laboratory should be shifted to Pemba when the new laboratory is established
- environmental assessment of the water intakes shall continue until all of them are studied
- much effort has to be put to the establishment protection zones around the water intakes
- selected personnel of the water project shall participate the EIA training arranged by FINNIDA for the ZILEM project in Zanzibar in June 1992
- no detailed pesticide study is recommended at this stage
- a short term environmental and laboratory consultancy shall take place to the project during the establishment of the new laboratory to assist in the set up of the laboratory and training of the laboratory staff, as well as to make a general situation analysis of the environmental work

2. INTRODUCTION

The report is based on the visit of Ms. Jaana Pasanen, an environmental consultant from Plancenter Ltd, to the Zanzibar Urban Water Supply Project. The consultancy assignment was for six weeks and its terms of reference are presented in annex 1. The data for the report was collected by working with the project personnel and interviewing people working in the environmental sections and representatives of local authorities involved in the project.

The report has been written in Finland by Jaana Pasanen with assistance of Auli Keinänen, Environmental Hygienist of Plancenter Ltd.

3. PRESENT SITUATION

3.1. *The laboratory work in the project*

After the establishment of the laboratory in 1990 the laboratory staff was trained and supervised for one month. Data about chemical and bacteriological analyses made in urban water intakes and some local wells in Unguja and Pemba since September 1990 is presented in annex 2. The first analyses carried out after the two months of the establishment of the laboratory in June 1990 were presented in the Preliminary Environmental Impact Assessment document published in 1991.

The latest results of the analyses carried out in the laboratory are presented in annex 3. The chemical quality of water is according to WHO guidelines (with the exception of iron and manganese levels, as well as color and turbidity in some intakes) and the main concern is bacteriological quality. Parameters analyzed were: color, turbidity, temperature, pH, conductivity, total dissolved solids, carbon dioxide, hardness, chloride, salinity, nitrite, nitrate, phosphorus, fluoride, total iron, manganese, chromium, copper, nitrogen-ammonia, cyanide (in some samples), as well as total and fecal coliform bacteria.

Although some chemical and bacteriological analyses have been made the laboratory work has not been as regular and continuous as was previously planned. The lack of direct supervision has resulted to a situation where the water quality monitoring has not been done properly. For instance no proper reporting of analyse results have taken place and no water analyses have been made during rainy season in spring time.

The general laboratory management has not been followed properly. It should be emphasized more that the laboratory has to be clean and all the files and the results of water analyses have to be in order and updated. Also more emphasis is needed on book-keeping of chemicals and reagents as well as on thinking and planning ahead. The insufficient book-keeping has been one reason for the shortage of chemicals and furthermore for the lack of water analyses.

A two day laboratory excursion with two of the laboratory staff was made to Dar es Salaam (30 - 31.1.1992) in order to get new ideas about general laboratory management and to provoke discussion within the laboratory staff about laboratory management and routines. The report of the excursion is presented in annex 4.

At the moment four laboratory technicians are working in the laboratory. Three of them have been there since the start of the laboratory in June 1990. The fourth technician has started to work in the laboratory about half an year ago. Obviously there has not been enough work for all of them.

The present load of work in the laboratory will be enough for two or three technicians. Only two can work efficiently in such a small laboratory at one time. With better division of tasks and with regular reporting and monitoring (as was previously planned) three technicians could have enough work to do and the laboratory would be more productive.

3.2. Environmental work in the project

3.2.1. Environmental assessment of water intakes (pit-latrines study)

A purpose of the environmental assessment of water intakes is to count all houses with or without pit-latrines or septic-tank and other potential sources of pollution at a certain distance (at least 300 meters) from each urban water intakes in Unguja and in Pemba in order to get information about potential pollution risks. The information received from this study will be used in ground water protection planning. Environmental assessment study is scheduled to be completed in April 1992. Preliminary plans for protection areas will be given to Zanzibar Integrated Land Use and Environment Management Project (ZILEM) in the end of April.

All four laboratory technicians will participate (under supervision of Mr. Hamad Juma Bakar, hydrogeologist) in the pit-latrines survey around each urban water intake in Unguja. The same study will also be done in Pemba.

The first results of the environmental assessment of water intakes are presented in annex 5.

3.2.2. Protection of ground water intakes

In Unguja about 600 trees have been planted in six water intake areas: Mtoni and Bububu spring, Kijito Upele, Mwembe Mchomeke, Chunga, Kaburi Kikombe and Kianga borehole. Unfortunately many of the trees have died of draught or have been eaten by the cattle. More planning, and follow up is needed for the protection activities.

3.2.3. Environmental education

According to the Work Plan 1992 of Zanzibar Urban Water Supply Project much effort will be put to the community education and participation during this year. The aim of the environmental education is to increase people's awareness of the impact of their own behavior on the water supply and to make people understand the close relationship between water, sanitation and health. The responsibility of the urban residents for their water sources will also be increased.

An educational TV-programme was the topic of the second education meeting held on the 4th of February in Zanzibar. The meeting was participated by Deputy Director of the Institute of Marine Science, two producers-directors from Zanzibar TV and two hydrogeologists, the training officer, the training and management consultant and the environmental consultant of the water project. TV of Zanzibar has started to make television series about water supply. The first half hour TV programme (title: usilolijua = something that you don't know) will be ready in the near future. The programmes are recorded on video in order to be shown repeatedly in different kinds of educational occasions e.g. by the Village Video Project.

Other activities included in the Community Education and Participation are presented in the Work Plan 1992 of Zanzibar Urban Water Supply Project.

In June 1992 an EIA-training course is planned to be conducted in Zanzibar Integrated Land Use and Environment Management Project. The training is arranged by Mr. Kari

Silfverberg (Environmental Advisor, FINNIDA) and Mr. Paul Driver (EIA-Consultant, IUCN). It is recommended that some local and expatriate employees of the Water Project will participate in the training (e.g. Training and Management Consultant (exp.), Hydrogeologist (local), Water Engineer (local), at least one laboratory technician, etc.).

4. PLANS AND RECOMMENDATIONS

4.1. Laboratory work in the project

4.1.1. Water quality control programme for March-August 1992

A water quality monitoring plan was prepared in February 1992 for March-August 1992, and is now followed up by the laboratory staff. In August, a new plan needs to be prepared for the new laboratory arrangements.

During March-August one sampling trip is going to be made each month to Unguja. A sampling trip to Pemba is going to be made every third month; in March and in July. The water quality control programme consists of analyses and reporting. The following chemical and bacteriological analyses should be made for all the samples. (Depending on the situation also other analyses e.g. chromium, copper, lead can be made if needed.)

a) Chemical and physical analyses:

- Appearance
- Odour
- Color
- Turbidity
- Temperature
- pH
- Conductivity
- Total dissolved solids
- Carbon dioxide
- Hardness
- Chloride
- Nitrate
- Nitrogen Ammonia
- Phosphorus
- Fluoride
- Iron
- Manganese

b) Bacteriological analyses:

- Total Coliforms
- Fecal Coliforms

c) Reporting:

A report consisting of all the laboratory data in table form (chemical and bacteriological data in one table) and a short summary should be made every month.

- A monthly report consists of:
- data from Unguja sample trip
 - data from Pemba sample trip (when visited)
 - weekly bacteriological analyses

In addition to the monthly sampling trips bacteriological analyses are going to be made every week to the following four intakes:

- Mtoni spring
- Bububu spring
- Kaburi Kikombe borehole
- Kijito Upele borehole

The results of the bacteriological analyses will be annexed into monthly report.

The more detailed work programme for the laboratory is presented in annex 6.

4.1.2. Job descriptions for the laboratory personnel

Job descriptions have been made for laboratory technicians to facilitate and increase the efficiency of the laboratory work. Sharing of responsibilities could also increase the motivation of the laboratory personnel. Very high specification, however, is not reasonable or possible in a small water laboratory. Everybody has to be able to do all types of laboratory work when necessary. All the staff should be involved in the general laboratory management.

One of the four technicians should go to work in Pemba when Pemba laboratory unit is established.

The job descriptions below are made for the existing water laboratory. When Saateni new laboratory is completed, they can be revised and detailed descriptions made if necessary.

Lab Techn. 1 (Mrs. Sanura, employee of the Urban Water Supply Section)

Duties:

- * to be a contact person between the project office and the laboratory
- * to be responsible for laboratory management:
 - taking care of necessary items; papers, copies, mark pens, washing liquid, towels etc.
 - organizing and participating in weekly cleaning of the laboratory
 - making chemical order together with other laboratory staff
 - book-keeping of chemicals
 - taking care of the chemical store
- * to carry out bacteriological analyses

Lab Techn. 2 (Mr. Mohammed, employee of the Department of Water Development)

Duties:

- * to be responsible for monthly reporting:
 - writing summaries with the assistance of other laboratory staff

- * to carry out chemical analyses
- * to participate in general laboratory routines; cleaning, planning

Lab Techn. 3 and 4 (Mr. Ameir and Mr. Omar, employees of the Urban Water Supply Section)

Duties:

- * to carry out chemical analyses
- * to assist in reporting
- * to participate in general laboratory routines; cleaning, planning
- * to take care of the availability of distilled water
- * to keep the data updated and in order
- * to assist in book-keeping of chemicals

4.1.3. The new laboratory

The new laboratory in Saateni is scheduled to be ready in August-September 1992. By that time all equipment and laboratory ware should be there as well as all personnel needed.

a) Supervision

The existing laboratory staff needs supervision. The new laboratory should have a local chemist who can take the overall responsibility of the laboratory work. In addition to supervision of continuous water monitoring training is also needed for the laboratory staff to make their reagents and bacteria media themselves instead of using ready-made kits. Also the use of new laboratory equipments requires specific training of the staff.

During the establishment of the new laboratory, a visit of a short term expatriate laboratory consultant is needed.

b) Laboratory practices

A continuous and detailed water monitoring programme needs to be developed for the laboratory. It should be planned very carefully which analyses are needed to be made continuously and which occasionally.

Both chemical and microbiological analyse methods shall be developed. For instance fecal streptococcus bacteria could also be analyzed. In addition to membrane filtration technique in bacteriological analyses MPN-method (most probable number) should be introduced in the new laboratory.

All the reagents and culture media are to be made in the laboratory. Ready-made kits; ampules, reagents etc. should only be used in emergency situations, if at all. The possibilities to buy necessary chemicals closer to Zanzibar e.g. from the neighboring countries should be enquired. This way they could faster be received in Zanzibar.

More effort has to be put to the laboratory analyses during the rainy season.

It is recommended that in future the urban water laboratory could extend its activities for rural water and waste water monitoring, i.e. the laboratory could be developed into a central water laboratory in Zanzibar.

c) Training of the laboratory staff

Training of the laboratory staff becomes important when the new laboratory is completed. The real need of training can more precisely be determined when the functioning of the laboratory is better known.

The training will be mainly practical training in the project laboratory given by the expatriate environmental and laboratory consultant, the new chemist and by some other local expert. Depending on the situations it would be recommended to participate in practical training in the other laboratories in Tanzania e.g. in the Central Government Laboratory in Dar es Salaam.

d) Equipments needed

Permanent and sustainable equipment will be ordered to the new laboratory. The old equipment will be transported to Pemba. A rough list of requirements is given below.

List of equipment:

- spectrophotometer
- pH-meter
- conductivity-/chloride-meter
- titration equipments
- distiller
- 2 incubators
- autoclave
- oven
- balance
- refrigerator
- other necessary equipments and glassware

4.1.4. A laboratory unit in Pemba

As soon as the new laboratory is completed a laboratory unit will be established in Pemba. One room in the project office of Chake Chake town will be set up as a small laboratory. In the near future both bacteriological and chemical analyses will be made in Pemba although the focus of the laboratory work will be in bacteriological analyses. The idea is to transfer the equipments now used in Zanzibar laboratory to the Pemba laboratory unit.

The pemba laboratory unit will work in close connection with the new laboratory in Unguja, under the supervision of the chemist there.

4.2. Environmental work in the project

4.2.1. Environmental assessment of water intakes (Pit-latrine study)

The environmental assessment of water intakes (pit-latrine study) will continue in Unguja and Pemba until all the intakes have been studied, probably by the end of April 1992.

4.2.2. Protection areas around water intakes

Preliminary recommendations for protection of urban water intakes (annex 7) have been given to the committee of the government, who is making a proposal for protection of water catchment areas.

A protection area around Mtoni spring, one of the most important urban water intakes, should be established very soon. According to the pit-latrine survey, nearly the whole catchment area is full of houses. Half of the houses have not latrine at all and half of them have pit-latrines, which can not be considered suitable for the catchment area.

Bububu spring area can still be protected with relatively small efforts, because the spring is located in the center of the forest. Only the close location of the Mwanyanya tree nursery in the catchment area can be problematic. Mwanyanya tree nursery is located about 250 meters away from the spring in a more elevated area. In the whole area soil is very permeable. A report of the use of pesticide in Mwanyanya tree nursery is presented in annex 8.

4.2.3. Environmental education

Lots of information about the importance of the clean drinking water will be spread among urban residents. Educational TV and radio programmes will be made as well as "key persons" e.g. teachers and health workers will be trained. Citizen's Water Supply Guide will also be prepared.

Appointment of information officer to the project this year will also increase interaction between users of the water/customers and Urban Water Supply Section. The officer will inform the customers about the safe use of water.

4.2.4. Pesticide study

The Mwanyanya tree nursery in Bububu spring area and the grain mill (located about 250-300 meters away from the spring) in Mtoni spring area were visited in order to estimate the need of detailed pesticide study. More observations about the use of pesticides should be made in rainy season in Mwanyanya tree nursery (annex 8). No pesticides are so far used in the grain mill.

A very detailed and careful plan has to be made if pesticides will be analyzed from certain water intakes. At the moment the pesticide study is not considered the most important one. Pesticide analyses are very expensive and need special techniques and skillful personnel. If pesticides are to be analyzed the water samples should be perhaps sent to Finland because there are not sufficient laboratories for such kind of analyses

in Tanzania. The Department of Chemistry in the University of Dar es Salaam may be able to do some analyses.

The idea that Zanzibar water laboratory could be enlarged to act as pesticide laboratory is unreasonable. This kind of high technology laboratory is not compatible with the idea of sustainable development. The maintenance of very expensive equipments for analyses (gaschromatography-mass-spectrometry); transportation of gases, maintenance service, repair of the equipments etc. may cause insuperable problems. Additionally the need for skillful personnel will make this project unrealistic. It would also be better to centralize activities and to develop laboratories where specific analyses have already been made. Investments and funds should be put to the Department of Chemistry instead of establishing a completely new pesticide laboratory in Zanzibar.

5. **A list of persons consulted**

Mr. Juma Bakar Alawi	Officer, Department of Environment
Mr. Leroy Duwal	Project Manager, Department of Forestry
Mr. Daudi Gomezulu	Acting Head of the Department, Water Resources Institute, Dar es Salaam
Mr. Francis Gumbo	Head of the Department, Central Laboratory, Dar es Salaam
Mr. Salim Mzee Hamed	Deputy Director, Institute of Marine Science
Mr. J. H. F. G. Heijthuijsen	Advisor, Applied Microbiological Unit, University of Dar es Salaam
Mr. Abdulrahman Salim Issa	Director, Department of Environment
Mr. James Kahatano	Senior Researcher, Department of Geology, University of Dar es Salaam
Mrs. Victoria A. Kazinja	Research Officer, Water Resources Institute
Mr. Said Kapilina	Geologist, Department of Geology, University of Dar es Salaam
Mr. M. R. Khan	Professor, Department of Chemistry, University of Dar es Salaam
Mrs. Kivaisi	Microbiologist, Applied Microbiological Unit, University of Dar es Salaam
Mr. Veikko Korhonen	Zanzibar Integrated Land Use and Environment Management project (ZILEM)

Mr. Kubena	Engineer, Water Resources Institute, Dar es Salaam
Mr. Timo Laisi	Zanzibar Integrated Land Use and Environment Management project (ZILEM)
Mr. Hamid Vuai Makungu	TV- producer-director
Mr. Mnyanga	Acting Principal of Water Resources Institute, Dar es Salaam
Mrs. Mwabeza	Chemist, Central Laboratory, Dar es Salaam
Mrs. Merja Mäkelä	Advisor, Department of Forestry
Mr. Suleiman Nasser	Officer, Department of Environment
Mr. M. H. H. Nkunya	Doctor, Department of Chemistry, University of Dar es Salaam
Mr. Mohammed Salum	Principal Secretary, Ministry of Water
Mr. Kari Silfverberg	Environmental Advisor, FINNIDA
Mr. Basha Ussi	TV- producer-director
Mr. Ali Thani	Manager, Mwanyanya Tree Nursery

**TERMS OF REFERENCE FOR A SHORT TERM CONSULTANCY FOR MS. JAANA PASANEN
TO THE PROJECT 22.1. - 4.3. 1992****1. Water laboratory**

- getting acquainted with the current situation in water laboratory arrangement in Zanzibar
- visit laboratories in Dar es Salaam hopefully together with Eero Meskus (Project Coordinator) and some of the laboratory staff to get acquainted with the laboratory methods used in Tanzania, as well as facilities and capacities of these water laboratories
- planning new water laboratory in Zanzibar and a bacteriological unit in Pemba together with the Zanzibar laboratory staff, with the assistance of Eero Meskus and other expatriate staff of the project
 - 1) list of equipment and materials needed (order list)
 - 2) staffing plan for the laboratory
- (- participate in laboratory work if needed)

2. Environment part

- visit and give recommendations about the most important water intakes and the ones which can have serious pollution problems (e.g. Bububu and Mtoni spring and other water intakes close to the tree nursery, large rice cultivations and small scale industries) and estimating the possible pollution risk of ground water
- organizing the planning of protection zones for water intakes with the personnel of forestry and environmental sections
- visit new small scale industries which have not been visited before and get information of dangerous waste management in relation to ground water pollution
- planning the study on pesticide contamination of groundwater (when and where the samples must be taken and where they will be analysed)
- follow up and strengthen the environmental monitoring work in the project:
 - * getting more information of new environmental studies made in Zanzibar and the phase of the other projects dealing environmental studies
 - * visiting institutions and organizations and meeting officers and representatives of local authorities involved in the project
 - * being generally a contact person between different instances and people

**BACTERIOLOGICAL AND CHEMICAL ANALYSES CARRIED OUT IN THE LABORATORY SINCE
SEPTEMBER 1990**

Sampling places	Sep. 1990		Jun. 1991		Jul. 1991		Aug. 1991		Nov. 1991		Dec. 1991		Jan. 1992		Feb. 1992		Mar. 1992	
	B.	C.	B.	C.	B.	C.	B.	C.	B.	C.	B.	C.	B.	C.	B.	C.	B.	C.
Unguja:																		
Mtoni spring			x		x		x				x	x	x	x	x	x		
Bububu spring			x		x		x		x	x	x	x	x	x	x	x	x	x
Kaburi Kikombe b/h			x		x		x		x	x			x	x	x	x	x	x
Kijito Upele b/h			x		x		x		x	x				x	x	x	x	x
Chunga b/h			x		x		x		x	x			x	x	x	x	x	x
Kianga b/h			x		x		x						x	x	x	x	x	x
Mwembe Mchomekeb/h			x		x		x		x	x			x	x	x	x	x	x
Kizimbani b/h			x		x		x		x	x			x	x	x	x	x	x
Mbweni b/h			x												x	x	x	x
Dimani cave			x										x	x	x	x	x	x
Saateni reservoirs					x								x	x	x	x	x	x
Bubmi Sudi b/h			x		x		x		x	x					x	x	x	x
Machui spring			x		x		x						x	x	x	x	x	x
Fuoni spring					x		x											
Pemba:																		
Miembeni spring	x	x	x															
Kwapweza spring	x	x	x															
Jamvini b/h															x	x		
Changaraweni b/h			x												x	x		
Changuo b/h		x	x															
Bungumi spring		x	x												x	x		
Gawani spring	x	x	x												x	x		
Masipa b/h	x	x	x												x	x		
Kiguuni spring	x	x	x												x	x		
Changaweni b/h		x	x												x	x		
Cogefar b/h	x	x	x															
Kengeja b/h															x	x		
Miti-Ulaya spring		x																
Bubujiko spring			x												x	x		
Weni	x	x												x	x			
Clove factory b/h		x	x															

B = bacteriological analyses, C = chemical analyses, b/h = borehole

THE RESULTS OF THE WATER ANALYSES

UNGUJA SAMPLE TRIP 16. - 19.3. 1992

		Mwembe Mchomeke borehole	Kianga borehole	Kizimbani borehole	Bububu spring 1	Bububu spring 2	Saateni reservoirs	Kijito Upele borehole	Chunga spring	Kaburi Kikombe 1 borehole	Kaburi Kikombe 2 borehole	Mbweni borehole	Dimani cave	WHO Guidelines
Appearance		Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	
Odour		Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	
Color	mg/l Pt	0	0	13	0	24	0	0	5.0	0	32	0	2.0	15
Turbidity	FTU	0	0	2.0	0	5.0	0	0	1.0	0	4.0	0	0	5
Temperature	oC	28	28	29	28	28	26	28	26	26	26	26	26	
pH		7.0	7.0	7.5	7.0	7.0	7.0	8.0	7.0	8.0	7.5	7.0	7.0	6.5 - 8.5
Conductivity	uS/cm	488	505	574	593	605	625	466	598	985	856	647	800	
TDS	mg/l	244	253	287	299	303	313	233	300	493	428	324	400	1000
CO2	mg/l	32	56	48	68	76	76	24	70	40	80	54	38	
Hardness	mg/l	231	212	270	253	260	287	205	256	305	302	247	251	500
Chloride	mg/l	11	8	9	7	14	13	15	10	124	78	26	76	250
Salinity	ppt	19.3	14.1	15.8	12.3	24.6	22.8	26.4	17.6	217.9	137.0	45.7	133.6	
Nitrate	mg/l	1.2	1.1	1.1	0.9	0.9	0.9	1.6	0.7	0.8	3.2	5.0	0.7	10
Phosphorus	mg/l	0.11	0.22	0.17	0.12	0.18	0.02	0.13	0.02	0.04	0.02	0.013	0.02	
Fluoride	mg/l	0.21	0.13	0.23	0.32	0.02	0.13	0.22	0.25	0.10	0.02	0.05	0	1.5
Iron, total	mg/l	0	0.01	0.06	0.02	0.05	0.02	0.06	0.02	0.08	0.73	0.02	0.01	0.3
Manganese	mg/l	0.1	0	0.1	0.1	0.1	0	0.1	0	0	0.1	0	0	0.1
Nitrogen Ammonia	mg/l	0	0	0	0	0	0.1	0	0	0	0.02	0	0	
Total coliforms	/100 ml	2	3	0	3	TNC	19	TNC	0	0	0	4	6	0 (occasionally 3)
Fecal coliforms	/100 ml	0	0	0	0	1	0	0	0	0	0	0	0	0

TNC = too numerous to count

THE RESULTS OF THE WATER ANALYSES

UNGUJA SAMPLE TRIP 24. - 26.2. 1992

		Mwembe Mchomeke borehole	Kianga borehole	Kizimbani borehole	Mtoni spring	Bububu spring 1	Bububu spring 2	Saateni reservoirs	Kijito Upele borehole	Chunga spring	Kaburi Kikombe 1 borehole	Kaburi Kikombe 2 borehole	Mbweni borehole	Dimoni cave	Bumbi Sudi 1 borehole	Bumbi Sudi 2 borehole	Machui spring	WHO Guidelines
Appearance		Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	
Odour		Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	
Color	mg/l Pt	0	0	60	3	0	0	0	2	0	0	18	0	0	5	2	7	15
Turbidity	FTU	0	0	12	2	0	0	0	1	0	1	7	0	0	1	0	2	5
Temperature	°C	28	28	29	29	28	28	28	28	28	29	29	32	28	27	29	28	
pH		7.5	7.0	7.5	7.0	7.0	7.0	7.5	7.5	7.0	7.5	7.5	7.5	7.5	7.0	7.0	7.0	6.5 - 8.5
Conductivity	µS/cm	577	514	515	640	612	609	638	472	633	1036	894	649	788	525	586	511	
TDS	mg/l	288	257	258	320	305	305	319	236	312	518	447	325	392	263	293	255	1000
CO2	mg/l	48	42	70	78	78	76	74	30	72	46	52	50	42	32	58	64	
Hardness	mg/l	267	237	242	315	284	279	294	201	281	318	308	265	253	245	267	232	500
Chloride	mg/l	11	7	10	12	7	9	12	10	5	117	88	27	54	8	5	13	250
Salinity	ppt	19.3	12.3	17.6	21.1	12.3	15.8	21.1	17.6	8.7	205.6	154.6	47.4	94.9	14.1	8.8	22.9	
Nitrite	mg/l	0.002	0.001	0.003	0.002	0.001	0.006	0.002	0.003	0.002	0.004	0.003	0.002	0.003	0.001	0.003	0.003	
Nitrate	mg/l	0.9	1.0	0.5	1.4	0.7	0.8	0.9	1.3	0.8	3.0	3.3	5.9	0.8	0.6	0.7	0.9	10
Phosphorus	mg/l	0.28	0.30	0.34	0.24	0.029	0.037	0.1	0.081	0.074	0.041	0.10	0.041	0.035	0.35	0.30	0.27	
Fluoride	mg/l	0	0	0	0	0.24	0.08	0.09	0.34	0.08	0.09	0	0.1	0.06	0	0	0	1.5
Iron, total	mg/l	0.06	0.02	0.74	0.02	0.01	0.03	0.02	0.09	0.01	0.04	0.76	0.01	0	0.03	0.01	0.03	0.3
Manganese	mg/l	0.2	0.1	0.3	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0.1
Chromium	mg/l	0	0.001	0.001	0	0.01	0.01	0.01	0.02	0.01	0.04	0.04	0.07	0.01	0.001	0	0.001	0.05
Copper	mg/l	0.14	0.38	0.25	0.54	0.23	0.23	0.37	0.05	0.42	0.26	0.44	0.36	0.35	0.24	0.31	0.33	1.0
Cyanide	mg/l	0.001	0.004	0	0.001	0.005	0.006	0.002	0.001	0.001	0.002	0.005	0.006	0.004	0.004	0.001	0.003	0.05
Nitrogen Ammonia	mg/l	0.2	0.13	0	0.01	0.01	0.06	0.03	0.05	0	0	0.03	0.01	0	0	0	0.01	
Total coliforms	/100 ml	5	2	8	30	8	55	8	32	9	0	0	TNC	9	1	2	64	0 [occasionally 3]
Faecal coliforms	/100 ml	0	0	0	0	0	0	0	4	0	0	0	0	1	0	0	0	0

TNC = too numerous to count

THE RESULTS OF THE WATER ANALYSES

PEMBA SAMPLE TRIP 9.2. - 10.2. 1992

		Jamvini borehole	Changuo borehole	Kwaoweza spring	Miembeni spring	Bungumi spring	Gawani spring	Masipa spring	Kiguuni spring	Cogefar borehole	Changara-weni borehole	Bubujiko spring	Miti Ulaya spring	Kengeja borehole	WHO Guidelines
Appearance		Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	
Odour		Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless	
Color	mg/l Pt	2	2	14	0	3	35	9	4	0	10	19	0	48	15
Turbidity	FTU	0	0	6	0	0	11	5	0	0	3	8	0	11	5
Temperature	°C	29	30	30	30	30	28	28	28	30	29	29	28	28	
pH		7.5	7.5	7.5	7.0	7.5	7.5	7.5	6.0	6.5	6.0	7.0	6.0	7.0	6.5 - 8.5
Conductivity	uS/cm	882	845	619	912	553	557	585	196	650	293	663	575	593	
TDS	mg/l	441	423	306	457	276	279	293	98	326	192	332	288	246	1000
CO2	mg/l	90	94	80	70	63	82	82	52	100	104	74	108	28	
Hardness	mg/l	321	310	262	285	236	233	270	38	232	51	283	177	255	500
Chloride	mg/l	30	26	13	68	15	16	9	25	56	11	32	45	16	250
Salinity	ppt	52.7	45.7	22.8	119.5	26.4	28.1	15.8	43.7	98.4	193.3	56.2	79.1	28.1	
Nitrite	mg/l	0.003	0.001	0.003	0.013	0.0	0.003	0.0	0.001	0.01	0.002	0.001	0.004	0.0	
Nitrate	mg/l	0.7	11	0.2	11.7	0.3	0.0	0.0	2.5	11.0	0.2	0.0	3.7	0.0	10
Phosphorus	mg/l	0.24	0.10	0.38	0.08	2.5	0.51	0.17	0.10	2.5	0.09	0.83	0.07	0.22	
Fluoride	mg/l	0.27	0.26	0.18	0.28	1.01	0.2	0.2	0.36	0.12	0.14	0.32	0.12	0.17	1.5
Iron, total	mg/l	0.05	0.04	0.39	0.04	0.12	0.58	0.15	0.19	0.0	0.34	0.27	0.03	1.16	0.3
Manganese	mg/l	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1
Chromium	mg/l	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.0	0.01	0.0	0.0	0.01	0.05
Copper	mg/l	0.68	0.35	0.35	0.32	0.21	0.12	0.24	0.03	0.3	0.06	1.28	0.01	0.68	1.0
Cyanide	mg/l	0.002	0.002	0.003	0.001	0.001	0.001	0.02	0.003	0.003	0.001	0.001	0.005	0.002	0.05
Nitrogen Ammonia	mg/l	0.05	0.01	0.0	0.13	0.03	0.0	0.0	0.0	0.0	0.01	0.03	0.24	0.0	
Total coliforms	/100 ml	0	0	0	0	0	0	4	TNC	0	0	4	32	3	0 (occasionally 3)
Fecal coliforms	/100 ml	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TNC = too numerous to count

**SUMMARY OF THE LABORATORY EXCURSION IN DAR ES SALAAM
30. - 31.1. 1992**

Participants

Mrs. Sanura M. Abdalla	Laboratory Technician
Mr. Hamad J. Bakar	Hydrogeologist
Ms. Jaana Pasanen	Environmental Consultant

Purpose of the excursion

The purpose of the excursion was to get ideas about techniques and methods used in certain water laboratories in Dar es Salaam as well as to provoke discussion within the staff about the laboratory management and routines (e.g. cleanliness, order, book-keeping of chemicals and reagents).

Laboratories visited

1. Water Resources Institute

Laboratory technicians are trained in this laboratory. All the technicians of the Zanzibar water laboratory have also studied here. During our visit there were no laboratory courses going on. Lots of discussions were held with the laboratory personnel about the necessity of cleanliness, management and safety precautions.

The persons interviewed were:

- Mr. Mnyanga (Acting Principal of Water Resources Institute)
- Mr. Kubena (Engineer)
- Mr. Daudi Gomezulu (Laboratory in Charge)
- Mrs. Kazinja (Research Officer)

2. Central Government Laboratory

One of the biggest and the most important laboratories in Tanzania mainland is The Central Government Laboratory. Compared to the Water Resources Institute the laboratory was better equiped, although some of the fine equipments were not functioning. Discussions were held with laboratory personnel about the difference of the water quality guidelines of WHO and Tanzania. Lots of information was received about the book-keeping and storage of chemicals.

The persons interviewed were:

- Mr. Francis Gumbo (Senior Principal Research Officer)
- Mrs. Mwabeza (Chemist)

3. University of Dar es Salaam

3.1. Department of Botany, Applied Microbiology Unit

An applied microbiological unit will be established in the Department of Botany. Now it is still under construction and consists of only one room filled with equipments. Discussions were

held with Dutch Advisor about what kind of equipment and methods would be useful and suitable for water quality monitoring in Zanzibar. Sustainable laboratory management was also discussed.

The persons interviewed were:

- Mr. V.H.F.G. Heijthuijsen (Advisor)
- Mrs. Kivaisi (Microbiologist)

3.2. Department of Geology

The Department of Geology has a small water laboratory where private enterprises and persons can have their water samples analysed. These commercial water analyses help the department to be more independent. Discussions were held with the personnel about the possibilities for the Water Laborator of Zanzibar to sell knowhow and services.

The persons interviewed were:

- Mr. Said Kapilima (Geologist)
- Mr. James Kahatano (Senior Researcher)

3.3. Department of Chemistry

Discussions were held about pesticides analyses and the Tropical Pesticide Institute in Arusha. Unfortunately there was no time for getting acquainted with the laboratories of the Department of Chemistry.

The persons interviewed were:

- Mr. M. H. H. Nkunya (Professor of Chemistry)
- Mr. M. R. Khan (Professor of Chemistry)

**RESULTS OF THE ENVIRONMENTAL ASSESSMENT OF WATER INTAKES
(PIT-LATRINE STUDY)**

Intakes studied	Number of houses within 300 m radius of the intake			
	Without latrine	With pit-latrine	With septic-tank	Under construction
Mtoni spring	61	65	13	12
Bububu spring	4	6	7	2
Kijito Upele borehole	12	43	-	22
Kaburi Kikombe borehole	21	78	40	47
Chunga borehole	-	5	-	-
Mwembe Mchomeke borehole *	12	16	1	3
Dimani cave	-	-	-	-

* In Mwembe Mchomeke borehole pit-latrines have been counted within a radius of 700 meters

DETAILED WORK PROGRAMME OF THE WATER LABORATORY

Unquja sample trip

Once every month water samples should be taken from eleven intakes in Unquja. The Unquja sample trip has been planned to take place in the first week of every month except in March, when it will start the third week. The sample trip starts always in the beginning of the week and a car TX 596 is booked for the use of the laboratory staff on Monday and on Wednesday (8.00 - 11.30 am)

Appearance, odour, conductivity, pH, TDS and temperature determinations should be made in the field. The rest of the chemical analyses will be made in the laboratory starting with the determinations which are more likely to be affected by sample storage: titration of carbon dioxide, hardness and chloride, measurements of colour, turbidity, nitrate, nitrogen ammonia and phosphorus and finally determinations of iron, manganese and fluoride. Bacteriological analyses of course have to be made immediately.

Programme for each first week of a month:

Monday	8.00 AM	The first six intakes will be visited in following order: <ul style="list-style-type: none"> - Mwembe Mchomeke borehole - Kianga borehole - Kizimbani borehole - Mtoni spring - Bububu spring - Saateni reservoirs
	Afternoon	After coming back to the laboratory the analyses both chemical and microbiological should be started at once. Those determinations which are more likely to be affected by sample storage should be made first.
Tuesday		The rest of the chemical analyses.
Wednesday	8.00 AM	The last five intakes will be visited in following order: <ul style="list-style-type: none"> - Kijito Upele borehole - Chunga borehole - Kaburi Kikombe borehole - Dimani cave - Mbweni borehole
	Afternoon	Analyses have to be started as mentioned previously.
Thursday		Rest of the chemical analyses should be made. All the analyses should be ready on Thursday afternoon.

Friday

Table and a short summary of the results have to be written.

It is also good if you write a short summary of the trip to your own laboratory book (brown one). (Note: you can start to write your own summary during analyses.)

In the end of each month a monthly report has to be given to Mr. Hemed S. Hemed (Director of the Department of Water Development) and Mr. Meskus. Also one copy should be taken to the laboratory and one sent to Plancenter head office (Mrs. Auli Keinänen) by fax.

Pemba sample trip

The Pemba sample trip should be made every third month. The next sample trip will be made during rainy season the third week of April and the following one the third week of July. The microbiological analyses are made in Pemba but chemical samples are transported to Zanzibar laboratory. The sample trip must be planned carefully to minimize the storage time of the chemical samples. It is not good to leave the bottles standing over the week-end.

Water samples should be collected in the following order:

1) First day:

Chake Chake:

- Jamvini borehole
- Changaweni borehole
- Changuo borehole
- Kwapweza spring
- Miembeni spring

2) Second day:

Wete:

- Bungumi spring
- Gawani spring
- Masipa spring

Mkoani:

- Kiguuni spring
- Cogefar borehole
- Changaraweni borehole

The final report of the results of Pemba should be annexed the Unguja monthly report in Zanzibar. In April and in July the monthly report consists of both Unguja and Pemba results.

Weekly microbiological analyses in Unguja

The sample trip should be started in the morning and a car TX 596 is booked for the use of the laboratory staff on Mondays from 8.00 to 10.00 AM. All four laboratory technicians take their own samples and make their own bacteriological analyses in the laboratory.

During Pemba sample trip those two laboratory technicians who stay in Zanzibar can make bacteriological analyses.

The results of the bacteriological analyses have to be annexed into the monthly report.

PRELIMINARY PROTECTED AREA PLAN AROUND WATER INTAKES

A ZONE

RESTRICTED AREA

No human activities allowed.

The immediate vicinity of the springs and boreholes should be protected by fence. The size and the form of the protected area depends on the local conditions. For instance in the Mtoni and Bububu spring area the oval shaped fenced area should reach about 100 m upstream and 50 m downstream from the springs.

In the fenced area admittance should be prohibited. Only water supply related operations should be allowed.

B ZONE

PROTECTED AREA

Only limited and controlled human activities allowed. Construction and waste management to be planned according to instructions and approval of the Water Authority.

The whole catchment area should be protected as follows:

- existing settlements without reliable sewerage should be gradually removed and no new houses should be allowed
- factories, industrial establishments, livestock buildings, fodder storage, silos etc. should not be allowed
- improper removal of soil, trees and vegetation as well as digging of holes should not be allowed
- transport or storage of dangerous chemicals, dumping of wastes, agriculture, improper use of fertilizers and pesticides, cemetery should not be allowed

The catchment area near existing settlements should be surrounded with stong instruction sign boards, mounted in cement.

A SUMMARY ABOUT PESTICIDES AND FERTILIZERS USED IN MWANYANYA TREE NURSERY IN ZANZIBAR

1. Background

The information received about pesticides used in Mwanyanya tree nursery was not exhaustive. It was mainly based on scattered memories of some employers. Some information was also a little bit confusing (e.g. regarding the use of Roxon). The amount of pesticides used earlier was unknown as well as the waste disposal.

a) Earlier use of pesticides and fertilizers

According to the interviews made in Mwanyanya tree nursery in February 1992 nine different pesticides have been used during the whole operation of the nursery. Besides pesticides lots of fertilizers are also used in the tree nursery.

Table 1. Pesticides and fertilizers used in Mwanyanya tree nursery during its operation.

Insecticides:	Fungicides:	Herbicides:	Fertilizers:
Dimethoate	Benomyl (Benlate)	Glyphosate (Round-up)	Ammonium sulphate
Endosulfan (Thiodan)	Thirame		Flora (N, P)
Fenitrothion			Muriate of potash
Lindane			Kekkilä 9
Malathion			Triple super phosphate
Trichlorfon			Turpeen Y lannos
			Urea

No information about quantities of pesticides other than lindane were received. Between the years 1983 -1988 altogether 16 liters of lindane (4 x 4 liters cans) was said being used in the tree nursery. Disposal of empty lindane cans was not known for sure; they have been reused by local people or dumped somewhere. Also some information was received about Roxon, the use of which was said to been stopped in 1983. It was however impossible to find a pesticide by that name. A trademark Roxion was found instead. It's chemical name is dimethoate which is still used nowadays.

Besides the data mentioned above a pesticide called mancozeb has also been used in the tree nursery according to FINNIDA's chemical survey made by Plancenter Ltd in 1991.

b) Waste management in the nursery

No detailed information was received about the earlier waste disposal of the chemicals. The old dumping place which was located just beside the river in the north west corner of the tree nursery has been closed since two to three years. It has not been cleaned because of the risk of erosion. The new dumping place is located about 30 meters more up to the river bank. No empty cans can be buried there. The dumping place serves only for organic waste e.g. plant residues and used planting soil. Empty canisters are buried under the ground behind the seedling plantation about 100-200 meters more up.

It is planned to transfer seedling plantations and greenhouses which now locate close to the river bank, more up during this year. The general idea is to gradually move the whole tree nursery further away from the river bank.

2. Present situation

Pesticides are generally used irregularly only when harmful pest can cause serious damages to the seedlings. They are mainly used in wet seasons (in spring and in autumn) when the threat of pests is most prominent. Those pesticides that are available are used. According to the staff interviewed, lindane would be used if it was available, because of it's high toxicity (which makes it more effective than other pesticides). In recent years it has been impossible to get lindane.

At present only three types of insecticides are used: trichlorfon, fenitrothion and dimethoate. Altogether about 8 liters of insecticides are used in a year. Fungicides are used even more irregularly than insecticides. At present only maneb is used (altogether about 1 kg in a year).

Table 2. Pesticide used at present in Mwanyanya tree nursery.

Insecticides:	Fungicides:
Trichlorfon	Maneb
Fenitrothion	
Dimethoate	

Fertilizers are also used depending on the situation. No clear estimation of the quantity was received. Those fertilizers which are available are used.

3. Recommendations on the use of pesticides in relation to ground water pollution

According to the results of Zanzibar water laboratory and the University of Dar es Salaam, the nitrate levels of Bububu spring water samples in dry season were very much below the WHO guidelines, which indicates that no influence of fertilizers on ground water can be found according to those analyses. No laboratory analyses have so far been made about the possible pesticide pollution.

Mwanyanya tree nursery is situated relatively close to the Bububu intake and is actually within the catchment area, Therefore all activities which could prevent the possible hazardous effects on the ground water have to be very seriously considered:

- empty cans of pesticides should not be buried inside Mwananyanya tree nursery area even if their number is small
- use of lindane and other very toxic pesticides should not be allowed
- Mwananyanya tree nursery has to start practicing more detailed book-keeping about the use of pesticides and fertilizers (including quantities and compositions of the chemicals)
- extension of the existing tree nursery in the future should not be considered; it is rather recommended to transfer the nursery gradually away from the Bububu spring area, if possible
- The Department of Water Development should be informed about the use of pesticides and fertilizers

More studies need to be made in the spraying time to be able to give detailed instructions about the use of pesticides. To be sure that there are no pesticides in the ground water, water samples should be taken for further pesticide analyses, which require much time and funds.

Persons interviewed in February 1992 were:

Mr. Ali Thani
Mr. Leroy Duwal
Mrs. Merja Mäkelä

Manager of the Tree Nursery
Project Manager; Forestry Department
Advisor; Forestry Department