APPENDIX D

SOCIO-ECONOMIC SITUATION

1. POPULATION

1.1 Present Situation

(1) The Main Land

The census surveys have been carried out once a decade with the latest one in 1988. The population of Tanzania Main Land and its growth rate for each decade are given in Table D.1.

(2) The Study Area

The population of the regions concerned with the Study Area, i.e., Morogoro, Coast and Dar Es Salaam and their growth rates for each decade are given in Table D.1.

The population in 1988 who were using water of the Ruvu River is shown in Table D.2. They are those who live within the area of the basin and those who get water through the pipeline system though they live outside the basin. The water supply system mainly consists of two trunk transmission lines, one from the Upper Ruvu intake, the other from the Lower Ruvu intake. Some of the residents in the basin were also drawing water from the system. The water from another small river basin is also injected into the system via Mtoni treatment plant, though the volume accounts for only a few percent of the total water supply.

1.2 Prediction of Population Growth

(1) The Main Land

The Census Office made a prediction of population growth in the Main Land of Tanzania up to 2010. It is based on the following assumption:

Assumption Made for the Projection

		1990	1995	2000	2005	2010	
Fertility	high	6.2	6.2	6.2	6.2	6.2	
	low	6.2	5.7	5.2	4.7	4.2	
							sex ratio
Average	Male	47	48	49	50	51	103
Life span	Female	50	51	52	53	54	100

Note: Migration is negligible.

Source: Population Census 1988; Projections.

It's tendency is extrapolated up to 2020, the target year for the municipal water supply to Dar Es Salaam in this Study. The mean projection of the high and low cases is shown in Table D.3 as a reference to the projection of the population growth.

(2) The Study Area

The population estimate of 1990 and 1991 of the three Regions concerned are given in Economic Survey 1991. This estimate was used to check the growth relationship between the Main Land and the Regions concerned in order to set the figures for each projection cycle. The population growth of Dar Es Salaam is furthermore checked by the urbanization trend projected by the World Resources Institute (WRI).

According to the WRI, 35 percent of African population lived in the urban areas in 1988 and the figure would rise to 55 percent in 2020. These growth rates were used for the population projection for the Study Area. Table D.3 gives the population projection for the Study Area.

The population growth rate of Dar Es Salaam consists of two parts. Natural growth rate is equal to the mean growth rate of the Main Land and transmigration from rural areas is calculated at two percent of the residents annually. In case of Morogoro Urban District, annual migration rate is calculated at eighty percent of that applied to Dar Es Salaam Region. The population in the concerned Regions is shown in Table D.4 by ward.

2. ECONOMY, PRESENT SITUATION AND FUTURE TREND

2.1 National Economy

The annual GDPs (total and per capita) of Tanzania Main Land between 1976 and 1991 are given in Table D.5, and the GDPs by kind of economic activities in current prices between 1982 and 1991 are given in Table D.6.

The annual growth rates of the total GDP and its two sectors, i.e. agriculture and industry for 1977 to 1991 are given in Fig. D.1.

In 1991, contribution to the total GDP by agricultural sector reached 62.5 percent. The manufacturing sector accounted for only 3.6 percent of the total GDP six years after the introduction of the Economic Recovery Plan (ERP).

The mainstay of the Tanzania economy is agriculture. With the help of steady growth of agriculture (annual growth rate of more than four percent for eight consecutive years up to 1991), the annual growth rates of GDP since 1984 have exceeded three percent except 1985. Thus our estimate of annual growth rate of GDP during the planning period is set at three percent on the constant price basis, taking the safer side. As the figure is less than a point above the population growth rate, it is considered that corresponding economic activities will not squeeze the natural resources too much.

Roughly speaking, 60 percent of the GDP of Tanzania consists of agriculture in 1991. If it will be able to grow at 3.5 percent annually, the rest would be allowed to grow at 2.25 percent annually to achieve the overall annual growth rate of three percent.

Though the manufacturing industry sector has contributed not much to the Tanzanian economy in terms of GDP (3.6 percent at current price in 1991), its contribution to the indirect tax

revenue was 65.5% in 1991/92 fiscal year, and it provides more than 80 percent of salaried workforce with job opportunities in the formal economy. Though it has a bright scope in future as many manufactured goods are imported at present (textiles : 90%, beer : 40%, sugar : 35%, footwear : 95%, cooking oil : 70%, tyres(except for bicycles) : 50%, radios : 80%), structural constraints can not be removed so easily. It may take some time to function normally.

2.2 National Economic Development Plan

The long-term perspective plan (1981-2000) was implemented in the context of socialism and self-reliance. The target of average GDP growth rate was set to be six percent.

Having seen the unsatisfactory progress of the plan, the Government introduced the first ERP for three years starting in 1986. The second ERP from 1989/90 to 91/92 ended. The core of the plan was to introduce a system of free market economy with an intention to revive the national economy as a whole.

The First and Second Priority Social Action Programmes (PSAP) were indispensable components of the ERPs to mitigate many unavoidable socio-economic strains of the poor accompanied by the economic reforms.

The present Union Five Year development Plan ended at the end of June. It had been initiated a year earlier than the first ERP that reassessments of some parts were called for.

2.3 Regional Economy

The annual RGDPs (total and per capita) of regions concerned with the Study Area between 1976 and 1991 are given in Table D.5, and the annual RGDP of the Coast Region by kind of economic activities between 1982 and 1991 are given in Table D.7. (These data for other two Regions were not able to be collected during the field survey.

In 1991, the average per capita RGDP of the Morogoro Region, which was about 93 percent of that of the Main Land, was about one third of that of the Dar Es Salaam Region. Per capita RGDP of the Coast Region was less than 12 percent of that of the Dar Es Salaam Region.

The characteristics of agriculture in the basin is described in Appendix-G of this Supporting Report. The manufacturing industry sector is discussed below;

Regional GDP of Dar Es Salaam, where agriculture does not contribute thereto so much, accounted for 20 percent of the total GDP in 1991. Then, the RGDP of Dar Es Salaam is equal to half of the GDP except that derived from agricultural sector. About 41 thousand people were engaged in the manufacturing industries in Dar Es Salaam in 1987. The so-called informal sector provided jobs for about 316 thousand persons in Dar Es Salaam in 1990.

There are 35 manufacturing industries located in the basin. The number of workforce totals around 4000. The details are given in Table D.8. With the advance of privatization, the existing factories in Morogoro Urban District owned solely by the Government or managed as a majority shareholder by it may boost their productivity if the resources are available favorably. Kibaha has industrial growth potential when public utilities reach them without hindrances.

There is no statistics available about informal sector in the basin, but besides fruit and vegetable growing and sale, charcoal making, transport and sales provide jobs to a considerable number of residents. (About 22 thousands people are engaged in charcoal making, and 55 thousands are involved in their sales throughout the Main Land.) With the increase of urban population, the use of charcoal would naturally increase. Hence, setting-up of a sustainable way of managing forests for firewood and charcoal would be given priority in the immediate future. There is a prospect of natural gas development from Songo Island to mitigate the tight energy supply situation.

Population density of each ward is not evenly spread in the basin. The gravity goes to the Uluguru Mountains, the river head, where residents live on the mountain slopes and are doing intensive crop-livestock farming. Hence, it is vital to stop the degradation of the environment as well as keeping at least the present level of their livelihood.

3. REGIONAL SOCIO-POLITICAL SITUATION

3.1 Administrative Unit

The structure of administration of the Main Land consists of five levels of hierarchy in terms of geographical units: Region, District, Division, Ward and Village. Administration of regions and districts have parallel structures. They are headed by both a commissioner and a development director. Except planning, finance and manpower departments, all the other departments are headed by an officer or an engineer from the central government.

Divisions are not given administrative importance, though there are some topographic characteristics being in between units of districts and wards although no code numbers are allocated to the divisions.

A ward, which is the electoral unit of the national parliament, and the villages have their elected government. They loan some stuff from the regional government to run their offices. The Revolutionary Party (CCM) still retains office after introduction of multi-party system.

The Ruvu basin extends itself in five districts, Morogoro Rural and Urban Districts of Morogoro Region, Bagamoyo, Kibaha and Kisalawe Districts of the Coast Region. Topographic boundary of the basin does not necessarily coincide with that of villages. It sometimes happens so that boundary areas of two river systems are low-lying flat plateau. Some villages in those areas have water sources in both river basins.

The water use of the basin also takes place in its outside through two intakes. Some residents along the trunk main pipelines in Bagamoyo and Kibaha Districts of the Coast Region and of major parts of the Dar Es Salaam Region are getting treated water. Plants on the irrigated plots or kitchen gardens and some livestock are also among the beneficiaries.

3.2 Communities in the Ruvu River Basin

The Waluguru and Wazaramo are two predominant communities in the basin. The former, matrilineal and mostly Catholics, mainly live in the Uluguru Mountains, as the name suggests. With the increase of community members, they have started to fill the piemonts of the

mountains and the river terraces further down. The latter, patrilineal and mostly Moslems, are the residents of the areas nearer to the coast.

There are some more communities in the basin. They are locally concentrated. From the upper reach downward, there are the Wakutu in the fertile valley of the Mgeta River, the Wakwavi in the Ngerengere River, and the Wakwere and Wadoe along the coast. They are agriculturists except the Wakwavi in its origin.

The Wakwavi, which is sometimes called Baraguyu, is a descendant of the Masai people, which has a pastoralist heritage. In the Ngerengere basin, they are leading a sedentary life, growing cereals and tubers, while taking care of their herds and cattle. The rangeland of the community was used to be far wider than their present ones. Population increase in the area, the creation of government agencies' large scale farms including erstwhile sisal estates, and the government livestock policies have made them change their pastoral way of life into more confined one; i.e., their rangelands spread themselves around their permanent settlement. It threatens them with the problem of over-grazing, but gives them a chance of sending their children to school, which itself is another dilemma to their parents as school-going reduces practical training of pastoral production usage.

4. OTHER SOCIO-ECONOMIC ASPECT

Total expenditure of water supply enterprise of Dar Es Salaam operated by NUWA in the fiscal year of 1991/92 amounted to TSh.3,389 million. (Recurrent Expenditure and Depreciation Costs account for 55.4 % and 44.6%, respectively) If actual production of water is set at 180,000m^3 per day, the unit cost of water produced by NUWA would be about TSh.51.58 per cubic meter. Even if all the water bills are fully collected at the present water rate, the amount would not cover the recurrent expenditure. The amount of the deficit would reach 14.755 percent of the recurrent cost.

During the Phase 1 Field Work, the Ruvu River basin was hit by a fairly big flood, but no house was washed away as all of them are built outside the flood plain habitually subject to deep flooding.

If flood happens during the rainy season, the potential damage could occur on paddy fields where transplanted paddy grow. Since one may plant maize even after the fields get hit by a flood, the substantial damage incurred is considered to be the costs (material and labour) so far spent.

The national socio-economic data are shown in Table D.9.

5. PRESENT SOCIO-ECONOMIC CONDITION OF SELEMBARA WARD IN PLANNED KIDUNDA RESERVOIR AREA

5.1 General

Major part of Selembara ward located upstream of the Kidunda dam site would be submerged when the planned Kidunda dam is constructed at the site proposed by the Study. The ward consists of four villages, i.e., Magogoni, Kiganila, Bwilajuu and Bwila-chini. The Magogoni village is located on the right bank of the Ruvu River, while the next two on the left bank. The last extends on both banks.

The right bank of the Ruvu River in this area is designated as buffer zone of the Selous Game Reserve under the SCP. Residents of Magogoni and Vikonge area of Bwila-chini, where a hunting community is living, deem to be removed out of the present location in future whether the Kidunda dam project would be implemented or not.

In case of the construction of the Kidunda dam, those on the left bank would need to be also moved out of the present site where they have been living for some generations. The earliest settlers came to the Bwila-chini village area. Then with the commencement of the Ujama movement in 1974, new immigrants from outside settled in a part of the Bwila-juu village. Now with the population growth within the Bwila-chini village, the village is about to be further divided, creating the new village called Kiburma.

Their land use and economic activities are mostly agricultural. Bus services between the ward and Ngerengere via Kisange are available while road condition permits it. On the other hand, communication with the ward across the river is done by canoes. Ambulance has been relying on them as a dispensary, which is located in the Magogoni village. A primary school is located in the Bwila-juu and Magogoni villages on the left bank and right bank sides of the Ruvu River, respectively.

As the area is infested with tse-tse files, the residents cannot afford to keep cattle except some goats. Pastoral community of Wakwavi has come down to stay in the Tunungwa and Kisange villages which are located on the left bank of the Ruvu River, some 20 km upstream of Kiganila. This fact suggests that the surrounding Miombo forests are less infested with tse-tse files.

5.2 Land Use and Agriculture

Land use and agriculture of the ward are given in Table D.10. Although it is difficult to size the population figures with accuracy as the Table shows the different statistics of the population, it give the general size of the activities in the ward.

Their agricultural activity has been extensive with a limited number of manpower equipped with only hoes and machetes. An average unit production per hectare of maize, paddy and sorghum is around 3 ton.

In addition to the crops listed in the Table, they grow cassava and millet for their subsistence and tobacco as a cash crop and vegetable, beans, pumpkins are found in the kitchen gardens. Tobacco they grow is a local variety so that its market is limited. There is few papaya in the

ward, which may be a proof of the fact that the area is flood-prone during the rainy season. The flood marks are clearly seen on the house walls. In the area, fishing activity of human being has been competed with the wildlife predator such as crocodile.

Average annual income per household in 1991 ranges between T.Shs. 20,000 and 25,000 according to the report of the Selous Conservation Programme (SCP). Most of the houses are made of wattle and mud walls with thatched roofs. A house with four rooms made of wattle-mud walls without roof costs them about T.Shs. 52,000. Every house has a detached toilet, which costs them T.Shs. five thousand to build. There is a shallow well with a hand pump in each village, but the pumps are either mulfanctioning or broken. A piece of burnt brick costs them T.Shs. 10, and cement block T.Shs. 15 per a piece. Transport cost of a bag of cement from Dar Es Salaam is about T.Shs. four hundred.

APPENDIX-D

TABLES

Table D.1 POPULATION IN MAIN LAND AND REGIONS

Region		Rate 1967-78	1978	Rate 1978-88	1988	1990	1991
Morogoro	Population	2.9	939,264	2.6	1,222,737	1,288,001	1,321,401
Area (km2)	Density/km2		13		17		
70,799	H'hold Size		4.7		5.3		
Coast	Population	1.7	516,586	2.1	638,015	665,382	678,402
Area (km2)	Density/km2		16		20		
32,407	H'hold Size		4.3		4.2		
Dar Es Salaam	Population	7.8	843,090	4.8	1,360,850	1,497,968	1,573,811
Area (km2)	Density/km2		605		977		
1,393	H'hold Size		4.1		4.3		
Mainland	Population	3.2	17,036,499	2.8	22,533,758	23,831,650	24,456,644
Area (km2)	Density/km2		19		26		
881,289*	H'hold Size		4.9		5.3		

Sources : 1967, 78, 88 : Population Census 1988, Preliminary Report 1990
1990, 91 Estimate : Economic Survey 1991, Planning Commission June 1992

Notes : *; excludes area of lakes

Table D.2 POPULATION IN STUDY AREA IN 1988

(1) Area Within The Basin

Region	District	Rural	Urban	Total	Urban Names
05	Morogoro Rural	304,790	6,182	310,972	Ngerengere
05	Morogoro Urban	0	117,593	117,593	
06	Bagamoyo	74,666	6,716	81,382	Chalinze
06	(L. Ruvu Pipeline)	7,819	0	7,819	
06	Kibaha	17,482	0	17,482	
06	(U. Ruvu Pipeline)	26,510	15,207	41,717	Mlandizi
06	Kisarawe	30,825	1,805	32,630	Maneromango
	Total	462,092	147,503	609,595	

(2) Water Supply Area Out of The Basin *

Region	District	Rural	Urban	Total	Urban Names
06	Bagamoyo	14,826	19,385	34,211	Dunda **
06	Kibaha	7,034	12,756	19,790	Tumbi
07	Kinondoni	52,388	556,705	609,093	
07	Ilala	5,933	306,227	312,160	
07	Temeke	5,548	307,341	312,889	
	Total	85,729	1,202,414	1,288,143	

Notes : * Water from Mtoni system is included
** Including Magomeni

Region : 05 = Morogoro, 06 = Coast, 07 = Dar Es Salaam

Source : 05, 07 : Population Census 1988, Regional Profile
06 : Data Base, Census Office

Table D.3 POPULATION PROJECTION - STUDY AREA

1,000 capita

Region	1988	1995	2000	2005	2010	2015	2020	Remarks
		88-95	95-00	00-05	05-10	10-15	15-20	
	Area within the Basin (1)							
05	311	375	428	488	554	625	699	Rural
06	131	153	170	189	209	231	253	Except (3)
Total	442	528	598	677	763	856	952	
avr. gr. rate pa		2.54 %	2.54 %	2.51 %	2.43 %	2.31 %	2.15 %	
	Area within the Basin (2)							
05	118	158	195	240	294	359	434	Rrban
avr. gr. rate pa		4.29 %	4.29 %	4.25 %	4.17 %	4.04 %	3.87 %	
	Area within the Basin (3) Along Piplines							
06	8	10	12	15	18	21	25	Bagamoyo
06	42	54	65	78	94	111	132	Kibaha
Total	50	64	77	93	112	132	157	
avr. gr. rate pa		3.77 %	3.77 %	3.74 %	3.67 %	3.57 %	3.42 %	
	Area of water supply outside the Basin							
06	54	63	76	92	110	131	155	
07	1,234	1,726	2,194	2,784	3,518	4,416	5,491	
Total	1,288	1,789	2,270	2,876	3,628	4,547	5,646	
avr. gr. rate pa		4.81 %	4.87 %	4.84 %	4.76 %	4.62 %	4.42 %	
	Main Land (as a reference)							
	22,534	27,324	31,542	36,344	41,707	47,539	53,665	
avr. gr. rate pa		2.91 %	2.91 %	2.87 %	2.79 %	2.65 %	2.45 %	

Region : 05 = Morogoro, 06 = Coast, 07 = Dar Es Salaam

Source : Main Land - 2010 : Statistical Abstract 1990

Rest : Consultants Calculation

Table D.4 POPULATION CENSUS IN 1988 (1/3)

Morogoro Region : 05

Morogoro Rural District : 2

Ward	No.	0 - 14	15 - 54	55 -	Total	
Kisaki	11	4,439	4,619	895	9,953	
Mngazi	21	3,072	3,430	709	7,211	
Bwakira Chini	31	4,326	4,597	1,047	9,970	
Bwakira Juu	41	1,990	1,905	432	4,327	
Singisa	51	4,600	3,860	928	9,388	
Kolero	61	3,148	3,282	724	7,154	
Kasanga	71	4,272	4,368	1,146	9,786	
Selembara	81	2,140	1,943	585	4,668	
Mvuha	91	3,467	3,656	886	8,009	
Tununguo	101	1,874	1,781	567	4,222	
Mkulazi	111	2,497	2,066	617	5,180	
Kidugalo	121	4,323	4,843	1,155	10,321	
Ngerengere	131	3,178	2,774	984	6,936	
Ngerengere	132	2,549	3,124	509	6,182	
Mikese	141	5,222	5,151	1,452	11,825	
Kingolwira	151	7,796	9,908	2,049	19,753	
Mzinga	161	5,046	6,098	913	12,057	
Kikeko	251	6,391	5,228	1,053	12,672	
Tchenzema	261	4,425	3,895	862	9,182	
Langali	271	4,425	3,653	1,152	9,230	
Mlali	281	5,296	5,426	1,421	12,143	
Kibogwa	311	3,742	3,305	915	7,962	
Kibungo	321	2,780	2,338	973	6,091	
Tawa	331	4,930	4,110	1,271	10,311	
Lundi	341	4,030	4,065	1,251	9,346	
Mtombozi	351	3,750	3,245	1,251	8,246	
Kisemu	361	5,291	5,097	1,607	11,995	
Mkuyuni	371	6,955	6,538	1,544	15,037	
Tegetero	381	3,138	2,501	558	6,197	
Kinole	391	5,086	4,361	829	10,276	
Kiroka	401	6,167	6,122	1,479	13,768	
Mzumbe	411	5,606	7,085	1,243	13,934	
Bunduki	431	3,773	2,926	941	7,640	
2 : Rural Area		137,175	134,176	33,439	304,790	
2 : Urban Area		2,549	3,124	509	6,182	Ngerengere
Morogoro Urban : 5		45,013	66,498	6,082	117,593	
Morogoro Total		184,737	203,798	40,030	428,565	

Table D.4 POPULATION CENSUS IN 1988 (2/3)

Coast Region 06 :

Ward	No.	Total :Ruvu	RV:Line	Out:Line	Remarks
Bagamoyo District 1					
Kiwangwa	11				
1, Fukayosi		1,904			
2, Masuguru		1,293			
3, Msinune		1,317			
4, Kiwangwa		2,975			*
5, Kidomole		169			
6, Mkenge		763			
Msata	21				
1, Msata		1,649			*
3, Mazizi		1,417			
Magomeni	53				
1, Makurunge	51	1,717			
2, Kaole	51			1,826	
3, Magomeni	52			10,192	
Dunda	62			9,193	
Kiromo	71				
1, Kiromo				2,411	DWE
2, Mataya			834		DWE
3,Buma			1,010		DWE
Zinga / Kerege	81			10,589	DWE
Yombo	91		5,975		DWE
Vigwaza	101	12,378			
Tarawanda	111	7,210			
Charinze	123				
Bwilingu	122	6,716			
others	121	15,375			
Lugoba	131	12,912			
Ubenazamozi	141	13,588			
1 : Rural Area		74,666	7,819	14,826	
1 : Urban Area		6,716	0	19,385	
Bagamoyo Total		81,382	7,819	34,211	

Ward	No.	Total :Ruvu	RV:Line	Out:Line	Remarks
Kibaha District 2					
Tumbi	13				
1, Twd. Pamoja	12			3,924	
2, Mkuza	12		3,131	3,131	*
4, Pangani	11			1,435	
5, Mwanalgali	11			4,476	
6, Bokotimiza	11			1,123	applied
7, Maili Moja	12			5,701	
Kibaha	21				
2, Kongowe			6,432		
3, Mwendapole			5,626		
4, Msangani			773		*
Magindu	31	6,530			Ruvu
Soga	41				
1, Soga			1,738		
2, Kipangege		412			
3, Misufini		270			
4, Vikube			1,101		
Visiga	51				
1, Zogowale		818			
2, Visiga			4,088		
3, Misugusugu			2,213		
4, Mbwana			1,332		
5, Miswe			1,041		
Ruvu	61	9,452			
Mlandizi	73				
1, Dusunyala	71		928		
2, Vikuruti	71		1,238		
3, Mlandizi : A	72		4,481		
4, Mlandizi : B	72		7,595		
2 : Rural Area		17,482	26,510	7,034	
2 : Urban Area		0	15,207	12,756	
Kibaha Total		17,482	41,717	19,790	

Ward	No.	Total :Ruvu	RV:Line	Out:Line	Remarks
Kisarawe District 3					
Marumbo	141	6,098			
Mwaneromango	153				
1, Mw. Romango	151	1,215			
2, Ma. Romango	152	1,805			
3, Msebamo	151	1,402			
4, Mengwa	151	962			
5, Boga	151	1,011			*
Cholesambula	171				
1, Sofu		273			
2, Mafumbi		496			
3, Kwala		1,993			
4, Kurui		871			
6, Chole Samvula		828			*
Mzenga	191	7,172			
Chakenge	201	4,218			
Mafiji	211	4,286			
3 : Rural Area		30,825	0	0	
3 : Urban Area		1,805	0	0	
Kisarawe Total		32,630	0	0	
Coast Region Total		131,494	49,536	54,001	

* on the basin ridges

Table D.4 POPULATION CENSUS IN 1988 (3/3)

Dar Es Salaam Region 07 :

Ward	No.	Out:Line	
Kinondoni District 1:			
Magomeni	11	16,938	
Makurumla	22	54,141	
Ndugumbi	32	32,548	
Tandale	42	58,357	N/C
Mwananyamala	52	72,956	
Msasani	62	51,225	
Kinondoni	72	42,301	
Mzimuni	82	23,989	LP
Kigogo	92	21,267	
Mabibo	102	43,381	
Manzese	112	59,467	N/C
Ubungo	122	47,281	
Kibanba	131	15,671	Kibaha
Goba	141	4,768	No Pump
Kawe	152	32,854	
Kunduchi	161	22,106	
Mbeweni	171	2,224	
Bunju	181		
1, Bunju' A'		2,225	
2, Bunju' B'		1,712	
5, Boko		3,682	
Kinondoni Rural		52,388	
Kinondoni Urban		556,705	
Kinondoni Total		609,093	

Ward	No.	Out:Line	
Ilala District 2:			
Ukonga	13		
R		2,889	
U		40,002	
Pugu	21	6,231	*
Msongola	31	13,279	*
Tabata	42	18,454	
Kinyerezi	51	3,044	
Ilala	62	35,372	
Mchikichini	72	14,852	
Vingunguti	82	33,876	
Kipawa	92	36,992	
Buguruni	102	48,286	
Kariakoo	112	12,506	
Jangwani	122	15,297	
Gerezani	132	7,490	
Kisutu	142	8,399	
Mchafukoge	152	8,439	
Upanga East	162	9,852	
Upanga West	172	11,019	
Kivukoni	182	5,391	
Ilala Rural		5,933	
Ilala Urban		306,227	
Ilala Total		312,160	

Ward	No.	Out:Line	
Temeke District 3:			
Kigamboni	13		
R		4,199	*
U		19,004	*
Vijibweni	21	2,566	*
Kibada	31	3,005	*
Kisarawe II	41	2,721	*
Somangira	51	6,743	*
Kimbiji	61	6,450	*
Mbagala	73		
R		5,548	
U		35,096	
Chamazi	81	5,444	*
Yombo Vituka	91	13,428	*
Charambe	103		*
R		2,491	*
U		16,166	*
Toa Ngoma	111	6,670	*
Miburani	122	71,990	
Temeke 14	132	91,280	
Mtoni	142	39,402	
Keko	152	42,836	
Kurasini	162	26,737	
Temeke Rural		5,548	
Temeke Urban		307,341	
Temeke Total		312,889	

Dar Es Salaam Rural	63,869
Dar Es Salaam Urban	1,170,273
Dar Es Salaam Total	1,234,142

* Out of service area

Table D.5 GDP OF MAIN LAND AND REGION

Year	GDP			Mil. TSh.	GDP per Capita			TSh.
	Morogoro	Coast	Dar Es Salaam	Mainland	Morogoro	Coast	Dar Es Salaam	Mainland
1980	1,944	463	9,462	37,454	1,983	889	9,072	2,072
1981	2,045	547	10,621	43,906	2,344	1,019	9,871	2,354
1982	2,441	690	11,718	52,546	2,769	1,252	10,453	2,729
1983	2,914	745	13,386	62,608	2,965	1,330	11,100	3,151
1984	2,383	860	16,754	78,143	3,185	1,511	12,927	3,811
1985	3,243	1,124	22,395	108,083	4,242	1,945	16,065	5,221
1986	4,224	1,408	28,228	140,866	4,874	2,336	21,953	6,715
1987	4,008	2,004	42,079	200,377	6,742	3,231	31,808	8,873
1988	5,703	2,852	68,436	285,152	9,326	4,469	50,284	12,919
1989	6,710	3,355	72,811	335,505	10,674	5,115	52,756	15,205
1990	12,022	4,007	84,151	400,719	15,502	5,943	58,508	16,837
1991	22,942	5,735	114,708	573,536	21,708	8,459	72,876	23,410

Source : National Accounts of Tanzania 1976 - 91, Bureau of Statistics

Table D.6 GDP BY KIND OF ECONOMIC ACTIVITIES AT CURRENT PRICES

(Unit : Mill. Tsh.)

Sector	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Agriculture	26,449	32,737	41,295	61,231	84,153	117,982	178,760	207,059	233,804	358,693
Mining	266	249	337	251	474	645	723	1,129	4,815	6,975
Manufacturing	4,361	4,869	5,932	6,665	8,551	14,792	15,187	15,197	18,301	20,680
Utilities	421	514	551	1,071	1,488	4,992	4,628	4,842	7,438	8,395
Construction	1,863	1,252	1,661	2,061	3,131	6,511	11,808	9,720	12,650	14,416
Commerce	6,814	8,148	10,447	14,195	19,476	25,963	41,591	50,392	56,638	83,325
Communication	3,395	3,507	4,789	7,021	7,797	11,584	14,259	23,854	36,242	47,017
Finance	4,891	5,252	6,028	6,659	8,127	11,061	14,132	19,187	24,123	28,757
Administraion	5,446	7,372	8,614	10,735	10,213	13,291	16,952	22,168	31,968	34,478
Bank Services	-1,360	-1,292	-1,511	-1,806	-2,544	-6,444	-12,888	-18,043	-25,260	-29,200
Total	52,546	62,608	78,143	108,083	140,866	200,377	285,152	335,505	400,719	573,536

Source : National Accounts of Tanzania 1976-91, Bureau of Statistics

Table D.7 RGDP OF COAST REGION BY KIND OF ECONOMIC ACTIVITIES - CURRENT PRICES -

(Unit : Mill. Tsh.)

Sector	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Agriculture	347.1	389.6	454.1	636.2	840.6	1,180.4	1,788.2	2,070.0	2,336.1	3,584.4
Mining	3.5	3.0	3.4	2.2	4.2	6.0	8.6	10.1	48.1	68.8
Manufacturing	57.3	58.1	65.4	69.7	85.9	148.3	151.2	151.0	184.3	206.5
Utilities	5.5	6.0	6.0	12.4	15.5	50.1	45.6	47.0	76.1	86.0
Construction	24.2	14.9	18.9	21.4	31.0	64.1	116.9	97.3	128.2	143.4
Commerce	89.7	96.9	115.2	147.2	194.3	260.5	416.4	503.3	565.0	831.6
Communication	44.9	41.7	52.5	73.1	77.4	116.2	142.6	238.2	360.6	470.3
Finance	64.2	62.6	66.2	69.7	81.7	110.2	142.6	191.2	240.4	286.8
Administraion	71.8	87.9	94.6	111.3	102.8	132.3	168.3	221.4	320.6	344.1
Bank Services	-17.9	-15.6	-16.3	-19.1	-25.3	-64.1	-128.3	-181.2	-252.4	-292.5
Errors	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.7	0.0	5.6
Total	690.3	745.1	860.0	1,124.1	1,408.1	2,004.0	2,852.1	3,355.0	4,007.0	5,735.0

Source : Regional Commissioner's Office of the Coast Region

Table D.8 DIRECTORY OF INDUSTRIES

Name	Rgisterd		Size	Owner	Products
Multi. Oilseed Proces.	MU	1971	4	MG	Cooking Oil
T. Tabaco Proces. & Market.	MU	1968	5	G	Cured Tobaco
Morogoro Polyster Textiles	MU	1985	5	G	Cotton Yarn, Fabr c
Dutumi Ginnery	MR	1979	4	CU	Cotton Lint
Morogoro Ginnery	MU	1926	3	CU	Cotton Lint
Morogoro Canvas Mill	MU	1984	3	G	Yarn, Canvas
Kiwanda Cha Magunia	MU	1986	3	G	Gunny Bags
Morogoro Tanneries	MU	1978	4	MG	Tanned Leather
Morogoro Shoe	MU	1980	3	G	Shoes
Morogoro Leather Goods	MU	-	4	G	Leather Goods
Morofgoro Ceramic Wares	MU	1986	4	G	Sanitary, Table Wares
Tanzania Automobile Manuf.(Tumbi)	C	-	4	MG	Scania Bus, Track, Valmet Tractors
TANESCO	MU	-	4	G	Electricity
TANESCO (Tumbi)	C	-	3	G	Electricity
Mecco Msolwa Quarries (Chalinze)	C	-	2	G	Aggregates
Uluguru Mica Mining	MU	1954	2	-	Mica
National Milling : NMC	MU	1973	2	G	Maize Flour
C. Kristakis Bakery	MU	1982	2	P	Bread
Sekulu Tailoring	MU	1976	1	CS	Tailoring
Uluguru Tailoring	MU	1962	1	CS	Tailoring
Vijana Washona Nguo	MU	1962	2	CS	Tailoring
B. H. Ladwa	MU	1985	1	P	Timber
Universal Mechanics	MU	1958	1	P	Timber
Chawama-Chalinze	C	1975	2	P	Wooden Comp. Spoons
Chakupe	C	1974	2	CS	Wooden Comp. Spoons
Ram Singh & Sons	MU	1968	1	P	Furniture
Pitamber R. & Sons	MU	-	1	P	Furniture
Magereza Mkoa wa Morogoro	MU	1975	1	G	Furniture
Halimashauri ya Wilaya	MU	1950	1	G	Furniture
Tanzania Adventist Press	MU	1975	2	P	Printing
Equator Publishing Agency	MU	1981	1	P	Printing, Bk Binding
Tanzania Pesticides	MU	1966	2	P	Insecti-, Pesticides
Bigwa Ceramic : Kingolwira	MR	1976	2	P	Burnt Bricks
Mvumila Workshop	MU	1980	1	P	Metal Products
SIDO Workshop	MU	1986	2	G	Spare Parts, Gears

Notes ; size ; 5 = 500<, 4 = 100-499, 4 = 50-99, 2 = 20-49, 1 = 10-19
ownership ; G = Government, P = Private, MG = Majority Government,
CU = Regional or District Co-operative Unions,
CS = Other Co-operative Societies

Source : Directory of Industries Vol. 1,2 : Bureau of Statistics, '92

Table D.9 NATIONAL SOCIO-ECONOMIC DATA

*LAND

Total	Cropland	Pasture	Forest	Others	(Wilderness)
886,040	52,400	350,000	411,800	71,840	70,530
100.0 %	6.0 %	40.0 %	46.0 %	8.0 %	8.0 %
change:/'78	2.2 %	0.0 %	-2.8 %	17.8 %	7.0 %

*Population	mil.	*Safe Drinking Water		*Sanitation : 1988	
1990	1995	Urban	Rural	Urban	Rural
27.32	32.97	75.0 %	46.0 %	75.0 %	77.0 %

*BASIC ECONOMIC INDICATOR

GNP	US$:1989	GDP Distribution : 1989		ODA : mil. US$: avr. annual	
Total	per capita	Agriculture	65.6 %	1982 - 84	1984 - 89
3,079	120	Industries	7.5 %	100	169
GNP net charge ; % pa		Services	26.9 %	ODA/GNP	
1969 - 79	1979 - 89			13.4 %	13.3 %
3.8 %	1.8 %	Total	100.0 %	p. capita ODA : '89 US$ 52	

Externaldebt	US$: 1989	1989	Gov. Expenditure US$: 1981		exchange rate
Total	per capita	/export	Total	per capita	Tshs/US$: '93
4,917	6.61	17.0 %	1,596	85	460

*AGRICULTURE

Agro Product Index : '80=100		Input			1988
88-90 : Total	88-90 : p. capt	Irrig. /Crop	Fertilizer	Pesticide	Tractor
122	88	3.0 %	9.0 kg/ha	5,733 ton	18,550

*WATER

Annual Renewable : 1990		Annual Withdrawal : 1970		Distribution : 1987	
Total	per capita	Total	per capita	Agriculture	74.0 %
76 km3	2,780 m3	0.48 km3	36 m3	Industries	5.0 %
				Domestic	21.0 %

*NATURAL AREAS

8 places	11,913 ha	12.60% of land area

Source : World Resources 1992-93, WRI, Oxford Univ. Press.

Table D.10 LAND USE AND AGRICULTURAL ACTIVITY IN THE PLANNED RESERVOIR AREA OF KIDUNDA DAM

		Name of Village				Total	Remark (Data Source)	
		Mggni	Kgnla	Bwila-J	Bwila-C			
Location (Bank side of the Ruvu River)		Right	Left	Left	Right/Left	-		
Population		929	979	806	1,962	4,676	CENSUS'88	
Population		na	1,016	na	2,700	na	WARD '93	
Population		na	2,128	881	2,961	5,970	SCP '91	+2.6pa
Population		1,420	1,170	1,104	1,014	4,708	DAO '92	
Workforce		696	573	541	497	2,307	DAO '92	
Household		237	195	184	169	785	DAO '92	
Household		na	266	220	370	856	SCP '91	
House No.		na	300	350	352	1,002	WARD '93	A.
(of burnt brick)			10	9	0	19	WARD '93	
Church+Pastor, School			5	1	0	6	WARD '93	
with gcs roof			na	20	45	65	WARD '93	
Housing Area (ha)		na	310	153	203	666	SCP '91	B.
Crop Land (ha)		na	837	310	641	1,788	SCP '91	C.
Maize	(max ha)	278	229	216	199	922	DAO '92	
	(act. ha)	252	179	196	159	786	DAO '92	
Paddy	(max ha)	40	115	24	38	217	DAO '92	
	(act. ha)	40	86	24	38	188	DAO '92	
Sorghum	(max ha)	278	229	128	199	834	DAO '92	
	(act. ha)	238	213	118	136	705	DAO '92	
Cotton	(max ha)	278	229	216	199	922	DAO '92	
	(act. ha)	78	89	65	39	271	DAO '92	
Total	(max ha)	874	802	584	635	2,895	DAO '92	
	(act. ha)	608	567	403	372	1,950	DAO '92	
Banana		na	900	1,050	1,056	3,006	WARD '93	Ax3
Coconut		na	450	525	528	1,503	WARD '93	Ax1.5
Mango		na	600	700	704	2,004	WARD '93	Ax2
Goat		256	420	135	150	961	DAO '92	
Poultry		3,680	4,027	2,116	2,312	12,135	DAO '92	
Duck		1,020	156	600	465	2,241	DAO '92	
Forest	(ha)		3,053	3,386	2,429	8,868	SCP '91	D.
Total	(ha)		4,200	3,849	3,273	11,322	SCP '91	B+C+D

SOURCE : WARD '93; from village chairmen
SCP '91; Selous Conservation Programme, DGTZ 1991
DAO '92; District Agriculture Office, 1992/93

NOTE : MGGNI=Magogoni, KGNLA=Kiganila, J=juu, C=chini
A big discrepancy in population of Bwila-chini is due to the fact if they count that of newly created Kiburma or not.

APPENDIX-D

FIGURE

Chart 1: GDP at 1976 Prices Average Annual Growth Rates

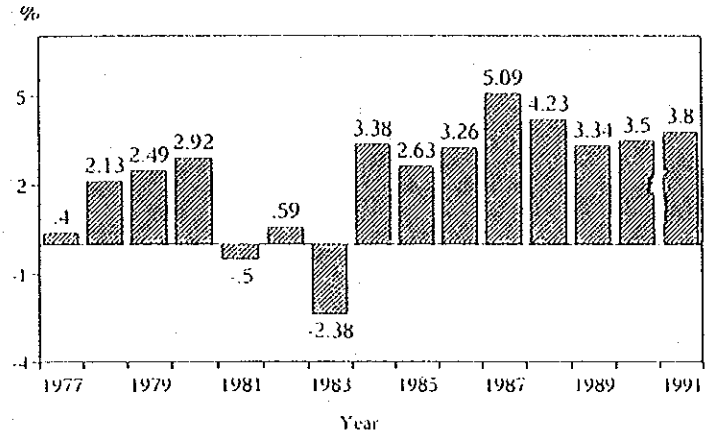


Chart 2: Agriculture (GDP) at 1976 Prices Average Annual Growth Rates

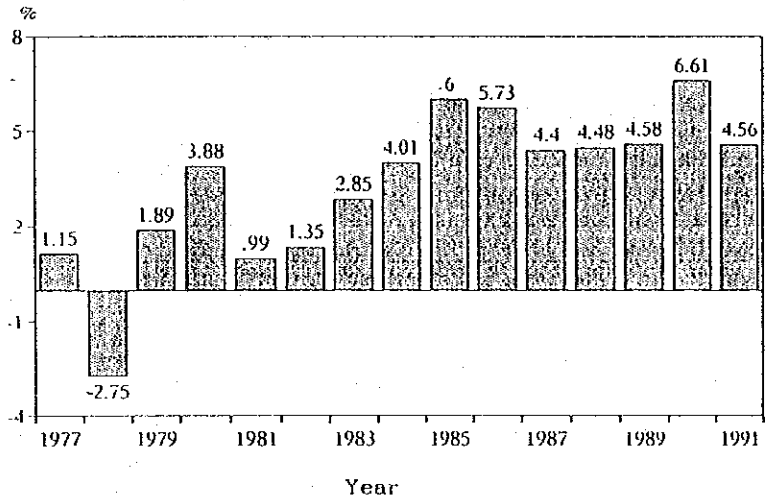
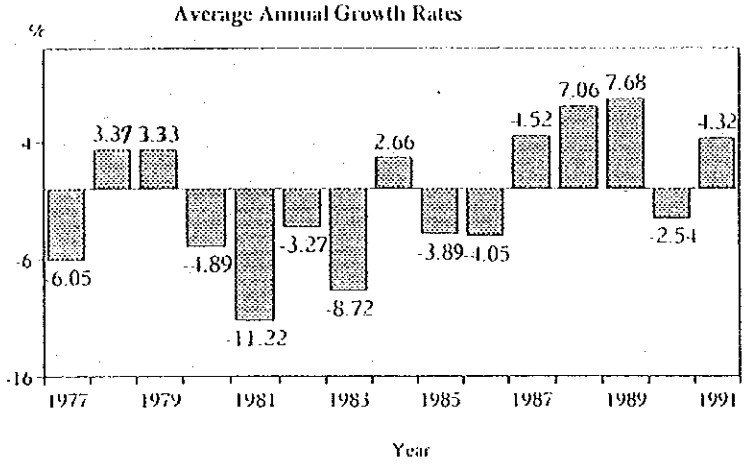


Chart 3: Manufacturing (GDP) at 1976 Prices
Average Annual Growth Rates



SOURCE: National Accounts of Tanzania 1976-1991, Bureau of Statistics, 1992.

Fig. D.1 ANNUAL GROWTH RATES OF TOTAL GDP AND SECTOR GDPS

APPENDIX-E

MUNICIPAL WATER DEMAND FORECAST

APPENDIX - E

MUNICIPAL WATER DEMAND FORECAST

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APPENDIX - E

MUNICIPAL WATER DEMAND FORECAST

1. PRESENT WATER SUPPLY CONDITIONS IN THE STUDY AREA

The water supply system for Dar Es Salaam city is owned and run by NUWA (National Urban Water Authority). The main water source of the water supply system is the River Ruvu and the water is conveyed to Dar Es Salaam through two (2) long trunk transmission mains. The areas along these transmission mains have been included in the service area since 1992. The major towns in the areas are Kibaha, the capital of the Coast Region, and Bagamoyo. A part of Dar Es Salaam city is also included in the areas along the transmission mains, which become populated and have a considerable amount of water demand recently. The characteristics of these areas are that the water supplied is used for agricultural production such as irrigation, horticulture, animal husbandry, poultry farming, etc. The Government as well as NUWA attempt to discourage water consumption in the agricultural sector applying the higher tariff which is equivalent to that for industrial sector.

The other major municipal water supply in the Study Area is the Morogoro water supply system which is owned by PMO (Office of the Prime Minister and First Vice President), and run by RDD office in Morogoro. Morogoro was ranked as municipality in 1991. The water supply system is expected to cover the whole area of the municipality in future.

The other smaller water supply in the Study Area is category of rural water supply. They are owned by PMO and run by the RDD office. In Dar Es Salaam, the rural water supply is run by RWSD. These rural water supply is minor in view of requirement of new water resources. Therefore, it is not discussed in this Study.

1.1 Dar Es Salaam Water Supply

The Dar Es Salaam water supply is characterized by an overall shortage of water and uneven distribution of the water in the city. The study on rehabilitation of Dar Es Salaam water supply, which was carried out by JICA in 1991, clarified the situation in 1990 as follows;

- Gross supply	296,300	m^3/day
Lower Ruvu treatment plant	207,500	m^3/day
Upper Ruvu treatment plant	82,000	m^3/day
Mtoni Treatment plant	6,800	m^3/day
- Transmission line		
Consumption and leakage	102,900	m^3/day
- Consumption within the distribution network	125,727	m^3/day
Domestic consumption	111,056	m^3/day
Industrial consumption	4,120	m^3/day
Commercial consumption	5,697	m^3/day
Institutional consumption	4,854	m^3/day
- Distribution leakage	67,673	m^3/day

The water leakage ratio in the distribution system is 35% of the net supply. The population served is estimated at 1,335,028. The Urban Sector Engineering Project, Infrastructure Rehabilitation (1992, PMO), gives almost the same figures as shown in Table E.1.

The general alignment of the water supply system is shown in Fig. E.1. The main water source is the Ruvu River, on which both the Upper Ruvu and Lower Ruvu intakes are provided. Although the river flow is unregulated, the river discharge is sufficient for the current production capacity of water throughout a year except for the extreme dry period.

(1) Upper Ruvu water supply scheme

The Upper Ruvu scheme was constructed in 1959. The capacity of the scheme was then increased in stages. The intake is located beside the Ruvu bridge. The treatment plant is at Mlandizi about 7 Km distant from the intake. After treatment, water is conveyed to the Kimara reservoir through the transmission pipeline. The whole facilities including intake, treatment plant and pumping stations are in good condition after the recent rehabilitation completed by Italian financing in 1992.

The new intake is designed for the maximum abstraction rate of 210,000 m^3/day (2.4 m^3/sec) which is more than twice the present capacity of the treatment plant of 82,000 m^3/day. The raw water pumping station building and some components in the treatment plant are also designed for the higher capacity in future. The 50 Km long transmission pipeline to the Kimara reservoir consists of 2 or 3 parallel mains depending on the locations. The pipes are made of steel as well as FRP of which diameters vary from 500 to 900 mm. A lot of illegal tapping are found along the steel pipe portion. This transmission line supplies water to Mlandizi town, Kibamba town, Kibaha ward of DSM and villages along the line as well.

The Kimara reservoir is located along the Morogoro road in the fringe of the city. There are three tanks with a capacity of 6,900 m^3, 6,900 m^3 and 18,000 m^3, respectively. The high water level of these tanks is 135 m. The water stored in the reservoir is supplied at about 5 a.m. and quitted usually between 9 and 10 a.m. when the tank dries up.

(2) Lower Ruvu water supply scheme

The Lower Ruvu scheme was constructed in 1975-1976. The intake is located 22 Km downstream of the Upper Ruvu intake or 18 Km upstream of the river mouth. A weir is provided on the river in order to keep the minimum level of the raw water well at the elevation of 3 m.

The intake structure has three (3) openings, one for low water level and the other for high water level. Although the design capacity is 386,000 m^3/day, the current operating capacity is 182,000 m^3/day. The water flows through the intake main by gravity. There are 4 pumps in the low lift pumping station, which provides a space for one additional pump for the future expansion of the capacity. The current operating capacity of the pumping station is 191,000 m^3/day.

The water is pumped to the treatment plant without sand separation. The plant is divided into two lines, each with a capacity of 91,000 m^3/day. The treatment consists of coagulation by in line mixing, flocculation and sedimentation in classifiers of the up-flow contact type, and rapid sand filtration. In addition, the water is chlorinated and neutralized. The plant is designed to have a capacity of 182,000 m^3/day. However, the current production reaches about 207,500 m^3/day, exceeding the capacity. This is because the water by-passes the rapid sand filters which are currently out of order. This results in production of the water with high turbidity. After the sand filters are rehabilitated, the production may drop to the nominal capacity of 182,000 m^3/day. The high lift pumping station has 4 pumps, which has a space for one additional pump for future expansion of the capacity. The current operating capacity is 182,000 m^3/day at 108 m head. The transmission main conveys water to the University reservoir with a 55 Km long prestressed concrete pipes of 1,350 mm in diameter. The water in Bagamoyo town, Bunju, Kunduchi, Mbweni and Goba wards of DSM, a part of Kawe ward and villages along the transmission main are supplied from the off-takes installed at 17 different places thereon.

The University reservoir is located in the northwestern part of the city. It consists of two (2) tanks, each having a capacity of 22,700 m^3, of which high water level is at the elevation of 70 m. The water is distributed from the reservoir mainly to the lower zone of Dar Es Salaam (DSM). The tanks are always empty. This means that the reservoir does not function as a system at all. NUWA has since 1980 undertaken minor rehabilitation works on the pumping stations and the treatment plant with the Canadian assistance. This assistance is currently being provided for the operation and maintenance of the treatment plant.

(3) Mtoni water supply scheme

The Mtoni scheme has the intake and plant beside the Kizinga River in the southern area of Dar Es Salaam city. The treatment plant provides a full treatment with a design capacity of 9,000 m^3/day. The facilities are in poor condition and the abstraction rate drops down to 1,500 m^3/day during the dry season. On average, the production rate is about 6,000 m^3/day according to the report of the Urban Sector Engineering Project. The water is directly supplied to the distribution network by pumping. Since this scheme was constructed in 1949, most of the main components such as the plant and the pumping station need rehabilitation.

The main features of the aforesaid three (3) schemes are summarized in the following table;

Main Facilities	Name of Schemes		
	Upper Ruvu	Lower Ruvu	Mtoni
- Water Source	Ruvu River	Ruvu River	Kizinga River
Intake:	210,000 m^3/day	386,000 m^3/day	unknown
- Raw Water Pumping St.	98,500 m^3/day H=70.2 m	191,000 m^3/day H=24 m	unknown
- Treatment plant	82,000 m^3/day	182,000 m^3/day	9,000 m^3/day
- Clean Water Pumping Station	98,500 m^3/day H=152.4 m	182,000 m^3/day H=108 m	unknown
- Transmission Main	Steel d=512 n 750*51km FRP d=900*21km	PC d=1350*55km	nil
- Booster station	98,500 m^3/day H=152.4 m	nil	nil
- Service reservoir	Kibaha 6,900m^3 Kimara 6,900 m^3*2	University 22,700 m^3*2	nil

The hourly variation of the supply from the reservoirs and the Mtoni plant is shown in Fig E.2. The hourly supply from the University reservoir does not vary so much during the 24 hours. The supply rate ranges between 6,000 m^3/hour and 7,000 m^3/hour except for a few hours in the morning. This means that the reservoir does not meet the water demand of the service area which comprises the lower zone of DSM, as the supply is far less than the demand. The operation of the Kimara reservoir is a intermittent service limited to the morning time between 5 a.m. and 10 a.m. This is because the reservoir can receive only 18,410 m^3/day from the Upper Ruvu scheme according to the previous JICA study. Therefore, it is obvious that most of the area covered by the distribution network is subject to the shortage of the municipal water.

The existing distribution system is the result of irregular extension works undertaken since 1950's. About 30% of the pipes are used for more than 30 years. The total length of the pipes is about 800 km. However, many areas lack proper secondary and tertiary networks due to the insufficient funds. As a result, networks of long and small diameter pipes have been installed.

The extent of encrustation of network pipes were examined by the JICA study in 1990. The pipes of diameter 200 mm and less at various places suffered from deposits consisting mainly of hardened silt and crust. It is observed that a flow area of these pipes has been reduced from the original one by 50%. The main cause of the occurrence of silt deposit is lack of filtration at the Lower Ruvu treatment plant.

The JICA study also undertook field tests for estimation of water leakage in the network. The leakage ratio ranging from 35% to 50% was measured in some areas, which is concerned with the water pressure in the pipes. The major reasons for water loss are:

- Leakage from pipes, pipe connections, valves and service connections
- Absence of water meters that does not encourage anyone to check on the water loss
- Illegal connections
- Lack of maintenance of the network

Rehabilitation of the network in the Upper zone was undertaken by the Italian funding in 1990. The works included:

- New 6.6 km long CI distribution main of 600 mm in diameter along Nelson Mandela road from Ubungo to Pugu road
- New 3.6 km long FRP distribution main of 400 mm in diameter connecting the Nelson Mandela main and the old main in Tabata area

According to the information from NUWA, there are about 70,000 registered connections in the city. Only 2,000 connections are metered, of which only 40% are functioning. In terms of domestic connection, there are three (3) types of water supply service levels in DSM as explained below;

- House connection: Within the housing unit, a number of taps are available. Kitchen, toilet, bathroom, etc. have water use equipment.

- Yard connection: Only one or two taps within the house premise are available. Usually taps are located in the yard at the back of the house, from which water is taken and carried by bucket and containers to the house.

- No connection: This type has no water connection within the house or house premise. Residents have to go to water kiosks, or standpipes or to their neighbors to fetch water in buckets.

The previous JICA study estimated the number of connections by the water service levels. The house connections were subdivided into the three (3) income levels. These connections were within the distribution networks as of 1990.

Type of Connection	No. of connections	Population served
House connection	94,710 (30%)	428,851 (32%)
high income	12,757 (4%)	69,663 (5%)
middle income	4,486 (1%)	24,467 (2%)
low income	77,467 (25%)	334,721 (25%)
Yard connection	74,150 (24%)	315,482 (24%)
No connection (kiosk/standpipe)	139,410 (45%)	590,695 (44%)
Total	308,270	1,335,028 (100%)

The average per capita consumption was calculated at 83 litre/day. The other connection such as industrial, commercial, institutional connections were estimated as follows;

Connection by Sector	Total	Metered
Industrial connection	475	54
Commercial connection	4,902	420
Institutional connection	1,141	61

For the service areas along the trunk transmission mains, NUWA established branch offices and started registration of connections in 1992. The population served is estimated in this Study at village level as shown in Tables E.3 and E.4. Names of registered consumers in industry, commerce, institution and agriculture as well as their consumption are collected in this Study.

Connection by Sector	Upper Ruvu scheme	Lower Ruvu scheme
Industrial connection	6 (273 m^3/day)	35 (17,268 m^3/day)
Commercial connection	6 (76 m^3/day)	41 (1,808 m^3/day)
Institutional connection	16 (1,578 m^3/day)	37 (1,710 m^3/day)
Agricultural connection	46 (2,208 m^3/day)	81 (6,328 m^3/day)
Total	74 (4,135 m^3/day)	149 (27,114 m^3/day)

Those institutions who are using water for agriculture are included in the agricultural connections. It is considered that a large number of small consumers in commercial, institutional, agricultural sectors are neglected in the registration. The per capita consumption for the domestic purpose is little known on the area. The Kibaha Master Plan (Draft, Ardhi Institute, 1993) describes that it varied from 50 to 200 litres with an average of 126 litres in the Kibaha town in 1988.

Consumption (lpcd)	%
50 - 100	40
100 - 150	25
150 - 200	20
Over 200	8
No answer	7
Total	100

About 23% of the households have gardens which use water for the purpose. This implies that water is relatively sufficient in the town. Therefore, it is regarded that the average per capita consumption is equivalent to the average per capita demand.

1.2 Morogoro Water Supply

The water supply system in Morogoro was introduced in 1930 harnessing the Morogoro River as the water source (Mambogo scheme). The current major source for the Morogor water supply is the Mindu dam located about 6 km distant from the town, which was completed in 1985 on the Ngerengere River, a tributary of Ruvu River (Ngerengere scheme). The other sources exist in the Uluguru Mountains. The overall alignment of the system is shown in Fig E.3. The Morogoro water supply system has the following facilities:

- Mindu dam	initial yield	57,500 m^3/day
	yield after 20 years	43,000 m^3/day
- Morogoro River intake (Mambogo scheme)	intake capacity	3,000 m^3/day
- Kigurunyembe intake	intake capacity	600 m^3/day
- Kibwe intake	intake capacity	400 m^3/day
- Vituli intake	under construction	
- Treatment plants	Ngerengere scheme cap.	1,000 m^3/hr
	Mambogo scheme cap.	2,700 m^3/day
- Pumping stations	Ngerengere scheme	
	transmission main (1 no.)	
	booster (1 no.)	
- Service reservoir	Ngerengere scheme	
	5,000 m^3 ground tank	
	450 m^3 elevated tank	
	Mambogo scheme	
	ground tank (4 nos., total capacity : 2,100 m^3)	
Distribution mains	pipes of 3"-16" in diameter, 54 Km long in total	

The Ngerengere scheme is distributing water to a large part of the Morogoro municipality including Kihonda industrial estate. The treatment plant of the scheme comprises conventional chemical flocculation, aeration, sedimentation and rapid sand filtration. The water is chlorinated before distribution. The treatment plant has a design capacity of 1,000 m^3/hour. Due to the damage to the sedimentation tanks, the present operating capacity is reduced to 500 to 600 m^3/hour or 10,000 to 12,000 m^3/day depending on the operation hours.

After treatment, water is pumped to the service reservoir with a capacity of 5,000 m^3 located in the northern fringe of the town. This reservoir directly conveys water to the Kihonda industrial estate and the low ground area bounded by the Iringa highway. The water is also pumped to the elevated tank and distributed to the main parts of the town.

The Mambogo scheme intakes water of the Morogoro River. There is a small and old treatment plant. However, the plant is not operated because the mechanical equipments are worn out. Only chlorinating is being done manually on random occasion. Hence, the water is virtually not treated before led to the four (4) adjacent tanks. The total capacity of the tanks is 2,100 m^3. The service area seems to be limited to the adjacent high land area, the southern part of the town and the university/college through a separate pipeline.

Two other intakes on the Kibwe and Kigurunyembe streams are also components of the water supply system. However, the combined yield from these sources are only about 1,000 m^3/day. The water is distributed to the southern part of the town from the Kibwe scheme and the eastern part of the town from the Kigurunyembe scheme. For these, water is not treated completely but chlorinated manually.

Another small intake is now under construction on the Vituli stream. The water will be supplied to Tungi and the eastern part of the municipality. The total storage capacity of 7,600 m^3 is considered sufficient taking into account the current rate of the water production. All the tanks are in good condition.

The main distribution network covers most of the town area. The network was strengthened between 1979 and 1985 by construction of a ring distribution main consisting of PVC pipes of 8"-12" in diameter. This project also included a 16" distribution main connected to the industrial area and an extension of the network mainly towards the east with installation of 4"-6" PVC pipes. The old distribution network in the center of the town which has been used for about 50 years comprises 3"-8" cast iron pipes with a substantially reduced capacity due to encrustation. Water leakage is often found in this area. The main problem is the leakage and subsequent drops of water pressure. During peak hours, the pressure drops significantly and water is being distributed unevenly within the town. The gravity supply to the industrial area is regularly shut off in order to divert more water into the town. The leakage level has not been surveyed since 1971. Table E.2 shows that the leakage varies from 0.7% to 38.4% depending on the quantity distributed.

There are about 4,000 registered connections in total, most of which are unmetered. Further, most of the meters are not operated. There are kiosks and standpipes that total 82 in the system. According to the population census of 1988, the population served by the water supply is as follows;

Type of Pipe Connection	Households	Population
Piped water within the premise	13,613 (49%)	57,477 (49%)
Piped water outside the premise	11,982 (43%)	47,937 (41%)
Total	27,910 (100%)	116,590 (100%)

This survey indicates that 90% of the population receives water from the water supply, but 45% of the population served fetches water from kiosks, standpipe and neighbors. The Study Team surveyed the number of kiosk/standpipe users in some model areas. The average number of users was 308 persons per kiosk/standpipe which exceeded 283 persons in 1971. The

population served at different levels of the water supply service and income levels of consumers were estimated in 1988. The types of water supply service levels are same as DSM.

- House connection and Yard connection	
high income	6,322
middle income	23,977
low income	27,178
- No connection	
neighbors	22,681
kiosk/standpipe	25,256
Total	105,414

The yard connection is utilized mostly by the low income people. It is common that the people share water with their neighbors. The Urban Sector Engineering Project (PMO,1992) estimated the water production and utilization budget as shown in the following:

Production/consumption Categories	Production (m^3/day)	Consumption (m^3/day)
Mindu dam	12,000	
Morogoro River	2,000	
Kibwe, Kigurunyembe	1,000	
Industries		4,500
Institution		2,500
Losses		3,000
Remains for domestic and commercial		5,000
Total	15,000	15,000

On the other hand, report of RWE, Morogoro, 1991, describes that the production is in a range of 16,000 to 19,000 m^3/day. If this budget is correct, the per capita consumption for domestic and commercial purposes comes to about 35 litre, which is very low and unrealistic. The Study Team surveyed the consumption of yard connection and kiosks/standpipes, and estimated at 35 litre for the per capita consumption of those who fetch water from neighbors, and at 24 litres for those who use kiosks/standpipes at 24 lpcd as shown in Tables E.5 and E.6. Besides, the RWE also reported the number of the industrial consumers and commercial consumers as follows;

Consumer by Sector	Large	Small
Industrial consumers	9	128
Commercial consumers	4	592

2. PREVIOUS WATER DEMAND FORECAST FOR THE MUNICIPAL WATER SUPPLY

2.1 Dar Es Salaam Water Supply

In 1970's, several studies were carried out for the purpose of expansion of the water supply capacity to cope with the increasing demand due to the rapid expansion and urbanization of the city.

Soon after the construction of the Lower Ruvu scheme, DSM faced the difficulty in the management of infra-structural and social service, emanating largely from the national economic problems between the late 1970's and the late 1980's. Due to such problems, the

extension of the Lower Ruvu scheme from 182,000 m^3/day to 546,000 m^3/day, proposed by the DSM Master Plan, was not carried out in 1980's. Under the situation, the inhabitants had to suffer from shortage of water because of the population growth and the distribution leakage caused by the poor maintenance.

The results of the water demand forecast made by the other previous studies are shown in Table E.11. They were made on daily average basis. In 1979, the Ministry of Lands, Housing and Urban Development, prepared the Dar Es Salaam Master Plan. In those days, NUWA DSMB made the water demand prediction as well. In 1991, Japan International Cooperation Agency (JICA) made a water demand prediction for the year 1995 in the course of the study on rehabilitation of Dar Es Salaam water supply. The water demand forecast in 1990 shows that the situation is getting worse. In 1992, the Office of the Prime Minister and First Vice President made a water demand prediction for the year 2002 in the Urban Sector Engineering Project, Infrastructure Rehabilitation.

The water demand prediction made in the previous JICA's study up to the year 1995 was based on the estimation of current water demand in 1990.

For the domestic demand, the population served within the distribution network was estimated in ward-wise for different water supply service levels such as house connection, yard connection, no connection (kiosk/standpipe). Further, the population served by house connection was divided into three (3) income levels. A total of population included in those categories is referred to in the foregoing Sub-section 1.1. The per capita demand of these connections was estimated based on the field survey on number of users and consumption reading meters in some selected model areas where water was relatively sufficient. The results obtained in the study are as follows:

House Connection	Per Capita Water Demand (lpcd)
High income	400 lpcd
Middle income	250 lpcd
Low income	160 lpcd
Yard connection	85 lpcd
No connection (Kiosk/standpipe)	22 lpcd

The per capita consumption figures were considered as they are equivalent to the per capita demand. The study also surveyed the water use equipment in those houses which were metered, and estimated the base consumption rates of the water use equipment from the consumption values, number of users and the possession ratios. Through this survey, non-luxury basic consumption was estimated at 80 lpcd.

Consumption	Base	House connection			Yard
	(lpcd)	high	middle	low	connection
Basic consumption	80	80	80	80	80
Shower	25	25	20	24	10
Flush toilet	30	30	29	29	2
Sink	30	30	30	23	2
Bathtub	140	140	24	54	0
Sprinkler	80	53	0	22	0
Car wash	50	17	0	6	0
Washing machine	40	18	2	2	0
Total (lpcd)	475	393	184	239	94

For industrial, commercial and institutional demand, the study estimated the number of consumers subdividing them into large and small consumers. The per consumer consumption of small consumers was also estimated from the consumption records as shown below:

Consumer by Sector	Large		Small		Total Consumption (m3/day)
	No. of Consumer	Consumption (m3/day)	No. of Consumer	Consumption (m3/day)	
Industrial consumers	6	1,050	469	6.2	2,907
Commercial consumers	5	411	4,897	1.2	5,871
Institutional consumers	2	685	1,139	4.1	4,670

Since the consumption was suppressed in some areas of DSM due to the insufficient water pressure, the water pressure measurement was carried out on the primary distribution system. In order to estimate the demand, the suppression factors of 0.95, 0.8, 0.7, and 0.6 were given to each ward depending on the effective pressures. The sectoral consumption was converted to the demand by dividing by these factors. The total demand was calculated, taking into account the current loss level of 35%, as summarized below:

Sector	Daily average demand (m3/day)
Domestic demand	128,180
Industrial demand	4,612
Commercial demand	6,282
Institutional demand	5,355
Sub-total	144,429
Leakage (35%)	77,771
Gross demand	222,200

For prediction of the water demand in 1995, the population was projected to increase at an annual growth rate of 3.5%, which was obtained through the study on the trend of historical growth rates. Different growth rates were given to each ward, considering the population density. Then the population served was estimated on ward basis, considering the planned extensions. The per capita demand of those categories were assumed to be the same as those in 1990.

The industrial, commercial and institutional demands were assumed to increase at the GDP growth rate for the last 5 years. The loss level was counted at 19.1%, assuming that the rehabilitation of water supply system was to be completed and the system was to be fully functional. As a result, the total demand in 1995 was estimated through the previous study as follows:

Consumer by Sector	Population Served	Daily Average Demand (m3/sec)
- Domestic demand	1,519,339	145,234
- House connection	487,723	99,315
high income	78,915	61,256
middle income	25,975	6,494
low income	382,833	31,565
- Yard connections	347,931	29,575
- No connections (Kiosk/standpipe)	683,685	15,043
- Industrial demand		5,479
- Commercial demand		7,462
- Institutional demand		6,363
Sub-total		164,338
Leakage (19.1%)		38,862
Gross demand		203,200

The peak factor was taken at 1.25 sa as to estimate the daily maximum demand, which is the same as that of 1990. Consequently, the daily maximum demand was calculated at 254,000 m^3/day.

The Urban Sector Engineering Project (PMO,1992) estimated the 1992 water demand, and predicted the 2002 water demand as shown in Table E.11. These figures include the demand in the areas along the transmission mains. The 1992 demand is 294,000 m^3/day on daily average basis, resulting in the smaller domestic demand and larger demand in other sectors as compared with those in the aforesaid JICA study. The study assumed that the per capita demand does not increase in future as well as the JICA study. The 2002 demand was estimated at 355,000 m^3/day, assuming the rehabilitation of the system before the year 2002. However the details of the prediction methods adopted are not mentioned in the report.

2.2 Morogoro Water Supply

There are some studies in 1970's for expanding the capacity of the Morogoro water supply system, including the construction of the Mindu dam.

In 1972, Ministry of Water Development and Power carried out a feasibility study on Morogoro town water supply. In 1974, the Ministry of Lands, Housing and Urban Development, prepared the Master Plan for Morogoro. In 1975, Ministry of Water, Energy and Minerals carried out the updated feasibility study for the Morogoro water supply. In 1978, Ministry of Water Energy and Minerals prepared the report on reticulation analysis. In 1992, Office of the Prime Minister and First Vice President set up the strategic integrated infrastructure development program in the Urban Sector Engineering Project, Infrastructure Rehabilitation.

The results of the water demand forecast made by these studies are shown in Table E.11. The Master Plan in 1974 did not predict the water demand. The report on reticulation analysis quotes the updated feasibility study.

Since the Mindu dam was completed in 1985, the water demand has increased because of the establishment of factories and the migration of people for job opportunities.

The Urban Sector Engineering Project estimated the per capita demand for domestic use in 1992 to be remarkably higher than the current per capita consumption which is described in the foregoing Sub-section 1.2. This is because the study followed the design criteria laid by the Government. The 1992 and 2002 water demands are shown in Table E.13. The details of the methods for prediction are not mentioned in the report. The losses were assumed to be reduced to 25% of the net demand.

The RWE, Morogoro estimated the demand in 1991 as shown below:

Demand by Sector	Water Demand (m3/day)
Domestic demand	18,104
Industrial demand	6,671
Demand of small scale industry	1,023
Institutional demand	664
Total	26,462

The per capita demand for the domestic use was calculated at 142 lpcd.

3. PLANNED WATER SUPPLY PROJECTS

3.1 Dar Es Salaam Water Supply

Since 1976, no further expansion of the supply capacity has been carried out. The Urban Sector Engineering Project considers that it is the most feasible to expand the treatment plant of the Lower Ruvu scheme to the extent corresponding to the present capacity of transmission main. The planned projects are as follows;

1) Improvement and rehabilitation of the Upper Ruvu scheme and the Dar Es Salaam Distribution system. This project is the second stage of that described in the foregoing Sub-section 1.1, which is implemented under the Italian financial assistance, including:

- Transmission main ; Replacement of the 4 km long old 750 mm main pipes between the Mlandizi treatment plant and the Kimara reservoir with 900 mm and 750 mm CI pipes. Rehabilitation of feeder and main appurtenances between Kibaha and Kimara.

- Distribution main ; five (5) distribution main of 600 mm in diameter in a total length of 20.3 km.

2) Rehabilitation of the Lower Ruvu scheme, the Mtoni system, and the distribution network. These works were studied by JICA in 1990 and 1991.

- Improvement of the Lower Ruvu scheme including repair of chlorinating system, construction of additional intake, minor repairs of classifiers
- Repair of the Mtoni scheme
- Leakage control measures including installation of meters
- Cleaning of an estimated 650 km pipelines in the distribution system

- Replacement of 90 km long service pipes of small diameter in the city center
- Laying of 38 km long additional primary mains of 200 mm to 900 mm in diameter in Oyster bay, Kinondoni, Temeke, Kurasini, Kigamboni and Mbagala.
- Installation of 46 km long secondary pipes of 100 mm to 150 mm in diameter in Tabata, Yombo, Ukonga, Mbezi and Kigamboni.

The total cost of this project was estimated at 7,500 million T.Shs. A part of this project will be financed under AFDB grant in near future.

3) Expansion of the Lower Ruvu treatment plant.

This project was planed as the second stage development to increase the capacity from 182,000 m^3/day to 273,000 m^3/day. The preliminary design was done in early 1980's. This study proposes the following works required for the expansion and estimated the following rough costs;

Items	Capacity	No. of units	Costs (Million US$)
Low lift pump (H=24 m)	Q=66 m^3/min.	1	1.3
Sand separators	Q=300,000 m^3/day	1	3.3
High rate classifier	Q=91,000 m^3/day	1	7.2
Rapid sand fitter	Q=91,000 m^3/day	1	9.4
Chemical dosing facilities	Q=91,000 m^3/day	1	6.1
Clear water basin	V=5,000 m^3	1	4.1
High lift pump (H=108 m)	Q=63 m^3/min.	1	2.3
Electrical facilities		1	7.7
Total			41.4

The schematic flow diagram after the expansion of the Lower Ruvu scheme is shown in Fig. E.4.

The Urban Sector Engineering Project proposes the investment plan for the improvement of the DSM water supply. The investment plan as well as the operation and maintenance cost for 1993 to 2004 are shown in Table E.14. The total investment cost is estimated at 323.5 million US$ including operation and maintenance cost.

3.2 Morogoro Water Supply

The Vituli scheme will be completed in near future as described in Section 1.2. There is not another on-going project nor a scheduled project. Following shows the proposed projects by the Urban Sector Engineering Project together with costs. The major concerns are the expansion of the treatment plant of the Ngerengere scheme and the heightening of the Mindu dam by 2.5 m in order to increase the storage capacity and the yield by 11,000 m^3/day. The total supply capacity is expected to increase from 26,000 m^3 to 40,000 m^3/day. The schedule for the augmentation of the bulk water supply is listed below;

Year	Components	Cost (Million US$)
1994-1996	- Expansion of treatment plant including pumping stations	
	- Additional trunk transmission main	
	- Additional storage of 6,500 m^3	
	- Expansion of primary network	11.0
1988-1999	- Heightening of the Mindu dam	
	- Additional storage of 6,000 m^3	6.8
2001	- Expansion of primary network	0.4

The investment plan as well as the operation and maintenance costs are shown in Table E.15. The total investment cost required between 1993 and 2002 amounts to 23.5 million US$ including operation and maintenance cost.

4. WATER DEMAND FORECAST FOR THE MUNICIPAL WATER SUPPLY

The water demand forecast for the Dar Es Salaam water supply including both areas of the distribution network and areas along the transmission mains is made for the target year 2020 and the intermediate years at interval of five (5) years. The water demand forecast for the Morogoro water supply is also attempted for the same years.

The water demand consists of domestic, industrial, commercial and institutional demand as well as leakage and wastage. The domestic demand is the multiplication of the population served and the averaged per capita demand. The daily average demand is calculated by the following formula:

$$\text{Average daily demand} = \frac{\text{Gross water demand}}{1 - \text{Leakage/wastage ratio (\%)} / 100}$$

Daily maximum demand is 125% of the average daily demand, applying the daily peak factor of 1.25, obtained through the previous JICA study for the DSM water supply. This forecast is made based on the estimated current water demand adopting 1990 as the base year for DSM and 1988 for Morogoro.

4.1 Dar Es Salaam Water Supply System

The water demand in the Dar Es Salaam water supply system is made applying the following assumptions and procedures;

(1) Domestic demand forecast

The service area of the Dar Es Salaam water supply system lies in the two (2) Regions; namely the Dar Es Salaam Region (06) and Coast Region (07). The population forecast for these Regions are made for the years up to 2020 as discussed in Appendix-D of this Supporting Report.

The population served in the distribution network is predicted to increase from 1,358 thousand in 1990 to 5,491 thousand in 2020 at annual growth rates varying in a range of 4.5 % to 4.9 % as shown in Table D.3. The average daily water demand per capital in the distribution network is projected dividing into the two categories; namely house connection and other type

of connections (yard connection and no connection). The per capita water demands in the both categories are predicted to increase in proportion to the annual increase rates of per capita GDP (1.8%), but it is assumed that the per capita water demand of the house connection would not exceed 300 lpcd with reference to those in capitals of other developing countries. As a result, the total domestic demand in the distribution network in the year 2020 is estimated 634,215 m^3/day as shown in Table 6.16.

The population in area along the transmission mains is forecast to increase from 109 thousand in 1990 to 312 thousand in 2020, while the per capita water demand therein is forecast to increase at the rates of the per capita GDP. The domestic water demand in area along the transmission mains in the year 2020 comes to 51.152 m^3/day.

(2) Water demand in other sectors

Except for the agricultural demand, those in other sectors are assumed to increase at annual growth rates same as those of the GDP, ie 3% between 1990 and 2000, and it was assumed to drop to 1.5% between 2000 and 2020.

With regard to the agricultural water demand, NUWA intends to apply higher water tariff to the users to reduce the water consumption for the purpose. Taking into account the water shortage likely to take place in near future due to the increasing water demand in Dar Es Salaam city, it is strongly hoped that the water source for the agricultural production is replaced by other one including ground water. In the present water demand forecast, it is assumed that the agricultural demand along the transmission main will remain unchanged until the year 2000.

(3) Water leakage and wastage ratio

The water leakage within the distribution network was estimated to be 35% of the daily average demand in the previous study for year 1990. In addition, the study assumed that the leakage ratio would decrease to 20% with the rehabilitation of the distribution system. While, the distribution leakage and wastage level in the area along the trunk transmission mains in 1990 is calculated at high ratio over 50% based on the gross consumption of each sector and the gross supply to the area. In the present water demand forecast, the water leakage and wastage ratio in the area is assumed to decrease to 20% in the target year 2020.

(4) Municipal water demand in 2020

Tables 6.16 and 6.17 show the water demand in the distribution network and along the transmission mains, respectively.

Through the above assumptions and procedures, the gross demand in the whole service area in the year 2020 is estimated at about 970 thousand m^3/day or 11.2 m^3/sec on an average daily basis, while the daily maximum demand at about 1,211 thousand m^3/day or 14.0 m^3/sec.

4.2 Morogoro Water Supply System

For the prediction of the water demand, the following assumptions and procedures are applied.

(1) Domestic demand

The population served in 1988 is obtained from the population census 1988. This assumes that there was not any service area outside the Morogoro urban area in 1988. The villages under service at present, which include Bigwa, Mkundi, Kihonda and Mindu, are counted in the population projection and included in the population served in 1995. Tungi, which will be served by the Vituli scheme currently under construction, is also counted in the projection for the year 1995. The other villages within the municipality, i.e. Lukobe, Konga Kikwge and Mtawala/Kingolwira, are counted in the projection for year 2000.

The annual growth rates available for the population projection are as per the rates of Morogoro urban area which are listed in Table D.3 presented in Appendix-D of this Supporting Report. The same growth rates as those for Morogoro urban area are applied for the villages.

The average per capita demand is assumed to increase in proportion to the growth rates of per capita GDP between 1985 and 1990, i.e. 1.7% per annum. The average per capita demand as of 1988 is estimated considering the income group structure and the water service levels. The per capita demand of each category is estimated based on the results of the survey performed in the Phase 1 Field Work. The non-luxury basic demand is assumed at 40 lpcd, referring to the consumption of yard connections. The per capita demand of high, middle, low income people is estimated based on the water use equipment survey conducted in the Phase 1 Field Work as shown in Tables E.8 , E.9 and E.10. The base consumption rates of water use equipment are determined from the previous JICA study for DSM. Since we could not find any equipment for house connection or yard connection in the houses of low income people, their demand is assumed to be equal to the non-luxury basic demand.

The number of the users per kiosk/standpipe as well as the number of kiosk and standpipes are surveyed in the Phase 1 Study. The population by the income level is obtained from the income class ratio of each ward, which is predicted by the RWE office. All the users of yard connection, kiosks and standpipes and those who borrow water from neighbors are classified as low class income people.

	Houses and Yard connection			No connection	
	High	Middle	Low	Neighbors	Kiosk/Standpipe
Population (1988)	6,322	23,977	27,178	22,681	25,256
Population ratios	6%	23%	26%	21%	24%
lpcd (1993)	370	80	40	35	24

Although the average per capita demand is calculated at 64 lpcd from these figures, it should be adjusted to that in 1988. The average per capita demand is reduced by the projection using the annual growth rate of 1.7%. As a result, the average per capita demand in 1988 is estimated at 59 lpcd and the domestic demand at 6,219 m^3/day.

(2) Industrial, commercial and institutional water demand

These demand is assumed to increase in proportion to the growth of GDP between 1985 and 1990, i.e. 3.9% per annum. The water demand in 1988 is estimated as shown in Table E.18, referring to the report of RWE in 1991. The demand of the factories (large consumers only) are reduced to half because some of the factories were still under construction in 1988 and even today they are not fully operated.

(3) Other miscellaneous demand

The other miscellaneous demand such as that for the public use, fire fighting and self-requirement is assumed to be 2% of the net demand. The distribution leakage is estimated at 35% of the daily average demand for year 1988, 40% for year 1995 and 20% for the following years. This leakage level of 20% is equivalent to the loss level 25% mentioned in the report of the Urban Sector Engineering Project as their loss level is for the net demand.

The daily average demand as of 1988 falls in the range of the supply record of 16,000 m^3/day to 19,000 m^3/day described in the RWE report in 1991. The leakage level of 35% for year 1988 is almost equivalent to the loss level of the Urban Sector Engineering Project (50%). The leakage level of 40% for year 1995 is explained such that leakage level would increase if supply increases, provided that the distribution system remains as same as before.

Consequently the daily average demand is estimated at 82,373 m^3/day (0.95 m^3/sec) and the daily maximum demand at 102,966 m^3/day (1.19 m^3/sec) in the year 2020.

APPENDIX-E

TABLES

Table E.1 MUNICIPAL WATER CONSUMPTION RECORDS IN DAR ES SALAAM WATER SUPPLY SYSTEM

	1990	1992
Production	296,330 m3/day	295,000 m3/day
Supply to the distribution network	193,400 m3/day	200,000 m3/day
Total consumption	125,727 m3/day	130,000 m3/day
Domestic consumption	111,056 m3/day	114,000 m3/day
Industrial consumption	4,120 m3/day	
Commercail consumption	5,697 m3/day	16,000 m3/
Institutional consumption	4,854 m3/day	
Distribution leakage	67,673 m3/day	70,000 m3/d

*; Source: The Study on Rehabilitation of Dar Es Salaam Water Supply in The United Repubilc of Tanzania, JICA, 1991 and Urban Sector Engineering *Project, Infrastructure Rehabilitation, Part 1, Volume 1*, PMO, 1992

Table E.2 WATER LOSS LEVEL IN MOROGORO WATER SUPPLY SYSTEM

1971	Total production (m3)	Total losses (m3)	Total (m3)	Total kiosks consumption (m3)
Jan	88,324	8,056(9.1%)	80,268	4,434
Feb	126,937	41,367(32.4%)	85,752	4,406
Mar	86,985	4,273(4.8%)	82,712	4,358
Apr	83,405	1,842(2.2%)	81,563	3,979
May	80,654	572(0.7%)	80,082	3,528
Jun	87,448	1,974(2.2%)	85,474	3,537
Jul	75,332	796(1.1%)	74,537	3,750
Aug	94,335	13,204(14.0%)	81.131	3,845
Sep	95,529	7,713(7.9%)	87,998	4,348
Oct	159,704	61,395(38.4%)	98,309	4,849
Averge	97,838	14,083(14.4%)	83,783	4,103

Source: Morogoro Town Water Supply Feasibility Study, MWDP, 1972

Table E.3 POPULATION SERVED BY UPPER RUVU SCHEME IN DAR ES SALAAM WATER SUPPLY SYSTEM

Names of villages	Ward	District / Region	Growth Rate per Annum	1990	Remarks
Ruvu Daragain	Ruvu	Kibaha/Coast	-0.11%	*1901	supply in 1993
Vigwaza	Ruvu	Kibaha/Coast	-0.11%	*4047	supply expected after1995
Visiga	Visiga	Kibaha/Coast	1.17%	4184	
Misugusugu	Visiga	Kibaha/Coast	1.17%	2267	
Mbwawa	Visiga	Kibaha/Coast	1.17%	1363	
Miswe	Visiga	Kibaha/Coast	1.17%	1065	
Mlandizi A	Mlandizi	Kibaha/Coast	2.22%	4682	
Mlandizi B	Mlandizi	Kibaha/Coast	2.22%	7936	
Mwendapole	Kibaha	Kibaha/Coast	2.70%	5934	
Kongowe	Kibaha	Kibaha/Coast	2.70%	6807	
Vikuge	Kibaha	Kibaha/Coast	2.70%	1162	
Disunyala	Kibaha	Kibaha/Coast	2.70%	979	
Vikuruti	Kibaha	Kibaha/Coast	2.70%	1306	
Maili Moja	Tumbi	Kibaha/Coast	4.08%	6174	
Twede Pamoja	Tumbi	Kibaha/Coast	4.08%	4253	
Mkuza	Tumbi	Kibaha/Coast	4.08%	6782	
Pangani	Tumbi	Kibaha/Coast	4.08%	1554	
Mwanalugali	Tumbi	Kibaha/Coast	4.08%	*4848	supply in 1993
Bokotimiza	Tumbi	Kibaha/Coast	4.08%	*1216	supply expected after1995
Kiluvya	Kibamba	Kinondoni/DSM	6.73%	2405	
Kibamba	Kibamba	Kinondoni/DSM	6.73%	637	
Kwenbe	Kibamba	Kinondoni/DSM	6.73%	1415	
Mbezi	Kibamba	Kinondoni/DSM	6.73%		
Total population served				78589	

Population marked with * is not included in the total.
Growth rate per annum is calculated from those cunsus data in 1978 and 1988 for each ward.

Table E.4 POPULATION SERVED BY LOWER RUVU SCHEME IN DAR ES SALAAM WATER SUPPLY SYSTEM

Names of villages	Ward	District / Region	Growth Rate per Annum	1990	Remarks
Yombo	B Yombo	Bagamoyo/Cst	1.64%	1685	
Matimbwa	Yombo	Bagamoyo/Cst	1.64%	1415	
Chasimba	Yombo	Bagamoyo/Cst	1.64%	1913	
Kongo	Yombo	Bagamoyo/Cst	1.64%	1159	
Kaole	Magomeni	Bagamoyo/Cst	2.93%	1935	
Bongwa	Magomeni	Bagamoyo/Cst	2.93%	542	
Majengo	Magomeni	Bagamoyo/Cst	2.93%	370	
Sanzale	Magomeni	Bagamoyo/Cst	2.93%	* 250	supply expected after1995
Nunge	Magomeni	Bagamoyo/Cst	2.93%	* 440	supply expected in 1995
Magomeni	Magomeni	Bagamoyo/Cst	2.93%	10798	
Kiromo	Dunda	Bagamoyo/Cst	1.18%	2499	
Matayu	Dunda	Bagamoyo/Cst	1.18%	864	
Buma	Dunda	Bagamoyo/Cst	1.18%	1047	
Dunda	Dunda	Bagamoyo/Cst	1.18%	9527	
Mapinga	Kerege	Bagamoyo/Cst	2.94%	2589	
Kerege	Kerege	Bagamoyo/Cst	2.94%	2207	
Zinga	Kerege	Bagamoyo/Cst	2.94%	2183	
Pande	Kerege	Bagamoyo/Cst	2.94%	1880	
Mlingotini	Kerege	Bagamoyo/Cst	2.94%	1769	
Kondo	Kerege	Bagamoyo/Cst	2.94%	593	
Bunju A	Bunju	Kinondoni/DSM	7.08%	2215	
Bunju B	Bunju	Kinondoni/DSM	7.08%	1564	
Boko	Bunju	Kinondoni/DSM	7.08%	1955	
Ununio	Kunduchi	Kinondoni/DSM	6.86%	504	
Tageta	Kunduchi	Kinondoni/DSM	6.86%	8820	
Mtogani	Kunduchi	Kinondoni/DSM	6.86%	3461	
Goba	Goba	Kinondoni/DSM	5.82%	2194	
Mbweni	Mbweni	Kinondoni/DSM	5.08%	1486	
Lugalo	Kawe	Kinondoni/DSM	4.87%	10716	
Total population served				77890	

Population marked with * is not included in the total.

Growth rate per annum is calculated from those cunsus data in 1978 and 1988 for each ward.

Table E.5 PER CAPITA CONSUMPTION OF YARD CONNECTION USERS IN MOROGORO MUNICIPALITY

House No	No. of Households	No. of Residents	Connection	Water Consumption (l/day)
207	1	6	Yard	3,629
201	2	8	Nil	
206	3	10	Nil	
209	1	4	Nil	
208	4	13	Yard	2,243
204	1	5	Nil	
205	2	6	Nil	
202	3	9	Nil	
203	5	14	Nil	
200	2	8	Nil	
210	2	4	Nil	
212	4	8	Nil	
211	1	4	Nil	
213	2	6	Nil	
214	3	10	Nil	
216	1	4	Nil	
215	2	6	Nil	
218	4	12	Nil	
217	2	8	Nil	
219	3	9	Nil	
228	2	6	Yard	2,400
220	1	3	Nil	
222	1	4	Nil	
224	4	10	Nil	
221	3	9	Nil	
223	1	3	Nil	
225	2	5	Nil	
226	3	6	Nil	
227	1	4	Nil	
229	2	8	Nil	
Total 30	68	212		8,272
Average	2.2	3.1		30 (Lpcd)

Table E.6 PER CAPITA CONSUMPTION OF KIOSK/STANDPIPE USERS IN MOROGORO MUNICIPALITY

Location Kiosk/Standpipe	No. of Houses	No. of Households	No. of Residents	Water Consumption (l/d)	Per Capita Consumption (lpcd)
Mtoni Str. Mubuyuni	30	142	473	11514	24.3
Sabasaba Str. Mji Mkuu	30	171	485	9986	20.6
Sultani Area Sultan	20	111	356	10286	28.9
Total	80	424	1314	31786	
Averge		5.3	3.1		24.2

Note : * ; Household Size

Table E.7 NUMBER OF USERS PER KIOSK/STANDPIPE IN MOROGORO MUNICIPALITY

Location of Kiosk Standpipe	No. of Houses	No. of Households	No. of Residents
Mtoni Str. Mbuyuni	30	142	473
Sabasaba Str. Mji Mkuu	30	171	485
Sultani Area Sultan	20	111	356
Kichangani 1			
Kichangani	24	68	272
Kichangani 2			
Kichangani	15	44	149
Kichangani 3			
Kichangani	11	30	113
Total	130	566	1848
Average	21.7	94.3	308

Table E.8 PER CAPITA CONSUMPTION OF HIGH INCOME HOUSEHOLDS WITH HOUSE CONNECTION IN MOROGORO MUNICIPALITY

	Base Consumption (ℓpcd)	House No. 1	2	3	4	5	6	7	8	9	10	Total	Average
House Lot No.							233	161			51		
No. of Households		1	1	1	1	1	1	1	2	1	1	11	
No. of Residents		8	8	3	3	2	6	10	35	10	9	94	
(Size of Household)													(8.5)
Basic Consumption	40	320	320	120	120	80	240	400	1,400	400	360	3,760	40.0
Shower	25	200	200	75	75	50	150	250	875	250	225	2,350	25.0
Flush Toilet	30	240	240	90	90	60	180	300	1,050	300	270	2,820	30.0
Sink	30	240	240	90	90	60	180	300	1,050	300	270	2,820	30.0
Bathtub	140	1,120	1,120	420	420	280	840	1,140	4,900		1,260	11,500	122.3
Sprinkler	80	640	640	240	240	160	480	800	2,800	800		6,800	72.3
Car Wash	50	400	400	150	150	100	300	500	1,750	500		4,250	45.2
Washing Machine	40			120	120		240					480	5.1
Total	435	3,160	3,160	1,305	1,305	790	2,610	3,690	13,825	2,550	2,385	34,780	369.9
Average (ℓ pcd)		395	395	435	435	395	435	369	395	255	265	370	

Table E.9 PER CAPITA CONSUMPTION OF MIDDLE INCOME HOUSEHOLDS WITH HOUSE CONNECTION IN MOROGORO MUNICIPALITY

	Base Consumption (ℓ pcd)	House No. 1	2	3	4	5	6	7	8	9	10	Total	Average
House Lot No.		27/B	34B	4/B	3A	8A	12A	20A	28A	32A	35B		
No. of Households		1	3	7	10	2	4	1	1	3	7	39	
No. of Residents		20	12	34	15	10	9	12	16	27	21	176	
(Size of Household)													(4.5)
Basic Consumption	40	800	480	1,360	600	400	360	480	640	1,080	840	7,040	40.0
Shower	25	500	300	850	375		225	300	400		525	3,475	19.7
Flush Toilet	30	600						360	480		630	2,070	11.7
Sink	30	600						360	480			1,440	8.2
Bathtub	140												
Sprinkler	80												
Car Wash	50												
Washing Machine	40												
Total	435	2,500	780	2,210	975	400	585	1,500	2,000	1,080	1,995	14,025	79.6
Average (ℓ pcd)		125	65	65	65	40	65	125	125	40	95	79.7	

Table E.10 PER CAPITA CONSUMPTION OF LOW INCOME HOUSEHOLDS WITH HOUSE CONNECTION IN MOROGORO MUNICIPALITY

	Base Consumption (ℓpcd)	House No. 1	2	3	4	5	6	7	8	9	10	Total	Average
House Lot No.		203	465	156	141	240	241	266	233	255			
No. of Households		2	5	8	10	4	1	1	8	1		40	
No. of Residents		7	16	14	16	8	8	5	20	10		104	
(Size of Household)													(2.6)
Basic Consumption	40	280	640	560	640	320	320	200	800	400		4,160	40.0
Shower	25												
Flush Toilet	30												
Sink	30												
Bathtub	140												
Sprinkler	80												
Car Wash	50												
Washing Machine	40												
Total	435	280	640	560	640	320	320	200	800	400		4,160	40.0
Average (ℓ pcd)		40	40	40	40	40	40	40	40	40		40	

Table E.11 PREVIOUS MUNICIPAL WATER DEMAND FORECASTS FOR THE STUDY AREA

(1) Water Demand Forecasts for Dar es Salaam City

(Unit : m3/day)

Year	DSM Master Plan	NUWA DSMB	JICA(1991)	Unban Sector Eng. Project
1978		*164,400		
1984	210,000			
1988		290,370		
1989	330,000			
1990			*222,195	
1992				*294,000
1995			203,000	
1998		510,210		
1999	630,000			
2002				355,000
2008		892,550		

(2) Water Demand Forecasts for Morogoro Municipality

(Unit : m3/day)

Year	Feasibility Study	Reticulation Analysis	RWE MOROGORO	Urban Sector Eng. Project
1971	*2,950			
1974	4,283			
1976		*5,150		
1980		6,887		
1985	9,676			
1990	12,925			
1991			*28,998	
1992				*27,000
1995	16,387			
2000	19,996			
2002				40,000

Remarks : These figures include losses(leakage).

The figures with * are the estimated values of current water demand.

Table E.12 PREVIOUS WATER DEMAND FOR DAR ES SALAAM WATER SUPPLY IN YEAR 1992 AND 2002

Consumer Category	Year 1992				Year 2002			
	Population		Demand		Population		Demand	
	%	Inhab.	ℓpcd	1,000 m3/day	%	Inhab.	ℓpcd	1,000 m3/day
Domestic:	78%	1,156,518		90.7	100%	1,963,500		140.4
Basic service	29%	435,525	25	10.9	46%	911,644	25	22.8
Single tap	24%	354,164	70	24.8	26%	501,619	70	35.1
Multi tap	25%	366,829	150	55.0	28%	550,237	150	82.5
Commerce				13.3				21.6
Institutions				15.0				25.0
Industries				17.0				27.0
Others				60.0				70.0
Net demand				196.0				284.0
Losses (%)	50%			98.0	25%			71.0
Gross demand				294.0				355.0

Table E.13 PREVIOUS WATER DEMAND FOR MOROGORO WATER SUPPLY IN YEAR 1992 AND 2002

Consumer Category	Year 1992				Year 2002			
	Population		Demand		Population		Demand	
	%	Inhab.	ℓpcd	1,000 m3/day	%	Inhab.	ℓpcd	1,000 m3/day
Domestic:	91%	129,500		10.7	100%	225,000		20.1
Basic service	33%	46,950	25	1.2	29%	66,230	25	1.7
Single tap	25%	35,550	70	2.5	30%	67,005	70	4.7
Multi tap	33%	47,000	150	7.1	41%	91,765	150	13.8
Commerce				1.6				2.9
Institutions				2.5				3.0
Industries				4.5				6.0
Others								
Net demand				19.3				32.0
Losses (%)	40%			7.7	25%			8.0
Gross demand				27.0				40.0

Source: Urban Sector Engineering Project, Infrastructure Rehabilitation, Part 2, Volume 1 and Volume 9, PMO, 1992

Table E.14 INVESTMENT PLAN FOR DAR ES SALAAM WATER SUPPLY

(1) Dar es Salaam Water Supply System Investment Plan

(Unit: Million US$)

Components	Year										Total
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	
Rehabilitation:											
Distribution system		3.1	3.1	3.1	3.1	3.1					15.5
Bulk supply system:											
- treatment plant		6.9	7.0								13.9
- pumping stations		1.6	1.7								3.3
- trunk bransm. mains		5.0	5.0	5.0	5.0						20.0
- storage		1.0	1.0	0.3							2.3
- primary mains		5.0	5.0	5.0							15.0
New construction:											
Distribution system		1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	1.1	10.2
Bulk supply system:											
- source			20.0								20.0
- treatment plant		6.9	7.0								13.9
- pumping stations		1.6	1.7								3.3
- trunk transm. mains											
- storage			5.0		5.0			5.0			15.0
- primary mains		6.8	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	46.8
Total		39.1	62.7	19.6	19.2	9.2	6.1	11.1	6.1	6.1	179.2

(2) Dar es Salaam Water Supply System Operation and Maintenance Costs

(Unit: Million US$)

Components	Year										Total
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	
Distribution system	0.59	0.61	0.63	0.65	0.67	0.68	0.70	0.72	0.74	0.76	6.80
Bulk supply system	11.96	12.36	12.76	13.15	13.55	13.95	14.35	14.75	15.15	15.55	137.50
Total	12.54	12.96	13.38	13.80	14.22	14.64	15.06	15.47	15.89	16.31	144.30

Source: Urban Sector Engineering Project, Infrastructure Rehabilitation, Part 2, Volume 1, PMO, 1992

Table E.15 INVESTMENT PLAN FOR MOROGORO WATER SUPPLY

(1) Morogoro Water Supply System Investment Plan

(Unit: Million US$)

Components	Year										Total
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2001	
Rehabilitation:											
Distribution system		0.4	0.4	0.4	0.4	0.3					1.9
Bulk supply system:											
- treatment plant		0.7									0.7
- pumping stations		0.1									0.1
- trunk bransm. mains			0.1								0.1
- storage			0.2								0.2
- primary mains			0.5								0.5
New construction:											
Distribution system		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1.8
Bulk supply system:											
- source						5.0					5.0
- treatment plant		1.8	1.7								3.5
- pumping stations		0.6		0.5							1.1
- trunk transm. mains		0.8									0.8
- storage			2.0				1.8				3.8
- primary mains		2.3		1.3					0.4		4.0
Total		6.9	5.1	2.4	0.6	5.5	2.0	0.2	0.6	0.2	23.5

(2) Morogoro Water Supply System Operation and Maintenance Costs

(Unit: Million US$)

Components	Year										Total
	1993	1994	1995	1996	1997	1998	1999	2000	2001	2001	
Distribution system	0.07	0.07	0.08	0.08	0.09	0.09	0.10	0.10	0.10	0.11	0.90
Bulk supply system	0.95	1.01	1.06	1.12	1.18	1.23	1.29	1.35	1.40	1.46	12.00
Total	1.02	1.08	1.14	1.20	1.26	1.32	1.39	1.45	1.50	1.57	12.90

Source: Urban Sector Engineering Project, Infrastructure Rehabilitation, Part 2, Volume 9, PMO, 1992

Table E.16 WATER DEMAND WITHIN THE DISTRIBUTION NETWORK OF DAR ES SALAAM CITY

Year	1990	1995	2000	2005	2010	2015	2020
I. Total Population served (thousand persons)	1,358	1,726	2,194	2,784	3,518	4,416	5,491
(Increase ratio of population in %)		(4.91)	(4.92)	(4.88)	(4.79)	(4.65)	(4.45)
II. Population by type of connections of water supply							
(1-1) Population by House Connection	435	502	579	667	766	873	986
- Per capita demand (lpcd)	204.0	236.5	274.2	300.0	300.0	300.0	300.0
(1-2) Population by yard connection/stand pipe	923	1,224	1,615	2,117	2,752	3,543	4,505
- Per capita demand (lpcd)	44.0	48.1	52.6	57.5	62.9	68.7	75.1
III. Sectoral Water Demand							
(1) Domestic demand (m3/day)	129,282	177,533	243,711	321,938	402,793	505,420	634,215
(2) Industrial demand (m3/day)	4,612	5,347	6,198	6,677	7,193	7,749	8,348
(3) Commercial demand (m3/day)	6,282	7,283	8,442	9,095	9,798	10,555	11,371
(4) Institutional and other demand (m3/day)	5,355	6,208	7,197	7,753	8,352	8,998	9,693
(5) Leakage (m3/day)	78,363	105,737	66,387	86,366	107,034	133,181	165,907
(Leakage ratio in %)	(35)	(35)	(20)	(20)	(20)	(20)	(20)
Daily average demand (m3/day)	223,893	302,107	331,936	431,828	535,170	665,903	829,533
Daily maximum demand (m3/day)	279,867	377,634	414,919	539,785	668,963	832,378	1,036,917

Table E.17 WATER DEMAND ALONG THE TRUNK TRANSMISSION MAINS IN DAR ES SALAAM WATER SUPPLY SYSTEM

Year	1990	1995	2000	2005	2010	2015	2020
- Population served (persons)	109	127	153	185	221	263	312
(Increase ratio of population in %)		(3.10)	(3.80)	(3.87)	(3.62)	(3.54)	(3.48)
- Per capita demand (lpcd)	96.0	105.0	114.7	125.5	137.2	150.0	163.9
(1) Domestic demand (m3/day)	10,464	13,329	17,557	23,209	30,312	39,439	51,152
(2) Industrial demand (m3/day)	15,639	18,130	21,018	22,642	24,392	26,277	28,308
(3) Commercial demand (m3/day)	2,183	2,531	2,934	3,161	3,405	3,668	3,951
(4) Institutional demand (m3/day)	3,225	3,739	4,334	4,669	5,030	5,419	5,837
(5) Agricultural demand (m3/day)	8,500	8,500	8,500	8,500	8,500	8,500	8,500
(6) Leakage (m3/day)	41,644	30,819	23,289	26,649	30,702	35,701	41,892
(Leakage ratio in %)	(51)	(40)	(30)	(30)	(30)	(30)	(30)
Daily average demand (m3/day)	81,655	77,048	77,631	88,829	102,341	119,003	139,640
Daily maximum demand (m3/day)	102,069	96,310	97,039	111,037	127,926	148,753	174,550

Table E.18 WATER DEMAND FOR MOROGORO WATER SUPPLY SYSTEM

Demand unit : m3/day

Year	1988	1995	2000	2005	2010	2015	2020
Population served	105,414	167,807	213,032	262,316	321,764	392,228	474,231
Per capita demand	59 ℓpcd	66 ℓpcd	72 ℓpcd	78 ℓpcd	85 ℓpcd	93ℓ pcd	101ℓ pcd
Domestic demand	6,219	11,075	15,338	20,461	27,350	36,477	47,897
Industrial demand	3,985	5,209	6,307	7,635	9,246	11,196	13,556
Commercial demand	336	439	532	644	780	944	1,148
Institutional demand	591	772	935	1,188	1,371	1,660	2,010
Other demand	223	350	462	1,784	775	1,006	1,292
Leakage	6,114 (35%)	11,897 (40%)	5,894 (20%)	7,618 (20%)	9,881 (20%)	12,821 (20%)	16,475 (20%)
Daily average demand	17,468	29,742	29,468	38,089	49,403	64,104	82,373
Daily maximum demand	21,835	37,178	36,835	47,611	61,754	80,130	102,966

APPENDIX-E

FIGURES

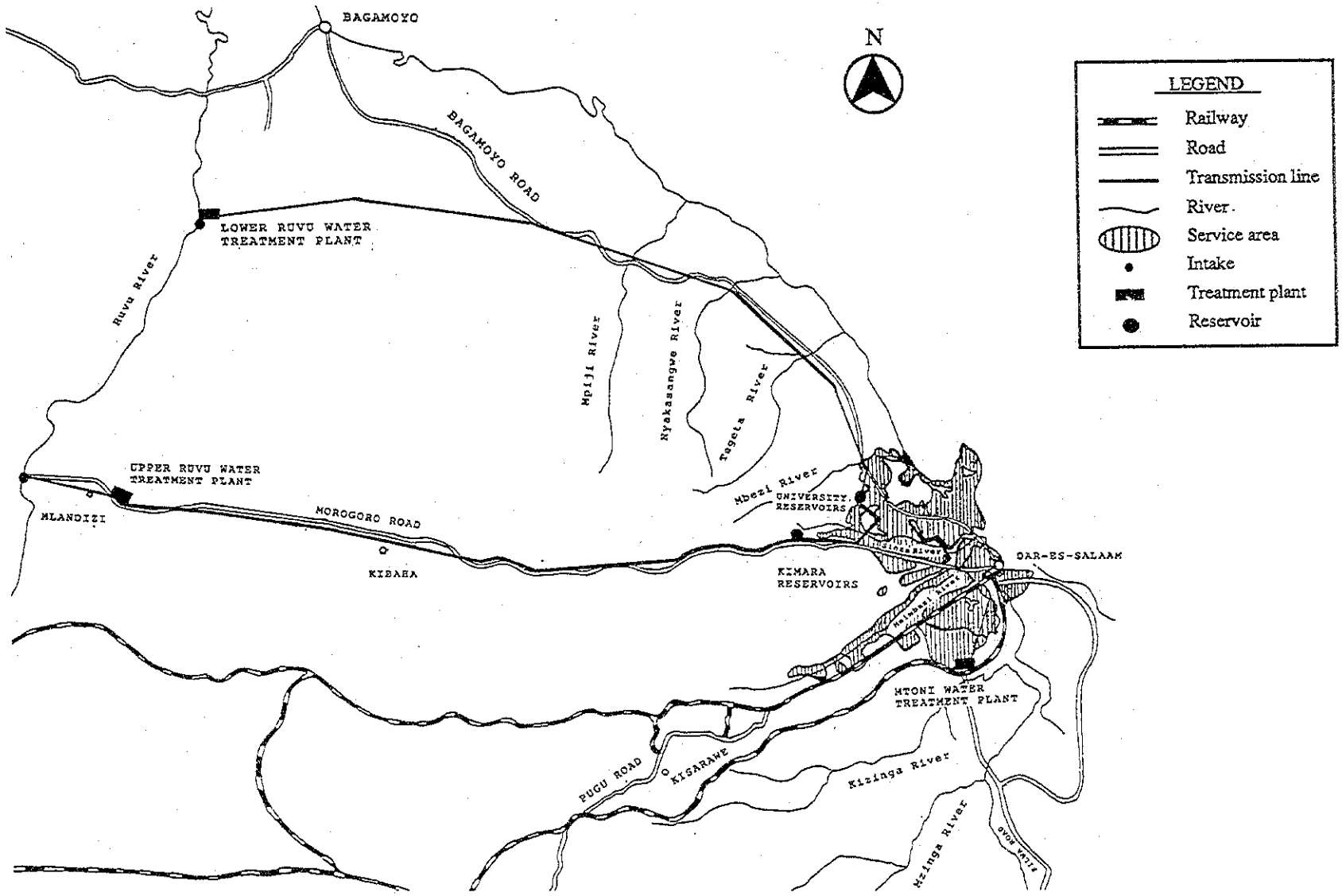
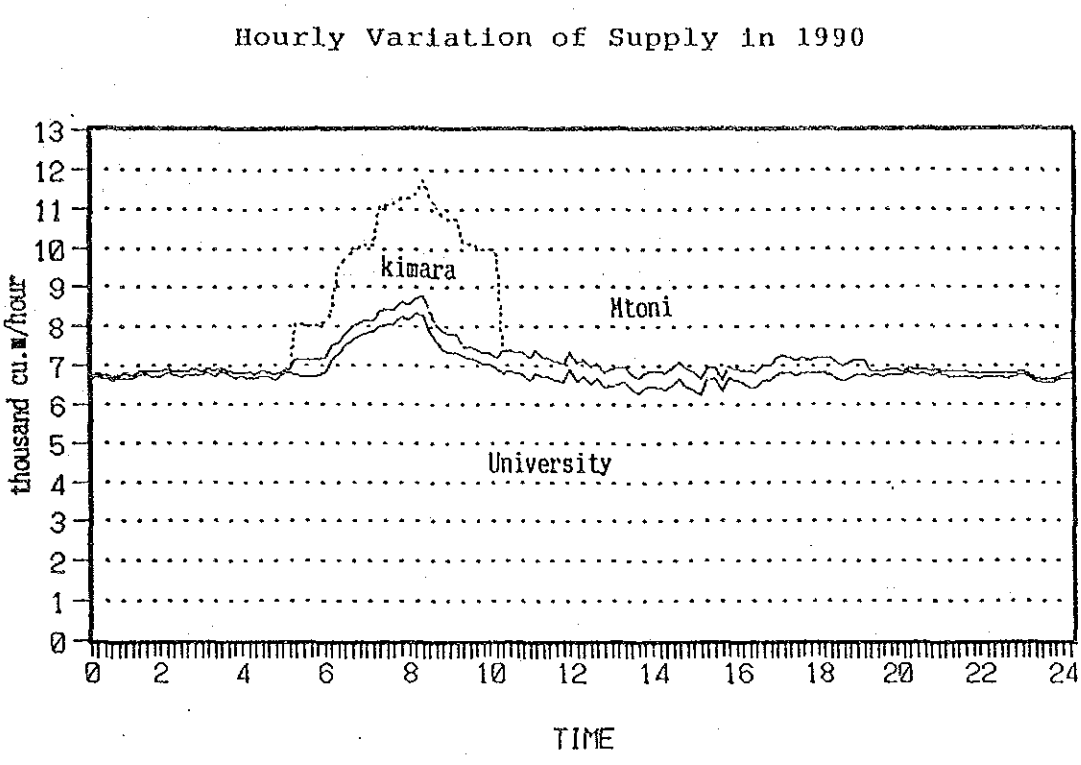
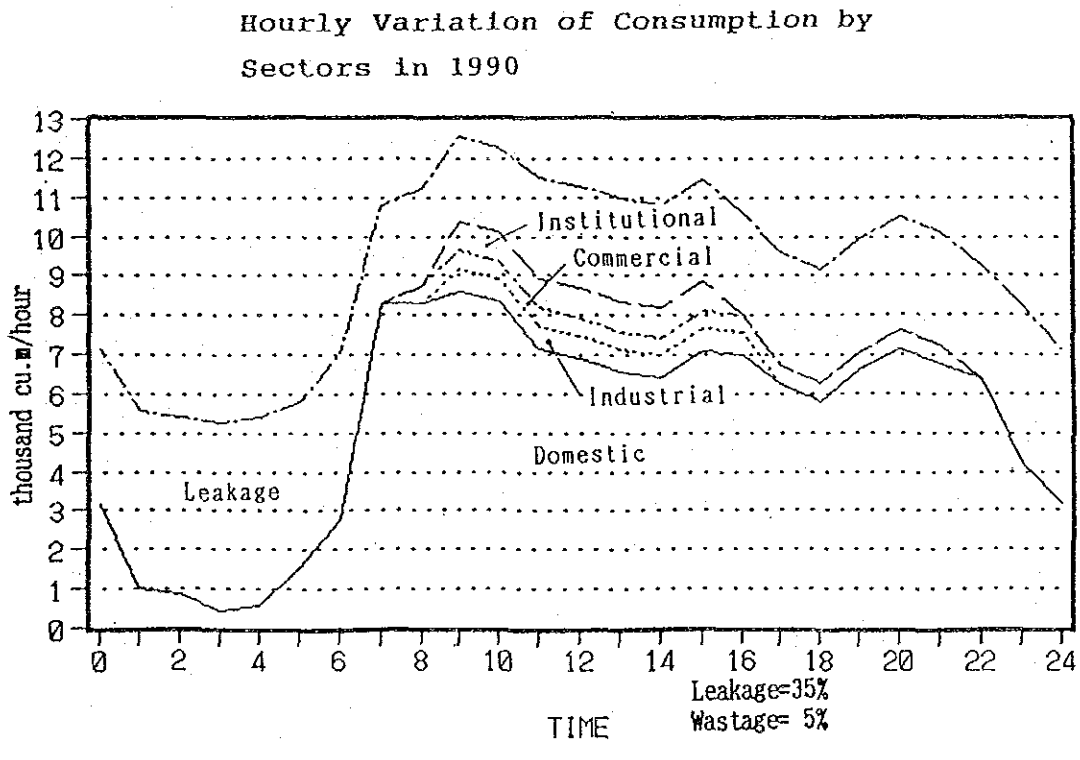


Fig. E.1 WATER SUPPLY SYSTEM IN DAR ES SALAAM CITY IN 1990





Source: The Study on Rehabilitation of Dar es Salaam Water Supply (JICA, 1991)

Fig. E.2 HOURLY VARIATION OF SUPPLY AND CONSUMPTION IN DAR ES SALAAM WATER SUPPLY SYSTEM

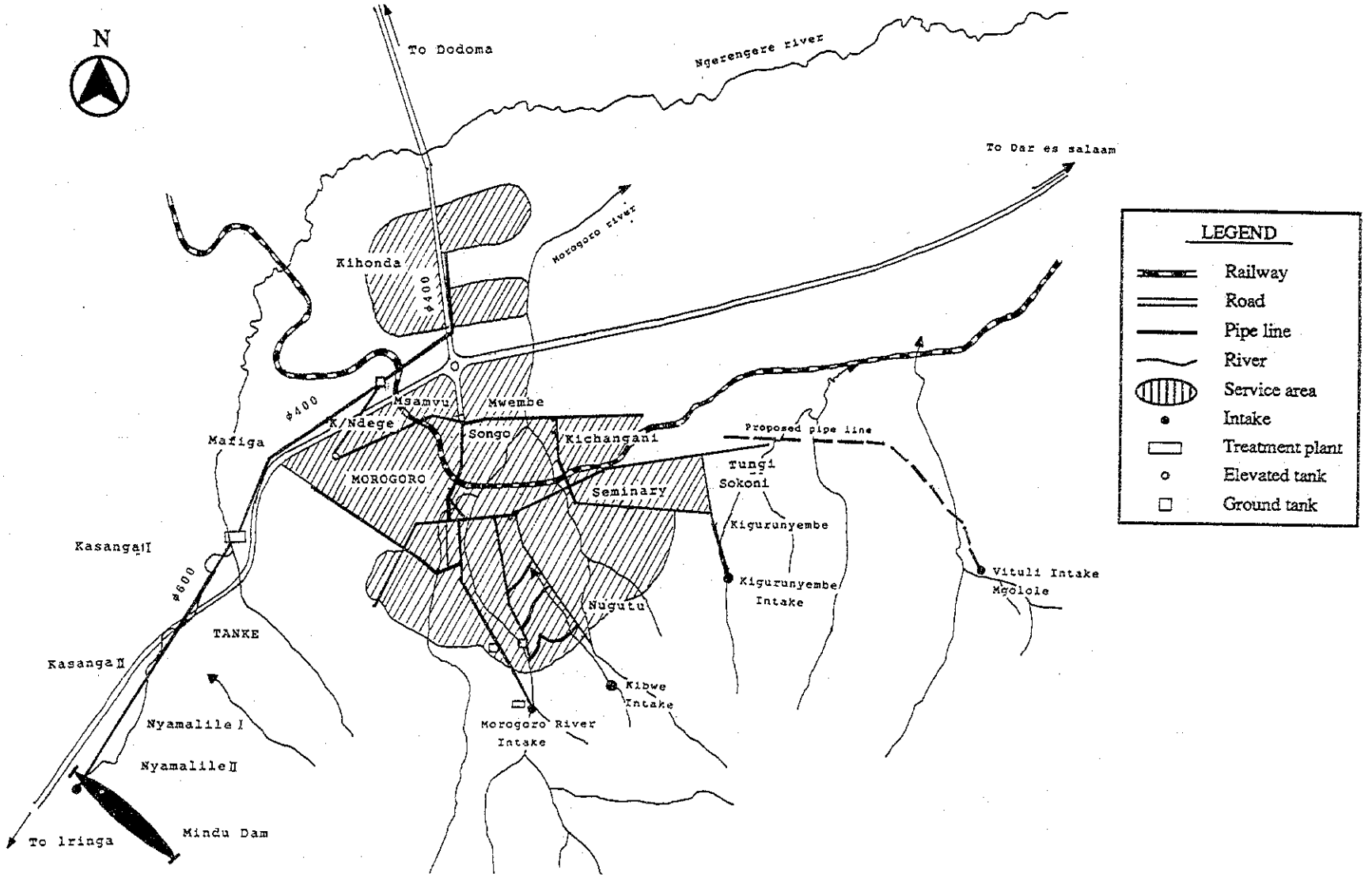
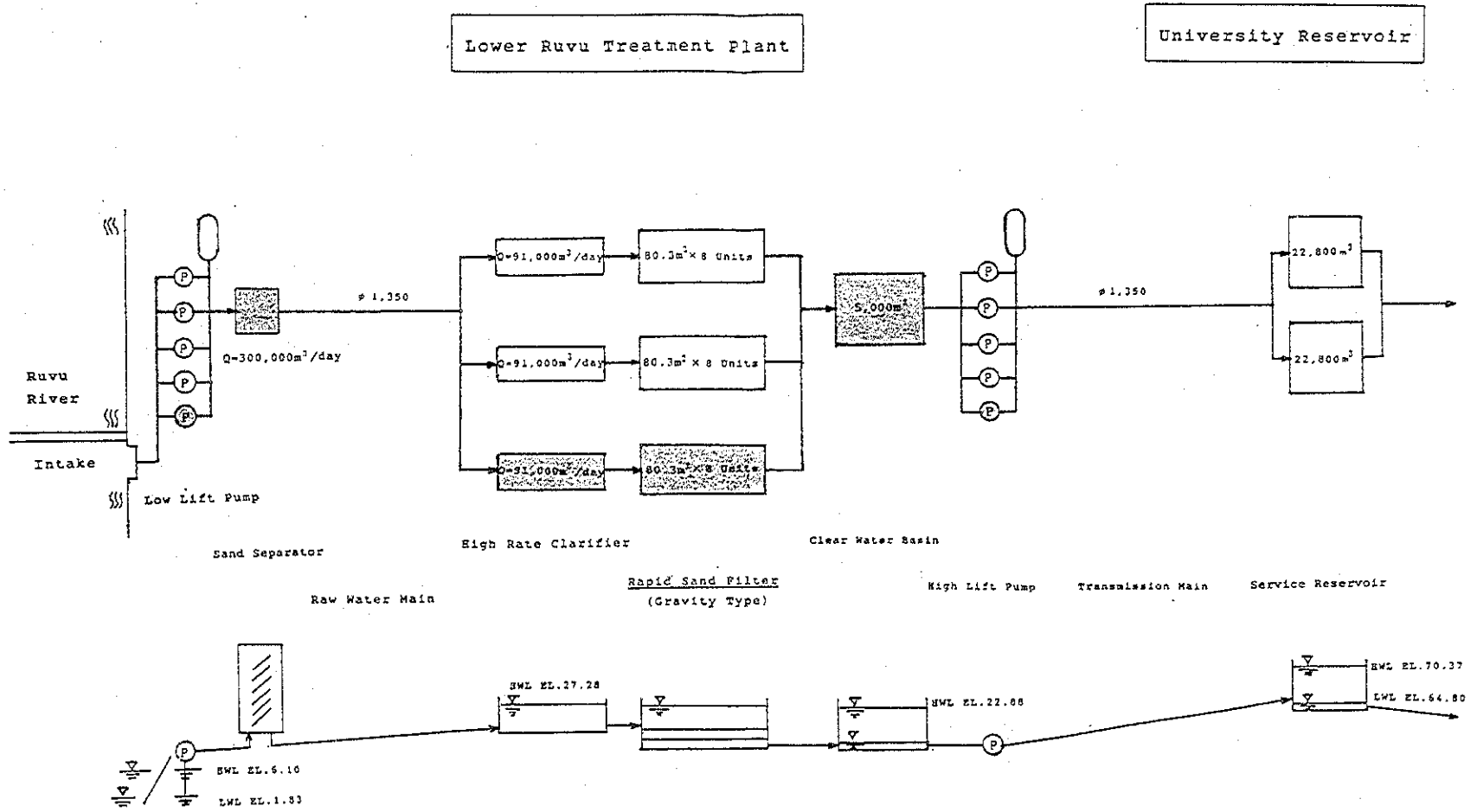


Fig. E.3 WATER SUPPLY SYSTEM IN MOROGORO MUNICIPALITY IN 1993



Remark: The hatched components are the items of the expansion project.

Fig. E.4 SCHEMATIC FLOW DIAGRAM OF LOWER RUVU PLANT SYSTEM

APPENDIX-F

ENVIRONMENTAL SURVEY

APPENDIX - F

ENVIRONMENTAL SURVEY

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APPENDIX - F

ENVIRONMENTAL SURVEY

1. STATE POLICY OF ENVIRONMENTAL PROTECTION

1.1 Environmental Policy and Organization

1.1.1 National environmental policy

Tanzania has not yet concluded an official national policy on environment. National Environmental Policy of the Government is currently under formulation in the parliament and Technical Committee meets regularly to work on the draft. However, each division of the Government, such as Agriculture, Livestock, Forest, Wildlife and Tourism, Population, Energy, etc., have their own general policies, some of which aim to protect and manage the environment.

The Government wants a National Environmental Policy (NEP) completed before finalizing the National Conservation Strategy (NCS), which is going to set forth an Environmental Action Plan. The NCS should be consistent with the NEP. NCS is under preparation and aims to set all policy of conservation and rational utilization of resources of Tanzania. The strategy is being prepared under the leadership of the National Environmental Management Council. The preparation involves all relevant sectors in the country. The NCS is likely to provide the foundation to formulate a wider national environmental policy (UNCED, 1992).

1.1.2 Central government organizations

Two government organizations are assigned to environmental management. One is the Environment Division of the Ministry of Tourism, Natural Resources and Environment (MTNRE) and the other one is National Environment Management Council (NEMC) of the same Ministry.

(1) Ministry of Tourism, Natural Resources and Environment

A new Ministry incorporating Tourism, Natural Resources and Environment was created in November 1990 by an order of the President. Tourism and the Natural Resources sub-sectors of Fisheries, Forestry and Wildlife were moved from the Ministry of Lands, which had hosted them for several years. In 1992, a Director of Environment was appointed to supervise an Environment Division consisting of eight professional staff. Environment Division, as the official government arm dealing with the environment, has begun to prepare a NEP. It is maintaining liaison with donors and with staff in other ministries involved in operation that could affect the environment and preparing to take on other functions of analysis, operations and promotion from the National Environment Management Council (NEMC) (WB, 1993). The organizational chart of MTNRE and Environment Division is shown in Fig. F.1.

(2) National Environment Management Council

National Environment Management Council (NEMC) was established in 1983 by the Act of Parliament No.19, and started to function in 1986. It was the first institutional home for the Environment. In 1992, NEMC was brought into the new Ministry and it is situated under the Environment Division. Its broad mandate includes formulation of policy and legislation on environmental management, coordination of the activities of all bodies concerned with environmental matters, stimulation of public and private participation for beneficial use of natural resources, advancement of scientific knowledge of changes in the environment, liaison with international organizations, and promotion of environmental education, of measures to ensure that development plans take account of environmental effects and of cooperation between government and other bodies engaged in environmental programs. The organizational chart of NEMC is explained in Fig. F.2.

(3) Relationship between Division and Council

The differing roles of the ministerial Division of Environment and the Council are in process of clarification. The Environment Division is playing a direct role in articulating environmental concerns in policy and planning and, in conjunction with designated contact points in other ministries. It will play a role in coordinating implementation of sectoral actions on the environmental matters and will remain within the present parent Ministry. The Council, which took on some ministerial functions when it was first established, is concentrating on its advisory role and is preparing to seek additional authority to compel preparation of standards of quality and safety and monitor compliance (WB, 1993).

1.1.3 Local government organization

Local government comes under the jurisdiction of the Office of the Prime Minister and First Vice-President, which is responsible for appointment of the staff of Regions and supervision of the operations of all local government bodies. Consequently, there is no responsible local government office for environment, and either the Division or Council has regional offices.

1.1.4 Responsible organization for water resources development plan

The responsible agency for the implementation of water resources development plan to preserve environment is the Ministry of Water, Energy and Minerals (MWEM). But NEMC may use its advisory and coordinating functions as a check on environmental soundness of projects and may make recommendations to ministries on the actions that they should take. The main objectives of the Water Policy of 1991 are: Clean and safe water within easy reach of all households (defined as within 400 meters); Adequate water for livestock and for industries and effective and sustainable utilization of nation water sources. The Policy recognizes serious gaps in guidelines, for example, on the responsibility for protection and conservation of permanent and emergency water sources (WB, 1993).

Several programme and projects in the field of environment are on-going in the Ruvu River basin. The scope and scale of these activities, the principal body of assistance provides capacity building services to the various divisions of MTNRE and NEMC. The Tanzania Forestry Action Plan including many projects in the Cast and Morogoro regions and depending on the Forestry and Beekeeping Division is backed principally by the Finnish International

Development Agency (FINNIDA) and the Swedish International Development Authority (SIDA). It has also attracted funding and technical forestry support from the Gesellschaft fuer Technische Zusammenarbeit (GTZ), Norwegian Agency for Development (NORAD) and Danish International Development Agency (DANIDA), the World Bank, the European Community, Netherlands and Japan. Also, under the Forestry and Beekeeping Division the Catchment Forest Project is in action on the Uluguru Mountains and the mangrove forest of the mouth of Ruvu River, being supported by NORAD. The Selous Conservation Programme of the Wildlife Division is being activated by a fund of GTZ. There was no close relation between these activities or divisions and the Environmental Division which was one of the counterpart organizations for the Study on the water resources development plan in the Ruvu River basin.

1.2 Environmental Legislation

1.2.1 Preservation and protection of environment

No overall legislation exists with respect to the preservation and protection of environment. The National Conservation Strategy (NCS) is under drafting. When the NCS and National Environmental Policy (NEP) are completed, Tanzania will consider on what to do next regarding sectoral legislation's conformance to NCS and NEP, and/or drafting a framework legislation on the environment. Some of the sectoral legislation, such as Forestry, National Parks and Wildlife, have provisions for addressing environment protection.

The principal legislation related to preservation and/or protection of natural resources, national park, game reserves, wildlife, forestry, fisheries, etc. are as follows:

a. Fauna Conservation Ordinance (an Ordinance is a law promulgated before independence) Cap.302 as amended by Acts No.15 and 17 of 1963 and Act No.7 of 1965
b. National Parks Ordinance (Amendment) Act No.44 of 1963
c. Forests Ordinance of 1957 Cap.389, Forests Ordinance (Amendment) Act No.43 of 1963
d. Land Ordinance Cap.113
e. Public Land (Preserved Areas) Ordinance (Amendment) Act No.28 of 1965
f. Industrial Licensing and Registration Act of 1967 and with amendments 1982
g. Water Utilization (Control and Regulation) Act of 1974 as amended by the Water Utilization (Control Regulation Amendment) Act of 1981
g. Fisheries Act No.6 of 1970
i. Natural Resources Ordinance Cap.25
j. Wildlife Conservation Act No.21 of 1974
k. National Environment Management Act No.19 of 1983

1.2.2 Environmental impact assessment study

No formal guidelines exist and discussion is continuing regarding formulation of policy and technical guidelines on Environmental Impact Assessment (EIA). NEMC has evaluated EIA and sometimes performed them. Otherwise, donor agencies and developers used their own national and/or international development agency guidelines.

According to the recommendations for EIA in Tanzania which were made on the seminar of November 1992, the scope of EIA was as follows:

a. EIA should be incorporated in all development planning activities in Tanzania.
b. Concerning on-going projects, EIA should be carried out in order to make room for taking the mitigation measures.
c. In carrying out EIA into practice, inter-sectoral cooperation and coordination should be the underlining principle.
d. In order to encourage effective public and NGO's participation in the implementation of EIA, NEMC should design training programs for all levels.

In effecting EIA in Tanzania it is recommended that all types of projects undertaken at all levels and in all areas should be subject to EIA.

The NEMC's overall function as an advisor to the government on environmental matter may cause the Council to recommend certain government actions related to the particular situation. Actually no formal organization for judging EIA exist. NEMC may have authority to judge it.

1.2.3 International environmental conventions

Principal international treaties and other agreements related to the environment of which Tanzania is also a member are as follows (MTNRE and Green Globe Yearbook, 1993):

a. Convention Related to the Preservation of Fauna and Flora in their Natural State; London, 1933.
b. Convention on the African Migratory Locust; Kano, 1962.
c. African Convention on the Conservation of Nature and Natural Resources; Algiers, 1968.
d. Convention Concerning the Protection of the World Cultural and Natural Heritage (World Heritage Convention); Paris, 1972 (UNESCO).
e. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); Washington DC, 1973 (UNEP).
f. United Nations Convention on the Law of the Sea (UNCLOS); Montego Bay, 1982.
g. FAO International Undertaking on Plant Genetic Resources; Rome, 1983 (FAO).
h. FAO International Code of Conduct on the Distribution and Use of Pesticides; Rome,1985 (FAO).
i. Convention on Biological Diversity; Rio de Janeiro, 1992 (UNEP).
j. Framework Convention Climate Change; Rio de Janeiro, 1992.

2. PRESENT ENVIRONMENTAL CONDITIONS IN THE STUDY AREA

2.1 Natural Conditions

2.1.1 Topography

The Ruvu River basin is dominated by the Uluguru Mountains rising to over 2,400 m above sea level, which runs from north to south in its western part. Further west, the Mindu Hills form the western boundary of the catchment area. About 40 km north of the Uluguru Mountains there exist the Nguru Mountains. In the central parts of the southern end there are the Maneramango Hills rising to 380 m.

In the basin, the predominant physiographical feature is the rolling nature of the terrain except the floodplains along the Ruvu, Mvuha and Mgeta Rivers. The Study Area may be divided into three geomorphological zones, namely the mountainous area, the transitional zone of foothills and steep piedmonts, and the floodplain.

2.1.2 Geology

The geological formations of the Study Area are largely metamorphic, igneous and sedimentary gneiss, Karroo, Marine Jurassic and Cretaceous limestones and sandstones, and the tertiary deposits. The tertiaries are predominant therein. The gneissic formations mostly occur in the Uluguru Mountains and in the western part of the Ngerengere River basin. They seem to have been thrust up by the upward movement of the basic gneiss, thus giving rise to serious fault zones in the rocks (FAO, 1961).

2.1.3 Animals

According to the FAO's report (1961), more than 30 years ago, the Ruvu River basin abounded with all types of wildlife, and the common animals were elephant, buffalo, lion, eland, waterbuck, sable and reedbuck. Hippo and crocodile were also seen, and rhinos strayed therein from the adjoining territories. Leopard was found in the Ngerengere area.

At present, very few detailed biological investigations have been carried out in the Study Area so that few information about inhabit of wildlife in the Ruvu River basin is available. Generally, it is said that most part of the basin is free from large wild animals. However, during the field survey, some species of wildlife were observed at certain areas: at the Mgeta Plain (Dutumi area), buffalo, crocodile and monkeys; at Middle Ruvu Valley (Kidunda area), elephant, hippo, warthog, baboon and crocodile; in downstream reach of the Ngerengere River (from Ngerengere to Utari area), leopard, monitor lizard, warthog and green snake; at the Lower Ruvu Valley (Lower Ruvu Water Station area), hippo and crocodile; at Kigongoni Prison area, buffalo, warthog, hippo, crocodile, python and green snake; at Kigongoni Ferry area, buffalo, warthog, baboon, hippo and crocodile and; at the Mkombez River area, giraffe and hyaena.

Except for the areas bordering the Mikumi National Park and the Selous Game Reserve, wildlife in the Ruvu River basin is dominated by "generalists" consisting mainly of vermin species which include baboons, monkeys, wild pigs and birds (especially *Quelea quelea*

aethiopica). There are a plenty of buffalo and occasionally elephants especially in the lower Ruvu. There is, therefore, conflict between wildlife and cultivation.

Other wildlife species are "specialists", being restricted to specific zones. For example hippos, bushbuck and crocodiles are confined to the river valleys. The wetlands in particular are rich in varieties and numbers of birds, especially herons, geese and egrets, indicating the importance for avian life. Since most of the floodplain is not utilized for cultivation, it forms a very important refuge for these animals and birds. Most of these animals and birds may be affected, should the ecology of the floodplain change.

The preliminary list of fish species inhabiting in the floodplain includes *Clarias, Tilapia, Hydrocynus, Schilbe, Barbus, Mormyrus, Bagrus, Synodontis, Labeo, Alestes* and *Anguilla.* The majority of species can tolerate both riverine and lake side conditions, breeding mainly in areas inundated by flood (IRA, 1993).

2.1.4 Vegetation and forest

The Ruvu River basin is well endowed with forest resources. The principal types of vegetation of the Study Area can be divided into six categories as follows (IRA, 1993 and FAO, 1961):

(1) Forest

In the Ruvu River basin three types of forest are distinct: a) Upland moist evergreen forests (Upper montane forest), part of the Afromontane Mosaic on the Uluguru Mountains mainly over 1,000 m above sea level. The dominant species are *Ocotea Usambarensis* (Camphorwood), *Khaya Nyasica* (mahogany), *Antiaris Usambarensis, Albizia sp.* and *Sterculia Appendiculata*, and they provide valuable timber; b) Lowland forests (Submontane forest), on the lower slopes of the Uluguru Mountains below 1,000 m. The main species are *Podocarpus* and *Chlorophora Excelsa* (mvule), providing good protection against erosion and c) Coastal forests remnant which are part of the Zanzibar-Inhambane Mosaic. The first two categories are mainly protected water catchment forests, while some of the coastal forest remnants are forests used mainly for production of fuelwood and building materials.

(2) Woodland

These comprise trees lower than those in the forest and with less closed canopy. This type of vegetation occupies about 80% of the basin. *Brachystegia* and *Pseudoberlinia* are the prominent species. *Pterocarpus angolensis* and *Afzelia guanzonensis* are the valuable types of timber. The ground cover is normally grass: *Andropogon spp., Panicum maximum* and *Eragrostis spp.* and herbs. This type of vegetation covers extensively the Chalinze-Ubena-Samozi-Ngerengere areas.

(3) Bushland and thicket

The vegetation of this dense shrub and low tree is often found in the Miombo woodlands. The Msua Thicket, in the western part of the Ruvu River basin is a dense mass of bushes and low trees verging on low forest. Some important species include *Euphorbia* and *Commiphora.*

(4) Wooded grassland

This type of vegetation is dominated by grass and herbs with low trees or bushes either grouped or scattered according to type. Canopy coverage is less than 50% with *Combretum* and *Acacia* forming the commonest species.

(5) Open grassland

Open grasslands cover most of the Ruvu floodplains and tributaries and consist of seasonally flooding areas and permanent marshes. In the better drained soils the grasslands have been opened up for agriculture. However, a large part of the floodplain remains unutilized.

(6) Mangroves

At the mouth of the Ruvu River, near Bagamoyo, there is a mangrove forest with an area of about 2,100 ha. There is more mangrove vegetation on the southern bank of the river than on the north. About 45% of the forest has a stand height of 10 m, being followed by 38% of those with a height of 15 m and 17% of those with a density of less than 50%. Dominant species are *Avicennia marina* and *Xylocarpus granatum* which form mixed stands. *Rhizophora* and *Ceriops* are next in the importance. Scattered trees of *Heritiera* and *Bruguiera* are also present on the upper river banks. On the landward side, mixed mangrove vegetation of *Avicennia, Bruguiera, Rhizophora* and *Ceriops* is common. At a few places, *Lumnitzera* grows on the landward margin. Seawards, the vegetation is dominated by *Rhizophora mucronata* and at the seaside *Sonneratia alba* forms a pure stand. The area of forest with low density is covered by *Avicennia-Ceriops* vegetation. Many old trees of *Avicennia* and *Xylocarpus* are present in the Ruvu River because exploitation of these in the past has been minimal. However, selective felling and clear-cutting of *Xylocarpus granatum* now takes place at some sites (Catchment Forestry, 1991).

The mangrove ecosystem, however, is very precious, and encompasses terrestrial, freshwater, marine and estuarine systems. It is extremely important as a feeding and nursery area for prawns, fish and shellfish and a harbour for numerous species of mammals and birds. They also prevent coastal erosion and protect coral reefs by preventing siltation. This mangrove forest is designated for the mangrove forest reserve.

2.2 Water Quality

2.2.1 Water quality standards

Two sets of the water quality standards are used in Tanzania as shown in Table F.1 (MLWHUD, 1986) and below:

a. WHO Standards (International Standard, WHO 1963)
The international standards for drinking water supplies are mostly applied to urban water supply and large-scale rural water supply.

b. Tanzania Temporary Standards (T.T.S. : Standard for Rural Water Supplies 1974)
The temporary water quality standards for domestic water supplies in Tanzania are applied to small rural water supply.

The Water Utilization Act of 1974 was amended in 1981, when the urban water supply act was promulgated, in order to make better provision for the control of water pollution. Four sections of the urban water supply act are devoted to conservation and protection of water. It also provides penalty clauses for offenses resulting in pollution of water.

2.2.2 Previous study of water quality

Some of the water characteristics of the Study Area were discoursed in the previous water quality studies. According to the JICA's report (1991), the raw water quality of the Ruvu River was characterized by high turbidity, even in the dry season. It exceeded 100 JTU (Jackson Turbidity Unit) and annual average was 200 - 500 JTU with iron and manganese content. In the past, removal of turbidity, iron, etc. was unsatisfactory due to inadequate injection of aluminum sulphate, resulting in insufficient flocculation.

In the DHV report (1980), it was reported that water quality parameters of the Ruvu River showed a negative health impact, such as fluoride and nitrate proved to be present in low or acceptable concentrations. Some 40% of all the samples got a "poor" qualification as far as their turbidity, mainly due to clay and loam, was concerned. The bacteriological quality was unsatisfactory for the majority of the water sources.

Concerning the water quality of ground water, according to the CIDA/CBA report (1979), hard saline water was generally found at sites located on the basement rock in Bagamoyo District and in boreholes throughout the region. The factors which frequently exceeded the WHO's maximum permissible levels were turbidity, colour, permanganate value and iron. The bacteriological quality of existing rural water supply was generally poor.

2.2.3 Water quality analysis

(1) Objective

The water quality analysis was carried out aiming at facilitating a comprehensive assessment of water quality, which might be affected by the implementation of water resources development and subsequent development works in the Study Area.

(2) Water sampling locations

Water sampling for the water quality analysis in the rainy season was carried out at a total of twenty (20) locations on the upper, middle and lower reaches of the Ruvu River and its tributaries as well as some wells in the Study Area so as to clarify the water quality of ground water.

On the other hand, in the dry season it was carried out at the twenty locations as well as those in the rainy season, for the purpose of comparison of water quality in the rainy season and dry season. Additionally, at five sampling locations to which the Study Team could not reach in the rainy season, water sampling was also carried out in the dry season. Thus, the water sampling was performed at a total of 25 locations in the dry season as indicated in Fig. F.3 and Table F.2. Furthermore, the water quality of existing reservoirs and creeks was analyzed at field in terms of electric conductivity.

(3) Analysis parameters

All water samples collected were tested in the laboratory of the Water Laboratories Unit, Ministry of Water, Energy and Minerals, concerning the physical, chemical and bacteriological water quality parameters listed in Table F.3.

For physical and chemical tests, turbidity and colour were measured to clarify the aesthetic quality of the water. A hach filter photometer was used. To minimize interference of turbidity when measuring colour, the turbidity was removed by filtration. pH was measured at the sampling point and also in the laboratory to obtain more accurate results. Electric conductivity was measured to determine the salt content in the water. Drel/5 with conductivity was used to measure it. The determination of dissolved oxygen was carried out in the laboratory. The azide modification of the Winkler iodometric titration method was used. Calorimetric, titrimetric and specific ion electrometric techniques were used for chemical analysis.

For bacteriological tests, the analysis was conducted both at field and in laboratory. The water samples collected in autoclaved glass bottles were analyzed to determine the total coliform and faecal coliform. The membrane filtration procedure was used. The volume filtered was 100 ml for the both coliform analyses. Total coliform was grown on M-Endo broth, while faecal coliform was grown on M-Faecal coliform broth. The field testing equipment (Millipore) was used to monitor the content of total coliform and faecal coliform at the sampling sites. The analysis was also conducted in the laboratory.

(4) Analysis results

The results of the water quality tests are shown in Table F.4 for the rainy season's samples and Table F.5 for the dry season's samples.

1) Rainy season

a. Physical and chemical tests

Water samples at many locations showed high turbidity and colour levels, especially at Sample No. 7, 8 and 9 which were all collected from the Ngerengere River. They are over 200 N.T.U. and 200 mgPt/l, because of sampling under the flooding condition which occurred immediately after heavy rain. Also Samples No. 4, 9 and 8 showed high values of SS.

Regarding all data, pH was comparatively high, showing over 7.5, in comparison with the results of simple measurement by experimental paper at sampling points. EC, HCO_3, total hardness and salinity showed a comparatively high levels at locations of No. 11, 15 and 19. In addition, SO_4, Ca, Mg and Na were also high in comparison with the others at No. 11 and 15, Umbenazomozi Bridge on the Msua River and Lugoba of the Mkombezi River. Furthermore, at No. 11 the density of Cl was as extremely high as over 3,800 mg/l. DO of No. 16 was under 5 mgO_2/l, while many samples showed COD over 6 mgO_2/l. SAR of No. 15 and 11 in the Mkombezi and Msua Rivers were calculated to be as high as over 18. Fe of No. 14 and 8 and Mg of No. 14 were wholly high. At almost all sampling locations, B and F were comparatively low.

The water samples at No. 5, 12, 15 and 19 were suitable for drinking purposes of rural water supply according to the Tanzania Temporary Standards. The rest sixteen were not suitable for domestic use without clarification because of high turbidity and colour levels and/or high Cl, Fe and Mn content. On the other hand, the water samples at No. 11 and 15 were classified as high salinity water (EC: 750-2,250 micron S/cm) or very high salinity water (EC>2,250 micron S/cm) and high sodium water (SAR: 18-26).

According to the USDA classification of irrigation water salinity (sulphate-free waters), high salinity water (C3) cannot be used for field where inadequate drainage is provided. Even with adequate drainage, special management for salinity control may be required and plants with good salt tolerance should be selected. The very high salinity water (C4) is not suitable for irrigation under ordinary conditions but may be used occasionally under very special circumstances. The soil must be permeable, drainage must be adequate, excessive amount of irrigation water must be applied to enable considerable leaching, and very salt-tolerant crops should be selected. According to the USDA classification of irrigation water sodicity (sulphate-free water), high sodium water (S3) may produce harmful levels of exchangeable sodium in most soils and will require special soil management under good drainage, high leaching and input of organic matter. Gypsiferous soils may not cause harmful levels of exchangeable sodium from such water.

b. Bacteriological tests

Except one ground water sample of the Dutumi well, nearly all water samples were seriously contaminated by coliform, especially at No. 8, 11, 4, 20 and 7, which are located downstream or near the settlement areas. Total coliform was over 4,000/100 ml and faecal coliform was over 2,000/100 ml. It seems that at many places drainage and surface runoff lead contamination of the water sources.

c. Conclusion

Almost all the water samples analyzed for physical, chemical and bacteriological tests, except the ground water of the Dutumi well, they should not be used for any domestic purposes unless they are treated and/or disinfected. Most of water samples, except for No. 1, 5, 6, 9 and 19, were not so suitable for irrigation water from viewpoint of physical and chemical parameters such as electric conductivity, dissolved oxygen, chemical oxygen demand and sodium adsorption ratio.

2) Dry season

a. Physical and chemical tests

In the Ruvu River basin, the streamflow in the dry season was remarkably less as compared with the rainy season flow. Generally, physical parameters such as turbidity, SS and colour levels are low. At sampling locations of No. 15, 16, 17 and 20, turbidity exceeded 30 N.T.U. and at No. 20 colour was over 50 mgPt/l.

Regarding all samples, pH was in a range of 6.5 to 8.5, but the majority were over 7.5. Also DO levels were low. At the Mkombezi and Usigwa Rivers, it was below 5 mg0_2/l and COD

levels were high at Mkombezi, Usigwa and Msua Rivers and Pangani reservoir with over 6 mgO_2/l. All sampling points were located on the small tributaries of Ruvu River.

There was a tendency that the value of EC of small stream was higher than that of larger stream. Especially, on the Msua and Mkombezi Rivers and on the Pangani reservoir located close to the eastern tributary of the Ruvu River, the EC values were metered to be as very high as over 2,250 micron S/l. In the upper reaches of the Msua and Mkombezi Rivers, it showed high values of EC also in the rainy season. The crystalline limestones lie at several places northwest of Chalinze and saline-sodic soils also deposit in the western area of the Ruvu River and south of the Msua River. From these, it seems that the water quality of those rivers is affected by such geologic conditions. CO_3, total hardness and salinity showed similar tendency, and total hardness value was over 600 mg/l at No. 15, 25 and 11. Also, downstream of the Morogoro municipality on the Ngerengere River, the EC value was comparatively high. Because of water storage at the Mindu dam, there was no streamflow in a stretch of the Ngerengere from the proposed dam site to the Morogoro municipality, and sewer of the Morogoro municipality collects along water edge of the Ngerengere River. It is considered that the content rate of sewer in the surface water of the Ngerengere River downstream of the Morogoro municipal was relatively high.

Total Nitrogen values at No. 24, 25, 15 and 9 were over 5.0 mg/l. In addition, Cl, SO_4, Ca, Mg, and Na were high in comparison with those at No. 11, 15 and 25, which are located on the Umbenazomozi Bridge across the Msua River, Lugoba of Mkombezi River and Pangani reservoir. These data of Cl were over 800 mg/l, and Na was over 500 mg/l. Furthermore, at No. 15 the density of K was extremely high. SAR at No. 8, 11, 15, 21 and 25 were calculated to be as very high as over 26. At No. 9 it was over 18. Fe of No. 10 (1.0 mg/l) and Mn of No. 11 (1.6 mg/l) were wholly high. At almost all sampling locations, B and F were comparatively low or nil.

Most of the samples analyzed during the dry season for physical and chemical parameters except the samples of No. 11, 15, 16, 17, 20 and 24 were suitable for drinking purposes of rural water supply. Therefore, almost all samples should be treated for turbidity removal in order to satisfy the international standard. On the other hand, the water samples at No. 11, 15 and 25 were classified as very high salinity water (EC>2,250 micron S/cm) and those at No.8, 9, 11, 15, 21 and 25 were classified as high sodium water (SAR: 18-26) or very high sodium water (SAR>26).

According to the USDA classification of irrigation water sodicity (sulphate-free water), very high sodium water (S4) is generally unsatisfactory for irrigation purposes except low and probably medium salinity water, for which the solution of calcium from the soil or use of gypsum or other amendments may make the use of these water possible.

b. Bacteriological tests

As well as the case in the rainy season, almost all the samples were contaminated by coliform except one ground water sample of Dutumi well of No. 19. The water samples seriously contaminated were those at No. 7, 9 and 8, which are all located on the Ngerengere River, showing that total coliform was over 3,000/1,000 ml and that faecal coliform was over

1,500/1,000 ml. It is considered that these contamination are caused by sewer from Morogoro municipality. The samples at No. 23, 72 and 89 were less contaminated indicating that total coliform was under 200/100 ml and that faecal coliform was under 100/100 ml.

c. Conclusion

Only the ground water of Dutumi well of No. 19 was judged suitable for drinking purposes of rural water supply without the treatment. Rest of the samples should not be used for any domestic purposes unless treated and/or disinfected. The ground water of Yombo well of No. 20 was contaminated in the dry season. Such contamination might have been brought about by use of contaminated lifting device, intrusion of soil and rubbish during the water sampling and spilt water running back into the well again. Some water samples at No. 8, 11, 12, 15, 16, 21 and 25, of which the majority were taken on the tributaries of the Ruvu River, were judged not so suitable for irrigation.

3) Comparison between the rainy season and dry season

The streamflows of the main and tributaries of the Ruvu River in the dry season are extraordinary less as compared with the rainy season flow. At almost all locations of water sampling, the physical parameters of the dry season flow such as turbidity, SS and colour increased in comparison with those of the rainy season flow.

Almost all pH values were reduced and some became acidic. EC values of all streamflows increased in comparison with those in the rainy season and increase rates of EC were comparatively large in the downstream reach of the Morogoro municipality on the Ngerengere River and on the Msua and Mkombezi Rivers. In case of the ground waters, as compared with those in the rainy season, these EC values were not changed so much. CO_3 and total hardness showed the similar tendency as well as the case in the EC value, but salinity highly increased at all locations. Nearly all DO values increased in the dry season as compared with those in the rainy season, while the COD reduced.

NH_4-N and NO_2-N reduced in the dry season at most of the sampling locations. As compared with the rainy season, some chemical parameters in the dry season increased at very high ratio, especially Cl at No. 13 and 15 and Mg at No. 11, 13 and 15 taken on the Msua and Mkombezi Rivers. On the Ngerengere River, Na of No. 8, 9 and 10 remarkably increased in the dry season. The density of K reduced at most of the sampling locations. SAR showed an increase at nearly all locations except only one sample of the Msumbisi River. At most of the sampling locations, B increased in the dry season and F reduced in the dry season.

Almost all the samples were contaminated by coliform except one ground water sample of Dutumi well in both the seasons. Except the Ngerengere River (Samples No.7 and 9), coliform remarkably reduced at the most parts of the basin.

It is considered that in the rainy season the water quality of the Study Area is remarkably affected by flood water and/or rain water. Especially it was seen on the physical and bacteriological parameters. The suitability of the water for drinking depended upon the season on which the sample was taken. Most of the samples analyzed during the rainy season were

not suitable and during the dry season most of the samples analyzed for physical and chemical parameters were suitable for domestic use.

2.3 Socio-economic Conditions

2.3.1 Settlement patterns

In the Ruvu River basin, over 50 percent of the total population live in mountainous and hilly areas. Settlements are also concentrated along river valleys and plains and along the major roads and railways. This settlement pattern is mainly a response to climatic and soil conditions, economic potentials as well as accessibility to market centres. Concentration of human settlement along the Morogoro/Bagamoyo road, for example, has resulted in the development of peri-urban clusters with increased commercial activities.

The Kwavis (Baraguyu) migrated into the Ruvu River basin from the northern regions in search of pastures during the last 100 years and quite recently. At first they settled on the western side of Bagamoyo between Rivers of Wami and Ruvu. Patterns of interaction developed, which suggest economic inter-dependence but the Kwavi still maintain distinct cultures and social borders. Some years back a few Kwavis settled close to the Ruvu River to take advantage of river valley pastures but this area has been taken up by the Government for irrigation and ranching activities forcing the Kwavis to move towards Chalinze where they also involve themselves in other activities like petty trading and farming (IRA, 1993).

2.3.2 Land tenure systems

All land was declared as state property immediately after independence. Moreover after the villagization program (under the Ujamaa Village Act of 1975) the state allocated land to the registered villages. The village governments, in turn, allocate some land to households and other remained for the common good. Land can be tilled or used by households in block or village communal farms.

There are four main land tenure systems in the Study Area, namely: a) Customary land tenure system - this is a traditional and the most common land tenure system among cultivators; b) Communal land tenure system - a common tenure system particularly among livestock keepers and in the villages; c) Rights of occupancy and d) Leaseholds.

Most of the Miombo woodlands are public (open) or village lands. Forest resources in such areas are controlled by the District Forest Officer.

2.3.3 Public health and hygienic conditions

According to the rank order of the most common diseases in the Study Area, Malaria is prevalent in almost all of the Ruvu River basin. Malaria is followed by upper respiratory tract infections, diarrhoea, worms, bilharzia (Schistosomiasis), eye diseases (mostly conjunctivitis), pneumonias and anaemia. Remarkably social diseases (*Gonorrhoea Syphilis*) also are occurring.

From time to time, episodes of epidemics such as cholera and meningitis strike villages especially those with low latrine coverage, or those receiving migrants for hired labour in farming areas or those highly visited for business/auction of food crops. According to the information of district medical and health offices, the type of diseases and number of cases reported clearly show that infections by water-related sanitation diseases are highly prevalent in the Study Area.

A disease occurs when the pathogen is in the water which is drunk by the animal or person who is infected. The disease can also be transmitted by any route which permits faecal matter of an infected person or animal to be ingested (Faecal-oral route). They include diarrhoea, dysenteries, typhoid and cholera.

2.4 Natural Conservation Area

At present, Tanzania has 14 national parks including Ngorongoro Conservation Area and Selous Game Reserve, which cover a total area of 103,171 Km^2 equivalent to about 11% of the total area of the country. Furthermore, it has 16 game reserves occupying 39,750 km^2 or 4% of Tanzania's area. Another area of 134,075 km^2 is under the Forest Reserves (Lyogello, 1991).

In the Study Area, there are one national park, Mikumi National Park and one game reserve, Selous Game Reserve and many forest reserves. The Mikumi National park lies at the western end of the Ruvu River basin which is the most upstream area of the Mgeta, Rudete, Msegere and Msoro Rivers, but the park boundary is not clear at some part of the Study Area. The Selous Game Reserve is situated in the southwest corner of the basin which is on the right bank of the Mgeta River downstream of Kisaki.

2.4.1 Mikumi National Park

The Mikumi National Park is in the Morogoro Region and this is the nearest park to the city of Dar Es Salaam. It is the fifth largest park in Tanzania and gazetted in 1964 with an area of 3,230 km^2. The Park is located between the villages of Doma and Mikumi on the Dar Es Salaam - Tunduma road. The Park Headquarters lie at an elevation of 549 m above sea level.

The Mikumi National Park covers the Mkata River floodplain, with its hardpan, ridges, swamps and black-clay grassland, the Miombo woodlands on the hill to the east and west, and the rivers with their fringe of tall trees and dense thickets. Rainfall in the Park varies by zones. At the Park Headquarters for instance, the average annual rainfall is 508 mm, while in the hills it is as high as 1,067 mm. The short rain usually takes place during November and December. Long-term rain occurs for the period from March to May.

The Park contains a spectacular concentration and variety of wildlife. The Mkata River floodplains form a horse-shoe shaped hills, which are the feeding grounds for large herds of buffalo and wandering groups of elephant. The wooded fringes of the plains harbour many wildebeest, zebra, impala, baboon, warthog, jackal, etc. (Lyogello, 1991).

The eastern parts of the Mikumi National Park is insider of the Ruvu River basin, and most of the Park portion of the basin is covered by Miombo woodland, a home of the black rhino (*Diceros bicornis*), the pangani black-and-white colobus monkeys (*Colobus angolensis*), the leopard (*Panthera pardus*) and many bird species including the guinea fowl (*Numida mitrata*), the lilac-breasted roller (*Coracias caudata*) and the European roller (*Coracias garrulus*), vultures and marabou storks (IRA, 1993).

2.4.2 Selous Game Reserve

The Selous Game Reserve is one of the largest wildlife areas left in the world. The Reserve, established in 1922, has a total area of about 50,000 km^2 or about 6% of, the total area of the country. It is situated between 7°-15' and 10°-15' South Latitude and between 36°-00' and 38°-45' East Longitude. The ground elevation 110 to 1,250 m above sea level. The Reserve is divided into four sectors. Animal viewing, boating, fishing and camping are restricted to the Northern sector which borders the Mikumi National Park.

The game reserve's boundaries have been changed some times, according to the Wildlife Conservation Act. The northern part boundary related to the water resources development in the Ruvu River basin is as follows: in an east-south east direction along a demarcated line to the point where the Kisaki - Kisanga - Mpanga road crosses the Kidai River; thence in an easterly direction downstream the Kidai River to a beacon at the point where the said river turns north to join the Mgeta River; thence along a demarcated line in a north-easterly direction to the Mgeta River; thence along the north bank of the Mgeta River in a north-easterly direction to the junction of the Ruvu and Mgeta Rivers; thence along a demarcated line to the Mkigura Mbuga; thence in a south-easterly direction along the northern limit of the Mkigura mbuga to the Dibwe water course.

The Reserve has two rainy seasons. In November to January, short rains occur, while long rains begin in February and end in May. Nearly three quarters of the vegetation in the Reserve has been dominated by the Miombo woodland (*Brachystegia spp.*). The other principal features include marshes, savannah, open plains, bushes, shrubs and thickets. The Rufiji River flows through the area. Thus the Selous ecosystem is rich and diverse. It, for instance, contains more than 2,000 species of plant and over 30 species of animals. Due to its unique ecological importance, the Reserve became listed by the Untied Nations as a "World Heritage Site" in 1982.

It is said that in the Reserve there are over 55,000 elephants, over 160,000 buffaloes and about 100 rhinos. The other animals include zebra, impala, wildebeest, waterbuck, warthong, kudu, giraffe, lion, leopard and others. Furthermore records show that there are over 350 species of birds in the Reserve (Lyogello, 1991).

According to the Selous Conservation Programme report, the Selous Game Reserve is known apart from the untouched landscape for its importance for the protection of elephants and rhinos. The vast river system of the Rufiji and its tributaries hold large populations of hippos and crocodiles. The Reserve is one of the most important sanctuaries for the African wild dog (*Lycaon pictus*: according to the Selous Census 1989, they were seen by the observers in