No.

The United Republic of Tanzania

THE STUDY ON WATER SUPPLY IMPROVEMENT IN COAST REGION AND DAR ES SALAAM PERI-URBAN IN THE UNITED REPUBLIC OF TANZANIA

Final Report

SUPPORTING REPORT

December 2005

JAPAN INTERNATIONAL COOPERATION AGENCY
Global Environment Department

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In this report, project costs are estimated based on prices as of July 29, 2005 with an exchange rate of US$1.00 = Tanzania Shilling (Tsh) 1,137 = Japanese Yen ¥ 112.47.

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ABBREVIATIONS

ATP	Affordability-to-Pay
B/C Ratio	Benefit Cost Ratio
BTC	Belgian Technical Cooperation
CBOs	Community-Based Organizations
CIDA	Canadian International Development Agency
COWSOs	Community-Owned Water Supply Organizations
DAWASA	Dar es Salaam Water and Sewerage Agency
DD	Draw Down
DDCA	Drilling & Dam Construction Agency
DRWS	Division of Rural Water Supply
DSM	Dar es Salaam
DTH	Dawn-the-hole Hammer
DWL	Dynamic Water Level
DWSP	District Water Supply and Sanitation Team
DWST	District Water and Sanitation Team
EC	Electric Conductivity
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
ESAs	External Support Agencies
EWURA	Energy and Water Utilities Regulation Authority
FRP	Fiber Reinforced Plastic
GDP	Gross Domestic Product
GIS	Geographical Information system
GNP	Gross National Product
GPS	Global Positioning System
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
IEE	Initial Environmental Examination
JICA	Japan International Cooperation Agency
LGRP	Local Government Reform Policy
M/M	Minutes of Meetings
MOL	Ministry of Land
MoNRT	Ministry of Natural Resource and Tourism
MoWLD	Ministry of Water and Livestock Development
NEMC	National Environmental Management Council
NPV	Net Present Value
NGOs	Non-Governmental Organizations
NWP	National Water Policy
NWSDS	National Water Sector Development Strategy

O&M	Operation and Maintenance
PEDP	Primary Education Development Programme
PER	Preliminary Environmental Report
PHAST	Participatory Health and Sanitation Transformation
PRSP	Poverty Reduction Strategy Paper
PWP:	Public Water Point
RF	Registration Form
RWSD	Rural Water Supply Division
RWSSP	Rural Water Supply and Sanitation Program
SC	Specific Capacity
SR	Scoping Report
SW	Scope of Work
SWAP	Sector Wide Approach
SWL	Static Water Level
TDS	Total Dissolved Solid
TOR	Terms of Reference
TRC	Technical Review Committee
UFW	Unaccounted-for water
UNICEF	United Nations International Children's Fund
VES	Vertical Electrical Sounding
VWCs	Village Water Committees
WDC	Ward Development Committee
WRI	Water Resources Institute
WSS	Water Supply System
WSSAs	Water Supply and Sanitation Authorities
WSSMC	Water Supply System Management Center
WTP	Willingness-to-Pay
WUAs	Water User Associations
WUGs	Water User Groups

<unit>	
l/min	liter/minute
masl	meter above sea level
mbgl	meter below grand level
min	minute

Chapter 1

Village Inventory Survey

CHAPTER 1 VILLAGE INVENTORY SURVEY

1.1 GENERAL

1.1.1 BACKGROUND

In the formulation of the study framework in the preliminary stages, several study items and outputs expected in the Study were set out largely depending on the utilization of database, which is currently developed in the GTZ supporting program of "Support to the Tanzania Water Sector Reform". The database is designed to provide, when completed, various and valuable information relating to rural water supply schemes such as physical status, administrative and institutional aspects, revenue collection, capital and operational costs, performance indicators, water source, and so forth.

In the initial stages of the Study, however, it was learnt that the database development in the Study area of Dar es Salaam Region and Coast Region was not completed in spite of achievement in other regions. Unavailability of database, therefore, affects a number of the items and outputs expected in the Study, of which critically affected ones are; 1) identification and finalization of the target communities of the Study, 2) problem analysis on the existing water supply schemes in both technical and socio-economic aspects, 3) formulation of water supply plan reflecting demand, population, situation of existing supply system (including rehabilitation), and other factors, and 4) selection of priority area and projects. Considering those items are the basis and backbone of the Study and some of them, in particular 1) above, shall be undertaken in the initial stage for the Study. Accordingly, it was agreed among stakeholders (i.e. JICA, MoWLD, District / Municipal staff) to carry out 'Village Inventory Survey' in the study area.

Furthermore, the community list of the study area (263 communities) prepared by Tanzanian side also lacks accuracy of profiles of the villages and/or sub-villages, such as population, and existence and non-existence of water supply facilities. It was revealed that approximately 100 communities, which had no access to improved water supply services, had been left out from the list. It further increased the necessity to conduct the Village Inventory Survey.

1.1.2 OBJECTIVES AND METHODOLOGY

The Village Inventory Survey was conducted to collect basic information and to comprehend water supply situation of the target communities in the Study. Primarily, the output of the survey is utilized in finalization of the target communities of the Study, and secondarily incorporated into socio-economic analysis, water supply plan, facility design, and selection of priority area and projects.

The survey was carried out by structured interview to the village and ward authorities on the field, such as Ward/ Mitaa/Village Executive Officer and Village Water Committee. In the interview, a questionnaire was utilized, of which survey items included: 1) population and location (by GPS coordinates) of the Village/Mitaa and its sub-villages, 2) type of community, 3) existing infrastructures (health/education institutions, market, etc.), and 4) water supply conditions. Each item was surveyed at the village level and more extensively at sub-village level. In total 573 Villages/Mitaa were surveyed, which corresponded to 998 sub-villages.

The survey was conducted by local staff employed by the Study team with assistance from Municipal and District Water Engineers.

1.1.3 SURVEY ITEMS

The following table (see *Table 1.1*) shows the items included in the Village Inventory Survey.

Table 1.1 Survey Items

Group	Survey Items
Community Population and Location	Population and number of households Location of the community (GPS coordinate)
Community Type	Community status (Village/Mitaa) Dwelling type of community
Infrastructure	School (types, number of pupil, toilet type, etc.) Health Facilty (types, number of bed and outpatient, toilet type, etc) Market types Telecommunication availability Electricity supply availability Extension Office
Water Supply Conditions	Water Source Number of Water Source Served population Type of supply system Ownership of the supply system Management responsibility of the supply system Type of community-based water organization Distance to water point Type of supply facility equipped Construction Year Number of domestic water points Functioning conditions of supply facility Operational conditions of supply facility Perceived condition of water quality Unit price of user fee Name of supply scheme

1.2 OUTPUT OF THE VILLAGE INVENTORY SURVEY

1.2.1 VILLAGE INVENTORY DATABASE PROCESSED

All the information collected through the field interview survey was entered and village inventory database is processed in excel format for the inventory purposes, as well as in SPSS format for the statistical purposes which can be utilized in socio-economic analysis, facility design, and operation and maintenance study.

1.2.2 FINALIZATION OF THE TARGET COMMUNITIES OF THE STUDY

Based on the village inventory that included key information of the communities in the study area such as population, location, and access to and supplying/functioning conditions of the improved water supply services, the target communities of the Study were finalized with counterpart organizations. In the finalization of the target communities of the Study, the following criteria was applied; 1) the communities having piped scheme with water source of either City Water/DAWASA, surface water (including small dam), deep tube well, or protected shallow well, are excluded from the target communities of the Study, while ones with water source of surface water (charco dam) or unprotected shallow well / dug well are included into the target, and, 2) communities having only hand pump for water supply or having no access to improved water supply are all included in the target. The criteria are built based on the consideration of supply capacity against demand and reliability of existing water source throughout the seasons, that is, communities with water sources which are neither meeting community's water demand nor supplying through the seasons are classified as the target communities of the Study, as shown in *Table 1.2*.

Table 1.2 Criteria for Selection of Target Communities

Community with:	Water Source	Supply Capacity	Reliability	Classification
Piped Scheme	City Water/DAWASA	enough	reliable	Excluded from the Target
	Surface Water (inc. Small dam)	enough	reliable	
	Deep Tube Well	enough	reliable	
	Protected Shallow Well	enough	reliable	
	Surface Water (charco dam)	enough	seasonal	Included in the Target
	Unprotected Shallow Well	not enough	seasonal	
Hand Pump	Deep Tube Well	not enough	reliable	
	Protected Shallow Well	not enough	seasonal	
	Unprotected Shall Well	not enough	seasonal	
No Improved Water Supply Service		-	-	

Reviewing the village inventory data with application of the criteria mentioned above, the target villages of the Study were finalized (See, *Table 1.3*), of which summary is given in the *Table 1.4* below. Whole inventory data for the surveyed villages is included in the Data Book A. As the result of the application of criteria extensively to the sub-village level, target Villages/Mitaa are classified as 'Targeted' which means entire village/mitaa is targeted, and 'Partly Targeted' which means some sub-villages are excluded from the target, but others are included as the target. In total, 278 Villages/Mitaa becomes the target communities, among which 257 Villages/Mitaa are entirely 'targeted' and 21 Villages/Mitaa are 'partly targeted'. Looking at sub-village level, 915 sub-villages are targeted.

Table 1.4 Summary of Target Communities

Region	District / Municipality	Village/Mitaa			Sub-Village*1		Population to be Covered in the Study (2002)
		Target	Partly Targeted	Not Targeted	Targeted	Not Targeted	
Coast	Bagamoyo	38	7	29	272	46	104,264
	Kibaha	21	3	21	62	8	40,334
	Kisarawe	71	3	3	222	8	85,787
	Mkuranga	69	5	3	314	8	161,263
	Total	199	18	58	870	78	391,648
Dar es Salaam	Ilala	22	2	50	32	3	217,358
	Kinondoni	14	0	111	0	0	113,351
	Temeke	22	1	78	13	2	142,137
	Total	58	3	239	45	5	472,846
Grand Total		257	21	295	915	83	864,494
Target Villages (Targeted and Partly Targeted)			278	-	915	-	-
Villages Surveyed				573		998	-

*1: Number of sub-villages composing the target villages

1.2.3 SECONDARY OUTPUT

Results of Village Inventory Survey are utilized in a multi-purpose manner. Key information and data are incorporated into the Geographic Information System (GIS) developed under the Study, while statistical results on the socio-economic aspects are analyzed in the Socio-Economic Study. Information on the existing water supply schemes are utilized in the facility design and preparation of rehabilitation plan, as well as in operation and maintenance plan analyzing the current situation of the scheme management. It is also utilized in the selection of priority area and project. Those outputs are presented in the respective chapters of the Main Report.

Table 1.3 Results of Village Inventory Survey (1/4)

District	Ward	Name of Target Villages	Long.	Lat.	Total Population of the Vilalge (2002)	Population to be served in the study area (2002)	No. of Sub-Villages	Dwelling Type of Community	Major Water Source	Electricity
Bagamoyo	Chalinze	Chamakweza	63902.2	382720.5	2,152	2,152	4	Clustered	River/Stream/Pond/Dam	Not Available
Bagamoyo	Chalinze	Mdaula	63757.1	381429	5,476	2,982	17	Clustered	River/Stream/Pond/Dam	Available
Bagamoyo	Chalinze	Msolwa	63729.2	381555.8	2,672	2,672	7	Clustered	River/Stream/Pond/Dam	Available
Bagamoyo	Dunda	Kaole	62741.2	385632.9	1,174	292	7	Concentrated	Unprotected Well	Available
Bagamoyo	Kibindu	Kibindu	55944.7	375526.8	5,605	5,605	5	Clustered	Unprotected Well	Not Available
Bagamoyo	Kibindu	Kwamduma	60102.9	380427.6	3,677	3,677	5	Scattered	Unprotected Well	Available
Bagamoyo	Kibindu	Kwamsanja	60504.9	380037.3	1,001	1,001	3	Concentrated	River/Stream/Pond/Dam	Not Available
Bagamoyo	Kiwangwa	Fukayosi	62440.9	384023.8	3,700	3,700	9	Clustered	River/Stream/Pond/Dam	Not Available
Bagamoyo	Kiwangwa	Kidomole	62621.1	384351	586	586	5	Clustered	River/Stream/Pond/Dam	Not Available
Bagamoyo	Kiwangwa	Kiwangwa	62227.4	383517.6	12,762	12,762	17	Clustered	Unprotected Well	Not Available
Bagamoyo	Kiwangwa	Masuguru	62130.2	382819.1	1,768	1,768	5	Clustered	River/Stream/Pond/Dam	Not Available
Bagamoyo	Kiwangwa	Mkenge	62805.2	383457.9	2,050	2,050	4	Clustered	River/Stream/Pond/Dam	Not Available
Bagamoyo	Kiwangwa	Msinune	62353.3	383325.7	1,927	1,927	5	Clustered	River/Stream/Pond/Dam	Not Available
Bagamoyo	Lugoba	Diozile	63015.1	381515.2	1,631	1,631	5	Clustered	River/Stream/Pond/Dam	Not Available
Bagamoyo	Magomeni	Magomeni	62844	385358.7	11,036	645	15	Concentrated	Unprotected Well	Available
Bagamoyo	Magomeni	Makurunge	62816.7	384755.9	1,636	1,636	7	Clustered		Not Available
Bagamoyo	Mbwewe	Kifuleta	60549.7	381217.4	3,523	3,523	3	Clustered	Unprotected Well	Not Available
Bagamoyo	Mbwewe	Kwang'andu	55839	381326.9	2,016	2,016	7	Clustered	Unprotected Well	Not Available
Bagamoyo	Mbwewe	Kwaruhombo	60513	380740.4	2,068	2,068	6	Concentrated	Unprotected Well	Not Available
Bagamoyo	Mbwewe	Pongwekiona	61052.1	381413.5	3,135	3,135	16	Scattered	Unprotected Well	Not Available
Bagamoyo	Miono	Kweikonje	55930.4	382149.5	1,124	1,124	4	Clustered	River/Stream/Pond/Dam	Not Available
Bagamoyo	Miono	Masimbani	60201.4	382500.5	1,181	1,181	8	Concentrated along the Road	River/Stream/Pond/Dam	Not Available
Bagamoyo	Miono	Mihuga	61053.6	382941.7	1,417	1,417	11	Clustered	River/Stream/Pond/Dam	Not Available
Bagamoyo	Mkange	Manda Mazingara	602352	383123.2	3,122	3,122	11	Clustered	River/Stream/Pond/Dam	Not Available
Bagamoyo	Mkange	Matipwili	61355.1	384238.8	2,698	2,698	7	Clustered	River/Stream/Pond/Dam	Not Available
Bagamoyo	Mkange	Mkange	60420.8	383336.3	2,396	2,396	9	Clustered	Protected Well	Not Available
Bagamoyo	Mkange	Saadani	60237.9	384638.2	1,344	1,344	8	Clustered	Unprotected Well	Not Available
Bagamoyo	Msata	Pongwe Msungura	61938	381548.1	1,005	1,005	4	Scattered	River/Stream/Pond/Dam	Not Available
Bagamoyo	Talawanda	Kisanga	63040.2	382459.6	855	855	2	Clustered	Unprotected Well	Not Available
Bagamoyo	Talawanda	Malivundo	63428.5	382315.5	1,166	1,166	5	Clustered	River/Stream/Pond/Dam	Not Available
Bagamoyo	Talawanda	Mindukeni	62812.6	382511.9	1,438	1,438	4	Clustered	Unprotected Well	Not Available
Bagamoyo	Talawanda	Msigi	63126.7	382622.8	1,124	1,124	2	Clustered	Unprotected Well	Not Available
Bagamoyo	Talawanda	Talawanda	62934.8	382800	4,124	4,124	5	Clustered	River/Stream/Pond/Dam	Not Available
Bagamoyo	Ubenazomozi	Kaloleni	63636.5	381005.5	3,210	3,210	4	Clustered	River/Stream/Pond/Dam	Not Available
Bagamoyo	Ubenazomozi	Matuli	64030.1	381309.4	1,977	1,349	7	Clustered	River/Stream/Pond/Dam	Not Available
Bagamoyo	Ubenazomozi	Mwidu	63807.6	380652.7	1,977	1,977	6	Clustered	River/Stream/Pond/Dam	Not Available
Bagamoyo	Ubenazomozi	Tukamisasa	63123.6	381227.2	3,051	3,051	8	Clustered	River/Stream/Pond/Dam	Not Available
Bagamoyo	Ubenazomozi	Ubenazomozi	63806.2	381009.6	2,490	2,490	10	Clustered	River/Stream/Pond/Dam	Available
Bagamoyo	Ubenazomozi	Visakazi	63852.2	380226.3	4,893	4,893	5	Clustered	River/Stream/Pond/Dam	Available
Bagamoyo	Vigwaza	Buyuni	63602.2	383747.1	1,759	1,759	9	Clustered	River/Stream/Pond/Dam	Not Available
Bagamoyo	Vigwaza	Kidogozero	63906.2	384218.7	2,416	1,077	4	Clustered	River/Stream/Pond/Dam	Not Available
Bagamoyo	Vigwaza	Vigwaza	64027.6	383719.8	4,039	4,039	12	Clustered	River/Stream/Pond/Dam	Available
Bagamoyo	Vigwaza	Visezi	64441.9	383749.9	1,281	1,281	5	Clustered	River/Stream/Pond/Dam	Not Available
Bagamoyo	Yombo	Yomobo	63349.9	385140.9	1,173	121	10	Clustered	Unprotected Well	Not Available
Bagamoyo	Zinga	Mapinga	63124.5	390512	2,811	195	6	Clustered	City Water/DAWASA	Not Available
	Sub-Total (Bagamoyo District)				**123,666**	**104,264**				
Kibaha	Kibaha	Kongowe	64420.9	385214.2	16,680	362	3	Clustered	Unprotected Well	Available
Kibaha	Kibaha	Msangani	64134.6	385654.2	3,025	3,025	2	Scattered	River/Stream/Pond/Dam	Available
Kibaha	Kibaha	Mwendapole	64505.5	385440.4	8,003	854	4	Scattered	River/Stream/Pond/Dam	Available
Kibaha	Kibaha	Pangani	64456.1	385933.3	2,800	2,800	2	Scattered	River/Stream/Pond/Dam	Not Available
Kibaha	Kibaha	Viziwaziwa	64329.8	385932.1	2,124	2,124	3	Scattered	River/Stream/Pond/Dam	Not Available
Kibaha	Kwala	Dutumi	64502	391408.7	1,300	1,300	2	Clustered	River/Stream/Pond/Dam	Not Available
Kibaha	Kwala	Mpelamumbi	64627.1	382842.5	346	346	2	Clustered	River/Stream/Pond/Dam	Not Available
Kibaha	Magindu	Gumba	64602.6	382119.5	5,000	5,000	5	Clustered	River/Stream/Pond/Dam	Not Available
Kibaha	Magindu	Gwata	64244	382215.5	2,136	2,136	4	Clustered	River/Stream/Pond/Dam	Not Available
Kibaha	Magindu	Lukenge	65216.7	383417.5	1,050	1,050	3	Clustered	River/Stream/Pond/Dam	Not Available
Kibaha	Magindu	Magindu	64902.4	381917.1	2,041	2,041	7	Concentrated	River/Stream/Pond/Dam	Not Available
Kibaha	Mlandizi	Mlandizi 'B'	64254.5	384418.9	18,048	4,040	6	Scattered	River/Stream/Pond/Dam	Available
Kibaha	Ruvu	Kikongo	64745.8	384122.3	710	710	2	Clustered	River/Stream/Pond/Dam	Not Available
Kibaha	Ruvu	Kitomondo	65209.9	383630.1	627	627	2	Clustered	River/Stream/Pond/Dam	Not Available
Kibaha	Ruvu	Lupunga	65034.3	384219	1,128	1,128	3	Scattered	River/Stream/Pond/Dam	Not Available
Kibaha	Ruvu	Minazi Mikinda	64839.6	383907.8	2,624	2,624	2	Concentrated along the Road	River/Stream/Pond/Dam	Not Available
Kibaha	Ruvu	Mwanabwito	64357.8	384409.2	1,540	1,540	2	Scattered	River/Stream/Pond/Dam	Not Available
Kibaha	Ruvu	Ngeta	64448.7	384143.2	1,616	1,616	2	Clustered	River/Stream/Pond/Dam	Not Available
Kibaha	Soga	Bokomnemela	65006.9	385503.6	2,831	2,831	4	Scattered	River/Stream/Pond/Dam	Available
Kibaha	Soga	Kipangege	65152.2	385020.2	347	347	2	Concentrated	River/Stream/Pond/Dam	Not Available
Kibaha	Soga	Misufini	64805	384855.5	337	337	2	Concentrated	River/Stream/Pond/Dam	Not Available
Kibaha	Soga	Mpiji	64614.1	385157.9	1,774	1,774	2	Scattered	River/Stream/Pond/Dam	Not Available
Kibaha	Tumbi	Bokotimiza	64856.4	385648.2	623	623	1	Scattered	River/Stream/Pond/Dam	Not Available
Kibaha	Visiga	Zogowale	64624.3	384843.6	1,099	1,099	3	Scattered	River/Stream/Pond/Dam	Not Available
	Sub-Total (Kibaha District)				**77,809**	**40,334**				
Kisarawe	Chole	Chole	72255.1	383741.5	2,685	2685	4	Concentrated	Unprotected Well	Not Available
Kisarawe	Chole	Kurui-Chole	71819.6	383759.6	1,032	1032	2	Concentrated along the Road	Protected Well	Not Available
Kisarawe	Chole	Kwala-Chole	72034.8	383914.2	2,245	2245	3	Scattered	Unprotected Well	Not Available
Kisarawe	Chole	Mafumbi	72044.3	383658.3	664	664	2	Scattered	Unprotected Well	Not Available
Kisarawe	Chole	Sofu	72053.7	383720.2	142	142	2	Scattered	Unprotected Well	Not Available

Table 1.3 Results of Village Inventory Survey (2/4)

District	Ward	Name of Target Villages	Long.	Lat.	Population (2002)	Served population in the study area (2002)	No. of Sub-Villages	Dwelling Type of Community	Major Water Source	Electricity
Kisarawe	Chole	Yombo Lukinga	72034.1	384024.4	862	862	2	Scattered	Unprotected Well	Not Available
Kisarawe	Kibuta	Bwama	71119.8	385738.8	1,332	1332	4	Clustered	Unprotected Well	Not Available
Kisarawe	Kibuta	Chang'ombe 'B'	70944.2	585148.3	989	989	2	Concentrated along the Road	Unprotected Well	Not Available
Kisarawe	Kibuta	Kauzeni	70644.9	385550.2	1,685	1685	2	Scattered	Unprotected Well	.
Kisarawe	Kibuta	Kibuta	70845.9	385535.4	2,050	2050	4	Clustered	Unprotected Well	Not Available
Kisarawe	Kibuta	Masanganya	70958.9	385420.6	2,289	2289	4	Scattered	Unprotected Well	Not Available
Kisarawe	Kibuta	Mtamba	70351.7	385448	840	840	3	Clustered		Not Available
Kisarawe	Kibuta	Muhaga	70719.7	385223.9	911	911	3	Clustered	River/Stream/Pond/Dam	Not Available
Kisarawe	Kiluvya	Kiluvya 'A'	65524.2	390033.7	2,267	1287	4	Scattered	River/Stream/Pond/Dam	Available
Kisarawe	Kiluvya	Mloganzila	64800.7	390305.8	1,250	1250	2	Clustered	Unprotected Well	Available
Kisarawe	Kiluvya	Tondoroni	64946.6	390140.7	4,233	4233	4	Clustered	Unprotected Well	Not Available
Kisarawe	Kisarawe	Kazimzumbwe	65751.6	390010	1,678	1678	4	Clustered	Water Vender	Not Available
Kisarawe	Kisarawe	Kifuru	65632.2	385627.7	544	544	2	Scattered	Water Vender	Not Available
Kisarawe	Kisarawe	Kisarawe	65418	390427.1	6,744	900	7	Scattered	River/Stream/Pond/Dam	Available
Kisarawe	Kisarawe	Visegese	65246.5	390128.5	1,182	1182	4	Scattered	Unprotected Well	Not Available
Kisarawe	Kurui	Kidugalo	70525.1	384614	532	532	2	Concentrated along the Road	Unprotected Well	Not Available
Kisarawe	Kurui	Kurui	70050.7	390127.5	584	584	0	Concentrated	Unprotected Well	Not Available
Kisarawe	Kurui	Mtakayo	70146.6	384417	998	998	2	Clustered	Protected Well	Not Available
Kisarawe	Kurui	Zegero	70143.6	384416.6	738	738	2	Scattered	Unprotected Well	Not Available
Kisarawe	Mafizi	Gwata	70809.8	383004.7	2,387	1956	6	Concentrated along the Road	River/Stream/Pond/Dam	Not Available
Kisarawe	Mafizi	Kimala Misale	70109.1	382959.5	720	720	2	Scattered	Unprotected Well	Not Available
Kisarawe	Mafizi	Mafizi	65855.5	383518.9	1,436	1436	3	Clustered	River/Stream/Pond/Dam	Not Available
Kisarawe	Mafizi	Nyani	70220.5	383424.6	861	861	3	Clustered	River/Stream/Pond/Dam	Not Available
Kisarawe	Mafizi	Ving'Andi	71531.6	381923.1	780	780	3	Clustered	River/Stream/Pond/Dam	Not Available
Kisarawe	Maneromango	Boga	71317.4	384711.5	2,038	2038	4	Scattered	Unprotected Well	Not Available
Kisarawe	Maneromango	Chale	71535.5	384815.4	516	516	3	Clustered	River/Stream/Pond/Dam	Not Available
Kisarawe	Maneromango	Kidugalo-Kanga	71103.1	384914.2	857	857	2	Scattered	River/Stream/Pond/Dam	Not Available
Kisarawe	Maneromango	Mengwa	71244.3	384349.4	996	996	2	Scattered	River/Stream/Pond/Dam	Not Available
Kisarawe	Maneromango	Msegamo	71128.5	384836	777	777	3	Scattered	River/Stream/Pond/Dam	Not Available
Kisarawe	Maneromango	Ngongele	71350.2	384700.3	710	710	2	Scattered	River/Stream/Pond/Dam	Not Available
Kisarawe	Marui	Kihare	72311.5	384008.1	720	720	3	Clustered	River/Stream/Pond/Dam	Not Available
Kisarawe	Marui	Kisangire	72612.5	384106.3	300	300	2	Concentrated along the Road	Unprotected Well	Not Available
Kisarawe	Marui	Marui-Mipera	71811.1	384740.3	1,034	1034	4	Clustered	Protected Well	Not Available
Kisarawe	Marui	Marui-Ngwata	72057.3	384616.2	1,443	1443	3	Clustered	River/Stream/Pond/Dam	Not Available
Kisarawe	Marui	Titu	72408	384053.7	427	427	3	Concentrated along the Road	Unprotected Well	Not Available
Kisarawe	Marumbo	Chang'ombe 'A'	70931.2	385154.3	548	548	2	Scattered	Unprotected Well	Not Available
Kisarawe	Marumbo	Kitonga	70957.3	384756.5	734	734	2	Scattered	River/Stream/Pond/Dam	Not Available
Kisarawe	Marumbo	Kivukoni	71030.8	385057.3	1,770	1770	3	Scattered	Unprotected Well	Not Available
Kisarawe	Marumbo	Marumbo	70843.6	384952.6	1,115	1115	4	Clustered	Unprotected Spring	Not Available
Kisarawe	Marumbo	Mfuru Kikwete	71143.6	385009.1	3,686	3686	5	Clustered	Unprotected Well	Not Available
Kisarawe	Marumbo	Palaka	70810.7	384732.9	963	963	4	Clustered	Unprotected Well	Not Available
Kisarawe	Masaki	Kisanga	70012.2	385911.2	2,125	2125	6	Clustered	Unprotected Well	Not Available
Kisarawe	Masaki	Masaki	70441.4	385820.8	2,786	2786	6	Clustered	Unprotected Spring	Not Available
Kisarawe	Masaki	Sungwi	70317	385844.2	1,573	1573	5	Clustered	Unprotected Well	Not Available
Kisarawe	Msanga	Bembeza	71636.3	384747.7	1,259	1259	2	Concentrated along the Road	Unprotected Well	Not Available
Kisarawe	Msanga	Mianzi	71622.3	384613.4	747	747	2	Concentrated along the Road	Unprotected Well	Not Available
Kisarawe	Msanga	Msanga	71612.4	384601.5	1,998	1998	3	Scattered	Protected Well	Not Available
Kisarawe	Msanga	Visiga	71619.3	384724.2	1,188	1188	2	Concentrated along the Road	Unprotected Spring	Not Available
Kisarawe	Msimbu	Gumba	70626	390021.6	1,385	1385	4	Clustered	Protected Well	Not Available
Kisarawe	Msimbu	Homboza	70338.5	390308.6	1,458	1458	5	Scattered	River/Stream/Pond/Dam	Not Available
Kisarawe	Msimbu	Kitanga	70302.5	390114.6	486	486	5	Scattered	Unprotected Well	Not Available
Kisarawe	Msimbu	Luhangai	70443.5	390059.6	769	769	4	Clustered	River/Stream/Pond/Dam	Not Available
Kisarawe	Msimbu	Maguruwe	70056.7	390122.8	497	497	5	Scattered	Unprotected Well	Not Available
Kisarawe	Msimbu	Msimbu	70637.6	390128.4	2,967	2967	7	Scattered	Protected Well	Not Available
Kisarawe	Mzenga	Chakenge	65542.3	384303.2	1,356	1356	2	Scattered	Unprotected Well	Not Available
Kisarawe	Mzenga	Mitengwe	65645.6	384248.4	408	408	4	Scattered	Unprotected Well	Not Available
Kisarawe	Mzenga	Mzenga 'A'	65605	384306.9	1,163	1163	2	Scattered	Unprotected Well	Not Available
Kisarawe	Mzenga	Vilabwa	65848.5	384311.2	197	197	3	Clustered	Unprotected Well	Not Available
Kisarawe	Vihingo	Chamalale	65307	384242	149	149	0	Scattered	Unprotected Well	Not Available
Kisarawe	Vihingo	Kibwemwenda	65220.5	384837.1	740	740	3	Clustered	Unprotected Well	Not Available
Kisarawe	Vihingo	Mihugwe	65330.3	383939	310	310	2	Clustered	Unprotected Well	Not Available
Kisarawe	Vihingo	Mzenga 'B'	65438.1	383909.4	1,231	1231	2	Scattered	Unprotected Well	Not Available
Kisarawe	Vihingo	Sangwe	65254.8	384444.7	741	741	4	Clustered	Unprotected Well	Not Available
Kisarawe	Vihingo	Vihingo	65815.6	383709.2	340	340	0	Scattered	Unprotected Well	Not Available
Kisarawe	Vikumburu	Kitonga	72650.4	383416.1	420	420	2	Scattered	Unprotected Well	Not Available
Kisarawe	Vikumburu	Koresa	72643.7	383707.9	689	689	3	Scattered	Unprotected Well	Not Available
Kisarawe	Vikumburu	Mtunani	72716.1	383703.8	504	504	2	Concentrated along the Road	Unprotected Well	Not Available

Table 1.3 Results of Village Inventory Survey (3/4)

District	Ward	Name of Target Villages	Long.	Lat.	Population (2002)	Served population in the study area (2002)	No. of Sub-Villages	Dwelling Type of Community	Major Water Source	Electricity
Kisarawe	Vikumburu	Pangala Mwingereza	72342.2	383703.4	778	778	3	Concentrated along the Road	Unprotected Well	Not Available
Kisarawe	Vikumburu	Vikumbulu	72618.9	383553.7	1484	1484	4	Clustered	Unprotected Well	Not Available
	Sub-Total (Kisarawe District)				**93,042**	**85,787**				
Mkuranga	Bupu	Bupu	71201.9	390131	1,435	1,435	4	Scattered	River/Stream/Pond/Dam	Not Available
Mkuranga	Bupu	Mamndikongo	70948	390333	1,421	1,421	4	Scattered	Unprotected Well	Not Available
Mkuranga	Bupu	Mandimpela	71105	390413	1,820	1,820	2	Scattered	Unprotected Well	Not Available
Mkuranga	Bupu	Tundu	71333	390339	1,416	1,416	4	Clustered	Unprotected Well	Not Available
Mkuranga	Kimanzichana	Kilimahewa	72307.3	390539.9	3,256	3,256	7	Clustered	Unprotected Well	Not Available
Mkuranga	Kimanzichana	Kimanzichana Kas.	72116	390358	1,006	1,006	3	Scattered	Unprotected Well	Not Available
Mkuranga	Kimanzichana	Kimanzichana Kus.	72201	390355	13,700	13,700	6	Concentrated	Unprotected Well	Not Available
Mkuranga	Kimanzichana	Kimbwinindi	71940	390420	3,250	3,250	4	Scattered	Protected Well	Not Available
Mkuranga	Kimanzichana	Mkenge	71752	390606	2,393	2,393	5	Scattered	River/Stream/Pond/Dam	.
Mkuranga	Kisiju	Binga	71612	391402	1,832	1,832	4	Clustered	Unprotected Well	Not Available
Mkuranga	Kisiju	Dondo	71851	391605	1,189	1,189	5	Clustered	River/Stream/Pond/Dam	Not Available
Mkuranga	Kisiju	Kalole	72119	391730	2,350	1,198	3	Clustered	Unprotected Well	Available
Mkuranga	Kisiju	Kerekese	72010	391814	2,800	2,800	3	Scattered	Borehole	Not Available
Mkuranga	Kisiju	Mpafu	71809	391941	665	665	0	Clustered	Unprotected Well	Not Available
Mkuranga	Kisiju	Sotele	71819	391401	1,917	1,917	3	Clustered	Unprotected Well	Not Available
Mkuranga	Kitomondo	Kikoo	72032	3990841	2,395	2,395	3	Clustered	River/Stream/Pond/Dam	Not Available
Mkuranga	Kitomondo	Kitomondo	71656	391202	1,799	1,799	4	Scattered	Unprotected Well	Not Available
Mkuranga	Kitomondo	Kiwambo	71812	390926	1,969	1,969	4	Clustered	Unprotected Well	Not Available
Mkuranga	Kitomondo	Mingombe	71830	391212	992	992	3	Scattered	Unprotected Well	Not Available
Mkuranga	Kitomondo	Mitaranda	71714	71554	1,552	1,552	2	Scattered	River/Stream/Pond/Dam	Not Available
Mkuranga	Kitomondo	Miteza	72157	390951.4	1,819	1,819	3	Clustered	Unprotected Well	Not Available
Mkuranga	Kitomondo	Njia Nne	72154	391124	6,788	6,788	8	Clustered	Unprotected Well	Not Available
Mkuranga	Lukanga	Lukanga	72840	390920	1,983	1,983	6	Clustered	Unprotected Well	Not Available
Mkuranga	Lukanga	Misasa	72859	391132	2,196	2,196	7	Clustered	River/Stream/Pond/Dam	Not Available
Mkuranga	Lukanga	Mkola	72634	391129	1,107	1,107	5	Scattered	Unprotected Well	Not Available
Mkuranga	Lukanga	Njopeka	73004	390831	6,611	6,611	6	Scattered	River/Stream/Pond/Dam	Not Available
Mkuranga	Lukanga	Sangalani	72613	391318	1,678	1,678	3	Scattered	River/Stream/Pond/Dam	Not Available
Mkuranga	Magawa	Kifumangao	73047	391558	681	681	3	Clustered	Unprotected Well	Not Available
Mkuranga	Magawa	Magawa	72724	391529	4,524	4,524	5	Scattered	River/Stream/Pond/Dam	Not Available
Mkuranga	Magawa	Mdini	72534	391735	1,648	1,648	4	Clustered	Unprotected Well	Not Available
Mkuranga	Magawa	Msonga	72513	391544	1,197	1,197	3	Scattered	River/Stream/Pond/Dam	Not Available
Mkuranga	Magawa	Mtongani	72353	391409	591	591	3	Concentrated along the Road	Unprotected Well	Not Available
Mkuranga	Magawa	Nasibugani	72331.7	391518.9	979	97	3	Clustered	Unprotected Well	Not Available
Mkuranga	Magawa	Nyamihimbo	72350	391249	889	889	4	Clustered	Unprotected Well	Not Available
Mkuranga	Magawa	Sangasanga	72149	391414	1,006	1,006	5	Scattered	Unprotected Well	Not Available
Mkuranga	Mkuranga	Dundani	70356	391348	1,577	1,577	5	Clustered	Unprotected Well	Available
Mkuranga	Mkuranga	Hoyoyo	70432	391042	3,320	3,320	4	Clustered	Unprotected Well	Not Available
Mkuranga	Mkuranga	Kibululu	70901	390831	1,005	1,005	3	Concentrated	Unprotected Well	Not Available
Mkuranga	Mkuranga	Kiparang'anda'A'	70918	391044	4,321	4,321	6	Scattered	Unprotected Well	Not Available
Mkuranga	Mkuranga	Kiparang'anda'B'	71042	391010	2,065	2,065	5	Scattered	Unprotected Well	Not Available
Mkuranga	Mkuranga	Kise	70715.7	391216.2	674	674	5	Scattered	Unprotected Well	Not Available
Mkuranga	Mkuranga	Kolangwa	70812.1	390631.3	500	500	4	Scattered	Unprotected Well	Not Available
Mkuranga	Mkuranga	Magoza	70753	390652	2,220	2,220	6	Clustered	Unprotected Well	Not Available
Mkuranga	Mkuranga	Mkuranga	70644	391157	4,583	2,823	6	Scattered	Unprotected Well	Available
Mkuranga	Mkuranga	Mkwalia	70752.5	391255.6	1,961	1,072	3	Scattered	Unprotected Well	Available
Mkuranga	Mkuranga	Sunguvuni	70650	391584	989	989	3	Clustered		Not Available
Mkuranga	Mkuranga	Tengelea	70553	390942	2,845	2,845	5	Clustered	River/Stream/Pond/Dam	Not Available
Mkuranga	Mwalusembe	Bigwa	71421	390903	2,098	2,098	4	Concentrated along the Road	Unprotected Well	Not Available
Mkuranga	Mwalusembe	Kitonga	71315	391010	1,500	1,500	4	Scattered	Unprotected Spring	Not Available
Mkuranga	Mwalusembe	Kiziko	71151	390740	1,286	1,286	3	Concentrated	Unprotected Well	Not Available
Mkuranga	Mwalusembe	Mwalusembe	71617	390823	5,886	5,886	5	Clustered	River/Stream/Pond/Dam	Not Available
Mkuranga	Nyamato	Kilmba	72723	390155.1	1,280	1,280	2	Scattered	Unprotected Well	Not Available
Mkuranga	Nyamato	Kilimahewa Kusini	72329	390537	1,920	1,920	4	Clustered	River/Stream/Pond/Dam	Not Available
Mkuranga	Nyamato	Mkiu	72707	390725	3,742	3,742	4	Clustered	River/Stream/Pond/Dam	Not Available
Mkuranga	Nyamato	Mvuleni	72538.1	390533	1,886	1,886	3	Clustered	Unprotected Well	Not Available
Mkuranga	Nyamato	Nyanduturu	72456	390637	1,668	1,668	4	Clustered	Unprotected Well	Not Available
Mkuranga	Nyamato	Tipo	72900	390114	1,997	1,997	3	Concentrated	Unprotected Well	Not Available
Mkuranga	Tambani	Dondwe	70439	390550	1,951	1,951	4	Scattered	Unprotected Well	Not Available
Mkuranga	Tambani	Kibamba	70501	391531	1,095	1,095	6	Scattered	Unprotected Well	Not Available
Mkuranga	Tambani	Mipeko	70109.9	391309.7	1,418	1,418	3	Scattered	River/Stream/Pond/Dam	Not Available
Mkuranga	Tambani	Mlamleni	65907	391444	2,318	2,318	10	Scattered	Unprotected Well	Not Available
Mkuranga	Tambani	Mwanadilatu	70215.8	391005.1	1,560	1,560	6	Scattered	River/Stream/Pond/Dam	Not Available
Mkuranga	Tambani	Mwanambaya	70300	391423	2,466	2,466	7	Scattered	Unprotected Well	Available
Mkuranga	Tambani	Tambani	65954	391117	1,538	1,538	5	Scattered	Unprotected Well	Not Available
Mkuranga	Vikindu	Kipala	67534.9	391704.2	2,029	2,029	3	Scattered	Unprotected Well	Available
Mkuranga	Vikindu	Kisemvule	70159	391659	2,260	2,260	4	Scattered	Unprotected Well	Not Available
Mkuranga	Vikindu	Malela	70616	391916	1,250	1,250	3	Clustered	Unprotected Well	Not Available
Mkuranga	Vikindu	Morogoro	70529.1	392232.8	1,500	1,500	5	Clustered	Unprotected Well	Not Available
Mkuranga	Vikindu	Mfurumwambao	70458	392249	1,435	1,435	4	Clustered	Unprotected Well	Not Available
Mkuranga	Vikindu	Mkokozi	65815.4	392049.9	1,769	1,769	4	Scattered	River/Stream/Pond/Dam	Not Available

Table 1.3 Results of Village Inventory Survey (4/4)

District	Ward	Name of Target Villages	Long.	Lat.	Population (2002)	Served population in the study area (2002)	No. of Sub-Villages	Dwelling Type of Community	Major Water Source	Electricity
Mkuranga	Vikindu	Vianzi	70247.5	392015.1	2,625	2,625	6	Scattered	Unprotected Well	Available
Mkuranga	Vikindu	Vikindu	70018.4	391825.3	5,125	5,125	10	Scattered	Unprotected Well	Available
Mkuranga	Vikindu	Yavayava	70724	392200	1,830	1,830	4	Scattered	Unprotected Well	Not Available
	Sub-Total (Mkuranga District)				**165,946**	**161,263**				
	Total (Coast Regionn)				**460,463**	**391,648**				
Ilala	Chanika	Buyuni	65720	390604	6,544	6,544	4	Scattered	Unprotected Well	Not Available
Ilala	Chanika	Chanika	65904	390529	13,906	13,906	8	Scattered	Unprotected Well	Not Available
Ilala	Chanika	Majohe	65451	390824	3,122	3,122	3	Scattered	River/Stream/Pond/Dam	Available
Ilala	Ilala	Shariff Shamba	64935	391519	6,708	6,708	0	Concentrated	Borehole	Available
Ilala	Kinyerezi	Kinyerezi	65043	390913	5,811	5,811	3	Scattered	Unprotected Well	Available
Ilala	Kipawa	Kipunguni	65307	391122	19,275	19,275	0	Concentrated	Unprotected Well	Available
Ilala	Kitunda	Kitunda	65408	391154	23,424	23,424	4	Scattered	Unprotected Well	Available
Ilala	Msongola	Msongola	64459	391406	3,668	3,668	4	Scattered	Unprotected Well	Not Available
Ilala	Msongola	Mvuti	70147	390724	4,108	4,108	5	Scattered	River/Stream/Pond/Dam	Not Available
Ilala	Pugu	Pugu Kajiungeni	65405	390713	7,821	3,850	3	Scattered	Unprotected Well	Available
Ilala	Pugu	Pugu Station	65309	390721	7,139	1,998	3	Scattered	Unprotected Well	Available
Ilala	Segerea	Amani	65005	391228	4,238	4,238	0	Concentrated	Borehole	Available
Ilala	Segerea	Kimanga Darajani	64935	391250	19,270	19,270	0	Concentrated	Borehole	Available
Ilala	Segerea	Kisukula	64942	391118	4,151	4,151	0	Concentrated	Unprotected Well	Available
Ilala	Segerea	Tembomgwaza	64948	391127	6,239	6,239	0	Concentrated	Unprotected Well	Available
Ilala	Tabata	Matumbi	64922	391347	4,304	4,304	0	Concentrated	Borehole	Available
Ilala	Tabata	Tabata	65016	391124	9,239	9,239	0	Concentrated	Borehole	Available
Ilala	Tabata	Tenge	64953	391307	4,750	4,750	0	Concentrated	Borehole	Available
Ilala	Ukonga	Gongo la Mboto	65257	390943	20,470	20,470	0	Concentrated	Unprotected Well	Available
Ilala	Ukonga	Guluka Kwalala	65312	390823	12,978	12,978	0	Concentrated	River/Stream/Pond/Dam	Available
Ilala	Ukonga	Markaz	65336	390954	4,279	4,279	0	Concentrated	Unprotected Well	Available
Ilala	Ukonga	Mongo la Ndege	65345	391022	3,698	3,698	0	Scattered	Borehole	Available
Ilala	Ukonga	Mwembe Madafu	65232	391028	27,648	27,648	0	Concentrated	Unprotected Well	Available
Ilala	Ulongoni	Ulongoni	65234	390950	3,680	3,680	0	Concentrated	Unprotected Well	Not Available
	Sub-Total (Ilala Municipality)				**226,470**	**217,358**				
Kinondoni	Bunju	Mabwepande	63908	390502	3,100	3,100	0	Scattered	City Water/DAWASA	Not Available
Kinondoni	Bunju	Mbopo	64116	390637	1,868	1,868	0	Clustered	Unprotected Well	Not Available
Kinondoni	Goba	Kulangwa	64337	390828	1,220	1,220	0	Scattered	River/Stream/Pond/Dam	Not Available
Kinondoni	Goba	Matosa	64420	390826	25,144	25,144	0	Scattered	River/Stream/Pond/Dam	Not Available
Kinondoni	Kawe	Changanyikeni	64610	391136	17,000	17,000	0	Concentrated	Water Vender	Available
Kinondoni	Kibamba	Kibwegere	64510	390257	3,000	3,000	0	Scattered	Unprotected Well	Available
Kinondoni	Kibamba	Kwembe	64915	390453	7,600	7,600	0	Scattered	Unprotected Well	Available
Kinondoni	Kimara	Kimara Baruti	64707	391132	14,584	14,584	0	Concentrated	Borehole	Available
Kinondoni	Kimara	Mavurunza	64817	391000	3,974	3,974	0	Concentrated	Water Vender	Available
Kinondoni	Kunduchi	Madala	64116	390812	8,932	8,932	0	Scattered	Unprotected Well	Available
Kinondoni	Mbezi	Mbezi-Luis	64659	390702	20,079	20,079	0	Concentrated	Protected Well	Available
Kinondoni	Mbezi	Mpiji Magohe	64345	390359	2,723	2,723	0	Scattered	Unprotected Well	Not Available
Kinondoni	Mbezi	Msakuzi	64507	390529	2,797	2,797	0	Scattered	Unprotected Well	Not Available
Kinondoni	Mbezi	Msumi	64240	390626	1,330	1,330	0	Scattered	Unprotected Well	Not Available
	Sub-Total (Kinondoni Municipality)				**113,351**	**113,351**				
Temeke	Chamazi	Msufini	65655.7	391345	6,427	6,427	0	Scattered	Unprotected Well	Not Available
Temeke	Charambe	Kibangulile	65538	391626	12,500	12,500	0	Concentrated	River/Stream/Pond/Dam	Available
Temeke	Kimbiji	Kizito Huonjwa	65925.8	393139.6	1,096	1,096	6	Concentrated	River/Stream/Pond/Dam	Not Available
Temeke	Makangarawe	Makangarawe	65302.9	391435.5	10,400	10,400	0	Concentrated	Borehole	Available
Temeke	Makangarawe	Yombo Dovya	65232.5	391502.6	15,881	15,881	0	Concentrated	Borehole	Available
Temeke	Mbagala	Kingugi	65412.2	391451.4	4,663	4,663	0	Concentrated	River/Stream/Pond/Dam	Available
Temeke	Mbagala Kuu	Mbagala kuu	65232.5	391502.8	11,540	11,540	0	Concentrated	Borehole	Available
Temeke	Mbagala Kuu	Mgeni Nani	65402.5	391744.5	7,020	7,020	0	Concentrated	River/Stream/Pond/Dam	Not Available
Temeke	Mjimwema	Kibugumo	65158.7	392207.7	1,883	1,883	0	Concentrated	Unprotected Well	Not Available
Temeke	Mjimwema	Mjimwema	65023.6	392112.4	5,670	5,670	0	Concentrated	Unprotected Well	Available
Temeke	Pemba Mnazi	Tundwi Songani	70409.7	393158.9	2,204	2,204	0	Scattered	River/Stream/Pond/Dam	Not Available
Temeke	Pembamnazi	Yale Yale Puna	70549	393157	3,321	3,321	4	Clustered	River/Stream/Pond/Dam	Not Available
Temeke	Tandika	Magurwe	65156.4	391514.1	6,599	6,599	5	Concentrated	Borehole	Available
Temeke	Tandika	Nyambwera	65217.1	391515	4,402	4,402	0	Concentrated	Borehole	Available
Temeke	Tandika	Tamla	65159.3	391526.3	5,814	5,814	0	Concentrated	Borehole	Available
Temeke	Tuangoma	Kongowe	65713.1	391701.4	3,165	3,165	0	Concentrated	River/Stream/Pond/Dam	Available
Temeke	Vijibweni	Kibene	65329.4	392020	751	751	0	Concentrated	River/Stream/Pond/Dam	Not Available
Temeke	Vijibweni	Kisiwani	65108.4	391923.3	1,060	1,060	0	Concentrated	Protected Well	Not Available
Temeke	Vijibweni	Mkwajuni	65130.2	391932.9	997	997	0	Concentrated	Protected Well	Not Available
Temeke	Vijibweni	Vijibweni	65139.5	391837.5	1,800	1,800	0	Concentrated	Protected Well	Not Available
Temeke	Yombo Vituka	Machimbo	65238.3	391401.3	15,421	15,421	0	Concentrated	Borehole	Available
Temeke	Yombo Vituka	Sigara	65314.3	391305.4	8,024	8,024	0	Concentrated	Borehole	Available
Temeke	Yombo Vituka	Yombo Vituka	65208.1	391350.4	11,499	11,499	0	Concentrated	Borehole	Available
Sub-Total (Temeke Municipality)					**142,137**	**142,137**				
Total (Dar es Salaam Regionn)					**481,958**	**472,846**				
Grand Total (Study Area)					**942,421**	**864,494**				

Chapter 2

Meteorology and Hydrology

CHAPTER 2 METEOROLOGY AND HYDROLOGY

2.1 GENERAL

Meteorological and hydrological analysis is carried out by using collected existing data. Macro water balance of the area is examined to determine the potential recharge of the groundwater. Potential for the surface water is calculated to determine the potential amount for water supply using surface water.

Objectives of the study are:

- To analyze a potential groundwater recharge from rainwater, from the viewpoints of topography, rainfall and runoff,
- To analyze a potential amount and area of surface water from the viewpoint of discharge and actual intake amount, as a result,
- To provide basic information for the surface water developing plan as a source of water supply.

2.2 METEOROLOGY

2.2.1 RAINFALL AND METEOROLOGICAL STATIONS IN THE STUDY AREA

There are 79 rainfall gauging stations in the Study Area, 57 in Coast region and 22 in Dar es Salaam region. Among them, seven stations measures temperature, and two stations measures temperature, humidity, radiation and wind in addition to the rainfall as Meteorological station.

Considering the data availability and the location, 13 stations were selected in and around the Study Area for the Meteorological analysis. *Table 2.1* shows the inventory of the stations and collected data and *Figure 2.1* shows the location. These data were collected from the Tanzania Meteorological Agency.

2.2.2 GENERAL METEOROLOGICAL CONDITION OF THE STUDY AREA

(1) Annual Rainfall

Average annual total rainfall is shown in Table 2.2 and its distribution is shown in *Figure 2.1*.

Table 2.2 Average Annual Total Rainfall

Unit: mm

No.	1	2	3	4	5	6	7	8	9	10	11	12	13
Station Name	Dar es Salaam International Airport	Kibaha agromat	Bagamoyo Salt mines	Ubena Prison	Ubena Zomozi	Kisarawa	Utete Bomani	Bagamoyo Bomani	Mandera Mission	Nghesse (Utari bridge)	Vikindu Forest	Mikula (Magogoni)	Mkuranga
Station Code	9639029	9638027	9638020	9638028	9638033	9639043	9838002	9638000	9638004	9738009	9739015	9738016	9739022
Annual Total Rainfall (mm)	1143.9	1002.3	942.4	1015.5	875.9	1529.9	849.7	983.2	992.2	921.8	1094.3	766.9	1141.3

Annual total rainfall varies greatly by the station. It ranges from 849.7 mm of Utete Bomani to 1529.9 of Kisarawe even in the Study Area.

Average annual total rainfall over the Study Area is calculated at 1036.0 mm using GIS.

(2) Monthly Rainfall

Variation in average monthly rainfall at all the selected stations averaged over the period when data is collected is shown in *Figure 2.2*. Rainfall patterns are similar in all the stations though annual total rainfall varies by the station. Maximum rainfall occurs in the month of April in all stations, and minimum rainfall occurs in the month of September in nine stations, July in three stations and August in one station.

Table 2.1 Inventory of Meteorological Stations and Collected Data

No.	Station Name	Station Code	Latitude	Longitude	Elevation (m)	Rainfall	Temp	Humidity	Wind	Sunshine	Radiation	Evaporation
1	Dar es Salaam International Airport	9639029	-6.87	39.20	53.0	1981-2003	1981-2003	1981-2003	1981-2000	1981-2003	1983-1993	1969-2003 except 1982-84
2	Kibaha Agromet	9638027	-6.83	38.97	167.0	1981-2003	1981-2003	–	–	1981-2003	–	–
3	Bagamoyo Salt Mines	9638020	-6.42	38.90	0.0	1981-2003	–	–	–	–	–	–
4	Ubena Prison	9638028	-6.62	38.08	305.0	1981-2003 except 1986, 94, 97-99	–	–	–	–	–	–
5	Ubena Zomozi	9638033	-6.62	38.17	(300)*	1981-2003 except 1984-85, 2001, 03	–	–	–	–	–	–
6	Kisarawa	9639043	-6.90	39.07	274.0	1981-2003	–	–	–	–	–	–
7	Utete Bomani	9838002	-8.02	38.75	52.0	1981-2003	–	–	–	–	–	–
8	Bagamoyo Bomani	9638000	-6.42	38.92	9.0	1981-2003	–	–	–	–	–	–
9	Mandera Mission	9638004	-6.22	38.38	213.0	1981-2003 except 1991, 93, 98-99	–	–	–	–	–	–
10	Nghesse (Utari bridge)	9738009	-7.05	38.37	91.0	1981-2003 except 1991, 95-96, 98, 2000, 02-03	–	–	–	–	–	–
11	Vikindu Forest	9739015	-7.33	39.30	91.0	1981-2003 except 1986-91, 93-2003	–	–	–	–	–	–
12	Mikula (Magogoni)	9738016	-7.25	38.25	(600)*	1981-2003, except 1992, 95-96, 99-2000, 02-03	–	–	–	–	–	–
13	Mkuranga	9739022	-7.18	39.15	(100)*	1981-2003, except 1981-83, 85-86	–	–	–	–	–	–

Remark: *: This figure is estimated from the map

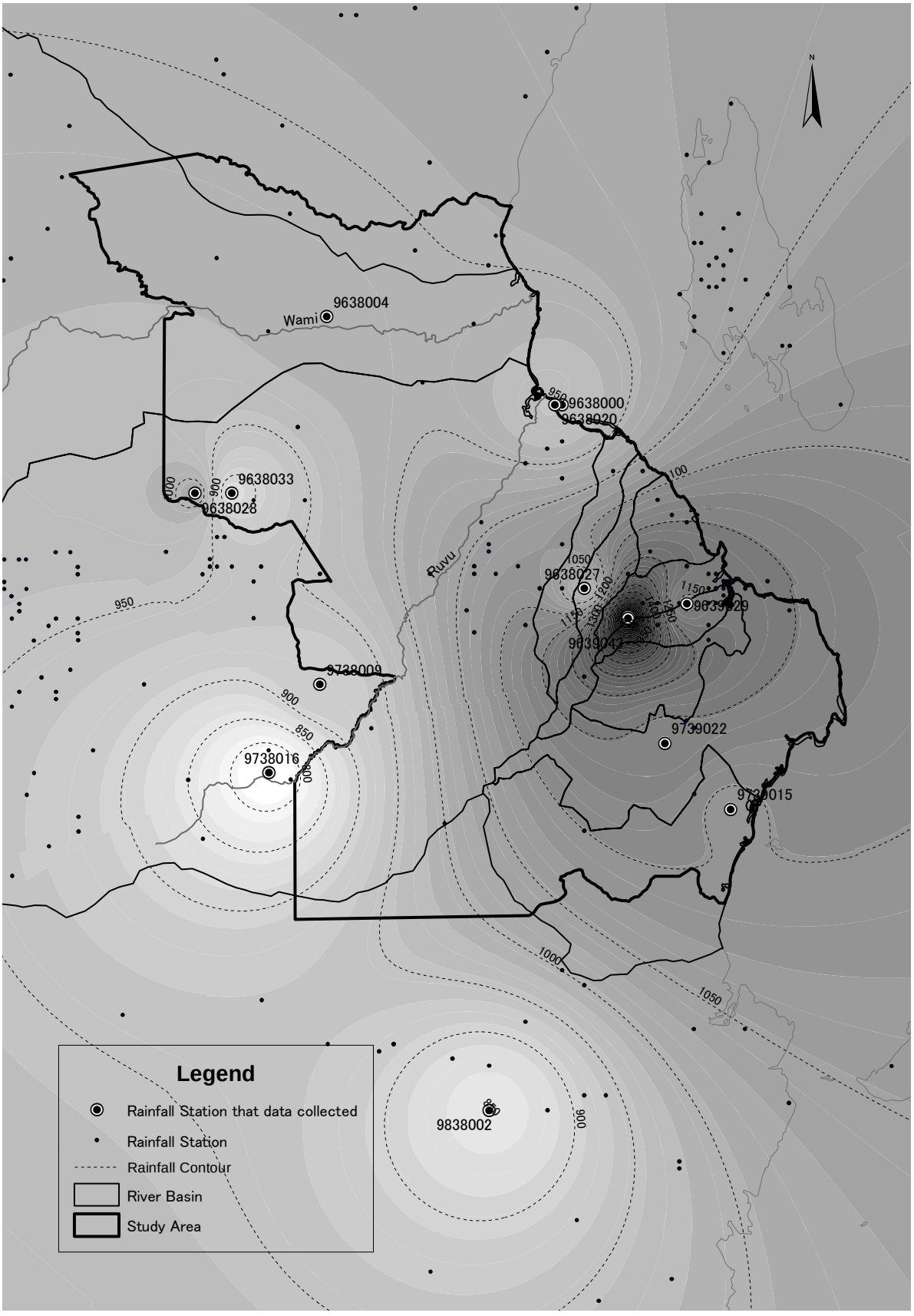


FIGURE 2.1 METEOROLOGICAL STATIONS AND ANNUAL RAINFALL DISTRIBUTION

THE STUDY ON WATER SUPPLY IMPROVEMENT IN COAST & DAR ES SALAAM | **JICA**

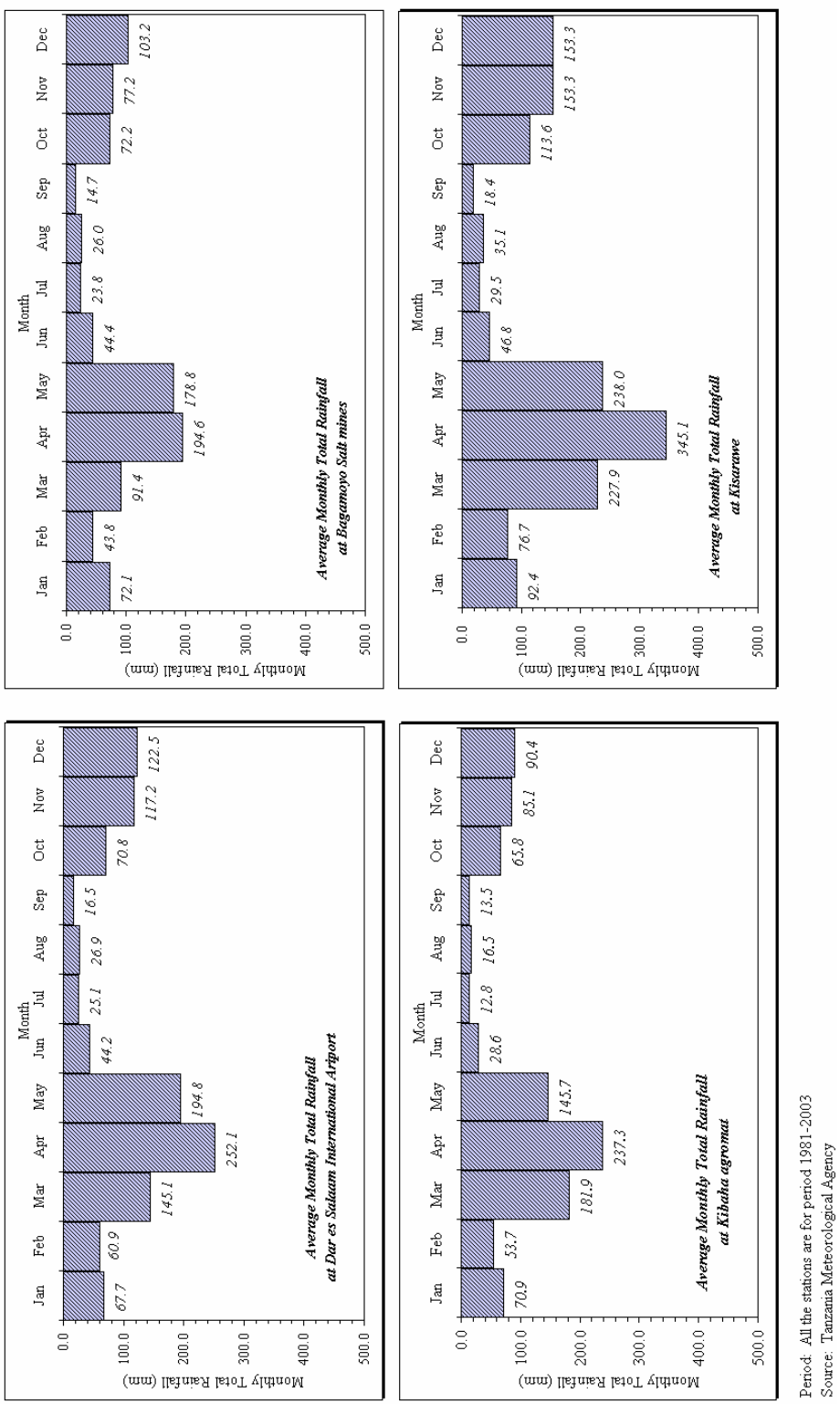


FIGURE 2.2 (1) MONTHLY VARIATION IN RAINFALL AND EVAPORATION

THE STUDY ON WATER SUPPLY IMPROVEMENT IN COAST & DAR ES SALAAM

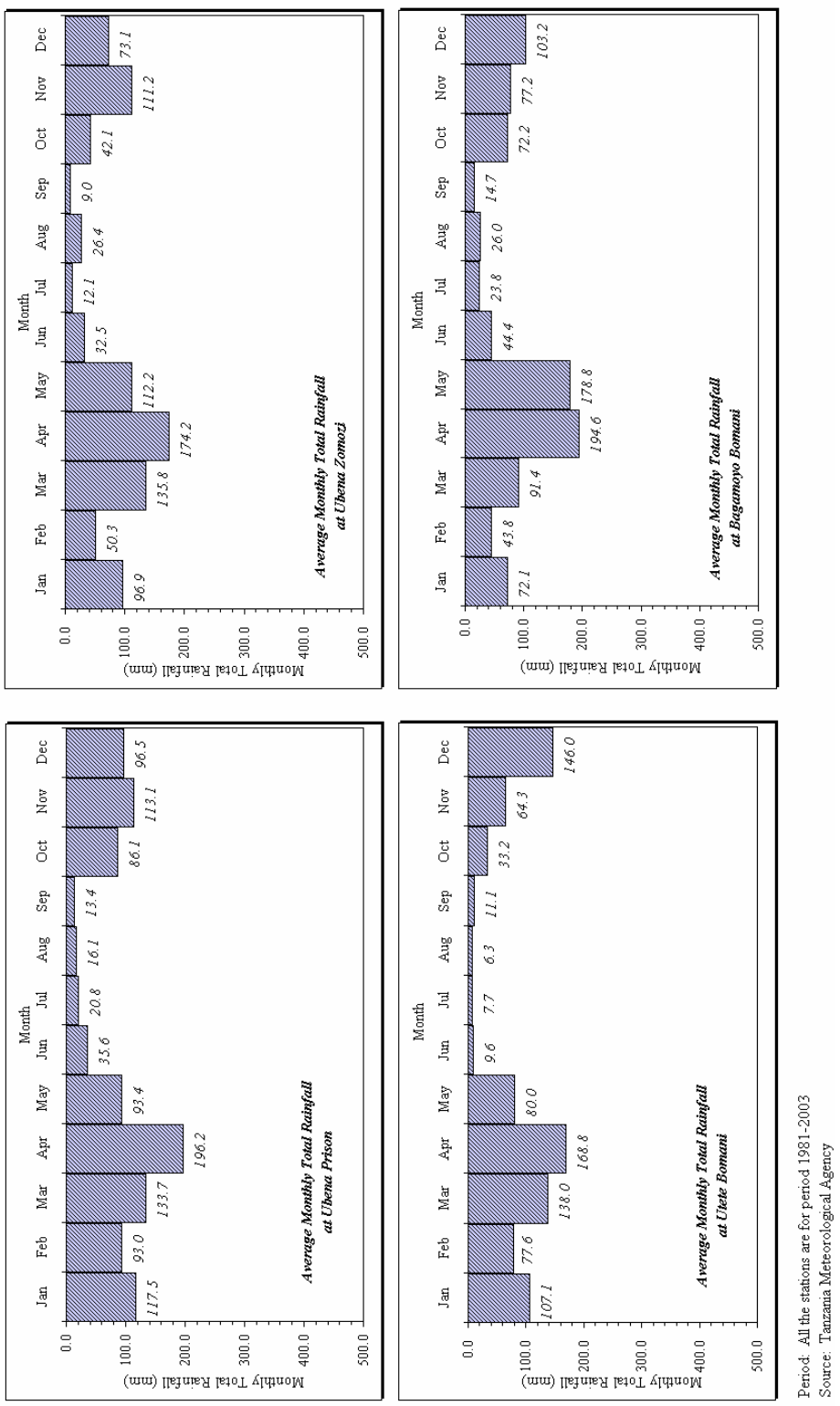


FIGURE 2.2 (2) MONTHLY VARIATION IN RAINFALL AND EVAPORATION

THE STUDY ON WATER SUPPLY IMPROVEMENT IN COAST & DAR ES SALAAM

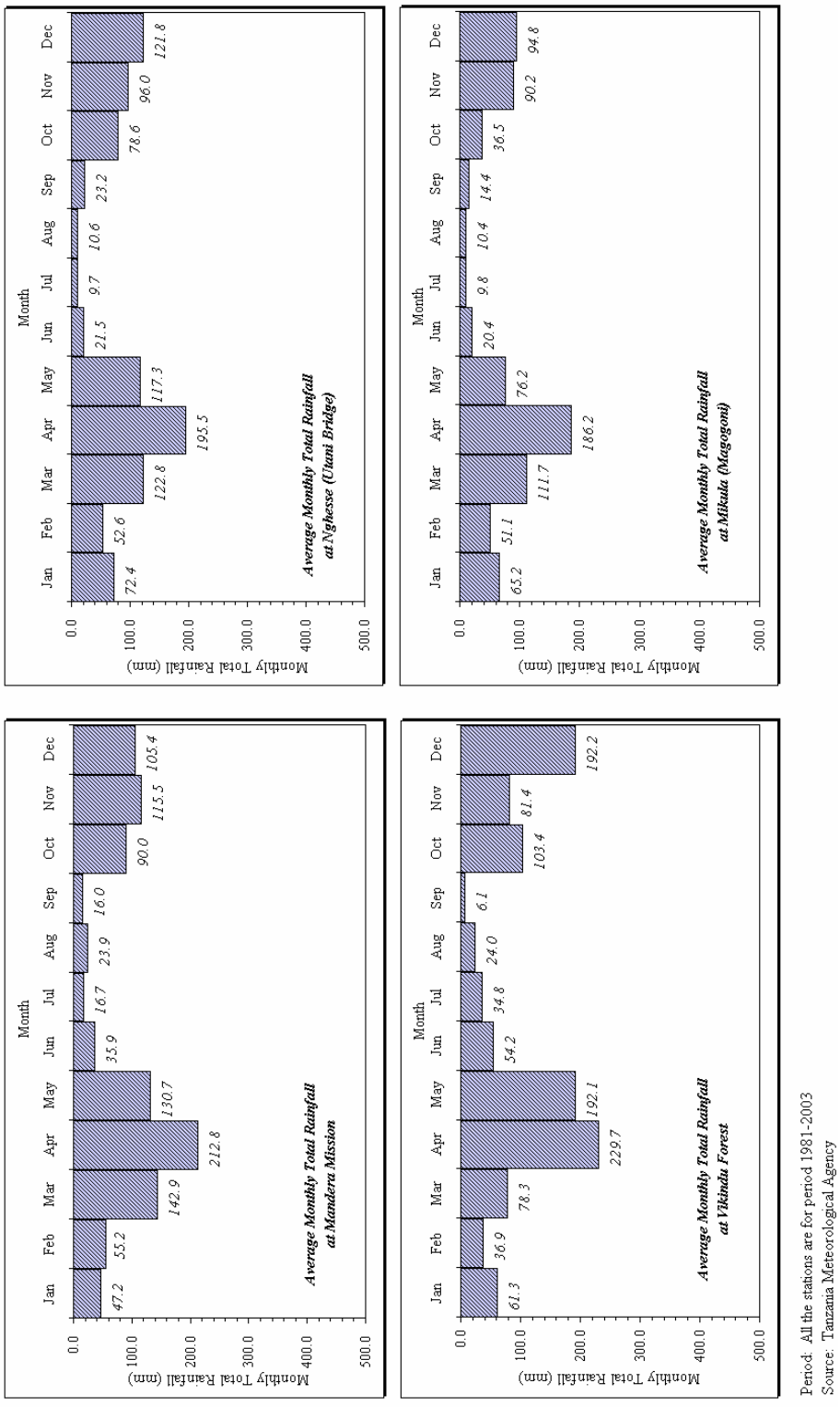
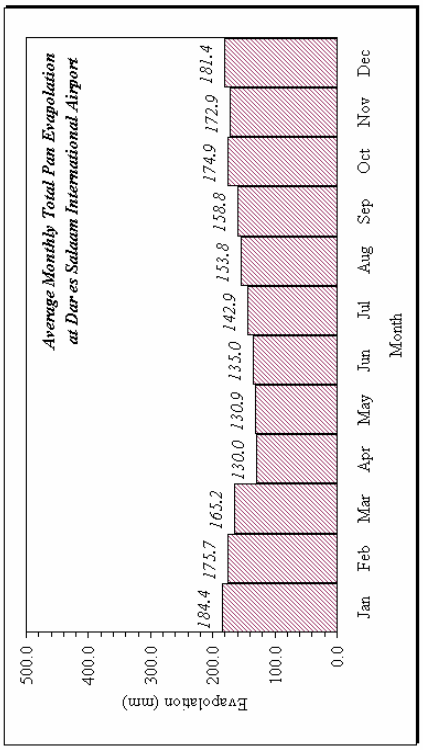
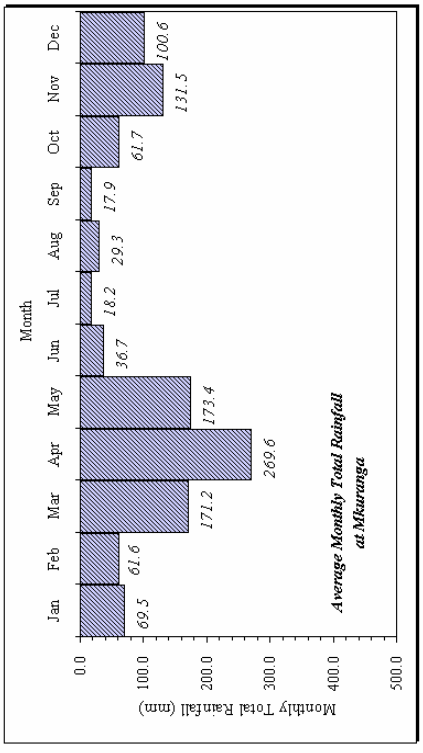


FIGURE 2.2 (3) MONTHLY VARIATION IN RAINFALL AND EVAPORATION

THE STUDY ON WATER SUPPLY IMPROVEMENT IN COAST & DAR ES SALAAM





Period: All the stations are for period 1981-2003
Source: Tanzania Meteorological Agency

FIGURE 2.2 (4) MONTHLY VARIATION IN RAINFALL AND EVAPORATION

THE STUDY ON WATER SUPPLY IMPROVEMENT IN COAST & DAR ES SALAAM

(3) Monthly Pan Evaporation

Daily pan evaporation is measured only at Dar es Salaam International Airport. Variation in average monthly pan evaporation at Dar es Salaam International Airport over the period 1981-2003 is shown in *Figure 2.2*. Mean annual total pan evaporation is calculated at 1,906 mm. Maximum pan evaporation occurs in the month of January (184 mm) and then in the months of December (181 mm) and February (176 mm).

(4) Monthly Temperature

Variation in monthly minimum, average and maximum temperature at Dar es Salaam International Airport and Kibaha Agromet stations averaged over the period 1981-2003 is shown in *Figure 2.3.* Average monthly minimum and maximum temperatures are observed in the months of August (18.3°C) and February (32.5°C) at Dar es Salaam International Airport, and in the months of August (18.9°C) and February (32.3°C) at Kibaha Agromet, respectively. Annual average temperature at Dar es Salaam International Airport and Kibaha Agromet are the same value of 26.0°C with small monthly variation.

(5) Monthly Relative Humidity

Relative humidity is measured only at Dar es Salaam International Airport. Variation in monthly average relative humidity of 0600GMT and 1200GMT at Dar es Salaam International Airport averaged over the period 1981-2003 is shown in *Figure 2.3.* Average monthly minimum and maximum relative humidity of 1200GMT are observed in the months of August-September (55%) and April (72%), respectively. Annual average relative humidity is 62%.

(6) Monthly Sunshine

Variation in monthly average sunshine at Dar es Salaam International Airport and Kibaha Agromet stations averaged over the period 1981-2003 is shown in *Figure 2.4*. Annual average sunshine at Dar es Salaam International Airport and Kibaha Agromet is 7.7 and 7.3 hours, respectively.

Radiation is measured only at Dar es Salaam International Airport Station. Variation in monthly average radiation is shown in *Figure 2.4.* Annual average radiation averaged over the period 1983-1993 is calculated at 551.3 mjm-2.

(7) Monthly Wind Velocity

Variation in monthly average wind velocity at Dar es Salaam International Airport averaged over the period 1981-2000 is shown in *Figure 2.4.* Annual average wind velocity at Dar es Salaam International Airport is calculated at 4.6 m.

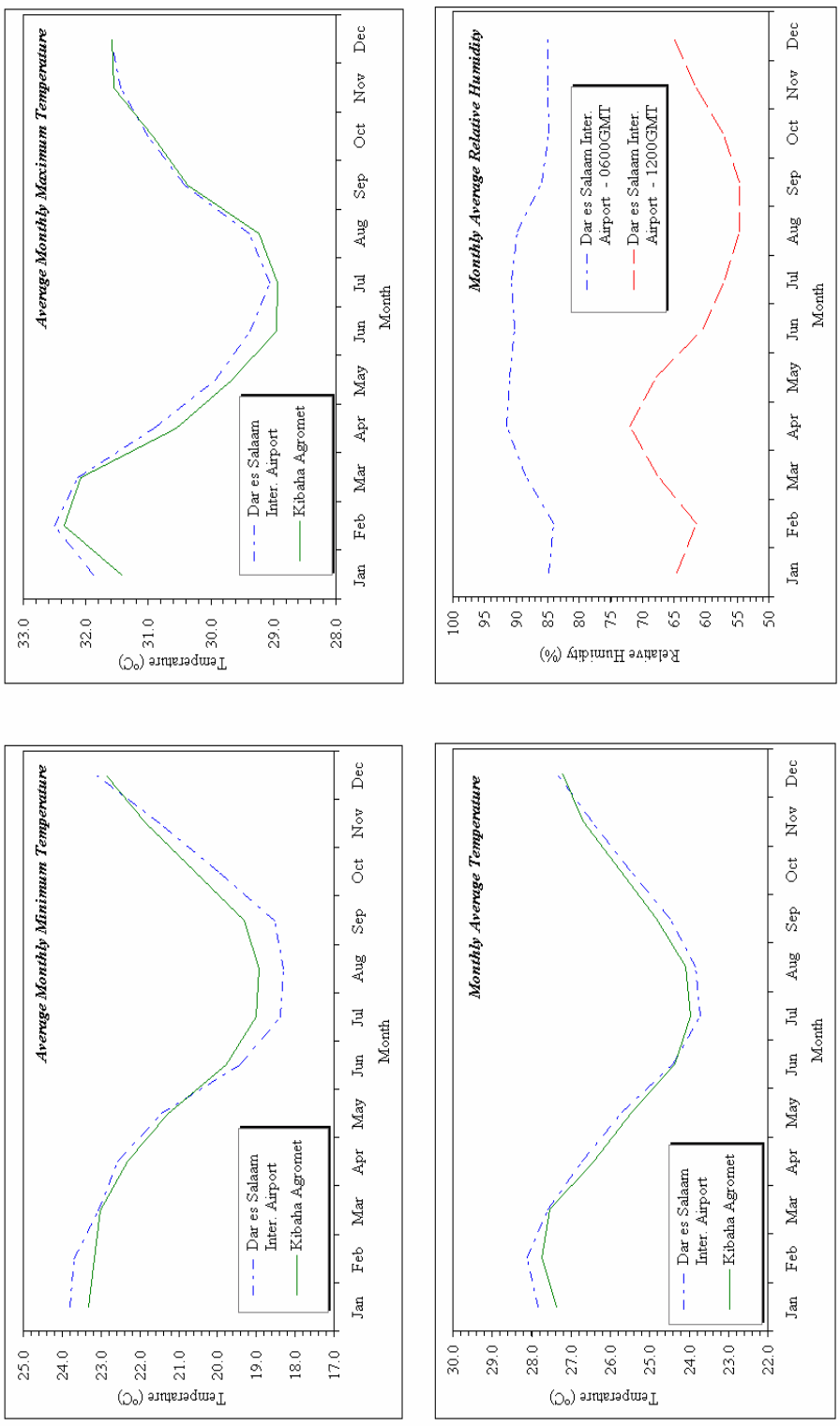
2.3 RIVER SYSTEM AND HYDROLOGICAL STATIONS

2.3.1 RIVER SYSTEM

(1) River System in Tanzania

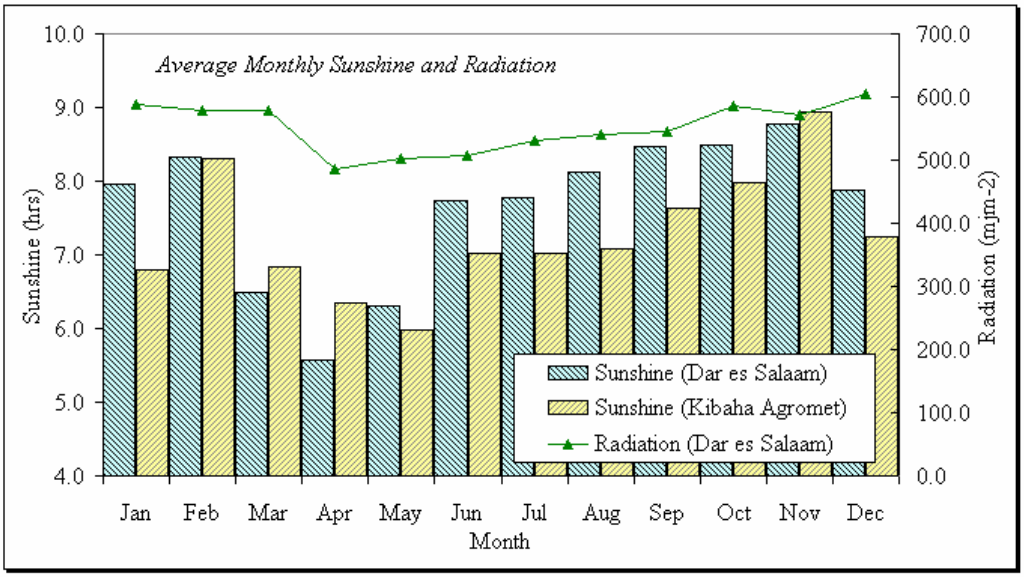
Tanzania is divided into nine major river basins as shown in *Figure 2.5* and as listed below:

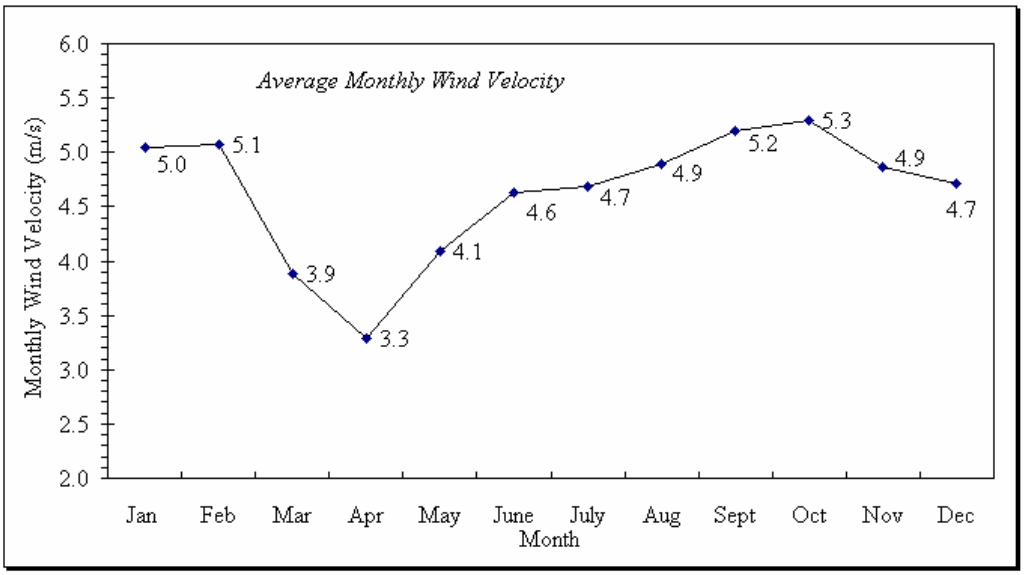
- Lake Victoria basin
- Lake Tanganyika basin
- Internal drainage basin
- Pangani basin
- Wami and Ruvu basin
- Lake Rukwa Basin



Period: All the data is for period 1981-2003
Source: Tanzania Meteorological Agency

FIGURE 2.3 MONTHLY VARIATION IN TEMPERATURE AND RELATIVE HUMIDITY





Period: Sunshine is for period 1981-2003, Radiation is for 1983-1993, Wind velicith is for 1981-2000
Source: Tanzania Meteorological Agency

FIGURE 2.4 MONTHLY VARIATION IN SUNSHINE, RADIATION AND WIND VELOCITY

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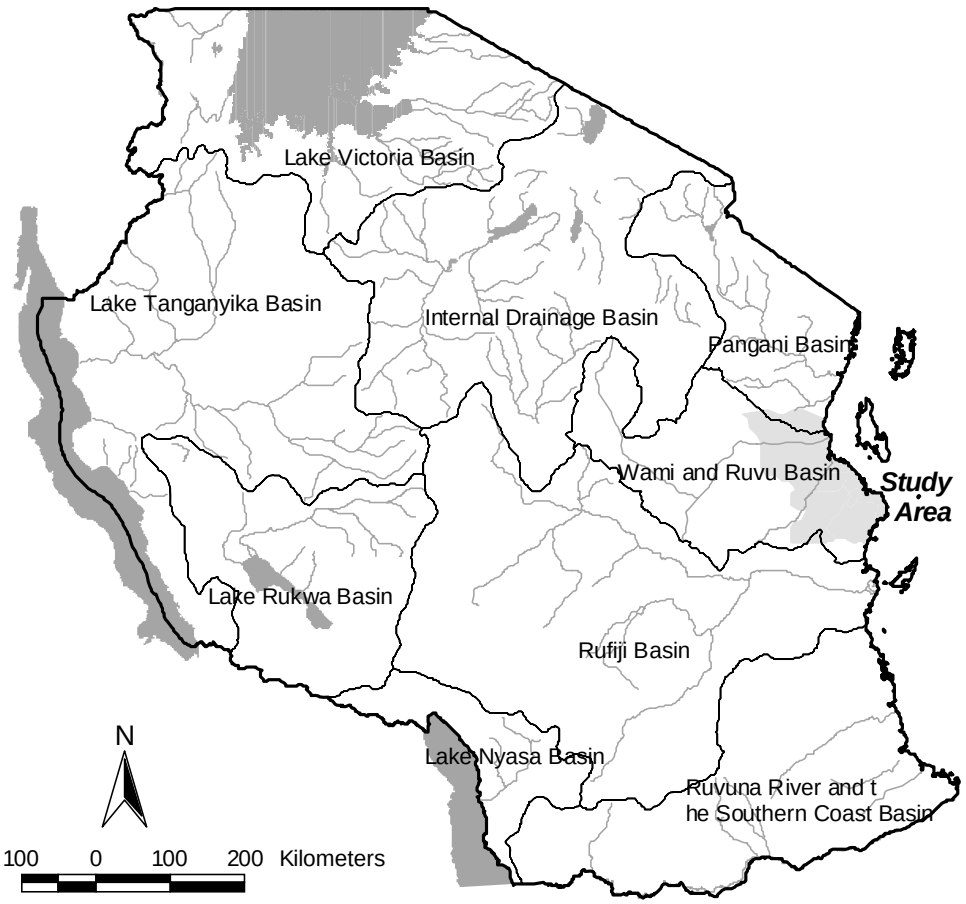

FIGURE 2.5 RIVER SYSTEM IN TANZANIA

THE STUDY ON WATER SUPPLY IMPROVEMENT IN COAST & DAR ES SALAAM | **JICA**

- Rufiji basin
- Lake Nyasa basin
- Ruvuma river and the Southern coast basin

Almost all the Study Area is included in Wami and Ruvu basin.

(2) River System in the Study Area

Study Area contains three major river basins, Pangani, Wami and Ruvu, and Rufiji basin. Wami and Ruvu basin is divided into two river basins, namely Wami, and Ruvu basin. In addition, Ruvu basin includes basin that Ruvu river itself streams, and small river basins where are located in west side of Ruvu basin and along the ocean.

In this Study, Hydrological analysis is conducted by the small river basins.

Table 2.3 shows the characteristic of the river basins in the Study Area and these locations are shown in *Figure 2.6.*

Table 2.3 Characteristics of the River Basins

Basin Name	River Name	Area (km^2)	Average Elevation (m)
Pangani	Tributary of Pangani	957	246.5
Wami	Wami	3749	285.1
Ruvu	Ruvu	8202	143.7
Coast R1	Mkuza, Kerege	518	140.7
Coast R2	Mpiji	489	168.6
Coast R3	Mbezi	312	77.7
Coast R4	Msimbo	319	115.4
Coast R5	Kizinga	249	88.9
Coast R6	Mzinga	615	109.5
Coast R7	Mbezi, Mbele, Ukooni	2128	80.5
Coast R8	Luhute, Luhule	1553	104.1
Rufiji	Tributary of Rufiji	723	150.0

2.3.2 HYDROLOGICAL STATIONS IN THE STUDY AREA

There are 38 stream gauging stations in the Study Area and Wami and Ruvu basin. Among them, seven stations are located in the Study Area. Considering the data availability and the location, seven stations were selected in and around the Study Area for the Hydrological analysis. An inventory on stream gauging stations in and around the Study Area, and data availability is presented in *Table 2.4*. Almost all the station has not been maintained after collapse of 1980's and measure has not been conducted. Location of the stations is shown in *Figure 2.6*.

2.4 METEO-HYDROLOGICAL ANALYSIS AND WATER BALANCE CONSIDERATION

2.4.1 GENERAL

Meteo-Hydrological analysis is carried out by using collected existing data. As for Hydrological Analysis, digital data collected through this Study is basically used and insufficient part was supplemented by the data from "Hydrological Year-Book 1950-1959, 1959-1965, 1965-1970, 1971-1980" of Ministry of Water.

2.4.2 DISCHARGE MEASUREMENT

The aim of discharge measurement in this Study is to confirm the reliability of the data, which have been measured by Ministry of Water and Livestock Development (hereinafter referred as

Table 2.4 Inventory of Hydrological Stations and Collected Digital Data

No.	Station Code	River	Location	Elevation (m)	Established Date	Basin Area (km^2)	Water Level		Calculated Discharge		Discharge Measurement		Remark
							From	To	From	To	From	To	
1	1H8**	Ruvu	Morogoro Rd.Br	15	1958/11/18	15190.0	11-Dec-58	30-Jun-90	11-Dec-58	31-Dec-80	30-Dec-58	8-Mar-89	Study Area
2	1H10**	Ruvu	Mikula	80	1965/11/8	5870.0	23-Aug-66	30-Sep-88	23-Aug-66	29-Feb-80	23-Aug-66	23-Aug-84	
3	1HA1A	Ngerengere	U/S Utari Br	No data	1966/1/30	2840.0	16-Mar-80	31-Oct-90	No data	No data	28-Jan-66	30-Mar-85	
4	1HA15*	Ngerengere	Mgude	No data	1968/10/15	2370.0	14-Oct-68	31-Dec-75	14-Oct-68	31-Mar-79	14-Oct-68	4-Jun-92	
5	1G1**	Wami	Dakawa	380	1953/11/14	28488.0	14-Nov-53	30-Sep-88	14-Nov-53	31-Dec-78	22-Oct-53	23-Mar-83	
6	1G2**	Wami	Mandera	168	1954/6/9	36450.0	9-Jun-54	31-Mar-85	9-Jun-54	31-Dec-78	9-Jun-54	27-Apr-84	Study Area
7	1J5*	Kizinga	Mbagala/Buza	No data	1966/7/8	192.0	8-Jul-66	30-Jun-76	No data	No data	8-Jul-66	8-Apr-94	
8	1J6*	Mzinga	Majimatitu	No data	1967/1/27	411.0	19-Apr-67	31-May-96	18-Apr-67	30-Sep-79	4-Apr-67	4-Apr-94	Study Area
9	1J7	Mbezi	Bigwa D/S	No data	1967/2/16	371.0	17-Feb-67	30-Sep-77	No data	No data	12-May-67	22-May-85	Study Area
10	1J8	Lake Manze	Mkenge	No data	1967/3/9	(Lake)	No data	No data	No data	No data	No data	No data	Study Area
11	1J9A	Mzinga	Kichemichemi	No data	1980/2/29	514.0	No data	No data	No data	No data	No data	No data	Study Area
12	1J10	Uvimba	Kibada	No data	1975/3/3	6.7	No data	No data	No data	No data	No data	No data	Study Area

Source: Ministry of Water and Livestock Development

Note *: Stations selected for Hydrological analysis

**: Stations selected for Hydrological analysis, which discharge measument is conducted

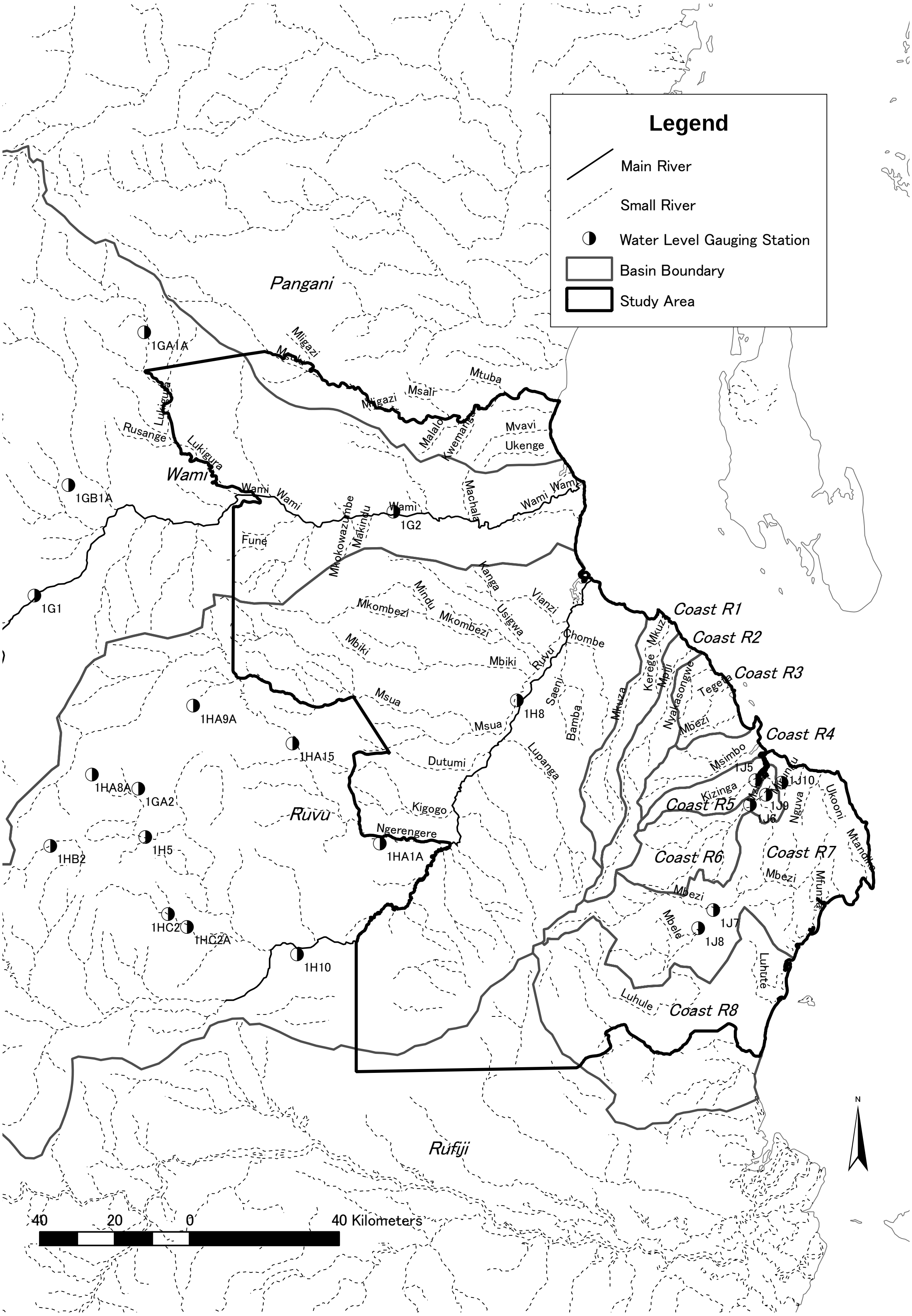

FIGURE 2.6 RIVER SYSTEM, BASIN AND HYDROLOGICAL STATIONS	
THE STUDY ON WATER SUPPLY IMPROVEMENT IN COAST & DAR ES SALAAM	**JICA**

"MoWLD"). Therefore, measuring sites are selected among the stations at which MoWLD conducted or conducts the water level and discharge measurement. After the sedulous discussion with the counterpart, four water level gauging station along the mainstreams of Wami and Ruvu river are selected as shown in *Table 2.4* and discharge measurement is conducted.

Location of the selected stations is shown in *Figure 2.6*.

Table 2.5 shows the results of measurement and comparison of calculated discharge using measuring results and rating curve, which is estimated from the past data.

Table 2.5 Results of Measurement and Comparison of Calculated Discharge

Station Code	Name of Station	Measured Date	Water Level (m)	Calculated Discharge (m^3/s)		Comparison (%) B/A
				Measuring Results A	Rating Curve B	
1H8	Ruvu Bridge	Nov. 23, '04	1.48	15.110	13.610	90.1
1H10	Mikula	Nov. 15, '04	1.20	20.011	16.175	80.8
1G1	Wami at Dakawa	Nov. 28, '04	0.59	2.032	2.221	109.3
1G2	Wami at Mandera	Nov. 22, '04	1.07	5.118	10.140	198.1

Discharge using measuring results and rating curve shows acceptable correlation except 1G2. Chalinze Water Supply facility was constructed and is operating at just downstream of 1G2. Therefore, site condition may have changed and/or pump operation may influence the measuring.

From the result of 1H8, 1H10 and 1G1, it can be judged that the past data is available for applying to hydrological analysis in this Study. Continuous measurement should be conducted for getting and improving the rating curve, however, because site condition may change like 1G2.

The equation and coefficient of rating curve used for the calculation is shown in *Table 2.6*.

Table 2.6 Equation and Coefficient of Raring Curve

Q = A*H^B+C

Station Code	Name of Station	Available Period	Coefficient			L.W.L (m)	R (%)
			A	B	C		
1H8*	Ruvu Bridge	86-89	6.72828	1.79702	-	6.11	88.5
			0.00151	6.27380	50	8.00	96.4
1H10*	Mikula	66-84	11.448	1.896	-	8.00	98.0
1G1	Wami at Dakawa	73-83	5.525	1.7275	-	4.50	94.2
			0.7526	3.0529	-	5.10	90.3
1G2	Wami at Mandera	81-84	7.5061	4.4451	-	2.50	98.3

Note 1) *: Rating curve of this station is from the result of "Study on Water Resources Development in the Ruvu River Basin," (Japan International Cooperation Agency, June 1994)

2) L.W.L: Limit water level

2.4.3 WATER BALANCE CONSIDERATION

Based on the collected data the overall water balance analysis for the Study Area is executed. The water balance can be described in the condensed form as:

$$W_r = W_{et} + W_{sr} + W_{re}$$

Where,

W_r : ***Average Rainfall (mm/year,)***

W_{et} : ***Evapo-transpiration (mm/year),***

W_{sr} : ***Surface Runoff (mm /year),***

W_{re} : ***Recharge to Groundwater (mm /year),***

In this consideration, the water balance is analyzed in each river basin within the Study area through the following process:

1. Rainfall analysis

   Total average annual rainfall is calculated using GIS

2. Evapo-transpitration analysis

   Average annual evapo-transpiration is calculated in Thornthwaite equation using the temperature and sunshine data of Dar es Salaam and Kibaha agromet stations and average elevation of each basin obtained by GIS.

3. Runoff analysis

   Specific discharge is calculated by using long-term average annual discharge. As for the basins, which discharge data have not recorded, specific discharge of neighboring basin is used as the value of relevant basin.

4. Potential recharge amount to the groundwater

Potential recharge amount to the groundwater is calculated using above investigation results.

Table 2.7 shows the result of above analysis and *Figure 2.7* shows the potential recharge to the groundwater by basins. Potential recharge amount to the groundwater by district is calculated using the result of basins as shown in *Table 2.8* and *Figure 2.8*.

Table 2.7 Result of Water Balance Analysis by Basins

Basin Name	Average Rainfall (mm/year) A	Average Evapo-transpiration (mm/year) B	Average Runoff (mm) C	Potential Recharge to Groundwater (mm) D=A-(B+C)	Percentage of Recharge to Groundwater D/A (%)
Pangani	999.2	761.1	53.0	185.1	18.5
Wami	985.8	747.1	53.0	185.7	18.8
Ruvu	989.2	798.6	135.6	55.0	5.6
Coast R1	1093.9	799.7	82.5	211.7	19.4
Coast R2	1144.2	789.5	82.5	272.2	23.8
Coast R3	1152.8	822.6	82.5	247.7	21.5
Coast R4	1267.1	808.9	82.5	375.7	29.7
Coast R5	1256.5	818.5	82.5	355.4	28.3
Coast R6	1206.9	811.0	96.7	299.1	24.8
Coast R7	1137.6	821.6	96.7	219.3	19.3
Coast R8	1085.7	813.0	96.7	176.0	16.2
Rufiji	986.7	796.3	96.7	93.7	9.5

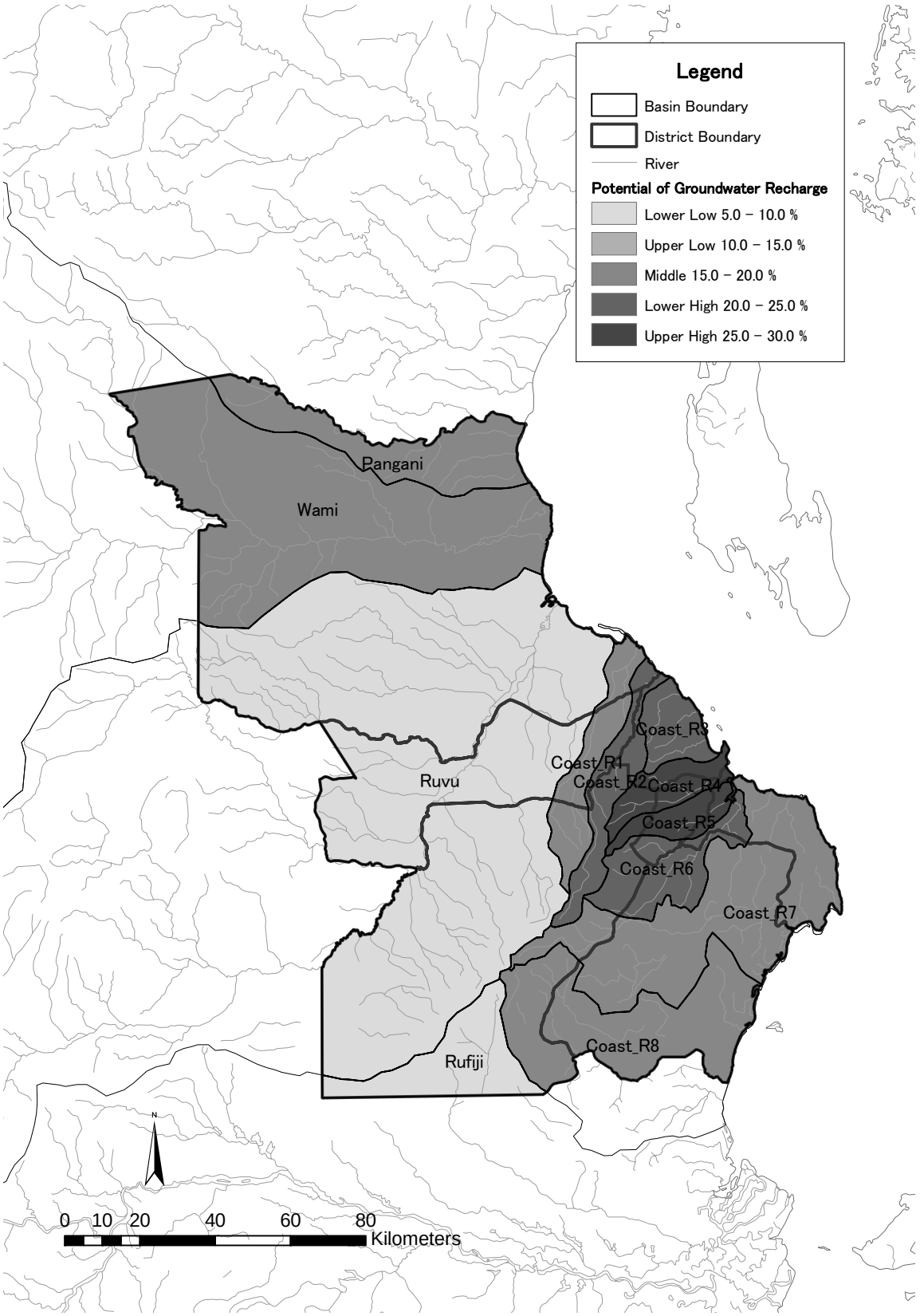

FIGURE 2.7 POTENTIAL RECHARGE TO THE GROUNDWATER BY BASINS

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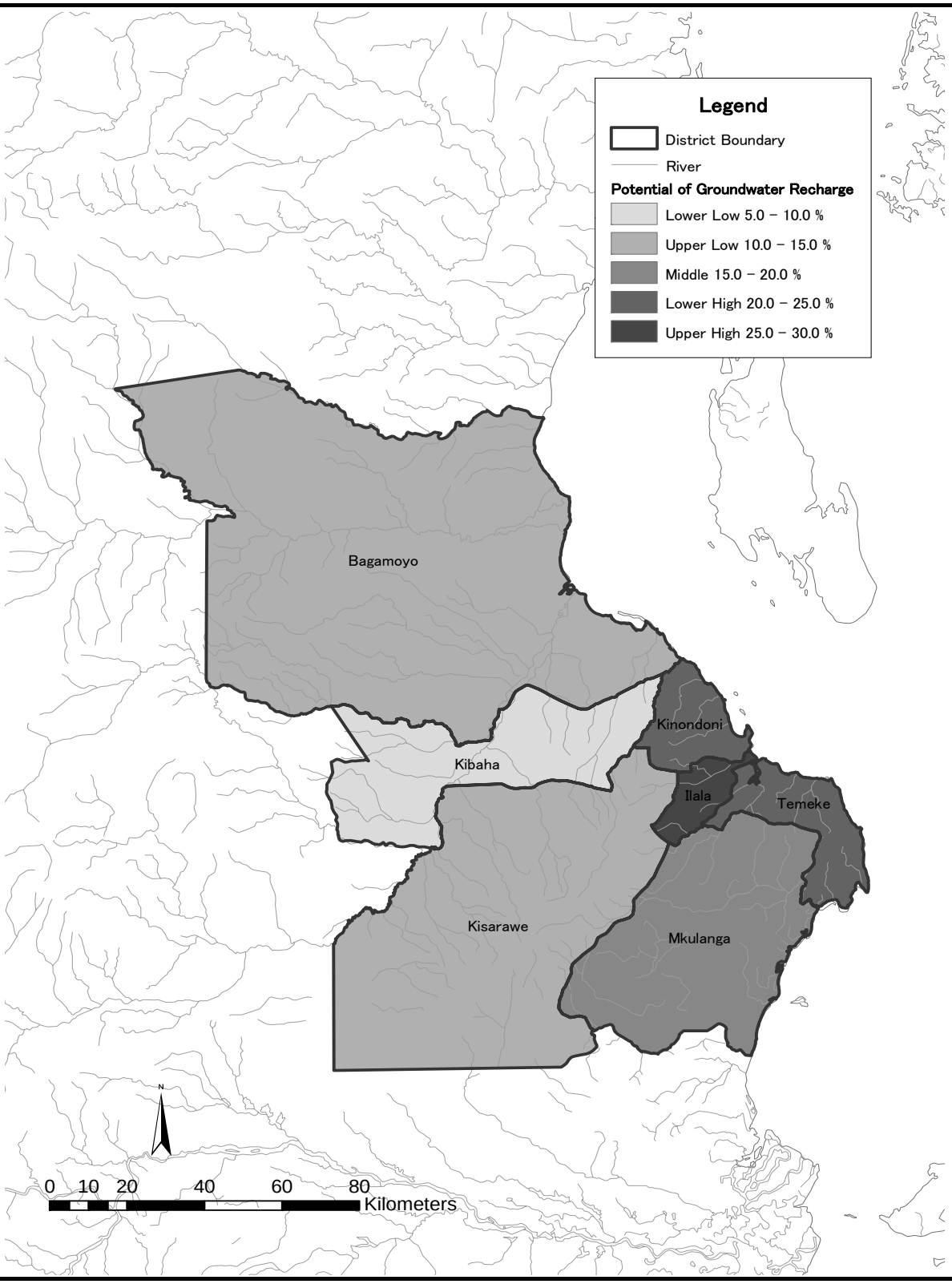

FIGURE 2.8 POTENTIAL RECHARGE TO THE GROUNDWATER BY DISTRICT

THE STUDY ON WATER SUPPLY IMPROVEMENT IN COAST & DAR ES SALAAM | **JICA**

Table 2.8 Result of Water Balance Analysis by District

Districr Name	Average Rainfall (mm/year) A	Average Evapo-transpiration (mm/year) B	Average Runoff (mm) C	Potential Recharge to Groundwater (mm) D=A-(B+C)	Percentage of Recharge to Groundwater D/A (%)
Bagamoyo	991.0	771.9	89.3	129.8	13.1
Ilala	1249.4	813.8	85.6	349.7	28.0
Kibaha	1007.3	798.3	127.4	81.8	7.9
Kinondoni	1177.5	813.6	82.5	281.4	23.8
Kisarawe	1032.0	800.9	117.0	114.1	10.6
Mkulanga	1124.9	817.1	96.7	210.7	18.7
Temeke	1157.7	820.0	95.4	241.9	20.8

Conclusion of the water balance consideration is summarized as follows:

- Coast R1 and Coast R2 basins are considered as high potential area of recharge to groundwater. On the other hand Ruvu and Rufiji basins are considered as low potential area of it.
- Ilala district has high potential of recharge to groundwater. Kibaha district has low potential of it.

2.5 SURFACE WATER POTENTIAL FOR WATER SUPPLY

2.5.1 GENERAL

In this section, a potential amount and area of surface water development is analyzed with an aim of providing basic information for the surface water developing plan as a source of water supply.

2.5.2 SELECTION OF THE RIVER

In order to supply stable water, river as a water source should be perennial. First, perennial rivers are selected from the rivers of the Study Area.

In the result of interview survey to related persons and investigation of the past discharge data, three rivers, namely the mainstream of Wami and Ruvu, and Kizinga are confirmed as perennial river in the Study Area. Actually intake is conducted from the other rivers as described in the following section. However, they are not proper for stable water supply source because they are dried up seasonally.

Following consideration of potential amount is carried out only for selected three perennial rivers.

2.5.3 EXISTING WATER RIGHTS AND INTAKE AMOUNT OF SELECTED RIVER

With the aim of domestic water supply, industrial use and irrigation, intake of surface water and groundwater are carried out from many points. *Table 2.9 and 2.10* shows the inventory of water rights in Wami and Ruvu basin, respectively. In the table, column of “status of permit” indicates the present condition of water right as follows:

“Application” means water right is under deliberation, “Provisional” means water right is provisionally permitted and consultation is needed after several years, “Final” means water right is permitted. From Provisional stage, applicant can use water. Therefore, calculation of actual intake amount includes “Provisional” and “Final” status. When calculate the actual intake amount, the amount which water right was permitted is considered to be equivalent of actual intake amount so that the data for actual intake amount could not be obtained.

Table 2.9 Water Right in Wami River Basin (1/9)

Ser. No.	W/Right No.	Name of Applicant	Locality	Address	Quantity (l/s)	Status	Source of Water	Source Type	District	Region	Water Use
1	1947	Alibhai Panju & sons	Bagamoyo	P.O.Box	0.05	Provisional	Wami River	Surface	Bagamoyo	Coast	Industrial
2	2266	Wami& Sadani Pl.	Bagamoyo	P.O.Box	1.60	Provisional	Wami River	Surface	Bagamoyo	Coast	Industrial
3	4853	Alec F.Misangu	Morogoro	P.O.Box	50.00	Provisional	Wami River	Surface	Bagamoyo	Coast	Irrigation
4	WA 0044	DistrictExecutive Director Bagamoyo Chalinze Water Supply	Bagamoyo	P.O.Box 10036	115.70	Provisional	Wami River	Surface	Bagamoyo	Coast	Public Supply
5	1234	Yusufali M.	Bagamoyo	P.O. Box	0.10	Application	Chamkoroma River	Surface	Bagamoyo	Coast	
6	2270	Regional Officer	Bagamoyo	P.O. Box	6.30	-	Buffalo Creek	Surface	Bagamoyo	Coast	
7	2912	Tanzania Sisal Corp.	Bagamoyo	P.O. Box	0.80	Final	Tambi River	Surface	Bagamoyo	Coast	
8	4003	Bagamoyo D.Council	Bagamoyo	P.O.Box	4.30	Final	Fukayozi D	Surface	Bagamoyo	Coast	
9	CR 2	Azania Investment	Bagamoyo	P.O. Box	1363.50	Application	Mbiki River	Surface	Bagamoyo	Coast	
10	1375	Dodoma N .Auth.l	Dodoma	P.O.Box	0.28	Provisional	Borehole	Groundwater	Dodoma	Dodoma	Domestic
11	1379	David G.P.Taylor	Dodoma	P.O.Box	0.28	Provisional	Borehole	Groundwater	Dodoma	Dodoma	Domestic
12	1382	David G.P.Taylor	Dodoma	P.O.Box	0.28	Provisional	Borehole	Groundwater	Dodoma	Dodoma	Domestic
13	1855	Eng. In Charge pwd	Dodoma	P.O.Box 71	39.40	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
14	2703	Dodoma D. Council	Dodoma	P.O.Box	0.26	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
15	2704	Dodoma D. Council	Dodoma	P.O.Box	0.54	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
16	2708	Dodoma D. Council	Dodoma	P.O.Box	2.00	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
17	2710	Dodoma D. Council	Dodoma	P.O.Box	2.20	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
18	2721	Dodoma D. Council	Dodoma	P.O.Box	0.35	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
19	2722	Dodoma D. Council	Dodoma	P.O.Box	0.42	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
20	2848	DDD.Dodoma	Dodoma	P.O.Box	1085.10	Final	Makutupora	Groundwater	Dodoma	Dodoma	Domestic
21	2863	DDD.Dodoma	Dodoma	P.O.Box	1345.20	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
22	2867	DDD Dodoma	Dodoma	P.O.Box	26.60	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
23	2868	DDD.Dodoma	Dodoma	P.O.Box	2.90	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
24	2869	DDD.Dodoma	Dodoma	P.O.Box	1.20	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
25	2922	DDD.Dodoma	Dodoma	P.O.Box	1.30	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
26	2923	DDD.Dodoma	Dodoma	P.O.Box	0.80	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
27	2924	DDD.Dodoma	Dodoma	P.O.Box	2.80	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
28	2974	DDD.Dodoma	Dodoma	P.O.Box	1.60	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
29	4312	DDD.Dodoma	Dodoma	P.O.Box	1.20	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
30	4313	DDD.Dodoma	Dodoma	P.O.Box	2.30	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
31	4314	DDD.Dodoma	Dodoma	P.O.Box	1.30	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
32	DO 110	DED-Dodoma	Dodoma	P.O.Box	3.10	Provisional	Borehole	Groundwater	Dodoma	Dodoma	Domestic
33	DO 118	DED-Dodoma	Dodoma	P.O.Box 1249	2.10	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
34	DO 119	DED-Dodoma	Dodoma	P.O.Box	3.30	Provisional	Borehole	Groundwater	Dodoma	Dodoma	Domestic
35	DO 122	DED-Dodoma	Dodoma	P.O.Box	2.40	Provisional	Borehole	Groundwater	Dodoma	Dodoma	Domestic
36	DO 123	DED-Dodoma	Dodoma	P.O.Box	3.90	Provisional	Borehole	Groundwater	Dodoma	Dodoma	Domestic
37	DO 127	DED-Dodoma	Dodoma	P.O.Box	2.10	Provisional	Borehole	Groundwater	Dodoma	Dodoma	Domestic
38	DO 131	DED-Dodoma	Dodoma	P.O.Box	3.60	Provisional	Borehole	Groundwater	Dodoma	Dodoma	Domestic

Table 2.9 Water Right in Wami River Basin (2/9)

39	DO 134	Municipal Director	Dodoma	P.O.Box 1249	3.80	Provisional	Borehole	Groundwater	Dodoma	Dodoma	Domestic
40	DO 18	Catholic Diocese Dom	Dodoma	P.O.Box 922	1.70	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
41	DO 19	Catholic Diocese Dom	Dodoma	P.O.Box 922	1.30	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
42	DO 19	Catholic Diocese Dom	Dodoma	P.O.Box 922	13.60	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
43	DO 2	DDD.Dodoma	Dodoma	P.O.Box	1.60	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
44	DO 2	DDD.Dodoma	Dodoma	P.O.Box	1.50	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
45	DO 20	Catholic Diocese Dom	Dodoma	P.O.Box 922	1.50	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
46	DO 21	Catholic Diocese Dom	Dodoma	P.O.Box 922	4.30	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
47	DO 26	Catholic Diocese Dom	Dodoma	P.O.Box 922	1.10	Provisional	Borehole	Groundwater	Dodoma	Dodoma	Domestic
48	DO 27	Catholic Diocese Dom	Dodoma	P.O.Box	0.40	Final	Well	Groundwater	Dodoma	Dodoma	Domestic
49	DO 27	Catholic Diocese Dom	Dodoma	P.O Box 922	0.40	Final	Ring well	Groundwater	Dodoma	Dodoma	Domestic
50	DO 28	CatholicDiocese Dod.	Dodoma	P.O.Box 922	0.60	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
51	DO 29	CatholicDiocese Dod.	Dodoma	P.O.Box 922	1.30	Provisional	Borehole	Groundwater	Dodoma	Dodoma	Domestic
52	DO 3	Municipal Director	Dodoma	P.O.Box 1249	2.80	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
53	DO 30	CatholicDiocese Dod.	Dodoma	P.O.Box 922	4.20	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
54	DO 31	Capital Water Eng.	Dodoma	P.O.Box	12.00	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
55	DO 32	Municipal Director	Dodoma	P.O.Box1249	2.20	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
56	DO 32	Municipal Director	Dodoma	P.O.Box 1249	2.20	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
57	DO 33	Municipal Director	Dodoma	P.O.Box 1249	2.90	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
58	DO 34	Municipal Director	Dodoma	P.O.Box 1249	3.30	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
59	DO 5	DDD.Dodoma	Dodoma	P.O.Box	2.50	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
60	DO 55	Head of Hydrogeological Studies.	Dodoma	P.O.Box 412	1.30	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
61	DO 6	DDD.Dodoma	Dodoma	P.O.Box	1.40	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
62	DO 7	DDD.Dodoma	Dodoma	P.O.Box	2.60	Provisional	Borehole	Groundwater	Dodoma	Dodoma	Domestic
63	DO 95	DED-Dodoma	Dodoma	P.O.Box	2.80	Provisional	Borehole	Groundwater	Dodoma	Dodoma	Domestic
64	DSM 48	Simon Sifuel Mambali	Dodoma	P.O.Box 8831	1.90	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
65	WA 0020	DED-Dodoma	Dodoma	P.O.Box 911	1.40	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
66	WA 0022	DED-Dodoma	Dodoma	P.O.Box 1126	2.40	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
67	WA 0023	DED-Dodoma	Dodoma	P.O.Box	1.80	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
68	WA 0024	DED-Dodoma	Dodoma	P.O.Box	1.80	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
69	WA 0025	DED-Dodoma	Dodoma	P.O.Box911	2.30	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
70	WA 0026	DED-Dodoma	Dodoma	P.O.Box 1126	2.10	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
71	WA 0027	DED-Dodoma	Dodoma	P.O.Box 1126	2.10	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
72	WA 0028	DED-Dodoma	Dodoma	P.O.Box 911	2.60	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
73	WA 0029	DED-Dodoma	Dodoma	P.O.Box	1.60	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
74	WA 0031	DED-Dodoma MjelekoW/S	Dodoma	P.O.Box	3.30	Provisional	Borehole	Groundwater	Dodoma	Dodoma	Domestic
75	WA 0031	DED-Dodoma	Dodoma	P.O.Box 1126	3.30	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
76	WA 0033	DED-Dodoma	Dodoma	P.O.Box	2.40	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
77	WA 0033	DED-Dodoma	Dodoma	P.O.Box 911	2.40	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic

Table 2.9 Water Right in Wami River Basin (3/9)

Ser. No.	W/Right No.	Name of Applicant	Locality	Address	Quantity (l/s)	Status	Source of Water	Source Type	District	Region	Water Use
78	WA 0034	DED-Dodoma	Dodoma	P.O.Box	2.20	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
79	WA 0034	DED-Dodoma	Dodoma	P.O.Box 1126	2.20	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
80	WA 0035	DED-Dodoma	Dodoma	P.O.Box	1.50	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
81	WA 0035	DED-Dodoma	Dodoma	P.O.Box1126	1.50	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
82	WA 0038	Municipal Director	Dodoma	P.O.Box 1249	3.80	Final	Borehole	Groundwater	Dodoma	Dodoma	Domestic
83	2195	Ikowa Farm	Dodoma	P.O. Box	4.50	Provisional	Mbiki River	Surface	Dodoma	Dodoma	
84	2867	DDD.Dodoma	Dodoma	P.O.Box	2.70	Application	Borehole	Groundwater	Dodoma Rural	Dodoma	Domestic
85	211	Prov.Vet.off.Central	Dodoma	P.O.Box	0.10	Application	Borehole	Groundwater	Dodoma U	Dodoma	Domestic
86	212	Prov.Vet.off.Central	Dodoma	P.O.Box	0.10	Final	Borehole	Groundwater	Dodoma U	Dodoma	Domestic
87	215	Prov.Vet.off.Central	Dodoma	P.O.Box	0.26	Application	Borehole	Groundwater	Dodoma U	Dodoma	Domestic
88	217	District Eng.EAR	Dodoma	P.O.Box	0.53	Application	well	Groundwater	Dodoma U	Dodoma	Domestic
89	218	District Eng.EAR	Dodoma	P.O.Box	0.53	Application	Borehole	Groundwater	Dodoma U	Dodoma	Domestic
90	219	District Eng.EAR	Dodoma	P.O.Box	0.53	Application	Borehole	Groundwater	Dodoma U	Dodoma	Domestic
91	1350	David G.P.Taylor(DodomaNative)	Dodoma	P.O.Box	0.06	Application	Borehole	Groundwater	Dodoma U	Dodoma	Domestic
92	WA 0045	StevenA.Smasangia	Dodoma	P.O Box 3252	0.09	Final	Borehole	Groundwater	Dodoma U	Dodoma	Domestic
93	WA 0046	Srs of Mary Immaculate	Miyuyi	P.O.Box 1348	2.00	Final	Borehole	Groundwater	Dodoma U	Dodoma	Domestic
94	WA 0047	M/S Salesian Seminar	Miyuyi	P.O.Box 2079	0.97	Final	Borehole	Groundwater	Dodoma U	Dodoma	Domestic
95	WA 0048	DonBosco Tech Institute	Miyuyi	P.O.Box 964	0.63	Final	Borehole	Groundwater	Dodoma U	Dodoma	Domestic
96	WA 0049	Franciscan Capuchin Friars	Miyuyi Mbwanga	P.O.Box 1522	0.28	Final	Borehole	Groundwater	Dodoma U	Dodoma	Domestic
97	WA 0050	Dodoma Urban Water	Makutupora Basin	P.O.Box 431	38.00	Final	Borehole	Groundwater	Dodoma U	Dodoma	Domestic
98	WA 0051	Dodoma Urban Water	Makutupora Basin	P.O.Box 431	63.10	Final	Borehole	Groundwater	Dodoma U	Dodoma	Domestic
99	WA 0052	Dodoma Urban Water	Makutupora Basin	P.O.Box 431	63.10	Final	Borehole	Groundwater	Dodoma U	Dodoma	Domestic
100	WA 0053	Dodoma Urban Water	Makutupora Basin	P.O.Box 431	126.30	Final	Borehole	Groundwater	Dodoma U	Dodoma	Domestic
101	WA 0054	Dodoma Urban Water	Makutupora Basin	P.O. Box 431	38.00	Final	Borehole	Groundwater	Dodoma U	Dodoma	Domestic
102	WA 0056	Dodoma Urban Water	Dodoma	P.O.Box 431	25.20	Final	Borehole	Groundwater	Dodoma U	Dodoma	Public Supply
103	WA 0057	Dodoma Urban Water	Dodoma	P.O.Box 431	14.10	Final	Borehole	Groundwater	Dodoma U	Dodoma	Public Supply
104	WA 0058	Dodoma Urban Water	Dodoma	P.O.Box 431	13.90	Final	Borehole	Groundwater	Dodoma U	Dodoma	Public Supply
105	WA 0059	Dodoma Urban Water	Dodoma	P.O.Box 431	13.90	Final	Borehole	Groundwater	Dodoma U	Dodoma	Public Supply
106	WA 0060	Dodoma Urban Water	Dodoma	P.O.Box 431	18.90	Final	Borehole	Groundwater	Dodoma U	Dodoma	Public Supply
107	WA 0061	Dodoma Urban Water	Dodoma	P.O.Box 431	26.00	Final	Borehole	Groundwater	Dodoma U	Dodoma	Public Supply
108	WA 0062	Dodoma Urban Water	Dodoma	P.O.Box 431	26.01	Final	Borehole	Groundwater	Dodoma U	Dodoma	Public Supply
109	WA 0063	Dodoma Urban Water	Dodoma	P.O.Box 431	24.44	Final	Borehole	Groundwater	Dodoma U	Dodoma	Public Supply
110	WA 0064	Dodoma Urban Water	Dodoma	P.O.Box 431	26.01	Final	Borehole	Groundwater	Dodoma U	Dodoma	Public Supply
111	WA 0065	Dodoma Urban Water	Dodoma	P.O.Box 431	26.01	Final	Borehole	Groundwater	Dodoma U	Dodoma	Public Supply
112	WA 0066	Dodoma Urban Water	Dodoma	P.O.Box 431	24.17	Final	Borehole	Groundwater	Dodoma U	Dodoma	Public Supply
113	WA 0067	Dodoma Urban Water	Dodoma	P.O.Box 431	26.01	Final	Borehole	Groundwater	Dodoma U	Dodoma	Public Supply
114	WA 0068	Dodoma Urban Water	Dodoma	P.O.Box 431	21.29	Final	Borehole	Groundwater	Dodoma U	Dodoma	Public Supply
115	WA 0069	Dodoma Urban Water	Dodoma	P.O.Box 431	26.01	Final	Borehole	Groundwater	Dodoma U	Dodoma	Public Supply
116	WA 0070	Dodoma Urban Water	Dodoma	P.O.Box 431	25.25	Final	Borehole	Groundwater	Dodoma U	Dodoma	Public Supply

Table 2.9 Water Right in Wami River Basin (4/9)

Ser. No.	W/Right No.	Name of Applicant	Locality	Address	Quantity (l/s)	Status	Source of Water	Source Type	District	Region	Water Use
117	WA 0071	Dodoma Urban Water	Dodoma	P.O.Box 431	37.88	Final	Borehole	Groundwater	Dodoma U	Dodoma	Public Supply
118	WA 0075	Assemblies of God	Dodoma	P.O.Box 70	0.42	Final	Borehole	Groundwater	Dodoma U	Dodoma	Domestic
119	WA 0076	CPPS Mission Water Pro.	Dodoma	PO.Box.1951	0.20	Application	Borehole	Groundwater	Dodoma U	Dodoma	Domestic
120	WA 0077	CPPS Mission Water Pro.	Dodoma	PO.Box.1951	0.20	Application	Borehole	Groundwater	Dodoma U	Dodoma	Domestic
121	WA 0078	CPPS Mission Water Pro.	Dodoma	PO.Box.1951	0.94	Final	Borehole	Groundwater	Dodoma U	Dodoma	Domestic
122	WA 0083	Stanslaus Mihungo	Dodoma	P.O.Box 501	0.35	Application	Borehole	Groundwater	Dodoma U	Dodoma	Domestic
123	233	District Eng.EAR	Dodoma	P.O. Box	1.10	Application	Dam	Surface	Dodoma U.	Dodoma	
124	DO 35	Municipal Director	Dodoma	P.O.Box 1249	2.20	Final	Borehole	Groundwater	Dodoma Urban	Dodoma	Domestic
125	DO 36	Municipal Director	Dodoma	P.O.Box 1249	0.53	Final	Borehole	Groundwater	Dodoma Urban	Dodoma	Domestic
126	DO 37	Municipal Director	Dodoma	P.O.Box 1249	2.50	Final	Borehole	Groundwater	Dodoma Urban	Dodoma	Domestic
127	DO 38	Municipal Director	Dodoma	P.O.Box 1249	40.00	Final	Borehole	Groundwater	Dodoma Urban	Dodoma	Domestic
128	DO 39	Municipal Director	Dodoma	P.O.Box 1249	0.51	Final	Borehole	Groundwater	Dodoma Urban	Dodoma	Domestic
129	DO 40	Municipal Director	Dodoma	P.O.Box 1249	2.70	Final	Borehole	Groundwater	Dodoma Urban	Dodoma	Domestic
130	DO 41	Municipal Director	Dodoma	P.O.Box 1250	4.50	Final	Borehole	Groundwater	Dodoma Urban	Dodoma	Domestic
131	DO 42	Municipal Director	Dodoma	P.O.Box 1249	2.50	Final	Borehole	Groundwater	Dodoma Urban	Dodoma	Domestic
132	DO 43	Municipal Director	Dodoma	P.O.Box 1249	2.40	Final	Borehole	Groundwater	Dodoma Urban	Dodoma	Domestic
133	DO 44	Municipal Director	Dodoma	P.O.Box 1249	2.40	Final	Borehole	Groundwater	Dodoma Urban	Dodoma	Domestic
134	DO 45	Municipal Director	Dodoma	P.O.Box 1249	1.60	Final	Borehole	Groundwater	Dodoma Urban	Dodoma	Domestic
135	DO 46	Municipal Director	Dodoma	P.O.Box 1249	2.50	Final	Borehole	Groundwater	Dodoma Urban	Dodoma	Domestic
136	DO 47	Municipal Director	Dodoma	P.O.Box 1249	2.30	Final	Borehole	Groundwater	Dodoma Urban	Dodoma	Domestic
137	DO 48	Municipal Director	Dodoma	P.O.Box 1249	0.55	Final	Borehole	Groundwater	Dodoma Urban	Dodoma	Domestic
138	DO 49	Municipal Director	Dodoma	P.O.Box 1249	1.70	Final	Borehole	Groundwater	Dodoma Urban	Dodoma	Domestic
139	DO 50	Municipal Director	Dodoma	P.O.Box1249	0.62	Final	Borehole	Groundwater	Dodoma Urban	Dodoma	Domestic
140	DO 51	Municipal Director	Dodoma	P.O.Box1249	0.57	Provisional	Borehole	Groundwater	Dodoma Urban	Dodoma	Domestic
141	DO 53	Municipal Director	Dodoma	P.O.Box1249	1.90	Provisional	Borehole	Groundwater	Dodoma Urban	Dodoma	Domestic
142	DO 54	Municipal Director	Dodoma	P.O.Box1249	3.20	Final	Borehole	Groundwater	Dodoma Urban	Dodoma	Domestic
143	10	Tanganyika Agr.Corp.	Mpwapwa	P.O.Box	5.30	Application	Borehole	Groundwater	Mpwapwa	Dodoma	Irrigation
144	10	Tanganyika Agr.Corp.	Mpwapwa	P.O.Box	5.40	Application	Borehole	Groundwater	Mpwapwa	Dodoma	Irrigation
145	227	Thomas Bain	Mpwapwa	P.O.Box	10.50	Provisional	Well	Groundwater	Mpwapwa	Dodoma	Irigation
146	231	M.J.W.English	Mpwapwa	P.O.Box	9.90	Application	Borehole	Groundwater	Mpwapwa	Dodoma	Irrigation
147	237	M.J.W. English	Mpwapwa	P.O.Box	10.00	Application	Borehole	Groundwater	Mpwapwa	Dodoma	Irrigation
148	1458	Diocese of Central Tanganyika	Mpwapwa	P.O.Box	1.10	Final	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
149	1468	R.F.Bain	Mpwapwa	P.O.Box	3.90	Application	Borehole	Groundwater	Mpwapwa	Dodoma	Irrigation
150	1469	R.F.Bain	Mpwapwa	P.O.Box	0.32	Final	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
151	1711	Tanganyika Agr. Corp.	Mpwapwa	P.O.Box	3.70	Application	Borehole	Groundwater	Mpwapwa	Dodoma	Irrigation
152	1712	Tanganyika Agr.Corp.	Mpwapwa/Kongwa	P.O.Box	0.70	Final	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
153	1713	Tanganyika Agr.Corp.	Mpwapwa/Kongwa	P.O.Box	No data	Final	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
154	1714	Tanganyika Agr.Corp.	Mpwapwa/Kongwa	P.O.Box	0.70	Final	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
155	1715	Tanganyika Agr. Corp.	Mpwapwa	P.O.Box	0.32	Final	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
156	1716	Tanganyika Agr.Corp.	Mpwapwa	P.O.Box	0.42	Application	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic

Table 2.9 Water Right in Wami River Basin (5/9)

Ser. No.	W/Right No.	Name of Applicant	Locality	Address	Quantity (l/s)	Status	Source of Water	Source Type	District	Region	Water Use
157	2633	Commissioner For Villages	Mpwapwa	P.O.Box	0.26	Final	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
158	2789	Mpwapwa D.Council	Mpwapwa	P.O.Box	0.84	Final	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
159	2790	Mpwapwa D.Council	Mpwapwa	P.O.Box	2.00	Application	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
160	2791	Mpwapwa D.Council	Mpwapwa	P.O.Box	1.40	Final	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
161	2792	Mpwapwa D.Council	Mpwapwa	P.O.Box	1.70	Final	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
162	2879	Bagamoyo D.Council	Bagamoyo	P.O.Box	0.27	Final	Charco	Groundwater	Mpwapwa	Dodoma	Domestic
163	2880	DED-Mpwapwa	Mpwapwa	P.O.Box	1.10	Final	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
164	4210	DDD-Mpwapwa	Mpwapwa	P.O.Box	0.63	Final	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
165	4211	DDD. Mpwapwa	Mpwapwa	P.O.Box	0.63	Final	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
166	4287	DDD-Mpwapwa	Mpwapwa	P.O.Box	2.90	Application	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
167	4319	DDD-Mpwapwa	Mpwapwa	P.O.Box	2.90	Final	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
168	DO 10	DED Mpwapwa	Mpwapwa	P.O.Box	1.90	Final	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
169	DO 11	DED.Mpwapwa	Mpwapwa	P.O.Box	0.61	Final	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
170	DO 22	Diocese of Dodoma	Mpwapwa	P.O.Box	1.70	Final	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
171	DO 77	DED Mpwapwa	Mpwapwa	P.O.Box	12.60	Application	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
172	DO 80	St Philip Theological College.	Mpwapwa	P.O.Box	15.00	Final	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
173	MG 94	Mkiti Kampuni ya Maji Dumila	Dumila	P.O. Magole	2.80	Final	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
174	WA 0014	Catholic Diocese Dom	Dodoma	P.O.Box 922	0.48	Final	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
175	WA 0014	Catholic Diocese Dodoma	Mpwapwa	P.O.Box	0.48	Final	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
176	WA 0085	Mpwapwa Urban Water Suply and Sewerage Authority	Mpwapwa	P.O.Box 288	6.90	Application	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
177	WA 0086	Mpwapwa Urban Water Suply and Sewerage Authority	Mpwapwa	P.O.Box 288	8.40	Application	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
178	WA 0087	Mpwapwa Urban Water Suply and Sewerage Authority	Mpwapwa	P.O.Box 288	4.10	Application	Borehole	Groundwater	Mpwapwa	Dodoma	Domestic
179	2755	Kisarawe D.Council	Kisarawe	P.O.Box	0.38	Final	Dam	Source Type	Mpwapwa	Dodoma	Domestic
180	WA 0084	MPWUWASA	Mpwapwa	P.O.Box	8.00	Application	Mayawile Spring	Surface	Mpwapwa	Dodoma	Domestic
181	WA 0089	Ushirika wa Umwagiliaji Msagali	Mpwapwa	P.O.Box	411.60	Application	Kinyasungwe River	Surface	Mpwapwa	Dodoma	Irrigation
182	228	T. Bain	Mpwapwa	P.O. Box	0.26	Application	Mayawile Spring	Surface	Mpwapwa	Dodoma	
183	229	Thomas Bain	Mpwapwa	P.O. Box	1.10	Application	Kikombo Stream	Surface	Mpwapwa	Dodoma	
184	232	Provisional	Mpwapwa	P.O. Box	10.00	Final	Mkenge Stream	Surface	Mpwapwa	Dodoma	
185	234	M.J.W. Engineer	Mpwapwa	P.O. Box	84.90	Application	Mseta River	Surface	Mpwapwa	Dodoma	
186	235	T. Bain	Mpwapwa	P.O. Box	367.80	-	Diwale River	Surface	Mpwapwa	Dodoma	
187	870	Victor Robert	Mpwapwa	P.O. Box	14.20	-	Wami River	Surface	Mpwapwa	Dodoma	
188	870	Victor Robert	Mpwapwa	P.O. Box	14.20	Application	Kibakwe Stream	Surface	Mpwapwa	Dodoma	
189	871	Land Bank	Mpwapwa	P.O. Box	56.60	Application	Mlanga Spring	Surface	Mpwapwa	Dodoma	
190	872	Native Authority	Mpwapwa	P.O. Box	0.33	Final	Tambi River	Surface	Mpwapwa	Dodoma	
191	1446	U.A. Patel	Mpwapwa	P.O. Box	0.00	Provisional	Tame River	Surface	Mpwapwa	Dodoma	
192	1447	T. Bain	Mpwapwa	P.O. Box	2.60	Provisional	Stormwater	Surface	Mpwapwa	Dodoma	
193	1448	Mrs. T.B. Bain	Mpwapwa	P.O. Box	14.20	Provisional	Tambi River	Surface	Mpwapwa	Dodoma	
194	1449	The Vicar	Mpwapwa	P.O. Box	7.00	-	Drainage Well	Surface	Mpwapwa	Dodoma	

Table 2.9 Water Right in Wami River Basin (6/9)

Ser. No.	W/Right No.	Name of Applicant	Locality	Address	Quantity (l/s)	Status	Source of Water	Source Type	District	Region	Water Use
195	1451	Director of LPRI	Mpwapwa	P.O. Box	9.40	Final	Nduaguya River	Surface	Mpwapwa	Dodoma	
196	1457	Public Works	Mpwapwa	P.O. Box	1.60	Application	Lufusi River	Surface	Mpwapwa	Dodoma	
197	1459	P.G. Tapsc	Mpwapwa	P.O. Box	7.00	-	Ilonga River	Surface	Mpwapwa	Dodoma	
198	1461	Procurator, RC Mission	Mpwapwa	P.O. Box	0.05	Application	Mho'ngwa	Surface	Mpwapwa	Dodoma	
199	1462	Native Authority	Mpwapwa	P.O. Box	0.52	Provisional	Tambi River	Surface	Mpwapwa	Dodoma	
200	1463	DDD Mpwapwa	Mpwapwa	P.O. Box	0.52	Application	Lumuma River	Surface	Mpwapwa	Dodoma	
201	1466	R.F. Bain	Mpwapwa	P.O. Box		Final	Tubugwe Spring	Surface	Mpwapwa	Dodoma	
202	1470	R.F. Bain	Mpwapwa	P.O. Box	2.50	Final	Swamp &	Surface	Mpwapwa	Dodoma	
203	2034	Mrs E. B. Bain	Mpwapwa	P.O. Box		Final	Tambi River	Surface	Mpwapwa	Dodoma	
204	2055	Commissioner For Villages	Mpwapwa	P.O. Box	1.00	Final	Nunge River	Surface	Mpwapwa	Dodoma	
205	2805	Mpwapwa Dist. Council	Mpwapwa	P.O. Box	3.80	Application	Tambi River	Surface	Mpwapwa	Dodoma	
206	DO 78	DED Mpwapwa	Mpwapwa	P.O. Box	12.60	Application	Kongwa Maji	Surface	Mpwapwa	Dodoma	
207	DO 82	Kijiji cha Ujamaa	Mpwapwa	P.O. Box	78.40	Final	Lufusi River	Surface	Mpwapwa	Dodoma	
208	DO 84	Chamkoroma Ujamaa	Mpwapwa	P.O. Box	110.00	Provisional	Mseta River	Surface	Mpwapwa	Dodoma	
209	DO 85	Chamkoroma Ujamaa	Mpwapwa	P.O. Box	15.00	Provisional	Mayawile Spring	Surface	Mpwapwa	Dodoma	
210	DO 86	Lufusi Ujamaa Village	Mpwapwa	P.O. Box	43.70	Application	Lumuma River	Surface	Mpwapwa	Dodoma	
211	DO 87	Mseta Kijiji cha Ujamaa	Mpwapwa	P.O. Box	22.00	Provisional	Mkenge Stream	Surface	Mpwapwa	Dodoma	
212	DO 88	Tubugwe Village	Mpwapwa	P.O. Box	51.00	Provisional	Nduaguya River	Surface	Mpwapwa	Dodoma	
213	DO 89	Wangi Kijiji cha Ujamaa	Mpwapwa	P.O. Box	62.10	Provisional	Msavya River	Surface	Mpwapwa	Dodoma	
214	DO 9	Catholic Diocese	Mpwapwa	P.O. Box	43.10	Final	Ilonga River	Surface	Mpwapwa	Dodoma	
215	WA 0010	PS Min. of Agr.	Dar	P.O. Box	2.10	Final	Ilonga River	Surface	Mpwapwa	Dodoma	
216	WA 0015	Kitati Kijiji cha Ujamaa	Mpwapwa	P.O. Box	3.80	Final	Itiliko & Mta	Surface	Mpwapwa	Dodoma	
217	WA 0017	Catholic Diocese of Dodoma	Dodoma	P.O. Box	1.10	Final	Spring	Surface	Mpwapwa	Dodoma	
218	WA 0018	Mafene/Lufusi	Mpwapwa	P.O. Box	44.00	Final	Mseta Spring	Surface	Mpwapwa	Dodoma	
219	WA 0043	DED Mpwapwa	Mpwapwa	P.O. Box	12.60	Final	Mbori River	Surface	Mpwapwa	Dodoma	
220	758	Director of Veterirary Services	Kilosa	P.O.Box	0.21	Application	Borehole	Groundwater	Kilosa	Morogoro	Livestock
221	815	East African Sisal Plantat	Kilosa	P.O.Box	0.20	Application	Borehole	Groundwater	Kilosa	Morogoro	Domestic
222	816	East African Sisal Plantat	Kilosa	P.O.Box	0.16	Application	Borehole	Groundwater	Kilosa	Morogoro	Domestic
223	817	East African Sisal Plantat	Kilosa	P.O.Box	6.80	Application	Borehole	Groundwater	Kilosa	Morogoro	Industrial
224	858	Scutari Sisal Estate	Kimamba	P.O.Box 4	0.26	Final	Borehole	Groundwater	Kilosa	Morogoro	Domestic
225	859	Scutari Sisal Estate	Kimamba	P.O.Box	5.80	Final	Borehole	Groundwater	Kilosa	Morogoro	Industrial
226	874	G.H.Shaw for Director of PW	Kilosa	P.O.Box	1.60	Final	Borehole	Groundwater	Kilosa	Morogoro	Domestic
227	1714	Tanganyika Agr. Corp.	Mpwapwa	P.O.Box	0.70	Final	Borehole	Groundwater	Kilosa	Morogoro	Domestic
228	2021	Tanganyika Agr. Corp.	Kilosa	P.O.Box	0.20	Final	Borehole	Groundwater	Kilosa	Morogoro	Domestic
229	2984	Kilosa Town Water Supply	Kilosa	P.O.Box	25.90	Provisional	Borehole	Groundwater	Kilosa	Morogoro	Public Supply
230	MG 80	Kimamba W/s Company	Kimamba	P.O.Box 76	10.00	Final	Borehole	Groundwater	Kilosa	Morogoro	Domestic
231	MG 81	Kampuni ya Maji Rudewa Gon.	Kilosa	P.O.Box	1.60	Final	Borehole	Groundwater	Kilosa	Morogoro	Domestic
232	863	Scutari Sisal	Kilosa	P.O. Box	0.26	Final	Kisangata River	Groundwater	Kilosa	Morogoro	
233	184	Joseph S.Francis Co.Dsouza	Kilosa	P.O.Box	2.50	Provisional	Wami River	Surface	Kilosa	Morogoro	Domestic
234	207	Tanganyika Sisal Estate	Kilosa	P.O.Box	14.20	Final	Wami River	Surface	Kilosa	Morogoro	Industrial

Table 2.9 Water Right in Wami River Basin (7/9)

Ser. No.	W/Right No.	Name of Applicant	Locality	Address	Quantity (l/s)	Status	Source of Water	Source Type	District	Region	Water Use
235	799	Sumagro Ltd	Kimamba	P.O.Box 9	7.30	Final	Miyombo	Surface	Kilosa	Morogoro	Industrial
236	1096	Kilosa Ginnery	Kilosa	P.O.Box	0.52	Final	Mkondoa River	Surface	Kilosa	Morogoro	Industrial
237	1103	Rudewa Estates	Kilosa	P.O.Box	11.40	Application	Wami River	Surface	Kilosa	Morogoro	Irrigation
238	4124	Director of Production Kilimo	Dar	P.O.Box	1132.00	Final	Miyombo	Surface	Kilosa	Morogoro	Irrigation
239	4907	Azania Agr.Enterp.	Kilosa	P.O.Box	7.00	Application	Wami River	Surface	Kilosa	Morogoro	Irrigation
240	4908	Azania Agr.Enterp.	Kilosa	P.O.Box	7.00	Application	Wami River	Surface	Kilosa	Morogoro	Irrigation
241	4963	Kikundi cha Umwagiliaji Kilangali	Kilosa	P.O.Box	400.00	Provisional	Miyombo	Surface	Kilosa	Morogoro	Irrigation
242	4968	Agro Industries	Kilosa	P.O.Box	130.00	Provisional	Wami River	Surface	Kilosa	Morogoro	Irrigation
243	MG 13	Ilonga Agr.Research	Kilosa	P.Bag	300.0 Jan-Jun 150.0 Jul-Sep 100.0 Oct-Dec	Provisional	Ilonga	Surface	Kilosa	Morogoro	Irrigation
244	MG 51	Ilonga Agr.Research	Kilosa	P.Bag	2.30	Provisional	Ilonga	Surface	Kilosa	Morogoro	Domestic
245	MG 98	Ilonga TTC	Kilosa	P.O.Box	1.30	Provisional	Ilonga	Surface	Kilosa	Morogoro	Irrigation
246	WA 0001-9	Chama cha Ushirika wa Um.Lumuma	Kilosa	P.O.Box	474.0 Jun-Nov 1,265.0 Dec-May	Final	Lumuma River	Surface	Kilosa	Morogoro	Irrigation
247	WA 0012	Kikundi cha Umwagiliaji Ilonga	Kilosa	P.O.Box	130.00	Final	Ilonga	Surface	Kilosa	Morogoro	Irrigation
248	WA 0013	Kikundi cha Umwagiliaji Chanzuru	Kilosa	P.O.Box	100.00	Final	Ilonga	Surface	Kilosa	Morogoro	Irrigation
249	70	H.M. Ahmed	Kilosa	P.O. Box	14.20	Provisional	Luandalanga	Surface	Kilosa	Morogoro	
250	71	H. Lallubhai	Kilosa	P.O. Box	283.00	Application	Nuhenda River	Surface	Kilosa	Morogoro	
251	101	M.K. & R.K.	Kilosa	P.O. Box	113.10	-	Mvumi River	Surface	Kilosa	Morogoro	
252	135	N. Abdallah	Kilosa	P.O. Box	0.27	-	Wami River	Surface	Kilosa	Morogoro	
253	136	Mbugani S.	Morogoro	P.O. Box	10.20	Provisional	Mdando Spring	Surface	Kilosa	Morogoro	
254	136	Mbugani S.	Kilosa	P.O. Box	10.20	Provisional	Kikundi Str.	Surface	Kilosa	Morogoro	
255	282	Bjorn Grace	Kilosa	P.O. Box	33.50	Provisional	Kisangata River	Surface	Kilosa	Morogoro	
256	347	PS Min. of F.	Kilosa	P.O. Box	0.26	Final	Mkata River	Surface	Kilosa	Morogoro	
257	754	Director of Vet.	Kilosa	P.O. Box	2.60	Application	Mkondoa River	Surface	Kilosa	Morogoro	
258	755	Director of Vet.	Kilosa	P.O. Box	0.50	Application	Tami River	Surface	Kilosa	Morogoro	
259	756	Director of Vet.	Kilosa	P.O. Box	0.50	Application	Miyombo River	Surface	Kilosa	Morogoro	
260	759	Ulaya Sisal	Kilosa	P.O. Box	3.30	Application	Milindo River	Surface	Kilosa	Morogoro	
261	800	Msowero Sisal	Kilosa	P.O. Box	17.60	Application	Niaranda Spring	Surface	Kilosa	Morogoro	
262	801	Director Agr.	Ilonga	P.O. Box	31.10	Provisional	Wami River	Surface	Kilosa	Morogoro	
263	801	Director of Agr. Research	Kilosa	P.O. Box	28.30	Application	Mvumi River	Surface	Kilosa	Morogoro	
264	905	N. Nicolaus	Kilosa	P.O. Box	5.30	Application	Vianze Spring	Surface	Kilosa	Morogoro	
265	1046	Kimamba Sisal	Kimamba	P.O. Box	14.15	Final	Mvumi River	Surface	Kilosa	Morogoro	
266	1169	J. Calligeris	Kimamba	P.O. Box	28.30	Provisional	Lumuma River	Surface	Kilosa	Morogoro	
267	1170	J. Calligeris	Kimamba	P.O. Box	28.30	Provisional	Wami River	Surface	Kilosa	Morogoro	
268	1337	Mr. Salum	Kilosa	P.O. Box	7.00	Application	Dizungwi River	Surface	Kilosa	Morogoro	
269	1441	M.K. & R.K.	Kilosa	P.O. Box	0.10	Application	Mkondoa River	Surface	Kilosa	Morogoro	
270	1473	Kisitwe Farm	Mpwapwa	P.O. Box	0.05	Final	Maguha Spring	Surface	Kilosa	Morogoro	
271	1490	W.A.. Hall	P.O.Kongwa	P.O. Box	14.20	Final	Wami River	Surface	Kilosa	Morogoro	

Table 2.9 Water Right in Wami River Basin (8/9)

Ser. No.	W/Right No.	Name of Applicant	Locality	Address	Quantity (l/s)	Status	Source of Water	Source Type	District	Region	Water Use
272	1769	Kisangata	Kimamba	P.O. Box	0.16	Final	Sungula/It is	Surface	Kilosa	Morogoro	
273	1769	Kisangata	Kimamba	P.O. Box	28.30	Final	Kisangata River	Surface	Kilosa	Morogoro	
274	1820	Msowero P	Dar	P.O. Box	283.00	Final	Mvumi River	Surface	Kilosa	Morogoro	
275	2018	Dr. F. Leutenant	Msowero	P.O. Box	56.60	Application	Kisangata River	Surface	Kilosa	Morogoro	
276	2035	Mbarak Ahmed	Kilosa	P.O. Box	42.50	-	Mkata River	Surface	Kilosa	Morogoro	
277	2049	Zombo Farmers	Kilosa	P.O. Box	28.30	Application	Ilonga River	Surface	Kilosa	Morogoro	
278	2370	Mr. Rajabal M	Kilosa	P.O. Box	14.50	Application	Kisangata River	Surface	Kilosa	Morogoro	
279	2404	Stela Sisal Estate	Kimamba	P.O. Box	0.11	Final	Msowero River	Surface	Kilosa	Morogoro	
280	2404	Stela Sisal Estate	Kilosa	P.O. Box	0.25	Application	Wami River	Surface	Kilosa	Morogoro	
281	2406	Mvumi Farm	Kilosa	P.O. Box	84.90	Final	Kapera Stream	Surface	Kilosa	Morogoro	
282	2436	Peya Sisal Estate	Kilosa	P.O. Box	2.60	Provisional	Mto-ya-Mawe	Surface	Kilosa	Morogoro	
283	2670	Tanzania Sisal Corp.	Kilosa	P.O. Box	56.60	Application	Chabima River	Surface	Kilosa	Morogoro	
284	2845	Rajabal M.	Kilosa	P.O. Box	0.04	Application	Myombo River	Surface	Kilosa	Morogoro	
285	2901	Tanzania Sisal Corp.	Kilosa	P.O. Box	0.85	Application	Ilonga River	Surface	Kilosa	Morogoro	
286	4114	DDD Kilosa	Kilosa	P.O. Box	424.50	-	Miyombo River	Surface	Kilosa	Morogoro	
287	4115	DDD Kilosa	Kilosa	P.O. Box	934.00	Final	Mvumi River	Surface	Kilosa	Morogoro	
288	4123	DDD Kilosa	Kilosa	P.O. Box	1132.00	-	Miyombo River	Surface	Kilosa	Morogoro	
289	4249	Tanzania Sisal Corp.	Kilosa	P.O. Box	163.00	Final	Pond	Surface	Kilosa	Morogoro	
290	4440	Azania Agr.Enterp.	Dar	P.O. Box	566.00	Application	Dizungwi River	Surface	Kilosa	Morogoro	
291	4604	Katibu Mkuu Kilimo	Dar	P.O. Box	15.80	Final	Ikowa Dam	Surface	Kilosa	Morogoro	
292	4871	China State	Kilosa	P.O. Box	49.30	Final	Wami River	Surface	Kilosa	Morogoro	
293	4909	Azania Agr.Enterp.	Kilosa	P.O. Box	6.00	Application	Mkata River	Surface	Kilosa	Morogoro	
294	4929	Diocese of Morogoro	Morogoro	P.O. Box	0.69	Provisional	Mnaga Stream	Surface	Kilosa	Morogoro	
295	MG 12	Afisa wa Maliasili	Kilosa	P.O. Box	2.83	Provisional	Kitungwa River	Surface	Kilosa	Morogoro	
296	MG 3	Gairo Gravity	Kilosa	P.O. Box	60.00	Application	Tami River	Surface	Kilosa	Morogoro	
297	MG 51	Mkurugenzi, Ilonga Agr. Res.	Kilosa	P.O. Box	1.60	Final	Wami River	Surface	Kilosa	Morogoro	
298	MG 8	DDD Kilosa	Kilosa	P.O. Box	0.70	Application	Mkata River	Surface	Kilosa	Morogoro	
299	MG 17	Regional Prisons Officer	Morogoro	P.O.Box	0.47	Final	Borehole	Groundwater	Morogoro	Morogoro	Domestic
300	MG 85	Catholic Integr Comm.	Morogoro	P.O.Box1769	0.12	Final	Borehole	Groundwater	Morogoro	Morogoro	Domestic
301	2730	Mkata Water Supply	Morogoro	P.O.Box	1.00	Provisional	Mkata River	Surface	Morogoro	Morogoro	Public Supply
302	4647	Mtibwa Sugar Ltd	Mtibwa	P.O.Box	2000.00	Provisional	Wami River	Surface	Morogoro	Morogoro	Industrial
303	4857	Cholima Agr. Research	Morogoro	P.O.Box 1892	250.00	Application	Wami River	Surface	Morogoro	Morogoro	Irrigation
304	4930	Nurali J.Ibrahim	Morogoro	P.O.Box	283.70	Provisional	Diwale River	Surface	Morogoro	Morogoro	Fish Farmig
305	332	Hembeti Sisal Estate	Morogoro	P.O. Box	0.20	Provisional	Mkindo River	Surface	Morogoro	Morogoro	
306	352	Turiani Sisal	Morogoro	P.O. Box	17.00	Provisional	Mkindo River	Surface	Morogoro	Morogoro	
307	352	Turiani Sisal	Turiani	P.O. Box	167.00	-	Wami River	Surface	Morogoro	Morogoro	
308	1294	William P. B.	Morogoro	P.O. Box	0.37	Final	Wami River	Surface	Morogoro	Morogoro	
309	1621	Mtibwa Suger	Mtibwa	P.O. Box	12.10	Provisional	Dizungwi River	Surface	Morogoro	Morogoro	
310	1862	S.L. Patel	Morogoro	P.O. Box	1.60	Final	Msavya	Surface	Morogoro	Morogoro	
311	2728	DDD Morogoro	Morogoro	P.O. Box	0.52	Application	Lumuma River	Surface	Morogoro	Morogoro	

Table 2.9 Water Right in Wami River Basin (9/9)

Ser. No.	W/Right No.	Name of Applicant	Locality	Address	Quantity (l/s)	Status	Source of Water	Source Type	District	Region	Water Use
312	2730	DDD Morogoro	Morogoro	P.O. Box	1.10	Application	Diwale River	Surface	Morogoro	Morogoro	
313	2916	Mtibwa Sugar	Mtibwa	P.O. Box	11.10	Provisional	Mtoyamawe	Surface	Morogoro	Morogoro	
314	4678	Mkuu wa Gereza Dakawa	Morogoro	P.O. Box	37.80	Provisional	Lumuma River	Surface	Morogoro	Morogoro	
315	4798	Mkindo Irrigation Scheme	Turiani	P.O. Box	620.00	Final	Kizunguzi River	Surface	Morogoro	Morogoro	
316	4912	AZAM Estate	Morogoro	P.O. Box	172.00	Provisional	Madoto River	Surface	Morogoro	Morogoro	
317	MG 2	Afisa wa Maliasili	Morogoro	P.O. Box	0.49	Final	Lufusi River	Surface	Morogoro	Morogoro	
318	MG 67	Mr. A. Y. Lukwaro	Morogoro	P.O. Box	0.12	Provisional	Mvumi River	Surface	Morogoro	Morogoro	
319	2292	Faztehali K	Morogoro	P.O. Box	4.30	Application	L. Kimangai	Surface	Morogoro	Morogoro	
320	2	Forest Project	Morogoro	P.O. Box	0.04	Application	Ngerengere River	Surface	Morogoro	Morogoro	
321	MG 82	Catholic Integr Comm.	Morogoro	P.O.Box1768	0.09	Final	Borehole	Groundwater	Morogoro Rural	Morogoro	Domestic
322	MG 83	Catholic Integr Comm.	Morogoro	P.O.Box1768	0.09	Final	Borehole	Groundwater	Morogoro Rural	Morogoro	Domestic
323	MG 22	Mkuu wa Gereza Dakawa	Mvomero	P.O.Box	0.60	Final	Borehole	Groundwater	Mvomero	Morogoro	Domestic
324	MG 23	Dakawa Centre	Morogoro	P.O.Box 2292	4.60	Final	Borehole	Groundwater	Mvomero	Morogoro	Domestic
325	WA 0090	Mtibwa Sugar Estates ltd	Mtibwa	P.O.Box 42	0.40	Application	Borehole	Groundwater	Mvomero	Morogoro	Domestic
326	WA 0091	Mtibwa Sugar Estates ltd	Mtibwa	P.O.Box 42	0.23	Application	Borehole	Groundwater	Mvomero	Morogoro	Domestic
327	WA 0092	Mtibwa Sugar Estates ltd	Mtibwa	P.O.Box 42	0.23	Application	Borehole	Groundwater	Mvomero	Morogoro	Domestic
328	WA 0093	Mtibwa Sugar Estates ltd	Mtibwa	P.O.Box 42	0.40	Application	Borehole	Groundwater	Mvomero	Morogoro	Domestic
329	1294	Mkata Ranch	Morogoro	P.O.Box	0.40	Final	Mkata River	Surface	Mvomero	Morogoro	Livestock
330	2728	Turiani Water Supply	Morogoro	P.O.Box	0.52	Provisional	Diwale River	Surface	Mvomero	Morogoro	Public Supply
331	4501	Mtibwa Sugar Estates ltd	Mvomero	P.O.Box	1500.00	Provisional	Diwale River	Surface	Mvomero	Morogoro	Irrigation
332	4583	NAFCO	Mvomero	P.O.Box	4000.00	Final	Wami River	Surface	Mvomero	Morogoro	Irrigation
333	4798	Mkindo Irrigation Scheme	Mvomero	P.O.Box	622.60	Final	Mkindo River	Surface	Mvomero	Morogoro	Irrigation
334	4920	Ismail Jumbe Diwani	Morogoro	P.O.Box	0.06	Provisional	Wami River	Surface	Mvomero	Morogoro	Domestic
335	4959	Mtibwa Sugar Estates ltd	Mtibwa	P.O.Box 42	2500.00	Provisional	Wami River	Surface	Mvomero	Morogoro	Irrigation
336	MG 24	Emilio Beghi	Mvomero	P.O.Box	40.00	Provisional	Dizungwi River	Surface	Mvomero	Morogoro	Irrigation
337	MG 75	Mvomero Water Supply co.	Mvomero	P.O.Box	7.00	Provisional	Mvomero River	Surface	Mvomero	Morogoro	Domestic
338	WA 0011	Kikundi cha Umwagiliaji Dihombo	Mvomero	P.O.Box	80.00	Provisional	Dizungwi River	Surface	Mvomero	Morogoro	Irrigation
339	WA 0079	Kikundi cha Umoja Group	Mvomero	P.O.Box	3.00	Provisional	Dizungwi River	Surface	Mvomero	Morogoro	Irrigation
340	WA 0080	Kimango Farm Enterp.	Morogoro	P.O.Box.642	23.10	Provisional	Wami River	Surface	Mvomero	Morogoro	Irrigation
341	MG 24	M/S Emilio	Morogoro	P.O. Box	40.00	Provisional	Gombo River	Surface	Mvomero	Morogoro	
342	RU 0011	Chama cha Umwagiliaji Mlali	Mzumbe	P.O. Box	70.0 Dec-May	Application	Mlali River	Surface	Mvomero	Morogoro	
343	RU 0012	Chama cha Umwagiliaji Mlali	Mzumbe	P.O. Box	10.0 Jun-Nov	Application	Myombo River	Surface	Mvomero	Morogoro	
344	WA 0079	Kikundi cha Umoja Group	Turiani	P.O. Box	3.00	Provisional	Wami River	Surface	Mvomero	Morogoro	
345	WA 0080	Kimango Farm Enterp.	Morogoro	P.O. Box	23.10	Provisional	Mlali River	Surface	Mvomero	Morogoro	
346	WA 0080	Kimango Farm Enterp.	Morogoro	P.O.Box.642	23.10	Provisional	Wami River	Surface	Mvomero	Morogoro	Irrigation

Note: The data have posibilities to be modified since the work to verify the status of the data is still on-going in Basin office.

Table 2.10 Water Right in Ruvu River Basin (1/6)

Ser. No.	W/Right No.	Name of Applicant	Locality	Address	Quantity (l/s)	Status	Source of Water	Source Type	District	Region	Water Use
1	2797	DAWASA	Dar	P.O.Box 1573	3152.80	Final	Ruvu River	Surface	Coast	Bagamoyo	Public Supply
2	22&2427	DAWASA	Dar	P.O.Box 1573	1050.90	Final	Ruvu River	Surface	Coast	Bagamoyo	Public Supply
3	3	DDD Bagamoyo	Bagamoyo	P.O.Box	0.79	Final	well	Groundwater	Bagamoyo	Coast	Domestic
4	88	D'arcy Shell Petrol Dev.	Bagamoyo	P.O.Box	0.04	Application	well	Groundwater	Bagamoyo	Coast	Domestic
5	993	H.J.Stanley & Sons	Bagamoyo	P.O.Box	0.10	Final	Well	Groundwater	Bagamoyo	Coast	Domestic
6	2261	Mrs B.H.Mann	Bagamoyo	P.O.Box	0.01	Final	Well	Groundwater	Bagamoyo	Coast	Domestic
7	CR 11	Regional Fisheries	Bagamoyo	P.O.Box 83 DSM	0.37	Final	well	Groundwater	Bagamoyo	Coast	Domestic
8	341	Karimjee Jivanjee Estate	Kisarawe	P.O.Box	5.20	Final	Dam	Surface	Bagamoyo	Coast	Domestic
9	609	Chhotalal Shivran B.	Bagamoyo	P.O.Box	3.30	Provisional	Ruvu River	Surface	Bagamoyo	Coast	Domestic
10	964	John W.T.Holloway	Bagamoyo	P.O.Box	No data	Final	Kivungwi Spring	Surface	Bagamoyo	Coast	Domestic
11	965	John W.T.Holloway	Bagamoyo	P.O.Box	No data	-	Msua River	Surface	Bagamoyo	Coast	Irrigation
12	966	John W.T.Holloway	Bagamoyo	P.O.Box	2.50	Final	Ruvu River	Surface	Bagamoyo	Coast	Domestic
13	1023	Ruvu Valley Sugar	Bagamoyo	P.O.Box	4.90	Provisional	Ruvu River	Surface	Bagamoyo	Coast	Domestic
14	1234	Yusufali Mussaji	Bagamoyo	P.O.Box	0.10	Application	Pond	Surface	Bagamoyo	Coast	Domestic
15	1909	V.C.Allen	Bagamoyo		0.10	Provisional	Mbegani Swamp	Surface	Bagamoyo	Coast	Domestic
16	2371	Comm. of Prisons	Bagamoyo	P.O.Box	1.30	Provisional	Ngerengere River	Surface	Bagamoyo	Coast	Domestic
17	2498	Comm. Of Prisons	Bagamoyo	P.O.Box	13.10	Application	Ngerengere River	Surface	Bagamoyo	Coast	Irrigation
18	2645	Comm. For Ujamaa	Bagamoyo	P.O.Box	0.38	Final	Mpiji River	Surface	Bagamoyo	Coast	Domestic
19	2653	Bagamoyo D.Council	Bagamoyo	P.O.Box	1.10	Application	Dam	Surface	Bagamoyo	Coast	Domestic
20	2693	Ingra Viadukt	Bagamoyo	P.O.Box	1.60	Application	Dam	Surface	Bagamoyo	Coast	Domestic
21	2877	Bagamoyo D.Council	Bagamoyo	P.O.Box	3.70	Final	Mindu Tulieni Dam	Surface	Bagamoyo	Coast	Domestic
22	2897	Director of Product	Bagamoyo	P.O.Box 9071	650.00	Final	Ruvu River	Surface	Bagamoyo	Coast	Irrigation
23	2900	Director of Production-Kilimo	Bagamoyo	P.O.Box 9071	3.50	Final	Msua River	Surface	Bagamoyo	Coast	Domestic
24	2911	Tanz. Sisal corp.Ubena	Bagamoyo	P.O.Box	525.50	Application	Dam	Surface	Bagamoyo	Coast	Industrial
25	4003	Bagamoyo D.Council	Bagamoyo	P.O.Box	4.30	Final	Fukayozi Dam	Surface	Bagamoyo	Coast	Domestic
26	4116	Nello L. Teer Co.	Bagamoyo	P.O.Box	0.90	Application	Ruvu River	Surface	Bagamoyo	Coast	Industrial
27	*1895	GM E.A.Railways	Bagamoyo	P.O.Box	1.10	Final	Ruvu River	Surface	Bagamoyo	Coast	Industrial
28	CR 2	Azania Investment	Bagamoyo	P.O.Box	1363.50	Application	Msumbiji River	Surface	Bagamoyo	Coast	Irrigation
29	CR 6	Ofisi ya Mkuu wa Wilaya Kib.	Kibaha	P.O.Box	1.30	Final	Well	Groundwater	Kibaha	Coast	Domestic
30	1585	River Farm	Kibaha	P.O.Box	0.21	Provisional	Nguva River	surface	Kibaha	Coast	Domestic
31	4	DED.Kisarawe	Kisarawe	P.O.Box 28003	1.10	Application	Well	Groundwater	Kisarawe	Coast	Domestic
32	5	DDD.Kisarawe	Kisarawe	P.O.Box 28003	1.10	Application	Well	Groundwater	Kisarawe	Coast	Domestic
33	10	Tanganyika Packers Ltd	Kisarawe	P.O.Box	0.58	Final	Borehole	Groundwater	Kisarawe	Coast	Industrial
34	85	Tanganyika Packers Ltd.	Kisarawe	P.O.Box	0.10	Final	Mbezi Well	Groundwater	Kisarawe	Coast	Domestic
35	86	Tanganyika Packers	Kisarawe	P.O.Box	0.11	Application	Lubungu Well	Groundwater	Kisarawe	Coast	Domestic
36	87	Tanganyika Packers Ltd.	Kisarawe	P.O.Box	0.10	Final	Luisi Well	Groundwater	Kisarawe	Coast	Domestic
37	170	Tanganyika Packers Ltd.	Kisarawe	P.O.Box	0.08	Final	Pugu Well	Groundwater	Kisarawe	Coast	Domestic
38	171	A.M.A. Karimjee	Kisarawe	P.O.Box	0.03	Final	Well	Groundwater	Kisarawe	Coast	Industrial
39	193	Christoss Zissis Lychnaras	Kisarawe	P.O.Box	3.60	Provisional	H.Well	Groundwater	Kisarawe	Coast	Industrial

Table 2.10 Water Right in Ruvu River Basin (2/6)

Ser. No.	W/Right No.	Name of Applicant	Locality	Address	Quantity (l/s)	Status	Source of Water	Source Type	District	Region	Water Use
40	442	Tanganyika Packers Ltd	Kisarawe	P.O.Box	0.58	Final	Borehole	Groundwater	Kisarawe	Coast	Industrial
41	443	Tanganyika Packers Ltd	Kisarawe	P.O.Box	0.58	Final	Borehole	Groundwater	Kisarawe	Coast	Industrial
42	444	Tanganyika Packers Ltd	Kisarawe	P.O.Box	0.58	Final	Borehole	Groundwater	Kisarawe	Coast	Industrial
43	809	Hellen Eggert	Kisarawe	P.O.Box	0.10	Application	Kondo Well	Groundwater	Kisarawe	Coast	Domestic
44	16	Liverpool Uganda Co. (T)	Kisarawe	P.O.Box	0.63	Final	Mazinga River	Surface	Kisarawe	Coast	Industrial
45	172	H.Kumbruch	Kisarawe	P.O.Box	8.50	Final	Pangani Dam	Surface	Kisarawe	Coast	Industrial
46	195	Manager of Ruvu Estates	Kisarawe	P.O.Box	5.30	Provisional	Ruvu River	Surface	Kisarawe	Coast	Industrial
47	196	Manager of Ruvu Estates	Kisarawe	P.O.Box	4.70	Provisional	Lake Mongomoli	Surface	Kisarawe	Coast	Industrial
48	242	Karimjee Jivanjee Estate	Kisarawe	P.O.Box	8.40	Final	Dam	Surface	Kisarawe	Coast	Industrial
49	335	Karimjee Jivanjee Estate	Kisarawe	P.O.Box	315.30	Final	Swamp	Surface	Kisarawe	Coast	Industrial
50	578	A.K.Jetha	Kisarawe	P.O.Box	0.16	Final	Msimbazi River	Surface	Kisarawe	Coast	Industrial
51	579	Nanji Karsan	Kisarawe	P.O.Box	7.10	Final	Msimbazi River	Surface	Kisarawe	Coast	Domestic
52	619	Tanganyika Packers Ltd.	Kisarawe	P.O.Box	0.07	Final	Singwa Pool	Surface	Kisarawe	Coast	Domestic
53	619	Tanganyika Packers Ltd.	Kisarawe	P.O.Box	0.07	Final	Singwa Pool	Surface	Kisarawe	Coast	Domestic
54	620	Tanganyika Packers Ltd.	Kisarawe	P.O.Box	0.13	Final	Elephant Pool	Surface	Kisarawe	Coast	Domestic
55	621	Tanganyika Packers Ltd.	Kisarawe	P.O.Box	0.07	Final	Elmi Pool	Surface	Kisarawe	Coast	Domestic
56	622	Tanganyika Packers Ltd.	Kisarawe	P.O.Box	0.07	Final	Luguluni Pool	Surface	Kisarawe	Coast	Domestic
57	698	John Ernest Cotton	Kisarawe	P.O.Box	0.03	Application	Nguva River	Surface	Kisarawe	Coast	Domestic
58	760	Director of Public Works	Kisarawe	P.O.Box	2.60	Final	Spring	Surface	Kisarawe	Coast	Domestic
59	876	Director of Dewji Sisal Est	Kisarawe	P.O.Box	4.00	Provisional	Kalekwa River	Surface	Kisarawe	Coast	Industrial
60	1051	Permanent Secr. L/F	Kisarawe	P.O.Box	0.26	-	Minondo Stream	Surface	Kisarawe	Coast	Irrigation
61	1135	Herbert William D.F.Officer	Kisarawe	P.O.Box	0.26	Application	Kivuli Stream	Surface	Kisarawe	Coast	Domestic
62	1154	Commissioner of Prisons	Kisarawe	P.O.Box	0.52	Final	Tegeta River	Surface	Kisarawe	Coast	Domestic
63	1423	Hooseni Sisal Estate	Kisarawe	P.O.Box	5.20	Final	Dam	Surface	Kisarawe	Coast	Industrial
64	1582	Kerala Diary	Kisarawe	P.O.Box	0.26	Final	Nguva River	Surface	Kisarawe	Coast	Domestic
65	1990	Mrs Nizar B. Schneckhan	Bagamoyo	P.O.Box	5.30	Final	Charco Dam	Surface	Kisarawe	Coast	Domestic
66	2188	River Farm Mrs Karmali	Kisarawe	P.O.Box	14.00	Final	Nguva River	Surface	Kisarawe	Coast	Domestic
67	2311	Nordic Tanganyika Project	Kisarawe	P.O.Box	No data	Application	Long E Stream	Surface	Kisarawe	Coast	Domestic
68	2441	E.A.Railway Corp.	Kisarawe	P.O.Box	5.20	Final	Ruvu River	Surface	Kisarawe	Coast	Industrial
69	2462	Principal SecretaryPWD	Kisarawe	P.O.Box	6.00	Final	Minaki Dam	Surface	Kisarawe	Coast	Domestic
70	2579	Tanganyika Dyeing&Weav.	Kisarawe	P.O.Box	7.10	Provisional	Tri.of Msimbazi River	Surface	Kisarawe	Coast	Industrial
71	2771	NordicTang. Project	Kisarawe	P.O.Box	1.30	-	Kibaha Stream	Surface	Kisarawe	Coast	Irrigation
72	4347	DED-Kisarawe	Kisarawe	P.O.Box	215.40	Final	VigogoniV.Catchment	Surface	Kisarawe	Coast	Domestic
73	4348	DED.Kisarawe	Kisarawe	P.O.Box	1.40	Final	Mkundi Springs	Surface	Kisarawe	Coast	Domestic
74	CR 12	Kibamba Farm Ltd	Kisarawe	P.O.Box	0.10	-	Mbezi River	Surface	Kisarawe	Coast	Irrigation
75	CR 13	DED.Kisarawe	Kisarawe	P.O.Box	4.60	Final	Reservoir	Surface	Kisarawe	Coast	Domestic
76	CR 13	DED.Kisarawe	Kisarawe	P.O.Box	4.60	Application	Reservoir	Surface	Kisarawe	Coast	Domestic
77	CR 8	DED.Kisarawe	Kisarawe	P.O.Box	0.97	Final	Pond	Surface	Kisarawe	Coast	Domestic
78	*3751	DAWASA	Dar	P.O.Box 1573	104.20	Final	Mtoni (Kizinga R.)	Surface	Dar	Dar	Public Supply

Table 2.10 Water Right in Ruvu River Basin (3/6)

Ser. No.	W/Right No.	Name of Applicant	Locality	Address	Quantity (l/s)	Status	Source of Water	Source Type	District	Region	Water Use
79	329	Karimjee Jivanjee Estate	Morogoro	P.O.Box	1.10	Final	Borehole	Groundwater	Morogoro	Morogoro	Domestic
80	330	Karimjee Jivanjee Estate	Morogoro	P.O.Box	1.10	Final	Borehole	Groundwater	Morogoro	Morogoro	Domestic
81	1338	National Agr.&Food	Morogoro	P.O.Box	1.60	Final	Borehole	Groundwater	Morogoro	Morogoro	Domestic
82	1342	Kiwege& Mgude Sisal	Morogoro	P.O.Box	1.60	Final	Borehole	Groundwater	Morogoro	Morogoro	Domestic
83	1344	National Agr.&Food	Morogoro	P.O.Box	2.50	Final	Borehole	Groundwater	Morogoro	Morogoro	Domestic
84	2329	B.D.Walji	Morogoro	P.O.Box	0.10	Final	Well	Groundwater	Morogoro	Morogoro	Domestic
85	2726	DDD Morogoro	Morogoro	P.O.Box	0.52	Application	Borehole	Groundwater	Morogoro	Morogoro	Domestic
86	2727	DDD.Morogoro	Morogoro	P.O.Box	0.52	Application	Borehole	Groundwater	Morogoro	Morogoro	Domestic
87	3572	KigurunyembeHosp.& Matern.	Morogoro	P.O.Box 865	2.60	Provisional	Borehole	Groundwater	Morogoro	Morogoro	Domestic
88	4432	TAZARA	Dar	P.O.Box 2834	0.83	Provisional	Well	Groundwater	Morogoro	Morogoro	Industrial
89	MG 16	Morogoro Dev Corp	Morogoro	P.O.Box	0.04	Application	Shallow well	Groundwater	Morogoro	Morogoro	Domestic
90	MG 76	Tanzania Tobacco	Morogoro	P.O.Box 2292	0.93	Final	Borehole	Groundwater	Morogoro	Morogoro	Industrial
91	MG 77	Tanzania Tobacco	Morogoro	P.O.Box 2292	0.93	Final	Borehole	Groundwater	Morogoro	Morogoro	Industrial
92	MG 78	Tanzania Tobacco	Morogoro	P.O.Box 2292	0.93	Final	Borehole	Groundwater	Morogoro	Morogoro	Industrial
93	MG 90	Jafferali A. Jaffer	Morogoro	P.O.Box 379	0.30	Final	Borehole	Groundwater	Morogoro	Morogoro	Domestic
94	MG 99	Society of Precious Blood	Dodoma	P.O.Box	4.60	Final	Borehole	Groundwater	Morogoro	Morogoro	Domestic
95	RU 0002	Mgolole Sisters	Morogoro	P.O.Box 1049	0.02	Final	Borehole	Groundwater	Morogoro	Morogoro	Domestic
96	RU 0009	SUA	Morogoro	P.O.Box 3001	0.46	Final	Borehole	Groundwater	Morogoro	Morogoro	Domestic
97	81	Ofisi ya Mkuu wa Wilaya	Morogoro	P.O.Box	No data	Application	Mgeta River	Surface	Morogoro	Morogoro	Domestic
98	327	Karimjee Jivanjee Estate	Morogoro	P.O.Box	6.80	Final	Ngerengere River	Surface	Morogoro	Morogoro	Domestic
99	328	Karimjee Jivanjee Estate	Morogoro	P.O.Box	7.60	Final	Dam and Ngerengere River	Surface	Morogoro	Morogoro	Industrial
100	331	IDM Mzumbe	Mzumbe	P.O.Box 1	9.20	Final	Ngerengere	Surface	Morogoro	Morogoro	Domestic
101	333	Dr.Edward Seitz	Morogoro	P.O.Box	0.77	Final	Mgeta River	Surface	Morogoro	Morogoro	Domestic
102	926	Arnatoglu Estates Mazim	Morogoro	P.O.Box	3.10	Final	Ngerengere River	Surface	Morogoro	Morogoro	Industrial
103	931	Catholic MissionMgeta	Morogoro	P.O.Box	0.16	Final	Mgeta River	Surface	Morogoro	Morogoro	Domestic
104	962	Dr.Edward Seitz	Morogoro	P.O.Box	1415.00	Final	Mgeta River	Surface	Morogoro	Morogoro	Domestic
105	975	Tubuyu Sisal Estate	Morogoro	P.O.Box	0.52	Application	Morogoro River	Surface	Morogoro	Morogoro	Domestic
106	982	Kihonda Sisal Estate	Morogoro	P.O.Box	5.20	Application	Ngerengere River	Surface	Morogoro	Morogoro	Industrial
107	1235	Fatehali K.Ramji	Morogoro	P.O.Box	2.60	Final	Kiroka River	Surface	Morogoro	Morogoro	Domestic
108	1236	Ascerali Akberali Vekonge Si	Morogoro	P.O.Box	2.00	Final	Ngerengere River	Surface	Morogoro	Morogoro	Domestic
109	1237	Tanzania Sisal Corp	Tanga	P.O.Box 123	0.90	Final	Pangawe Spring	Surface	Morogoro	Morogoro	Domestic
110	1237	Tanzania Sisal Corp	Morogoro	P.O.Box	0.90	Final	Pangawe Spring	Surface	Morogoro	Morogoro	Domestic
111	1343	National Agr.& co.	Mvomero	P.O.Box	4.00	Final	Ngerengere River	Surface	Morogoro	Morogoro	Domestic
112	1417	Henry G.Dodd	Morogoro	P.O.Box	0.08	Provisional	Kikundi River	Surface	Morogoro	Morogoro	Domestic
113	1418	H.G.Dodd	Morogoro	P.O.Box	0.16	Final	Kikundi River	Surface	Morogoro	Morogoro	Domestic
114	1418	PS Min. of Agr.	Morogoro	P.O.Box	0.16	Final	Kikundi River	Surface	Morogoro	Morogoro	Domestic
115	1486	Kiwege& Mgude Sisal	Morogoro	P.O.Box	0.53	Final	Ngerengere River	Surface	Morogoro	Morogoro	Domestic
116	1487	Kiwege& Mgude Sisal	Morogoro	P.O.Box	6.80	Final	Ngerengere River	Surface	Morogoro	Morogoro	Domestic
117	1489	NationalLutheran Council.	Morogoro	P.O.Box	0.03	Final	Kinyamdum Stream	Surface	Morogoro	Morogoro	Domestic

Table 2.10 Water Right in Ruvu River Basin (4/6)

Ser. No.	W/Right No.	Name of Applicant	Locality	Address	Quantity (l/s)	Status	Source of Water	Source Type	District	Region	Water Use
118	1494	Mafica Sisal Estates	Morogoro	P.O.Box 41	0.57	Final	Kikundi River	Surface	Morogoro	Morogoro	Domestic
119	1494	Mafiga Sisal Estates	Morogoro	P.O.Box	0.58	Final	Kikundi River	Surface	Morogoro	Morogoro	Domestic
120	1564	Central Line Sisal Estate	Morogoro	P.O.Box	0.80	Final	Ngerengere River	Surface	Morogoro	Morogoro	Industrial
121	1953	Mazimbu Sisal Estate	Morogoro	P.O.Box	0.31	Final	Ngerengere River	Surface	Morogoro	Morogoro	Domestic
122	2028	Mwananchi Sisal Estate	Morogoro	P.O.Box	3.70	Provisional	Morogoro River	Surface	Morogoro	Morogoro	Domestic
123	2113	PS Min. of H.Affairs	Dar	P.O.Box 9000	3.40	Provisional	Ngerengere River	Surface	Morogoro	Morogoro	Industrial
124	2292	Faztehali KassamMills	Morogoro	P.O.Box	4.30	Application	Ngerengere River	Surface	Morogoro	Morogoro	Irrigation
125	2293	Central Line Sisal Estate	Morogoro	P.O.Box	5.20	Final	Ngerengere River	Surface	Morogoro	Morogoro	Domestic
126	2329	B.D.Walji	Morogoro	P.O.Box	0.08	Final	Mlali River	Surface	Morogoro	Morogoro	Domestic
127	2486	Kiroka Plantation	Morogoro	P.O.Box	0.05	Provisional	Kiroka River	Surface	Morogoro	Morogoro	Domestic
128	2498	Comm.for Prisons	Dar	P.O.Box 9190	2.60	Final	Ngerengere River	Surface	Morogoro	Morogoro	Domestic
129	2729	Morogoro D.Council	Morogoro	P.O.Box	1.10	Final	Mlali River	Surface	Morogoro	Morogoro	Domestic
130	2729	DDD.Morogoro	Morogoro	P.O.Box	1.10	Application	Mlali River	Surface	Morogoro	Morogoro	Domestic
131	2850	Mzinga Corp.TPDF	Morogoro	P.O.Box 737	13.60	Final	Mzinga River	Surface	Morogoro	Morogoro	Domestic
132	2999	Kizuka TPDF	Morogoro	P.O.Box 50	11.60	Final	Ngerengere River	Surface	Morogoro	Morogoro	Domestic
133	4006	Nello L.Teer	Morogoro	P.O.Box	2.80	Provisional	Ngerengere River	Surface	Morogoro	Morogoro	Industrial
134	4374	Mr.Asmani Ismail	Morogoro	P.O.Box	0.06	Provisional	Ngerengere River	Surface	Morogoro	Morogoro	Domestic
135	4426	Tanzania Leather Ass. Ind	Morogoro	P.O.Box	5.20	Final	Ngerengere River	Surface	Morogoro	Morogoro	Industrial
136	4433	TAZARA	Morogoro	P.O.Box	2.70	Final	Ruvu River	Surface	Morogoro	Morogoro	Domestic
137	4434	TAZARA	Dar	P.O.Box 2834	3.90	-	Ruvu River	Surface	Morogoro	Morogoro	Industrial
138	4553	Registered Trustees of R.C	Morogoro	P.O.Box	1.30	Final	Ngerengere River	Surface	Morogoro	Morogoro	Domestic
139	4581	Africa National Congress SA	Morogoro	P.O.Box	0.04	Application	Ngerengere River	Surface	Morogoro	Morogoro	Domestic
140	4585	TPDF Vikenge	Morogoro	P.O.Box	20.80	Provisional	Ngerengere River	Surface	Morogoro	Morogoro	Domestic
141	4602	Taj Mohamed	Morogoro	P.O.Box 204	7.90	Provisional	Magasy Stream	Surface	Morogoro	Morogoro	Domestic
142	4609	NDC Tannery Morogoro	Morogoro	P.O.Box	5.20	Provisional	Ngerengere River	Surface	Morogoro	Morogoro	Industrial
143	4701	Kingolwira Fish Farming	Morogoro	P.O.Box	42.20	Final	Mgolole Stream	Surface	Morogoro	Morogoro	Fishfarming
144	4827	Mkti Melela-Kipera w/s	Morogoro	P.O.Box 1880	7.00	Final	Mlali River	Surface	Morogoro	Morogoro	Domestic
145	4851	Mr. C.A.Mrema	Morogoro	P.O.Box 1147	0.02	Application	Pangawe Spring	Surface	Morogoro	Morogoro	Domestic
146	4859	ANC of S.Africa	Morogoro	P.O.Box	33.30	Application	Ngerengere River	Surface	Morogoro	Morogoro	Domestic
147	4954	D.General TAFORI	Morogoro	P.O.Box 1854	1.10	Final	Ngerengere River	Surface	Morogoro	Morogoro	Domestic
148	1417/19	H.G.Dodd	Dar	P.O.Box 1592	No data	Provisional	Mlali River	Surface	Morogoro	Morogoro	Domestic
149	1417/9	H.G.Dodd	Morogoro	P.O.Box	0.26	Provisional	Mlali/Kikonde River	Surface	Morogoro	Morogoro	Domestic
150	3223A	Pangawe Sisal Estate	Morogoro	P.O.Box	4.60	Final	Ngerengere River	Surface	Morogoro	Morogoro	Industrial
151	3223B	Dimon Morogoro Tobacco	Morogoro	P.O.Box	3.00	Final	Ngerengere River	Surface	Morogoro	Morogoro	Industrial
152	MG 100	Fr. T. Winkelmolen	Morogoro	P.O.Box 640	1.00	Final	Nugutu Stream	Surface	Morogoro	Morogoro	Domestic
153	MG 29	Hassan W. Sabu	Morogoro	P.O.Box	0.02	Application	Nongeni Stream	Surface	Morogoro	Morogoro	Domestic
154	MG 41	Mohamed Mbarak	Morogoro	P.O.Box	1.20	Application	Ngerengere River	Surface	Morogoro	Morogoro	Livestock
155	MG 43	Mkiti Nugutu'B' Village	Morogoro	P.O.Box 166	0.16	Provisional	Nongeni Stream	Surface	Morogoro	Morogoro	Domestic
156	MG 46	Nugutu Sub-Village	Morogoro	P.O.Box 1862	1.20	Provisional	Kigomilemwanza Stream	Surface	Morogoro	Morogoro	Domestic

Table 2.10 Water Right in Ruvu River Basin (5/6)

Ser. No.	W/Right No.	Name of Applicant	Locality	Address	Quantity (l/s)	Status	Source of Water	Source Type	District	Region	Water Use
157	MG 54	Kikundi cha Bigwa Bara.	Morogoro	P.O.Box 1066	0.40	Provisional	Bigwa Stream	Surface	Morogoro	Morogoro	Domestic
158	MG 59	Umoja wa Vijana wa Kujitolea	Morogoro	P.O.Box	0.02	Provisional	Bigwa Stream	Surface	Morogoro	Morogoro	Irrigation
159	MG 69	Mr. M.F.P Mwamnyanyi	Morogoro	P.O.Box 544	5.00	Application	Mlulu Stream	Surface	Morogoro	Morogoro	Domestic
160	MG 71	Mr.K.K.Wetengere	Morogoro	P.O.Box 35	0.10	Application	Lukuyu Stream	Surface	Morogoro	Morogoro	Domestic
161	MG 91	Masista wa Moyo	Morogoro	P.O.Box 1049	8.40	Provisional	Mgolole Stream	Surface	Morogoro	Morogoro	Domestic
162	RU 0001	TOSCA Morogoro	Morogoro	P.O.Box	16.50	Provisional	Ngerengere River	Surface	Morogoro	Morogoro	Irrigation
163	RU 0005	Shule ya Mafunzo Pangawe	Morogoro	P.O.Box	6.20	Final	Mgolole Stream	Surface	Morogoro	Morogoro	Domestic
164	RU 0006	Mgolole Sisters	Morogoro	P.O.Box	1.27	Provisional	Mlulu Stream	Surface	Morogoro	Morogoro	Domestic
165	RU 0007	Nemitondo Water Users Assoc.	Morogoro	P.O.Box	0.23	Provisional	Nongeni Stream	Surface	Morogoro	Morogoro	Domestic
166	RU 0008	Chris Lowey	Morogoro	P.O.Box	0.05	Final	Morogoro River	Surface	Morogoro	Morogoro	Domestic
167	RU 0010	SUA	Morogoro	P.O.Box 3000	0.46	Final	Ngerengere River	Surface	Morogoro	Morogoro	Domestic
168	RU 0012	MD. MOROUWASA	Morogoro	P.O.Box	1.01	Application	Mgolole Stream	Surface	Morogoro	Morogoro	Public Supply
169	RU 0014	MD. MOROUWASA	Morogoro	P.O.Box	4.54	Application	Mgolole Stream	Surface	Morogoro	Morogoro	Public Supply
170	3546	TRC Ngerengere Station	Morogoro		0.69	-	Ngerengere River	Surface	Morogoro	Morogoro	Domestic
171	4928	Kimango Farm Enterp.	Morogoro		6.25	-	Ngerengere River	Surface	Morogoro	Morogoro	Irrigation
172	MG 101	Mkiti Kiji Mkambarani	Morogoro		4.80	-	Mlulu Stream	Surface	Morogoro	Morogoro	Domestic
173	MG 102	Mkiti Kijiji Kibangile	Morogoro	Morogoro	1.60	-	Mtukila Stream	Surface	Morogoro	Morogoro	Domestic
174	MG 54	Mkiti Maji Bigwa Barabarani	Morogoro		0.40	-	Bigwa Stream	Surface	Morogoro	Morogoro	Domestic
175	RU 0004	Dimon Morogoro Tobacco	Morogoro		4.30	-	Ngerengere River	Surface	Morogoro	Morogoro	Irrigation
176	RU 0013	MD. MOROUWASA	Morogoro		1.17	-	Mgolole Stream	Surface	Morogoro	Morogoro	Public Supply
177	2631	Commissioner for V.Sett.	Morogoro	P.O.Box	0.21	Application	Bwakira River	Surface	Morogoro	Morogoro	Livestock
178	MG 40	Mkiti Kiroka Kiziwa	Morogoro	P.O.Box1880	7.80	Provisional	Maembe stream	Surface	Morogoro Rural	Morogoro	Domestic
179	MG 50	Mvuha Parish	Mvuha	P.O. Box 640 Moro	0.58	-	Kitomoko Spring	Surface	Morogoro Rural	Morogoro	Domestic
180	RU 0003	Omar Awadh Assaid	Morogoro Urban	P.O.Box 727	0.58	Application	Borehole	Groundwater	Morogoro Urban	Morogoro	Industrial
181	3536	Tungi Ltd	Morogoro	P.O.Box 11	9.90	Final	Ngerengere River	Surface	Morogoro Urban	Morogoro	Industrial
182	4007	TAZAMA Pipeline	Morogoro	P.O.Box 2157DSM	0.50	-	Ngerengere River	Surface	Morogoro Urban	Morogoro	Domestic
183	4299	Luth. Junior Seminary	Morogoro	P.O.Box 303	3.20	Provisional	Mgolole Stream	Surface	Morogoro Urban	Morogoro	Domestic
184	4691	Principal TTC Moro	Morogoro	P.O.Box 691	4.20	Final	Mgolole Stream	Surface	Morogoro Urban	Morogoro	Domestic
185	4714	MD. MOROUWASA	Morogoro	P.O.Box 5476	300.90	Provisional	Ngerengere River	Surface	Morogoro Urban	Morogoro	Domestic
186	4828	Bigwa FDC	Morogoro	P.O.Box339	5.00	Final	Mgolole Stream	Surface	Morogoro Urban	Morogoro	Domestic
187	4868	Mr. Karuwesa	Morogoro	P.O.Box 1250	2.00	Provisional	Lukuyu Stream	Surface	Morogoro Urban	Morogoro	Domestic
188	4947	SUA	Morogoro	P.O.Box 3000	8.00	Provisional	Mzinga River	Surface	Morogoro Urban	Morogoro	Domestic
189	MG 26	Bigwa Secondary Sch.	Morogoro	P.O.Box369	0.46	Provisional	Bigwa Stream	Surface	Morogoro Urban	Morogoro	Domestic
190	MG 47	KIJIMAKI	Morogoro	P.O.Box339	0.23	Provisional	Bigwa Stream	Surface	Morogoro Urban	Morogoro	Domestic
191	MG 48	Bigwa Secular Instit.	Morogoro	P.O.Box1003	0.52	Provisional	Bigwa Stream	Surface	Morogoro Urban	Morogoro	Domestic
192	MG 68	Principal TTC Moro	Morogoro	P.O.Box 691	2.90	Final	Nongeni Stream	Surface	Morogoro Urban	Morogoro	Domestic
193	MG 72	Mr. T. Sanga	Morogoro	P.O.Box5476	0.25	Provisional	Pangawe Spring	Surface	Morogoro Urban	Morogoro	Domestic
194	MG 86	MD. MOROUWASA	Morogoro	P.O.Box 5476	1.80	Provisional	Nongeni Stream	Surface	Morogoro Urban	Morogoro	Domestic
195	MG 87	MD. MOROUWASA	Morogoro	P.O.Box 5476	1.70	Provisional	Kilakala	Surface	Morogoro Urban	Morogoro	Domestic
196	MG 88	MD. MOROUWASA	Morogoro	P.O.Box 5476	60.80	Provisional	Morogoro River	Surface	Morogoro Urban	Morogoro	Domestic

Table 2.10 Water Right in Ruvu River Basin (6/6)

Ser. No.	W/Right No.	Name of Applicant	Locality	Address	Quantity (l/s)	Status	Source of Water	Source Type	District	Region	Water Use
197	MG 89	MD. MOROUWASA	Morogoro	P.O.Box 5476	8.90	Provisional	Mgolole Stream	Surface	Morogoro Urban	Morogoro	Domestic
198	4709	Mzumbe University	Mzumbe	P.O.Box 1	4.20	Final	Ngerengere River	Surface	Mvomero	Morogoro	Domestic
199	RU 0011	Chama cha Wakulima Mlali	Mzumbe	P.O.Box 34	10 dry season 70 wet season	Application	Mgera River	Surface	Mvomero	Morogoro	Domestic
200	RU 0016	MzumbeSeco. School	Mzumbe	P.O.Box 19	3.50	Application	Ngerengere River	Surface	Mvomero	Morogoro	Domestic
201	955	Kurt-JungeKibungoEst.	Morogoro	P.O.Box	0.11	-	Stream	Surface	Morogoro	Morogoro	Irrigation
202	4855	Mr. G.Zambetakis	Morogoro	P.O.Box 833	0.05	Final	Ngerengere River	Surface	Morogoro	Morogoro	Irrigation
203	MG 14	SUA	Morogoro	P.O.Box 3000	24.00	Final	Kikundi Stream	Surface	Morogoro	Morogoro	Irrigation
204	MG 14	Mkuu wa Chuo cha Sokoine	Morogoro	P.O.Box	7.00	Provisional	Ngerengere River	Surface	Morogoro	Morogoro	Irrigation
205	MG 67	Mr.A.Y.Lukwaro	Morogoro	P.O.Box	0.11	Provisional	Kitungwa Stream	Surface	Morogoro	Morogoro	Irrigation
206	4928	M/S Kimango Farm	Morogoro	P.O.Box 642	3.00	Final	Ngerengere River	Surface	Morogoro Urban	Morogoro	Irrigation

Note: The data have posibilities to be modified since the work to verify the status of the data is still on-going in Basin office.

Table 2.11 summarizes intake amount sorted and integrated in upstream and downstream of specified gauging station of selected four rivers.

Table 2.11 Intake Amount from Selected Rivers

River Name	Station Code	Total Intake Amount of Upstream (m^3/s)	Total Intake Amount of Downstream (m^3/s)
Ruvu	1H8	0.017* (0.007)	4.866
Wami	1G2	9.002 (9.002)	0.167
Kizinga	1J5	0	0.104

Note *: This figure includes only intake amount from the mainstream of Ruvu river.

( ): This figure shows total intake amount outside of the Study Area out of total intake amount of upstream of the station

2.5.4 POTENTIAL AMOUNT AND AREA OF SURFACE WATER DEVELOPMENT

In making the balance of river discharge, actual intake amount and potential amount for surface water development, the river maintenance flow constitutes key components of estimation of potential amount for surface water development. Although the maintenance flow of a river needs to be determined normally taking into account various aspects such as navigation, fishing, picturesque scenery, salt water intrusion, clogging of river mouth, riparian structures, groundwater table, flora and fauna, and river water quality, the maintenance flow is examined in the following process in this Study:

1. Droughty-water discharge

   Daily natural discharge with a probability of exceedance of 97% is defined as droughty-water discharge, and droughty-water discharge of each year is found from the past discharge data at the gauzing stations of target rivers selected in the previous section.

2. Available discharge

   Average droughty-water discharge over all the observed period is calculated, and it is defined as available discharge.

3. Maintenance flow

   Droughty-water discharge of 10-year return period is calculated by probability analysis, and the value to add the droughty-water discharge of 10-year return period and actual total intake amount of downstream of gauging station is defined as maintenance flow.

4. Potential amount of surface water development

   Potential amount of surface water development is calculated using above investigation results.

Table 2.12 shows the result of the analysis.

Table 2.12 Potential Amount of Surface Water Development

Unit: m^3/s

River	Station Code	Available Discharge (Average Droughty-Water Discharge) A	Droughty-Water Discharge of 10-year Return Period B	Actual Total Intake Amount in Downstream of the Station C	Maintenance Flow Discharge D=B+C	Potential Amount of Surface Water Development E=A-D
Ruvu	1H8	7.073	3.260	4.866	8.126	-1.053
Wami	1G2	6.781	1.611	0.167	1.778	5.003
Kizinga	1J5	0.074	0.015	0.104	0.119	-0.045

Conclusion of the analysis of potential amount of surface water development is summarized as follows:

- The Wami river has enough potential for development. As shown in *Table 2.11*, any intake isn't conducted in the upstream of 1G2 within the Study Area. Therefore, total amount of 5.003 m^3/s is considered as a potential amount of surface water development.
- Because an actual intake amount is beyond the available discharge, the Kizinga river is impossible to develop the surface water newly.
- As for the Ruvu river, available discharge is over the maintenance flow discharge. Since the actual total intake amount is less than available discharge, however, surface water development is considered to be possible if priority of surface water development is put up than securement of maintenance flow. In such case, total amount of 2.197 and 2.207 m^3/s is considered as a potential amount of surface water development of upstream and downstream of 1H8, respectively, taking into account of actual intake amount within the Study Area. At the same time, further surface water development is not recommended after all from the view of river maintenance.

2.5.5 POTENTIAL AREA FOR SURFACE WATER DEVELOPMENT

(1) Potential Area by Distance from the River

In the result of the above investigation, rivers at which surface water development is available is only the mainstream of Wami river. Taking into account the accessibility of the river as a water source, potential area is classified by distance of 5, 10 and 15 km from the mainstream of Wami river.

(2) Potential Area by Vertical Drop from the River

Taking into account the ability of water supply facility, potential area by distance is evaluated using the vertical drop of 100 m from the river as an index. In the result of the analysis using GIS, the area within 5km from the Wami river is selected as a potential area of surface water development.

Figure 2.9 shows the potential area as a result of the above analyses.

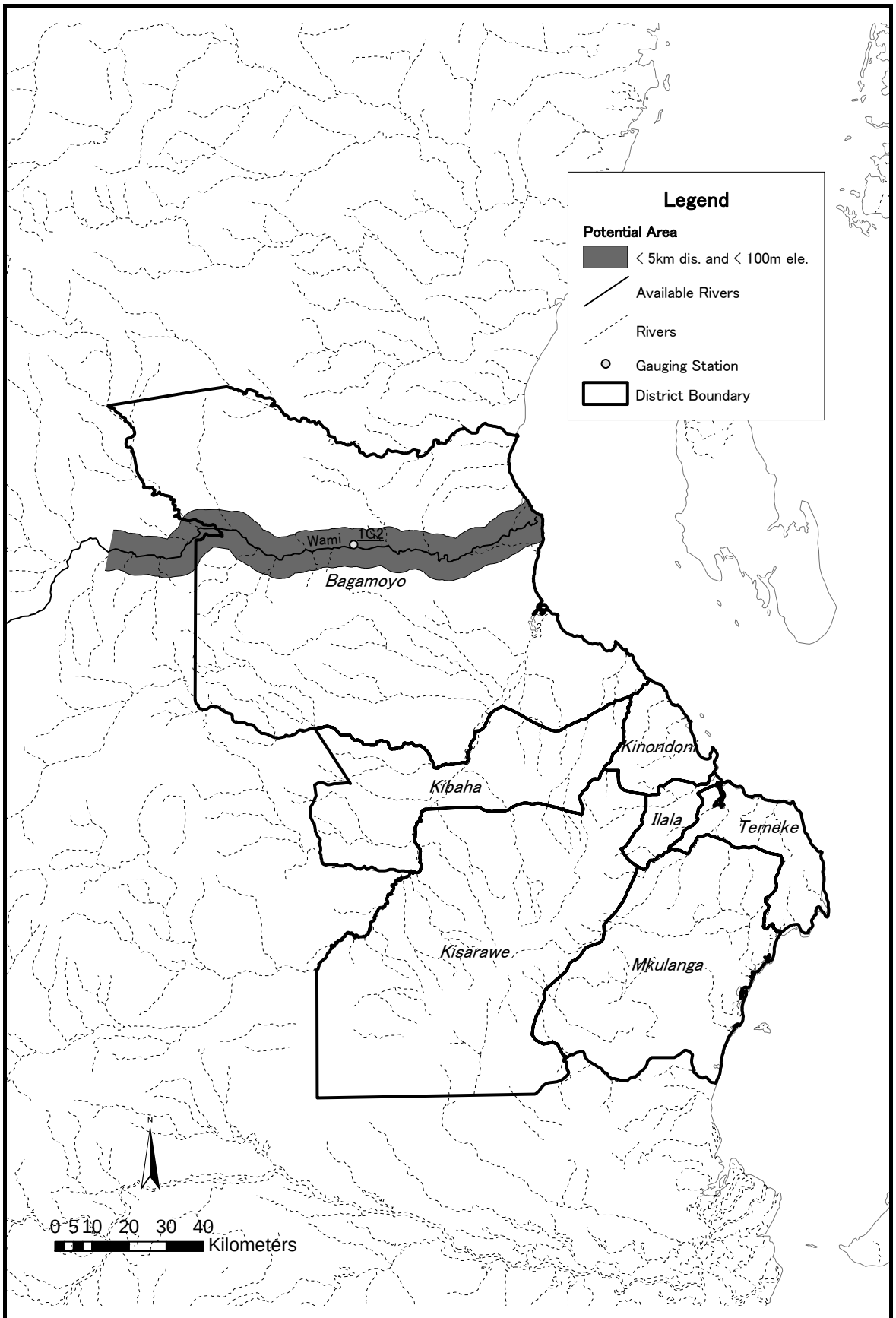

FIGURE 2.9 POTENTIAL AREA OF SURFACE WATER DEVELOPMENT

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Chapter 3

Topography and Geology

CHAPTER 3 TOPOGRAPHY AND GEOLOGY

3.1 INTERPRETATION OF LANDSAT IMAGERY

3.1.1 GENERAL

The Landsat imagery over the two regions of Coast and Dar es Salaam of Tanzania was used for the examination of geological structure, which is one of the factors to control the groundwater occurrence in the Study area.

3.1.2 DATA USED

The latest data of LANDSAT/ETM+ with wide coverage area and the 30m spatial resolutions were used for the examination of imagery. Although some parts of the imagery are clouded over, it does not affect the target area. All of the data were satisfactory for the interpretation. The data list is shown in *Table 3.1*.

Table 3.1 The Data Used for the Interpretation of Imagery

Sensor	Path-Row	Date	Spatial resolution	Projection
LANDSAT/ETM+	167-064	07/07/2000	30m (Band 1-7)*	UTM, zone 37
LANDSAT/ETM+	166-064	30/06/2000	30m (Band 1-7)*	UTM, zone 37
LANDSAT/ETM+	167-065	07/07/2000	30m (Band 1-7)*	UTM, zone 37
LANDSAT/ETM+	166-065	30/06/2000	30m (Band 1-7)*	UTM, zone 37

Note: *; Resolution of Band 6 is 90m

3.1.3 MOSAIC

The digital mosaic of the area was assembled in the following processes, using Band 1, 4 and 5, combination of which emphasizes the colour variation of geological units and structures.

- Edge enhancement.
- DN value correction by using its statistic analysis in overlapping areas between images.
- Mosaicking.
- Geometric correction using GCP.
- Grey level stretching.
- Trimming and annotation

3.1.4 INTERPRETATION

Interpretation work consisted of the following items.

- Photogeological interpretation of extracting of faults and lineaments
- Extracting of fold, bedding and intrusive rock
- Density map of lineaments
- Vegetation index interpretation
- Providing the digitalized files of the above results (ArcView GIS data).

3.1.5 RESULTS OF THE INTERPRETATION

The results of the interpretation are described in the *Section of 3.3.2* Geological Structures in this chapter.

3.2 INTERPRETATION OF AERIAL PHOTOGRAPHS

3.2.1 GENERAL

The aerial photographs over the geological units of Pre-Cambrian, Jurassic and Cretaceous were used for the examination of the micro geological structure. In these geological units, micro fractures are important factor to control the occurrence of groundwater in such basement rock terrain.

3.2.2 LOCATION AND DATA USED

The locations selected and the data obtained for the interpretation are listed in *Table 3.2*. These locations are selected mainly from the locations of geophysical prospecting, to utilise the results of interpretation for the selection of test well drilling location. Since the films are very old, it is developed in 1950th most of area; the photographs are not available in some area. In such case, other remarkable locations near the locations of geophysical prospecting were selected.

Table 3.2 Location and Data of the Aerial Photographs Interpretation

Topographic Map No.	Village Name	Geological Unit	Flight Line	Number of Aerial Photographs
147/4	Kibindu	Pre-Cambrial	197TN3	19 to 25
148/3	Kwamduma	Pre-Cambrial	197TN5	66 to 69
			Sag 2056 8886	142 to 144
167/3	Pongwe FR	Pre-Cambrial	190TN7	051 to 054
167/4	Lugoba	Pre-Cambrial	197TN4	255 to 258
			197TN7	013 to 015
168/3	Kiwangwe	Jurassic	197TN4	221 to 224, 184 to 185
				093 to 097, 200 to 201
184/1	Ubenazomoji	Pre-Cambrial to Jurassic	197TN7	055 to 058
184/3			197TN7	059 to 061
184/2	Chalinze	Cretaceous	190TN7	08 to 012
			197TN1	170 to 173
			107TN4	251 to 254
184/4	Magindu	Jurassic	197TN4	247 to 250
	Lukenge		197TN3	330 to 334
203/1	Kurui	Cretaceous	190TN4	171 to 174
221/1	Kisangire	Cretaceous	190TN4	165
203/3	Mafumbi	Cretaceous	190TN4	159 to 164, 166 to 169
203/4	Msanga	Cretaceous to Neogene	190TN4	60 to 70
203/2	Marumbo	Neogene	190TN4	71 to 75

3.2.3 RESULTS OF THE INTERPRETATION

Most of the interpreted lineaments are related to drainage and few to vegetation and tone difference. The lineaments that trend NNE-SSW dominate over lineament trending NNW-SSE. There are few lineaments having its trend E-W and N-S are observed. A few interpreted lineaments shows either left lateral or right lateral movement. The area where Pre-Cambrian formation is distributed, it is mainly west part of Bagamoyo plateau, have high density of lineament probably because of their signature in drainage and vegetation. General features of geological structure of each geological region are described as follows. Interpreted micro geological feature is shown in *Figure 3.1*.

(1) Precambrian

Considering Kibindu, Kuwamduma, Pongwe, lugoba and Ubenanzomozi areas, the lineaments have more or less northwest-southeasterly and northeast-southwesterly trends which actually tend to follow the main tectonic disturbance (fault directions). The Precambrian block in the area consists of isolated large hills dissected by dendritic valleys. In the Kibindu area, the lineaments indicate NW-SE trending direction as well as NE-SW directions. At certain locations the trending belt appears to be in a N-S direction. The trend may not necessarily be associated with faulting, but also may be due to the whole tectonic activities which affected large part of the mobile Mozambique belt which runs from south to the north.

(2) Jurassic

Kiwangwe, Ubenanzomozi, Magindu and Lukenge, areas are considered. To the east and southeast of the Precambrian block in the vicinity of these areas, the rocks are either overlain by the continental Karoo sediments or marine Jurassic deposits. To a large extent, these rocks are ill-exposed forming an undulating terrain. The area is largely covered by substantial red soil. This thick soil cover is interpreted as remnant of Mkata or Kingolwira surfaces which are tilted easterly. The tectonic structure accommodating these deposits was formed by the down faulted low relief depressions which follows the lineament trends of the Precambrian block. One of this major fault is of NE-SW direction (Tanga Fault) which corresponds to the Karoo Rifting episode which commenced in Permo-Triassic times following the old lineaments. Overstepping the Tanga-Fault Trend between Lugoba and Msata (South of Wami), the marine Middle Jurassic limestones form isolated ridges along the NE-SW lineaments (Kapilima 1984, 2002). The Ngererngere River, which passes through the terrain in a large northward facing arc, is the only perennial stream in the area.

(3) Cretaceous

Chalinze, Kurui, Kisangire, Mafumbi and Msanga areas are relevant. The area is characterized by mainly soft sediments (marls and mudstones) occasional limestones forming an undulating plain. There are no remarkable ridges in this terrain. However, occasionally there are small ridges striking in a NNE direction and dipping gently to the east. Still the trends of the lineaments do not differ significantly from those in older rocks.

At the vicinity of Maneromango, the area is elevated a broad and plateau like structures. However, along the Lake Mansi depression, the flat alluvial sediments are developed which are drained by the northern tributaries of the Rufiji River and finally the Ruvu River.

(4) Neogene

Msanga and Marumbo areas are relevant. The lithology comprises non-consolidated sediment to semi-consolidated course to fine grained sands associated with massive white sandstones. Coastal plain shows two terraces, the narrow lower or coastal terrace which is from sea level to terrace about 10 m high and extends along most of the coast. Holocene sediments are found on the lower terrace and include beach ridges, salt pans, lagoonal silts and deltaic mangrove swamps. The upper or higher terrace is wide and south of the Wami River extends inland for about 6 km to about

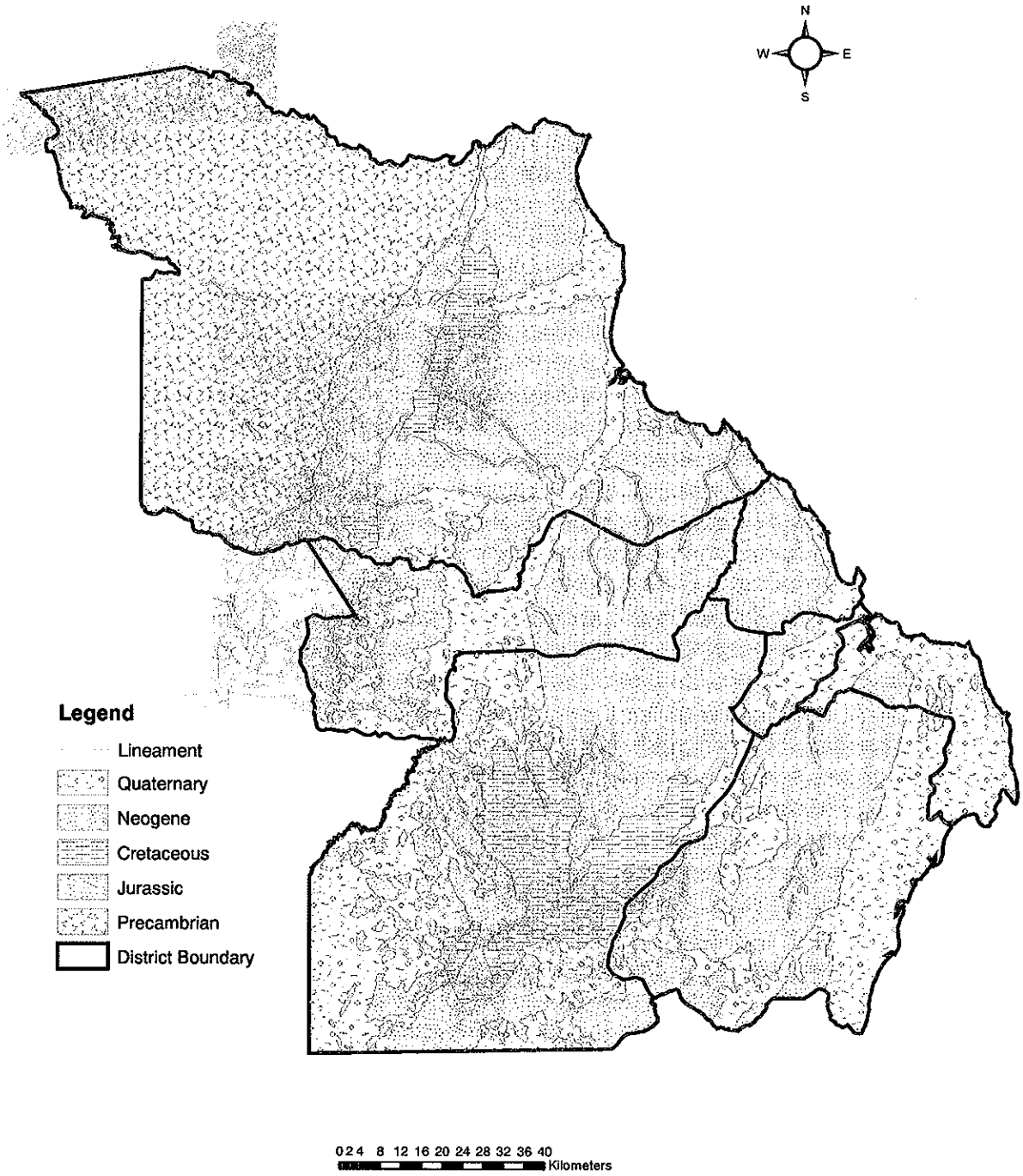


FIGURE 3.1 INTERPRETED MICRO GEOLOGICAL STRUCTURE OF THE BASEMENT ROCK REGIONS

THE STUDY ON WATER SUPPLY IMPROVEMENT IN COAST & DAR ES SALAAM | **JICA**

35 m. Further north the terrace rises gradually about 70 m. The lineaments are more less the same as those of the older formations.

The similarity in structural lineaments can be explained by the tectonic processes which were involved in the formation of the Mozambique belt, the youngest orogenic belt in East Africa. It exhibits north-south structural trends and extends from northern Mozambique and Malawi in the south through Tanzania and Kenya, into Sudan, Ethiopia and Northern Somalia on the Red sea Coast (Peters, 1991).

3.3 TOPOGRAPHY AND GEOMORPHOLOGY

3.3.1 TOPOGRAPHY

On the basis of the digital elevation data of USGS, a topographic map of the study area was delineated as shown in *Figure 3.2*. The contour lines are at 20 m interval.

Heights of the Study area are in a range from 0 m in the coast area along the Indian Ocean to approximately 600 m in the north-western hilly area in Bagamoyo District. The topography in general reflects the geological structure in the Study area. The north-western area, mainly in Bagamoyo District is characterized by the plateau with 200 to 600 m high. The eastern fringe of the plateau is surrounded by generally flat hills of which height is approximately 100 to 300 m. The hilly topography is wide spread in the eastern half of the Study area. Two pairs of hills are recognized elongating in a NE-SW direction. River terraces and coastal terrace are recognized along the Wami River, the Ruvu River and the Indian Ocean.

Major river systems are the Wami Rive, the Ruvu River, Kizinga River and Ngerengere River. Only the Wami and the Ruvu are the perennial rivers. The Wami River and its tributaries deeply eroded the plateau and formed steep and deep valleys. In contrary, the Ruvu River formed wide gentle shape of valleys.

3.3.2 GEOMORPHOLOGIC CHARACTERISTIC

Three major plateau and hilly topographic features are recognized. This topography is dissected into three main blocks by the Ruvu River and the Kizinga-Lowland. Out of three blocks only Msanga-Pugu Hills has a topographical name. In this Study, they are temporarily called the Bagamoyo Plateau, the Msanga-Pugu Hills and the Mkuranga Hills toward from northwest to southeast.

Bagamoyo Plateau rises in the western part of the Study area. The Plateau is formed by the Precambrian rocks in the major part and by the Jurassic and Cretaceous rocks in the eastern marginal area. The Bagamoyo Plateau is sub-divided into two blocks by the Wami River, the Mbwewe Sub-Plateau and the Chalinze Sub-Plateau. The Mbwewe Sub-Plateau is characterized by mountainous features elongated in E-W direction. The highest point is near Kibindu Village and gradually decreases its height toward east reaching 300 m. The Chalinze Sub-Plateau shows rather gentle features with 200 to 400 m of height.

The eastern margin of the Bagamoyo Plateau is fringed with a hill gently inclined to ESE direction. The Hill is called Ruvu Hills formed by the Neogene formation. Elevation of the Hill is from 150 to 200 m. The foot of the Hill is the gently inclined flood plain of the Ruvu River.

Along the Ruvu River, a trench like lowland is recognized. It is called geologically the Ruvu Graben, formed by down-faulting at both sides of the lowland. The Graben is approximately 2 km in width and extends in NNE-SSW direction.

The eastern side of the Ruvu River is characterized by wide spread hilly features of 100 to 300 m in height. There are two hills in parallel elongated in a NNE-SSW direction. The two hills show different features each other. The north-western side of hill is called Msanga-Pugu Hills formed by the Neogene formation. Most of Kisarawe District lies in this area. The Hills has a ridge in

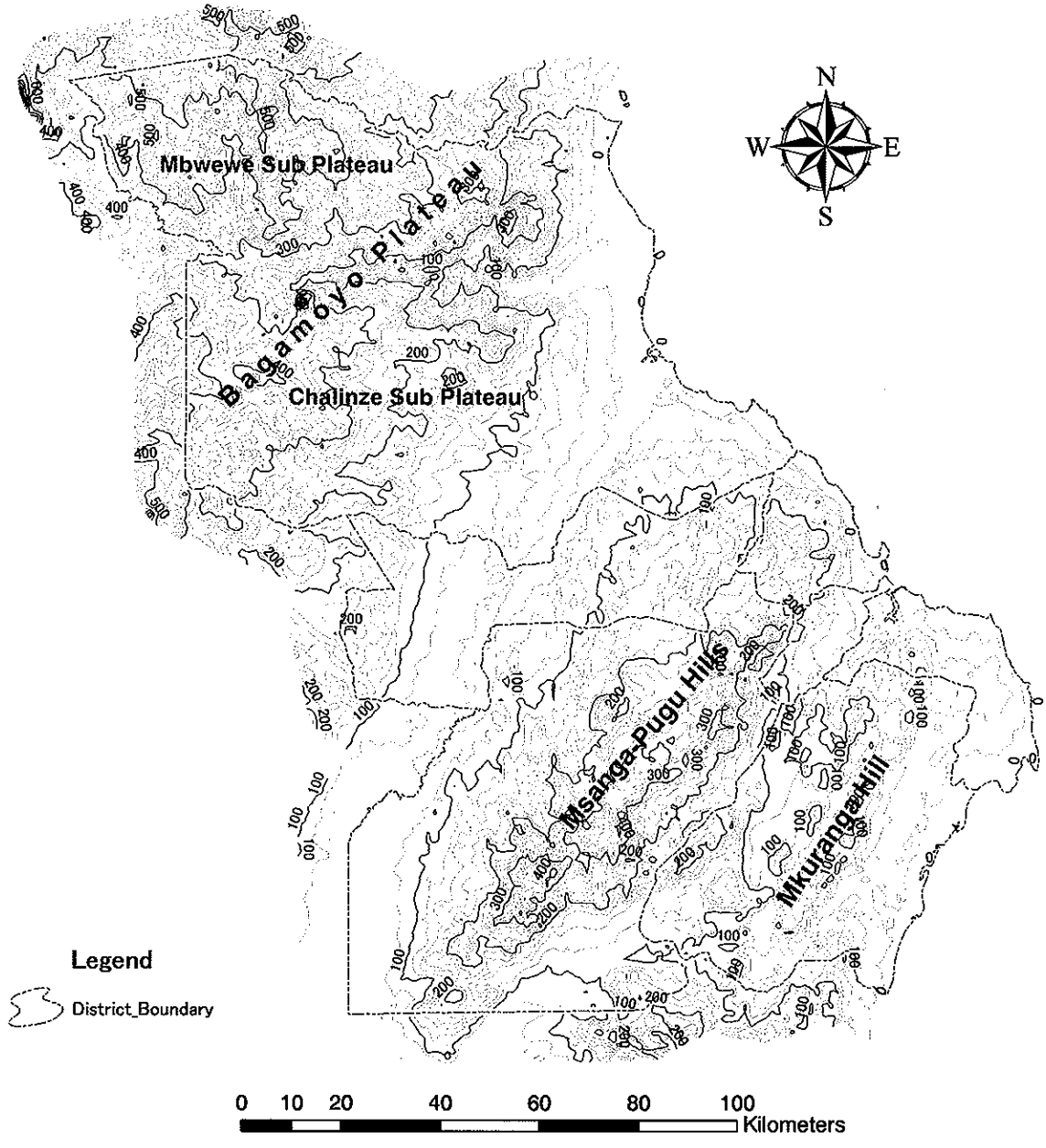


FIGURE 3.2 TOPOGRAPHIC MAP OF THE STUDY AREA

THE STUDY ON WATER SUPPLY IMPROVEMENT IN COAST & DAR ES SALAAM | **JICA**

the eastern margin of which height is 200 to 400m. The eastern side of the ridge is steep slope and the western side is a gentle slope to the Ruvu River. The Msanga-Pugu Hills seems to be tilted to the NW direction.

On the other hand, the southeaster side of hill is generally flat. It is approximately 100 m in height. The hills are called the Mkuranga Hills. The eastern margin of the hill is fringed with the coastal terraces.

3.4 GEOLOGY

3.4.1 GENERAL GEOLOGY OF TANZANIA

The geology of Tanzania comprises mainly the Precambrian (Archaean, Proterozoic) and Phanerozoic (Upper Palaeozoic, Mesozoic and Cenozoic). The Archaean rocks are characterized by a granite-greenstone terrain in which linear belts of greenstones are set in a field of predominantly granitic rocks. The Tanzanian Craton covers the central part of the Territory up to south and east part of Lake Victoria. Most of the granitic rocks are younger than the gereenstones, though a few of them may be older. The geological map of Tanzania is shown *Figure 3.3*. The stratigraphic table with the major geological event is shown in *Table 3.3*.

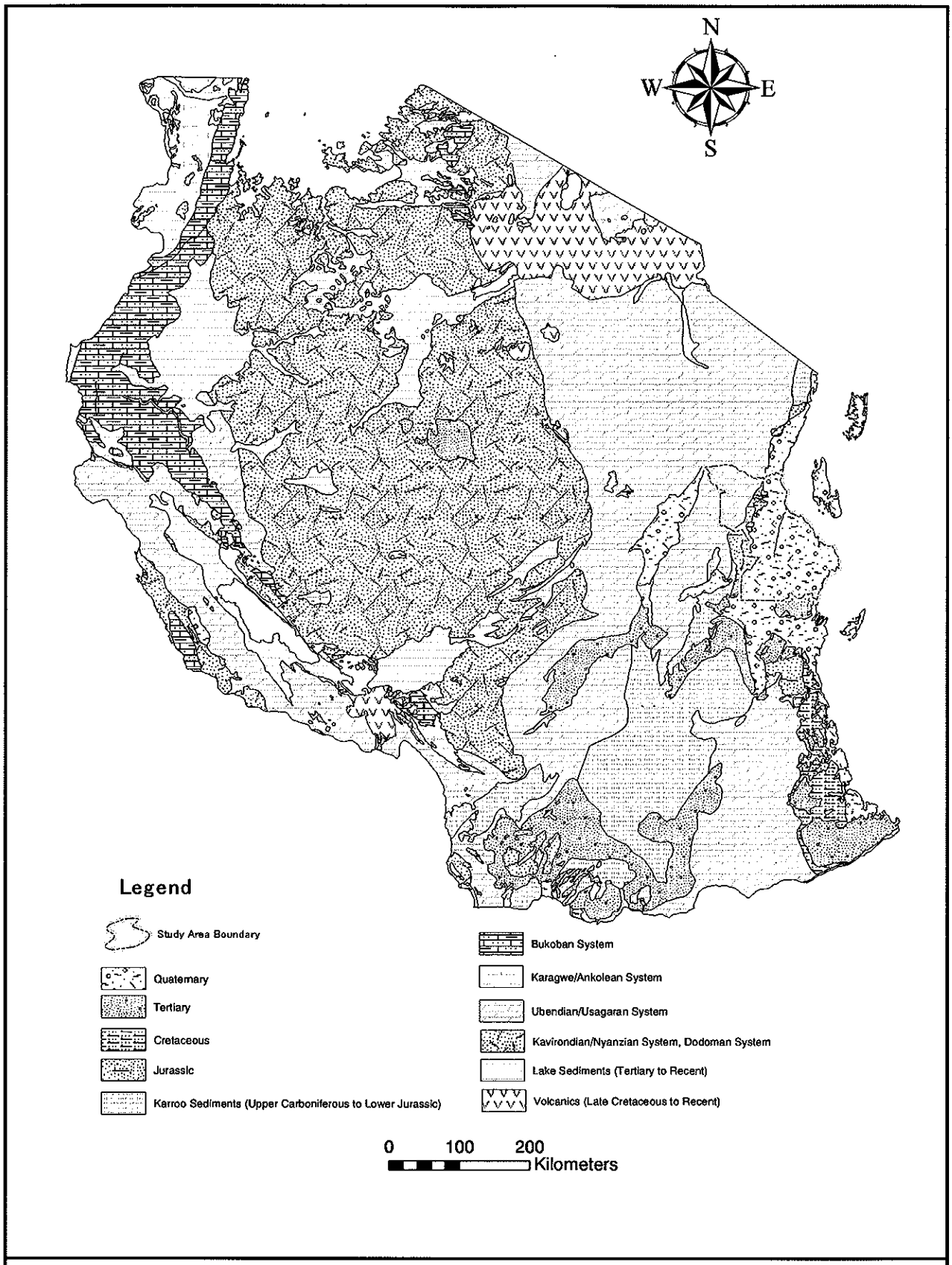


FIGURE 3.3 GEOLOGICAL MAP OF TANZANIA

THE STUDY ON WATER SUPPLY IMPROVEMENT IN COAST & DAR ES SALAAM | JICA

Table 3.3 Stratigraphic Geology of Tanzania, After Spence (1957)

	Period	Sediment	Lithology	Contemporary events and conditions of deposition
QUATERNARY	Recent Pleistocene	Alluvium	Silty clay and sand	
NEOGGENE	Pliocene	Mkindu Beds	Coarse pebbly sand	Slight faulting. Continental deposition on the surface
PALEOGENE	Miocene Oligocene Eocene			Formation of a flat erosion surface
CREATACEOUS		Luwegu-Tunduru sandstones in the south, resting on Karroo beds	Massive friable sandstone	Continental deposition. Folding and igneous intrusions.
JURASSIC	Upper	Kitunda Limestone	Sandy, oolitic limestone	Sediments deposited in a shallow sea. Marine transgression
	Middle			
	Middle	Ngerengere Beds	Coarse, calcareous sandstone	
	Lower			
KARROO Upper Carboniferous to Lower Jurassic	Storm berg series	Coarse sandstone of the Rufiji River	Coarse sandstones	Uplift.
	Beau ford Series	NYAKATITU SUCCESSION	VIII Sandstone and red mudstone	Estuarine deposition becoming continental at top
			VII Sandstones	Marine incursion
			VI Sandstone and black and green mudstones V Black shales	Estuarine deposition Faulting and uplift
			IV Coarse sandstones and shales	
			III Coarse sandstones and shales	
	Ecca Upper Series		II Coarse sandstones	Continental deposition
			I Coarse sandstone and red mudstone	
	Lowe Mvuha Beds			Faulting
	Dwyka series		Coarse sandstone conglomerates and shales	Dwyka glaciation
PRECAMBRIAN	Basement		Gneiss, schists and dolomite limestone	

N.B.-Alternative brackets denote unconformities.

(1) Precambrian Geology

The Precambrian rocks in Tanzania are represented by the Archaean and Proterozoic rocks.

1) Archaean

Dodoman System:

The rocks assigned to the Dodoman are of Archaean age and appear to be older than the greenstones and their granites. The Dodoman is mainly of sedimentary origin and forms a band across the southern part of the craton.

Nyanzian system:

This system comprises the sequence of dominantly mafic volcanic rocks and immature sediments which form the greenstone belts of the central craton. The Nyanzian greenstones are of major economic importance as they host most of Tanzanian's gold deposits. The rocks can be subdivided into a Lower and an Upper Series on basis of a recognizable upward transition from mafic to felsic lavas, with minor tuffs and interbedded sediments. The Lower Series

consists primarily of basalt, andesite and dacite pillow lavas. The sediments include banded iron formation (BIF) recrystallized cherts, and some shale and conglomerate. The Upper Series of the Nyanzian sequence is characterized by the assemblage of felsic lavas, tuffs, and ferruginous cherts, BIF and subordinate meta-pelites. The presence of BIF within units consisting mostly of felsic tuff is a constant relationship. Maximum thickness of the banded iron formations is probably between 100 m and 400 m whereas the maximum thickness of felsic tuff is on the order of 2,000m to 4,000 m. The greenstones are generally metamorphosed to greenschist facies, locally to almandine amphibolite facies.

Kavirondian System:

These rocks occur in northernmost Tanzania (Musoma-Mara greenstone belt) but are more widely distributed in adjacent Kenya. They comprise mainly of conglomerates, coarse arkosic and feldspathic grits and quartzites resting unconformably on the Nyanzian rocks from which they have been partially derived.

Granite-Gneiss Terrain:

These rocks form the matrix surrounding the greenstones. As in most Archean cratons, the age relations are not clear, with some granites clearly intruding greenstones, some possibly older than greenstones but most of indeterminate affinity. Some age dates are clearly Proterozoic, while others are purely Archaean.

2) Proterozoic

The Proterozoic include the Ubendian System, Usagaran System, and Karagwe – Ankolean System.

Ubendian System:

This comprise Lower Proterozoic to Archaean mobile belt rocks bounds the Archaean craton on its southwest side. It includes a variety of high grade metamorphic rocks of both sedimentary and igneous origin and is thought to contain a large component of reworked Archean rocks. The dominant lithology is gneiss with minor mafic and ultramafic intrusives, late granites and rare marbles. Structural trends are mainly northwesterly. Metamorphism is mainly of the almandine amphibole facies, rarely reaching the granulite facies.

Usagaran System:

Again this system consists of metamorphic rocks and occurs south and east of the Archaean craton. Granulites and biotite gneisses of politic origin make up a large portion of the unit, with quartzites also common. The granulite facies of metamorphism is attained in a number of areas. The Usagaran contains metamorphosed Archean material. Structural trends are dominantly to the southwest. Rocks of granulitic facies of the Ubendian and Usagaran Systems are rich in a variety of coloured gemstones.

Karagwe Ankolean System:

This system forms part of the Kibaran Fold Belt which extends from Uganda to Zambia, west of Lake Victoria, and underlies the western extremity of Tanzania. It is younger than the Ubendian and Usagaran, and bears different lithologies and structures. The sedimentary features of the Karagwe – Ankolean rocks reflect shallow water deposition, with argillites, phyllites, low grade sericite schists and quartzites. The granites have alteration haloes containing tin and tungsten mineralization in veins. The sedimentary sequencwe strikes to the north in general, but is deformed into ovoid domes by the granites. Resistant quartzites form ridges enclosing oval “arenas” around these domes.

Bukoban System:

The Bukoban rocks represents the rocks at the Proterozoic-Palaeozoic boundary, they are weakly deformed but not metamorphosed. It includes sandstones, quartzites, shales, red beds, dolomitic limestones, chert and amygdaloidal lavas. The Bukoban occurs mainly in the northestern quarter of Tanzania.

(2) Phanerozoic Geology

The Phanerozoic rocks comprise the Upper Paleozoic to Lower Mesozoic (Karoo System), Upper Mesozoic and Cenozoic.

Karoo System:

The term Karoo has originated from South Africa to denote largely continental sediments ranging in age from Carboniferous through Permian to Lower Jurassic with occasional marine incursions. The marine incursions are associated with evaporitic sequence (gypsum, anhydrite, salt) well developed in the Mandawa Basin. Along the Tanzanian coast, the Karoo Rifting episode developed during Permian (Kent 1972). This phase was the first manifestation of the sedimentary tectonic events affecting the whole coastal region. The Karoo sediments in Tanzania consists predominantly fluviatile coarse grained arkosic sandstones, siltstones, shales associated with coal deposits and uranium traces. They unconformably overly the Precambrian basement complexes. The tectonic structure accommodating these Karoo deposits was a result of occasional subsidence followed by the down-faulted low relief depressions which were filled with clastic sediment.

Upper Mesozoic:

This includes Upper Mesozoic sedimentary rocks on the coastal basins. The sediments consist of coralliferous limestones, calcareous sandstones, septarian marls, and shales. The basins in which these rocks accumulated apparently were formed during break-up of the Gondwana continent during Middle Jurassic times.

(3) Cenozoic Geology

Rift Valley Faulting:

The breakup of the eastern side of the African Plate during Mesozoic time greatly accelerated during the late Cenozoic time. The East African Rift system consists of a series of en echelon grabens or rift valleys often associated with volcanism. In Tanzania, rifting is concentrated along two arms, the Western Rift occupied by lakes Nyasa and Tanganyika and the Eastern (or Gregory) Rift, passing through Lake Natron to Lake Nyasa. There are also subsidiary rift grabens at Lake Rukwa, along the Indian Ocean coast in the Selous Basin of southeast Tanzania. The rifting created lakes Nyasa, Tanganyika, Rukwa, Eyasi, Manyara, Natron and other small ones. The rifts have been the sites of sedimentation during Cenozoic time. Karoo rocks are preserved only in these depressions. The coastal basins contain several kilometers of marine sediments, mainly of Miocene and younger. The unconsolidated clay bound sands, which are fluvial continental, overlie sporadically the Miocene sediments.

Igneous Rocks:

In East Africa, as elsewhere is accompanied by volcanic activity and hot springs Kilimanjaro volcanic province in northeast and Rungwe volcanic province in the southeast. In both areas, the rocks are intermediate to mafic alkalic extrusives, with local intrusives. Emplacement of diamond bearing kimberlite was another, but minor volcanic event.

Residuals:

Extensive portions of the land surface underlain by Precambrian rocks have been subjected to intensive physical and chemical weathering for tens of million years. Intermittent uplift lead to peneplanation during Late Cretaceous to Tertiary, the prolonged weathering event lead to the formation of laterites and bauxites underlain by substantial thickness of kaolinitic saprolites (Mutakyahwa, 1991).

3.4.2 GEOLOGY OF STUDY AREA

Geological map of the study area is shown *Figure 3.4*. A total of six major geological formations of 1) Precambrian, 2) Jurassic, 3) Cretaceous, 4) Neogene and 5) Quaternary are identified. The geological features of each formation distributed in the Study area are summarized as follows.

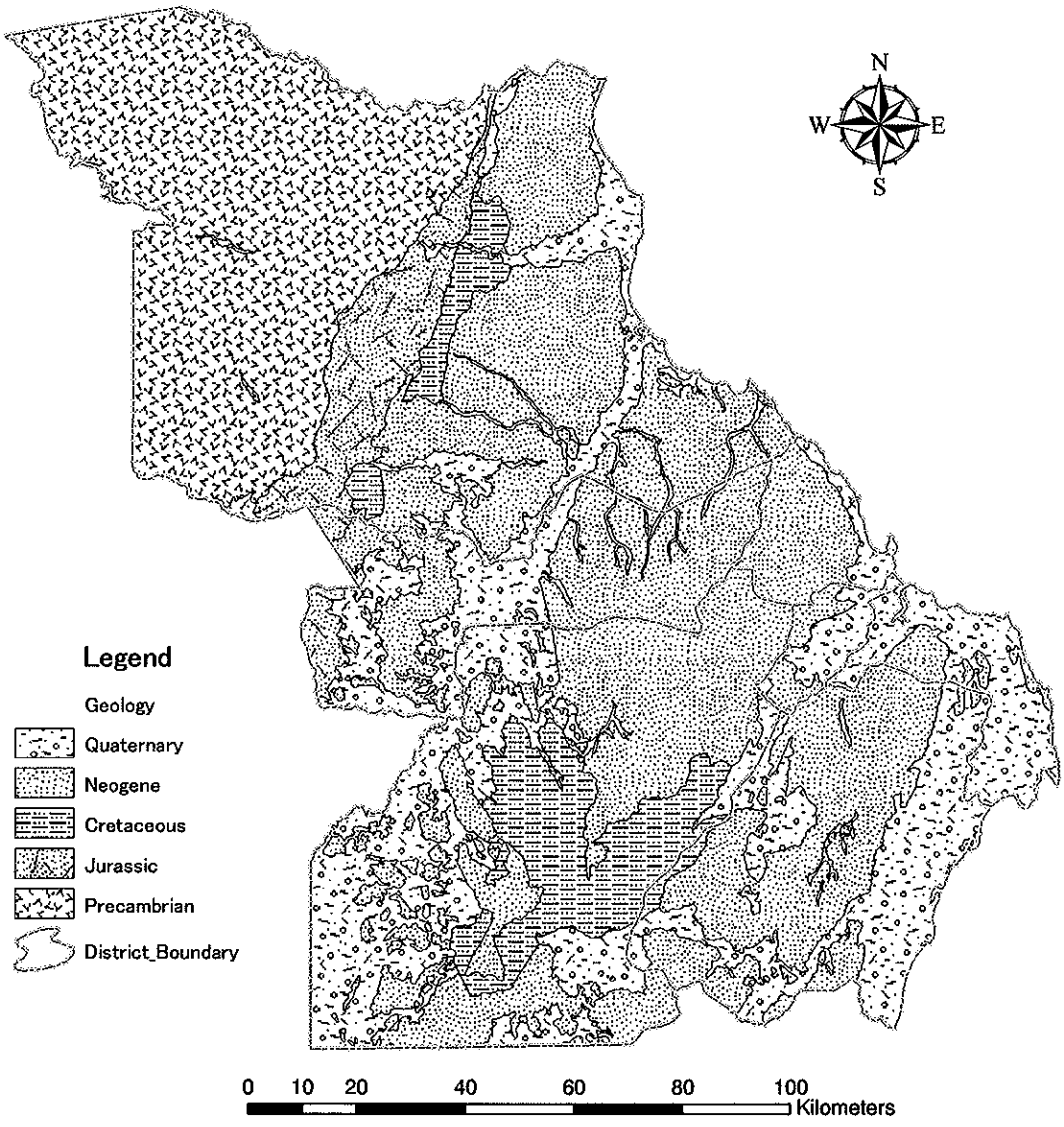


FIGURE 3.4 GEOLOGICAL MAP OF THE STUDY AREA

THE STUDY ON WATER SUPPLY IMPROVEMENT IN COAST & DAR ES SALAAM | **JICA**

(1) Precambrian

The Precambrian is distributed mainly in Bagamoyo Plateau. Miono, Kibindu, Mbwewe, Msata and Ubenazomoji Wards are main Ward included in this area. It consists mainly of gneiss and granulite in the lower part and crystalline limestone intercalated with schists and gneiss. Many faults and lineaments are recognized in the area. Due to weathering of formation, surface of Bagamoyo Plateau is generally dense covered by soils. Outcrops area limited in areas along the rivers such as the Wami River and its tributaries where the rocks are fresh.

As mentioned in Clause 4.2 of this Chapter, the Precambrian rocks are extensively fractured and faulted. It is recognized in both satellite images and aerial photos. Fractures and lineaments are concentrated in Kwandoma village and in the area around Ubenazomoji.

In general, the groundwater often occurs in such fissures, lineaments, joints and weathered zone.

(2) Jurassic

The eastern edge of Bagamoyo Plateau is occupied by the Jurassic which unconformably overlies the Precambrian and overlain by the Cretaceous. Villages, Masuguru, Kisanga and Malivundo in Bagamoyo District are located in this area. The Jurassic is unmetamorphosed and comprised mainly of sandstone intercalated sometimes with shale, siltstone and conglomerate.

It is pointed out by Aitken (1959) that early Jurassic sequence began with boulder-bearing sandstones. It is confirmed in this Study; boulder bearing sandstone uncomformably overlies gneiss of Precambrian in Misasa Village, Lugoba Ward, Bagamoyo District (See, *Figure 3.5*). The Middle Jurassic is consists of reef limestone and the Upper Jurassic is composed of sandstone and siltstone. Jurassic sandstone is well consolidated filling the matrix with fine materials.

Jurassic sandstone is considered as impermeable; fissures, lineaments, joints and weathered zone are expected to store groundwater.

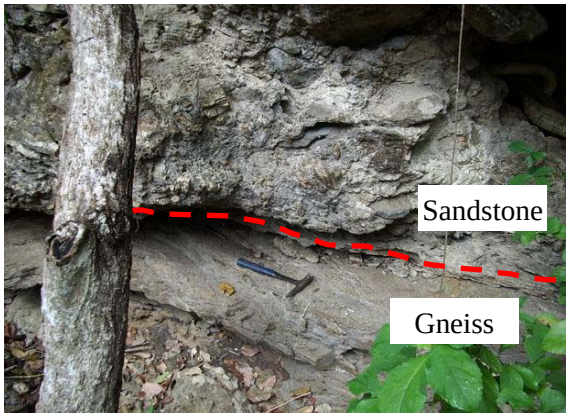


Figure 3.5 Outcrop of Boulder-Bearing Sandstone

(3) Cretaceous

The Cretaceous crops out in narrow areas occupying the edge of Bagamoyo Plateau. It is underlain by the Jurassic and overlain by the Neogene. Only Talawanda Village, Bagamoyo District falls in this area. Another distribution area is in the southwestern foot of the Msanga-Pugu Hills; many villages in Kisarawe District located in the south from Masaki Village fall in this area. In this area, the Cretaceous Formation is distributed in the hillside and foot of hills underlying the Neogene Formation.

The Cretaceous is divided into three formations, Wami Formation, Kisanga Shale Formation and Luzengozi Formation in ascending order (Bayliss 1973).

The Wami Formation (Lower part) is characterized by a basal succession of thinly bedded silty shale and sandstone. This sequence is overlain by shale with interbedded sandstone (Kiwanga Shale Formation: Middle part). The sandstone unit is intercalated with sandy limestone and shale, (Kigua sandstone). The Luzengozi Formation (Upper part) is a sequence of shale.

Fissures and lineaments are less developed in the Bagamoyo Plateau. On the other hand, they are well developed in the southeastern side of the Msanga-Pugu Hills as shown in *Figure 3.6*.

The Cretaceous is consolidated sedimentary rocks and most of the formation is occupied by shale or clayey sediments. Therefore, groundwater can be stored in weathered rocks, and

fissure, joints and faults zones.

(4) Neogene

The Neogene strata occur widely in the eastern half of the Study area, covering most of areas in Ruvu Hill, Msanga-Pugu Hills and Mkuranga Hills.

Detailed discussion on the Neogene in the Study area was made by Tample (1970). The Neogene consists of less sorted intercalation of sandy clay and clayey sand accompanied by lenses of sand and clay. The matrix is always clayey. It is suggested that the Neogene deposited in a fresh to salt water, sub aerial to marine environment.

A study by CIDA (1979) revealed that montmorillonite was dominantly contained in the Neogene sediments. It is a reason why no continuous aquifers exist within the Neogene sediments. An outcrop in the cut along the road from Dar es Salaam to Kisarawe well shows the characteristics of the Neogene sediments (See *Figure 3.6*). In the outcrop, the sediments is mainly consists of less sorted fine sand with clayey matrix. Bedding planes are recognized and sometimes cross-bedding are developed. Permeability of the sediments seems to be low.

Figure 3.6 Outcrop of Neogene

Fractures and faults are well developed in the Msanga-Pugu Hills (See, *Figure 3.6*); N-S and NNE-SSW directions of faults and NNW-SSE and NNE-SSW directions of lineament.

The geological history of Neogene in the Study area is summarized by CIDA (1979) as shown in *Table 3.3*.

(5) Quaternary

The Quaternary is distributed in a limited area, along the Ruvu River, near the river mouth of the Wami River and along the coast. These deposits consist of sand, gravel, silt and clay.

A fluvial deposit is distributed filling the Ruvu Graben along the Ruvu River. The thickness of this deposit has not been confirmed, but it is estimated more than 100m from the existing borehole data.

Near the river mouth of the Wami, an alluvial fan is formed. Other alluvial deposits are recognized in the urban area of Dar es Salaam and along the coast.

The fluvial and alluvial Quaternary except the coastal deposit seems to be a good source of groundwater due to its permeability and recharge received from rivers.

Table 3.4 Geological History of Neogene in the Study Area, After CIDA 1979

HOLOCENE/RECENT			C.O.D. rising sea levels giving rise to erosion 2m. terrace (Threfall, 1950; Chittick, 1962; Battistini 1966) post-glacial maximum Rising sea level to C.O.D 40m. submerged channel (koert, 1913) 12m. terraces (Alexander, 1968)= 30m terrace at Bagamoyo (Moore, 1963) (23,800)= 1,000 B.P Alexander 1965). Faulting leading to the deformation of the older reefal limestones.
PLEISTOCENE	Upper	Eustatic fluctuations of sea level-not fully worked out-insufficient data	
	Middle		
	Lower		
			Wazo Kunduchi and? Kimbiji-Buyuni marine limestones (Holroyd,

Upper PLIOCENE Lower		1954 Moore, 1963) Faulting probably plio-pleistocene, leading to deformation of the Neogone erosion surface; development of the Ruvu fault? (Saggerson & Baker, 1965).
Upper		Erosion leading to the development of a Neogene erosion surface (Spence, 1957 Bartholomew, 1963); no upper Miocene or Pliocene rocks in the area.
MIOCENE Lower		Uplift and marine regression? Movement along coastal faults. Clay bound sand mbiji series deltanic estuarine facies with marine intercalations i.e. minor marine oscillations. Minor unconformity.
		Kaolinitic and dolomitic sandstones and shales of the Pugu series. (Reck & Dietrich, 1921; Quennel, Mckinlay & Aitken, 1956; Zehnder,1958).

3.4.3 GEOLOGICAL STRUCTURES

(1) General Geological Structure

The Study area is located in the eastern side of the "East African Rift valley" and its structural development is similar to a typical continent (Kent et al, 1971). The East African Rift System and associated regional geology were discussed by Baker (1971); Baker and Whohlenberg (1971); Baker et al (1972); Degens at al (1971); Furon (1963); Houghton (1965); King (1970); Quennel et al (1956); McConnell (1972); and Pallister (1971).

The first geological map published is contributed by Kent et al (1959): Geological Map of Tanganyika (1:1,000,000). A couple of geological maps in a scale of 1:250,000 were prepared in the Study area by following authors;

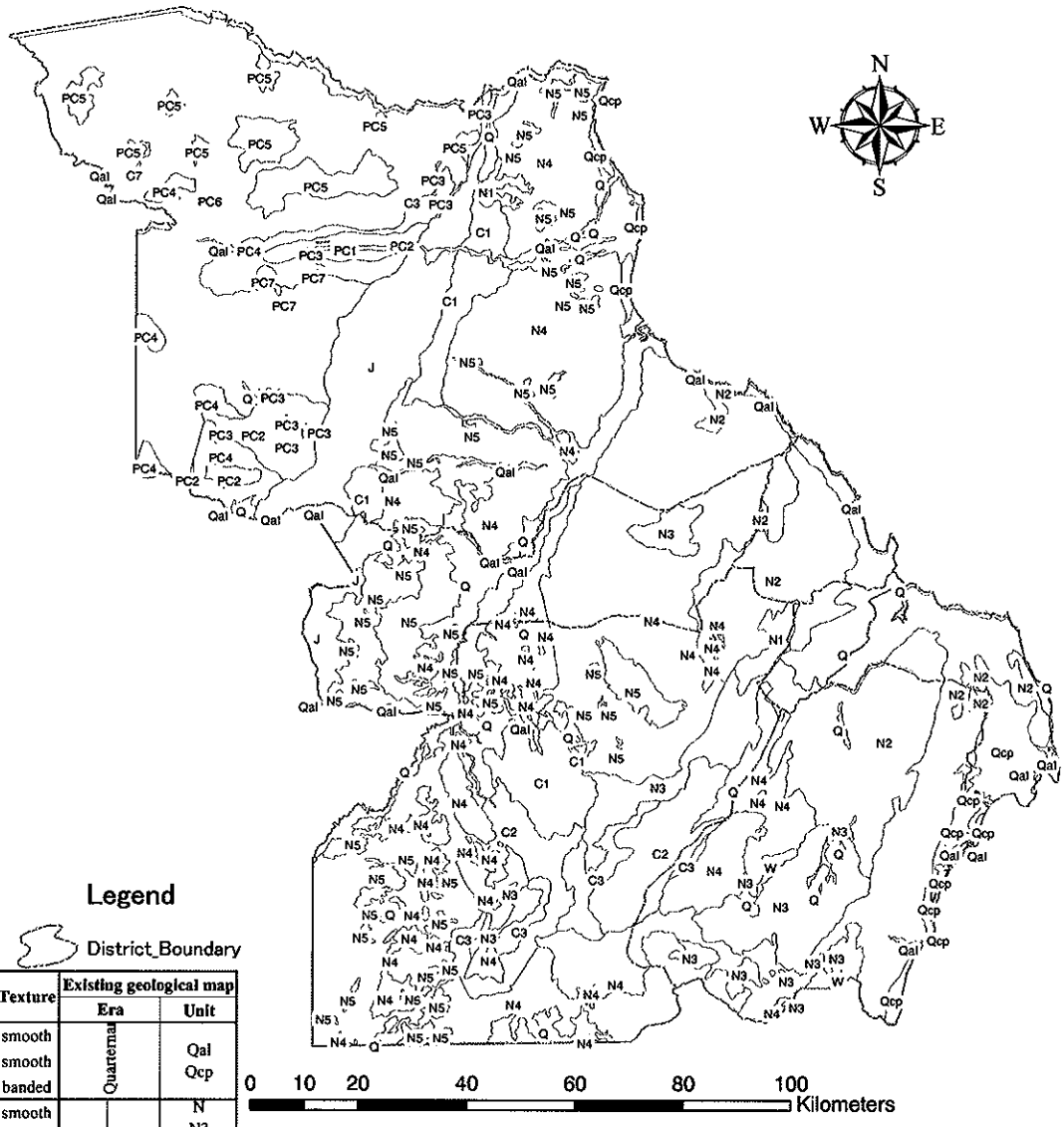
- Bagamoyo: Moor (1963)
- Kindugallo: Wright and Aitken (1960)
- Dar es Salaam: Bartholomew (1963)
- Mbwewe: Solesbury et al (1973)

Geology of the Study area is composed of Precambrian Basement Rocks and overlying Jurassic, Cretaceous, Neogene and Quaternary Formations.

The basement rocks occur in the western plateau area, Bagamoyo Plateau, and the younger formations successively overlies toward east. The Neogene widely occupies the central to eastern part of the Study area. Those formations are cut by faults. Lineaments are well observed in every formations; NNE-SSW as main direction, and N-S and NNW-SSE of sub ordinary direction and as minor direction of E-W. The most remarkable structure is Ruvu Graben which is a low land formed along the Ruvu River by down faulting. The Ruvu Graben divides the Study area into two blocks; the western side is occupied by mainly older formations, the Precambrian, the Jurassic and by the Mesozoic and Neogene in the eastern side of Msanga-Pugu Hills and Mkuranga HIlls.

(2) Interpreted Geological Units

Based on the photogeological interpretation of landsat image, geological unit is classified as shown in *Figure 3.7* and *Table 3.5*. A total of 19 geological units are distinguished and these are contrastive to the units of the existing geological map in each formation of Pre-Cambrian, Jurassic, Cretaceous, Tertiary and Quaternary Era. General features of each unit are as follows.



Legend

District_Boundary

Unit	Texture	Existing geological map		
		Era		Unit
Q	smooth	Quaternary		Qal
Qal	smooth			Qcp
Qcp	banded			
N5	smooth	Tertiary	Paleogene	N
N4	smooth			N3
N3	mottled			N2
N2	rough			N1
N1	smooth			Nm
				Npl, Nph
C3	rough	Cretaceous		C
C2	smooth			C3
C1	smooth			C2
				C1
J	smooth	Jurassic		Jsc, J, Jsa
PC7	rough	Pre-Cambrian		PC
PC6	smooth			
PC5	mottled			
PC4	rough			
PC3	smooth			Xcd
PC2	rough			PC
PC1	rough			

FIGURE 3.7 DISTRIBUTION OF THE GEOLOGICAL UNITS

THE STUDY ON WATER SUPPLY IMPROVEMENT IN COAST & DAR ES SALAAM | **JICA**

Table 3.5 Classifications of the Geological Units

Unit	Texture	Drainage		Rock Characteristics		Existing geological map		
		Pattern	Density	Residence	Bedding	Era		Unit
Q	smooth	-	-	-	-	Quarternary		Qal Qcp
Qal	smooth	meandering	medium	-	-			
Qcp	banded	-	-	-	-			
N5	smooth	-	-	low	massive	Tertiary	Paleogene	N
N4	smooth	sub-parallel	low	low	massive			N3
N3	mottled	sub-parallel	low	low	massive			N2
N2	rough	dendritic	high	low	massive			N1
N1	smooth	sub-parallel	low	moderate	massive			Nm Npl, Nph
C3	rough	sub-dendritic	medium	moderate	massive	Cretaceous		C C3 C2 C1
C2	smooth	sub-dendritic	medium	moderate	massive			
C1	smooth	sub-parallel	low	moderate	massive			
J	smooth	sub-dendritic	low	low	massive	Jurassic		Jsc, J, Jsa
PC7	rough	-	-	high	massive	Pre-Cambrian		PC Xcd PC
PC6	smooth	sub-parallel	low	low	massive			
PC5	mottled	sub-dendritic	low	low	massive			
PC4	rough	sub-dendritic	low	low	massive			
PC3	smooth	-	-	high	bedded			
PC2	rough	sub-parallel	high	low	massive			
PC1	rough	dendritic	high	low	massive			

1) Pre-Cambrian

Geological formation of Pre-Cambrian is distributed in hilly terrain of western part of Bagamoyo and Kibaha districts. The formation is classified as 7 units from PC1 to PC7. PCI, PC2, and PC4 are distributed along the Wami River flows from east to west. These units have well developed arborescens drainage texture. PC3 corresponds with crystalline limestone, dolomitic limestone of Xcd in existing geological map, and distributes as a layer within the PC2 and PC4. PC5 is distributed in the northern end of study area, and have well developed drainage texture. PC6 is distributed extensively in the Pre-Cambrian, and forms flatland of the area. It is generally smooth texture; the drainage texture and bedding stratification are poor. PC7 is distributed in very limited area along Wami River. It is considered that the unit is intrusive rock of Pre-Cambrian.

2) Jurassic

Jurassic geological unit (J) is distributed band of NNE-SSW direction from central to northern part of study area. The unit corresponds of calcareous shale or sandstone (Jsc) of the existing geological map. It is generally smooth texture; the drainage texture is poor.

3) Cretaceous

Geological formation of Cretaceous is distributed in central and northern part of the study area. From the configuration of the ground surface, the formation is classified as three units of C1 to C3. C1 is distributed in hilly terrain of central part of Kibaha district. The drainage texture is not developed well, it is generally smooth. C2 is distributed in eastern and western slope of central hilly terrain of Kibaha district. Compare with C1, drainage texture is much developed. C3 is distributed in south-eastern part of hilly terrain of Kibaha district. The units have well developed arborescens drainage texture.

4) Neogene

The Neogene formation ranges all over the study area, and classified as five units of N1 to N5. N1 is identified limited area of northern part of the study area. This unit corresponds with Npl (coarse grain sandstone) and Nph (fine to medium grain quartz sandstone) of the existing geological map. N2 is distributed in eastern part, Kinondoni and Ilala municipals of Dar es Salaam Region. The unit shows thickly developed straight through or arborescens drainage texture. N3 is distributed hilly area of Kisarawe and Mukuranga Districts. The drainage texture is not developed well, it is flat land. N4 and N5 range all over the study area. These are generally shows smooth texture, except deep erosional valley Wami and Ruvu drainage areas.

5) Quaternary

The Quaternary units of Q, Qal and Qcp are distributed in flood plain, alluvial plain and coastal plain of the study area, respectively.

(3) Results of Lineament Analysis

Lineaments interpretation image is shown in *Figure 3.8*. Major lineaments are likely in a specific orientation and continuous on the image. The major lineaments are mainly developed in N-W, NE-SW and NW-SE directions. General features of the imagery are as follows;

1) Northeast Area

The area is hilly terrain, and Pre-Cambrian and Jurassic formations are distributed. The area is also densest lineaments and faults developed area within the study area. In general, the N-S orientation predominates. In additions, in the vicinity of the boundary of Pre-Cambrian and Jurassic, the lineament of NW-SE orientation is observed.

2) Central Area

The area is hilly terrain. The geological formations of Cretaceous to Neogene are distributed. In general, N-S and NE-SW orientations are well developed in this area. The NE-SW orientation is developed in parallel with extension of geological unit of Cretaceous and Jurassic.

3) Southern Area

The area is flatland and Neogene formation ranges. The minor lineaments are mainly developed in NE-SW, NW-SE and N-S directions. NE-SW orientation is mainly developed in the vicinity of the boundary of Neogene and Quaternary. NW-SE orientation is developed in the edge of Neogene unit, and it is in parallel with Ruvu River. N-S orientation is mainly developed in the boundary of Neogene and Quaternary of the coastal plain, it is in parallel with coastal line.

Figure 3.9 lineament density map shows that the lineaments are dense in northeast and central part study areas where Pre-Cambrian to Cretaceous formations is distributed. High density areas exist in the vicinity of crossing N-S and NW-SW directions of the northeast, and crossing N-S and NE-SW directions of the northeast of the central. In the southern part of the study area, in the area crossing N-S and NE-SW directions is slightly dense.

(4) Comprehensive Analysis of the Landsat Imagery

Based on the photogeological interpretation and lineament analysis, to understand the occurrence of the groundwater resources, important geological and structural features of the area are examined. *Figure 3.10* of comprehensive analysis map shows that the study are can be classified into four geological zones of 1) Wami zone, 2) Ruve zone, 3) Dar es Salaam – Maneromango zone and 4) Rufiji zone.

1) Geological Structural Features

General features of the geological structure of the four zones are as follows;

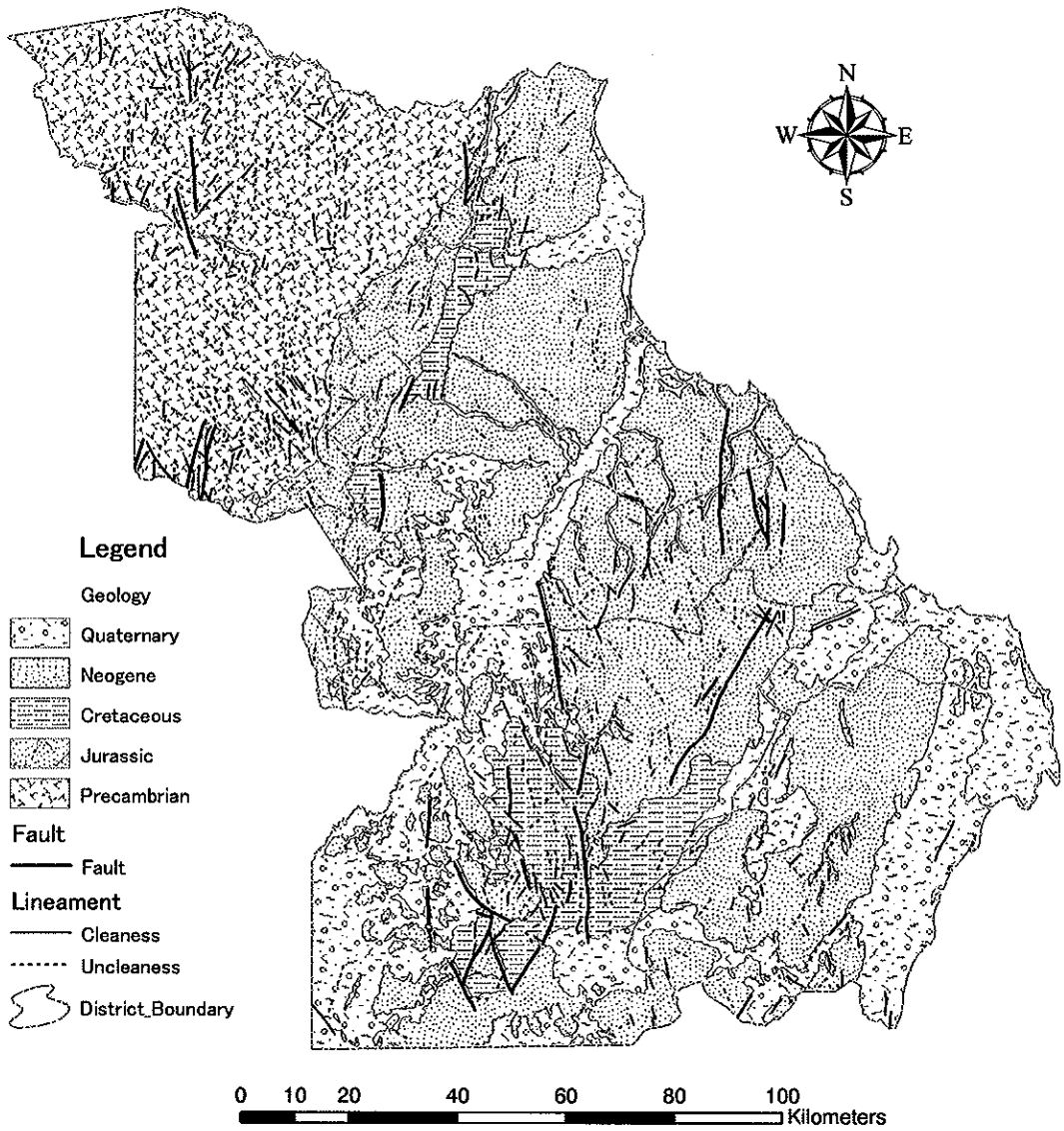


FIGURE 3.8 LINEAMENT INTERPRETATION IMAGE

THE STUDY ON WATER SUPPLY IMPROVEMENT IN COAST & DAR ES SALAAM | **JICA**

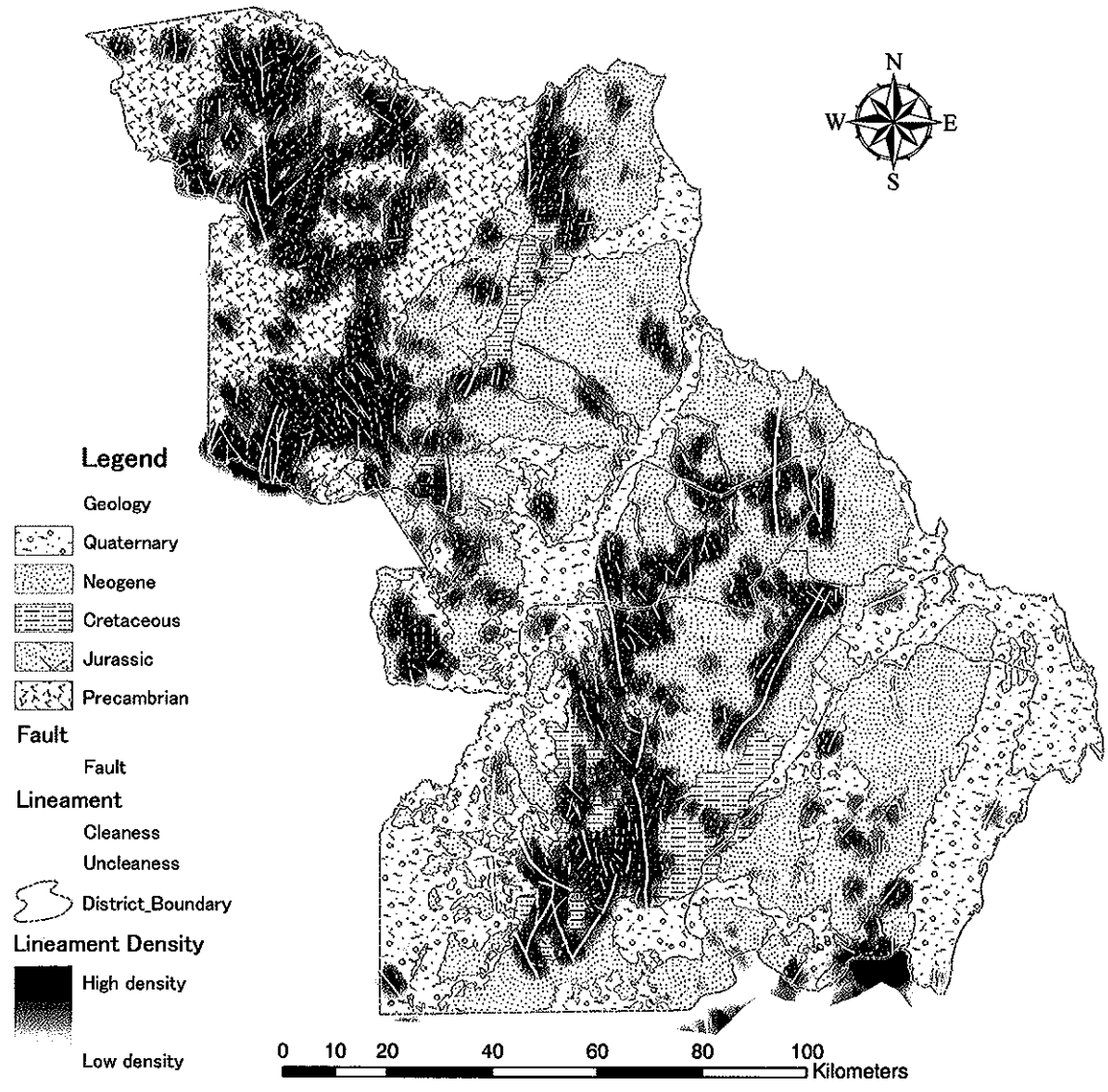


FIGURE 3.9 LINEAMENT DENCITY

THE STUDY ON WATER SUPPLY IMPROVEMENT IN COAST & DAR ES SALAAM | **JICA**

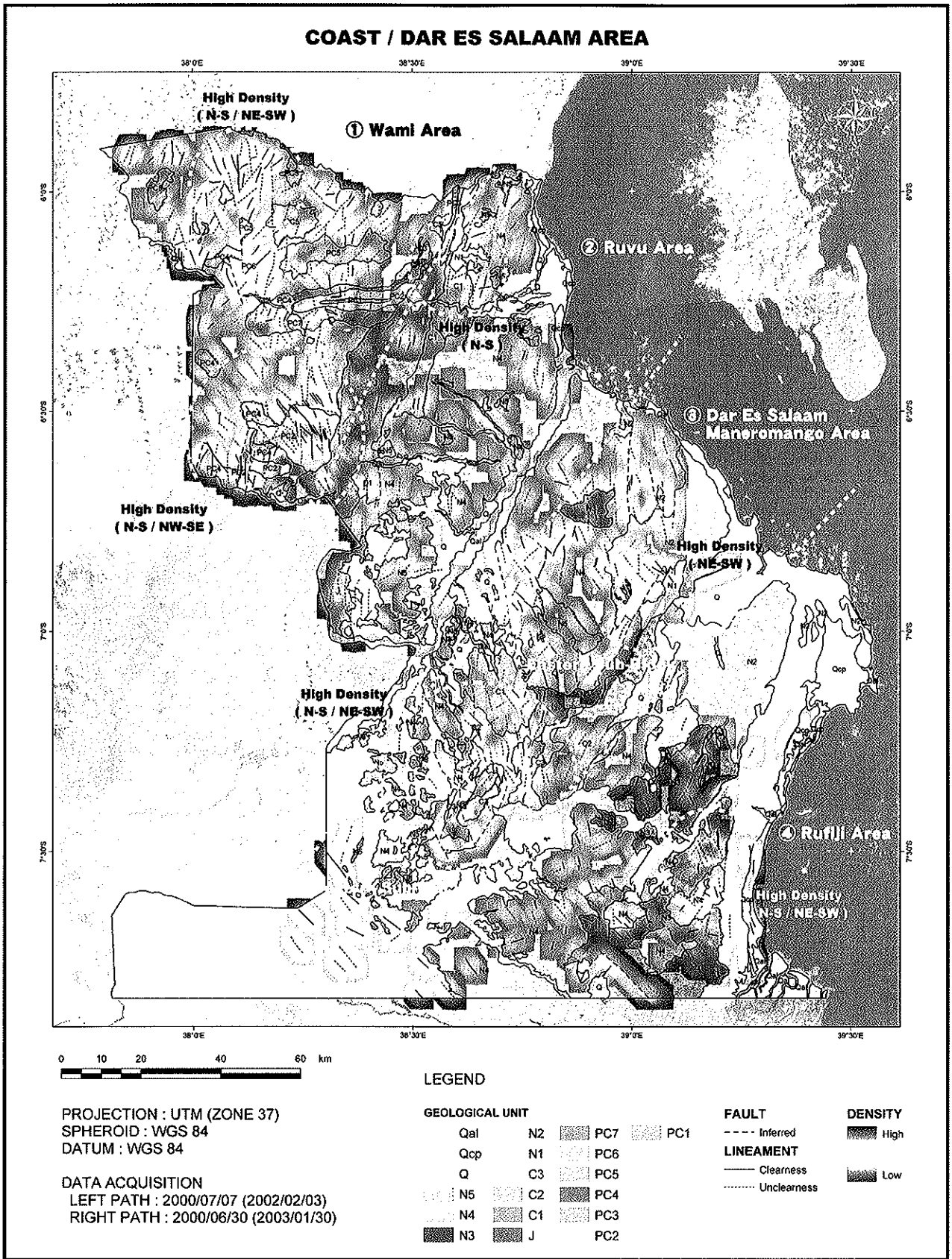


FIGURE 3.10 COMPREHENSIVE ANALYSIS MAP

THE STUDY ON WATER SUPPLY IMPROVEMENT IN COAST & DAR ES SALAAM | **JICA**

- Wami Zone

The zone is generally hilly terrain, and Pre-Cambrian and Jurassic formations are distributed. The lineaments of N-S and NW-SE orientations predominate. The lineament is dense in the area of crossing each orientation.

- Ruve Zone

The zone is generally flatland to hilly terrain. The geological region is Jurassic to Neogene formations. The rift valley structure with the synclinal axes of Ruve River is observed.

- Dar es Salaam – Maneromango Zone

The zone is generally hilly terrain, and Cretaceous to Neogene formations is distributed. The lineaments of N-S and NE-SW orientations predominate. The lineament is dense in the area of crossing N-S and NE-SW directions. The zone is divided into two sub-zones by the fault of N-S orientation. The cretaceous formation is distributed in west side sub-zone, while the Neogene formation distributed east side sub-zone.

- Rufiji Zone

The zone is hilly terrain to flatland and the geological formation of Neogene is distributed. The lineaments of NE-SW, NW-SE and N-S orientations predominate. The lineament is dense in the area of crossing N-S and NE-SW directions.

2) Occurrence of the Groundwater Resources

Considering above geological structure, the occurrence of the groundwater resources is anticipated that it is promising in the areas of 1) fissure zone of Pre-Cambrian and Jurassic formations, 2) permeable layers of Neogene formation, 3) sedimentary layers of quaternary formation. The topographic and geological conditions to be occur the groundwater in these areas are as follows

- Fissure Zone of Pre-Cambrian and Jurassic Formation

- In the vicinity of faults
- The area where lineaments are continuity developed
- The area where lineaments and faults are distributed high density
- The area of crossing lineaments of N-S and NW-SE or NE-SW directions

- Permeable Layer of Neogene Formation

- Continuity geological unit (layer)
- The lineaments scattered area
- Thick sedimentary layers of Neogene formation

- Permeable Layer of Neogene Formation

- The flood plain of major rivers and surrounding area
- Alluvial flat plain

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Chapter 4

Geophysical Exploration

CHAPTER 4 GEOPHYSICAL EXPLORATION

4.1 OUTLINE OF EXPLORATION

4.1.1 OBJECTIVES AND METHODS

The objectives of geophysical exploration are 1) to clarify general geo-electrical feature in the Study area, 2) to assist in the evaluation of the potential of water resources by delineating promising areas for drilling, and 3) to transfer the technology of geophysical prospecting to the counterpart personnel.

Two types of electrical survey methods were adopted in the Study. One is a Vertical Electrical Sounding (VES) method using Schlumberger configuration, and the other is a Two Dimensional Electrical Imaging (2D Imaging) method using dipole-dipole configuration. The VES method has been usually used for groundwater exploration, and is useful to investigate the hydrogeological structure of the subsurface in the simple geological setting (horizontal layers parallel with the ground surface). The 2D imaging method, on the other hand, is relatively new technology, and is useful for more complicated geological structure.

4.1.2 LOCATION OF GEOPHYSICAL EXPLORATION

A total of 50 areas, consisting of 33 areas in Coast region and 17 areas in Dar es Salaam region were selected for the geophysical exploration. The VES survey was carried out at all areas, and the measurements were made at five stations in each area. Based on the result of the VES survey, 16 areas were selected carefully for the 2D imaging survey. The measurements were made on the survey line of 350m length in each area. The surveyed areas are shown in *Figure 4.1*. The area name and number of the VES stations and 2D imaging lines area listed in *Table 4.1*. Additional VES survey were carried out at three stations in Potea during the technical transfer program. The measurements were made at a total of 253 VES stations and 16 2D imaging lines. Coordinates of all VES stations are listed in *Table 4.2* to *4.7*, and that of 2D survey lines are in *Table 4.8*.

4.1.3 SURVEY METHODOLOGY

Prior to the geophysical exploration, the Study team visited all the survey area to define the survey location on the basis of the geological and geomorphological features of the area. The coordinates of the stations were recorded by a GPS.

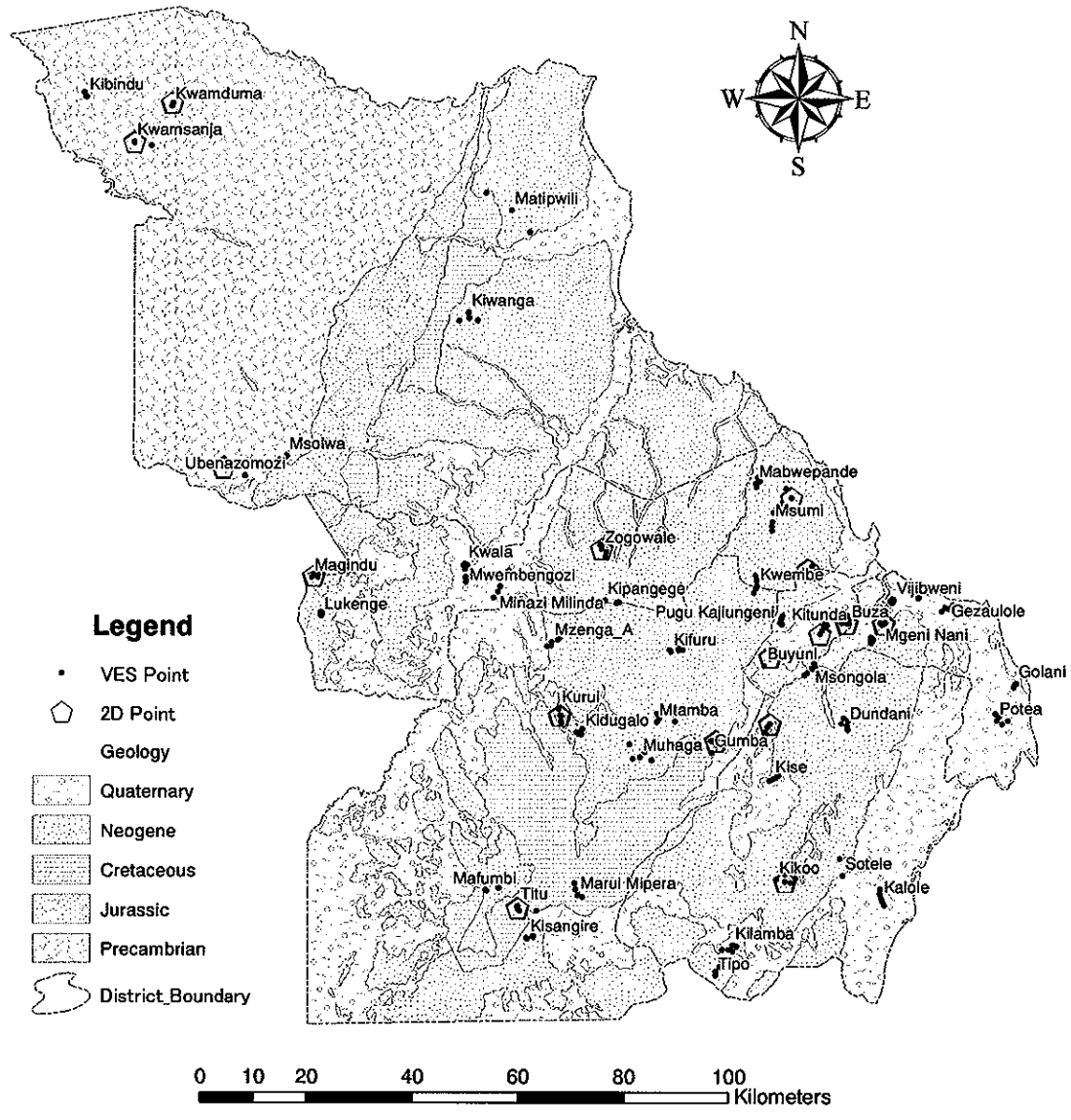

Figure 4.1 Location Map of Geophysical Exploration

THE STUDY ON WATER SUPPLY IMPROVEMENT IN COAST & DAR ES SALAAM | JICA

Table 4.1 Outline of Geophysical Exploration

Region	District / Municipality	Ward	Village	Sub-Village	Geology	VES stations	2D lines
Coast	Bagamoyo	Kibindu	Kibindu		PC	5	
			Kwamduma		PC	5	1
			Kwamsanja		PC	5	1
		Mkange	Matipwili		N	5	
		Ubena	Ubenazomozi		PC	5	1
		Chalinze	Msolwa		PC	5	
		Kiwangwa	Kiwangwa		N	5	
	Kibaha	Kwala	Kwala		N	5	
			Mwembengozi		N	5	
		Magindu	Lukenge		J	5	
			Magindu		J	5	1
		Ruvu	Minazi Mikinda		Q	5	
		Soga	Kipangege		N	5	
		Visiga	Zogowale		N	5	1
	Kisarawe	Chole Sambla	Mafumbi		N	5	
		Kibuta	Mtamba		N	5	
			Muhaga		N	5	
		Kisarawe	Kifuru		N	5	
		Kurui	Kidugalo		N	5	
			Kurui		C/N	5	1
		Marui	Kisangire		C	5	
			Marui Mipera		C	5	
			Titu		C	5	1
		Msimbu	Gumba		C/N	5	1
		Mzenga	Mzenga ‘A’		N	5	
	Mkuranga	Kisiju	Kalole		Q	5	
			Sotele		N	5	
		Kitomondo	Kikoo		N	5	1
		Mkuranga	Dundani		N	5	
			Kise		N/Q	5	
		Nyamato	Kilamba		N	5	
			Tipo		N	5	
		Tambani	Dondwe		N	5	1
Sub Total						165	10
Dar es Salaam	Kinondoni	Bunju	Mabwepande		N	5	
		Kibamba	Kwembe		N	5	
		Kimara	Mavurunza		N	5	1
		Kunduchi	Madala		N	5	1
		Mbezi	Msumi		N	5	
	Ilala	Chanika	Buyuni		N/Q	5	1
		Kitunda	Kitunda		Q	5	1
		Msongola	Msongola		Q	5	
		Pugu	Pugu Kajiungeni		Q	5	
	Temeke	Charambe	Kibangulile		Q	5	
		Kimbiji	Kizito Huounjwa	Golani	Q	5	
		Makangarawe	Buza		N	5	1
		Mbagala Kuu	Mgeni Nani		N	5	1
		Mjimwema	Mjimwema		Q	5	
		Pemba Mnazi	Yale Yale Puna	Potea	Q	5+3	
		Vijibweni	Vijibweni		Q	5	
		Somangira	Gezaulole		Q	5	
Sub Total						88	6
Ground Total						253	16

Table 4.2 Coordinates of VES stations in Coast Region (1)

District	Ward	Village	Sub - Village	VES No.	Coordinates(UTM)		Elevation	Coordinates(Lat,Lon)	
					East	North		Latitude	Longitude
Bagamoyo	Kibindu	Kibindu		1	381815	9336740	408	5° 59' 58.1"S	37° 55' 55.7"E
				2	381728	9336709	407	5° 59' 59.1"S	37° 55' 52.9"E
				3	381715	9336800	404	5° 59' 56.1"S	37° 55' 52.5"E
				4	381320	9337593	403	5° 59' 30.3"S	37° 55' 39.7"E
				5	381356	9337603	405	5° 59' 29.9"S	37° 55' 40.9"E
		Kwamduma		1	397964	9334933	413	6° 0' 57.9"S	38° 4' 40.9"E
				2	397961	9334950	411	6° 0' 57.3"S	38° 4' 40.8"E
				3	397947	9334990	408	6° 0' 56.0"S	38° 4' 40.3"E
				4	398099	9335521	417	6° 0' 38.7"S	38° 4' 45.3"E
				5	398110	9335546	416	6° 0' 37.9"S	38° 4' 45.7"E
		Kwamsanja		1	390848	9328085	404	6° 4' 40.4"S	38° 0' 49.0"E
				2	390837	9328144	402	6° 4' 38.5"S	38° 0' 48.7"E
				3	390831	9328176	401	6° 4' 37.5"S	38° 0' 48.5"E
				4	394072	9327499	393	6° 4' 59.7"S	38° 2' 33.9"E
				5	394101	9327507	393	6° 4' 59.4"S	38° 2' 34.8"E
	Mkange	Matipwili		1	468546	9311032	47	6° 13' 58.8"S	38° 42' 56.4"E
				2	465610	9311129	53	6° 13' 55.5"S	38° 41' 20.8"E
				3	462143	9315230	201	6° 11' 41.9"S	38° 39' 28.1"E
				4	457345	9318594	315	6° 9' 52.3"S	38° 36' 52.1"E
				5	457253	9318581	316	6° 9' 52.7"S	38° 36' 49.1"E
	Ubena	Ubenazomozi		1	407624	9266550	247	6° 38' 5.1"S	38° 9' 51.5"E
				2	407624	9266526	247	6° 38' 5.9"S	38° 9' 51.5"E
				3	411727	9265082	250	6° 38' 53.1"S	38° 12' 5.1"E
				4	411731	9265106	249	6° 38' 52.3"S	38° 12' 5.2"E
				5	411729	9265121	249	6° 38' 51.9"S	38° 12' 5.1"E
	Chalinze	Msolwa		1	419554	9268666	225	6° 36' 56.8"S	38° 16' 20.1"E
				2	419614	9268838	216	6° 36' 51.2"S	38° 16' 22.1"E
				3	419607	9268845	214	6° 36' 51.0"S	38° 16' 21.9"E
				4	418387	9268102	229	6° 37' 15.1"S	38° 15' 42.1"E
				5	418436	9268137	231	6° 37' 14.0"S	38° 15' 43.7"E
	Kiwangwa	Kiwangwa		1	452238	9294407	235	6° 22' 59.8"S	38° 34' 5.2"E
				2	453968	9295858	236	6° 22' 12.6"S	38° 35' 1.6"E
				3	454009	9295985	233	6° 22' 8.5"S	38° 35' 2.9"E
				4	455742	9294481	195	6° 22' 57.5"S	38° 35' 59.3"E
				5	454158	9294858	236	6° 22' 45.2"S	38° 35' 7.7"E

Table 4.3 Coordinates of VES stations in Coast Region (2)

District	Ward	Village	Sub - Village	VES No.	Coordinates(UTM)		Elevation	Coordinates(Lat,Lon)	
					East	North		Latitude	Longitude
Kibaha	Kwala	Kwala		1	453528	9248112	90	6° 48' 7.4"S	38° 34' 46.0"E
				2	453361	9247489	88	6° 48' 27.7"S	38° 34' 40.5"E
				3	453366	9248466	90	6° 47' 55.9"S	38° 34' 40.7"E
				4	453816	9248293	88	6° 48' 1.5"S	38° 34' 55.3"E
				5	453099	9248255	87	6° 48' 2.8"S	38° 34' 32.0"E
		Mwembengozi		1	453588	9245734	89	6° 49' 24.9"S	38° 34' 47.8"E
				2	453550	9245084	87	6° 49' 46.0"S	38° 34' 46.6"E
				3	453683	9245690	93	6° 49' 26.3"S	38° 34' 50.9"E
				4	456515	9246462	38	6° 49' 1.2"S	38° 36' 23.2"E
				5	453539	9246001	77	6° 49' 16.2"S	38° 34' 46.2"E
	Magindu	Lukenge		1	426124	9239395	196	6° 52' 50.3"S	38° 19' 52.8"E
				2	426248	9239090	201	6° 53' 0.2"S	38° 19' 56.8"E
				3	426296	9238646	201	6° 53' 14.7"S	38° 19' 58.3"E
				4	426155	9238879	203	6° 53' 7.1"S	38° 19' 53.8"E
				5	426378	9239257	195	6° 52' 54.8"S	38° 20' 1.0"E
		Magindu		1	425091	9246466	181	6° 48' 60.0"S	38° 19' 19.4"E
				2	424690	9246170	178	6° 49' 9.6"S	38° 19' 6.4"E
				3	424400	9245966	181	6° 49' 16.2"S	38° 18' 56.9"E
				4	425572	9246533	167	6° 48' 57.8"S	38° 19' 35.1"E
				5	425512	9245950	177	6° 49' 16.8"S	38° 19' 33.1"E
	Ruvu	Minazi Mikinda		1	459578	9243256	41	6° 50' 45.7"S	38° 38' 2.9"E
				2	458740	9242138	41	6° 51' 22.1"S	38° 37' 35.6"E
				3	459985	9244249	45	6° 50' 13.4"S	38° 38' 16.2"E
				4	461217	9246905	41	6° 48' 46.9"S	38° 38' 56.4"E
				5	461680	9247163	43	6° 48' 38.5"S	38° 39' 11.5"E
	Soga	Kipangege		1	482006	9241115	162	6° 51' 55.9"S	38° 50' 13.7"E
				2	482210	9241238	157	6° 51' 51.8"S	38° 50' 20.3"E
				3	479842	9241602	136	6° 51' 40.0"S	38° 49' 3.2"E
				4	482115	9241091	158	6° 51' 56.6"S	38° 50' 17.2"E
				5	482576	9241224	148	6° 51' 52.3"S	38° 50' 32.3"E
	Visiga	Zogowale		1	480104	9250683	123	6° 46' 44.2"S	38° 49' 11.8"E
				2	479968	9249804	132	6° 47' 12.9"S	38° 49' 7.4"E
				3	479224	9251312	128	6° 46' 23.7"S	38° 48' 43.2"E
				4	479227	9251870	122	6° 46' 5.6"S	38° 48' 43.3"E
				5	478976	9252220	121	6° 45' 54.2"S	38° 48' 35.1"E

Table 4.4 Coordinates of VES stations in Coast Region (3)

District	Ward	Village	Sub - Village	VES No.	Coordinates(UTM)		Elevation	Coordinates(Lat,Lon)	
					East	North		Latitude	Longitude
Kisarawe	Chole Samvula	Mafumbi		1	459875	9187406	315	7° 21' 4.5"S	38° 38' 11.2"E
				2	459795	9187361	315	7° 21' 5.9"S	38° 38' 8.6"E
				3	457555	9186866	292	7° 21' 22.0"S	38° 36' 55.5"E
				4	457260	9186948	284	7° 21' 19.3"S	38° 36' 45.9"E
				5	459791	9197787	332	7° 15' 26.4"S	38° 38' 8.7"E
	Kibuta	Mtamba		1	493220	9218802	239	7° 4' 2.6"S	38° 56' 19.0"E
				2	489896	9220291	251	7° 3' 14.1"S	38° 54' 30.6"E
				3	489717	9218695	268	7° 4' 6.0"S	38° 54' 24.8"E
				4	490470	9220000	264	7° 3' 23.5"S	38° 54' 49.3"E
				5	490173	9219244	270	7° 3' 48.2"S	38° 54' 39.7"E
		Muhaga		1	487444	9212992	309	7° 7' 11.7"S	38° 53' 10.6"E
				2	488764	9211497	274	7° 8' 0.4"S	38° 53' 53.7"E
				3	486596	9212083	304	7° 7' 41.3"S	38° 52' 43.0"E
				4	484522	9214514	288	7° 6' 22.1"S	38° 51' 35.4"E
				5	485167	9211774	292	7° 7' 51.4"S	38° 51' 56.4"E
	Kisarawe	Kifuru		1	493960	9232570	206	6° 56' 34.2"S	38° 56' 43.2"E
				2	493957	9232173	210	6° 56' 47.1"S	38° 56' 43.1"E
				3	492454	9231965	205	6° 56' 53.9"S	38° 55' 54.1"E
				4	492175	9232343	202	6° 56' 41.6"S	38° 55' 45.0"E
				5	494703	9232311	202	6° 56' 42.6"S	38° 57' 7.4"E
	Kurui	Kidugalo		1	474422	9216705	189	7° 5' 10.7"S	38° 46' 6.2"E
				2	475090	9216358	201	7° 5' 22.0"S	38° 46' 27.9"E
				3	475660	9217331	198	7° 4' 50.3"S	38° 46' 46.5"E
				4	475425	9216870	200	7° 5' 5.3"S	38° 46' 38.9"E
				5	475475	9216345	205	7° 5' 22.4"S	38° 46' 40.5"E
		Kurui		1	471601	9219742	171	7° 3' 31.7"S	38° 44' 34.3"E
				2	471337	9219893	160	7° 3' 26.8"S	38° 44' 25.7"E
				3	471139	9221145	160	7° 2' 46.0"S	38° 44' 19.2"E
				4	471575	9218762	168	7° 4' 3.6"S	38° 44' 33.4"E
				5	471682	9218479	166	7° 4' 12.8"S	38° 44' 36.9"E
	Marui	Kisangire		1	466374	9178091	144	7° 26' 8.0"S	38° 41' 43.0"E
				2	466252	9178378	148	7° 25' 58.6"S	38° 41' 39.0"E
				3	465229	9177922	145	7° 26' 13.4"S	38° 41' 5.6"E
				4	465217	9177819	143	7° 26' 16.8"S	38° 41' 5.2"E
				5	465033	9178008	143	7° 26' 10.6"S	38° 40' 59.2"E
		Marui Mipera		1	474176	9188223	212	7° 20' 38.2"S	38° 45' 57.7"E
				2	474334	9187056	213	7° 21' 16.2"S	38° 46' 2.8"E
				3	474778	9185940	219	7° 21' 52.5"S	38° 46' 17.3"E
				4	475645	9185682	205	7° 22' 0.9"S	38° 46' 45.5"E
				5	475679	9185639	201	7° 22' 2.3"S	38° 46' 46.7"E
		Titu		1	463747	9183020	271	7° 23' 27.4"S	38° 40' 17.4"E
				2	463290	9183911	272	7° 22' 58.4"S	38° 40' 2.5"E
				3	463412	9183982	272	7° 22' 56.1"S	38° 40' 6.5"E
				4	463338	9183527	308	7° 23' 10.9"S	38° 40' 4.0"E
				5	467006	9183148	276	7° 23' 23.3"S	38° 42' 3.7"E
	Msimbu	Gumba		1	500021	9215101	220	7° 6' 3.1"S	39° 0' 0.7"E
				2	500537	9215136	186	7° 6' 2.0"S	39° 0' 17.5"E
				3	500149	9212921	162	7° 7' 14.1"S	39° 0' 4.9"E
				4	501350	9215015	171	7° 6' 5.9"S	39° 0' 44.0"E
				5	497431	9214771	240	7° 6' 13.9"S	38° 58' 36.2"E
	Mzenga	Mzenga 'A'		1	471279	9234477	123	6° 55' 31.9"S	38° 44' 24.0"E
				2	470895	9234196	121	6° 55' 41.0"S	38° 44' 11.5"E
				3	469817	9233822	119	6° 55' 53.2"S	38° 43' 36.4"E
				4	469658	9233065	121	6° 56' 17.8"S	38° 43' 31.2"E
				5	468933	9232952	117	6° 56' 21.5"S	38° 43' 7.5"E

Table 4.5 Coordinates of VES stations in Coast Region (4)

District	Ward	Village	Sub - Village	VES No.	Coordinates(UTM)		Elevation	Coordinates(Lat,Lon)	
					East	North		Latitude	Longitude
Mkuranga	Kisiju	Kalole		1	532840	9184108	32	7° 22' 52.0"S	39° 17' 51.3"E
				2	532470	9184831	28	7° 22' 28.5"S	39° 17' 39.2"E
				3	532307	9185320	31	7° 22' 12.6"S	39° 17' 33.9"E
				4	532075	9186259	31	7° 21' 42.0"S	39° 17' 26.3"E
				5	532179	9187155	35	7° 21' 12.8"S	39° 17' 29.6"E
		Sotele		1	525742	9192868	71	7° 18' 6.9"S	39° 13' 59.6"E
				2	526088	9192935	73	7° 18' 4.7"S	39° 14' 10.9"E
				3	525033	9189794	56	7° 19' 47.0"S	39° 13' 36.5"E
				4	526037	9191154	98	7° 19' 2.7"S	39° 14' 9.2"E
				5	524450	9192903	126	7° 18' 5.8"S	39° 13' 17.4"E
	Kitomondo	Kikoo		1	515154	9188425	79	7° 20' 31.7"S	39° 8' 14.3"E
				2	514146	9188537	56	7° 20' 28.1"S	39° 7' 41.4"E
				3	512475	9188968	86	7° 20' 14.1"S	39° 6' 46.9"E
				4	514133	9189936	102	7° 19' 42.5"S	39° 7' 41.0"E
				5	516097	9189169	84	7° 20' 7.5"S	39° 8' 45.0"E
	Mkuranga	Dundani		1	526017	9217278	109	7° 4' 52.0"S	39° 14' 8.1"E
				2	524768	9218388	131	7° 4' 15.9"S	39° 13' 27.4"E
				3	525749	9218033	162	7° 4' 27.4"S	39° 13' 59.4"E
				4	526101	9218964	160	7° 3' 57.1"S	39° 14' 10.8"E
				5	525240	9219448	111	7° 3' 41.3"S	39° 13' 42.8"E
		Kise		1	512838	9208567	97	7° 9' 35.8"S	39° 6' 58.6"E
				2	512314	9208155	90	7° 9' 49.3"S	39° 6' 41.5"E
				3	511745	9207989	92	7° 9' 54.7"S	39° 6' 22.9"E
				4	511149	9207640	87	7° 10' 6.0"S	39° 6' 3.5"E
				5	514095	9209396	77	7° 9' 8.8"S	39° 7' 39.6"E
	Nyamato	Kilamba		1	503390	9175723	86	7° 27' 25.5"S	39° 1' 50.6"E
				2	502224	9175766	89	7° 27' 24.1"S	39° 1' 12.6"E
				3	504157	9176580	82	7° 26' 57.5"S	39° 2' 15.6"E
				4	504968	9176287	91	7° 27' 7.1"S	39° 2' 42.1"E
				5	504259	9175454	63	7° 27' 34.2"S	39° 2' 19.0"E
		Tipo		1	501830	9172472	69	7° 29' 11.3"S	39° 0' 59.7"E
				2	500973	9171658	85	7° 29' 37.8"S	39° 0' 31.7"E
				3	500948	9170866	75	7° 30' 3.6"S	39° 0' 30.9"E
				4	502426	9172904	93	7° 28' 57.3"S	39° 1' 19.2"E
				5	502084	9173756	82	7° 28' 29.5"S	39° 1' 8.0"E
	Tambani	Dondwe		1	510273	9216750	94	7° 5' 9.4"S	39° 5' 34.9"E
				2	509544	9214805	103	7° 6' 12.7"S	39° 5' 11.1"E
				3	510316	9216339	94	7° 5' 22.8"S	39° 5' 36.3"E
				4	510752	9217724	110	7° 4' 37.7"S	39° 5' 50.5"E
				5	511137	9218247	103	7° 4' 20.6"S	39° 6' 3.1"E

Table 4.6 Coordinates of VES stations in Dar es Salaam Region (1)

Municipality	Ward	Village	Sub - Village	VES No.	Coordinates(UTM)		Elevation	Coordinates(Lat,Lon)	
					East	North		Latitude	Longitude
Kinondoni	Bunju	Mabwepande		1	509044	9264141	106	6° 39' 26.1"S	39° 4' 54.6"E
				2	509260	9264251	105	6° 39' 22.5"S	39° 5' 1.6"E
				3	508547	9263689	106	6° 39' 40.8"S	39° 4' 38.4"E
				4	508608	9263105	111	6° 39' 59.8"S	39° 4' 40.4"E
				5	508870	9264855	101	6° 39' 2.8"S	39° 4' 48.9"E
	Kibamba	Kwembe		1	508399	9246274	165	6° 49' 7.9"S	39° 4' 33.6"E
				2	508670	9245502	160	6° 49' 33.1"S	39° 4' 42.5"E
				3	508740	9244799	169	6° 49' 56.0"S	39° 4' 44.8"E
				4	508476	9243878	150	6° 50' 25.9"S	39° 4' 36.2"E
				5	508188	9243055	155	6° 50' 52.8"S	39° 4' 26.8"E
	Kimara	Mavurunza		1	519174	9248202	108	6° 48' 5.0"S	39° 10' 24.7"E
				2	518354	9247513	92	6° 48' 27.5"S	39° 9' 58.0"E
				3	518122	9247254	104	6° 48' 35.9"S	39° 9' 50.4"E
				4	517662	9247173	119	6° 48' 38.6"S	39° 9' 35.4"E
				5	516054	9246764	132	6° 48' 51.9"S	39° 8' 43.1"E
	Kunduchi	Madala		1	514211	9262760	94	6° 40' 11.0"S	39° 7' 42.9"E
				2	515254	9260985	107	6° 41' 8.8"S	39° 8' 16.9"E
				3	514912	9259160	124	6° 42' 8.2"S	39° 8' 5.7"E
				4	513858	9258694	120	6° 42' 23.4"S	39° 7' 31.4"E
				5	513416	9259946	103	6° 41' 42.6"S	39° 7' 17.0"E
	Mbezi	Msumi		1	512452	9259045	121	6° 42' 12.0"S	39° 6' 45.6"E
				2	511871	9258163	129	6° 42' 40.7"S	39° 6' 26.7"E
				3	511671	9256469	152	6° 43' 35.9"S	39° 6' 20.2"E
				4	511643	9254761	164	6° 44' 31.5"S	39° 6' 19.3"E
				5	511621	9255602	159	6° 44' 4.1"S	39° 6' 18.6"E
Ilala	Chanika	Buyuni		1	511332	9230974	98	6° 57' 26.2"S	39° 6' 9.3"E
				2	511213	9230641	101	6° 57' 37.0"S	39° 6' 5.4"E
				3	510150	9229329	101	6° 58' 19.7"S	39° 5' 30.8"E
				4	511285	9231561	101	6° 57' 7.0"S	39° 6' 7.8"E
				5	512165	9232300	87	6° 56' 43.0"S	39° 6' 36.5"E
	Kitunda	Kitunda		1	521704	9237400	51	6° 53' 56.8"S	39° 11' 47.3"E
				2	521978	9236933	53	6° 54' 12.0"S	39° 11' 56.2"E
				3	521499	9236708	51	6° 54' 19.3"S	39° 11' 40.6"E
				4	521116	9236065	52	6° 54' 40.3"S	39° 11' 28.1"E
				5	520633	9235255	56	6° 55' 6.7"S	39° 11' 12.4"E
	Msongola	Msongola		1	519805	9228989	65	6° 58' 30.7"S	39° 10' 45.5"E
				2	519614	9229649	61	6° 58' 9.2"S	39° 10' 39.2"E
				3	519251	9228712	64	6° 58' 39.7"S	39° 10' 27.4"E
				4	518183	9227907	60	6° 59' 6.0"S	39° 9' 52.6"E
				5	517806	9227556	70	6° 59' 17.4"S	39° 9' 40.3"E
	Pugu	Pugu Kajiungeni		1	513471	9237126	133	6° 54' 5.8"S	39° 7' 19.0"E
				2	513538	9238707	110	6° 53' 14.3"S	39° 7' 21.1"E
				3	513378	9238222	118	6° 53' 30.1"S	39° 7' 15.9"E
				4	513083	9237387	118	6° 53' 57.3"S	39° 7' 6.3"E
				5	513268	9237250	122	6° 54' 1.8"S	39° 7' 12.4"E

Table 4.7 Coordinates of VES stations in Dar es Salaam Region (2)

Municipality	Ward	Village	Sub - Village	VES No.	Coordinates(UTM)		Elevation	Coordinates(Lat,Lon)	
					East	North		Latitude	Longitude
Temeke	Charamba	Kibangulile		1	530705	9234344	40	6° 55' 36.2"S	39° 16' 40.6"E
				2	530221	9234598	69	6° 55' 27.9"S	39° 16' 24.9"E
				3	530369	9234230	56	6° 55' 39.9"S	39° 16' 29.7"E
				4	530329	9233634	19	6° 55' 59.3"S	39° 16' 28.4"E
				5	530459	9233816	17	6° 55' 53.4"S	39° 16' 32.6"E
	Kimbiji	Kizito Huonjwa	Golani	1	557343	9225270	31	7° 0' 30.9"S	39° 31' 9.0"E
				2	557401	9225473	33	7° 0' 24.3"S	39° 31' 10.9"E
				3	557643	9226155	48	7° 0' 2.1"S	39° 31' 18.8"E
				4	557912	9225965	38	7° 0' 8.3"S	39° 31' 27.5"E
				5	557619	9225872	56	7° 0' 11.3"S	39° 31' 18.0"E
	Makangarawe	Buza		1	526301	9238410	38	6° 53' 23.8"S	39° 14' 17.0"E
				2	525679	9237310	41	6° 53' 59.7"S	39° 13' 56.8"E
				3	526041	9237300	38	6° 53' 60.0"S	39° 14' 8.6"E
				4	524897	9238104	55	6° 53' 33.8"S	39° 13' 31.3"E
				5	524792	9237408	44	6° 53' 56.5"S	39° 13' 27.9"E
	Mbagala Kuu	Mgeni Nani		1	532963	9237388	38	6° 53' 57.0"S	39° 17' 54.2"E
				2	532663	9237206	33	6° 54' 2.9"S	39° 17' 44.4"E
				3	532442	9237092	29	6° 54' 6.6"S	39° 17' 37.2"E
				4	532299	9237122	32	6° 54' 5.7"S	39° 17' 32.5"E
				5	532066	9237354	30	6° 53' 58.1"S	39° 17' 24.9"E
	Mjimwema	Mjimwema		1	539351	9242050	16	6° 51' 25.0"S	39° 21' 22.2"E
				2	539397	9242318	19	6° 51' 16.3"S	39° 21' 23.7"E
				3	539171	9242950	19	6° 50' 55.7"S	39° 21' 16.3"E
				4	538026	9242462	19	6° 51' 11.6"S	39° 20' 39.0"E
				5	537949	9242638	17	6° 51' 5.9"S	39° 20' 36.5"E
	Pemba Mnazi	Yale Yale Puna	Potea	1	555218	9218380	31	7° 4' 15.4"S	39° 30' 0.0"E
				2	556242	9218966	29	7° 3' 56.2"S	39° 30' 33.4"E
				3	554148	9219040	32	7° 3' 53.9"S	39° 29' 25.1"E
				4	553916	9220234	36	7° 3' 15.0"S	39° 29' 17.5"E
				5	554648	9219760	34	7° 3' 30.4"S	39° 29' 41.4"E
				1	553737	9220161	36	7° 3' 17.4"S	39° 29' 11.7"E
				2	553685	9220168	36	7° 3' 17.2"S	39° 29' 10.0"E
				3	553814	9220150	35	7° 3' 17.8"S	39° 29' 14.2"E
	Vijibweni	Vijibweni		1	534503	9241559	19	6° 51' 41.1"S	39° 18' 44.2"E
				2	534250	9241160	24	6° 51' 54.1"S	39° 18' 36.0"E
				3	534584	9241798	21	6° 51' 33.3"S	39° 18' 46.9"E
				4	533970	9241551	22	6° 51' 41.4"S	39° 18' 26.9"E
				5	534300	9241887	22	6° 51' 30.4"S	39° 18' 37.6"E
	Somangira	Gezaulole		1	545870	9240819	9	6° 52' 4.9"S	39° 24' 54.6"E
				2	545446	9240241	9	6° 52' 23.8"S	39° 24' 40.8"E
				3	545006	9240055	9	6° 52' 29.8"S	39° 24' 26.5"E
				4	544319	9240265	16	6° 52' 23.0"S	39° 24' 4.1"E
				5	543680	9239587	17	6° 52' 45.1"S	39° 23' 43.3"E

Table 4.8 Coordinates of 2D Survey Lines

Region	District / Municipality	Village	ST No.	Coordinates(UTM)		Elevation	Coordinates(Lat,Lon)	
				East	North		Latitude	Longitude
Coast	Bagamoyo	Kwamduma	0	397849	9335470	425	6° 0' 40.4"S	38° 4' 37.2"E
			175	397980	9335590	414	6° 0' 36.5"S	38° 4' 41.4"E
			350	398110	9335700	425	6° 0' 32.9"S	38° 4' 45.7"E
		Kwamsanja	0	390875	9327926	403	6° 4' 45.6"S	38° 0' 49.9"E
			175	390839	9328098	401	6° 4' 40.0"S	38° 0' 48.7"E
			350	390800	9328266	403	6° 4' 34.5"S	38° 0' 47.5"E
		Ubenazomozi	0	407607	9266456	241	6° 38' 8.2"S	38° 9' 51.0"E
			175	407654	9266626	244	6° 38' 2.6"S	38° 9' 52.5"E
			350	407703	9266792	245	6° 37' 57.2"S	38° 9' 54.1"E
	Kibaha	Magindu	0	424590	9246086	186	6° 49' 12.3"S	38° 19' 3.1"E
			175	424752	9246155	187	6° 49' 10.1"S	38° 19' 8.4"E
			350	424912	9246222	185	6° 49' 7.9"S	38° 19' 13.6"E
		Zogowale	0	479153	9251150	113	6° 46' 29.0"S	38° 48' 40.8"E
			175	479232	9251322	113	6° 46' 23.4"S	38° 48' 43.4"E
			350	479312	9251464	109	6° 46' 18.8"S	38° 48' 46.0"E
	Kisarawe	Kurui	0	471127	9219914	147	7° 3' 26.1"S	38° 44' 18.8"E
			175	471307	9219904	151	7° 3' 26.4"S	38° 44' 24.7"E
			350	471482	9219890	159	7° 3' 26.9"S	38° 44' 30.4"E
		Titu	0	463434	9183376	290	7° 23' 15.8"S	38° 40' 7.2"E
			175	463340	9183518	290	7° 23' 11.2"S	38° 40' 4.1"E
			350	463237	9183664	280	7° 23' 6.4"S	38° 40' 0.8"E
		Gumba	0	500849	9215136	111	7° 6' 2.0"S	39° 0' 27.7"E
			175	501028	9215096	115	7° 6' 3.3"S	39° 0' 33.5"E
			350	501182	9215036	107	7° 6' 5.2"S	39° 0' 38.5"E
	Mkuranga	Kikoo	0	513974	9188542	51	7° 20' 27.9"S	39° 7' 35.8"E
			175	514149	9188540	48	7° 20' 28.0"S	39° 7' 41.5"E
			350	514330	9188536	45	7° 20' 28.1"S	39° 7' 47.4"E
		Dondwe	0	511016	9218368	93	7° 4' 16.7"S	39° 5' 59.1"E
			175	511179	9218292	99	7° 4' 19.2"S	39° 6' 4.4"E
			350	511327	9218208	99	7° 4' 21.9"S	39° 6' 9.2"E
Dar es Salaam	Kinondoni	Mavurunza	0	518539	9247336	92	6° 48' 33.3"S	39° 10' 4.0"E
			175	518426	9247460	83	6° 48' 29.2"S	39° 10' 0.3"E
			350	518297	9247576	89	6° 48' 25.4"S	39° 9' 56.1"E
		Madala	0	515138	9261080	113	6° 41' 5.7"S	39° 8' 13.1"E
			175	515242	9260984	113	6° 41' 8.8"S	39° 8' 16.5"E
			350	515361	9260852	111	6° 41' 13.1"S	39° 8' 20.3"E
	Ilala	Buyuni	0	511086	9230990	104	6° 57' 25.6"S	39° 6' 1.3"E
			175	511264	9230944	102	6° 57' 27.1"S	39° 6' 7.1"E
			350	511423	9230902	100	6° 57' 28.5"S	39° 6' 12.3"E
		Kitunda	0	520545	9235110	49	6° 55' 11.4"S	39° 11' 9.5"E
			175	520651	9235262	49	6° 55' 6.4"S	39° 11' 13.0"E
			350	520734	9235406	49	6° 55' 1.7"S	39° 11' 15.7"E
	Temeke	Buza	0	525541	9237220	37	6° 54' 2.6"S	39° 13' 52.3"E
			175	525686	9237306	51	6° 53' 59.8"S	39° 13' 57.0"E
			350	525845	9237386	50	6° 53' 57.2"S	39° 14' 2.2"E
		Mgeni Nani	0	532504	9237156	51	6° 54' 4.6"S	39° 17' 39.2"E
			175	532663	9237206	45	6° 54' 2.9"S	39° 17' 44.4"E
			350	532841	9237256	50	6° 54' 1.3"S	39° 17' 50.2"E

- ST No.: 0 and 350 are edge of line, and 175 is center of line.

4.2 BASIC PRINCIPLES AND METHODOLOGY

4.2.1 VES METHOD

Schlumberger configuration was adopted for VES survey. In this method, four electrodes are placed in the ground on one line symmetrically around the mid-point, the measurement point. The current is injected through the outer electrodes (A, B), and the potential difference between the inner electrodes (M, N) is measured simultaneously. The electrodes are moved out around the midpoint and a new measurement is taken. *Figure 4.2* shows Schlumberger configuration and the procedure of VES survey.

The apparent resistivity is expressed as,

$$\rho_a = \frac{\pi}{4l}\left(L^2 - l^2\right)\frac{V}{I} \quad [\, L \geq 5l \,],$$

where, V is the potential difference, I is the current value, L is the distance between A and B and l is distance between M and N.

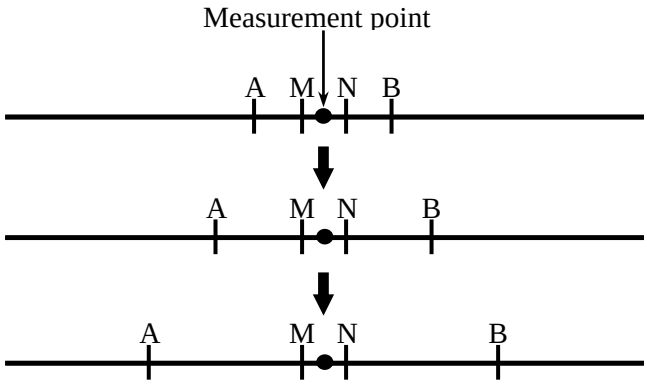

Figure 4.2 Schlumberger Configuration and Procedure of the Survey

For the analysis of the VES data, software called RESIXP developed by Interpex Ltd. (USA) was used. Finally, number of layers and thickness and resistivity of each layer were estimated for each VES station.

4.2.2 2D IMAGING METHOD

In the 2D imaging method, plenty of apparent resistivity data are measured along the survey line using many combinations of electrodes which are placed at regular interval on the line. Dipole-dipole configuration was adopted for the 2D imaging method. The data acquired using dipole-dipole configuration has the feature of high resolution and being sensitive to lateral change of resistivity, therefore it is useful for detecting fault, fracture and contact of geological formations.

Figure 4.3 shows dipole-dipole configuration. The measurement starts with a spacing of "*a*" between the C1 and C2 (and also the P1 and P2) electrodes. The first sequence of measurements is made with a value of 1 for the separation factor "*n*" (which is the ratio of the distance between the C2 and P1 electrodes to the C1-C2 dipole length), followed by "*n*" equals to 2 while keeping the C1-C2 dipole spacing fixed at "*a*". When "*n*" is equal to 2, the distance between C2 and P1 electrodes is twice the C1-C2 dipole length. For subsequent measurements, the "*n*" is usually increased to a maximum value about 7, after which accurate measurements are difficult due to very low potential values. To increase the depth of investigation, the spacing between the C1-C2 dipole is increased to "2*a*", and another series of measurements with different values of "*n*" is made.

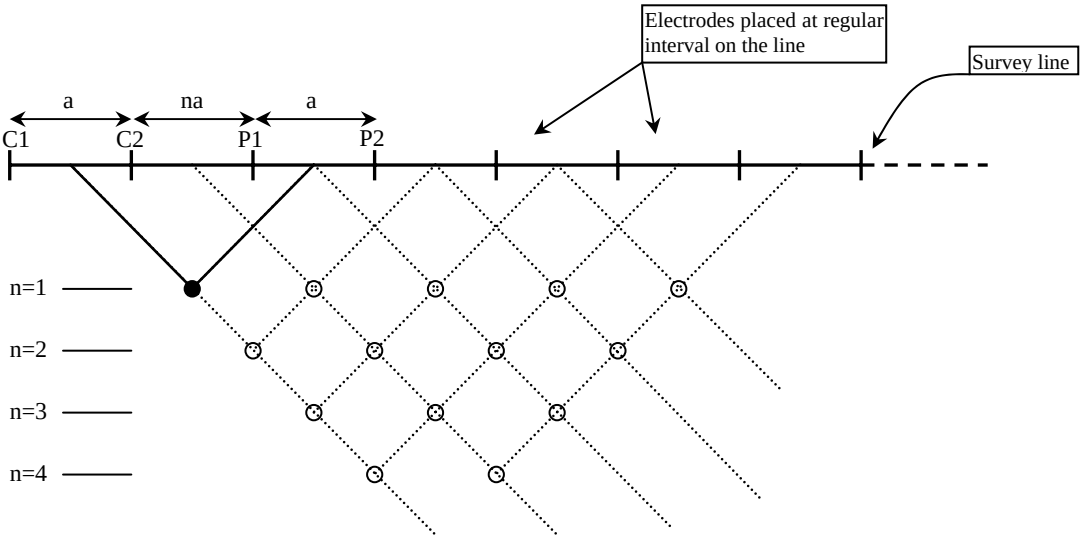

Figure 4.3 Dipole-Dipole Configuration

In the 2D imaging survey of the Study, the survey line with 350m length was set in each area, and the data were measured at n = 1 to 7 for a = 10m, 3 to 7 for 20m and 3 to 6 for 40m. Number of data acquired for each survey line is 360.

The apparent resistivity is expressed as,

$$\rho_a = n(n+1)(n+2)\pi a \frac{V}{I}.$$

The apparent resistivity data were interpreted using a 2D inversion software called RES2DINV developed by Geotomo Software (Malaysia). Finally, a resistivity section was made for each survey line, and the geological structure was estimated using the resistivity section.

4.3 RESULTS OF GEOPHYSICAL EXPLORATION

4.3.1 COAST REGION

(1) Kibindu

The survey location is shown in *Figure A-1,* and the interpreted sections for VES are in *Figure A-2*. Surface geology is Precambrian. From Figures A-1 to A-117 are shown as in Appendix A.

As shown in Section-1, low to middle resistivity zone(10 to 400Ωm) considered to be weathered rock is overlaid on fresh Precambrian bedrock which shows high resistivity (600 to 1600Ωm). The thickness of weathered zone is about 40m at VES-3 and 90m at VES-2, and increases eastward. The resistivity values at VES-1 are relatively low, and the resistivity structure is quite different between VES-1 and 2 although the distance between the two stations is very short. From these situation of resistivity and also taking into consideration that a lineament is estimated in the east of VES-1, there may be fracture zone around VES-1. Section-2 shows thinner weathered zone compared with that of Section-1. The thickness is about 20m.

(2) Kwamduma

The survey location is shown in *Figure A-3* and the interpreted sections for VES and 2D are in *Figures A-4* and *A-5* respectively. Surface geology is Precambrian.

Section-1 and 2 show same formation where the weathered zone showing low to middle resistivity (20 to 300Ωm) is overlaid on fresh Precambrian bedrock showing high resistivity (800 to 6000Ωm). The thickness of the weathered zone is 20 to 30m on Section-1, and about 10m on Section-2. As the result of 2D imaging, a fault dipping southward was detected at 180 to

200m on the survey line. The thickness of weathered zone is about 50m on the south side of the fault. A test well was drilled at 175m located on the south side of the fault, resulting in the yield of 3.5t/hour. The lithology consists of weathered or slightly weathered gneiss and fresh gneiss. Fractured gneiss is detected between 18 to 20m where the resistivity shows low value.

(3) Kwamsanja

The survey location is shown in *Figure A-6* and the interpreted sections for VES and 2D are in *Figures A-7* and *A-8* respectively. Surface geology is Precambrian.

Section-1 shows that weathered zone with 10 to 20m thickness is overlaid on the fresh Precambrian bedrock. In section-2, the thickness of weathered zone is 10m at VES-4 and 30m at VES-5. The resistivity of bedrock ranges from 1100 to 7600Ωm, and that of weathered zone from 5 to 150Ωm. As the result of 2D imaging, weathered zone is thicker between 200m and 280m.

(4) Matipwili

The survey location is shown in *Figure A-9*, and the interpreted sections for VES are in *Figure A-10* Surface geology is Neogene.

Generally, a layer of clay to sandy clay is overlaid on a layer of sand to clayey sand except for VES-5. There is extremely low resistivity of 4Ωm at deeper part of VES-5. Section-2 and 3 show lateral change of strata. At the deeper part of VES-2, slightly high resistivity of 75Ωm is analyzed, and it is considered to be sand. A test well was drilled at VES-2.

(5) Ubena Zomozi

The survey location is shown in *Figure A-11* and the interpreted sections for VES and 2D are in *Figures A-12* and *A-13* respectively. Surface geology is Precambrian.

Section-1 and 2 show almost same formation where weathered zone with 20 to 30m is overlaid on fresh Precambrian bedrock, and the thickness of weathered zone is thicker northward. The resistivity of bedrock ranges from 2500 to 29000Ωm, and that of weathered zone from 6 to 180Ωm. The result of 2D imaging shows almost same formation as that of VES result. The thickness of weathered zone increases northward. At 210m of the survey line, the thickness changes remarkably.

(6) Msolwa

The survey location is shown in *Figure A-14*, and the interpreted sections for VES are in *Figure A-15* Surface geology is Precambrian.

The thickness of weathered zone is less than 10m. The resistivity of bedrock ranges from 800 to 20000Ωm, and that of weathered zone from 5 to 200Ωm.

(7) Kiwangwa

The survey location is shown in *Figure A-16*, and the interpreted sections for VES are in *Figure A-17*. Surface geology is Neogene.

At the deeper part of VES-1, there is high resistivity of 800Ωm, and it is considered to be fresh Cretaceous bedrock. Except for this, extremely low resistivity is dominant, and it is considered to be clay. Thin layer of sand to clayey sand is overlaid on this thick clay layer.

(8) Kwala

The survey location is shown in *Figure A-18*, and the interpreted sections for VES are in *Figure A-19*. Surface geology is Neogene.

Sections show almost three layers consist of sand to clayey sand, clay to sandy clay and sand to clayey sand from bottom to surface except for VES-1. VES-1 shows low resistivity from deeper part to near surface. Lateral change of the layer thickness is recognized.

(9) Mwembemgozi

The survey location is shown in *Figure A-20*, and the interpreted sections for VES are in *Figure A-21*. Surface geology is Neogene.

Low resistivity considered to be clay to sandy clay is dominant all over the sections. A layer of sand to clayey sand is overlaid on the low resistivity layer at VES-1 and 2. Lateral change of strata is seen between VES-1 and 2.

(10) Lukenge

The survey location is shown in *Figure A-22*, and the interpreted sections for VES are in *Figure A-23*. Surface geology is Jurassic.

High resistivity of 100Ωm is recognized at deeper part of VES-4, and is considered to be Jurassic bedrock. Middle resistivity of 20 to 50Ωm is overlaid on the bedrock, and is considered to be slightly weathered rock. Its thickness is 60 to 100m. Upper layer shows low resistivity of 10 to 30Ωm, and is considered to be weathered rock. Its thickness increase northward.

(11) Magindu

The survey location is shown in *Figure A-24* and the interpreted sections for VES and 2D are in *Figures A-25* and *A-26* respectively. Surface geology is Jurassic.

Sections show two layered formation consists of Jurassic bedrock of 50 to 90Ωm and upper weathered rock of 20 to 40Ωm. At VES-4, extremely low resistivity of 5Ωm is recognized at the depth of 10 to 40m. The thickness of the weathered rock layer is thickest at VES-3, showing 100m. As the result of 2D imaging, high resistivity over 100Ωm is distributed in the western part below the depth of 50m, and eastern part shows middle resistivity of 40 to 80Ωm. The former is considered to be fresh Jurassic bedrock and latter is slightly weathered rock. Upper weathered layer shows low resistivity less than 30Ωm. A test well was drilled at VES-3.

(12) Minazi Mikinda

The survey location is shown in *Figure A-27*, and the interpreted sections for VES are in *Figure A-28*. Surface geology is Quaternary.

Clay to sandy clay layer is distributed thickly from VES-1 to VES-4. Thin sand layer is overlaid the clay to sandy clay layer. VES-2, VES-5 and the deeper part of VES-4 show slightly high resistivity corresponding to sand to clayey sand.

(13) Kipangege

The survey location is shown in *Figure A-29*, and the interpreted sections for VES are in *Figure A-30*. Surface geology is Neogene.

Deeper part is sand to clayey sand layer, and clay to sandy clay layer is overlaid in general. VES-2 shows different feature that deeper part is high resistivity of 120Ωm. Upper layer is clay to sandy clay, but its thickness is larger than that of other VES stations. A test well was drilled at VES-4.

(14) Zogowale

The survey location is shown in *Figure A-31* and the interpreted sections for VES and 2D are in *Figures A-32* and *A-33* respectively. Surface geology is Neogene.

Clay to sandy clay layer is overlaid on sand to clayey sand layer. The thickness of upper layer increases northward, and it is about 100m at VES-5. There is sand to clayey sand layer of 20m thickness partly at the shallower part of VES-5. As the result of 2D imaging survey, general formation consists of sand to clayey sand layer at deeper part and clay to sandy clay layer overlaid. Lateral change is recognized. In the lower layer, north side shows slightly high resistivity of almost 100Ωm, and the thickness of upper layer increase southward.

(15) Mafumbi

The survey location is shown in *Figure A-34*, and the interpreted sections for VES are in *Figure A-35*. Surface geology is Neogene.

Section-1 shows four layered formation consists of alternation of sand to clayey sand layer and clay to sandy clay layer. The third layer of sand to clayey sand is thickest, almost 60m. the layers incline eastward contrary to topography. Section-2 shows two layered formation consists of lower sand layer and upper sand to clayey sand layer. No low resistivity is recognized in Section-2. Upper layer is thickest at VES-1, and its thickness is about 70m.

(16) Mtamba

The survey location is shown in *Figure A-36*, and the interpreted sections for VES are in *Figure A-37*. Surface geology is Neogene.

High resistivity of 900 to 2000Ωm are recognized at deeper part of VES-2, VES-4 and VES-5. Fresh Cretaceous bedrock may be laid beneath Neogene formation. VES-3 and VES-1 show relatively low resistivity compared with other VES stations. There is possibility of fracture zone at VES-3 and VES-1 since a lineament and a fault are estimated near VES-3 and VES-1 respectively.

(17) Muhaga

The survey location is shown in *Figure A-38*, and the interpreted sections for VES are in *Figure A-39*. Surface geology is Neogene.

Except for VES-1 and shallower part of VES-4, low resistivity less than 10Ωm is distributed dominantly. Many lineaments are estimated in this area, and a fault is also estimated in the east of VES-2. A lineament is running along Section-1. Low resistivity may be caused by fracture zone filled with clay.

(18) Kifuru

The survey location is shown in *Figure A-40*, and the interpreted sections for VES are in *Figure A-41*. Surface geology is Neogene.

Extremely low resistivity from 1 to 6Ωm are distributed dominantly. Slightly high resistivity of 15Ωm is recognized at the depth between 40 and 90m of VES-4.

(19) Kidugalo

The survey location is shown in *Figure A-42*, and the interpreted sections for VES are in *Figure A-43*. Surface geology is Neogene.

Extremely low resistivity from 1 to 7Ωm are distributed dominantly. Thin layer of sand to clayey sand is overlaid on the low resistivity layer. At the VES-5, the thickness of the sand to clayey sand layer is thickest, and its thickness is about 30m.

(20) Kurui

The survey location is shown in *Figure A-44* and the interpreted sections for VES and 2D are in *Figures A-45* and *A-46* respectively. Surface geology is Cretaceous and Neogene.

As the results of VES survey, high resistivity is recognized at deeper part of VES-4 and 5 on the south of this area, and is considered to be fresh Cretaceous bedrock. Sand to clayey sand layer is laid at deeper part of VES-2 and 3. Clay to sandy clay layer is overlaid at all VES stations. The result of 2D imaging survey shows that the formation consists of clay to sandy clay layer and sand to clayey sand, and lateral change of layer is remarkable.

(21) Kisangire

The survey location is shown in *Figure A-47*, and the interpreted sections for VES are in *Figure A-48*. Surface geology is Neogene.

As the results of VES survey, formation consists of clay to sandy clay and sand to clayey sand.

Lateral change of layers is remarkable. The formation may be disturbed by fault estimated to the east of this area.

(22) Marui Mipera

The survey location is shown in *Figure A-49*, and the interpreted sections for VES are in *Figure A-50*. Surface geology is Cretaceous.

At deeper part, a layer showing middle resistivity from 40 to 70Ωm is laid, and low resistivity from 9 to 30 is overlaid. The resistivity is considered to be too small for Cretaceous formation. A fault is estimated along the Section, and many lineaments are also estimated around this area, therefore fracture zone may be formed as a whole.

(23) Titu

The survey location is shown in *Figure A-51* and the interpreted sections for VES and 2D are in *Figures A-52* and *A-53* respectively. Surface geology is Cretaceous.

As the results of VES survey, the formation consists of Cretaceous bedrock showing high resistivity and overlaid weathered zone showing middle resistivity except for VES-2. At VES-2, middle resistivity continues to deeper part. It is considered to be fracture zone. Some faults and many lineaments are estimated around this area. As the result of 2D imaging survey, lateral change of resistivity is recognized remarkably at deeper part, and is considered to be a fault. A test well was drilled on the ridge above the station of VES-1.

(24) Gumba

The survey location is shown in *Figure A-54* and the interpreted sections for VES and 2D are in *Figures A-55* and *A-56* respectively. Surface geology is Cretaceous and Neogene.

Many lineaments are estimated in this area, therefore the results of VES survey show remarkable lateral change of resistivity structure. Low resistivity values are recognized at lower part of VES-5, upper part of VES-4 and almost whole part of VES-3. These low resistivity may be caused by fracture zone. As the result of 2D imaging survey, a fault dipping eastward is estimated at the center of the survey line. In the east of the fault, high resistivity reaching 1000Ωm is distributed. In the west of the fault, low resistivity is dominant.

(25) Mzenga 'A'

The survey location is shown in *Figure A-57*, and the interpreted sections for VES are in *Figure A-58*. Surface geology is Neogene.

There are many lineaments estimated in this area. And a fault is also inferred in the west of the area. As the results of VES survey, upper layer showing low resistivity is recognized at all VES stations, and thickness is almost uniform. On the other hand, the structure of deeper part shows lateral change. The resistivity is remarkably changed between VES-4 and 3 and between VES-3 and 2. Lineaments are estimated there.

(26) Kalole

The survey location is shown in *Figure A-59*, and the interpreted sections for VES are in *Figure A-60*. Surface geology is Quaternary.

Middle to high resistivity corresponding to sand to clayey sand layer is distributed at shallower part, and its thickness increases toward VES-4. Low resistivity corresponding to clay to sandy clay layer is distributed under the sand to clayey sand layer. At the deeper part of VES-1, slightly high resistivity of 80Ωm is recognized.

(27) Sotele

The survey location is shown in *Figure A-61*, and the interpreted sections for VES are in *Figure A-62*. Surface geology is Neogene.

A lineament is estimated between VES-1 and 2, and the resistivity structure is showing lateral change. Middle to high resistivity corresponding to sand to clayey sand is dominant in this area.

Low resistivity corresponding to clay to sandy clay are recognized at shallower part of VES-2 and 3.

(28) Kikoo

The survey location is shown in *Figure A-63* and the interpreted sections for VES and 2D are in *Figures A-64* and *A-65* respectively. Surface geology is Cretaceous and Neogene.

A fault is estimated at VES-2, and the resistivity structure of VES-2 is different from that of other VES stations. Other points shows almost two layered structure, upper layer is clay to sandy clay and lower is sand to clayey sand. As the result of 2D imaging survey, high resistivity reaching 750Ωm is distributed almost horizontally at the depth from 20 to 80m. Under this high resistivity layer, low resistivity is recognized. Such resistivity structure is consistent with the result of VES-2. No remarkable change of resistivity caused by the fault is recognized.

(29) Dundani

The survey location is shown in *Figure A-66*, and the interpreted sections for VES are in *Figure A-67*. Surface geology is Neogene.

Low resistivity showing 10 to 12Ωm are distributed dominantly. At the deeper part of VES-3, very low resistivity of 4Ωm is recognized. It is considered that clay to sandy clay is dominant in this area. At VES-1, Slightly high resistivity of 50Ωm is distributed differentially at the depth from 30 to 80m. A fault is estimated in the west of VES-1. A test well was drilled at VES-2, resulting in the yield of 39l/min..

(30) Kise

The survey location is shown in *Figure A-68*, and the interpreted sections for VES are in *Figure A-69*. Surface geology is Neogene and Quaternary.

The formation consists of alternation of sand to clayey sand layer and clay to sandy clay layer. VES-4 is showing slightly different structure from other VES stations. The resistivity of the lowest layer is very low, and the thickness of overlaid sand layer is thinner than that of other VES stations. A test well was drilled at VES-4.

(31) Kilamba

The survey location is shown in *Figure A-70*, and the interpreted sections for VES are in *Figure A-71*. Surface geology is Neogene.

Sections are showing that sand to clayey sand layer with the thickness of 50 to 60m is overlaid on clay to sandy clay layer generally. VES-5 is showing different structure, and lateral change of resistivity is recognized between VES-1 and 5.

(32) Tipo

The survey location is shown in *Figure A-72*, and the interpreted sections for VES are in *Figure A-73*. Surface geology is Neogene.

VES-1, 2 and 3 are showing that the formation consists of clay to sandy clay layer and sand to clayey sand layer, while VES-4 and 5 are showing high resistivity of 160 to 400Ωm. There is remarkable change of resistivity structure between VES-1 and 4.

(33) Dondwe

The survey location is shown in *Figure A-.74* and the interpreted sections for VES and 2D are in *Figures A-75* and *A-76* respectively. Surface geology is Neogene.

Low resistivity corresponding to clay to sandy clay is distributed dominantly. Middle resistivity corresponding to sand to clayey sand are recognized at the depth from 40 to 65m of VES-1 and from 30 to 90m of VES-5. The result of 2D imaging survey shows almost horizontal layered structure. Middle resistivity corresponding to sand to clayey sand layer is recognized at the depth from 40 to 80m.

4.3.2 DAR ES SALAAM REGION

(1) Mabwepande

The survey location is shown in *Figure A-77*, and the interpreted sections for VES are in *Figure A-78*. Surface geology is Neogene.

The formation consists of alternation of sand to clayey sand layer and clay to sandy clay layer. The thickness of sand to clayey sand layer is thickest at VES-5. The depth of sand to clayey sand layer changes remarkably between VES-1 and 2.

(2) Kwembe

The survey location is shown in *Figure A-79*, and the interpreted sections for VES are in *Figure A-80*. Surface geology is Neogene.

Clay to sandy clay is dominant. Sand to clayey sand is recognized at deeper part of VES2, 3 and 4 and at the depth from 15 to 55m of VES-1. A fault passing along the VES-5, 4 and 3 is estimated.

(3) Mavurunza

The survey location is shown in *Figure A-81* and the interpreted sections for VES and 2D are in *Figures A-82* and *A-83* respectively. Surface geology is Neogene.

As the results of VES survey, layered structure is quite different each other, and lateral change of resistivity is remarkable. Very low resistivity of 3Ωm is recognized at deeper part of VES-2, while high resistivity of 400Ωm is at deeper part of VES-1 located next to VES-2. As the result of 2D imaging survey, very low resistivity less than 5Ωm is distributed over the almost whole region. Slightly high resistivity is recognized partly at the southeastern part of the line.

(4) Madala

The survey location is shown in *Figure A-84* and the interpreted sections for VES and 2D are in *Figures A-85* and *A-86* respectively. Surface geology is Neogene.

Section-1 shows that middle resistivity corresponding to sand to clayey sand layer is distributed dominantly and high resistivity of 300Ωm is recognized at deeper part of VES-1. Section-2 shows that clay to sandy clay layer is overlaid on sand to clayey sand layer, and the thickness of the upper layer increase toward VES-5. As the result of 2D imaging survey carried out at VES-2, middle to high resistivity corresponding to sand to clayey sand layer is distributed dominantly. The layer inclines northwestward.

(5) Msumi

The survey location is shown in *Figure A-87*, and the interpreted sections for VES are in *Figure A-88*. Surface geology is Neogene.

VES-4, 5 and 3 show similar layered structure where clay to sandy clay layer with thickness from 30 to 50m is overlaid on sand to clayey sand layer. VES-1 shows thick sand to clayey sand layer with thickness of 85m. A test well was drilled at VES-2 resulting in the yield of 20l/min.. The lithology consists of sand above the depth of 55m and clayey sand below. The resistivity shows low value of 7Ωm below the depth of 40m, and it is considered to represent clayey sand layer.

(6) Buyuni

The survey location is shown in *Figure A-89* and the interpreted sections for VES and 2D are in *Figures A-90* and *A-91* respectively. Surface geology is Neogene.

A Lineament is estimated passing along VES-4 and 5. Section shows remarkable lateral change of resistivity structure. Formation consists of clay to sandy clay layer and sand to clayey sand layer mainly. High resistivity over 200Ωm are recognized partly. As the result of 2D imaging survey carried out at VES-1, remarkable lateral change of resistivity is recognized at center of

the line. It is considered to be a fault. In the west side of the fault, high resistivity reaching 300Ωm is distributed, while in the east side, low to middle resistivity is distributed. A test well was drilled at the center of the 2D line resulting in the yield of 16.5l/min.. The lithology consists of clay to sandy clay between 13m and 28m, and sand in other part. At the clay to sandy clay layer, the resistivity shows low values of several Ωm.

(7) Kitunda

The survey location is shown in *Figure A-92* and the interpreted sections for VES and 2D are in *Figures A-93* and *A-94* respectively. Surface geology is Quaternary.

Section-1 shows remarkable lateral change of resistivity structure. VES-5 shows relatively high resistivity compared with other VES stations. Section-2 shows horizontal structure, and sand to clayey sand layer is dominant. As the result of 2D imaging survey carried out at VES-5, lateral change of resistivity is recognized from 210 to 240m of the line. It is considered to be a fault dipping northward.

(8) Msongola

The survey location is shown in *Figure A-95*, and the interpreted sections for VES are in *Figure A-96*. Surface geology is Neogene and Quaternary.

VES-3, 4 and 5 show that sand to clayey sand is dominantly distributed, while VES-1 and 2 show that thin sand layer is overlaid on thick clay to sandy clay layer and high resistivity is recognized beneath the clay to sandy clay layer. There is lateral change of the structure between VES-1 and 3.

(9) Pugu Kajiungeni

The survey location is shown in *Figure A-97*, and the interpreted sections for VES are in *Figure A-98*. Surface geology is Neogene.

Section-2 shows that the formation consists of alternation of sand to clayey sand layer and clay to sandy clay layer. The thickness of upper sand to clayey sand layer is thickest at VES-3. The layered structure of Section-2 is almost horizontal, while Section-1 shows remarkable lateral change of resistivity structure.

(10) Kibangulile

The survey location is shown in *Figure A-99*, and the interpreted sections for VES are in *Figure A-100*. Surface geology is Neogene and Quaternary.

The formation consists of clay to sandy clay layer and sand to clayey sand. In general, upper part is low resistivity corresponding to clay to sandy clay layer, and lower part is middle to high resistivity corresponding to sand to clayey sand layer. Clay to sandy clay is dominant.

(11) Golani

The survey location is shown in *Figure A-101*, and the interpreted sections for VES are in *Figure A-102*. Surface geology is Quaternary.

The formation consists of clay to sandy clay layer and sand to clayey sand layer mainly. High resistivity of 200 to 600Ωm are recognized at VES-5 and deeper part of VES-4. Lateral change of resistivity structure is remarkable.

(12) Buza

The survey location is shown in *Figure A-103* and the interpreted sections for VES and 2D are in *Figures A-104* and *A-105* respectively. Surface geology is Quaternary.

High resistivity of 3600 to 4000Ωm are recognized at VES-1 and 2. Other part consists of clay to sandy clay layer and sand to clayey sand layer. As the result of 2D imaging survey carried out at VES-2, the structure inclines westward in general, and lateral change is remarkable. The resistivity changes at shallower part of 80m and at deeper part of 190m of the line. These are considered to be faults.

(13) Mgeni Nani

The survey location is shown in *Figure A-106* and the interpreted sections for VES and 2D are in *Figures A-107* and *A-108* respectively. Surface geology is Quaternary.

The resistivity is relatively high compared with other Quaternary formation area, and low resistivity corresponding to clay to sandy clay is not recognized. Lateral change of resistivity structure is remarkable. As the result of 2D imaging survey carried out at VES-2, the resistivity is distributed complicatedly, and remarkable lateral change is recognized at 140 to 160m of the line.

(14) Mjimwema

The survey location is shown in *Figure A-109*, and the interpreted sections for VES are in *Figure A-110*. Surface geology is Quaternary.

Section-1 shows that the resistivity structure consists of middle to high resistivity corresponding to sand to clayey sand layer and high resistivity from 100 to 250Ωm. High resistivity are recognized at shallower part of VES-1 and 2, and at deeper part of VES-1. The resistivity structure of Section-2 consists of low resistivity corresponding to clay to sandy clay layer, middle to high resistivity and high resistivity from 100 to 500Ωm. It is possible that the high resistivity represents limestone.

(15) Potea

The survey location is shown in *Figure A-111*, and the interpreted sections for VES are in *Figure A-112*. Surface geology is Quaternary.

Section-1 and 2 show that clay to sandy clay is distributed dominantly, and high resistivity are recognized at deeper part of VES-5 and 3. Middle to high resistivity corresponding to sand to clayey sand layer are recognized VES-1 and 4. A test well was drilled about 100m apart from VES-4, resulting in the yield of plenty of water. Additional VES survey was conducted at three station around the test well as the field trip of technical transfer to Water Resources Institute. As the results of these additional VES survey, middle resistivity of 30Ωm is recognized below the depth of 30m at the test well, and it corresponds to good aquifer of sand layer detected below the depth of 35m by the test well.

(16) Vijibweni

The survey location is shown in *Figure A-113*, and the interpreted sections for VES are in *Figure A-114*. Surface geology is Quaternary.

Sections show that high resistivity layer is laid at shallower part, and is considered to be limestone. Very low resistivity of 2Ωm is recognized at deeper part of VES-2 and 4. It is possible that these very low resistivity values represent sea water. Lateral change of resistivity structure is recognized between VES-1 and 2 and between VES-4 and 5.

(17) Gezaulole

The survey location is shown in *Figure A-115*, and the interpreted sections for VES are in *Figure A-116*. Surface geology is Quaternary.

High resistivity is recognized at shallower part of VES-2, 3 and 4 and at deeper part of VES-1 and 5. It is possible that these high resistivity represents limestone. Except for these high resistivity, the formation consists of clay to sandy clay layer and sand to clayey sand layer. Lateral change of the resistivity structure is recognized between VES-3 and 4. In the east side of VES-3, sand to clayey sand layer is dominant, while in the west of VES-4, clay to sandy clay layer is thicker.

4.4 INTERPRETATIONS

4.4.1 CLASSIFICATION OF RESISTIVITY

Figure A-117 is plotting the resistivity values for each geological formation. The resistivity values are derived from the results of 1D analysis. The resistivity values are unevenly distributed, and are classified according to lithology for each formation. *Table 4.9* shows the classification. There is clear difference between fresh bedrock and weathered rock or fracture for Precambrian formation, while not clear for Jurassic and Cretaceous formation. One of the reasons is statistical uncertainty by inadequate number of samples for Jurassic and Cretaceous formation. For Neogene and Quaternary formation, the resistivity values are classified into four. Low resistivity less than 12Ωm corresponds to clay to sandy clay, and middle resistivity from 15 to 60Ωm to clayey sand to sand. High resistivity from 200 to 400Ωm for Neogene formation corresponds to compact sandstone. High resistivity for Quaternary formation is also considered to be Neogene sandstone. Since the formation is derived from geological map and represents just surface geology, it is provable that Neogene sandstone exists at deeper part in Quaternary formation area. Extremely high resistivity more than 600Ωm is considered to be limestone.

Table 4.9 Classification of Resistivity for Each Formation

Formation	Resistivity	Lithology
Precambrian	> 1000	Fresh bedrock
Precambrian	10 – 200	Weathered rock or fracture
Jurassic	60 – 100	Fresh bedrock
Jurassic	15 – 40	Weathered rock or fracture
Cretaceous	100 – 1000	Fresh bedrock
Cretaceous	15 – 60	Weathered rock or fracture
Neogene	200 – 400	Sandstone
Neogene	15 – 60	Clayey sand to sand
Neogene	2 – 12	Clay to sandy clay
Neogene	> 600	Limestone ?
Quaternary	200 – 400	Neogene sandstone
Quaternary	20 – 60	Clayey sand to sand
Quaternary	3 – 12	Clay to sandy clay
Quaternary	> 600	Limestone ?

4.4.2 PROMISING ZONE

(1) Precambrian, Jurassic and Cretaceous formation area

There are two types of potential zone for water resources. One is a bottom of weathered zone. In these area, geological formation consists of hard and compact bedrock and overlaid weathered rock. If the thickness of weathered zone is large, there is the potential of water at the bottom of weathered zone. The potential area as weathered zone are VES-2 in Kibindu, VES-5 in Kwamsanja and VES-5 in Ubenazomozi. Another is a fracture zone. A fracture zone saturated with water shows relatively low resistivity compared with fresh bedrock. The fracture zone is clarified by conducting VES survey at several stations along a line perpendicular to the lineament. 2D imaging survey is more useful because the lateral change of resistivity is recognized directly. The potential area as fracture zone are VES-1 in Kibindu and 175m point

of the 2D survey line in Kwamduma. In Kwamduma, a fault was estimated by 2D imaging survey, and test well was drilled resulting in the yield of enough water.

(2) Neogene and Quaternary formation area

The geological formation consists mainly of sand and clay sediments. Coarse sand layer is expected as good aquifer. Clay shows low resistivity less than 10Ωm. Relatively high resistivity zone from 15 to 100Ωm is considered as high potential area. In Potea, the test well was drilled, and good aquifer was detected below the depth of 35m. As the results of VES survey at the same point, a layer of 30Ωm was recognized below the depth of 30m, and is considered to represent the aquifer. The resistivity of groundwater is one of important factor for interpretation of the results of electrical survey. In general, the resistivity of sand layer saturated with water is not less than that of groundwater. Therefore, if the resistivity less than that of groundwater is recognized, it can be considered to be clay. Lateral change of strata situation is often seen in Neogene and Quaternary formation. In such a case, 2D imaging survey is useful to grasp lateral change of resistivity structure.

4.5 TECHNICAL TRANSFER OF GEOPHYSICAL EXPLORATION TO WATER RESOURCES INSTITUTE

4.5.1 BACKGROUND AND OUTLINE OF TECHNICAL TRANSFER

Water Resources Institute (WRI) is a subordinate organization of Ministry of Water and Livestock Development and is training technicians for water resources development. WRI holds equipment for the electrical survey donated by JICA Expert who had been dispatched to WRI. A technical transfer to professional hydrogeologists in WRI was carried out utilizing this equipment. The technical transfer is related with application of the electrical survey to water resources development, and following activities were conducted.

- Lecture on the principle of the electrical survey and the equipment.
- Training on the operation of the equipment.
- Field trip to geophysical survey site.
- Training on the analysis of data obtained by the equipment.
- Instruction of digital data filing.
- Workshop on the application of the electrical survey to the water resources development.
- Assistance to the preparation of curriculum.

The participants of this program are listed in *Table 4.10*.

Table 4.10 The Participants of the Technical Transfer Program

Name	Title
Mr. Benedict P. Michael	Hydrogeologist, Principal of WRI
Mr. Jonathan Mgaiwa	Hydrogeologist
Ms. Elinide Madiwa	Hydrogeologist

The donated equipment is McOHM EL manufactured by OYO Corporation of Japan. McOHM EL can be used for electrical survey and electrical logging. The specification of McOHM EL is described in *Table 4.11*

Table 4.11 The Specification of McOHM EL

Transmitting section		Data memory section	
Output current	2, 20, 60 or 120mA	RAM capacity	98kB (approximately 4000 data can be stored
Max output voltage	400V		
Duration time	2, 3 or 4sec		
Data acquisition section		FDD capacity	512(Header) + 48 x N(Data numbers) [bytes]. In case of 1.2MB disk, max N is about 26200.
Input impedance	10MΩ		
Max input voltage	±5V		
Min detective voltage	1μV		
Stacking	1, 4, 16 or 64		

A software for analysing the data of the electrical survey had been also donated. The software is called WinSEV, and is used for 1D inversion analysis of VES data.

4.5.2 TRAINING PROGRAM APPLIED

(1) Lecture on the principle of the electrical survey and the equipment

Lecture on the principle of the electrical survey and the equipment was given in advance of on-the-job training. Detailed subjects of lecture are as follows.

- The principle of the electrical survey.
- The principle of McOHM EL.
- Operation of McOHM EL.
- Procedure of VES survey.

(2) Training on the operation of McOHM EL

The following on-the-job training activities were conducted at suitable sites close to WRI campus.

- Site selection.
- Preparation for VES survey.
- Data acquisition with McOHM EL.
- Quality control of measured data.
- Proper usage of equipment and its maintenance.

The VES survey were conducted at four points in two days. The data obtained by this training were used for the training on the analysis.

(3) Field trip to the geophysical survey site.

Field trip was carried out at Potea, one of the Study area, where the Study team had already conducted VES survey at five points. A test well had been drilled at the site 100m distant from one of the VES stations, and good aquifer had been detected. As an activity of field trip, The Study team and WRI member conducted VES survey using McOHM EL at three stations on and around the test well. The data obtained by this field trip were used for the training on the analysis, and compared with the results of test well drilling.

(4) Training on the analysis of data obtained by McOHM EL

In advance of practical training, lecture was given on the following subjects.

- Objective of analysis.
- Methodology of analysis.

Practical training of analysis using the software, WinSev, was conducted as follows.

- Data input.
- Data editing.
- Inversion analysis.
- Output.

The data obtained by on-the-job training and the field trip were used for this training on the analysis.

(5) Instruction of digital data filing

Instruction of digital data filing was given on the following subjects.

- Outline of data filing.
- Contents of digital data.
- Utilization of folder structure.
- Storing the data into the file.
- Utilization of digital data.

(6) Workshop

The workshop about the application of electrical survey to groundwater exploration was held. The subjects of the workshop were as follows;

- Outline of exploration.
- Site selection.
- Exploration depth.
- Measurements.
- Analysis.
- Interpretation.
- Examples of exploration in the Study.
- Recommendation.

A lively discussion was made regarding utilization of multiple methods in the survey of fracture zone, the difficulty of measurements in Neogene and Quaternary formation area and the relation between the resistivity of groundwater and strata. The handout used for the workshop is attached to *Appendix B*.

(7) Assistance to the preparation of curriculum

A curriculum of WRI is created according to the guidelines given by the National Council for Technical Education. The Study team made a textbook about the electrical survey which can be used as basic idea for curriculum creation. Slides of figures and explanations about the electrical survey which can be used in teaching students were also made by MS PowerPoint. The textbook is attached to *Appendix C*, and the slides are to *Appendix D*.

4.6 CONCLUSIONS AND RECOMMENDATIONS

4.6.1 CONCLUSIONS

General geo-electrical feature in Coast and Dar es Salaam region was clarified by the geophysical exploration. Neogene and Quaternary formations show extremely low resistivity less than 10Ωm considered to be clay to sandy clay and low to middle resistivity from 10 to 100Ωm considered to be sand to clayey sand. Relatively high resistivity values over 100Ωm are recognized occasionally, and these are considered to be well consolidated sandstone or limestone. On the other hand, Precambrian, Jurassic and Cretaceous formations consist mainly of fresh bedrock and weathered rock. Fresh bedrock is showing high resistivity and weathered rock is relatively low resistivity.

One of the geological features in the Study area is that the strata condition shows lateral change in a short distance. In Neogene and Quaternary formation area, thickness and depth of each layer varies laterally. In Precambrian, Jurassic and Cretaceous formation area, thickness of weathered zone changes by fault. In such a case, 2D imaging survey was very useful to grasp the change of geological structure because the analyzed data is expressed as the resistivity section.

Based on the results of the geophysical exploration, 10 test wells were drilled. Several boreholes yield enough water, and a usefulness of geophysical survey was proved. Some boreholes yield little water contrary to the prospect of geophysical survey. In such a case, further consideration of the resistivity comparing to the results of drilling is required.

4.6.2 RECOMMENDATIONS

A site for geophysical survey should be selected carefully. Geological and geomorphological information is useful for the site selection. If the target is fracture zone, geological structure should be taken into account. Lineaments distribution map derived from satellite image or aerophoto is useful to select the site for fracture zone. Detailed information about fracture zone or fault such as strike or dipping is derived from electrical profiling or magnetic survey easily. After that, the VES survey should be conducted at several stations along a line which is perpendicular to the lineament, then promising zone is detected as relatively low resistivity zone within the high resistivity zone. 2D imaging is more useful because resistivity distribution is delineated as section, and detailed structure can be estimated. If the target is alluvial aquifer, geomorphological low place is most suitable site from geological viewpoint, but accessibility, distance and height difference between the site and the community should be also taken into account. Neogene formation is not distributed horizontally, but lateral changes of strata situation are seen in many places. In such a case, VES survey conducting at several stations along a line or 2D imaging survey are useful to grasp the lateral change of resistivity structure.

There is a difficulty of measurements clarified by the geophysical exploration. It is the extremely low resistivity observed in Neogene and Quaternary formation area. The extremely low resistivity is considered to be caused by clay sediments or saline water, and is showing several Ωm. If the apparent resistivity is very low, the potential difference measured by VES survey is also very low, and the data is noisy and unstable. For example, if the current of 100mA is injected to the ground of 3Ωm using the electrodes configuration of 100m for AB/2 and 20m for MN/2, the measured potential difference is 0.4mV. In general, the potential difference should be more than several mV for good data. In the case mentioned above, if the current value is 500mA, the measured potential difference becomes 2.0mV, and the data quality is improved. Apparent resistivity value of 3Ωm is not unusual in the Study area, therefore the maximum current of the equipment for electrical survey should be 500mA at least.

The resistivity of groundwater was measured at existing well in several survey areas. The resistivity ranges from 3 to 45Ωm, and is not uniform. The resistivity of groundwater is one of

important information to interpret the results of electrical survey because the resistivity of subsurface depends on the resistivity of groundwater and water content.

Chapter 5

Socio-Economic Survey

CHAPTER 5 SOCIO-ECONOMIC SURVEY

5.1 INTRODUCTION

5.1.1 OBJECTIVES

The socio-economic survey was conducted in 50 villages selected in the study area in October 2004. Objective of the socio-economic survey is to comprehend baseline data related to socio-economic conditions of the study area, current status of water use, and perception and capacity of community members on operation and maintenance of water supply facilities. Findings of the survey are also utilized, together with other data and information collected through literature review and the village inventory survey, in further analysis on socio-economic issues to be considered in formulation of water supply plan and operation and maintenance plan.

5.1.2 METHODOLOGIES AND SURVEY ITEMS

Execution of the survey was sub-contracted out to a local consultant based in Dar es Salaam. The field survey team formed by the local consultant consisted of five groups with each team comprising a sociologist and assistant sociologist/community participation expert accompanied by a staff from district/municipal council. The entire process and quality of the survey was supervised by the JICA study team. The field survey was conducted in October 2004 and collected data was processed in November 2004.

The survey employed the structured interview with questionnaire at villages/mitaas and households selected as samples in the study area. Two types of questionnaires prepared by the JICA study team were used in the survey after pre-tested by the field survey teams. *Table 5.1* shows survey items and target groups.

Table 5.1 Survey Items

Type of Survey	Informant	Survey Item	
Village Key Informant Survey	Members of Village/Mitaa Government and Members of Village Water Committee	1. Demographic information	
		2. Accessibility to utility services	• district center, bank and fuel station
		3. Economic activities in the community	
		4. Institutional setup of the community	• Type of existing community-based organizations • experiences in communal activities • availability of support from external agencies such as government and NGO
		5. Present status of health and sanitation of community members	• Type of sanitation facilities • Major diseases in the community • Availability of hygiene education program • Accessibility to health and medical services
		6. Present status of water supply	• Type of source • Operational status • Amount of user fee for the water source • Activities of water vendors
		7. Operation and maintenance of existing water supply facilities	• Responsible actor for O&M • Measure taken at breakdown of the facilities • Daily O&M activities • Financial management
		8. Valuation on the Improved Water Supply Services	• Perception on positive and negative impacts of water supply • Demand for improved water supply

Type of Survey	Informant	Survey Item	
Sample Household Survey	Household head and spouse (if available)	1. Socio-economic characteristics of the household	• Composition of household members • School attendance of children and education level of adults • Level of income and expenditure • Physical condition of house
		2. Priority in issues related to improvement of living conditions	
		3. Present status of water use	• Type of water source and usage • Level of water consumption • Perception on quality and quantity of water available • Cost spent to obtain domestic water
		4. Valuation on the improved water supply services	• Level of satisfaction in the present water supply conditions • Preferable type of improved water supply facilities • Willingness to pay • Affordable amount for user fee • Type of contribution for investment cost
		5. Present status of health and sanitation of household members	• Major diseases among the household members • Type of sanitation facility used by the household • Hygiene practices

5.1.3 SAMPLING METHOD AND TARGET COMMUNITIES OF THE FIELD SURVEY

The field survey was conducted in 50 villages/mitaas selected in the study area. 50 samples from village level and 200 from household level were collected.

Selection of the target communities of the survey was done in accordance with five categories listed below by type and operational condition of existing water supply facilities.

- Category A: Communities which have piped scheme in use
- Category B: Communities which have piped scheme, but not in use
- Category C: Communities which have protected shallow well or deep well with hand pump in use
- Category D: Communities which have protected shallow well or deep well with hand pump, but not in use
- Category E: Communities which have no communal protected water source

The JICA study team agreed with respective District/Municipal Water Engineer Office on selection of villages/mitaas which satisfy these categories. Name of the communities selected as the survey samples and its classification are indicated in the list of target communities of the survey (See *Table 5.2*). While 10 villages/mitaas per category was supposed to be surveyed in the initial plan, number of samples per survey category had a small variation as shown in the table due to availability of communities meeting the category in the study area.

Meanwhile, for interview at the household level, random sampling method was applied to select four households each in 50 communities to make number of samples 200 in total.

5.2 GENERAL SOCIO-ECONOMIC CONDITIONS OF THE STUDY AREA

This section features general socio-economic conditions of the study area mainly confirmed from the village inventory survey.

Table 5.2 List of Target Communities of the Socio-Economic Survey

Region/Distr / Category of Suvery	Coast Region								Dar es Salaam Region						Total
	Bagamoyo		Kibaha		Kisarawe		Mkuranga		Ilala		Kinondoni		Temeke		
	Village	(Ward)	Village	(Ward)	Village	(Ward)	Village	(Ward)	Village	(Ward)	Village	(Ward)	Village	(Ward)	
Category A (Piped Scheme in Use)			Mwembengozi Kwala	(Kwala) (Kwala)	Gwata Maneromango Sokoni	(Mafizi) (Maneromango)			Kisiwani Kasulu Minazi Mirefu Kigilagila	(Tabata) (Ilala) (Kiwalani) (Kiwalani)	Mabwepande	(Bunju)	Kilakala	(Yombo Vituka)	10
Category B (Piped Scheme not in Use)	Kibindu Kwaruhombo Fukayoshi Mdaula	(Kibindu) (Mbwewe) (Kiwangwa) (Chalinze)	Minazi Mikinda	(Ruvu)	Ngongele	(Maneromango)	Njopeka Kalole	(Lukanga) (Kisiju)	Mvuti	(Msongola)	Kisiwani	(Ubungo)	Tundwi Songani	(Pemba Mnazi)	11
Category C (Handpump Well/Borehole in Use)			Zogowale Mkuza Gwata	(Visiga) (Tumbi) (Magindu)	Homboza Kauzeni	(Msimbu) (Kibuta)	Mwalusembe Mpera Kisemvule	(Mwalusembe) (Vikindu)			Kibangu	(Makuburi)	Kibugumo	(Mjimwema)	9
Category D (Handpump Well/Borehole not in Use)	Mkange	(Mkange)	Lupunga Mwendapole	(Ruvu) (Kibaha)			Kimanzichana Kusini Mingombe Mwanambaya	(Kimanzichana) (Kitomondo) (Tambani)	Pugu Station	(Pugu)	Bunju'A' Chalinze	(Bunju)	Kibene Mwanamsekwa	(Vijibweni) (Toa Ngoma)	10
Category E (No Protected Water Source)	Talawanda	(Talawanda)	Misufini Magindu	(Soga) (Magindu)	Kihare	(Marui)	Kikoo	(Kitomondo)	Amani	(Segerea)	Changanyikeni Mavurunza Matosa	(Kawe) (Kimara) (Goba)	Msufini	(Chamazi)	10
Total No. of Target Villages by District	6		10		6		8		7		7		6		50

5.2.1 POPULATION OF THE TARGET COMMUNITIES OF THE STUDY

Information on population of each target community of the study was collected in the village inventory survey since population by single village/mittaa has not yet revealed from the latest population and housing census results. Through an interview to the village/mitaa government officials, population record at 2002 was collected from each community. It contains total population of the community, composition of sub-villages, and distribution of population in each sub-village.

As a result of the village inventory survey, population size of 278 target communities varies from 140 to 27,000 in 2002. Median population sizes of the target communities in two regions are about 1,600 in Coast Region and 5,800 in Dar es Salaam Region, respectively. *Table 5.3* shows descriptive statistics of the population size of the target communities by district and *Figure 5.1* and 5.*2* describe distribution of the target communities by categories of population size.

Table 5.3 Population Size of Target Communities by District (2002)

District	Mean Pop.	Median Pop.	Minimum Pop.	Maximum Pop.
Coast Region				
Bagamoyo	2,748	2,050	586	12,762
Kibaha	3,242	1,695	337	18,048
Kisarawe	1,257	976	142	6,744
Mkuranga	2,242	1,819	500	13,700
Dar es Salaam Region				
Ilala	9,436	6,391	3,122	27,648
Kinondoni	8,096	3,537	1,220	25,144
Temeke	6,179	5,670	751	15,881

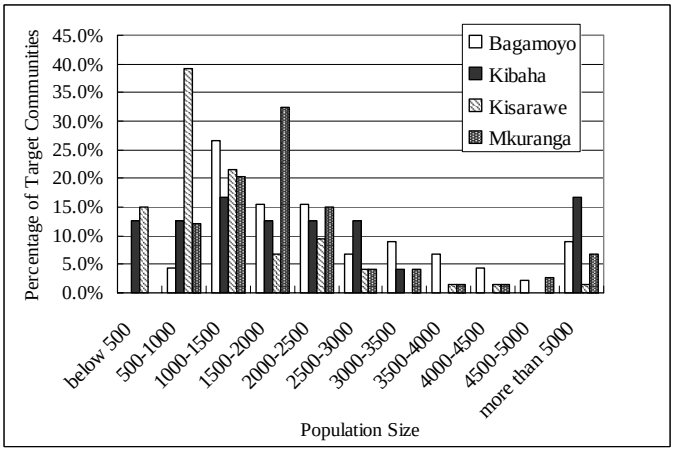

Figure 5.1 Distribution of Target Communities by Population Size (2002) (Coast Region)

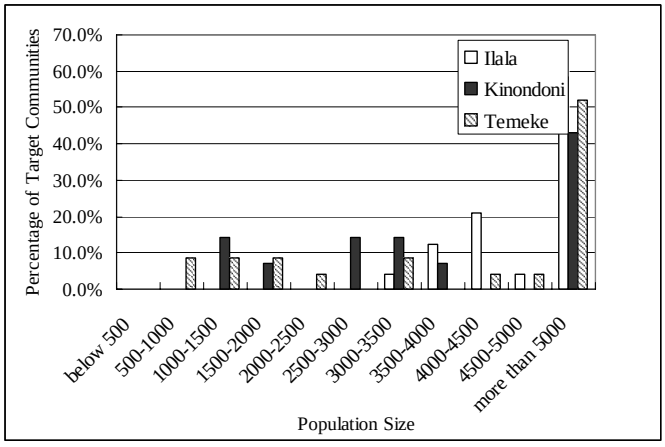

Figure 5.2 Distribution of Target Communities by Population Size (2002) (Dar es Salaam Region)

5.2.2 CHARACTERISTICS OF COMMUNITY ESTABLISHMENT

(1) Type of Communities

1) Form of Communities

Form of the communities in the target regions are categorized in village and mitaa according to the rural or urban settings of the society. As shown in *Table 5.4*, about 80% of the target communities are classified in the form of village while others, mostly located in Dar es Salaam Region, are in the form of mitaa. Each village is further divided into sub-villages. Number of

sub-villages forming one village varies by district. Target communities in Bagamoyo have the largest number of sub-villages among the study area. The average number of sub-villages per village in the district is seven while three to four sub-villages consists of one village in case of Kibaha, Kisarawe and Mkuranga.

Table 5.4 Distribution of Target Communities by Form of Village or Mitaa

		Form of Community		
		Village	Mitaa	Total
District	Bagamoyo	44	1	45
	Kibaha	22	1	22
	Kisarawe	74	0	74
	Mkuranga	74	0	74
	Ilala	9	15	24
	Kinondoni	0	14	14
	Temeke	2	21	23
Total		226	52	278

2) Dwelling Type of Communities

Dwelling type of the communities is one of the factors to be considered in formulation of water supply plan and designing the water supply facilities. From this aspect, dwelling type of each target community was confirmed physically during the village inventory survey. *Table 5.5* indicates distribution of target communities by the dwelling type, either i) houses are concentrated in center place of the community, ii) houses are concentrated along the road, iii) houses are clustered in several places in the community, or iv) houses are scattered in the different directions. Nearly 40% of the target communities are categorized in the clustered type of dwelling and another 40% are in scattered setting.

Table 5.5 Distribution of Target Communities by Dwelling Type

			Concentrated	Concentrated along the Road	Clustered	Scattered	Total
District	Bagamoyo	Count	4	1	37	3	45
		% within District	8.9%	2.2%	82.2%	6.7%	100.0%
	Kibaha	Count	3	1	9	11	24
		% within District	12.5%	4.2%	37.5%	45.8%	100.0%
	Kisarawe	Count	2	11	28	33	74
		% within District	2.7%	14.9%	37.8%	44.6%	100.0%
	Mkuranga	Count	4	2	30	38	74
		% within District	5.4%	2.7%	40.5%	51.4%	100.0%
	Ilala	Count	14	0	0	10	24
		% within District	58.3%	.0%	.0%	41.7%	100.0%
	Kinondoni	Count	4	0	1	9	14
		% within District	28.6%	.0%	7.1%	64.3%	100.0%
	Temeke	Count	20	0	1	2	23
		% within District	87.0%	.0%	4.3%	8.7%	100.0%
Total		Count	51	15	106	106	278
		% within District	18.5%	5.4%	38.4%	37.7%	100.0%

5.2.3 INFRASTRUCTURE

Status of power supply in the target communities in Coast Region is low. Only 11% of the target communities receive supply from the commercial power line. Even in Dar es Salaam Region, communities located in outskirts of the urban centers do not have connection to the electric power supply. Regarding the access to the telecommunication system, about 60% of the target communities are covered by the network of service providers of the mobile phone. (See *Table 5.6*)

Table 5.6 Distribution of Target Communities by Availability of Power Supply and Telecommunication Network

District	Total No. of Target Villages/Mitaas	No. of Villages with Power Supply	No. of Villages with Telecommunication Network	
			Land Line	Mobile
Bagamoyo	45	8	2	37
Kibaha	24	5	3	12
Kisarawe	74	3	3	18
Mkuranga	74	9	0	49
Ilala	24	19	13	23
Kinondoni	14	7	3	14
Temeke	23	13	6	21
Total	278	64	30	175

5.3 STATUS OF WATER USE BY HOUSEHOLDS IN THE STUDY AREA (RESULTS OF SOCIO-ECONOMIC SURVEY IN THE SAMPLE COMMUNITIES)

5.3.1 CHARACTERISTICS OF RESPONDENTS AND SAMPLE HOUSEHOLDS

(1) Characteristics of Respondents

The key informants of the survey at the village level was village/mitaa chairperson, officials of the village/mitaa government, and members of the village/mitaa water committee. In the sample household survey, 200 respondents consisting of 50:50 ratio of male and female were obtained. 70% of the respondents are household heads followed by spouse of the household heads (23%). 40% of the household heads who responded to the interview were accompanied by his spouse.

(2) Characteristics of Sample Households

Around 80% of sample households are male-headed. Average age of the household heads is 49 with 18 at the lowest and 90 at the highest. *Figure 5.3* shows distribution of sample households by sex and age group of household heads. Household heads in 67% of the sample households have monogamous families while polygamous households are 13%.

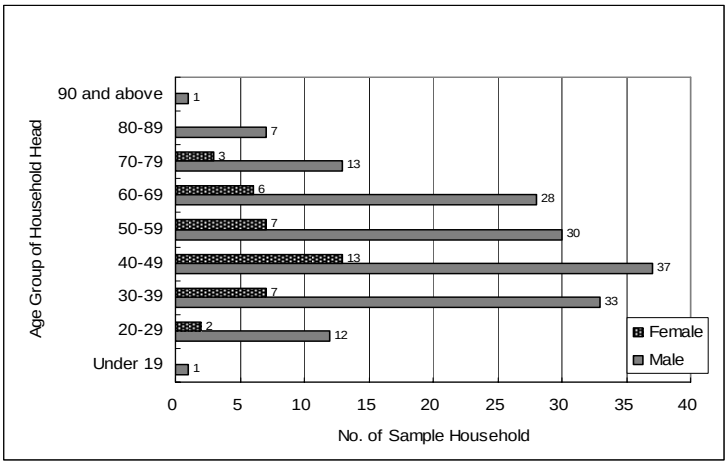

Figure 5.3 Distribution of Sample Households by Sex and Age Group of Household Head

Mean number of household members is six in the 200 sample households. *Table 5.7* shows mean and median number of household members by district. Results of the survey revealed the number of household members slightly higher than the one obtained by the national population and housing census 2002. According to the results of the census 2002, average household size in Coast and Dar es Salaam regions is four.

Table 5.7 Mean and Median Numbers of Household Members in the Sample Communities

District	No. of Sample Households	Mean No. of Household Members	Median No. of Household Members
Bagamoyo	24	6	5
Kibaha	40	6.4	6
Kisarawe	24	6.08	5
Mkuranga	32	5.91	6
Ilala	28	7.75	7
Kinondoni	28	6.75	6
Temeke	24	8.21	7.5
All Samples	200	6.69	6

(3) School Attendance of Children and Education Level of Adults

Total 160 boys and 182 girls at primary school age (7-13) were confirmed in the sample households. Among them, 94% of boys and 93 % of girls are attending the primary schools. Gap between the enrolment rate of boys and girls is not big in the sample households. Higher enrolment rate of girls than boys was also observed in Kibaha and Mkuranga. Main reasons of non-attendance of the primary school explained by the respondents are listed below.

- Busy with helping household chores
- Household cannot afford education cost
- The child is handicapped or sick.

Regarding the highest education level of the adults in the sample households, majority of male and female in Coast Region completed primary school with less than 10% of members who completed the secondary school. In Dar es Salaam, on the other hand, 26% of male and 17% of female completed the secondary school as their highest level of education. Attention is also to be paid that about 30% of female adults in the sample households in Coast Region received no primary education at all. *Figure 5.4 to 5.7* indicates percentage of adult members in the sample households by sex, region and the highest level of education they received.

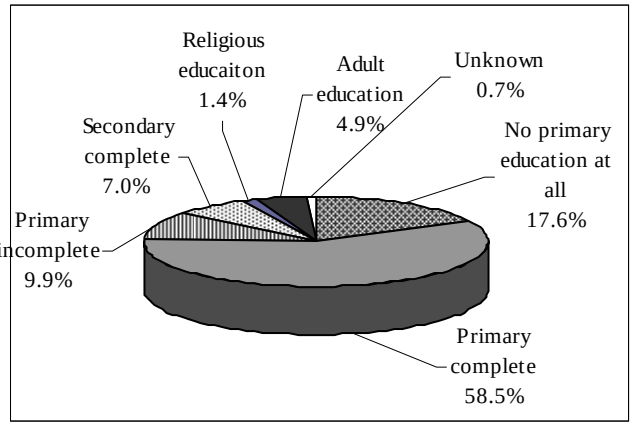

Figure 5.4 Highest Level of Education of Adult Men (18 and above) in Household Members (Coast Region)

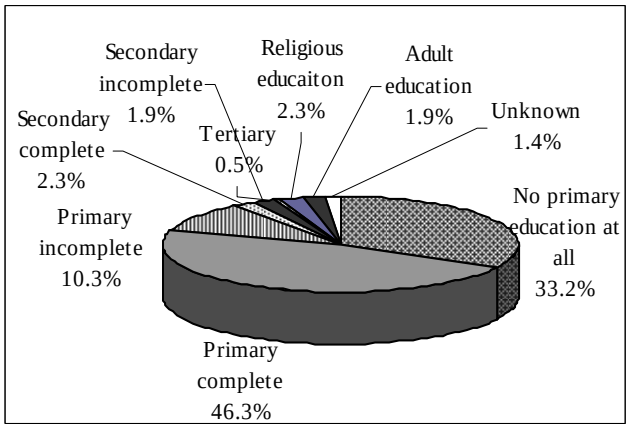

Figure 5.5 Highest Level of Education of Adult Women (18 and above) in Household Members (Coast Region)

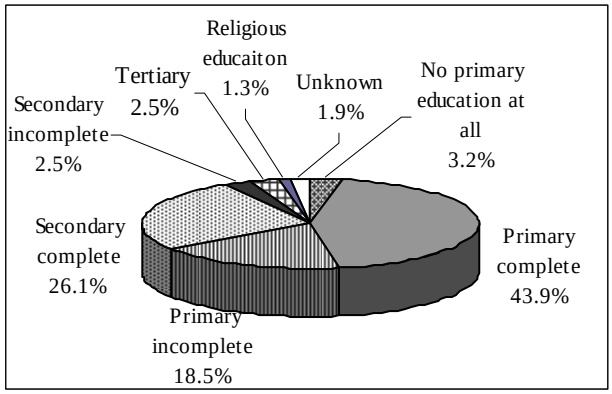

Figure 5.6 Highest Level of Education of Adult Men (18 and above) in Household Members (Dar es Salaam Region)

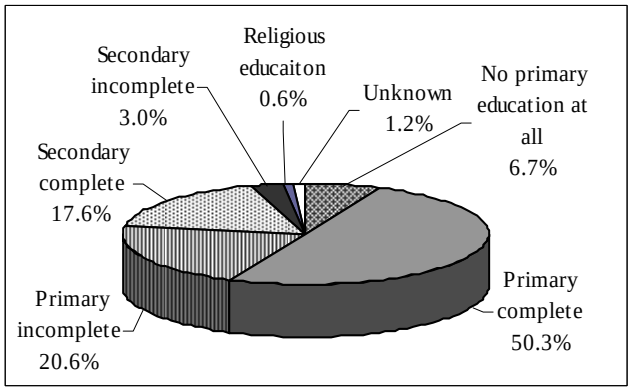

Figure 5.7 Highest Level of Education of Adult Women (18 and above) in Household Members (Dar es Salaam Region)

(4) Housing Type

94% of the sample households live in the self-owned houses and others are in the rented houses. Average number of rooms in the household is three in Coast Region and four in Dar es Salaam. Type of the materials used for roof and wall of the house is different from the urban and rural settlements as generally observed. 50% of sample households in Coast Region and 66% in Dar es Salaam use asbestos or iron sheet for roofing while other houses are straw thatched. For wall materials, households with using mud and wood is the largest group (72%) in the Coast Region followed by the houses with concrete block wall (12.5%). In Dar es Salaam, 67% of the sample households uses concrete block for the wall materials.

(5) Level of Income and Expenditure

80% of the sample households in Coast Region stated that farming is their primary source of income, which is the main economic activity in the entire region. As the secondary sources of household income, retail (46%) and casual work (13%) are followed by remittance from the household members working outside the village and others. In case of Dar es Salaam, 42% of the households depends their income on sales from retail activities followed by farming (28%) and salary from permanent employment (16%). The three largest categories of the secondary income source are remittance from the household members (24%), farming (16%) and casual work (9%).

32% of the sample households has Tsh30,000-60,000 of monthly average income followed by the group with Tsh60,000-100,000 (23%) and Tsh20,000-30,000 (18%). Comparing at the regional level, income group of Tsh30,000-60,000 is the largest (41%) among the households in Coast Region. The second largest group is within the category of Tsh20,000-30,000 (23%) and Tsh60,000-100,000 (20%). Meanwhile, distribution of income groups in sample households in Dar es Salaam shows wider variation than Coast Region. The largest group is Tsh60,000-100,000 (28%) followed by Tsh30,000-60,000 (18%), Tsh100,000-150,000 (16%), Tsh150,000-200,000 (16%) and Tsh200,000-300,000. *Figure 5.8* and *5.9* show distribution of sample households by district and monthly average income group.

Regarding the expenditure level, median expenditure in Coast Region is Tsh45,000 and Tsh60,000 in Dar es Salaam.

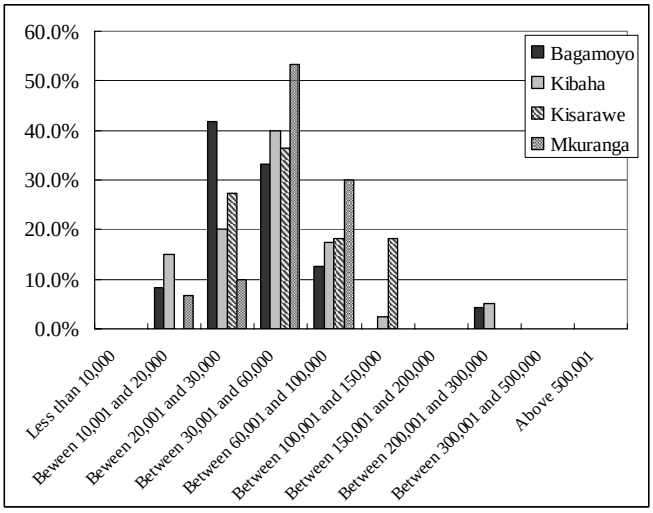

Figure 5.8 Distribution of Sample Households by Income Level (Tsh/HH/month) (Coast Region)

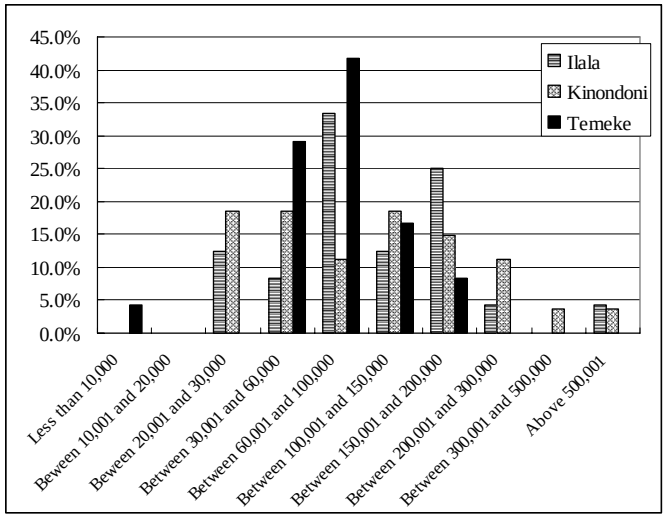

Figure 5.9 Distribution of Sample Households by Income Level (Tsh/HH/month) (Dar es Salaam Region)

5.3.2 PRACTICE OF WATER USE/CONSUMPTION BY THE SAMPLE HOUSEHOLDS

(1) Type of Water Source and Usage

Primary water source for the sample households is mainly unprotected source in rainy season. 53% of the respondents answered that their households use unprotected source, mainly unprotected shallow well, for getting water for domestic use such as drinking, cooking, and washing dishes and clothes. Another 20% of the households have access to the water supply from the piped schemes which are mostly communal water supply through public taps. Also, among the group who has access to the piped scheme, about 10% fetches domestic water from yard tap located at neighbor's house or their own dwelling.

Due to the nature of seasonality of water supply from the unprotected source, number of users of protected source or services from water vendor increases in dry season for domestic water consumption. Meanwhile, for productive purpose such as livestock watering, gardening and brick making, unprotected source is the main water source for most of the sample households throughout the year. It is to be noted that sample households consuming the water for livestock watering and gardening is only 13% to 17% of all samples. Households using water for brick making for construction of houses are about 45%. *Figure 5.10 to 5.19* show distribution of sample households by type of primary source for each usage.

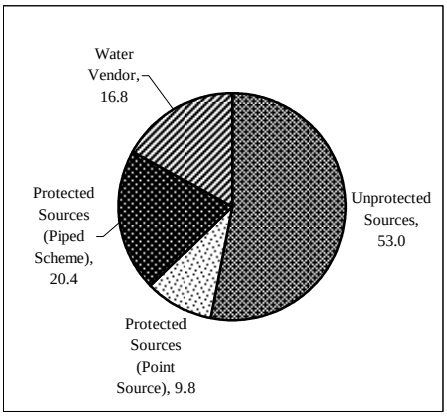

Figure 5.10 Primary Water Source for Drinking in Rainy Season

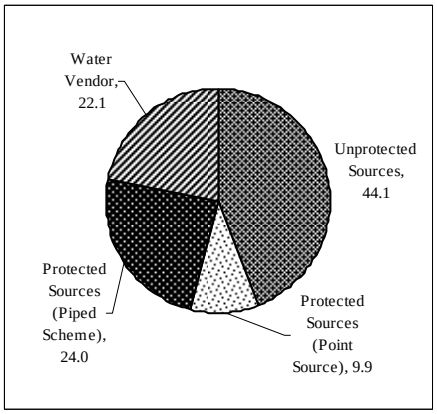

Figure 5.11 Primary Water Source for Drinking in Dry Season

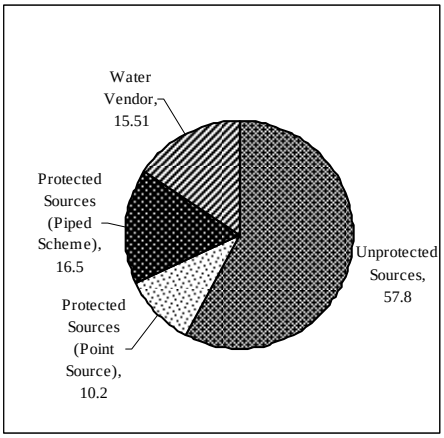

Figure 5.12 Primary Water Source for Cooking and Washing in Rainy Season

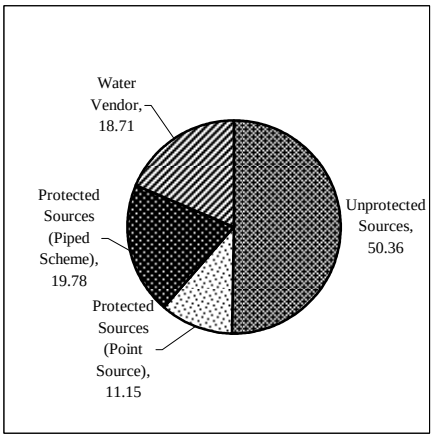

Figure 5.13 Primary Water Source for Cooking and Washing in Dry Season

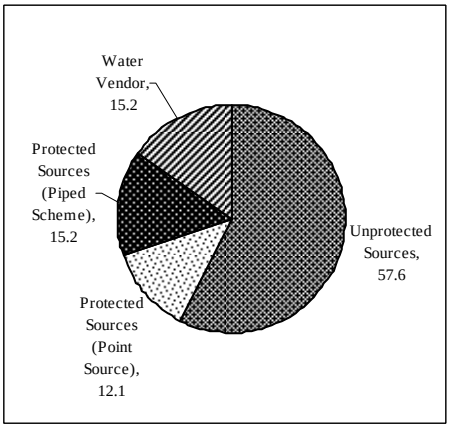

Figure 5.14 Primary Water Source for Livestock Watering in Rainy Season

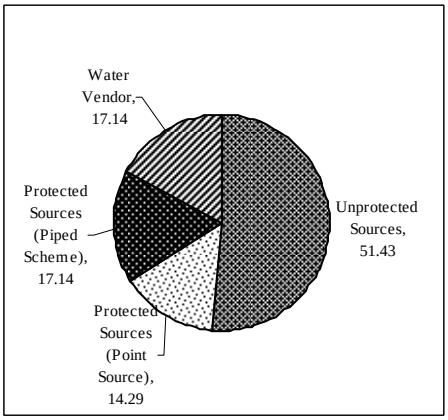

Figure 5.15 Primary Water Source for Livestock Watering in Dry Season

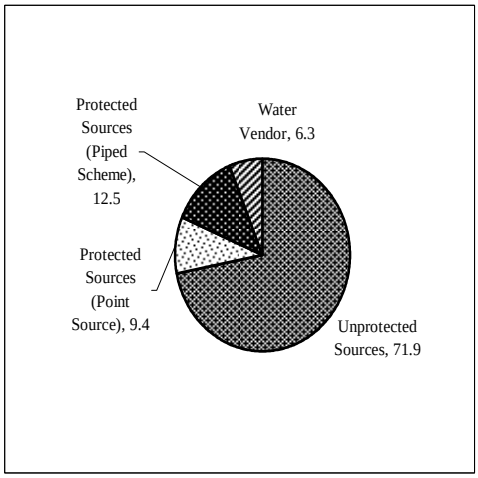

Figure 5.16 Primary Water Source for Gardening in Rainy Season

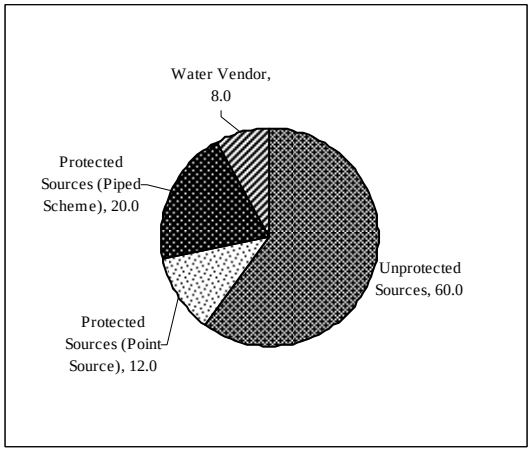

Figure 5.17 Primary Water Source for Gardening in Dry Season

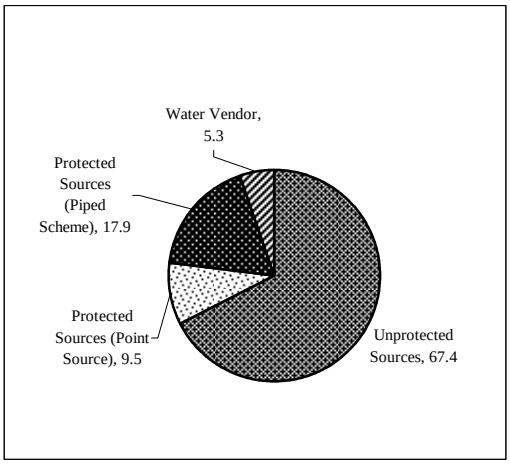

Figure 5.18 Primary Water Source for Construction of Houses in Rainy Season

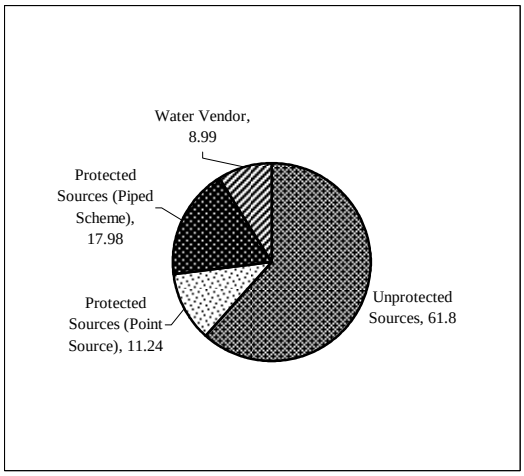

Figure 5.19 Primary Water Source for Construction of Houses in Dry Season

The survey also revealed that about 70% of the sample households use single water source for drinking. Most of these households also use same water source for cooking and washing as well. *Table 5.8* indicates type of source for drinking water for the households which have access to one source. Among the households with single source for drinking water, 60% of households in rainy season and 50% in dry season use unprotected source.

Table 5.8 Distribution of Sample Households which Use Single Water Source for Drinking

	1) Rainy Season		2) Dry Season	
Type of Water Source	Count	% of Responses	Count	% of Responses
Stream/ River	4	2.8	4	2.6
Dam/Charco/Pond	14	9.8	18	11.5
Rainwater	6	4.2	0	0
Unprotected Spring	0	0	0	0
Unprotected Shallow Well	68	47.6	63	40.4
Protected Spring	1	0.7	1	0.6
Protected Shallow Well with Bucket	2	1.4	3	1.9
Protected Shallow Well with Handpump	7	4.9	8	5.1
Deep Well with Handpump	8	5.6	6	3.8
Public Tap	17	11.9	22	14.1
Piped into Yard or Plot	5	3.5	8	5.1
Piped into Dwelling	6	4.2	7	4.5
Water Vendor (by tanker)	2	1.4	5	3.2
Water Vendor (by hand cart)	3	2.1	11	7.1
Other	0	0.0	0	0
Total Response	143	100	156	100

Reasons why the households use the water source are mainly i) availability of water all the time in case of supply from piped scheme, ii) no alternative source for users of unprotected source or water vendor, iii) short distance from home, and iv) quantity of water available at the source.

(2) Water Consumption for Domestic Water

Daily per capita water consumption for the domestic use is 22 liter/capita/day in rainy season and 15 liter/capita/day in dry season at median level for all sample households. Observing the

water consumption by region, the median figure for per capita daily consumption is 22 liter in Coast Region and 23 liter in Dar es Salaam Region in rainy season. However, the amount is drastically reduced to 14 lter/capita/day in Coast and 18liter/capita/day in Dar es Salaam during the dry season.

Figure 5.20 and 5.21 show distribution of sample households which use single unprotected source for domestic use by region and level of daily consumption of domestic water. Households in this group consume about 24 liter/capita/day in rainy season and 14 liter/capita/day in dry season on average from the unprotected water source such as unprotected shallow well and dam/charco. Meanwhile, water consumption level of users of public tap is 17 liter/capita/day in rainy season and 20 liter/capita/day in dry season on average from the survey results, which shows increase of water use in dry season in contrast to the users of the unprotected source.

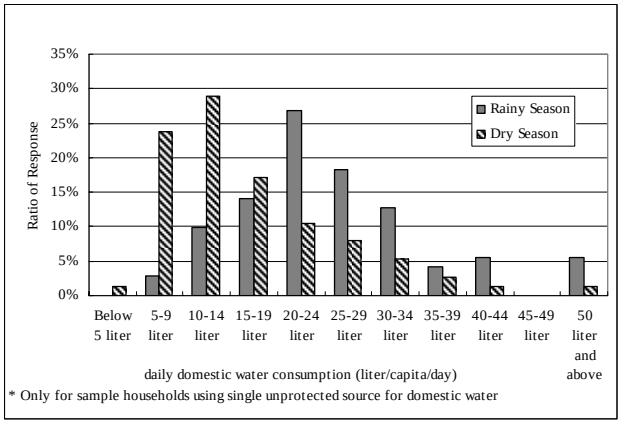

Figure 5.20 Distribution of Sample Households by Daily Per Capita Consumption of Domestic Water (Coast Region)

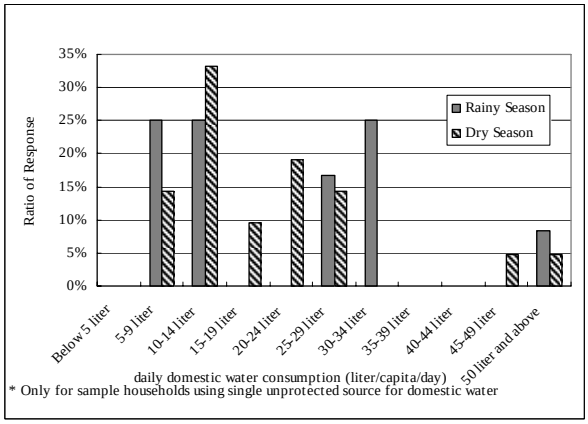

Figure 5.21 Distribution of Sample Households by Daily Per Capita Consumption of Domestic Water (Dar es Salam Region)

(3) Frequency and Time Taken for Water Fetching

Frequency of water fetching is four times in rainy season and three times in dry season in Coast while twice a day in rainy season and three times in dry season in Dar es Salaam on average. As indicated in *Figure 5.22*, water is collected during 6:00-9:00 in the morning in rainy season and very few after 18:00. However, 40% of the sample households in each region require to go to fetch water in the early morning in dry season due to the reasons such as time consumed to wait for the water discharge at the source, highly congested number of users at one source or longer distance to go to the source where water is available.

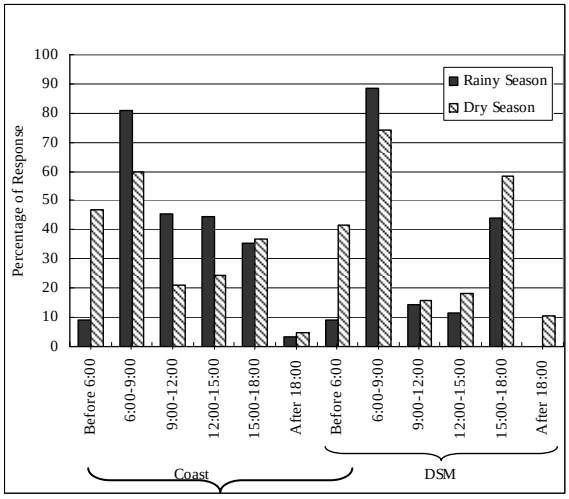

Figure 5.22 Timing of Water Fetching

Time taken for water fetching was assumed based on information on time from house to the water source and time spent at the source to wait for his or her turn. Median time to taken to the water source in sample households in Coast Region is 15 minutes in both rainy and dry seasons while 10 minutes in Coast Region. This result indicates that the primary water sources for the sample households are located relatively near to their dwelling. An attention is to be paid that half of the sample households are using unprotected source as the primary source for drinking due to no alternative source is available for them. Therefore, short time to taken to the source does not necessarily means that the accessibility to the water supply for the sample household is in good condition. In addition to that, big difference in time to queue at the source in rainy season and dry season is also one of the problems for the sample households in relation to accessibility issue. 4 minutes in Coast Region and 10 minutes in Dar es Salaam are the median figures of time to queue at the water source in rainy season. On the other hand, sample households have to spend one hour in Coast Region and 30 minutes in Dar es Salaam Region in dry season at median level. Also, some of the households spend more than two hours to reach to the water source or wait for half day for water discharged at the seasonal source. *Figure 5.23 and 5.24* shows distribution of sample households by duration of time taken for water fetching in each region.

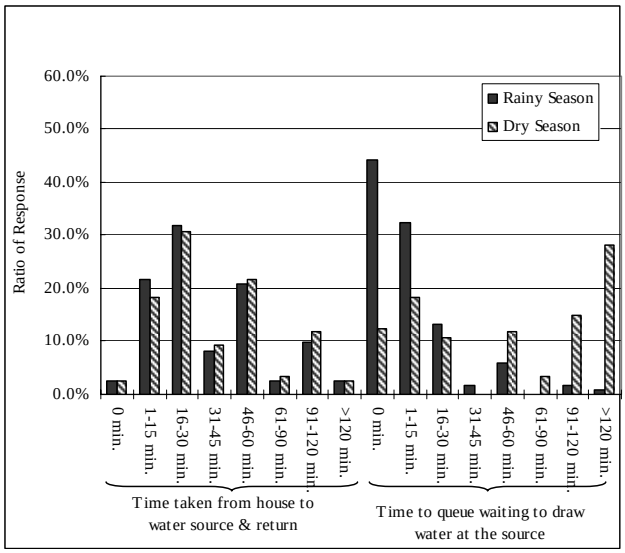

Figure 5.23 Distribution of Sample Households by Region and Time Taken for Water Fetching (Coast Region)

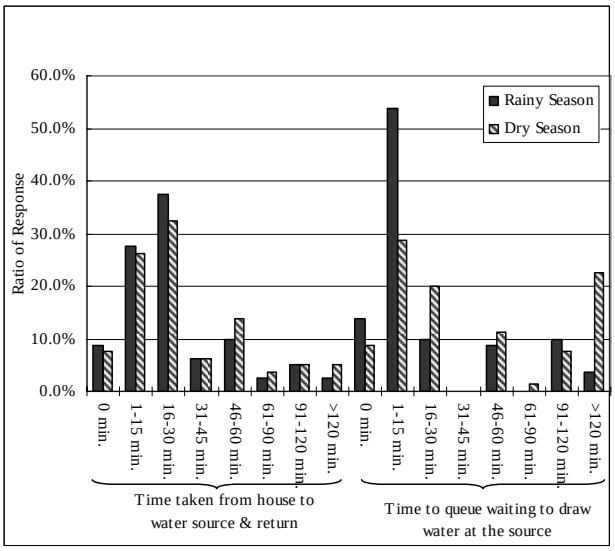

Figure 5.24 Distribution of Sample Households by Region and Time Taken for Water Fetching (Dar es Salaam Region)

(4) Responsible Persons for Water Fetching

Collection of water for the household is perceived as the work of adult women who is responsible for household chores in the study area. 80% of the respondents in Coast Region and 77% of in Dar es Salaam answered that adult women in the household is the primary water collector for them. As the secondary responsible person for water fetching, girl children bear the work load to help mothers in 32% of the sample households in Coast Region while the percentage of involvement of boy children for water collection is relatively lower (10%) than girls. In Dar es Salaam Region also, the status of higher involvement of girl children in water collection than boys was observed. Adult men also play a part of the secondary actor to collect water, especially in case that the water source is located in a distance from the house or collection of water for the productive purposes such as house construction.

5.3.3 PERCEPTIONS OF RESIDENTS ON EXISTING WATER SUPPLY CONDITIONS

(1) Level of Satisfaction in the Current Water Supply Conditions

On the present status of water supply to the sample households, around 70% of respondents in Coast Region and 65% in Dar es Salaam stated that they were not satisfied with the conditions.

Furthermore, 13% of respondents in each region answered they were not satisfied at all in the present water supply which the household can access to. Main areas of concern attributed to dissatisfaction of sample households in Coast Region are i) water quality, ii) distance to the water source, iii) queuing time at the source to wait for his or her turn to fetch water, and iv) quantity of water which the household can obtain. In case of Dar es Salaam, the problem stated with the highest percentage of the households is same as Coast Region, that is quality of water. It is followed by quantity of water available and amount of user fee for the water supply services. Higher ratio of sample households in Dar es Salaam than Coast Region depends on their domestic water to the water vendors, especially in dry season. Since amount of user fee charged by the water vendors is usually more expensive than other type of water supply, households which have no alternative source to get water seem to express perception of dissatisfaction on amount of user fee.

(2) Perception on Quality and Quantity of Water Available for the Household

Figure 5.25 and 5.26 shows perceptions of respondents on quality of water consumed for drinking at households. In order to analyze differences in level of satisfaction on quality by type of water source, perceptions of the sample households which are using single water source for drinking water were also compared in *Figure 5.27 and 5.28.*

Approximately 45% of the respondents answered quality of drinking water is bad (poor) or very bad in rainy season mainly because of muddy water. For the water quality in dry season, about 35% of the respondents have perception of bad or very bad though majority of them answered that the quality was fair. Reason of dissatisfaction in dry season is mainly brackish water.

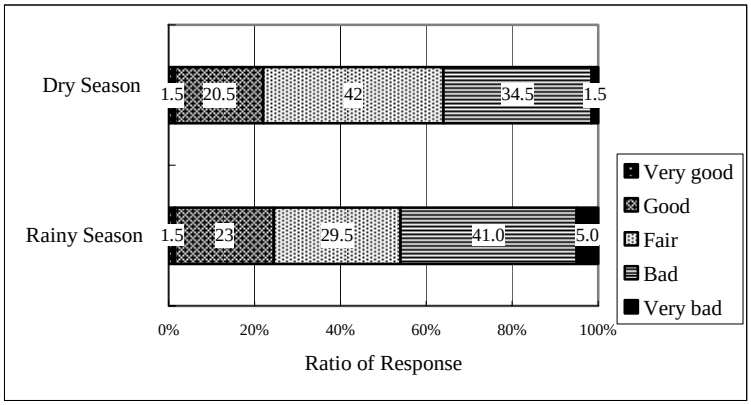

Figure 5.25 Perception on Quality of Drinking Water

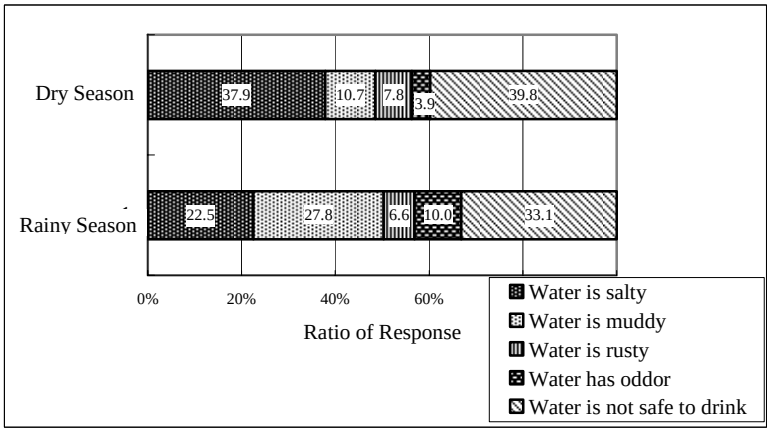

Figure 5.26 Reason of Dissatisfaction on Water Quality

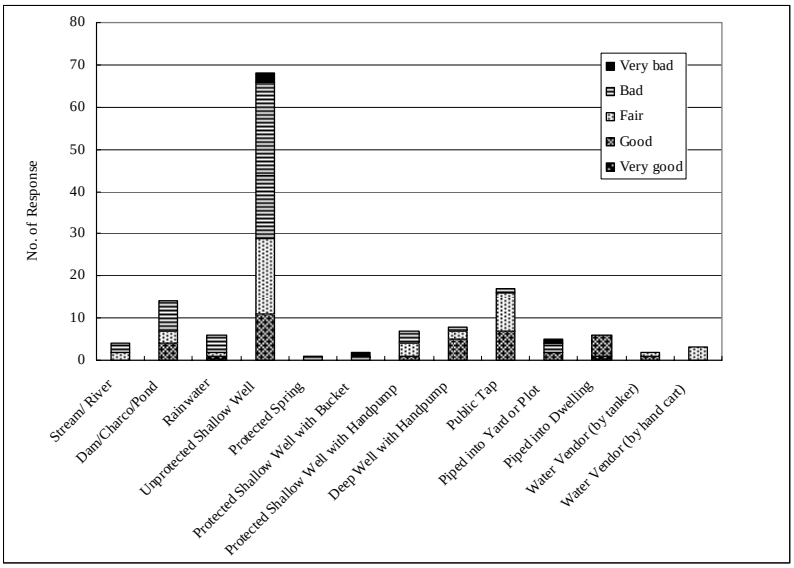

Figure 5.27 Perceived Quality of Water Source for Drinking by Type of Source (Rainy Season)

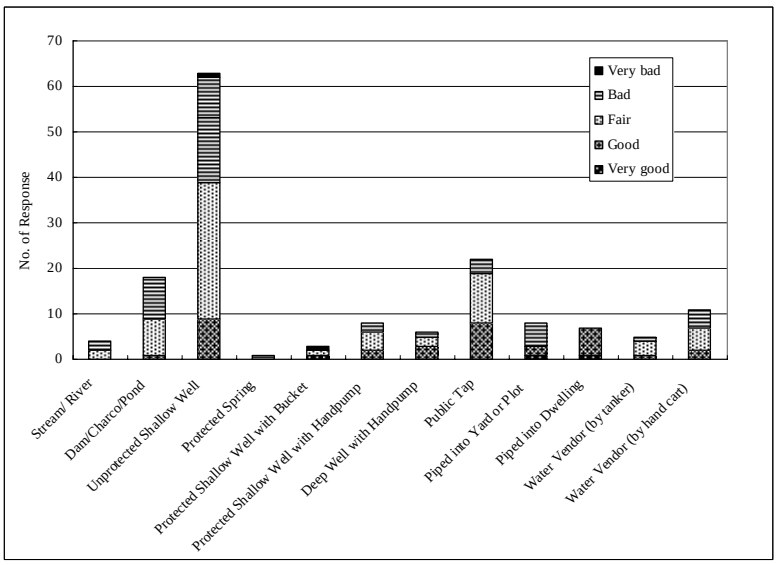

Figure 5.28 Perceived Quality of Water Source for Drinking by Type of Source (Dry Season)

As for water quantity available for the households, half of the respondents perceived fair and another 30% answered that quantity is sufficient in rainy season. However, quantity of water accessible in dry season is perceived insufficient by half of the respondents which consist of 70% of sample households in Coast Region and 30% in Dar es Salaam. Level of water consumption of households which stated dissatisfaction in water quantity in dry season is 17 liter/capita/day.

(3) Perception on Frequency of Water Fetching

Increase of frequency to collect water in dry season is perceived as inconvenient by nearly 60% of the sample households in Coast Region and 45% in Dar es Salaam. As mentioned in the previous part of this section, frequency of water fetching a day increase from three times in rainy season to four in dry season in Coast Region and twice a day in rainy season to three times in dry season in Dar es Salaam. *Figure 5.29* shows perceptions of respondents on frequency of water fetching in rainy season and dry season.

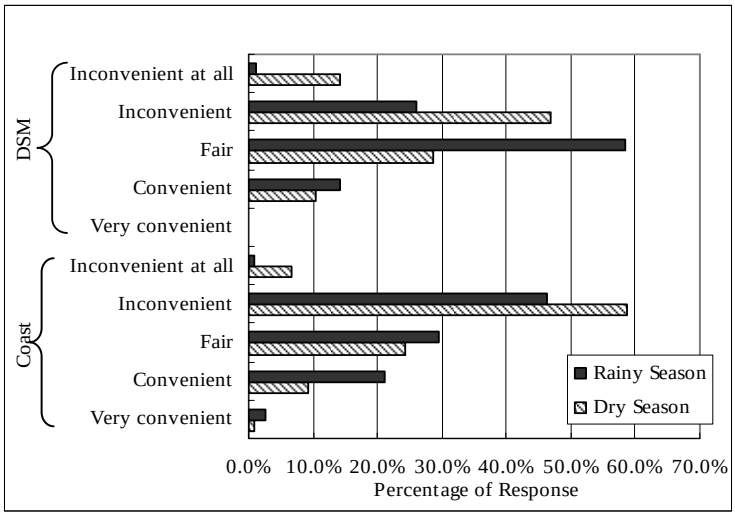

Figure 5.29 Perception on Frequency of Water Fetching

5.3.4 FINANCING FOR WATER USE

(1) Unit Price of User Fee by Water Source

The survey confirmed that the unit price of user fee is generally within the range of Tsh20-35 per 20 liter container (Tsh1-1.7/liter) whatever the type of water source is. This range of the user fee is commonly applied to communal water source such as unprotected shallow well, hand pump well, public tap, and use of private tap connected to neighbor's yard or dwelling. Meanwhile, Tsh100-200 per 20 liter container (Tsh5-10/liter) is charged for the service from the water vendors. Among the sample households in Dar es Salaam, some of them buy water from water vendors run by tanker at Tsh30,000-35,000 per $10m^3$.

In the study area, the unit price charged per 20 liter container is commonly practiced and the price is the flat rate. Monthly payment per household is also applied, though it is a few cases, to the user fee for protected shallow well or deep well with hand pump or public tap with a range of Tsh500-1000/month/household. In case of private connection at yard or into dwelling of own house, monthly payment per household is the common system.

Generally, the sample households using hand pump well or public tap express that the unit cost charged to the water use from the respective source is fair while most of the users of service from the water vendor perceive the price is very expensive.

(2) Total Costs Spent by the Sample Households to Obtain Domestic Water

As shown in *Table 5.9*, sample households generally spend Tsh200/day in rainy season and Tsh300/day in dry season for obtaining domestic water. From the household size of each sample, per capita cost spent for water can be computed Tsh33 in rainy season and Tsh60 in dry season at median level. Gap between the cost in rainy season and the one in dry season is big in Dar es Salaam. The households pay double to obtain water in dry season.

Table 5.9 Total Costs Spent by the Sample Households to Obtain Domestic Water

		All Samples		Coast Region		Dar es Salaam Region	
		Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season
Valid N		96	128	37	62	59	66
Missing		104	72	83	58	21	14
(Unknown)		3	3	2	2	1	1
(No cost is incurred to obtain water)		101	69	81	56	20	13
Total Cost (Tsh/HH/Day)	Mean	299	530.58	209.3	319.1	355.25	729.24
	Median	200	300	150	200	200	560
Per Capita Cost (Tsh/cap/day)	Mean	48.219	82.168	41.569	55.194	52.389	107.506
	Median	33.333	60	33.333	42.857	35.714	83.333

Figure 5.30 and 5.31 show distribution of sample households by level of per capita expenditure for water. It is also to be noted that more than half of the sample households in Coast Region and about 20% of households in Dar es Salaam currently obtain water free of charge. This case is observed in users of unprotected source in most cases while no fee is charged to the communal protected well with hand pump in some cases.

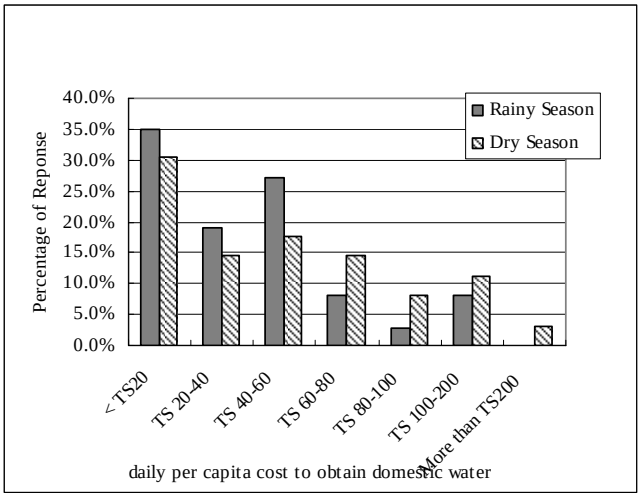

Figure 5.30 Distribution of Sample Households by Daily Per Capita Cost for Domestic Water (Coast Region)

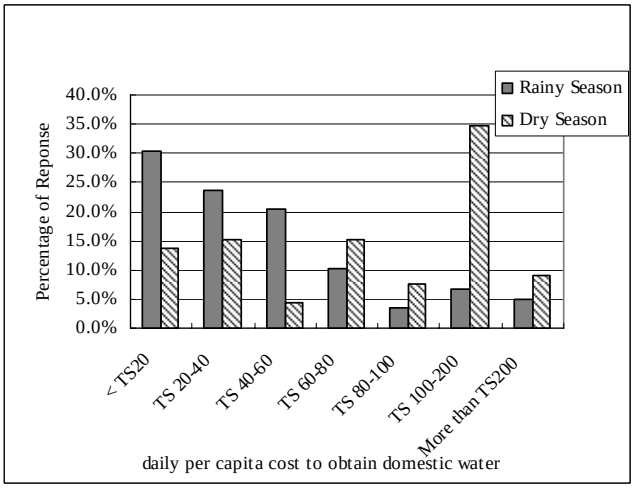

Figure 5.31 Distribution of Sample Households by Daily Per Capita Cost for Domestic Water (Dar es Salaam Region)

5.3.5 VALUATION ON THE IMPROVED WATER SUPPLY

(1) Priority Ranking in Improvement of Living Conditions

The sample households put the first priority on improvement of water supply conditions among areas of their concerns related to improvement of living condition in the communities where they live. The highest number of response went to improvement of health facilities and services as the second priority. *Table 5.10* shows the matrix of priority ranking on perceived concerns of respondents related to improvement of living conditions. The other area of interest especially for the sample households in Coast Region is condition of access road.

Table 5.10 Matrix of Priority Ranking on Perceived Concerns of Respondents Related to Improvement of Living Conditions in the Community

		2nd Priority								
		Electricity	Health	Education	Water Supply	Sanitation	Garbage Disposal	Access Road	Other (specify)	Total
1st Priority	Electricity		7	4	3	0	0	3	0	17
	Health	0		3	10	0	0	5	0	18
	Education	0	3		4	0	0	1	0	8
	Water Supply	17	67	15		3	3	32	4	141
	Sanitation	0	1	0	1		0	1	0	3
	Garbage Disposal	0	0	0	0	0		0	0	0
	Access Road	1	2	1	5	0	1		0	10
	Other (specify)	0	0	0	1	0	0	0		1
	Total	18	80	23	24	3	4	42	4	198

(Valid cases: 198, Missing: 2 cases ("Don't know/ Not sure"))

(2) Needs for the Improved Water Supply

In Coast Region, 90% of respondents expressed their needs of improved water supply. About 60% of them stated that they would like to have the improved water supply even the rate of user fee is more expensive than present. This percentage includes the households which are using the water source free of charge presently. 20% responded their preference of improved water supply if the rate remains same level as the present and another 10% put a condition that the rate should be cheaper than the present to have improved water supply.

Meanwhile, in Dar es Salaam, the percentage of households is lower (45%) than Coast Region in terms of improved water supply with higher rate than the present one. 25% of the respondents stated that they would like to have better service provision on water supply if the user fee remains changed and another 20% with perception that the rate should be cheaper than the present level.

(3) Preference of Type of Improved Water Supply and Expected Impacts

As shown in *Figure 5.32*, piped water scheme is the most preferred type of water supply for the sample households. In Coast Region, almost same percentage of households with those who prefer piped scheme with groundwater source put their preference on the piped scheme with water source from river or spring. Possible reasons of preference of rive or spring water can be considered as past experiences in problems with protected shallow wells and deep wells they used though further assessment will be required in the planning stage of priority project. On the other hand, piped water scheme with groundwater source is the most preferable type of the improved water supply among the sample household in Dar es Salaam.

In case of piped water scheme, public water point is mostly preferred to the sample households in Coast Region (56%) followed by connection to the yard tap at own house (35%). In Dar es Salaam Region, 34% of households who prefer to the piped scheme answered that they would like to use yard tap connected to neighbor's house. Another 25% each go to public tap and yard tap at own house. Those who prefer to connection into their own dwelling is about 5% each in both regions.

Since time consumed for water fetching is one of the problems for the sample households, good percentage of households express their preference on connection to yard tap at nearby houses or own house to reduce the load.

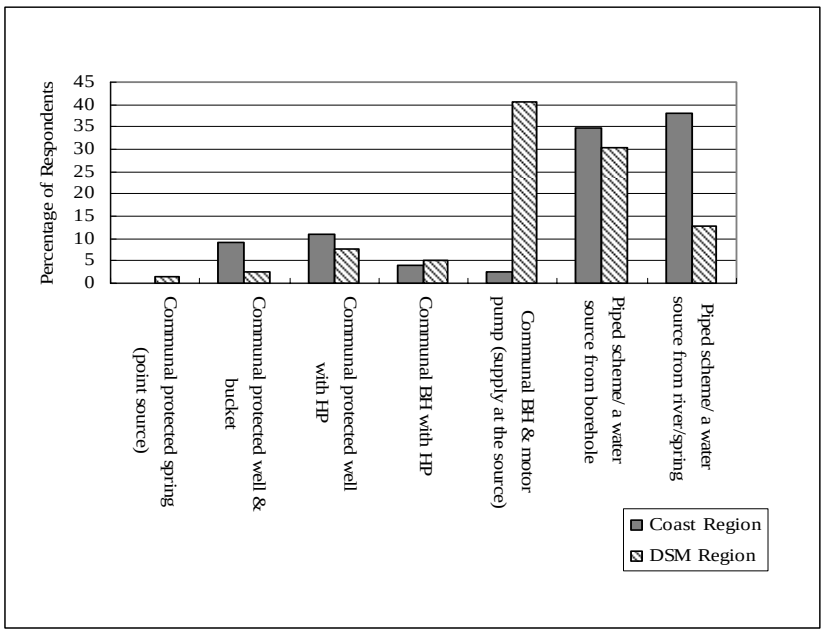

Figure 5.32 Distribution of Sample Households by Preferable Type of Improved Water Supply

(4) Awareness on Responsibilities of Communities in Operation and Maintenance

Awareness of sample communities is high in terms of responsibilities of users in operation and maintenance of water supply. 45% of the respondents answered that Village Water Committee or other form of user group should be primarily responsible for daily operation and maintenance of the facilities. Another 20% also stated that users themselves should be involved in the operation and maintenance. On the other hand, perceptions of the respondents on cost recovery have variety. 50% of them think the primary responsibility on cost recovery of O&M should be borne by the users or Village Water Committee or other form of user group through contribution of fund from users. Meanwhile, another 20% responded that the village government or both users and local authorities should be responsible for cost recovery for O&M.

(5) Willingness to Pay

The sample households in Coast Region expressed level of maximum amount affordable for user fee as Tsh20 per 20 liter container for water supply from hand pump well. The amount is at same level even in case of piped scheme. In Dar es Salaam Region, median figure of maximum amount is Tsh20 for hand pump well and Tsh22 for piped scheme.

Table 5.11 shows maximum affordable amount stated by the sample households by category of household income level. Those which prefer to piped scheme with public tap or individual connection at Tsh30,000 or more of monthly income show maximum affordable amount as Tsh20 per 20 liter container at median level. The amount is at the same level with the present status on unit cost which most of the households pay for water. From results of the survey, maximum affordable amount expressed by the sample households does not indicate much difference among the income groups.

Meanwhile, affordable amount for piped scheme with individual connection varies among the income groups in case of monthly payment. The ratio of affordable amount to the monthly income is approximately 5% or below for each income group.

Table 5.11 Maximum Amount Affordable for Water by Level of Household Income

Type of Water Supply		Category of Income Level of Sample Households									
		<10,000	10,000–20,000	20,000–30,000	30,000–60,000	60,000–100,000	100,000–150,000	150,000–200,000	200,000–300,000	300,000–500,000	Above 500,000
Well with hand pump (Tsh/20 liter)	N Valid	1	10	33	53	40	16	12	5	1	1
	Missing	0	0	2	9	4	1	0	2	0	1
	Mean	10.00	14.00	16.06	17.74	18.13	21.88	18.33	20.00	20.00	50.00
	Median	10.00	10.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	50.00
Piped scheme with public tap (Tsh/20 liter)	N Valid	1	10	32	55	40	16	11	4	1	1
	Missing	0	0	3	7	4	1	1	3	0	1
	Mean	10.00	17.00	22.19	19.91	23.13	26.88	21.36	22.50	20.00	50.00
	Median	10.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	50.00
Piped scheme with public tap (Tsh/HH/month)	N Valid	0	0	3	5	2	1	1	3	0	0
	Missing	1	10	32	57	42	16	11	4	1	2
	Mean			600.00	700.00	2250.00	125.00	10000.00	5333.33		
	Median			500.00	500.00	2250.00	125.00	10000.00	5000.00		
Piped scheme/ individual connection (Tsh/20 liter)	N Valid	0	8	21	36	31	8	6	0	0	0
	Missing	1	2	14	26	13	9	6	7	1	2
	Mean		19.38	27.86	25.14	28.39	30.00	355.00			
	Median		20.00	20.00	20.00	20.00	25.00	30.00			
Piped scheme/ individual connection (Tsh/HH/month)	N Valid			9	21	18	7	7	7	1	1
	Missing			26	41	26	10	5	0	0	1
	Mean			1355.56	2604.76	4416.67	4428.57	5571.43	8928.57	2000.00	30000.0
	Median			1000.00	1500.00	4250.00	3000.00	5000.00	10000.00	2000.00	30000.0

Note:
"Valid": Number of sample households in the income category, which prefer to the type of water supply and mode of payment
"Missing": Number of sample households in the income category, which did not show interest in the type of water supply and mode of payment

(6) Billing Method Preferred by the Sample Households

Half of the sample households prefer to flat rate per liter or container as the billing method of water supply. Another 30% responded that flat rate per household per month is their preference. Those who expect progressive increasing tariff system to be applied in the improved water supply is 15% of the total sample households.

In terms of mode of payment, 60% of the sample households responded that they would like to pay user fee at water point when drawing water. Monthly payment is preferred by about 30% of households.

Preference on billing method and mode of payment reflects the system commonly applied to the present water supply in the study area.

(7) Willingness to Contribute for Investment Costs for Improved Water Supply

Apart from the contribution towards operation and maintenance costs, 60% of households in Coast Region are willing to contribute for labor force for construction of improved water supply scheme. Another 23% stated that they could make cash contribution at Tsh2,000-4,000 per household per average. Those who are willing to contribute in kind such as construction materials is about 8%. Only 3% of the sample households answered no contribution could make for the investment cost.

In Dar es Salaam, half of the sample households responded that they could contribute in cash at Tsh3,000-5,000 per household for initial costs of construction of improved water supply facilities. Another 30% are willing to contribution in form of provision of labor force and 10% by provision of construction materials. Type of materials available for contribution is sand in most cases.

5.3.6 CONCLUSION

Through the field survey, needs of the sample households for improved water supply is high, especially among the group which is using single unprotected source for domestic water. Problems perceived by the households categorized in this group is low reliability of water source due to mainly shortage of water in dry season to result in reduction of water use, poor quality of water, and heavy load to collect water. Users of services by the water vendor also have acute needs on improved water supply due to high costs charged to the service.

The households in the majority income group of Tsh30,000-60,000 in the samples expressed the maximum amount affordable for the user fee is Tsh20 per 20 liter. Households in adjacent categories of income group such as Tsh20,000-30,000 and Tsh60,000-100,000 also stated the same level of amount as the affordable price for them.

The further study to formulate water supply plan for the priority projects requires paying attention to the economic status of households and level of affordable amount confirmed in the field survey so that type of water supply facilities proposed meets the level of affordability of users. At the stage of selection of the priority villages, amount of willingness to pay by the type of water supply facility is to be confirmed with the community members based on the actual scenarios of alternative projects.

5.4 PROJECTION OF FUTURE WATER DEMAND

Future water demand is projected for domestic use and institutions of schools and health facilities based on the analysis of the past trend of population growth in the study area and population projection in 2010, 2015 and 2020. The projected demand at the target year is utilized for formulation of the outline of water supply plan and further detail design of the priority projects.

5.4.1 POPULATION PROJECTION OF THE STUDY AREA

(1) District Population

For the population forecast at the district level, the population growth rate of 1988-2002 from the latest census data was applied. *Table 5.12* shows the projected population size of each target district in 2010, 2015 and 2020.

Table 5.12 Projected Future Population of Target Districts

District	Population					Annual Average Growth Rate
	2002 (Census)	2004 (Projected)	2010 (Projected)	2015 (Projected)	2020 (Projected)	
Bagamoyo	228,967	238,217	268,271	296,193	327,021	2.0%
Kibaha	131,242	140,318	171,489	202,694	239,576	3.4%
Kisarawe	95,323	98,011	106.537	114,207	122,428	1.4%
Mkuranga	186,927	200,241	246,147	292,346	347,215	3.5%
Ilala	634,924	694,681	909,861	1,139,288	1,426,567	4.6%
Kinondoni	1,083,913	1,174,616	1,494,859	1,827,485	2,234,125	4.1%
Temeke	768,451	840,775	1,101,209	1,378,885	1,726,579	4.6%

(2) Population of the Target Communities

Future population of the target communities were analyzed based on the present population size collected in the village inventory survey and annual average growth rate of each district which was used for the population projection at the district level. In case that the study is supposed to cover a specific area or sub-villages in the community instead of the entire area of the village/mitaa, population of the served area in the study was further examined apart from the total population of each community. *Table 5.13* summarizes the results of projection on total populations of the entire target communities and the ones for the served area of the study in each

district. *Figure 5.33* shows the exponential curve of the projected population growth in the served area of the study by region.

Table 5.13 Total Population of the Target Communities and Served Areas

District		2002 (Census)	2004 (Projected)	2010 (Projected)	2015 (Projected)	2020 (Projected)
Bagamoyo	Total	123,666	128,663	144,895	159,973	176,627
	Served Area	104,264	108,477	122,163	134,876	148,916
Kibaha	Total	77,809	83,191	101,670	120,169	142,035
	Served Area	40,334	43,124	52,703	62,291	73,627
Kisarawe	Total	93,042	95,664	103,987	111,475	119,498
	Served Area	85,787	88,204	95,878	102,782	110,179
Mkuranga	Total	165,946	177,766	218,520	259,527	308,246
	Served Area	161,263	172,749	212,354	252,204	299,547
Sub-Total (Coast)	Total	460,463	485,284	569,072	651,144	746,406
	Served Area	391,648	412,554	483,098	552,153	632,269
Ilala	Total	226,470	247,786	324,538	406,371	508,837
	Served Area	217,358	237,816	311,480	390,020	488,364
Kinondoni	Total	113,351	122,835	156,324	191,110	233,636
	Served Area	113,351	122,835	156,324	191,110	233,636
Temeke	Total	142,137	155,514	203,686	255,045	319,358
	Served Area	142,137	155,514	203,686	255,045	319,358
Sub-Total (DSM)	Total	481,958	526,135	684,548	852,526	1,061,831
	Served Area	472,846	516,165	671,490	836,175	1,041,358
Total	Total	942,421	1,011,419	1,253,620	1,503,670	1,808,237
	Served Area	864,494	928,719	1,154,588	1,388,328	1,673,627

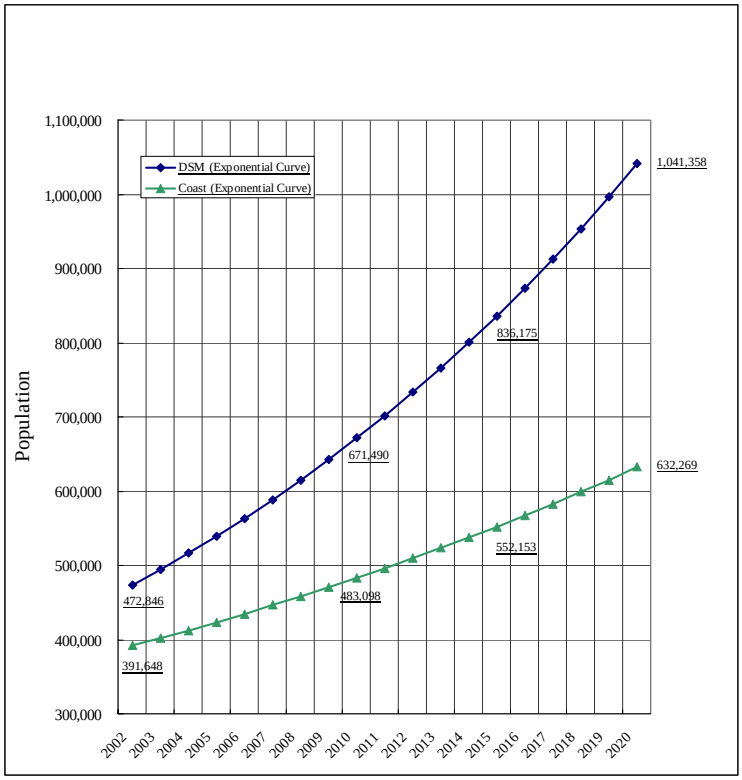

Figure 5.33 Population Projection of the Study Area

5.4.2 DESIGN CRITERIA ON UNIT SUPPLY RATE

For the analysis of the volume of domestic and institutional water demands in the study area, the design criteria of MoWLD was applied as stated in *Table 5.14* below. The unit supply rate applied for the domestic water is 25 liter/capita/day for both rural and urban areas subject to the communal water supply from public taps.

Table 5.14 Unit Supply Rate

Category		Unit	Rural	Urban	Remarks
Domestic		lit/capita/day	25	25	served from public taps
Public Institution (School)*1	Day School	lit/pupil/day	10	10	without flush toilet (pit latrine, VIP*2, pour flush toilet only)
	Boarding School	lit/pupil/day	70	70	
Public Institution (Health)*1	Dispensary	lit/visitor/day	10	10	out patient only
	Health Centre 1	lit/bed/day	50	50	without flush toilet (pit latrine, VIP*2, pour flush toilet only)
	Health Centre 2	lit/bed/day	100	100	with flush toilet
	Hospital	lit/bed/day		200	District hospital

*1 : Domestic water consumption for staff of school and health facilities is assumed to be included in the unit rate for the domestic use.

*2: VIP, Ventilated Improved Pit (Latrine)

5.4.3 WATER DEMAND FOR DOMESTIC USE

Based on the projection of future population at the district and village levels as well as the unit supply rate, the potential domestic water demand was estimated for each target community. Table 5.*15* shows the estimated trend of total amount of daily water demand from 2010 to 2020 as a result of the demand projection for domestic use in each target area to be covered in the study.

Table 5.15 Projection of Domestic Water Demand for the Served Areas

Year	Domestic Water Demand in the Study Area (m^3/day)								
	Bagamoyo	Kibaha	Kisarawe	Mkuranga	**Coast Total**	Ilala	Kinondoni	Temeke	**DSM Total**
2010	3,055	1,315	2,398	5,302	12,070	7,786	3,907	5,090	16,783
2011	3,115	1,362	2,431	5,495	12,403	8,145	4,068	5,326	17,539
2012	3,177	1,409	2,465	5,687	12,738	8,520	4,235	5,571	18,326
2013	3,241	1,457	2,499	5,886	13,083	8,912	4,409	5,828	19,149
2014	3,306	1,506	2,534	6,092	13,438	9,322	4,590	6,096	20,008
2015	3,371	1,555	2,568	6,306	13,800	9,751	4,778	6,377	20,906
2016	3,439	1,610	2,606	6,526	14,181	10,199	4,974	6,669	21,842
2017	3,508	1,665	2,642	6,754	14,569	10,668	5,178	6,976	22,822
2018	3,578	1,722	2,679	6,991	14,970	11,159	5,390	7,297	23,846
2019	3,650	1,780	2,717	7,235	15,382	11,672	5,611	7,633	24,916
2020	3,722	1,839	2,757	7,490	15,808	12,209	5,843	7,986	26,038

5.4.4 WATER DEMAND FOR INSTITUTIONS

For institutions, demands for the schools and health facilities in each district were considered. Projection of water demand for schools is based on total number of pupils attending pre-primary, primary and secondary schools by type of class, i.e. day school or boarding school. Information on number of pupils in the private schools was not available sometime at regional and district offices. In such case, number of pupils attending public schools was only considered.

The water demand for the health facilities includes the ones for hospitals, health centers and dispensaries. The demand for the hospitals and health centers were calculated based on the bed capacities of the facilities while average number of outpatients per day was used to examine the water demand for dispensaries since their services are limited for the outpatients only.

Total water demand for both schools and health facilities in each district is estimated as shown in *Table 5.16*. Considering the ratio of the total water demand for institutions to the domestic water demand at district level, around 15% in maximum is required to be included in addition to the domestic water.

An assessment of actual institutional water demand at the community level is supposed to be done at the stage of detail water supply planning for each prioritized village with checking the present status of water supply at the schools and health facilities located within the served areas.

Table 5.16 Estimated Ratio of Institutional Water Demand to Domestic Water Demand

Region	District	Total Water Demand (m^3/day) in Districts (2004)		Demand for Institution/ Domestic (%)
		Domestic*1	Institution*2	
Coast	Bagamoyo	5,955	632	10.6
	Kibaha	3,508	542	15.5
	Kisarawe	2,450	363	14.8
	Mkuranga	5,006	467	9.3
Total (Coast Region)		16,919	2,004	11.8
Dar es Salaam	Ilala	17,367	1,301	7.5
	Kinondoni	29,365	1,855	6.3
	Temeke	21,019	1,801	8.6
Total (DSM Region)		67,751	4,957	7.3

*1 Domestic: Estimated water demand of total population in each district in Year 2004

*2 Institution: Water demand of schools (pre-primary, primary, and secondary) and health facilities (hospital, health center, and dispensary) in each district in Year 2004

5.5 COMMUNITY AWARENESS SURVEY

5.5.1 BACKGROUND AND PURPOSE

Priority communities and projects are identified, developing the selection criteria and flow chart under the Study, for promising intervention/implementation of the Priority Project. Community Awareness Survey was carried out targeting those 36 communities selected as candidate for the implementation of the Priority Project, in order to assess; 1) current water supply condition, 2) managerial status of community-based organization, 3) awareness of the community on the problems associated with current water supply, 4) communities' preference to the level of the improved water supply facilities, 5) communities' choice in the form of community-based management, 6) willingness of the communities to manage, operate and maintain the improved supply scheme, 7) willingness and affordability of the communities to pay for operation and maintenance of the scheme, and 8) communities' awareness and willingness to contribute to the construction cost.

The results and findings are utilized for further prioritization of target communities and project, as well as for the formulation of management, operation and maintenance plan, in particular, for the preparation of capacity development plan.

5.5.2 METHODOLOGY

In order to achieve the objectives mentioned above in an efficient manner within the limited time

framework of the Study, questionnaire interview with village authorities (i.e. group questionnaire interview) is employed as a survey method. Those interviews were held at 36 priority communities, and collected questionnaires were summarized in a database with preparation of community profile.

5.5.3 FINDINGS

The followings are the findings and observation obtained from the priority communities surveyed under the Study.

(1) Development Needs of the Communities

Questions were given to the community authorities on what their community put first three (3) priority among their development needs. Almost all (98%) of the communities responded that improvement of water supply is one of three (3) development needs identified by their communities, followed by construction of school (64%) and clinic/dispensary (61%) (see *Figure 5.34*). Among those communities interviewed, most of them (71%) expressed that the improvement of water supply condition is the first priority in the community development needs (see Figure 5.35).

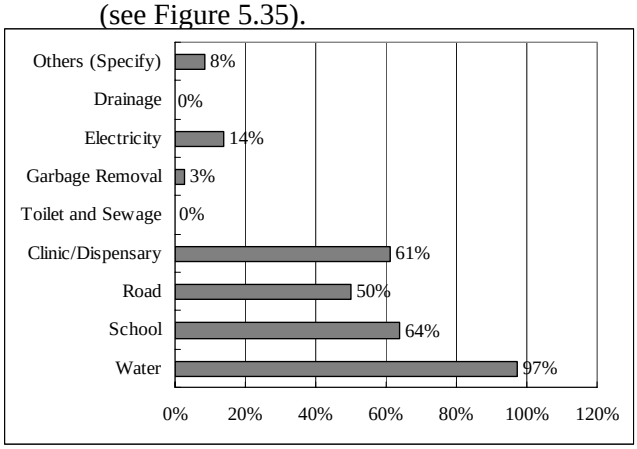

Figure 5.34 Three Major Development Needs

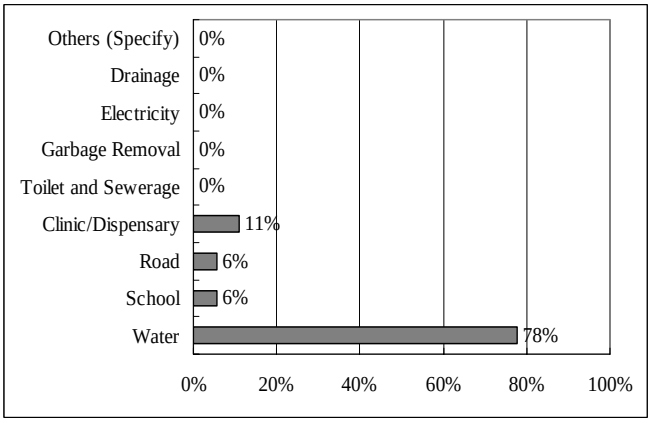

Figure 5.35 First Development Need

(2) Existing Community-Based Organization for Water Supply and Village Water Fund

Existence and forms of community-based organization for water supply management in the priority communities were investigated through the Community Awareness Survey. It is observed that seven (7) number of priority communities among 36 (19%) does not have any form of community-based organization for water supply, while the rest of 29 communities (81%) formed ones for water supply. Among those 29 communities having community-based organizations, most of the communities (27 number) established conventional "Village Water Committee", while 2 communities formed either "Water User Association" or "Water Cooperative/Trust".

With regard to the Village Water Fund, which shall be accumulated for the community development activities for water, 11 communities (31%) among 36 currently possess the one, while the rest of community does not have any. The amount accumulated for the Village Water Fund in those 11 communities is considerably ranging from 20,000 Tsh. to 240,000,000 Tsh., with median amounting to 200,000 Tsh.

(3) Community Preference in Type of Improved Water Supply Scheme

It is well exposed that all the priority communities prefer to the Level-2 supply scheme as means for improving water supply situation in future. Two (2) number of the priority communities opt for the river surface water as source for the supply scheme where the utilization of river water is much familiar and cost effective, while the rest of 34 communities prefer to the groundwater/borehole.

(4) Responsibility and Willingness to Pay for Operation and Maintenance

Majority (78%) of the priority communities responded that community-based organization such as Water Committee/User Association is responsible for operation and maintenance of the improved supply scheme, followed by Village Authority (19%) and Users themselves (3%). It is notable that none of the communities answered the responsibilities are belong to either government or district authority, acknowledging the community-based management principle in the operation and maintenance of the improved supply scheme (see *Figure 5.36*).

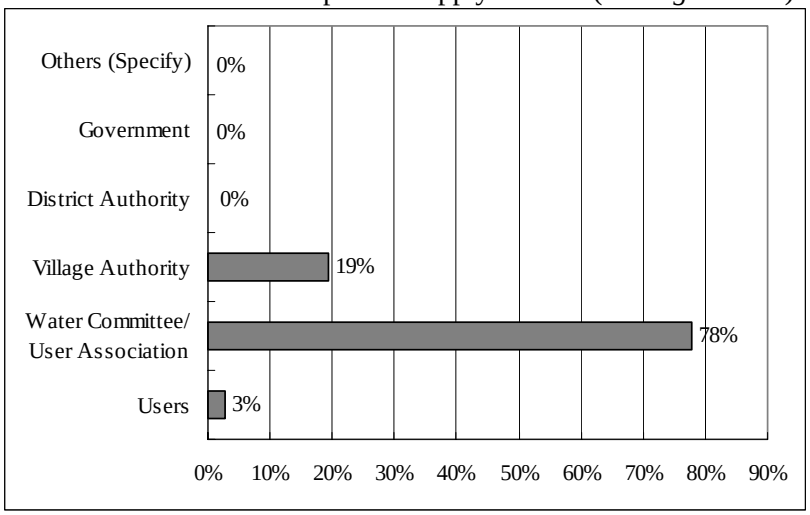

Figure 5.36 Organization Responsible for O&M of Supply Scheme

Referring to the maximum amount that communities are willing to pay for the operation and maintenance of the improved water supply scheme, the mean and median figures are amount to Tsh 38 and Tsh 20 per 20 liter-bucket, respectively. It shall be also noted that none of the communities are reluctant and negligent for payment.

(5) Community Contribution to the Construction of Supply Scheme

It has been become rather common practice in the implementation of the water supply project in the country that community contributions both in cash and labor are posed as precondition for the commitment of Government and External Support Agencies in implementation of water supply projects. Communities are often encouraged to share the capital/initial cost for the construction of improved supply scheme in a certain percentage, that is usually 5 to 10 percent of the construction cost depending on the decision of the stakeholders. The question on the community contribution was given to the priority communities to find the possibility for its introduction to the Priority Project formulated under the Study.

Figure 5.37 shows that majority of the community (72%) responded their willingness to contribute both in cash and labor for the construction of the scheme, while the rest answered only in labor contribution. Among those communities willing to share the capital cost, maximum amounts of contribution are at Tsh. 1,357 and Tsh. 1,000 in mean and median, respectively.

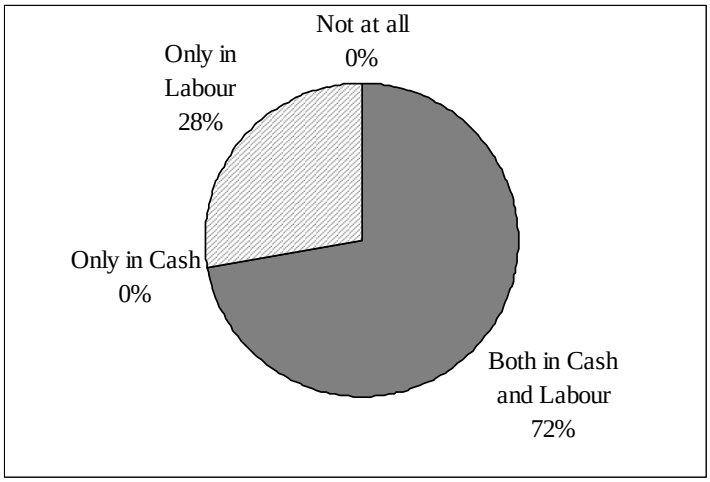

Figure 5.37 Willingness for Community Contribution

(6) Acceptability in Introduction of Increasing Block Tariff

The Study recommends the introduction of increasing block tariff structure with lifeline tariff as one of means for the pro-poor management of the improved water supply scheme (refer to Chapter 9 to the Main Report). Thus, acceptability among the priority communities in introduction of the block tariff was examined in Community Awareness Survey.

Most of the communities (33 priority communities among 36, amount to 92 percent) agreed to introduction of increasing block tariff structure in management of improved supply scheme, expressing fairness in charging system. It can be said that its introduction in scheme management is acceptable for the most of the communities.

(7) Perception on Current Water Supply Conditions

The degree of awareness and satisfaction on the current water supply conditions perceived by the communities is an important factor when considering their motivation and participation in management, operation and maintenance of the improved water supply scheme. It is commonly said that the more the community is dissatisfying the current supply condition, the more motivation and participation in operation and maintenance is expected. The Community Awareness Survey revealed the degree of satisfaction on the current supply condition. *Figure 5.38* shows the community perception on the current supply condition in dry season and rain season, respectively, asking respondent weigh up the degree of satisfaction by five ranking ("very good", "good", "fair", "bad", and "very bad"). Seasonal gap in the degree of satisfaction shall be noted. Percentage of respondents perceiving dissatisfaction (i.e. those responding "bad" and "very bad") stays at around 70 percent in dry season, while the one decreases at 40 percent in rain season. Considering the main water sources for domestic use in the priority project are unprotected and contaminated, the awareness of the communities on water quality shall be more enhanced through hygiene and sanitation education to maximize the impact in health and hygiene aspects to be brought by the implementation of the Priority Project.

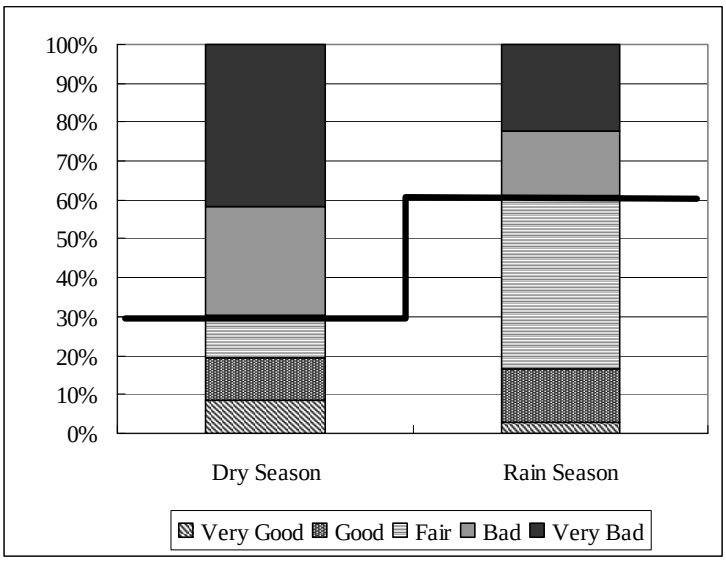

Figure 5.38 Perception on the Current Water Supply Conditions

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