Department of Rural Water Supply (DRWS)
Ministry of Water (MoW)
The United Republic of Tanzania

The Study on Rural Water Supply in Mwanza and Mara Regions in the United Republic of Tanzania

Final Report
MAIN REPORT

September 2006

JAPAN INTERNATIONAL COOPERATION AGENCY

KOKUSAI KOGYO CO., LTD.

In this report, the project cost is estimated using the May 2006 price and at an exchange rate of 1 US$= 114.58 Japanese Yen = 1181 Tanzania Shilling.

PREFACE

In response to a request from the Government of Tanzania, the Government of Japan decided to conduct a development study on Rural Water Supply in Mwanza and Mara Regions in the United Republic of Tanzania and entrusted the study to Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Toshiyuki Matsumoto of KOKUSAI KOGYO CO., LTD. between April 2005 and July 2006.

The team held discussions with the officials concerned of the Government of Tanzania and conducted field surveys in the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Tanzania for their close cooperation extended to the study.

September 2006

Ariyuki Matsumoto
Deputy Vice President
Japan International Cooperation Agency

Independent Administrative Agency Japan International Cooperation Agency
Mr. Ariyuki Matsumoto, Deputy Vice President

September 2006

Letter of Transmittal

As the Water Supply Plan for the Mwanza and Mara regions in the Republic of Tanzania has now come to an end, the Final Report of the plan is presented here.

This report mainly includes a summary of the results, from the study team of specialists from Kokusai Kogyo Co., Ltd, of the formulation of the Priority Project and the Water Supply Plan carried out in the Mwanza and Mara regions of Tanzania over a period of 17 months from April 2005 until August 2006.

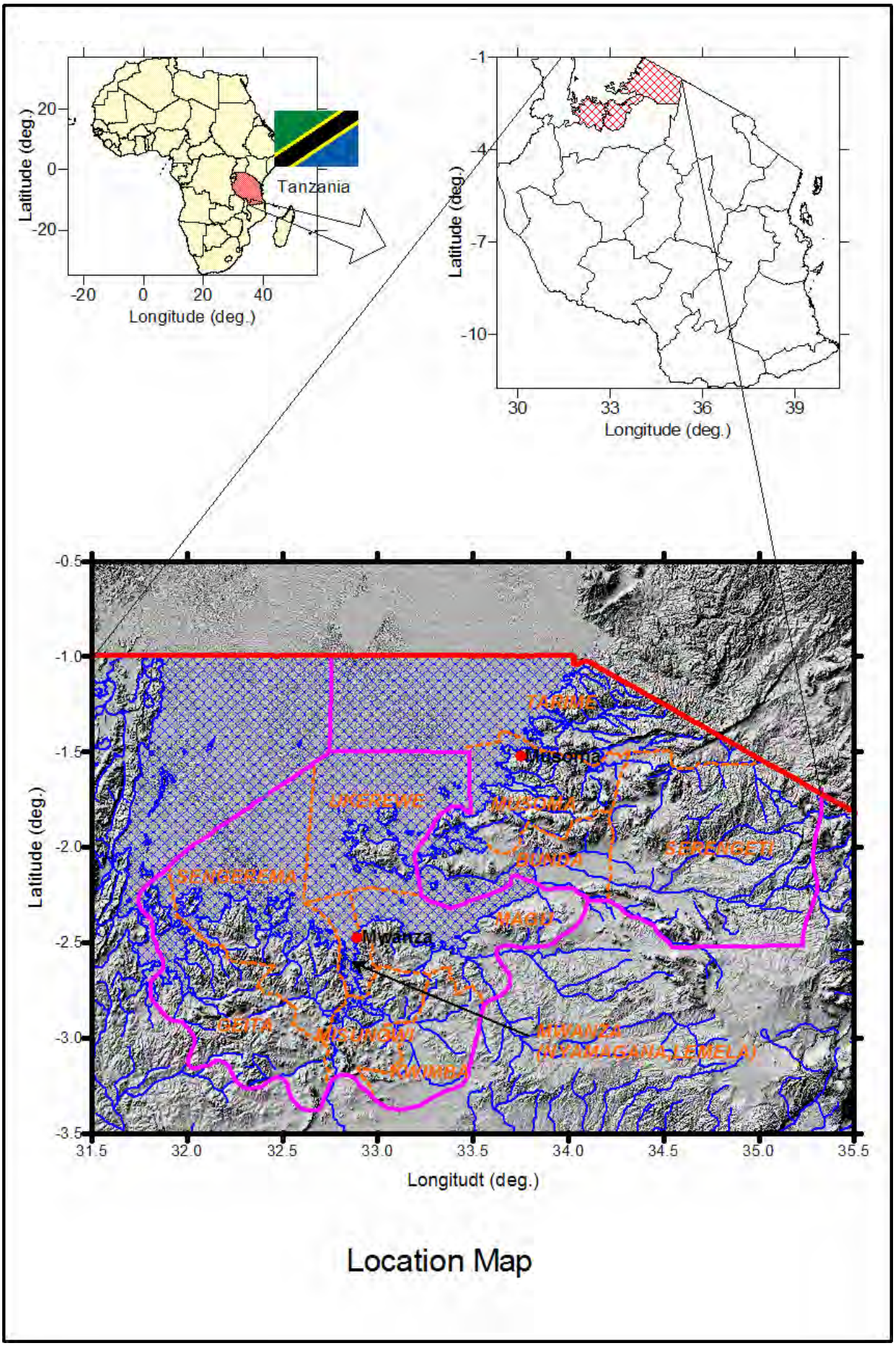
As described in detail in the report, the Water Supply Plan was formulated for 428 villages and 57 existing pipeline water supply facilities in the Mwanza and Mara regions. Water sources were selected for these 428 villages based on the hydrological conditions of the villages and the positional relationship between the villages and Lake Victoria, and water supply rates were established. A plan was formulated for the repair and expansion of the existing pipeline water supply facilities. In regard to the priority project, planning was carried out for wells with hand pumps and pipeline water supply facilities selected from the villages and facilities set out in the water supply plan.

I would like to extend my deepest gratitude to the kindness and cooperation given to the study group by the Department of Rural Water Supply of Ministry of Water, the Lake Victoria Basin Water Office as well as the regions of Mwanza and Mara and all the people related to the districts.

I would like to express my warm appreciation for the valuable advice and guidance provided for carrying out the study by your Agency, the Embassy of Japan in Tanzania and the JICA Tanzania Office.

It is hoped that the result of the study will be that the continuous water supply, made possible by the water supply plan, will be utilized in future in the Mwanza and Mara regions.

The Study on Rural Water Supply in Mwanza and Mara Regions in the United Republic of Tanzania
Toshiyuki Matsumoto, Team Leader



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Dried Traditional Water Source (Dry Season)

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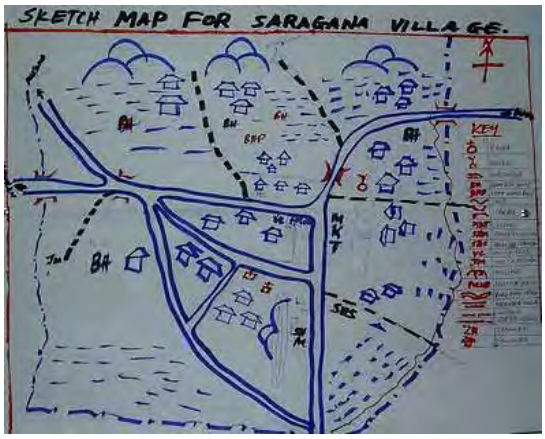

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ATP:	Affordability To Pay
AfDB:	African Development Bank
AFD:	Agence Française de Développement
BWO:	Basin Water Office
CBOs:	Community Based Organization
CIDA:	Canadian International Development Organization
COWSOs:	Community Owned Water Supply Organizations
CDO:	Community Development Officer
DC:	District Commissioner
DC:	District Council
DED:	District Executive Director
DDCA:	Drilling & Dam Construction Agency
DRWS:	Department of Rural Water Supply
DPO:	District Planning Officer
DWD:	District Water Department
DWE:	District Water Engineer
DWP:	Domestic Water Points
DWST:	District Water and Sanitation Team
DWT:	District Water Technician
EC:	Electric Conductivity
EIA:	Environmental Impact Assessment
ESAs:	External Support Agencies
EU:	European Union
FGD:	Focus Groups Discussion
FSPs:	Facilitation Service Providers
TSPs:	Technical Service Providers
GDP:	Gross Domestic Product
GEF:	Global Environmental Facility
GIS:	Geographic Information System
GNP:	Gross National Product
GOT:	Government of Tanzania
GTZ:	Deutsche Gesellschaft fur Technische Zusammenarbeit
HESAWA:	Health through Sanitation and Water
IEE:	Initial Environmental Examination
IFAD:	International Fund for Agricultural Development
IDA:	International Development Association
IWSs:	Improved Water Sources
JICA:	Japan International Cooperation Agency
LGRP:	Local Government Reform Policy
LVBWO:	Lake Victoria Basin Water Office
LVEMP:	Lake Victoria Environmental Management Project
MDGs:	Millennium Development Goals
M/M:	Minutes of Meeting
MOF:	Ministry of Finance
MOL:	Ministry of Land
MoW:	Ministry of Water
NEMC:	National Environmental Management Council
NGO:	Non-Governmental Organization

NAWAPO:	National Water Policy
NWSDP:	National Water Sector Development Policy
O&M:	Operation and Maintenance
PRA:	Participatory Rural Appraisal
PRSP:	Poverty Reduction Strategy Paper
RF:	Registration Form
PHAST:	Participatory Health and Sanitation Transformation
PMO-RALG:	Prime Minister's Office, Regional Administration and Local Government
RAS:	Regional Administrative Secretariat
RRA:	Rapid Rural Appraisal
RWSD:	Rural Water Supply Division
RWSSP:	Rural Water Supply and Sanitation Program
SIDA:	Swedish International Development Cooperation Agency
SC:	Specific Capacity
SR:	Scoping Report
SWAP:	Sector Wide Approach to Planning
SWL:	Static Water Level
TBA:	Traditional Birth Attendant
TOR:	Terms of Reference
Tsh/TSH:	Tanzanian Shillings
TWSs:	Traditional Water Sources
UFW:	Unaccounted for Water
UNICEF:	United Nations International Children's Fund
VES:	Vertical Electric Sounding
VEO:	Village Executive Officer
VF:	Village Fundis (Artisans)
VHC:	Village Hesawa Committee
VHV:	Village Health Volunteer
VWC:	Village Water Committee
WB:	World Bank
WEO:	Ward Executive Officer
WRI:	Water Resources Institutes
WSS:	Water Supply System
WSSAs:	Water Supply and Sanitation Authorities
WSSMC:	Water Supply System Management Centre
WTP:	Willingness To Pay
WUA:	Water User Association
WUG:	Water User Group

Chapter 1

Introduction

1 Introduction

1.1 General

This Report summarizes the final plans of the Study based on the Draft final Report on Rural Water Supply in Mwanza and Mara Regions in the United Republic of Tanzania (hereinafter referred to as "the Study"). The final results and plans were acquired under the Study which was carried out during the term from April 2005 to July 2006.

The Final Report is mainly described into the water supply plan and the priority project. The former contents includes the water supply plan including the O&M plan regarding the 428 villages and 57 existing piped schemes selected based on the investigation of natural and social conditions in the Mwanza and Mara regions. The latter contents summarize the priority project including the implementation plan, organizational /institutional plan and O&M plan for the priority villages and existing piped schemes.

1.2 Background of the Study

The United Republic of Tanzania occupies a total land area of 945 thousand sq. km and has a total estimated population of 34.4 million as of 2002. Being one of the least developed countries, the nation's annual GDP per capita has remained at US$ 270 (2001).

According to 2001 statistics, access to safe water per total population of the country is 88% for the urban area, and 46% for the rural area. The Government of Tanzania commenced the Rural Water Supply Plan (RWSP) in 1971 to secure safe and hygienic water within 400m for all Tanzanians by 1991, but the achievement was limited. In 2002, the government of Tanzania announced the "National Water Policy" to further increase national water supply coverage.

The project regions, both Mwanza and Mara, are on the coast of Lake Victoria. The regions have a good economic environment due to the well facilitated fishery base and suitable agricultural land with favorable rainfall. Mwanza ranks in the top five out of 21 regions in terms of contribution to the national GDP (Mara ranks 12th).

Most of the water supply facilities in the two regions are aged, having been constructed in the 1960s and 1970s. In response to the unfavorable condition of water supply facilities, SIDA implemented the HESAWA Project from 1985 to 2001 and as a result, new water supply facilities were constructed in 15 districts surrounding Lake Victoria. However, the high population growth has caused an increase in the demand for water, and the current water supply rate for the two regions is 49% in Mwanza and 45% in Mara (Source of 2004 by NRWSSP, Jan. 2006).

Both regions mainly use the traditional well and shallow well water. In general, lake water is used for urban areas and lake water (mainly in the rainy season), dams and ponds are used for rural areas. However, most facilities do not have a purification system, which causes sanitation problems.

Taking this situation into consideration, the Government of Tanzania requested technical assistance from the Government of Japan in August 2004 for the review of the Master Plan and the implementation of a Feasibility Study for the future water supply project.

In response to the request, the Government of Japan decided to conduct the study and dispatched a preparatory study team to Tanzania in August 2003. After discussions between the Ministry of Water and Livestock Development and the JICA Preparatory Study Team, the

Scope of Work for the Study on Rural Water Supply in the Mwanza and Mara regions was decided.

1.3 Objectives of the Study

The objectives of the study are:

1) To formulate a water supply plan for selected villages in the Mwanza and Mara regions.

2) To conduct a preliminary design on the priority projects for the target year of 2015.

3) To develop the capability of counterpart personnel from the Ministry of Water and other authorities concerned in the course of the Study.

1.4 Work Schedule and Main Works

The Study has been carried out for a period of 17 months, starting from April 2005 until August 2006. The study period is divided into two stages as outlined in the Scope of the Study. The detailed work flow is attached in Figure 1.4-1.

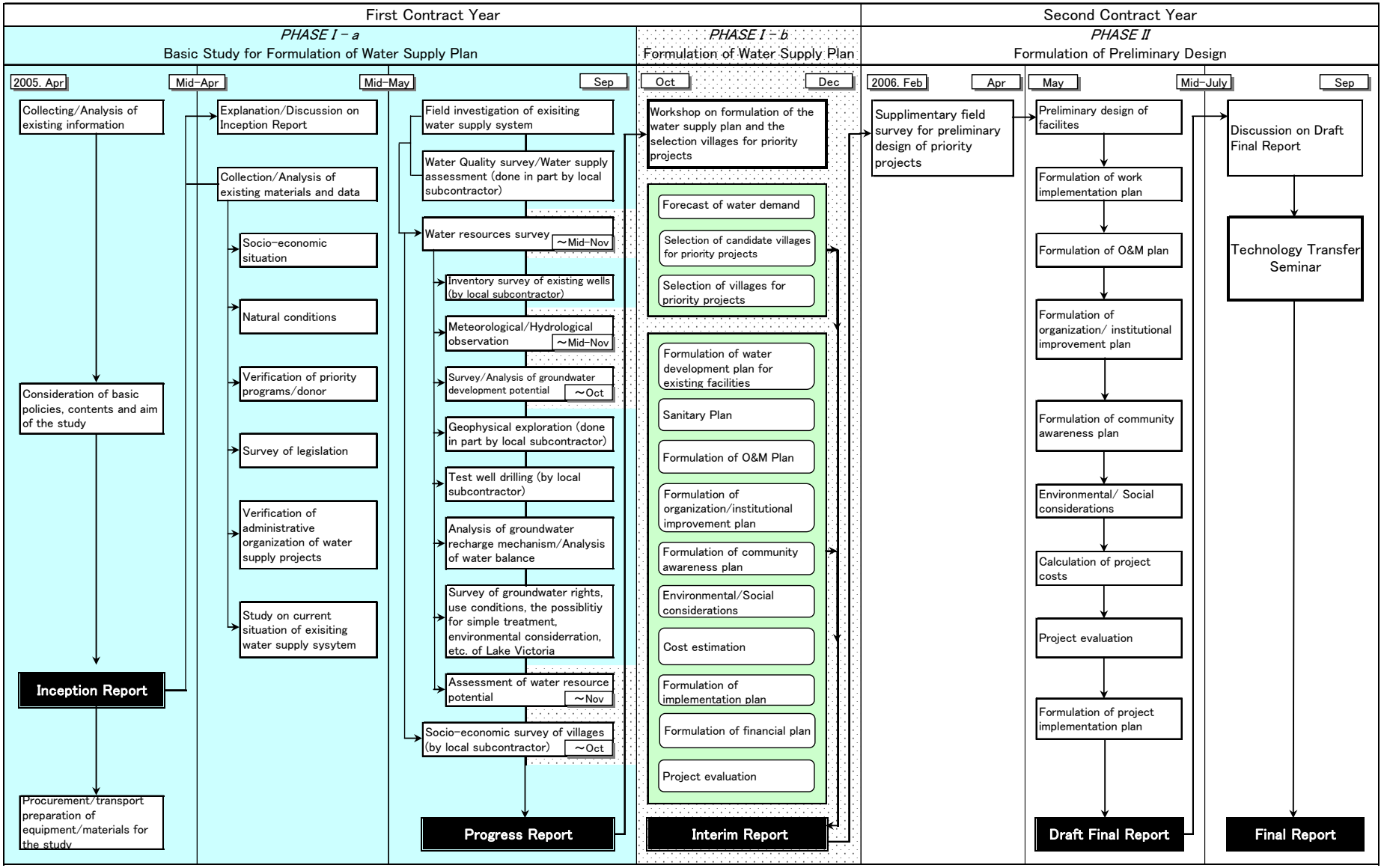


Figure 1.4-1: Flow Chart of Study

1.5 Study Area and Selected Villages and Existing Piped Schemes

1.5.1 Study Area

The study will cover requested villages in eight districts in the Mwanza region and four districts in the Mara region, as shown in Figure 1.5-1.

- ✓ Districts in Mwanza region: Misungwi; Sengerema; Kwimba; Magu; Geita; Ukerewe; and Nyamagana+Ilemela

  Total Area: about 19,590Km^2

- ✓ Districts in Mara region: Bunda; Musoma(R); Tarime; and Serengeti

  Total Area: about 19,560km^2

1.5.2 Selected Villages and Existing Piped Schemes for Water Supply Plan

The number of requested villages submitted by MoW to the JICA Study Team is identified as a total of 929 villages in the Mwanza and Mara regions. In addition, a total of 428 villages, 205 in the Mwanza region and 223 in the Mara region, were selected as the target villages for the Water Supply Plan based on the criteria.

The number of requested piped schemes in the Mwanza and Mara regions submitted by MoW to the JICA Study Team is identified as a total of 110 piped schemes. In addition, a total of 57 piped schemes, 37 in the Mwanza region and 20 in the Mara region, were selected as the target schemes for the Water Supply Plan based on the criteria.

The number of villages and existing piped schemes for water supply plan in each district is as follows:

Table 1.5-1: Number of Villages and Existing Piped Schemes for Water Supply Plan

District		No. of Target Villages	No. of Target piped schemes
Mwanza Region	Misungwi	16	5
	Sengerema	74	7
	Kwimba	23	6
	Magu	23	7
	Geita	43	4
	Ukerewe	25	8
	Nyamagana+Ilemela	1	0
Sub Total		205	37
Mara Region	Bunda	25	4
	Musoma(Rural)	60	5
	Tarime	114	9
	Serengeti	24	2
Sub Total		223	20
Total		428	57

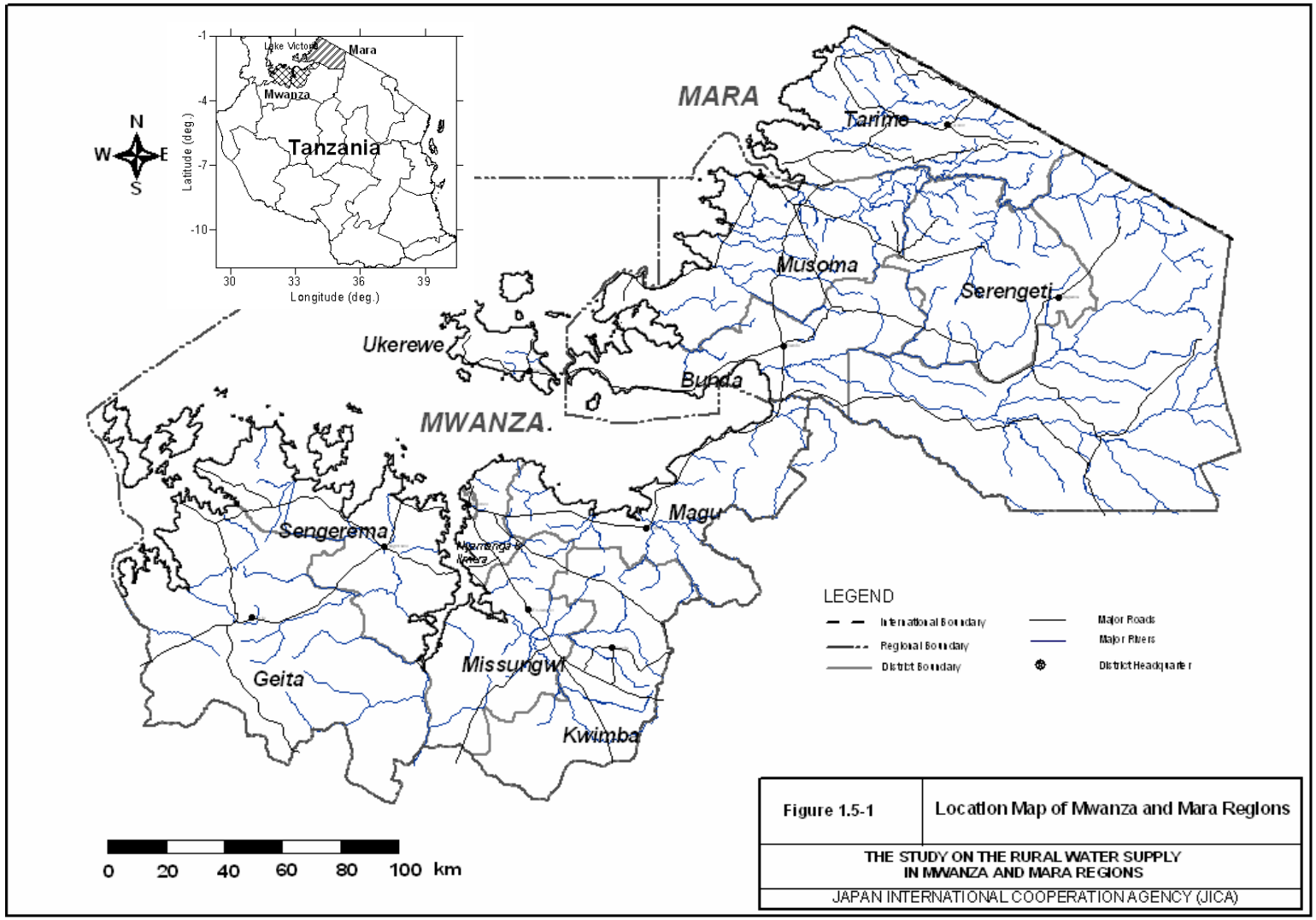


Figure 1.5-1 Location Map of Mwanza and Mara Regions

THE STUDY ON THE RURAL WATER SUPPLY
IN MWANZA AND MARA REGIONS

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

1.6 Study Organization and Persons involved

1.6.1 The JICA Study Team

The JICA Study Team is composed of the following thirteen (13) experts, with Mr. Toshiyuki Matsumoto, senior chief engineer of Kokusai Kogyo Co., Ltd., as the team leader and coordinator of undertakings relevant to the project involving the Government of Tanzania, JICA and other agencies concerned. The personnel and assignment plan is as shown in Table 1.6-1.

Table 1.6-1: JICA Study Team Member

Name	Responsibility	Country of Origin
Mr. Toshiyuki Matsumoto	Team Leader/Water Supply Plan	Japan
Mr. Kensuke Ichikawa	Hydrogeologist (A)/ Groundwater Development Plan (A)	Japan
Mr. Shigeki Kihara	Hydrogeologist (B)/ Groundwater Development Plan (B)	Japan
Mr. Kazuyuki Suenaga	Hydrological/Meteorological Analysis	Japan
Mr. Daisaku Kiyota	GIS/Database	Japan
Mr. Tsugio Ishikawa	Geophysical Survey	Japan
Mr. Shoji Masumura	Socio-economic Survey	Japan
Mr. Taketoshi Fujiyama	Facility Design/Cost Estimation	Japan
Ms. Rie Kawahara	O&M Plan	Japan
Mr. Tomohiro Kato	Environmental/Social Considerations	Japan
Mr. Takeshi Yoshikawa	Team Coordinator (Phase I)	Japan
Ms. Mitsuko Nakamura	Team Coordinator (Phase II)	Japan
Ms. Risako Imai	Team Coordinator	Japan

1.6.2 Persons involved

The Tanzanian side has allocated the necessary number of counterpart personnel based upon the team. The counterpart personnel are composed of the following 15 members in the Mwanza and Mara regions.

Table 1.6-2: Counter Personnel Member

Name	Responsibility	Institution
Mr. Wales Nkanwa Mr. Felix Mboje	Team Leader/Water Supply Plan	RAS MW DED Musoma MR
Mr. Remius Matata Mr. William Mabula	Hydrogeologist (A)/(B) Groundwater Development Plan (A)/(B)	BWO MW BWO Musoma MR
Mr. Lusekelo Mwambuli Mr. Sariro Mwita	Hydrological/Meteorological Analysis	BWO MW BWO Musoma MR
Mr. Faustini Songo	GIS/Database	BWO MW
Mr. Sumbuka Buluba Mr. Dimoso Mmba	Geophysical Exploration	DED Ilemela MW BWO Musoma MR
Mr. J. Kyamba Ms. Edith Nyeme	Socio-economic Survey	RAS MW DED Musoma MR
Mr. B.M. Nkwande	Facility Design/Cost Estimation	RAS Musoma MR
Mr. Daniel Mkare Ms. Mary Masanza	O&M Plan	RAS MW DED Bunda MR
Mr. Lucas Misana	Environmental/Social Considerations	BWO Musoma MR

MW: Mwanza, MR: Mara

A total of ten District Water Engineers are involved in the Study as shown in the following list.

Table 1.6-3: DWE Officers in Each District

Name	Institution
Mr. Selemani Kiyenza	Misungwi District Water Engineer
Mr. Wawa Nyonyoli	Sengerema District Water Engineer
Mr. R. H. Karugwa	Kwimba District Water Engineer
Mr. Henry Salala	Magu District Water Engineer
Mr. Abudalla Abdul	Geita District Water Engineer
Mr. Daniel Butati Petro	Ukerewe District Water Engineer
Mr. Sumbuka Buluba	Ag. City Water Engineer for Mwanza City
Mr. M. Nyandiga	Bunda District Water Engineer
Mr. Felix Mboje	Musoma (R) District Water Engineer
Mr. Josephat Ngodagula	Serengeti District Water Engineer

Chapter 2

General Condition of Study Area

2 General Condition of Study Area

2.1 General

The study area is the Mwanza and Mara Regions, which face Lake Victoria. The lowest area is 1,134m above sea level, and the weather is relatively milder due to its height and wind than seaside Regions. Both Regions are mostly cultivated countries comprising of flatland and low lying hills, and base their economical background in the agricultural sector, activities such as crop farming, livestock, forestry and fishery and provides most of the local population with employment opportunities and income sources.

Although the area faces towards a freshwater lake, the shortage of water supply especially in the dry season is a serious concern in those regions due to the rapid expansion of the population, pollution of the lake and shortage of facilities for water supply

2.2 Meteorology and Hydrology

2.2.1 Meteorology

A meteorological and hydrogeological study was conducted to clarify the potential use of water sources such as surface water and groundwater. The meteorological analysis was carried out by using existing data such as rainfall, evaporation, temperature and humidity. The annual average rainfall in the Mwanza and Mara Regions is 946 mm, average evaporation is about 1,800mm and average temperature is about 24.5 degree Celsius. The value of evaporation is measured by pan, and this method is not indicating representative area and surface structure. Therefore, Thornthwaite method has been used for the estimation of the evapotranspiration by the area for the hydrologic calculation.

a. Rainfall

The average and total annual, monthly rainfall for 35 years (from 1970 to 2004) at each meteorological station are tabulated in Table 2.2-1. A distribution map (isohyte) with meteorological stations is presented in the Figure 2.2-1. The monthly rainfall at the respective station is shown in Figure 2.2-2.

Table 2.2-1: Average Monthly and Annual Rainfall (Unit:mm)

Region	Station Code	Station Name	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Mara	9133000	Musoma Airport	58.76	67.17	123.32	180.91	113.79	27.78	16.41	14.54	26.47	62.16	96.69	87.77	875.76
	9133002	Shirati Mission	78.66	62.26	118.29	200.75	119.83	29.33	32.16	26.08	29.80	63.73	108.08	75.49	944.46
	9133007	Kiabakari Prison	93.41	90.99	160.55	198.88	126.30	22.93	14.80	14.37	29.33	80.48	137.99	114.93	1084.95
	9133013	Bwayi Primary School	56.39	52.66	102.42	142.43	76.83	12.10	6.02	13.13	16.66	32.76	56.35	55.18	622.91
	9134033	Mugumu Primary School	105.21	100.08	140.81	150.62	121.05	51.12	34.29	59.56	61.53	77.99	114.92	121.49	1138.66
	9234005	Seronera	105.29	97.76	141.28	143.44	85.00	39.39	10.86	21.43	36.27	47.89	93.78	86.04	908.42
Mwanza	9132002	Ukerewe	156.83	117.76	193.30	234.35	113.20	41.84	34.75	53.95	80.09	125.21	174.06	187.68	1513.03
	9232009	Mwanza Airport	114.80	103.71	144.29	171.73	72.17	18.43	11.51	22.36	23.07	83.60	154.41	147.78	1067.86
	9232027	Kahunda	104.70	97.82	145.21	174.77	86.17	9.55	9.12	20.50	68.29	121.33	184.17	141.31	1162.93
	9232028	Nyehunge Primary School	97.13	89.76	127.09	152.33	82.67	18.56	7.84	12.93	31.71	85.52	124.54	131.21	961.31
	9232029	Buslwangiri Primary School	109.62	74.04	108.38	121.16	70.29	7.68	3.97	14.93	28.12	65.19	109.12	103.34	815.84
	9233001	Sumve T.T.C.	109.20	97.82	148.58	164.75	73.55	6.43	8.75	10.39	13.24	74.19	110.61	137.54	955.05
	9233005	Ngudu	93.11	95.09	140.96	136.81	57.80	16.11	4.12	5.91	16.56	61.63	130.34	126.32	884.75
	9233031	Nyanguge Primary School	67.39	56.27	99.45	116.91	49.95	19.81	3.87	8.05	13.55	46.30	102.19	109.17	692.90
	9233035	Mwanangwa Primary School	93.27	67.19	104.91	131.33	51.73	6.14	1.99	2.21	15.49	54.41	113.38	103.78	745.83
	9332011	Kharumwa Primary School	104.37	104.80	127.23	108.54	55.35	11.49	4.72	2.28	24.97	61.26	143.78	137.33	886.13
	9333058	Buhingo Parish	101.32	82.80	150.82	139.68	52.86	3.98	3.90	4.45	18.68	72.28	118.00	119.49	868.26
Shinyanga	9333005	Masuwa	117.68	99.94	149.12	131.52	52.38	6.37	1.70	5.87	8.06	42.14	122.10	163.83	901
Average			98.17	86.55	134.78	155.61	81.16	19.39	11.71	17.39	30.10	69.89	121.92	119.43	946.10

The average annual rainfall in the study area is 946.1 mm. The maximum annual rainfall is

2,080 mm and the minimum annual rainfall is 358 mm. The maximum average monthly rainfall is 234.35 mm, and the minimum average monthly rainfall is 1.7 mm.

The dry season is from June to September, and the rainy season is November to April, this is the same at each station.

b. Evaporation

Evaporation was measured at five stations, but data was available at only two stations (Mwanza A.P. and Musoma A.P.) due to a large amount of missing data. The fluctuation of the average monthly evaporation for 20 years (from 1985 to 2004) is shown in Figure 2.2-3.

The maximum average monthly evaporation is 173.4 mm at Musoma in September and 177.0 mm at Mwanza in September. The minimum average monthly evaporation is 132.6 mm at Musoma in April and 113.7 mm at Mwanza in January

There are two high periods of evaporation in a year, which are in April and during July to October, both in the Mwanza and Mara Regions.

As mentioned previously, the estimation of the evapotranspiration has been carried out by the Thornthwaite method.

c. Temperature

The maximum monthly temperature is 31.1 degree Celsius at Musoma and 32.1 degree Celsius at Mwanza, recorded both in September 1997. The minimum monthly temperature is 14.6 degree Celsius at Musoma in July 1999 and 11.6 degree Celsius at Mwanza in July 1998. It can be said that the maximum monthly temperature is almost stable within the range from 27 to 29. The minimum monthly temperature decreases to almost 15 degree Celsius in July, and ranges from 16 to 18 degree Celsius. The average monthly temperature is shown is Figure 2.2-4.

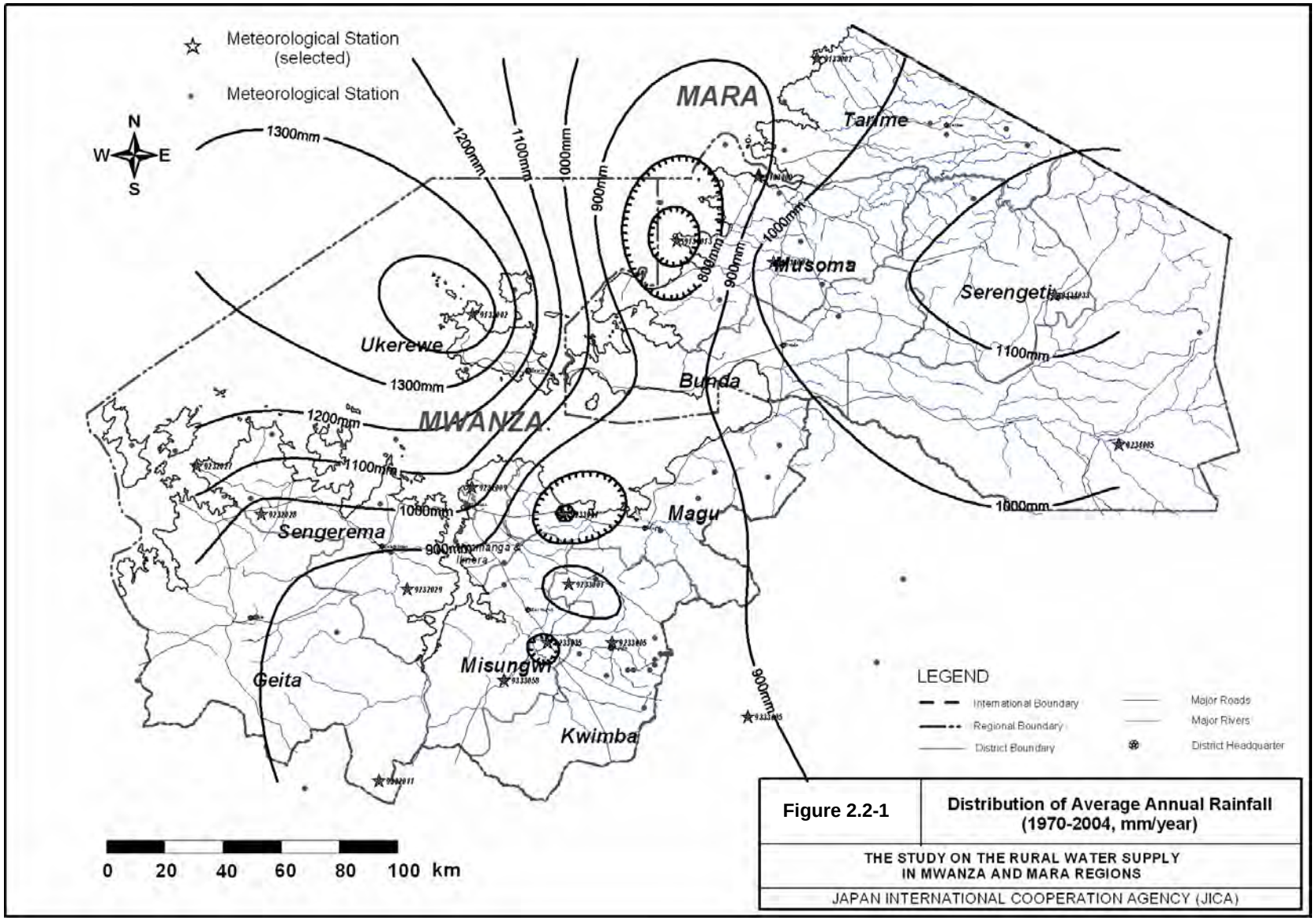
The maximum average monthly humidity is recorded as 84 % in January, February and April at Musoma, and 91% in Mwanza in February. The minimum average monthly humidity is 46% in Musoma in June and August and 37% in Mwanza in July. The fluctuation of average monthly humidity ranges from 55 to 80% in the rainy season and 45 to 70%in the dry season.

2.2.2 River System

The river system in the study area is shown in Figure 2.2-5. Almost all rivers and streams flow into Lake Victoria, except in the southwest area of the Mwanza region. Divisional river basins and its catchment area are shown in Figure 2.2-5.

The main rivers in the study area are Mori river, Mara river, Suguti river, Grumeti river, Mbalageti river, Duma river, Simiyu river, Magogo river, Moame river and Isanga river in order from north side. Mara river, Grumeti river, Duma river, Simiyu river and Isanga river in particular have long streams with many tributaries. The flow directions of the main rivers are from east to west in the north-east area, from south-east to north-west in the central area and from south to north in the western area.

Discharges from each river from the existing record and river discharge measurement are shown in the Figure 2.2-8. According to the past record, three rivers of Mori, Simiyu and Mara River are considered as permanent rivers, of which only Mori River is examined as a reliable river which constantly discharges a flow of over 5 mm/month.


Meteorological Station (selected)
Meteorological Station
N
W
E
S
MARA
MWANZA
Tarime
Musoma
Serengeti
Ukerewe
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Sengerema
Geita
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Kwimba
1300mm
1200mm
1100mm
1000mm
900mm
800mm
LEGEND
International Boundary
Regional Boundary
District Boundary
Major Roads
Major Rivers
District Headquarter
0 20 40 60 80 100 km
Figure 2.2-1
Distribution of Average Annual Rainfall (1970-2004, mm/year)
THE STUDY ON THE RURAL WATER SUPPLY IN MWANZA AND MARA REGIONS
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

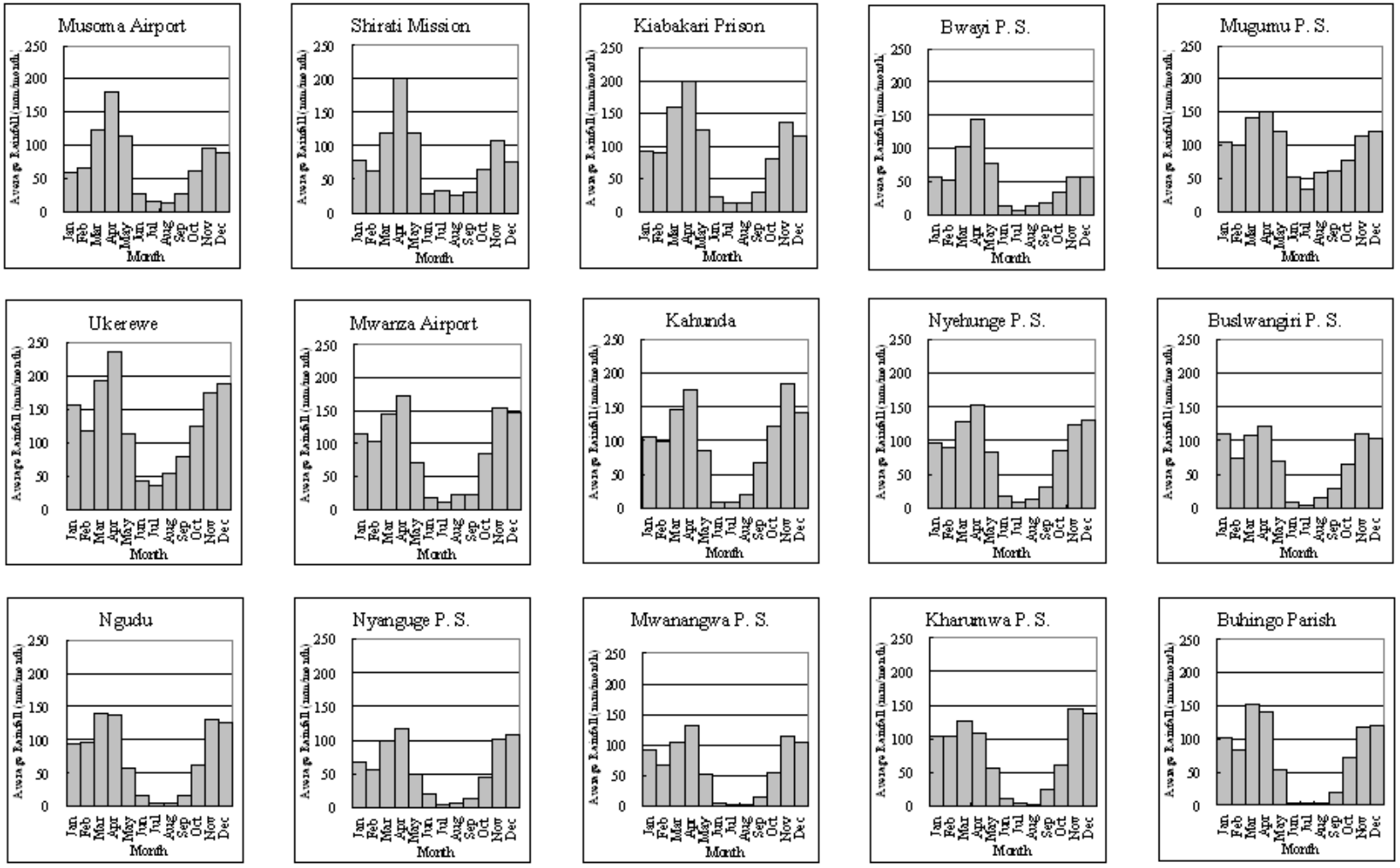

Figure 2.2-2: Average Monthly Rainfall (mm/month, 1970-2004)

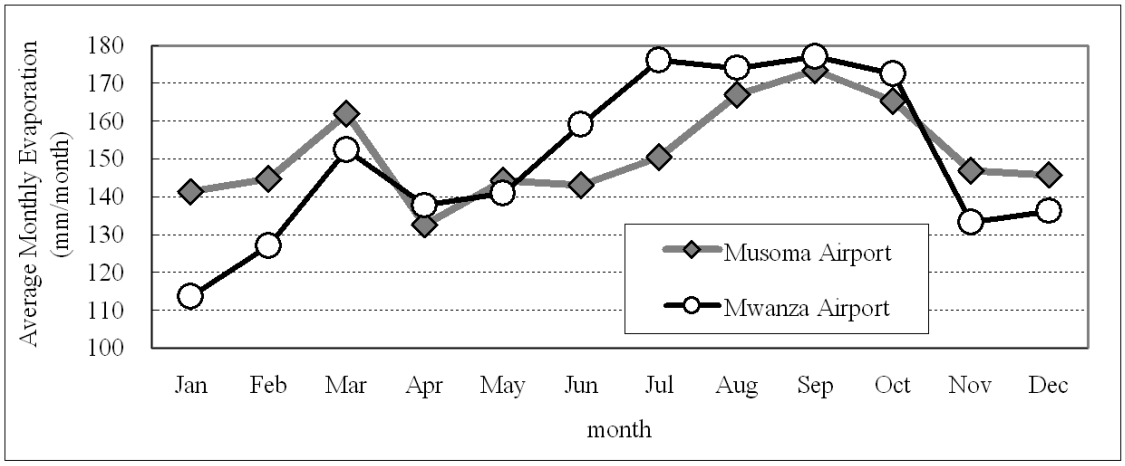

Figure 2.2-3: Average Monthly Evaporation (mm/month, 1985-2004)

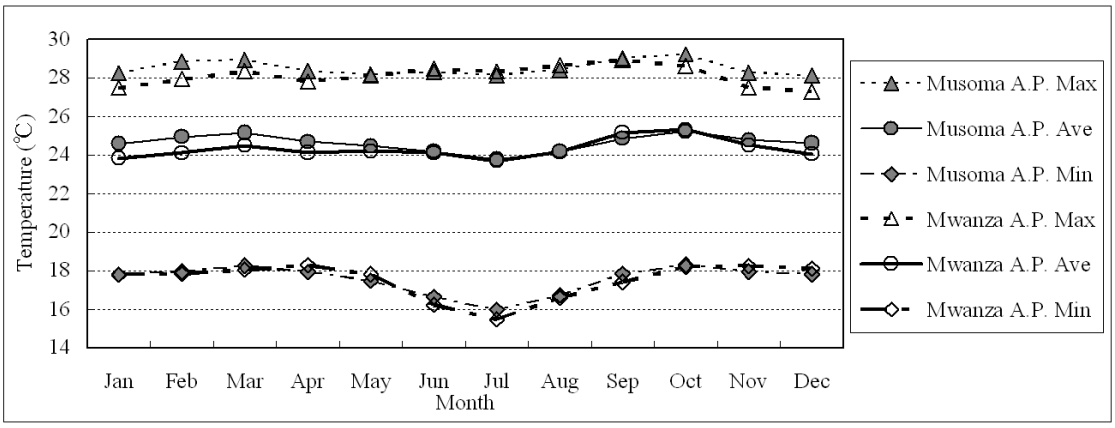

Figure 2.2-4: Average Monthly Temperature (℃, maximum and minimum, 1970-2004)

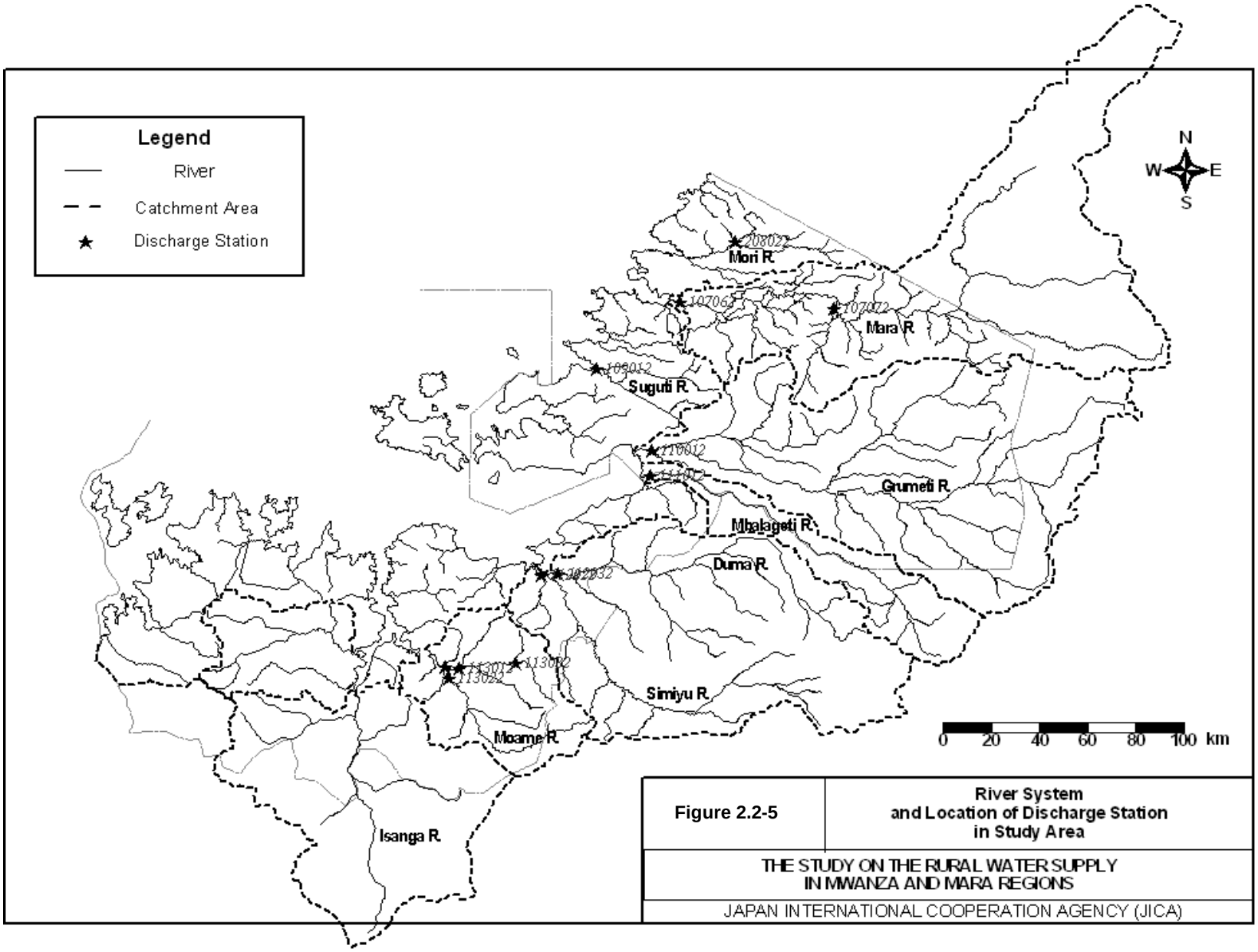

Figure 2.2-5 River System and Location of Discharge Station in Study Area

THE STUDY ON THE RURAL WATER SUPPLY
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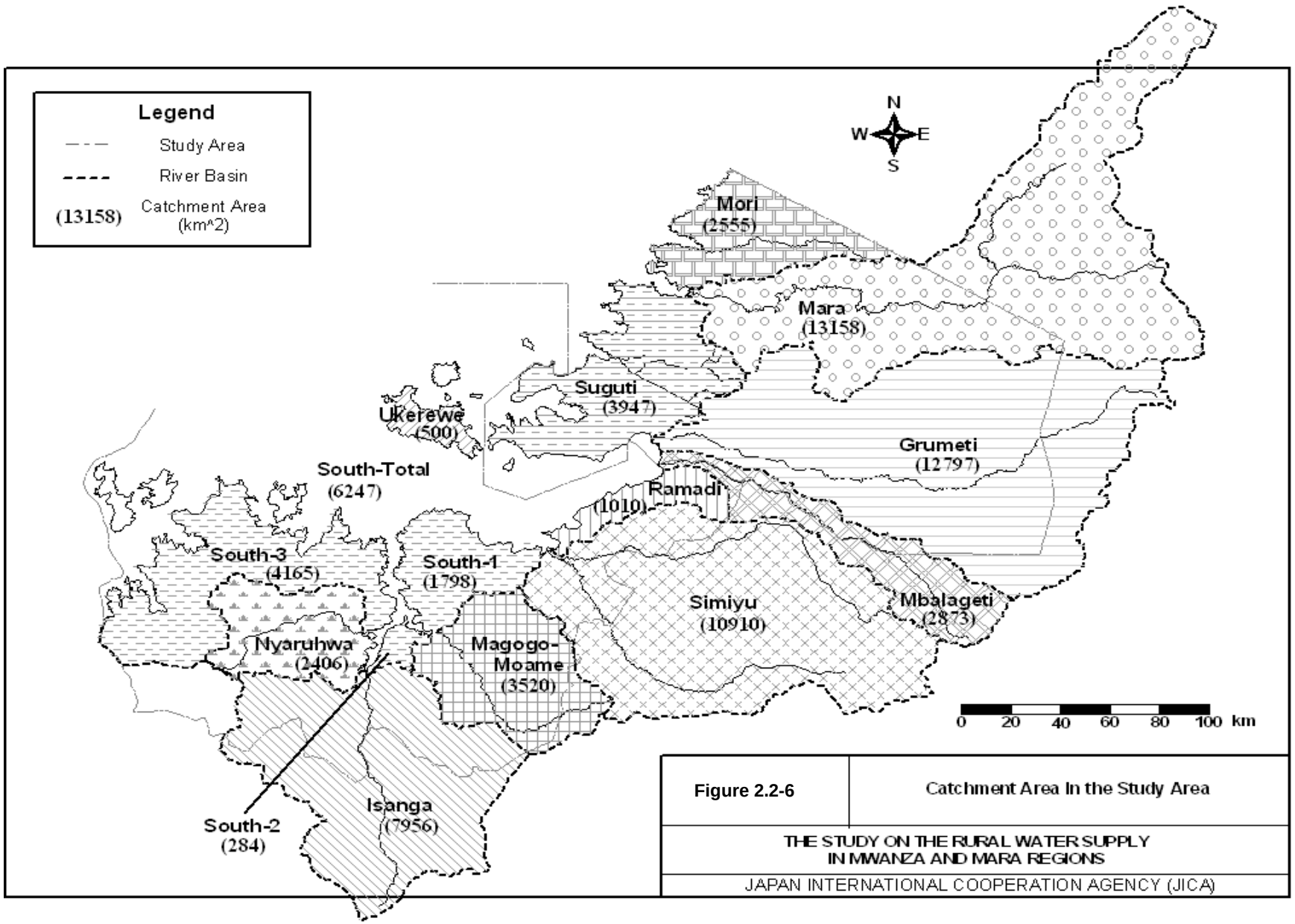

Figure 2.2-6 Catchment Area In the Study Area

THE STUDY ON THE RURAL WATER SUPPLY
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2.2.3 Lake Victoria

Lake Victoria which is located north of the study area has an area of 69,490 km^2, maximum water depth of 82m and an average water depth of 40m.

The present water level of Lake Victoria is about 1,134m above sea level, and fluctuation of water level from 1965 to 2004 is shown in Figure 2.2-7. These results indicate the trend of a decrease in water level from 1,136m to 1,134m during the past 40 years (1965- 2005).

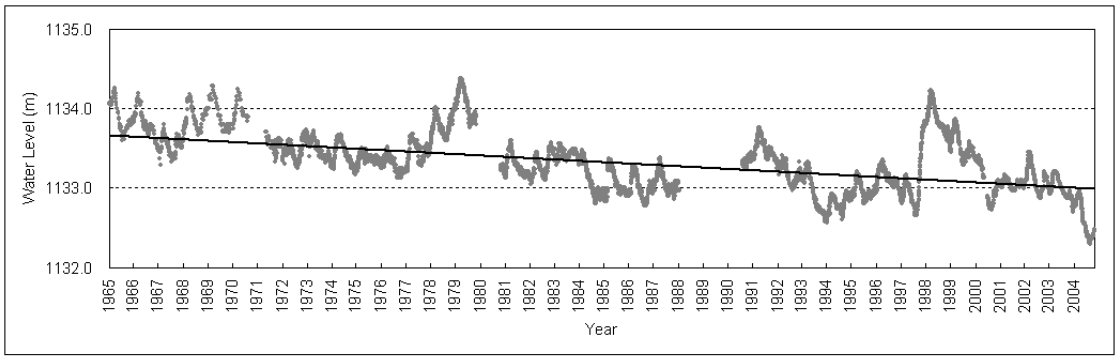

Figure 2.2-7: Water Level of Lake Victoria (1965-2005)

According to the LVEMP data, potential sum of 33m^3/s annual inflow is calculated to the water balance of the Lake in the short-term. This inflow will raise the water level of 0.015m of the Lake which the value is considerably low compare to the short-term annual fluctuation, comparing with the above table of the long-term data. Presumably, the water level of the Lake Victoria is strongly controlled by evaporation, rainfall and inflow from the tributary from the surrounding catchment.

It is an international lake which shares its border with Tanzania, Kenya and Uganda. All of the river discharge in the study area inflows into Lake Victoria. The total volume of stored water in Lake Victoria is always affected by the precipitation from the surrounding rivers flowing into the lake, evaporation and the artificial consumption and discharge of the shore side cities and villages.

2.2.4 Feature of Hydrology

The feature of hydrology in the study area is delineating Lake Victoria. The area can be subdivided into fourteen (14) river basins, and the entire river flows into the Lake. Mara, Simiyu and Mori rivers are categorized as perennial rivers, but only Mara river discharges a constant flow rate of more than 5 mm/month.

However, the Lake is an international lake which shares its borders with Kenya and Uganda. Therefore, the detailed hydrological features shall be studied through joint cooperation of the concerned countries.

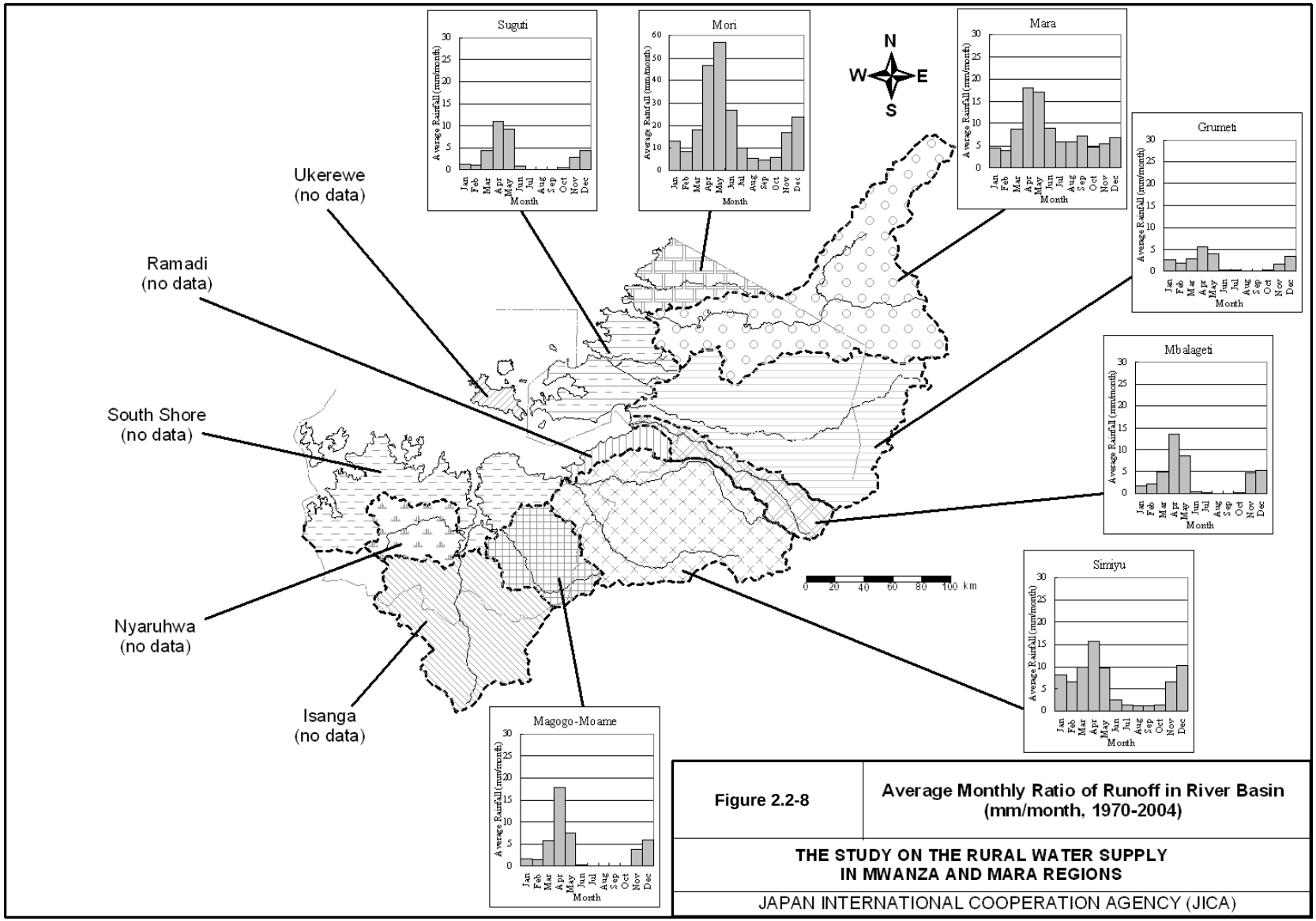

Figure 2.2-8 **Average Monthly Ratio of Runoff in River Basin (mm/month, 1970-2004)**

THE STUDY ON THE RURAL WATER SUPPLY IN MWANZA AND MARA REGIONS

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2.3 Topography and Geology

2.3.1 Topography of the Study Area

The geomorphology of the study area is featured by flatland with some hills and terrain which project the geologic character of the area. The land is bordered on the north (Mwanza region) and west (Mara region) by Lake Victoria, which is one of the largest freshwater lakes in the world.

The Mwanza region is mostly occupied by low-lying land and rolling hills from the north to east end and particularly in the south-western area, the region is composed of comparatively higher ridges and deep, wide valleys. The typical topographical feature of the flatland in the area is the so called “monadnock” or “inselberg”, which is characteristic of an arid to semiarid landscape in the latest stage of the erosion circle.

The lake shore is composed of relatively undulating ridges and hills, and the region is divided into west and east portions by the Mwanza Gulf – Smith Sound which cuts deeply into the mainland.

The Mara region is characterized by sharp valleys and rolling hills with some terraces bounded by structural lineaments. Wide valleys are developed along the major rivers of Mara, Grumeti and Mori. Cliffs can be found along the large fault structure.

The altitude is lowest at Lake Victoria (1,134m) and the highest portion is some 1400m above sea level.

Most of the land area is cultivated. Dams can often be found in areas used for agriculture and grazing. The shaded surface map created from satellite radar is presented in Figure 2.3-1. The contour map with the river and stream systems is shown in Figure 2.3-2 and the satellite image (Landsat) of the area is shown in Figure 2.3-3.

2.3.2 Geology and Hydrogeology of the Study Area

a. Geological Structure and Geological Units

The geological interpretation was made based on the following sheets:

- Geological Map of Tanganyika (Scale 1:2,000,000 A.M. Quennell, Tanganyika Geological Survey, 1959)
- Geological Map, 1st Edition (Scale 1:125,000, Mineral Resource Division, Dodoma, 1966 Quarter Degree Sheet)

A simplified geological map (based on the Geological Map of Tanganyika, 1959) is presented in Figure 2.3-4. The geologic time table in comparison with the geological unit in the study area is shown in Table 2.3-1.

Table 2.3-1: Geologic Time Table of the Study Area

EONS	ERAS	PERIODS	EPOCHS	EPOCKS AND ROCK FORMATION AT MWANZA AND MARA REGIONS			
				EPOCHS		Abbriviation: Formation and Rocks	
						Sediment and	Volcanic and Plutonic
Phanerozoic	Cenozoic	Quaternary	Holocene	Kainozoic	Neogene	**N**: alluvial, lacustrine, terrestrial, fluviatile, marine deposits	**Nv**: alkaline volcanics; basalt; pyroclastics
			Pleistocene				
		Tertiary	Pliocene				
			Miocene				
			Oligocene		Paleogene	P: marine deposits	
			Eocene				
			Paleocene				
	Mesozoic	Cretaceous		Mesozoic	Cretacious	C: continental and marine sediments	
		Jurassic			Jurassic	J: estuarine and marine deposits	
		Triassic			Karroo	K: continental sediments	
	Paleozoic	Permian		Paleozoic			
		Carboniferous			Bukoban	**B**: mudstone; shale and phyllite; sandstone; arkose; quartzite; congromerate; limestone	Bv: basalt and andesite
		Devonian					
		Silurian					
		Ordovician					
		Cambrian					
Pre-cambrian	Proterozoic	Ediacara or Vendian		Proterozoic			Gp: granite and granodiorite
		Neoproterozoic			Karagwe – Ankolean and Ukingan	A: phyllite; schist; quartzite; sandstone G: augen gneiss; migmatite; porphyry	**Gl**: granite and granodiorite
		Mesoproterozoic					
		Paleoproterozoic					
	Archean			Archean	Usagaran and Ubedian	X: marble; quartzite; schist and gneiss	**Gl**: granite and granodiorite
					Kavirondian	**V**: quartzite; phyllite	
					Nyanzian	**Z**: banded ironstone; meta–volcanics; schist and porphily	**Gs**: granite and granodiorite (foliated, gneissose or migmatitic
					Dodoman	**D**: schist; gneiss; quartite	
	Hadean						

* Geologic time reflects the Geological Society of America (GSA) 1999 Geologic Timescale, compiled by A.R. Palmer and J. Geissman -- S. Rieboldt, Nov. 2002

** Epochs and Rock Formation in the Mwanza and Mara regions are compiled, referring to the Summary of the Geology of Tanganika (A.M. Quennel, A.C.M. Mckinlay, W.G. Aitken, 1956)

*** Bold abbreviation indicates the rocks observed in the study area.

In general, geological formations observed in the area can be divided into the following three units by age:

- **Precambrian plutonic, volcanic and metamorphosed rocks** (granite and granodiorite, schist, gneiss, meta volcanics)
- **Paleozoic sedimentary rocks** (Bukoban series; mudstone, shale and phyllite, sandstone, congromerate and limestone)
- **Neocene deposits** (alluvium, laterite, marine and lake origin sediments, fan and terrace deposits and volcanic rocks)

Precambrian rocks occupy about 80% of the total land area of the Mwanza and Mara regions. Out of the Precambrian rocks, plutonic rocks such as granite and granodiorite are commonly exposed in the area. The assemblage formed by Petrozoic–Archean granite and greenstone is located in the central nucleus of the country, and the so-called Tanzania Craton, surrounded

by Proterozoic belts. Paleozoic (ot pre-Karroo) rocks are only found in a few areas, mostly in the Mara region. Neocene deposits are common in the surface geological observations and the sediments are chiefly distributed at the lake and riverside.

b. Lineament and Structure

Lineament interpretation was made on the aerial photographs obtained from the Surveys and Mapping Division, Ministry of Lands.

In general, clear lineaments are observed in the mountainous areas in Geita, Sengerema, Misungwi, Mwanza, the north western area of Magu and northern Kwimba in the Mwanza region. In the Mara region, lineaments are widely observed, except for the flat terrace formed in the surroundings of major rivers.

The lineaments were classified into the following categories:

- Clear lineament
- Relatively clear lineament
- Other minor lineament (not obvious but readable, rounded or not long (less than 5km))

Lineaments were observed in the whole region, except the lowland and flat area, as most of the area is covered by plutonic rocks. The direction of the major lineaments tends to be as follows by respective area.

- The major trend of lineaments in Geita, Sengerema, Ukerewe, West of Misungwi and Mwanza rural area is in a WNW-ESE direction, intersected by several lineaments in a NNE-SSW direction. Some of the lineaments are also confirmed in the NNW-SSE direction. The area is basically segmented into small fragments of rock mass.

- Low lying hills and flatland are abundant in the area of Kwimba, and part of Magu. Strong lineaments cannot be seen, but lineaments in a WE-SW, WNW-ESE direction have developed. Lineaments in a NNE-SSW and WNW-ESE direction intersect in the north-eastern part of Magu.

- South of Bunda is the flatland of the river terrace. Major lineaments in a NW-SE direction can be found at the boundary with the Musoma District.

- The major trend of lineaments in the Musoma, Tarime and Serengeti areas is in NW-SE, NE-SW and EW directions, but there is high irregularity of the lineaments in the area. They also intersect each other, and are fragmented. The large fault structure is well identified by aerial photograph at the boundary of Tarime, Serengeti, and Musoma.

A lineament map on the scale of 1:50,000 is under preparation due to some missing parts of the topographical maps which are to be interpreted. The major lineaments in the area are presented in Figure 2.3-5.

Figure 2.3-6 shows the lineament density. The figure indicates the number of major (clear) lineaments in the area of 4 sq. km.

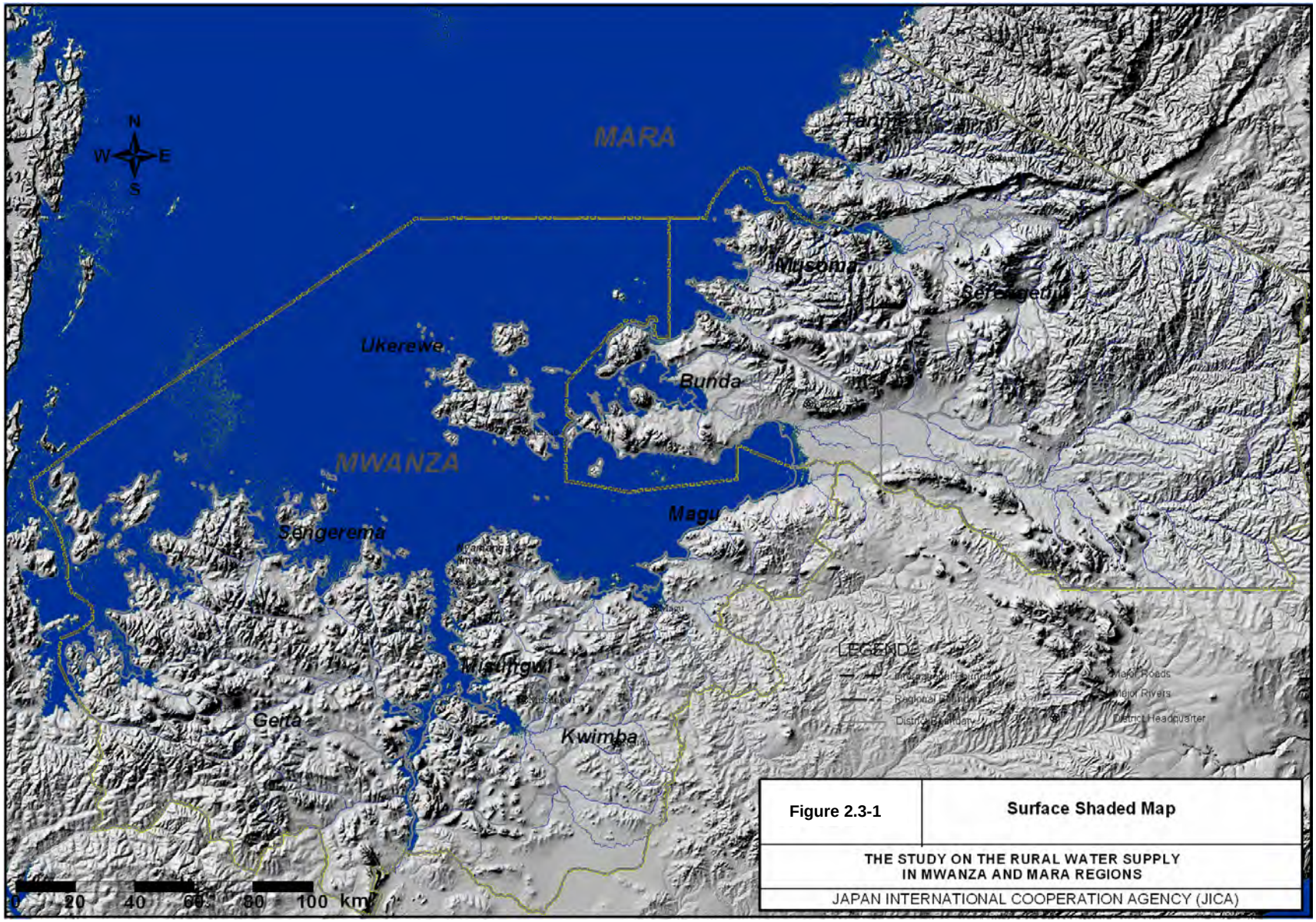

Figure 2.3-1 **Surface Shaded Map**

THE STUDY ON THE RURAL WATER SUPPLY
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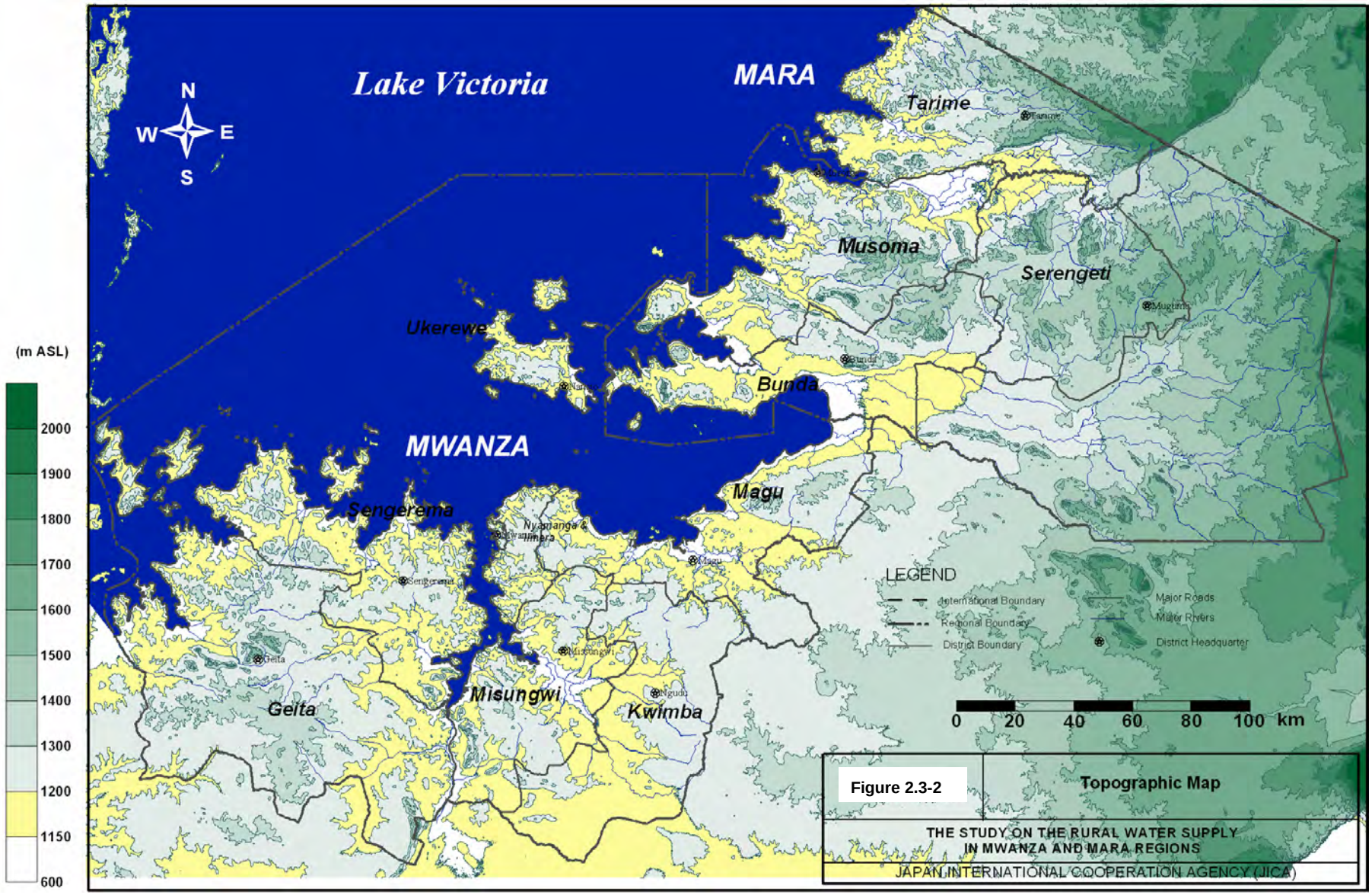

Lake Victoria
MARA
Tarime
Musoma
Serengeti
Ukerewe
Bunda
MWANZA
Magu
Sengerema
Misungwi
Geita
Kwimba
N
W
E
S
(m ASL)
2000
1900
1800
1700
1600
1500
1400
1300
1200
1150
600
LEGEND
International Boundary
Regional Boundary
District Boundary
Major Roads
Major Rivers
District Headquarter
0 20 40 60 80 100 km
Topographic Map
THE STUDY ON THE RURAL WATER SUPPLY
IN MWANZA AND MARA REGIONS
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Figure 2.3-2

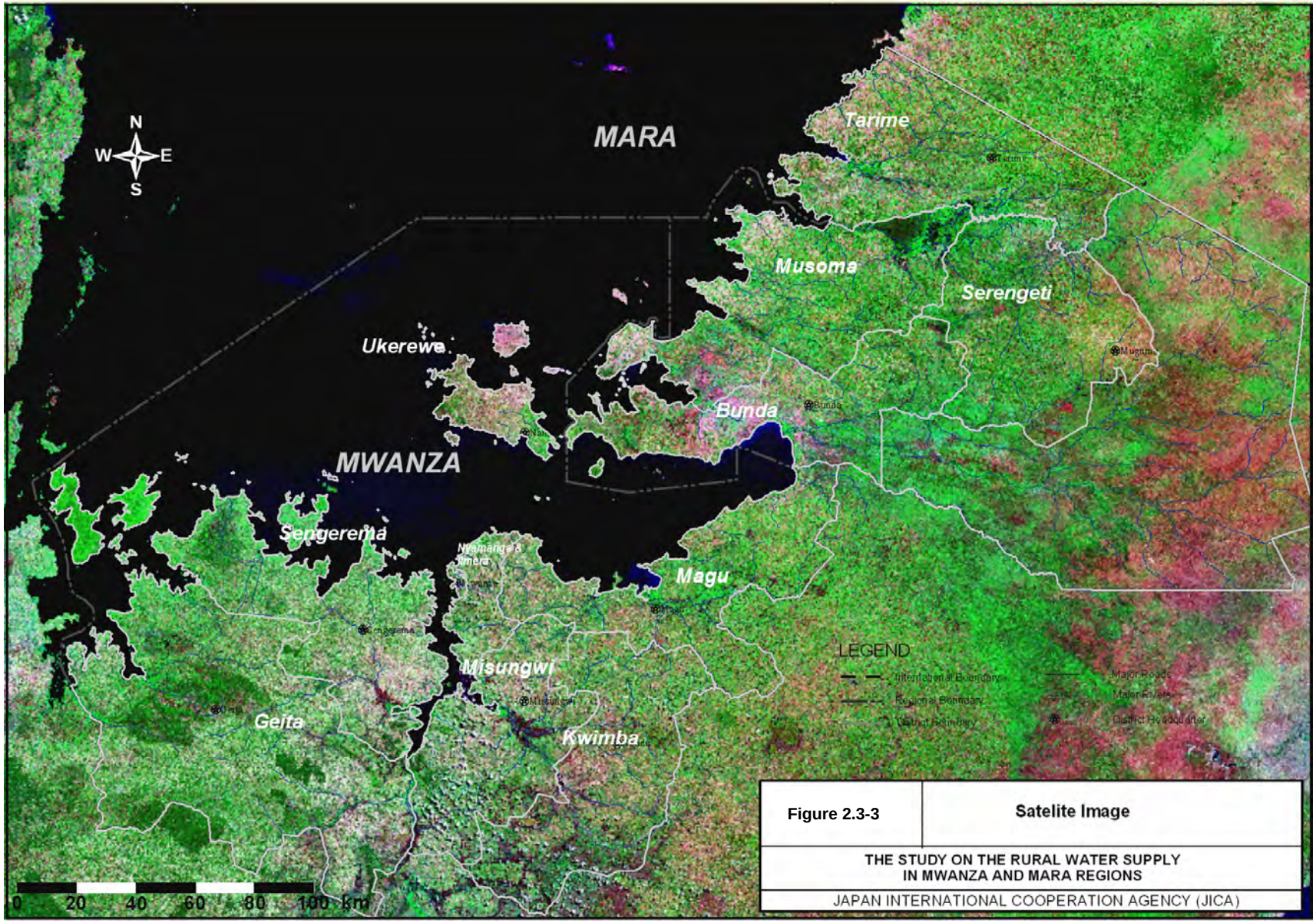


Figure 2.3-3	Satelite Image
THE STUDY ON THE RURAL WATER SUPPLY IN MWANZA AND MARA REGIONS	
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	

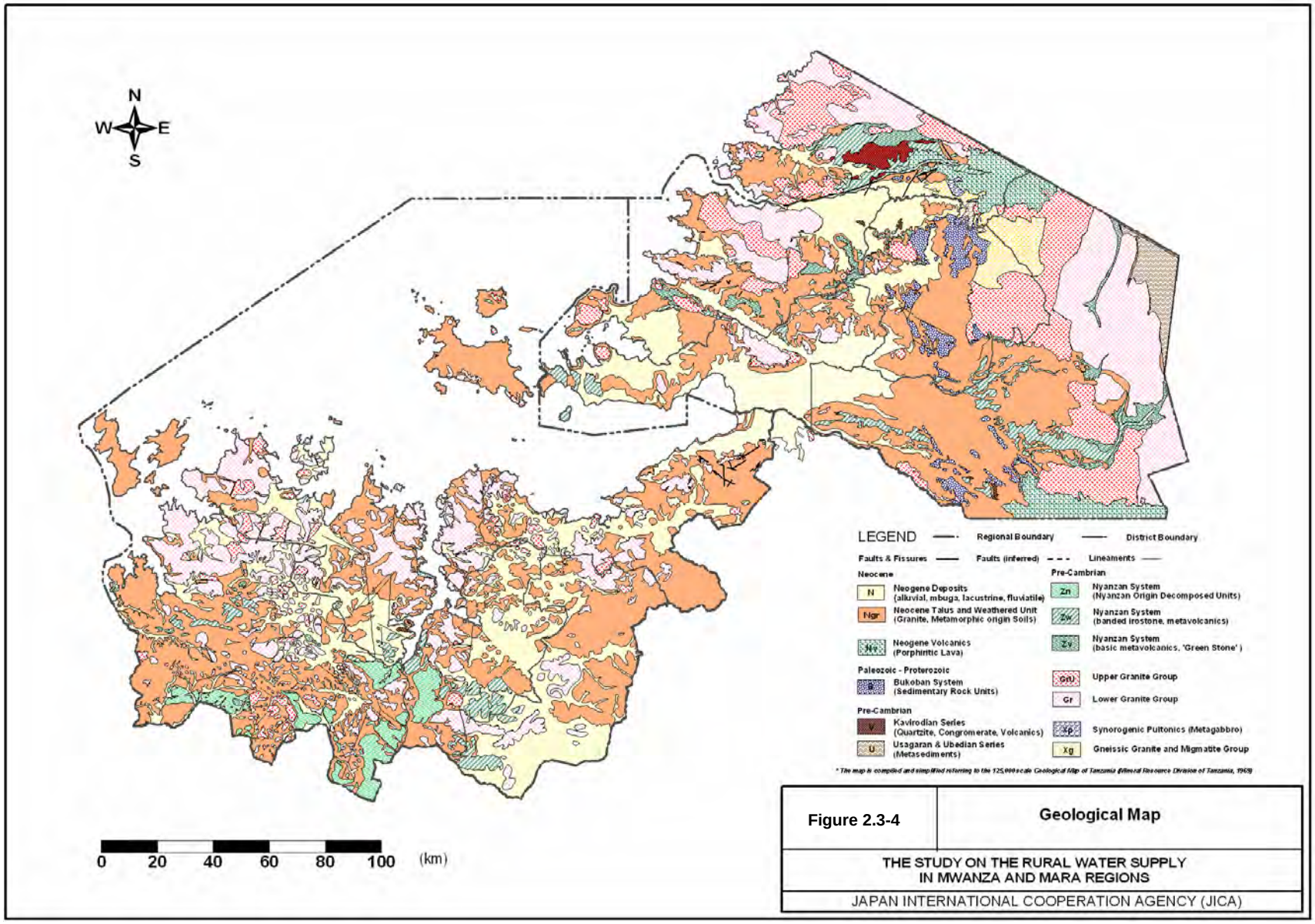
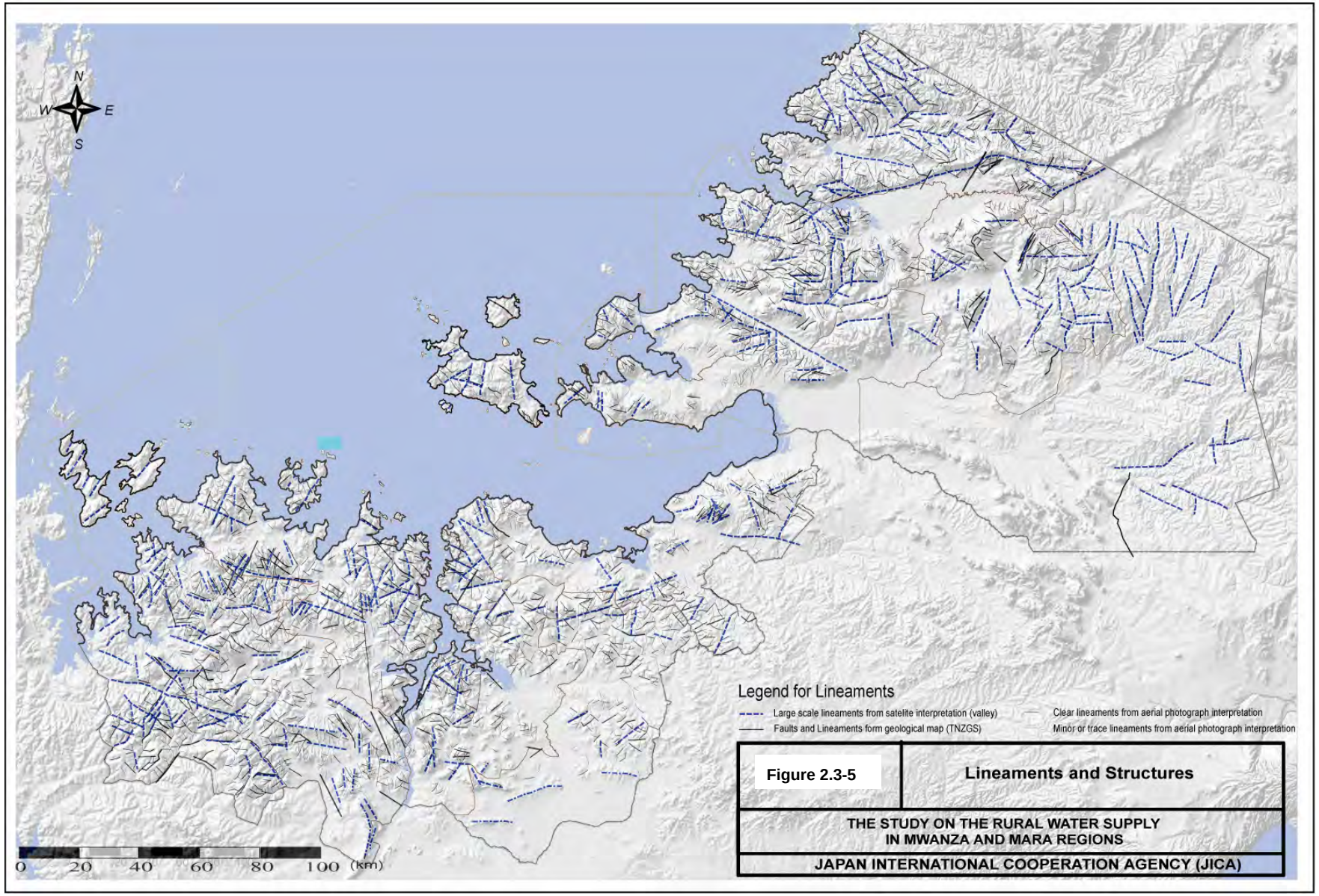
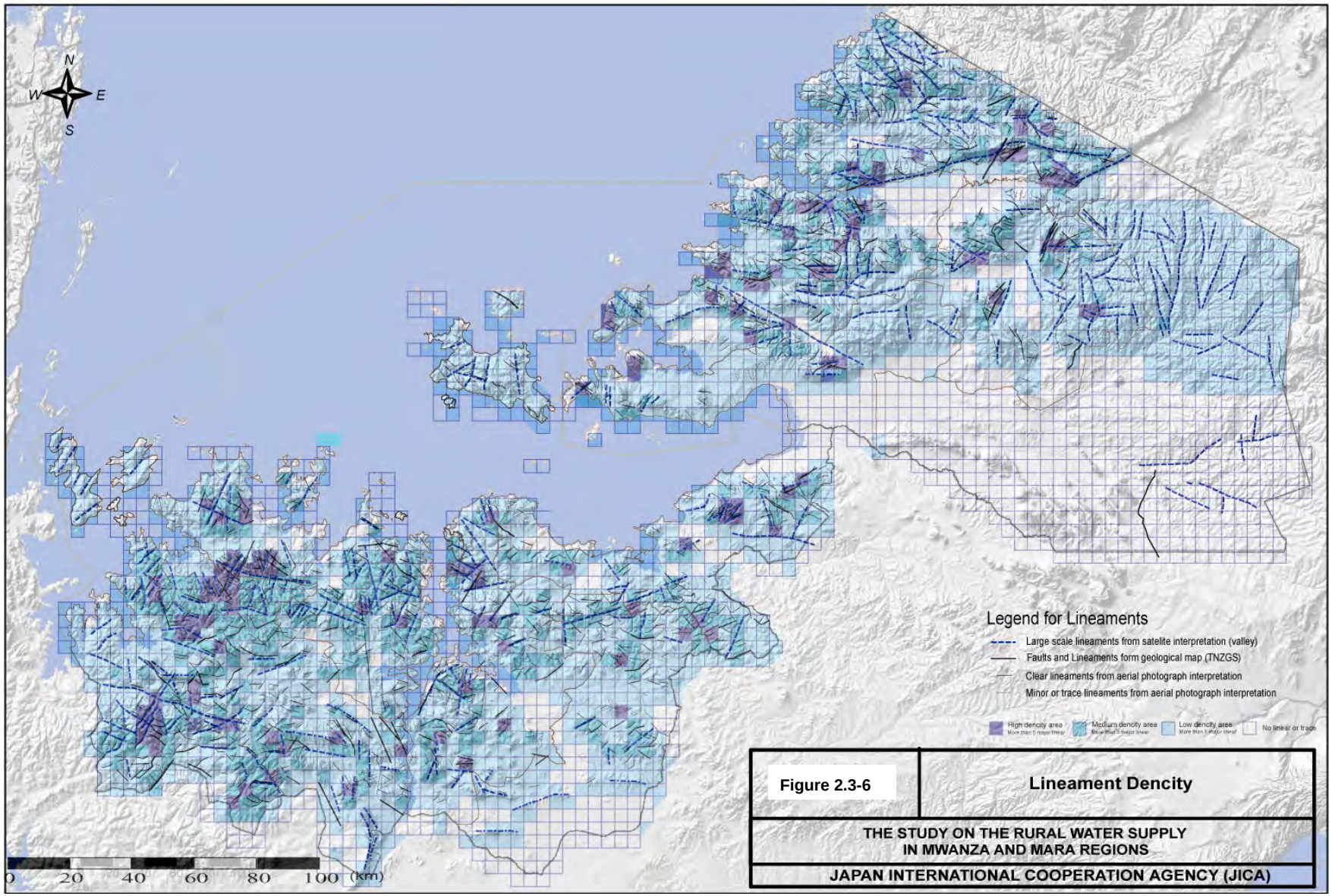


Figure 2.3-4 **Geological Map**

THE STUDY ON THE RURAL WATER SUPPLY
IN MWANZA AND MARA REGIONS

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)


N
W
E
S
0 20 40 60 80 100 (km)
Legend for Lineaments
Large scale lineaments from satelite interpretation (valley)
Faults and Lineaments form geological map (TNZGS)
Clear lineaments from aerial photograph interpretation
Minor or trace lineaments from aerial photograph interpretation
Figure 2.3-5
Lineaments and Structures
THE STUDY ON THE RURAL WATER SUPPLY
IN MWANZA AND MARA REGIONS
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)


N
W
E
S
Legend for Lineaments
Large scale lineaments from satelite interpretation (valley)
Faults and Lineaments form geological map (TNZGS)
Clear lineaments from aerial photograph interpretation
Minor or trace lineaments from aerial photograph interpretation
High dencity area
Medium dencity area
Low dencity area
No linear or trace
0 20 40 60 80 100 (km)
Figure 2.3-6
Lineament Dencity
THE STUDY ON THE RURAL WATER SUPPLY
IN MWANZA AND MARA REGIONS
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

2.4 Socio-economic Conditions in the Study Area

2.4.1 Population and Demographic Characteristics

a. Statistical Data on Population

Population censuses were conducted in the United Republic of Tanzania in 1967, 1978, 1988 and 2002. The censuses indicated that the total population was 12.3 million, 17.5 million, 23.2 million, and 34.4 million, respectively.

b. Population Size and Growth Rate by Region

The 2002 population census indicated that the biggest region by population size was Mwanza with a population of 2,929,644, accounting for 8.8 percent of the total population in Tanzania mainland. Mara was ranked 13th among 21 regions in the country with a population of 1,363,397 (4.1 % of the total population).

The average annual population growth rate in Tanzania was 2.9 % between 1988 and 2002 censuses. The average annual population growth rate is 3.3% in Mwanza and 2.5% in Mara.

2.4.2 Local Administrative Divisions

a. Administrative Divisions

Tanzania mainland is administratively divided into 21 regions. Zanzibar has three regions and Pemba two regions. Each region is divided into districts which are further sub-divided into wards. There exists one level between district and ward, i.e. a division which is made up from a number of wards. In the 1978 census, ward was used as the only administrative level below district. Under each ward, there are a number of villages.

b. Community Structures

Communities in Tanzania can be classified into in urban and rural areas. In rural areas, most communities are called villages. In urban areas, the classification of “mtaa” (street) is used to indicate a quarter or division of the urban area.

A village is the lowest level of administrative unit led by a village chairperson and village executive officer. A village sometimes consists of several sub-villages (kitongoji). The lowest level of community structure is called a ten-cell which actually contains ten to fourteen households. The leader for this structure is called ten-cell leader or “mjumbe”.

The “mtaa” is an urban neighbourhood: the smallest unit of urban administration and equivalent to a village council. It has an elected committee and the committee chairman is the leader. The following table shows the number of villages and “mtaa” of each district in the Mwanza and Mara regions.

Table 2.4-1: Distribution of Administrative Units in Mwanza Region

Region	District	Division	Ward	Village	Mtaa
Mwanza	8	33	174	712	379
Mara	4	20	79	414	138
Total	12	53	253	1126	517

Source: (1) National Bureau of Statistics; (2) Socio-economic Profile Mara Region, 2003

2.4.3 Regional Economy

Detailed economic conditions such as agriculture, fisheries, economic infrastructure (road, marine transport and energy) and social services (education, health) are described in the supporting report. The major activities and Per Capita GDP in each region is described as follows.

a. Mwanza Region

a.1 Economic Activities

The agricultural sector including crop farming, livestock, forestry and fishery provides most of the local population with employment opportunities and income sources. It employs over 85 % of the labor force. The most important food crops grown in the Mwanza region are maize, paddy, sorghum/millet, cassava, beans and cowpeas. The major cash crops are cotton and groundnuts.

Fisheries activities in Lake Victoria contribute significantly to the regional economy in terms of foreign exchange earning. Commercial fishing is carried out by fishing companies using modern fishing gear and vessels. In addition, there are nearly 30,000 fishermen and 8,000 registered fishing vessels in the region, producing about 1.16 million tons of fish in 2001.

a.2 Per Capita GDP

Per capita GDP in Mwanza region had increased from 76,324 Tsh in 1995 to 184,513 Tsh in 2000 at current value. In terms of U.S. dollars, per capita GDP had increased from US$102 in 1995 to US$231 in 2000.

Table 2.4-2: Per Capita GDP in Mwanza Region

Year	GDP at current value in million Tsh	Per capita GDPat current value in Tsh	Per capita GDP in U.S. dollars	Exchange rate in Tsh
1995	203,939	76,324	102	575
1996	n.a	n.a	n.a	580
1997	313,469	117,316	158	612
1998	n.a	n.a	n.a	665
1999	460,566	172,368	232	744
2000	643,595	184,513	231	800

Source: (1) Socio-economic Profile, Mwanza Region, 2003; (2) Study team's estimate

b. Mara Region

b.1 Economic Activities

The agricultural sector including crop farming, livestock, forestry and fishery provides most of local population with employment opportunities and income sources. It employs over 85 % of the labor force. Crop farming is the most important economic activity, followed by livestock keeping and fishing. Fishing is important for the people living along the lake shores in the Bunda, Musoma and Tarime districts.

Maize and cassava are the main food crops, being the staple food for most households. Paddy is considered as a cash crop when farm households have surplus production. The main cash crops are cotton, coffee and groundnuts. Cotton is the predominant cash crop in the region.

Fishing provides employment of people along the lakeshore generating good income and

sustains the fish trade within and outside the country. Fishing contributes little to the regional economy compared to crop production and livestock keeping.

b.2 Per Capita GDP

Per capita GDP in the Mara region increased from 81,476 Tsh in 1995 to 181,113 T. shillings in 2000 at current value. In terms of U.S. dollars, per capita GDP increased from US$142 in 1995 to US$226 in 2000.

Table 2.4-3: Per Capita GDP in Mara Region

Year	GDP at current value in million Tsh	Per capita GDP at current value in Tsh	Per capita GDP in U.S. dollars	Exchange rate in Tsh
1995	95,360	81,476	142	575
1996	117,423	97,686	168	580
1997	146,924	118,734	194	612
1998	173,550	136,055	205	665
1999	202,241	153,804	207	744
2000	245,495	181,113	226	800

Source: Socio-economic Profile, Mara Region, 2003