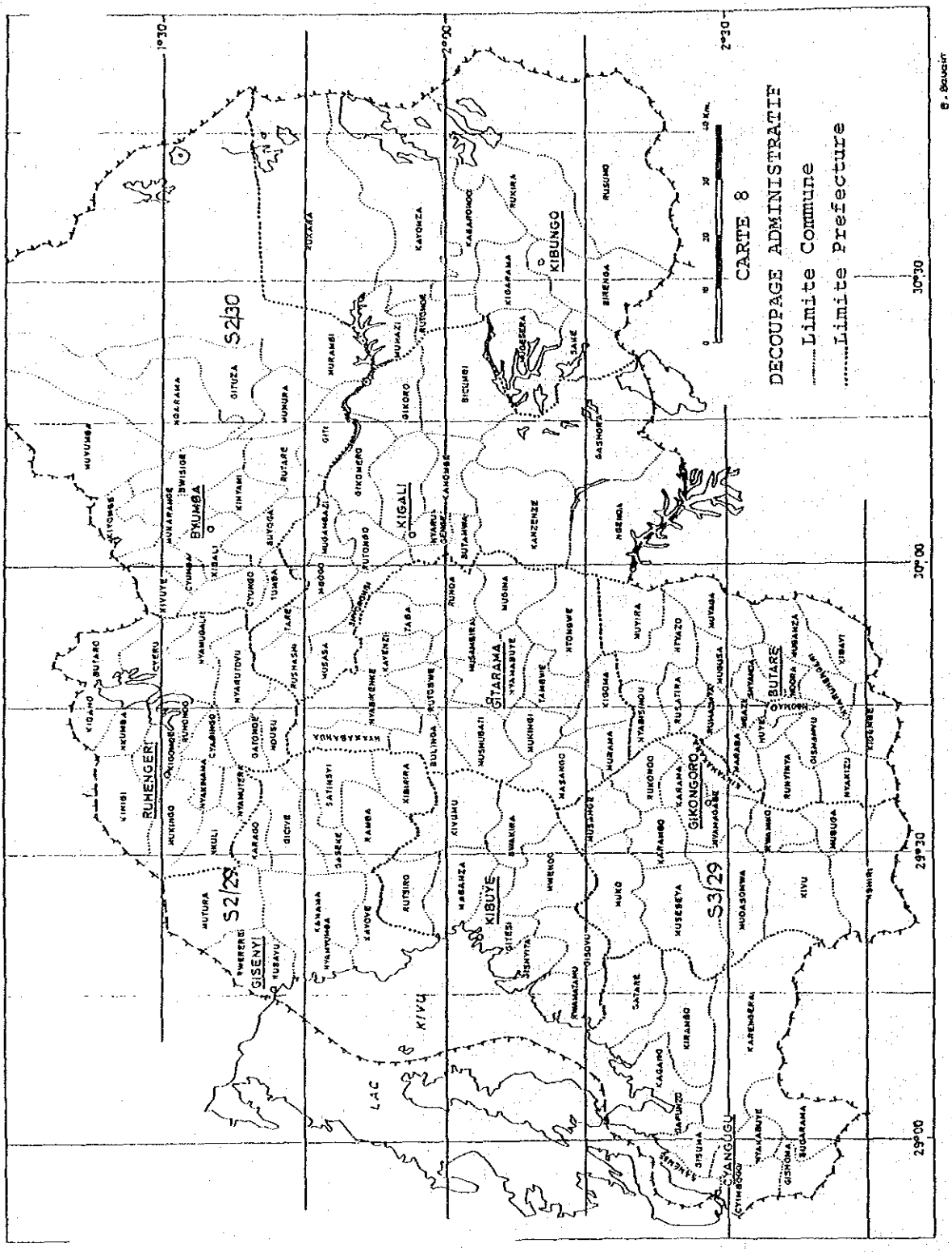

Administration Boundary of RWANDA

A) Kigali
B) Butare
C) Gisenyi
D) Ruhengeli
E) Bynmba
F) Gitarama
G) Gikongoro
H) Kibungo
I) Kibuya
J) Cyangugu

APPENDIX B

PHYSICAL SETTING

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APPENDIX B

PHYSICAL SETTING

1. GENERAL

Geo-morphological, geological and hydro-geological studies, including analysis of existing data, aerial-photo interpretations, field works, was carried out during August to October, 1989, to obtain following information:

- Geomorphology

to help the description of:

. drainage systems/river basin
. land classifications
. areas where topography-geology regime are closely related

- Stratigraphy and its properties

to investigate the position and extent of aquifers and aquiclude, taking accounts of weathering, lithology and origin.

- Structural geology

to delineate geological formations/horizons and structures of secondary permeability in areas where formations have been displayed by technic activities.

The outline descriptions of geomorphology, geology and hydro-geology in the study area are given below.

1.1 LOCATION

The Study Area lies between latitudes 1°37' and 2°25' S and longitudes 30°16' and 30°53'E, and located on the southeast margin of the Republic of Rwanda.

1.2 GEOMORPHOLOGY

The study area consists of mountains and hills ranging in altitude from 1,300 to 1,900 m. In most of the Study Area, widely and deeply dissected valleys are observed and the relative height of mountains or hills to valleys generally exceeds 200 m. As the many valleys occur, the plateau-like hills and mountains are progressively eroded, leaving only a series of peaks and ridges of approximately the same height. The geo-morphological future around the Study Area is presented in Fig. B.1.

1.3 GEOLOGY AND HYDROGEOLOGY

In the study area, Precambrian formations are widely distributed and composed mainly quartzite, schist and granite. Besides these, Quaternary formations are formed in some valleys and comprised from clay, sand, gravel and talus.

Mostly fold structure lines extend to south-northern direction and there are some fault lines that mainly run parallel with them.

The surface of Precambrian formations are covered by weathered zones and below these strong fissured sections are developed until almost 50 m deep. Further weak fissured sections are continued until fair depths that are assumed as almost 200 m deep.

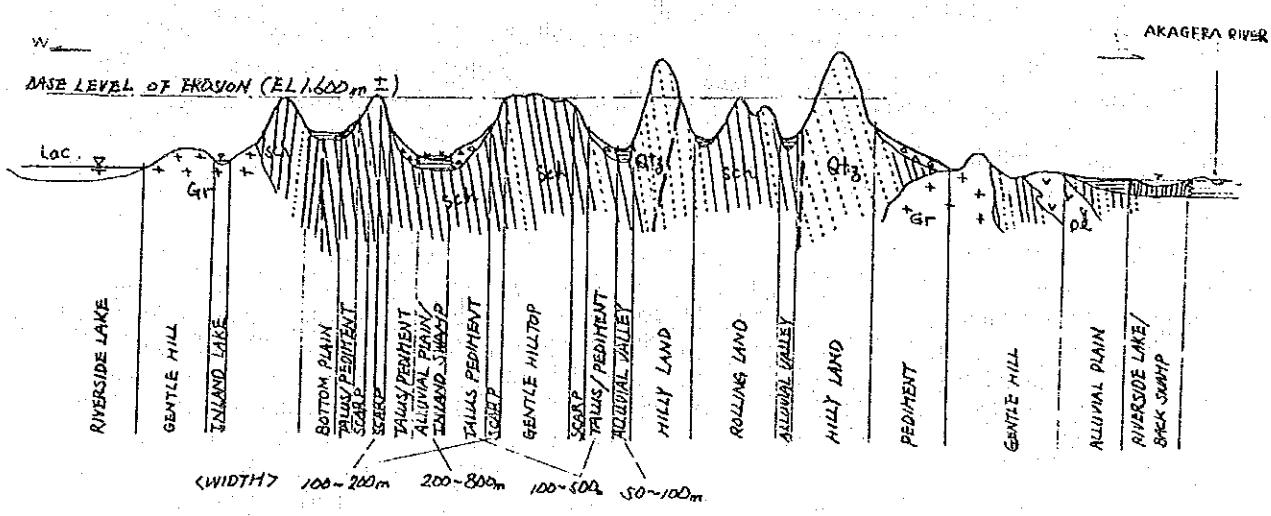
Since precambrian formations are formed in the oldest geological age, its original textures are very hard and un-permeable bedrock. But the coarse beds in these weathered zones and fissured sections are conceived good aquifers.

Quaternary formations in some valleys are deposited until depths less than almost 20 m, and good aquifers are formed in sand and gravel beds among them.

2. TOPOGRAPHY

The topographic conditions of the Area have been studied using topographical maps scaled 1:50,000, in conjunction with aerial-photo interpretation and field check.

Using the geographical feature and the drainage system, 7 land classification units have been separated. The characteristics of the units are listed in Table B.1 and schematic cross section is as a follow:



Schematic Cross Section of Geomorphology

The distribution of the units within the Study Area is given as a follow are presented on Fig. B.2.

On the basis of distribution of the land classification units, the Study Area would be conveniently divided into three (3) geographical regions to study the development constraints involved; i.e. Gentle Lowland, Rolling Land and Hilly Highland. The general boundaries in between each region are given in Fig. B.2.

Gentle Lowland:
This land is found around main lakes and the Akagera River. The region mainly consist of "F" (alluvial flat) and "U" (undulating land) of land classification units and is generally underline by granitic rock. Though the elevations range from 1,300 m to 1,450 m, relative heights are less than 100 m. The mean slope gradient is estimated as 10%-15% and the Region occupy 26% of the total study area.

Rolling Land:
This land widely occurs in the area and consist of varied land units; i.e. "F", "U", "R" (rolling land), "HM" (steep slope area) and "H" (hilly steep land). The elevation range from 1,350 m to 1,700 m and relative heights are generally 200 m to 300 m. The uplands are is generally dissected with steep slope of 15%-25% and the narrow slender lowland is widely scattered. The Region occupy 54% of the study area.

Hilly Land:
This land is found in eastern potion of the study area and occupy 20% of total. The elevation range from 1,350 m to 1,900 m and relative heights are more than 250 m. The region consist of land units "HM", "H" and "M" (mountainous area), and generally has convex surface and steep slope of over 17% gradient.

3. GEOLOGY

3.1 GENERAL

The geological conditions in the Study Area was studied on the basis of the geological map(scale at 1:100,000) prepared by Royal Museum of Central Africa(see "Hydro-geological Map"). The geological information were also obtained from aerial-photo interpretation and were partially supported by field investigation. The geological conditions are presented in Hydrogeological Map with geological sections.

3.2 STRATIGRAPHY

The Study Area in Kibungo Prefecture is composed of Pre-cambrian rock formations (politic schist, sericite, phyllite quartzite), granitic rocks intruded into the Pre-cambrian formations and unconsolidated Quaternary deposits (talus sediments, alluvial river/lacustrine deposits).

The Kibungo Prefecture area is divided into three geographical regions; i.e. Gentle Lowland, Rolling Land, Hilly Land, generally each having different geologic conditions.

In the western half of the study area, mainly schist with thin sandstone and quartzite beds occurs and Rolling Land is dominant; in the eastern half, a large quartzite extrusion and Hilly Land are evident together with massive granitic outcrops found on some marginal Gentle Lowlands in the Area.

Pre-cambrian formations are divided into three (3) classifications of stratigraphy;

Miyove Series of upper
Byumba Series of middle
Inferieure Series of lower.

Granitic rocks are also divided into two (2) types;

massive less altered granite, in the southeastern part and gneissose granite around the main lakes.

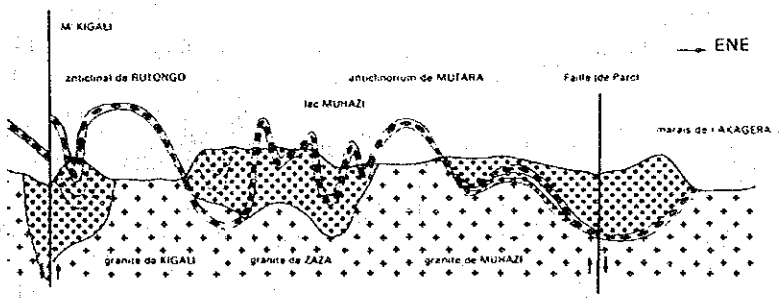
A few basic intrusive rocks of diorite are scattered in the southern to eastern margins of the Area.

The detailed descriptions of litho-stratigraphy in the Study Area is given in Table B.2 and the distributions are outlined in Fig. A.2.

3.3 STRUCTURAL GEOLOGY

Pre-cambrian formations are generally laid NS and mostly dipped straight. Many folds with axes of a NNE-SSW trend and faults of a mainly NNE-SSW trend occur. A few conjugate faults also run in the EW direction.

Four major synclinal axis are found among main streams and/or depressions as below:



Main faults also run center and east of the Study Area, and generally eastern section of the fault was relatively slipped down and western section was relatively uplifted. The geological structure of Rwanda is outlined in Fig. B.3.

Further descriptions of topography and geology are given in Appendix I "HYDROGEOLOGY".

4. LANDUSE

4.1 GENERAL

The landuse pattern of Rwanda including the Study Area was studied by MINITRAPEE and a landuse map scaled at 1:20,000 has been drawn with the delineation of dominant landuse.

The landuse pattern in the Study Area is characterized by the geographical location in the area since relief and distribution of rainfall. The land in the Study Area was classified into four categories as follows;

A1: savanna with agricultural lands
A2: low-lying savanna with agricultural lands
F : savanna with forests
S : swamp/swampy lands

4.2 DESCRIPTION OF EACH CATEGORY

(1) Savanna with Agricultural Lands(A1)

Rainfed croplands under annual cultivation are mainly found in the relatively higher lands together with a scattering of savanna grasslands. Generally, apart from the irrigation, around half of agricultural area is cultivated annually, except a few lower land where irregular irrigation from streams/swamps. These areas are densely cultivated and banana/coffee/bean are main crops. Houselights are generally found on upper slope and ridge area.

(2) Low-lying Savanna with Agricultural Lands(A2)

Landuse patterns in this area are similar to those of "A1" but many irregularly irrigated croplands are broadly scattered in the lower parts. There is a greater availability of water on the lands in low-lying area from perennial swamps and springs. Main crops of uplifted lands area similar to those of "A1" and those of low lands are banana, rice, maize.

Agricultural lands within "A1" and "A2" of the Study Area extend to 1,455 km2(55 % of total).

(3) Savanna with Forests

The area is mainly covered with sparse forest with steep topography and some stone surfaces. The vegetation is considered to be mostly natural and seldom cropland is found. Also, many plant trees area of small scale are scattered in "A1" and "A2". The relief energy of the

lands is relatively higher in the Study Area.

The extent of the forest/woods is 1,124 km2(42 % of total), including afforestation area.

(4) Swamp/Swampy Lands

Broad swampy lands occurs along the Akagera river and its tributaries with widths of 1 to 5 km. Swamp and enclosed water surface are also found western and eastern margins.

4.3 DISTRIBUTION OF LANDUSE PATTERN

The distribution of landuse pattern is presented on Fig. B.4 and the coverage of agricultural lands, pasture and forest/woods in uplifted dryland are given in Table below.

- Agricultural Lands	:	1,455 km2 (55 %)
- Pasture	:	88 km2 (3 %)
- Forest/woods	:	1,124 km2 (42 %)
		2,667 km2 (100 %)

Characteristics of Land Classification Unit

Land Classification Unit		Description	
		Topography	Groudwater
W	LAKE	Riverside Lake Enclosed basin being adjacet to Akagera alluvial plain	Effluent stream to the lake
		Inland Lake Inland enclosed depressions	Influent stream from the lake
F	ALLUVIAL FLAT	Back Swamp Broad alluvial swamps along Akagera River	Permanently flooded with high G.W. table
		Inland Swamp Swamp/swampy land on broad (over 200m width) and narrow (less than 200m width) river valley	Long term flooded with high G.W. table
		Alluvial plain Dried to moist, flat plain along main rivers, partly cultivated	Parts flooded with relatively high G.W.
		Bottom plain Dried,flat plain with over 500m width, a few cultivated	Aquiclude materials within shallow part
		Alluvial Valley Alluvial land along main stream/drainage mostly banana planted	Relatively high G.W. table with some springs
U	UNDULATING LAND	Undulationg to rolling land in lowlying land	Aquiclude area
R	ROLLING LAND	Dissected area with scarp and very narrow hilltops, mainly underline by schist	Mainly recharge zone small discharge zone at lower parts
HM	STEEP SLOPE	The areas generally have steeper surface	
H	HILLY STEEP LAND	Talus/Pediment Slope ranging from 8 to 15 with 300m to 600m width, land, mostly planted/ cultivated	Upper recharge zone, lower transmission/ discharge zone. G.W.T. within 100m
		Scarp/Steep Slope Erosion slope with gradient of 15 to 30 and 100m to 300m width, few planted and nonhabitation	Mainly recharge area
		Gentle Hilltop Broad to narrow undulating hilltop with altitude of more than 1,500m m.s.l. mainly cultivated and many habitatons (base level of erosion in the area)	Recharge area
M	MOUNTAINOUS AREA	Dissected hilly land with rocky slopes, few cultivated	Recharge area, non G.W/ except lower part

Description of the Stratigraphy

· HOLOCENE ET PLELSTOCENE

Alluvion de fonds de vallees, de basses et de moyennes terrasses; cones de dejection.(Certaines de ces formations appartiennent a l'Holocene, d'autres au Pleistocene; la distinction n'a pu ^etre faite lors de l''etablissement de la carte)

· PRECAMBRIEN

BURUNDIEN

· Série de Miyove

environ 1800 m

Schistes avec trois importantes intercalations de quartzites, localement grossiers vus sur environ 1400 m

Quartzites et poudingues de Rwinkwavu : quartzites, quartzites conglomératiques, poudingues environ 400 m

· Série de Byumba

environ 2500 m

Phyllades et quartzophyllades avec deux ou trois intercalations de quartzites épaisses d'environ 100 m environ 1500 m

Quartzites environ 1000 m quartzites, souvent grossiers et d'aspect arkosique, formant souvent deux couches séparées par une intercalation schisteuse. Vers le Nord, l'épaisseur de ces couches se réduit à 50 à 100 m avec intercalation d'environ 700 m de roches schisteuses.

· Série(s) inférieure(s)

Schistes et phyllades noirs ou gris avec quelques intercalations minces et discontinues de quartzites — environ 850 m

Quartzite de la Mulindi (Yanzi) — jusque 250 m à l'Est

Schistes et phyllades noirs ou gris avec quelques intercalations minces et discontinues de quartzites — 500 m à l'Est

Quartzite

à l'Est : deux bancs de quartzite de 150 à 200 m, séparés par une intercalation schisteuse d'environ 100 m

Alternances de phyllades, quartzophyllades et quartzites passant vers le bas à des séricito-schistes, des micaschistes et des quartzites micacés — plus de 3600 m

· ROCHES GRANITIQUES

·Granites, paragneiss et orthogneiss

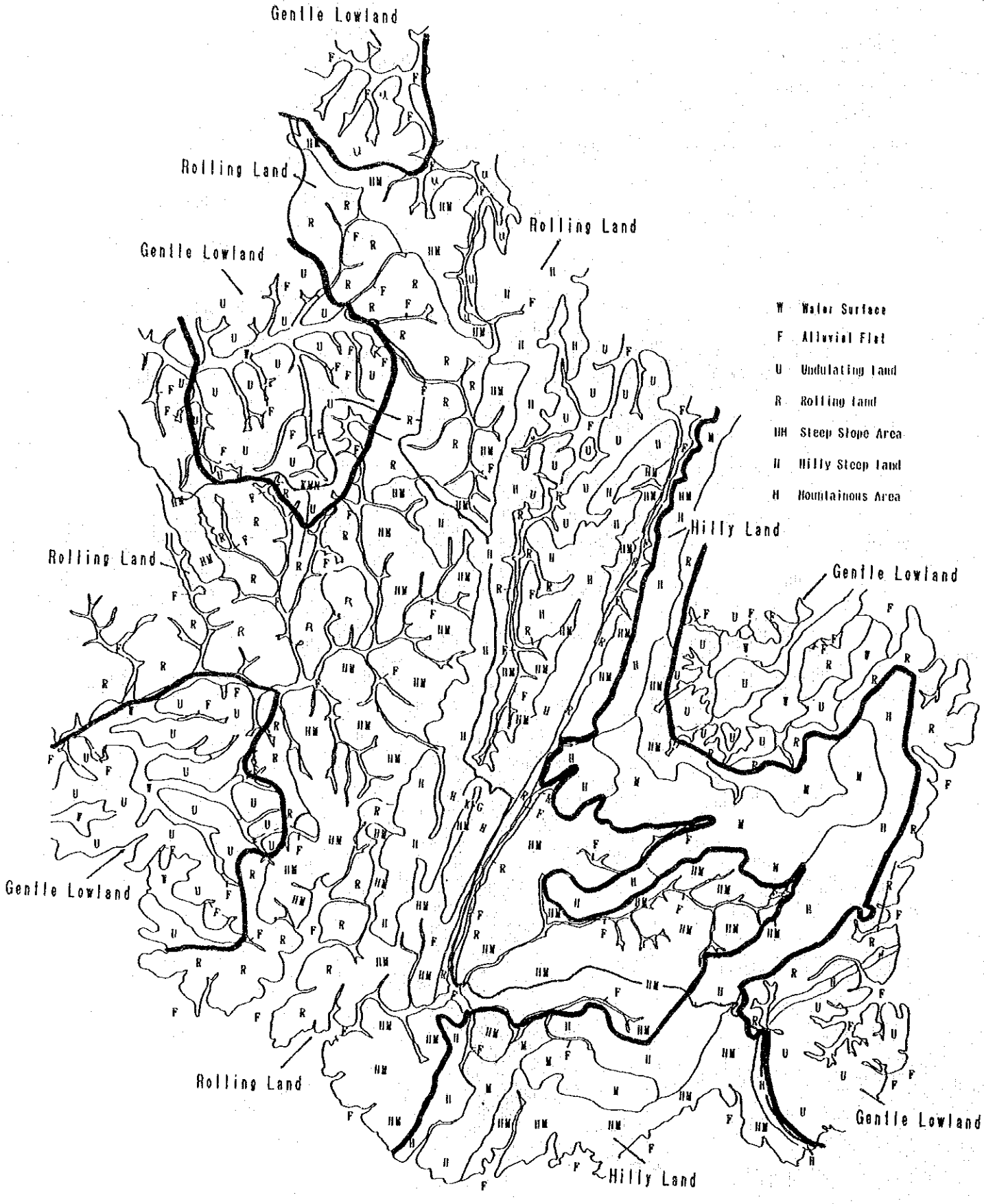
·Granites paragneiss et orthogneiss avec enclaves de roches sedimentaires non differenciees, comprises

Zones riches en pegmatites

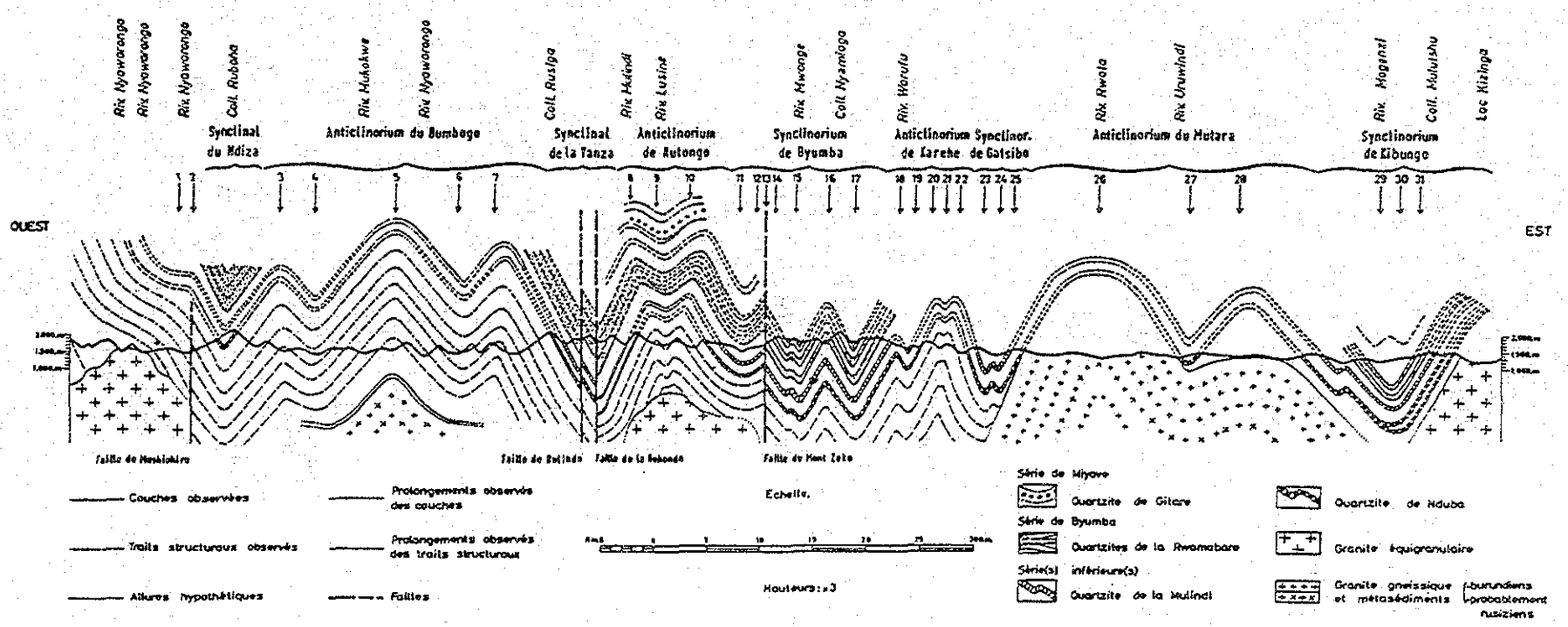
· ROCHES INTRUSIVES BASIQUES

· Roches intrusives basiques: dolerites et gabbros plus ou moins amphibolitisees et saussuritisees


Ligne de partage des eaux entre le bassin du Zaire et le lac Victoria
Escarpement de l'Akagera
Escarpement de faille
Faille probable
Alvéoles évidées dans les granites et les gneiss à relief mou
Principaux ensembles de barres quartzitiques ou de conglomérats quartzitiques
Principales zones évidées dans les roches pélitiques (phyllades, micaschistes, schistes métamorphiques, divers) à relief plus ou moins accidenté
Section du réseau hydrographique hérité de l'ancien réseau pré-appalachien
Bas Fonds
1483
Mutara
Byumba
2019
1088
1729
Muhazi
Kigali
1379
Rwamagana
1892
Kibungo
L. Cyohoha N.
Bugesera
L. Cyohoha S.
1836
1300
Rusumo
Maxaga
Geomophology



Land Classification



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Synclinorium de Byumba
11. Synclinal de Rugasi
12. Anticlinal de la Rugabano
13. Synclinal de Zoko (2)
14. Anticlinal de Kayanga
15. Synclinal de la Sisi
16. Anticlinal de Shenga
17. Synclinal de Nyakabongo

Anticlinorium de Karehe
18. Anticlinal de la Birarama
19. Synclinal de la hte Warufu
20. Anticlinal de Kiyombe
21. Synclinal de Murambi
22. Anticlinal de la Byanga

Synclinorium de Gatsibo
23. Synclinal de Mumure
24. Anticlinal de Rugogwe
25. Synclinal de Nyakayaga

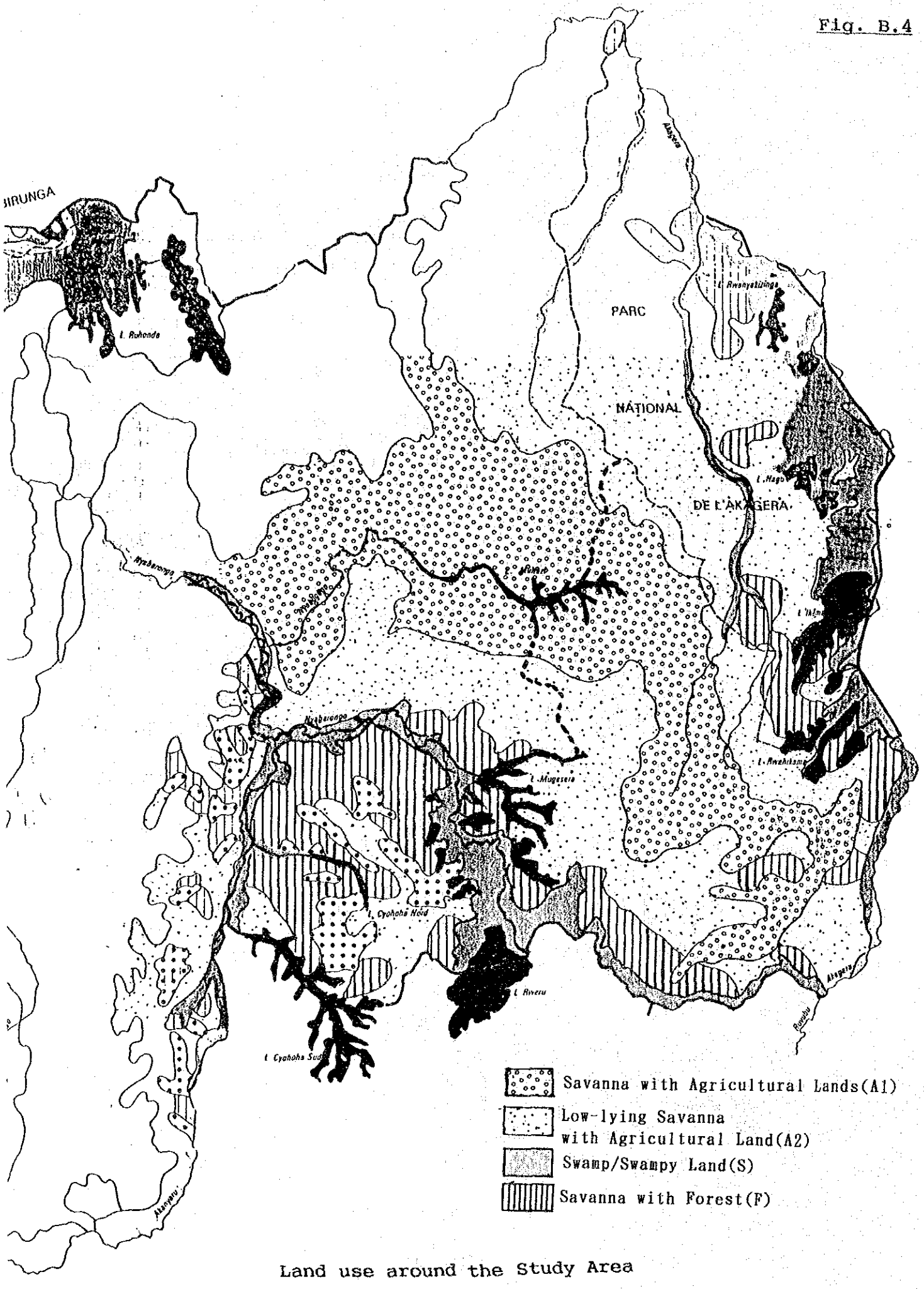
Anticlinorium du Mutara
26. Anticlinal de la Karangaza
27. Synclinal de Gabiro
28. Anticlinal de la Rusharaza

Synclinorium de Kibungo
29. Synclinal de Rubanga
30. Anticlinal de Rwinkwavu
31. Synclinal de Muganza

The Geological Structure of Rwanda

Fig. B.3

Fig. B.4



Land use around the Study Area

APPENDIX C

METEOROLOGY AND HYDROLOGY

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METEOROLOGY AND HYDROLOGY

1. METEOROLOGY

1.1 GENERAL

No systematic observation has been carried out in the Study Area, though Kibungo and Zaza Meteorological Stations and some rain gauges exist. The following ten weather observation stations record the rainfall and temperatures in the Study Area.

Station	Location			Observation Item		
	Lond.	Lati.	Altitude	P.P.	Temp.	Evapo.
Akagera	30 43 E	1 52 S	1,550 m	***		
Bare	30 30 E	2 16 S	1,550 m	***		
Kibungo	30 32 E	2 10 S	1,680 m	***	***	***
Mpanga	30 49 E	2 04 S	1,400 m	***		
Nyarubuye	30 45 E	2 12 S	1,750 m	***		
Ruhunda	30 26 E	1 54 S	1,530 m	***		
Rukira	30 35 E	2 13 S	1,500 m	***		
Rukumberi	30 21 E	2 11 S	1,350 m	***		
Rwamagana	30 25 E	1 57 S	1,550 m	***		
Zaza	30 25 E	2 08 S	1,515 m	***	***	

Note: P.P. = Precipitation, Temp.= Temperature,
Evapo.= Evaporation

The locations and altitude of meteorological observation point are given in Fig. C.1. The observed data is written up in an annual report by the Division de Climatologie of MINITRANSCO.

Each weather observation station's monthly rainfall data for 1987 and the average monthly rainfall data for a ten year period (1978 through 1987) are shown in Table C.1 and Fig. C.2.

Since the rainfall in the Study Area is sporadic, no correlation between each area and its daily rainfall is seen. Also, each area's monthly rainfall deviates. The 10 year record shows that the highest rainfall occurs in April. The further northeastern and eastern regions have less rainfall.

1.2 METEOROLOGICAL CHARACTERISTICS

Although situated near the Equator, the Study Area has a rather mild climate. The year is divided into 4 seasons, as outlined below, which do not significantly affect temperature variation.

- Rainy season	:	Mid-March	- Mid-May
- Dry season	:	Mid-May	- Mid-September
- Rainy season	:	Mid-September	- Mid-December
- Dry season	:	Mid-December	- Mid-March

The climate in the Study Area can be divided into three categories based on rainfall amount and length of dry period:

"Ia" in southern and eastern parts:
annual rainfall of less than 900 mm with a longer dry season,

"Ib" in center:
annual rainfall of around 1,000 mm with a shorter dry season and

"Ic" in the northern parts:
annual rainfall of around 1,000 mm with a long dry season and rainfall concentrated in therainy season.

Meteorological classification in Rwanda is presented in Fig. C.3.

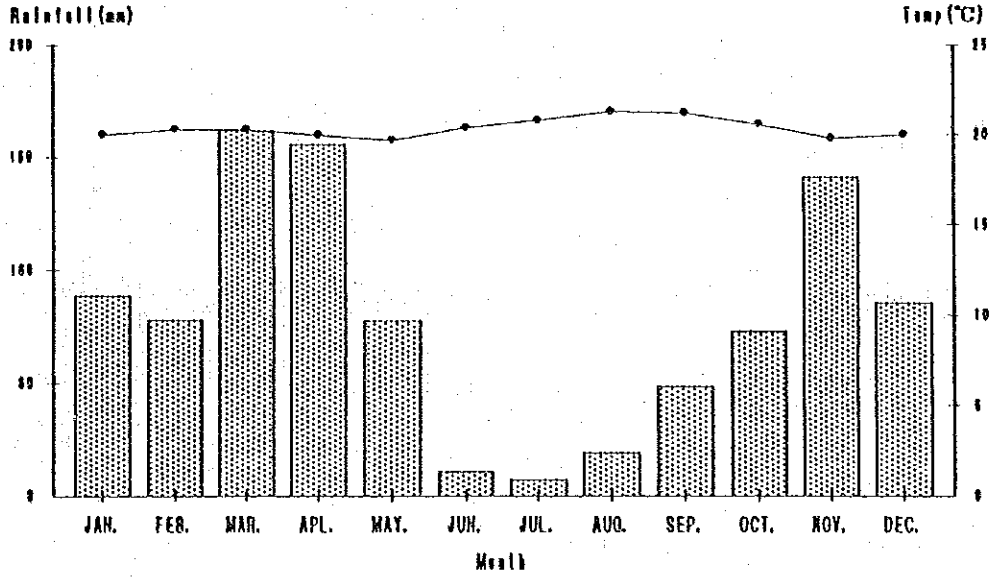
1.3 RAINFALL

Observation data on rainfall in the "Bulletin Climatologique" (from 1979 to 1987) shows that a maximum rainfall of 1,351 mm p.a. was recorded at Zaza (1982) in the center of the Area and a minimum precipitation of 640 mm p.a. was recorded at Ruhanda (1984) in northern portion of the Area.

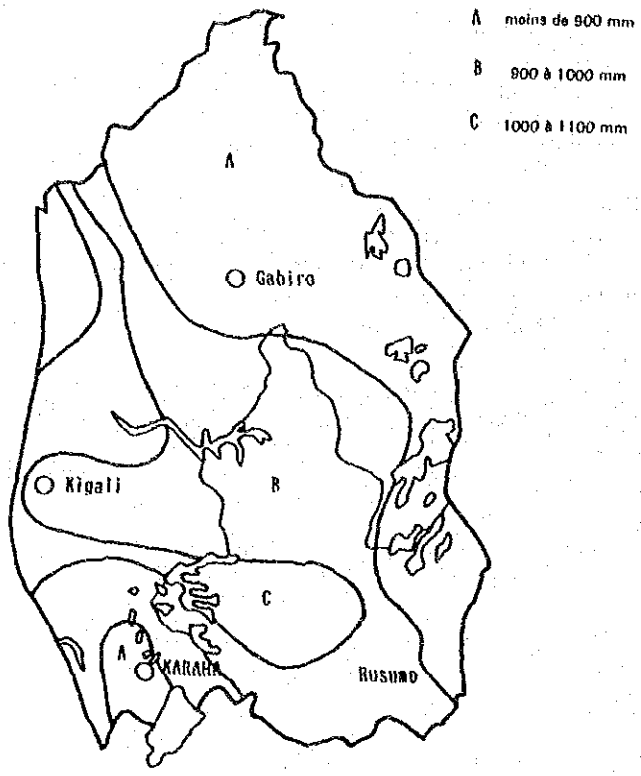
At Kibungo station, around 1,000 mm p.a. is an average and around 800 mm p.a. is the precipitation of a 5 year return. Generally more than 70 mm p.m. of rainfall is recorded during rainy season (Mar. to Apr.) and less than 20 mm p.m. during along dry season (Jun. to Aug.).

Observation data on rainfall in the "Bulletin Climatologique" are not available for the water balance examination, except the data at Kigali and Kibungo meteorological stations because of daily observations being not completed.

The monthly average rainfall observed at Kibungo Observation Station are shown in Table C.2, and in the following figure:



Mean Monthly Climatological Data



Annual Rainfall Class

Maximum daily rainfall (see Table below) between 1980 and 1987 is;

142.8 mm/day (NYAKIBANDA, 16/Aug./1981) in Rwanda
85.2 mm/day (ZAZA, 25/Apr./1981) in the Study Area.

Daily Maximum Rainfall Record

YEAR	Rainfal	- RWANDA -		Rainfal	- KIBUNGO -	
	(mm)	Date	Site	(mm)	Date	Site
1980	108.0	28/Feb	KIGALI	57.5	29/May	RUHUNDA
1981	142.8	16/Aug	NYAKIBANDA	85.2	25/Apr	ZAZA
1982	102.8	28/May	MURAMBI	85.2	25/Jun	ZAZA
1983	84.7	19/Feb	BYIMANA	71.0	24/Apr	RUKIRA
1984	94.8	10/Apr	RWAGIHURA	58.0	10/Jan	RUKIRA
1985	120.1	19/Mar	RWINKWAVU	82.0	29/Mar	RUKIRA
1986	107.0	6/Apr	NYAMIYAGA	73.5	27/Apr	NYARUBUYE
1987	109.2	14/Jan	KANSI	63.5	28/Dec	RUKIRA

Draughty rainfall of 10 year-period of Kibungo is estimated as around 750 mm p.a. as given in Fig. C.4.

1.4 TEMPERATURE

The annual mean temperature is 20°C to 19°C, and the fluctuation during the months is as small as 1°C.

The daily temperature is around 30°C maximum and 11°C minimum. Seasonal temperature deviation is quite small, but, the temperature is slightly lower during rainy seasons.

The monthly average temperature at Kibungo Observation Station are presented in Table C.3.

1.5 EVAPORATION

The evaporation data are not available in Kibungo. However, according to the data in Kigali, the monthly mean evaporation is around 95 mm, and the maximum is 5.82 mm/day in August and the minimum is 1.92 mm/day in April(refer to J.3 of Appendix J).

2. HYDROLOGY

2.1 CATCHMENT AREA OF THE STUDY AREA

The Study Area can be divided into the following eleven (11) catchment areas. The rivers that come from these catchment area flow into the Muhazi and Mugesera lakes, but, their water eventually flows into the Akagera River which forms which forms the border with Tanzania.

Catchment	Name of Basin	Catchment Area(km2)
A	Ngungu River Basin	349
B	Lake Muhazi Basin	346
C	Nyakora River Basin	502
D	Lake Nasho Basin	267
E	Lake Mugesera Basin	432
F	Lake Sake Basin	420
G	Lake Kabavubyi Basin	167
H	Rwagitugusa River Basin	658
I	Akagera River Southern Basin	226
J	Akagera River South-Eastern Basin	161
K	Akagera River Eastern Basin	152
	Total	3,680

The boundaries of drainage basins are presented in Fig. C.5.

2.2 OBSERVATION STATION AND GENERAL CHARACTERISTICS OF DISCHARGE

In the Study Area, the stages of rivers and lakes are observed at the following gauge stations. the observed data is written up in an annual report by MINIAGRI. Data since 1982 obtained for the Study.

List of Observation Stations

Station	Location	Long.	Lati.	Observation Item
River Akagera	Rusumo	30 47'E	2 23'S	Water Level of River
Lake Mugesera	Rubago	30 22'E	2 11'S	Water level of Lake
Lake Muhazi	Rwesero	30 11'E	1 48'S	Water level of Lake
Lake Sake	Rubago	30 22'E	2 11'S	Water level of Lake

The discharge data at Akagera Hydrological Station are given in Table C.4 and the water level of the lake are given in Table C.5.

The Specific discharge data in Rwanda are summarized as below:

Specific Discharge in Rwanda

River	Location	C. Area	Maximum		Average		Minimum	
		km2	m3/s	l/s/km2	m3/s	l/s/km2	m3/s	l/s/km2
1.Akanyaru	Kibeho	182.0	12.1	66.5	3.5	19.2	2.5	13.5
2.Karungeri	Ngarama	280.0	34.4	122.7	10.0	35.6	7.5	26.8
3.Migina	Kigembe	225.0	9.1	40.5	1.7	7.7	0.6	2.5
4.Mukunga	Rwaza	670.0	11.5	17.2	7.6	11.3	4.3	6.4
5.Mwange	Cyamutara	258.0	15.1	58.5	2.0	7.6	1.3	5.2
6.Mwogo	Gikongoro	200.0	3.6	18.1	1.1	5.3	0.7	3.7
7.Mwogo	Nyabisindu	520.0	20.7	39.8	4.9	9.4	1.6	3.0
8.Rusumo	Rugezi	190.0	5.0	26.3	1.1	5.8	0.6	2.9
9.Sebeya	Gisenyi	320.0	12.0	37.6	4.1	12.8	2.1	6.7
10.Sebeya	Nyundo	220.0	14.0	63.7	3.6	16.2	2.7	12.1
Average		306.5	13.8	49.1	4.0	13.1	2.4	8.3

Source : ANNUAIRE HYDROLOGIQUE(1985)

Based upon the discharge data, regarding the time of concentration of runoff discharge in Rwanda, and concentration in short time is observed at the stream area connected to the river channel because of steep slope, but that in the river channel is relatively long time due to flat topography.

2.3 DISCHARGE IN THE STUDY AREA

The results of the flow measurements conducted during September 1989 at each river's representative location is shown in Fig. C.6.

According to the results, the specific discharge of each river is in the range of 1.3 to 2.8 liters/s/km2. The specific discharge values are somewhat smaller than the values for other areas shown in the following table. The reason for this is assumed to be that the infiltration at the open channels' embankment sections and the papyrus growing areas is substantially large.

Specific Discharge in Study Area

No.	River Name	Discharge (m3/s)	Catchment Area(km2)	Specific Discharge (l/s/km2)	Observation Data
1	MWERERA	0.09	66.75	1.35	7 Sep. 1989
2	GASHOGOSHOGO	0.03	21.75	1.38	7 Sep. 1989
3	KIBAYA	0.17	60.05	2.83	9 Sep. 1989
4	KIBILIZI	0.41	291.43	1.41	9 Sep. 1989
5	NYAGASENYI	0.2	96	2.08	9 Sep. 1989
6	NKUNGU	0.51	254.08	2.01	9 Sep. 1989
7	NYABISHUNZI	0.04	28.25	1.42	9 Sep. 1989

Sites of hydrogical Survey is shown in Fig. C. 5.

According to the existing data available for the similar rivers (Mwange River in north of Kigali) and observation records, it is estimated that the characteristics of river discharge in the Study Area are:

direct runoff: clearly and quickly occurred, after rainfall of more than 20 mm/day.

sub-surface runoff of small peaks of discharge to continue more than one week.

basic runoff is estimated as 1.4 m3/sec (587 m3/day/km2 = 0.6 mm/day).

daily mean specific discharges range from 19.2 lit./sec/km2 to 5.3 lit./sec/km2. The annual runoff coefficient is 26%.

flood discharges are estimated 30 lit./sec/km2 to 60 lit./sec/km2.

The relation between rainfall and discharge of the Nwange River is presented in Fig. C.7.

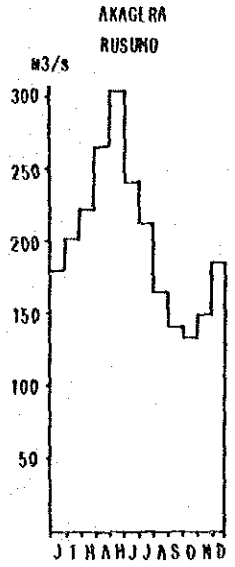
2.4 LAKE HYDROLOGY

Sizable lake water surfaces are found within the Study Area. The total area within the Study Area is 87 km2 except lakes on eastern margin, and total storage amount of water is estimated to be 690 million m3 as show in Table below:

Volume of Lake Water

NAME	Area of water Surface (km2)	Mean Depth (m)	Volume (million m3)
MUHAZI	34.10	14	477.4
MUGUSERA	39.20	4	156.8
SAKE	14.30	4	57.2

The runoff discharges of Akagera River in April, May and June are quite large, while those discharges in the months from August through February are comparatively small and stable, as below. Such phenomena are caused by rainfall pattern in the months and storage capacity of the sizable lakes.



Correlation between rainfall and the stage of the Muhazi Lake is shown in Fig. C.7. It show that the fluctuation of the Lake-water is less than 2.0 m.

Monthly Precipitation in the KIBUNGO (1987)

	Akagera	Bare	Kibungo	Nyarubuye	Rukira	Rwamagana	Zaza	Mpanga	Ruhunda	Rukumbeli	Ave.
JAN.	93.6	88.8	135.9	48.5	158.1	77.9	95.0	109.5	58.9	77.7	94.4
FEB.	24.0	41.3	17.9	30.2	20.2	41.2	44.9	13.2	79.5	81.0	39.3
MAR.	79.0	116.2	132.3	101.4	104.0	126.5	195.2	81.2	196.6	114.9	124.7
APL.	162.9	134.4	202.8	127.9	101.0	151.7	109.1	84.2	125.9	176.1	137.6
MAY.	48.8	72.0	52.5	55.6	79.2	126.0	82.1	49.6	119.3	162.8	84.8
JUN.	92.0	3.2	3.9	15.6	0.0	42.2	26.8	***	24.1	0.0	20.8
JUL.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AUG.	0.0	7.5	0.3	3.1	0.0	39.2	0.0	9.0	15.2	0.0	7.4
SEP.	11.0	58.9	104.1	174.5	27.0	117.5	85.1	29.7	108.4	80.2	79.6
OCT.	51.8	119.7	135.0	41.9	136.0	85.1	135.6	89.6	54.2	81.4	93.0
NOV.	126.2	159.7	226.3	136.6	286.5	138.9	111.2	95.8	128.7	231.9	164.2
DEC.	***	31.9	40.0	35.7	0.0	26.7	29.8	24.8	0.7	***	19.0
Annual	689.3	833.6	1051.0	771.0	912.0	972.9	914.8	586.6	911.5	1006.0	864.9

Monthly Precipitation in the KIBUNGO (Average)

	Akagera	Bare	Kibungo	Nyarubuye	Rukira	Rwamagana	Zaza	Mpanga	Ruhunda	Rukumbeli	Ave.
JAN.	55.0	70.5	89.2	71.0	86.4	84.5	75.7	***	65.2	77.7	67.5
FEB.	10.0	80.5	96.2	83.2	95.4	130.6	88.8	***	67.0	81.0	73.3
MAR.	21.9	98.9	128.0	112.4	127.7	136.6	137.8	***	95.8	114.9	97.4
APL.	30.0	214.5	155.7	147.1	178.1	195.9	170.3	***	152.5	176.1	142.0
MAY.	10.0	101.9	102.8	82.3	109.4	139.8	112.5	***	90.2	162.8	91.2
JUN.	63.0	16.2	14.0	9.1	11.9	22.1	22.4	***	68.9	0.0	22.8
JUL.	0.0	6.3	8.2	80.5	9.7	16.4	89.2	***	11.7	0.0	22.2
AUG.	0.0	19.1	23.3	16.7	23.4	29.1	24.1	***	28.3	0.0	16.4
SEP.	6.0	66.3	59.1	45.4	61.7	82.4	67.1	***	71.5	80.2	54.0
OCT.	8.5	96.6	75.7	78.4	79.6	124.4	99.1	***	95.8	81.4	74.0
NOV.	20.0	153.1	126.0	109.3	126.0	180.0	141.3	***	120.3	231.9	120.8
DEC.	***	133.5	101.2	95.3	***	132.1	116.0	***	85.8	***	66.4
Annual	224.4	1057.4	979.4	930.7	909.3	1273.9	1144.3	0.0	953.1	1006.0	847.9

Table C.1

Table C.2

Monthly Precipitation at the Kibungo Meteorological Station (1978-1987)

(Unit : mm)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	Average(55)
JAN.	133.4 (10)	57.1 (14)	62.9 (7)	119.2 (15)	86.1 (13)	67.1 (4)	41.4 (11)	112.7 (15)	71.2 (14)	135.9 (14)	88.7(89.2)
FEB.	89.7 (14)	101.9 (12)	76.3 (8)	105.8 (9)	41.5 (8)	62.6 (9)	56.6 (12)	133.2 (11)	91.5 (13)	17.9 (11)	77.7(96.2)
MAR.	230.2 (16)	231.1 (10)	114.3 (10)	280.0 (22)	96.0 (7)	182.4 (17)	105.2 (15)	158.3 (14)	87.1 (20)	132.3 (22)	161.7(128.0)
APL.	201.3 (17)	200.5 (23)	84.9 (18)	112.6 (15)	113.7 (18)	173.4 (19)	88.7 (18)	252.5 (18)	127.6 (21)	202.8 (21)	155.8(155.7)
MAY.	57.0 (9)	152.4 (12)	98.7 (16)	70.8 (11)	147.3 (18)	58.2 (10)	17.8 (5)	31.0 (11)	89.2 (17)	52.5 (16)	77.5(102.8)
JUN.	2.6 (1)	52.4 (4)	4.7 (2)	2.4 (2)	15.4 (2)	1.5 (2)	0.7 (1)	15.2 (1)	9.2 (2)	3.9 (1)	10.8(14.0)
JUL.	0 (0)	NT (0)	NT (NT)	NT (NT)	0.7 (1)	NT (NT)	57.6 (6)	14.2 (1)	NT (NT)	NT (NT)	7.3(8.2)
AUG.	41.8 (6)	26.1 (3)	NT (NT)	61.4 (8)	1.2 (2)	22.3 (6)	7.7 (5)	13.7 (3)	16.0 (2)	0.3 (1)	19.1(23.3)
SEP.	37.5 (5)	35.9 (5)	47.0 (6)	81.1 (11)	39.1 (13)	54.8 (6)	17.1 (6)	49.8 (13)	17.2 (8)	104.1 (14)	48.4(59.1)
OCT.	96.2 (10)	36.8 (8)	26.7 (10)	72.1 (12)	82.7 (15)	76.8 (16)	98.2 (14)	64.5 (15)	39.1 (12)	135.0 (18)	72.8(75.7)
NOV.	133.6 (17)	76.3 (14)	141.3 (18)	64.7 (15)	90.6 (19)	154.7 (17)	183.4 (24)	206.4 (17)	233.7 (26)	126.0 (23)	141.1(126.0)
DEC.	82.1 (10)	18.9 (11)	100.3 (13)	124.4 (16)	90.0 (14)	129.9 (15)	35.2 (13)	101.0 (19)	69.6 (19)	101.2 (7)	85.3(101.2)
TOTAL	1105.4 (115)	984.4 (116)	757.1 (108)	1094.5 (136)	812.5 (130)	983.7 (121)	709.6 (130)	1152.5 (138)	851.4 (154)	976.1 (148)	946.2(976.1)

Source : BULLETIN CLIMATOLOGIQUE ANNEE(1978-1987) :Division : Climatologie(MINITRACOM)

Mean Monthly Temperature at the Kibungo Meteorological Station(1978-1987)

(Unit : °C)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	Average
JAN.	--	--	--	20.5	19.8	--	19.6	20.2	20.2	19.8	20.0
FEB.	--	--	--	20.8	20.6	--	19.9	19.8	20.0	20.8	20.3
MAR.	--	--	--	20.0	20.7	--	20.4	20.2	19.7	20.9	20.3
APL.	--	--	--	20.7	19.7	20.6	19.8	19.2	19.6	20.5	20.0
MAY.	--	--	--	20.1	19.6	18.3	20.3	19.6	19.5	20.4	19.7
JUN.	--	--	--	20.4	19.9	21.2	20.5	19.8	20.3	20.7	20.4
JUL.	--	--	--	20.7	20.1	21.5	20.3	20.0	21.5	21.8	20.8
AUG.	--	--	--	21.2	21.3	21.1	21.1	20.6	21.7	22.1	21.3
SEP.	--	--	--	20.7	21.4	21.0	21.5	--	20.9	21.8	21.2
OCT.	--	--	--	20.7	19.8	20.1	20.4	20.5	21.2	21.2	20.6
NOV.	--	--	--	20.1	19.7	19.8	19.8	19.8	19.6	20.1	19.8
DEC.	--	--	--	20.2	--	19.5	19.5	19.8	19.6	21.6	20.0
Annual Ave.	--	--	--	20.2	20.2	--	20.3	--	20.3	21.0	20.4
Annual Max.	--	--	--	29.6	30.2	--	29.2	--	29.4	30.4	--
Annual Min.	--	--	--	11.1	12.9	--	11.0	--	12.6	13.8	--

Sources:BULLETIN CLIMATOLOGIQUE ANNEE(1978-87):Division de Climatologie(MINITRACOM)

Table C.3

Table C.4

Monthly Discharge at the Akagera Hydrological Station(1978-1987)

(Unit : m3/s)

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	Average
JAN.	228.8	248.9	223.0	211.2	204.1	239.9	224.1	187.8	240.0	198.0	220.6
FEB.	221.1	302.6	200.0	203.8	197.8	230.0	235.0	244.0	255.0	214.0	230.3
MAR.	298.5	341.6	213.0	214.7	192.2	233.0	228.1	244.0	257.0	232.0	245.4
APL.	476.9	382.3	259.0	210.6	235.1	238.8	234.7	315.2	287.0	267.0	291.1
MAY.	509.2	536.2	205.0	223.3	315.6	294.9	213.5	398.2	437.0	---	348.1
JUN.	402.3	476.7	270.0	202.4	248.7	244.9	166.2	346.0	376.0	---	303.7
JUL.	288.8	355.7	225.0	191.2	224.9	216.0	150.2	240.2	278.0	263.0	243.3
AUG.	219.0	248.0	181.0	142.5	178.9	184.4	126.2	190.6	218.0	237.0	192.6
SEP.	179.6	196.4	179.0	131.7	144.7	150.4	117.8	187.8	173.0	217.0	167.7
OCT.	181.9	174.4	167.0	145.2	160.1	173.9	137.5	189.2	172.0	203.0	170.4
NOV.	196.3	208.4	169.0	187.8	202.5	196.9	174.1	206.0	231.0	194.0	196.7
DEC.	255.9	213.7	183.0	216.6	291.9	218.8	209.3	244.0	241.0	191.0	226.5
Annual Ave.	288.2	307.0	213.0	190.1	216.3	218.5	184.7	240.2	264.0	---	236.4
Annual Max.	574.1	596.3	239.2	327.0	350.8	324.4	248.2	428.0	474.0	321.0	
Annual Min.	167.2	163.6	107.5	152.0	131.1	137.9	103.0	172.0	157.0	168.0	

Source : ANNUAIRE HYDROLOGIQUE 1978-1987 (MINIAGRI)

Mean Monthly Water Level of the Lake[MUHAZI] (1976-1985)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Ave.
JAN.	0.85	0.72	0.83	1.22	0.90	0.85	0.98	1.19	1.27	1.08	0.99
FEB.	0.76	0.75	0.84	1.23	0.97	0.88	0.96	1.13	1.26	1.15	0.99
MAR.	0.75	0.78	1.04	1.22	0.92	0.96	0.87	1.12	1.29	1.19	1.01
APL.	0.76	0.87	1.20	1.29	0.93	1.06	1.00	1.14	1.29	1.44	1.10
MAY.	0.80	1.05	1.52	1.47	1.00	1.15	1.35	1.24	1.23	1.75	1.26
JUN.	0.78	0.95	1.29	1.43	0.96	1.13	1.34	1.27	1.13	1.55	1.18
JUL.	0.63	0.79	1.13	1.25	0.86	1.00	1.19	1.16	1.00	1.38	1.04
AUG.	0.62	0.66	0.98	1.08	0.77	0.91	1.05	1.05	0.96	1.22	0.93
SEP.	0.62	0.64	0.90	0.99	0.74	0.93	0.96	1.05	0.90	1.18	0.89
OCT.	0.62	0.58	0.90	0.87	0.87	0.97	1.03	1.08	0.90	1.21	0.90
NOV.	0.70	0.65	0.95	0.78	0.94	0.96	1.12	1.17	1.01	1.33	0.96
DEC.	0.68	0.76	1.10	0.96	0.90	0.86	0.98	1.27	1.09	1.46	1.01
Annual	0.71	0.77	1.06	1.15	0.90	0.97	1.07	1.16	1.11	1.33	1.02

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Ave.
JAN.	1465.98	1465.85	1465.96	1466.35	1466.03	1465.98	1466.11	1466.32	1466.40	1466.21	1466.12
FEB.	1465.89	1465.88	1465.97	1466.36	1466.10	1466.01	1466.09	1466.26	1466.39	1466.28	1466.12
MAR.	1465.88	1465.91	1466.17	1466.35	1466.05	1466.09	1466.00	1466.25	1466.42	1466.32	1466.14
APL.	1465.89	1466.00	1466.33	1466.42	1466.06	1466.19	1466.13	1466.27	1466.42	1466.57	1466.23
MAY.	1465.93	1466.18	1466.65	1466.60	1466.13	1466.28	1466.48	1466.37	1466.36	1466.88	1466.39
JUN.	1465.91	1466.08	1466.42	1466.56	1466.09	1466.26	1466.47	1466.40	1466.26	1466.68	1466.31
JUL.	1465.76	1465.92	1466.26	1466.38	1465.99	1466.13	1466.32	1466.29	1466.13	1466.51	1466.17
AUG.	1465.75	1465.79	1466.11	1466.21	1465.90	1466.04	1466.18	1466.18	1466.09	1466.35	1466.06
SEP.	1465.75	1465.77	1466.03	1466.12	1465.87	1466.06	1466.09	1466.18	1466.03	1466.31	1466.02
OCT.	1465.75	1465.71	1466.03	1466.00	1466.00	1466.10	1466.16	1466.21	1466.03	1466.34	1466.03
NOV.	1465.83	1465.78	1466.08	1465.91	1466.07	1466.09	1466.25	1466.30	1466.14	1466.46	1466.09
DEC.	1465.81	1465.89	1466.23	1466.09	1466.03	1465.99	1466.11	1466.40	1466.22	1466.59	1466.14
Annual	1465.84	1465.90	1466.19	1466.28	1466.03	1466.10	1466.20	1466.29	1466.24	1466.46	1466.15

(continue)

Table C.5 (1)

Mean Monthly Water Level of the Lake [MUGESERA] (1976-1985)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Ave.
JAN.	0.49	-0.15	0.52	0.94	0.72	0.50	0.03	0.95	0.46	0.06	0.45
FEB.	0.33	0.07	0.51	0.82	0.78	0.46	0.04	0.66	0.45	0.10	0.42
MAR.	0.24	0.21	0.82	0.76	0.19	0.34	0.01	0.41	0.43	0.16	0.36
APL.	0.36	0.46	1.64	0.93	0.38	1.06	0.96	0.48	0.55	0.61	0.74
MAY.	0.59	1.04	1.40	1.57	0.86	1.39	0.91	1.37	0.62	1.50	1.13
JUN.	0.69	0.84	1.29	1.40	1.16	1.26	1.28	1.07	0.33	1.00	1.03
JUL.	0.37	0.38	0.58	0.90	0.70	0.64	0.70	0.44	0.10	0.77	0.56
AUG.	0.10	0.30	0.19	0.36	0.24	0.27	0.18	0.09	***	1.25	0.30
SEP.	0.00	0.38	0.47	0.39	0.03	0.22	0.01	0.01	***	1.05	0.26
OCT.	0.36	0.24	0.42	0.43	0.03	0.12	0.00	0.05	***	1.03	0.27
NOV.	0.32	0.49	0.42	0.45	0.15	0.08	0.14	0.25	0.03	1.11	0.34
DEC.	0.40	0.67	0.77	0.65	0.65	0.05	0.65	0.54	0.11	1.30	0.58
Annual	0.35	0.41	0.75	0.80	0.49	0.53	0.41	0.53	0.26	0.83	0.54

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Ave.
JAN.	1328.63	1327.99	1328.66	1329.08	1328.86	1328.64	1328.17	1329.09	1328.60	1328.20	1328.59
FEB.	1328.47	1328.21	1328.65	1328.96	1328.92	1328.60	1328.18	1328.80	1328.59	1328.24	1328.56
MAR.	1328.38	1328.35	1328.96	1328.90	1328.33	1328.48	1328.15	1328.55	1328.57	1328.30	1328.50
APL.	1328.50	1328.60	1329.78	1329.07	1328.52	1329.20	1329.10	1328.62	1328.69	1328.75	1328.88
MAY.	1328.73	1329.18	1329.54	1329.71	1329.00	1329.53	1329.05	1329.51	1328.76	1329.64	1329.27
JUN.	1328.83	1328.98	1329.43	1329.54	1329.30	1329.40	1329.42	1329.21	1328.47	1329.14	1329.17
JUL.	1328.51	1328.52	1328.72	1329.04	1328.84	1328.78	1328.84	1328.58	1328.24	1328.91	1328.70
AUG.	1328.24	1328.44	1328.33	1328.50	1328.38	1328.41	1328.32	1328.23	1328.14	1329.39	1328.44
SEP.	1328.14	1328.52	1328.61	1328.53	1328.17	1328.36	1328.15	1328.15	1328.14	1329.19	1328.40
OCT.	1328.50	1328.38	1328.56	1328.57	1328.17	1328.26	1328.14	1328.19	1328.14	1329.17	1328.41
NOV.	1328.46	1328.63	1328.56	1328.59	1328.29	1328.22	1328.28	1328.39	1328.17	1329.25	1328.48
DEC.	1328.54	1328.81	1328.91	1328.79	1328.79	1328.19	1328.79	1328.68	1328.25	1329.44	1328.72
Annual	1328.49	1328.55	1328.89	1328.94	1328.63	1328.67	1328.55	1328.67	1328.40	1328.97	1328.68

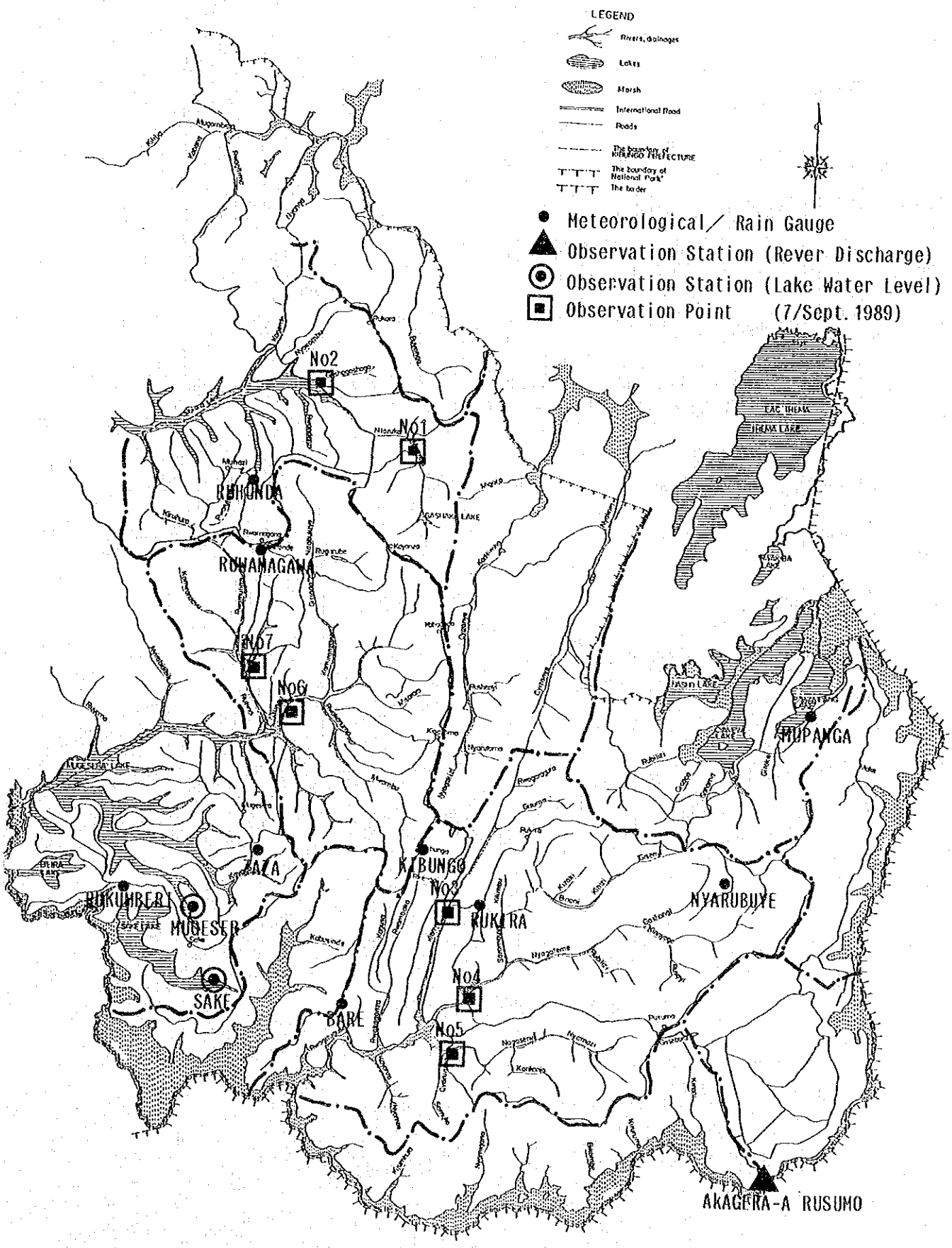
(continue)

Table C.5 (2)

Mean Monthly Water Level of the Lake [SAKE] (1976-1985)

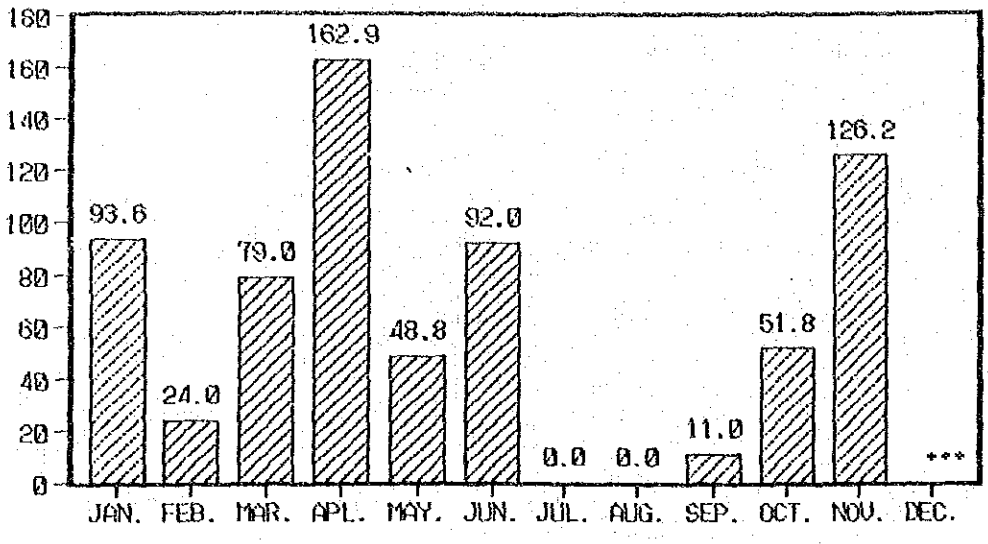
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Ave.
JAN.	1.03	0.83	0.98	0.90	0.90	0.74	0.47	0.87	0.85	0.23	0.78
FEB.	0.97	0.90	0.88	0.95	0.97	0.41	0.38	0.70	0.77	0.29	0.72
MAR.	0.93	0.96	1.02	1.06	0.92	0.58	0.05	0.59	0.82	0.43	0.74
APL.	1.02	1.03	1.29	1.11	0.93	0.98	0.53	0.82	0.92	0.72	0.93
MAY.	1.11	1.10	1.10	1.11	1.00	1.09	1.00	1.03	0.75	0.91	1.02
JUN.	1.10	1.07	1.07	1.14	0.96	0.90	1.01	0.89	0.25	0.46	0.89
JUL.	0.92	0.90	0.93	1.01	0.86	0.50	0.52	0.40	0.00	0.40	0.64
AUG.	0.78	0.76	0.83	0.91	0.77	0.33	0.08	0.10	0.00	0.68	0.52
SEP.	0.70	0.69	0.74	0.76	0.74	0.54	0.00	0.00	0.00	0.63	0.48
OCT.	0.69	0.62	0.78	0.70	0.87	0.43	0.11	0.30	0.12	0.94	0.56
NOV.	0.65	0.74	0.82	0.70	0.94	0.44	0.65	0.83	0.56	1.29	0.76
DEC.	0.72	1.00	0.86	0.80	0.90	0.41	0.48	0.95	0.65	1.30	0.81
Annual	0.89	0.88	0.94	0.93	0.90	0.61	0.44	0.62	0.47	0.69	0.74

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	Ave.
JAN.	1329.17	1328.97	1329.12	1329.04	1329.04	1328.88	1328.61	1329.01	1328.99	1328.37	1328.92
FEB.	1329.11	1329.04	1329.02	1329.09	1329.11	1328.55	1328.52	1328.84	1328.91	1328.43	1328.86
MAR.	1329.07	1329.10	1329.16	1329.20	1329.06	1328.72	1328.19	1328.73	1328.96	1328.57	1328.88
APL.	1329.16	1329.17	1329.43	1329.25	1329.07	1329.12	1328.67	1328.96	1329.06	1328.86	1329.07
MAY.	1329.25	1329.24	1329.24	1329.25	1329.14	1329.23	1329.14	1329.17	1328.89	1329.05	1329.16
JUN.	1329.24	1329.21	1329.21	1329.28	1329.10	1329.04	1329.15	1329.03	1328.39	1328.60	1329.03
JUL.	1329.06	1329.04	1329.07	1329.15	1329.00	1328.64	1328.66	1328.54	1328.14	1328.54	1328.78
AUG.	1328.92	1328.90	1328.97	1329.05	1328.91	1328.47	1328.22	1328.24	1328.14	1328.82	1328.66
SEP.	1328.84	1328.83	1328.88	1328.90	1328.88	1328.68	1328.14	1328.14	1328.14	1328.77	1328.62
OCT.	1328.83	1328.76	1328.92	1328.84	1329.01	1328.57	1328.25	1328.44	1328.26	1329.08	1328.70
NOV.	1328.79	1328.88	1328.96	1328.84	1329.08	1328.58	1328.79	1328.97	1328.70	1329.43	1328.90
DEC.	1328.86	1329.14	1329.00	1328.94	1329.04	1328.55	1328.62	1329.09	1328.79	1329.44	1328.95
Annual	1329.03	1329.02	1329.08	1329.07	1329.04	1328.75	1328.58	1328.76	1328.61	1328.83	1328.88

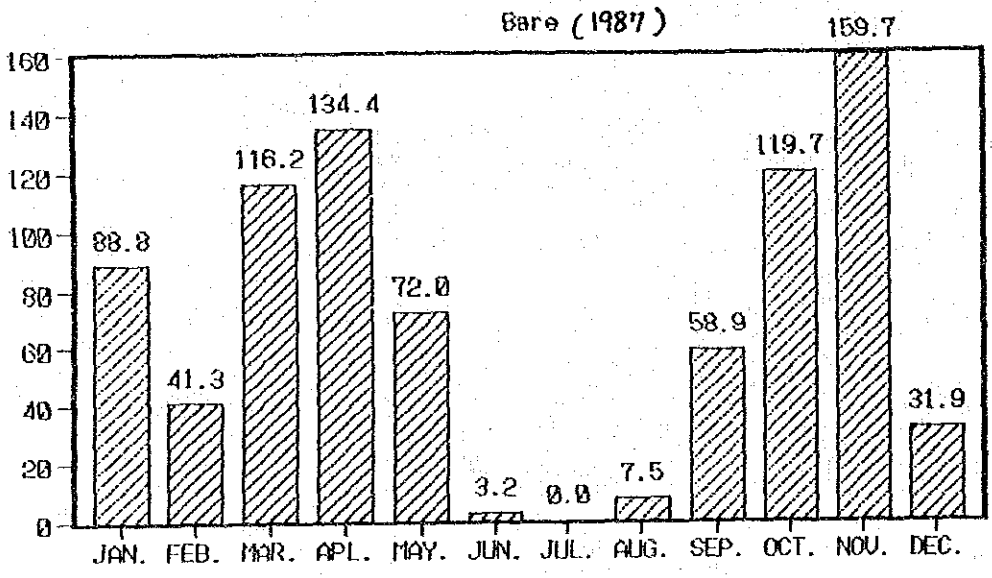


Location of Gauge and Observation Station

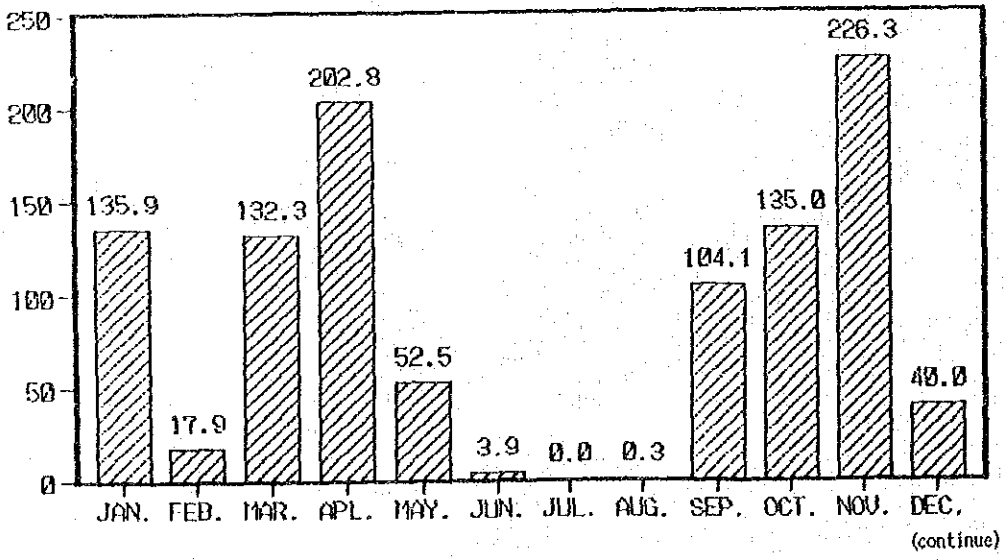
Akagera



Bare (1987)



Kibungo



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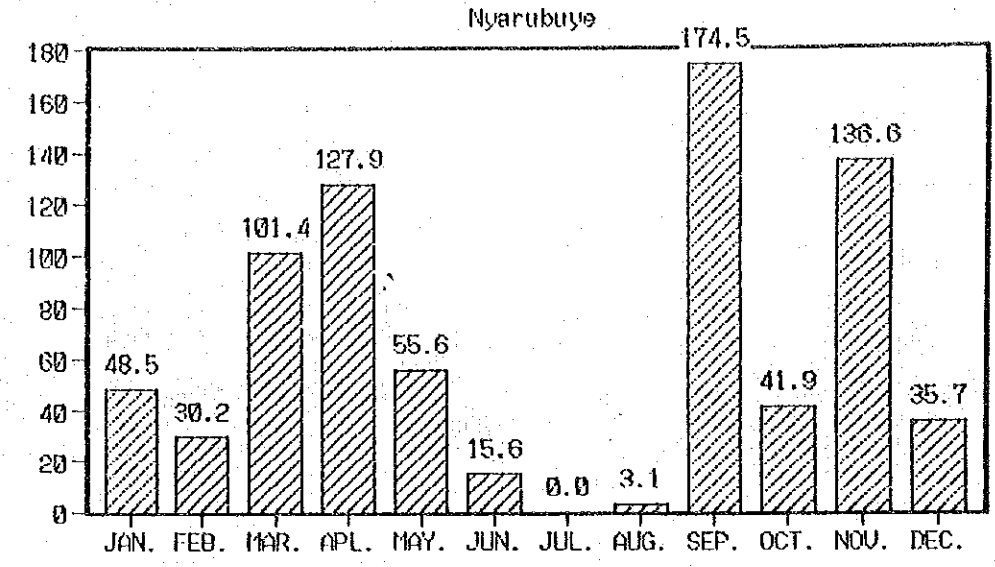
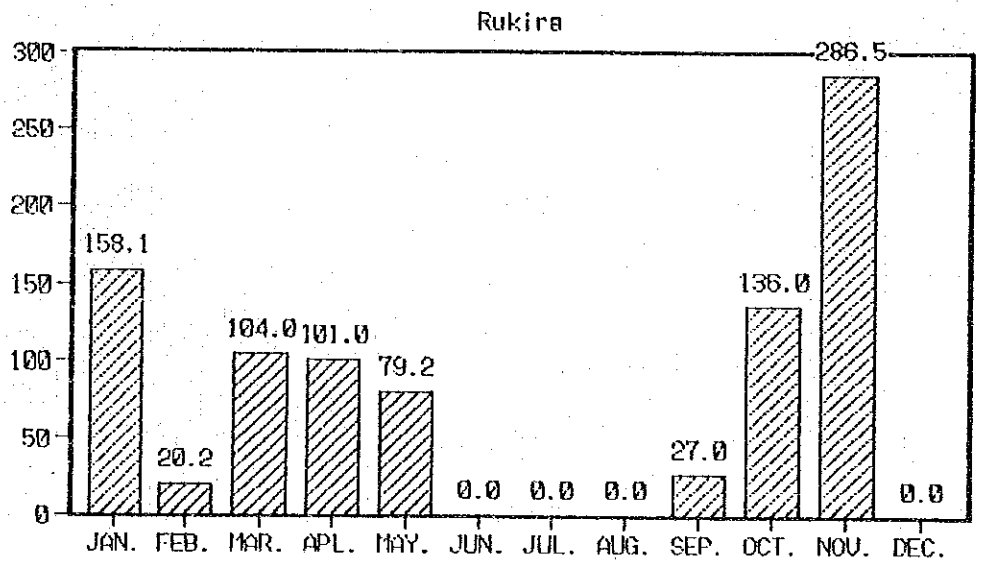
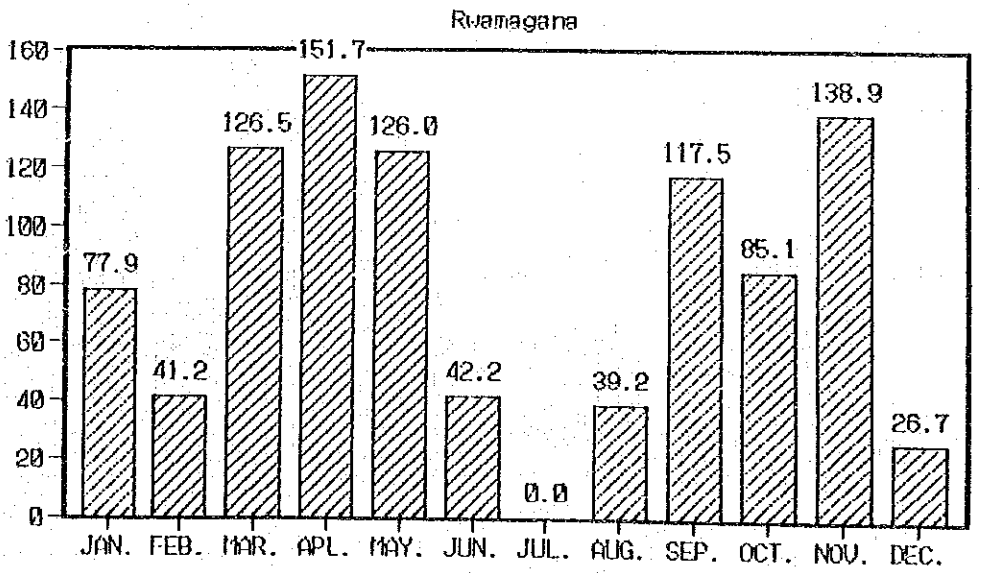
Monthly Mean Precipitation







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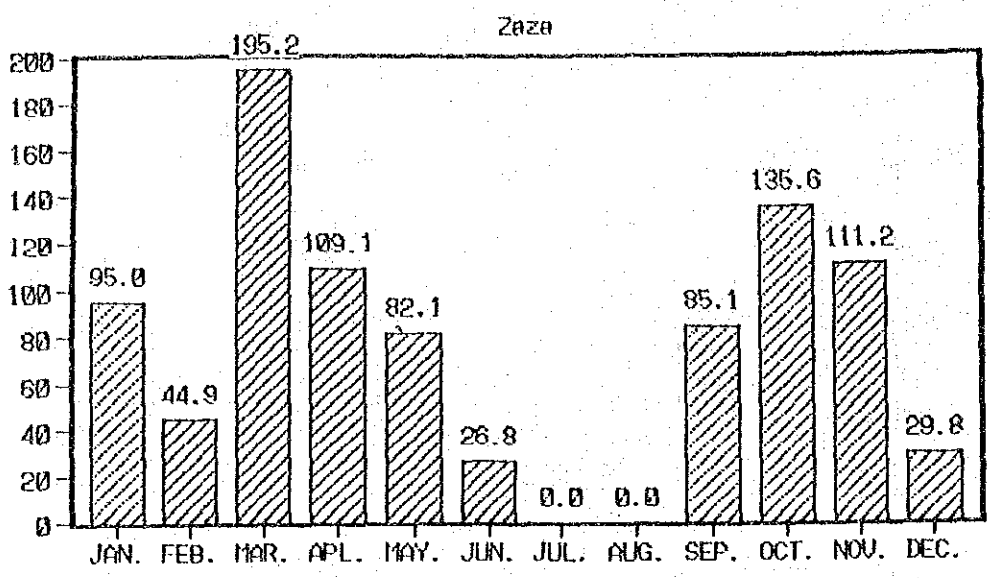
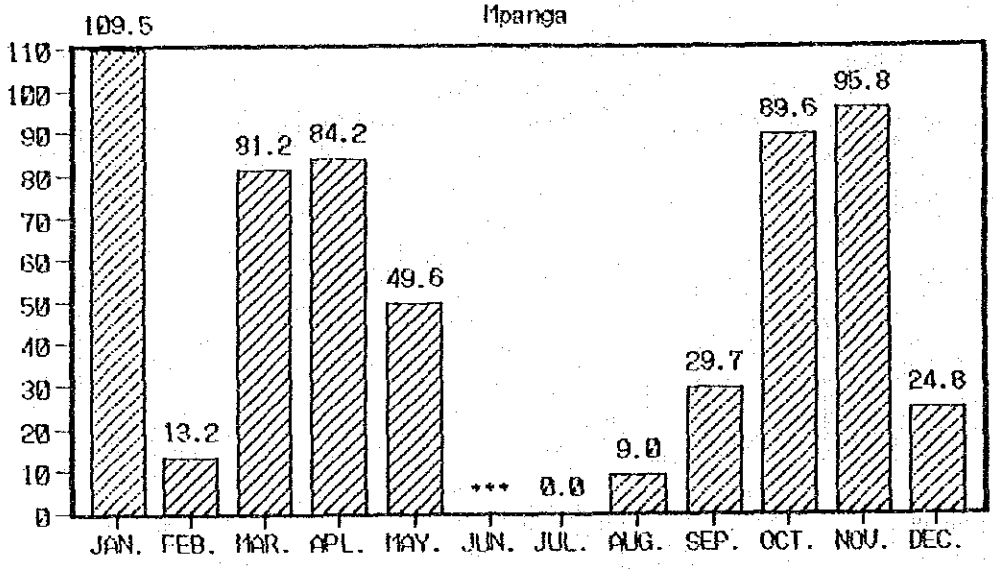
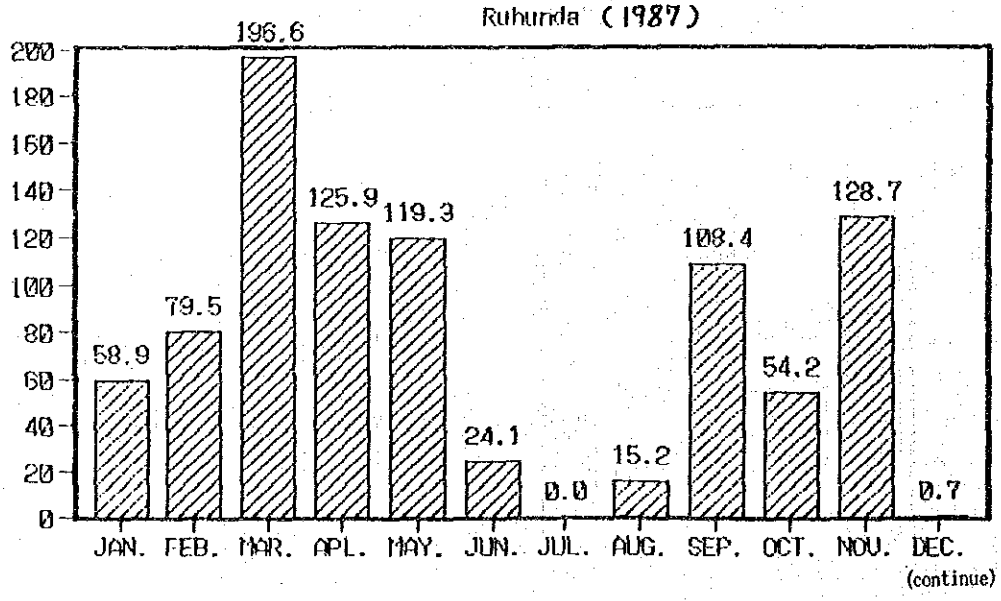
Monthly Mean Precipitation







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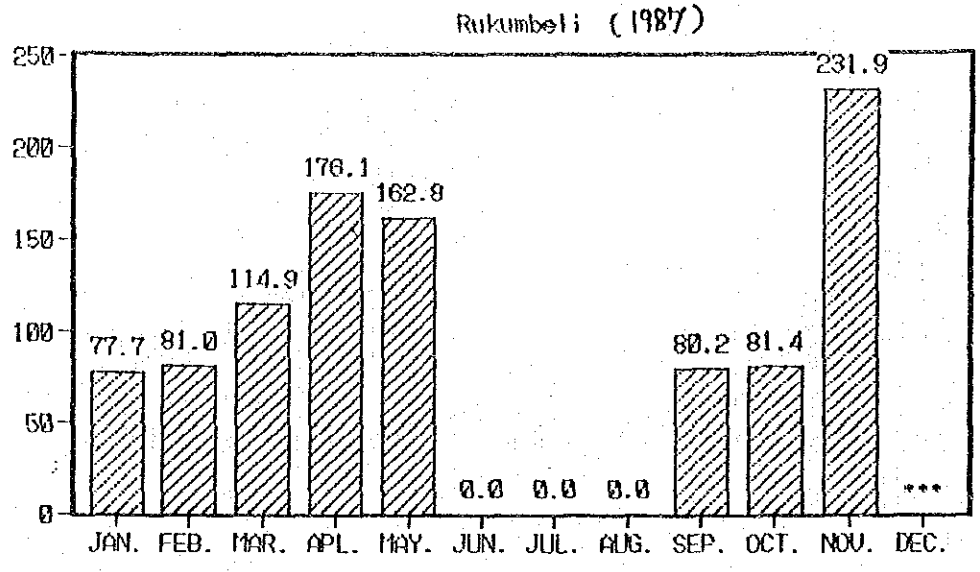
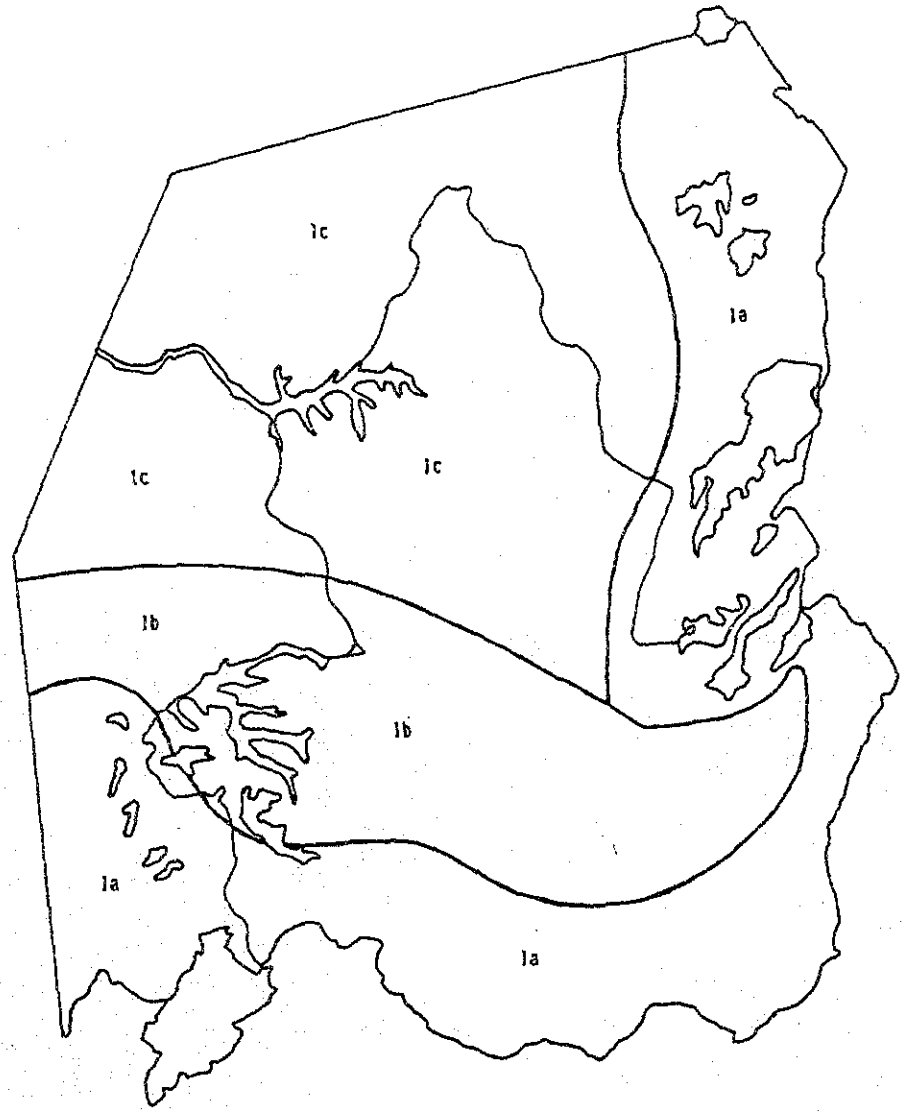
Monthly Mean Precipitation



Monthly Mean Precipitation



Classification Meteorological

Ia. Les bas-fonds fluvio-lacustres du Bugesera et de l'Akagera sont, au-dessous de 1 400 m, des terres chaudes (21°) que des amplitudes de type tropical rafraichissent mal (max. moy. d'août : 29°4, min. moy. juillet 13°5). Nulle part ailleurs la grande saison sèche n'est aussi marquée en durée (115 jours) et en intensité (60 mm), mais, tant du fait de l'évaporation des nappes d'eau (18 000 ha évaporant 1 400 mm) que de l'apport considérable des pluies de deuxième saison (350 mm, 45 %), l'ambiance est bien plus souvent à la moiteur qu'à la siccité d'un air faiblement ventilé par des brises anarchiques. Là, prospère, Acacia seyal, biotope préférentiel de Glossina morsitans.

Ib. Le corsage plissé du complexe fluvio-lacustre du Bugesera doit quelques singularités climatiques à l'abondance des eaux dormantes prisonnières de dénivellations vigoureuses. Les pluies sont plus abondantes (1 050 mm) mais surtout mieux réparties (48 % - 10 % - 41 %) et moins erratiques que sur les plateaux du Centre-Est. Elles sont renforcées par les phénomènes convectifs qui se développent à partir des nappes d'eau et qui ont pour effet inverse, d'encercler le Bugesera, particulièrement sec, dans un anneau nébuleux. La chaleur moyenne (20°5) et les différents types d'oscillations assurent la transition avec le type thermique Kaguérien. Toute la région est en fait un assemblage complexe de climats locaux depuis celui du Mayaga qui convient particulièrement bien au sorgho jusqu'à celui du Mirenge (Zaza), réputé pour ses bières de bananes. Elle est submergée par la colonisation, officielle ou spontanée, depuis que les glossines y ont été éradiquées.

Ic. Au cœur de l'ancien Rwanda pastoral, les vaste interfluves du bassin Muhazi-Nyabugogo, qui s'étalent entre 1 500 et 1 600 m, sont théoriquement plus humides (1 000 mm) mais les précipitations n'y sont pas aussi bien réparties (54 % - 9 % - 37 %). Leur irrégularité interannuelle est sans doute la plus considérable de tout le pays car la région, piedmont de la haute pénéplaine de Byumba, peut recevoir de lourdes averses d'avril-mai quand la ligne de grains vient buter contre l'escarpe. Le peuplement agricole n'a cessé de se renforcer depuis le tournant du XXème siècle partout où la dégradation pastorale a laissé subsister des sols suffisamment épais pour retenir l'humidité.

KIBUNGO

	mm/year		mm/year
1979 NEN	989.400	1984 NEN	704.600
1980 NEN	757.100	1980 NEN	757.100
1981 NEN	1186.500	1986 NEN	851.400
1982 NEN	887.400	1982 NEN	887.400
1983 NEN	972.600	1983 NEN	972.600
1984 NEN	704.600	1979 NEN	989.400
1985 NEN	1139.500	1987 NEN	1051.000
1986 NEN	851.400	1985 NEN	1139.500
1987 NEN	1051.000	1981 NEN	1186.500

T(Nen)	mm/year
2	944.87
5	809.73
10	741.50
20	686.54
30	658.19
40	639.71
50	625.62
80	598.15
100	586.25
200	550.87
500	508.27

RUKIRA

	mm/year		mm/year
1979 NEN	924.000	1981 NEN	909.200
1980 NEN	1008.500	1984 NEN	914.400
1981 NEN	909.200	1979 NEN	924.000
1982 NEN	964.700	1987 NEN	962.900
1983 NEN	1019.900	1982 NEN	964.700
1984 NEN	914.400	1986 NEN	986.200
1985 NEN	1256.900	1980 NEN	1008.500
1986 NEN	986.200	1983 NEN	1019.900
1987 NEN	962.900	1985 NEN	1256.900

T(Nen)	mm/year
2	966.07
5	923.39
10	909.74
20	901.42
30	897.89
40	895.82
50	894.37
80	891.79
100	890.77
200	888.07
500	885.38

RUHUNDA

	mm/year		mm/year
1979 NEN	827.900	1984 NEN	640.900
1980 NEN	775.400	1981 NEN	650.300
1981 NEN	650.300	1980 NEN	775.400
1982 NEN	913.000	1985 NEN	811.000
1983 NEN	902.700	1986 NEN	827.500
1984 NEN	640.900	1979 NEN	827.900
1985 NEN	811.000	1983 NEN	902.700
1986 NEN	827.500	1987 NEN	911.500
1987 NEN	911.500	1982 NEN	913.000

T(Nen)	mm/year
2	800.44
5	714.79
10	673.72
20	641.69
30	625.53
40	615.12
50	607.26
80	592.10
100	585.61
200	566.55
500	544.09

KIGARI

	mm/year		mm/year
1979 NEN	1118.000	1983 NEN	917.100
1980 NEN	1073.900	1986 NEN	953.800
1981 NEN	1166.400	1982 NEN	988.000
1982 NEN	988.000	1984 NEN	995.100
1983 NEN	917.100	1985 NEN	1035.100
1984 NEN	995.100	1980 NEN	1073.900
1985 NEN	1035.100	1979 NEN	1118.000
1986 NEN	953.800	1987 NEN	1132.400
1987 NEN	1132.400	1981 NEN	1166.400

T(Nen)	mm/year
2	1041.05
5	969.73
10	933.13
20	903.36
30	887.91
40	877.79
50	870.05
80	854.92
100	848.34
200	829.71
500	804.90

NYARUBUYE

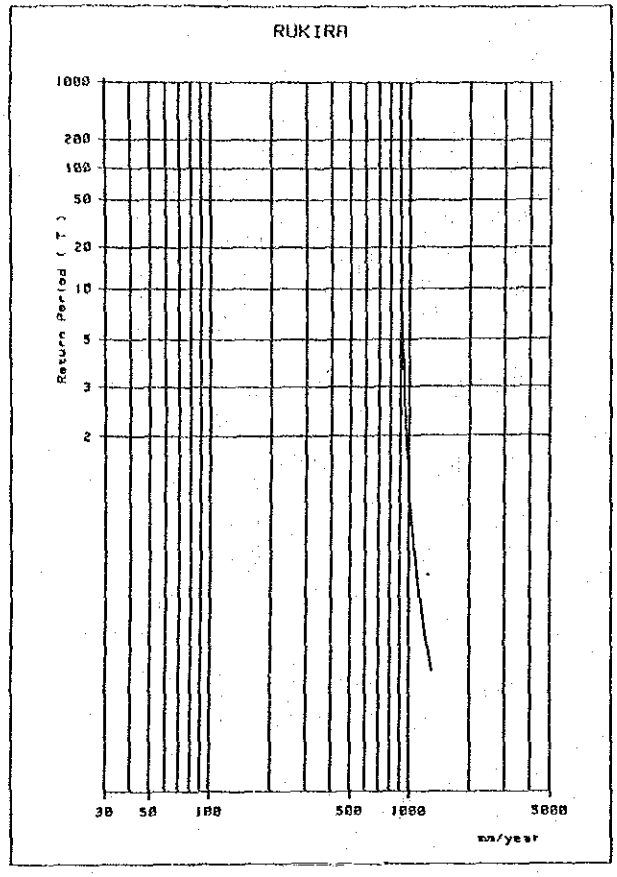
	mm/year		mm/year
1979 NEN	981.500	1983 NEN	695.900
1980 NEN	751.100	1984 NEN	717.500
1981 NEN	770.300	1986 NEN	723.300
1982 NEN	1058.000	1980 NEN	751.100
1983 NEN	695.900	1981 NEN	770.300
1984 NEN	717.500	1987 NEN	771.000
1985 NEN	871.400	1985 NEN	871.400
1986 NEN	723.300	1979 NEN	981.500
1987 NEN	771.000	1982 NEN	1058.000

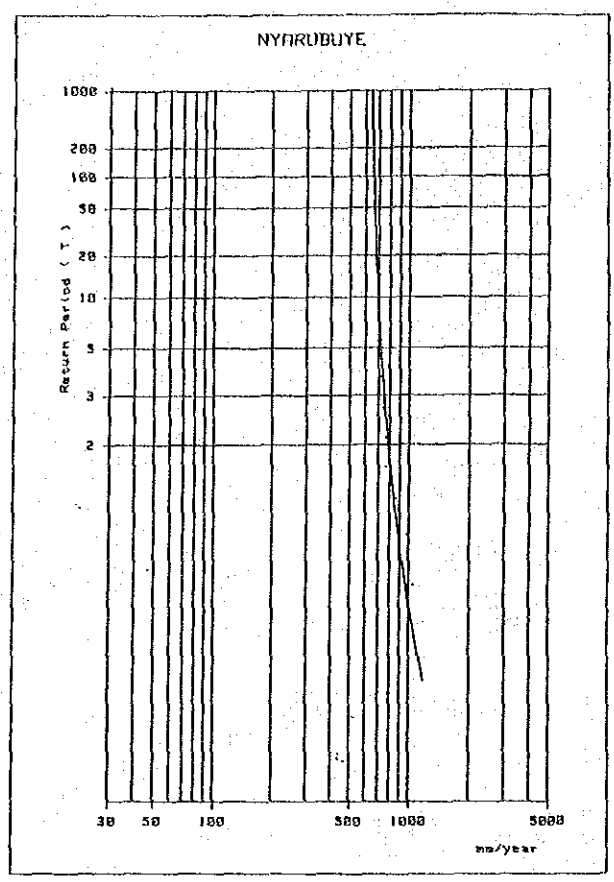
T(Nen)	mm/year
2	786.90
5	719.11
10	694.52
20	678.37
30	671.13
40	666.77
50	663.63
80	657.93
100	655.62
200	649.31
500	642.69

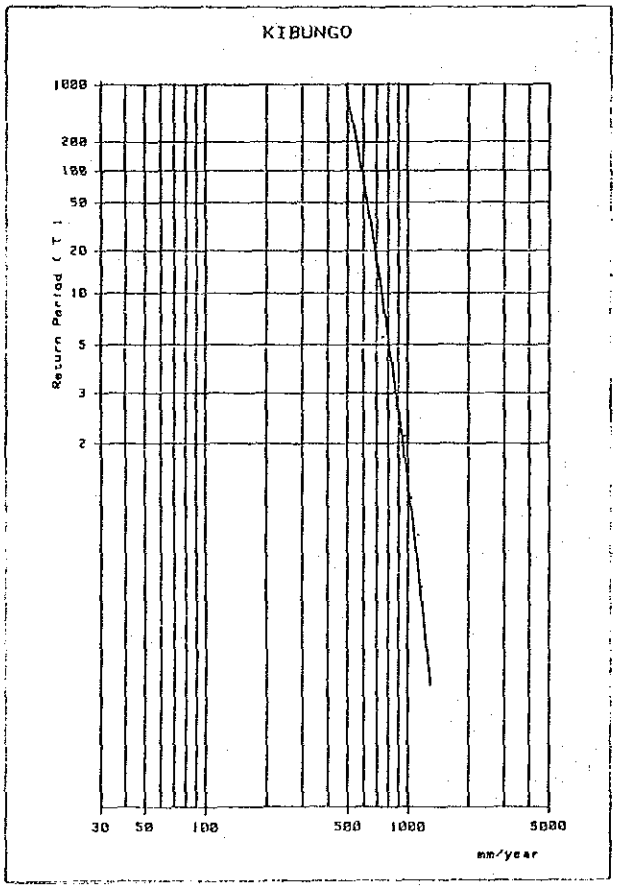
(continue)

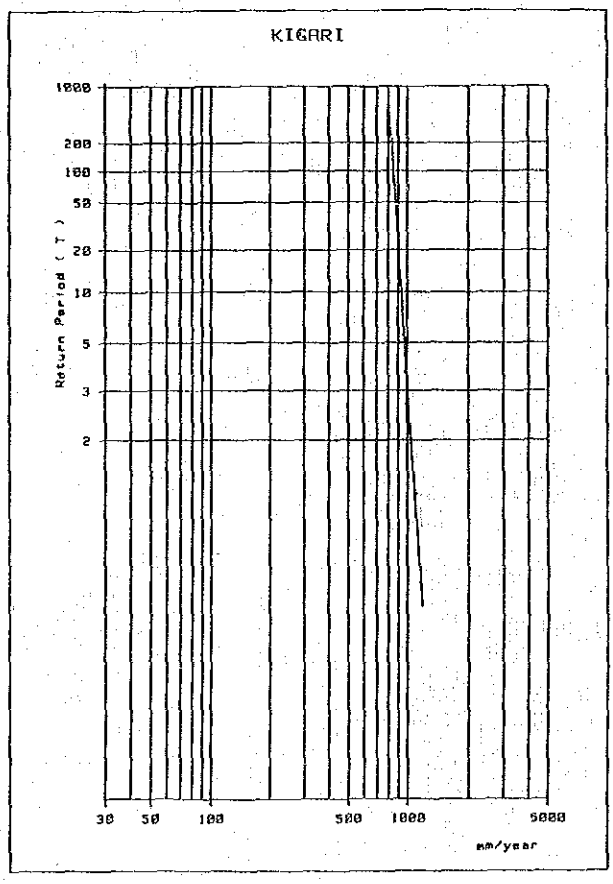
Stochastic Analysis of Precipitation in the Study Area

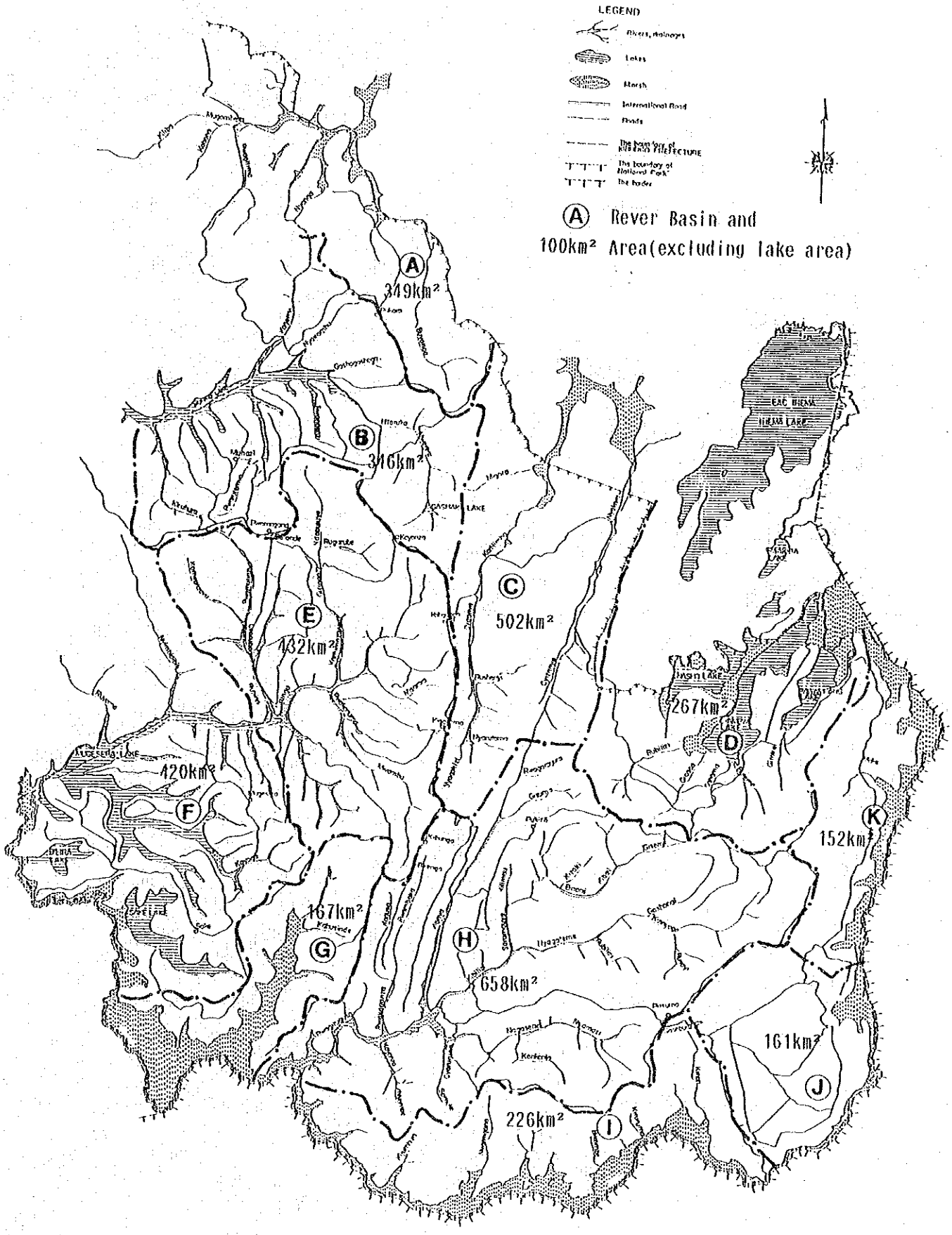
Fig. C.4 (1)


RUKIRA
Return Period (T)
1000
200
100
50
20
10
5
3
2
30
50
100
500
1000
5000
mm/year


NYARUBUYE
Return Period (T)
1000
200
100
50
20
10
5
3
2
30
50
100
500
1000
5000
mm/year

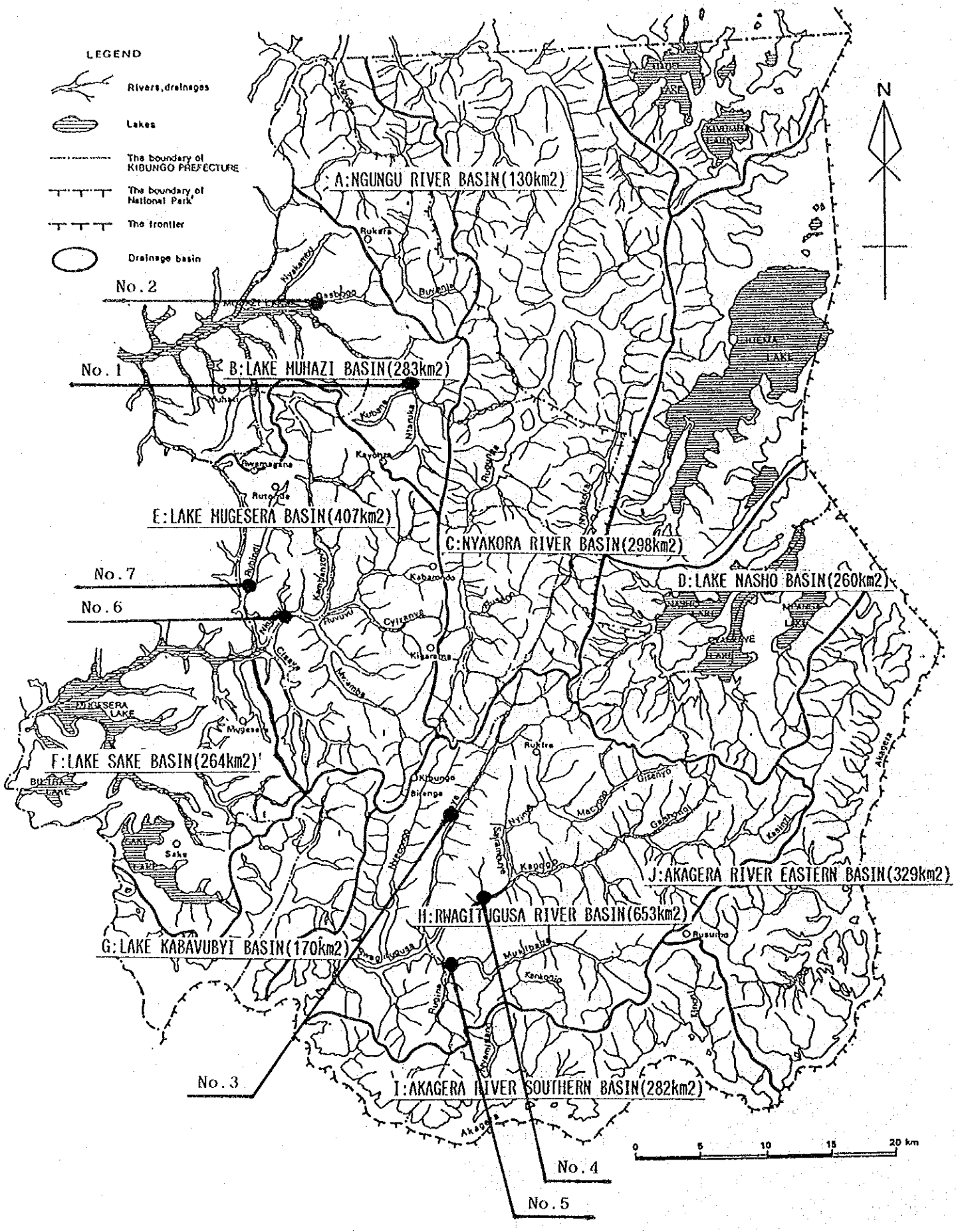

KIBUNGO
Return Period (T)
1000
200
100
50
20
10
5
3
2
30
50
100
500
1000
5000
mm/year


KIGARI
Return Period (T)
1000
200
100
50
20
10
5
3
2
30
50
100
500
1000
5000
mm/year

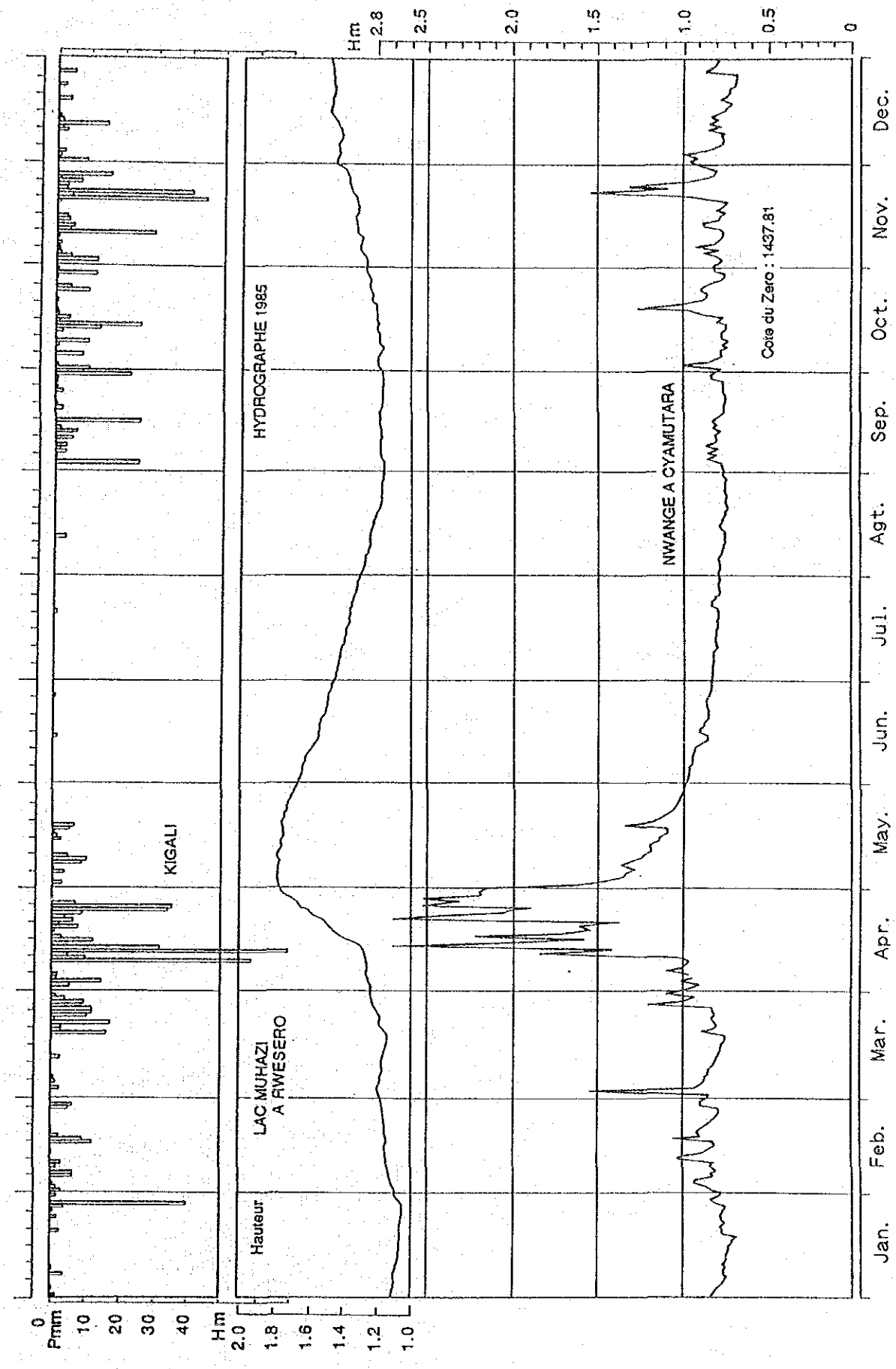


River System and River Basin

Fig. C.6



SITES OF HYDROLOGICAL SURVEY



The Relation between Rainfall, Discharge and Lake Water Level

APPENDIX D

ADMINISTRATION AND POPULATION

TABLE OF CONTENTS

LIST OF TABLE

LIST OF FIGURE