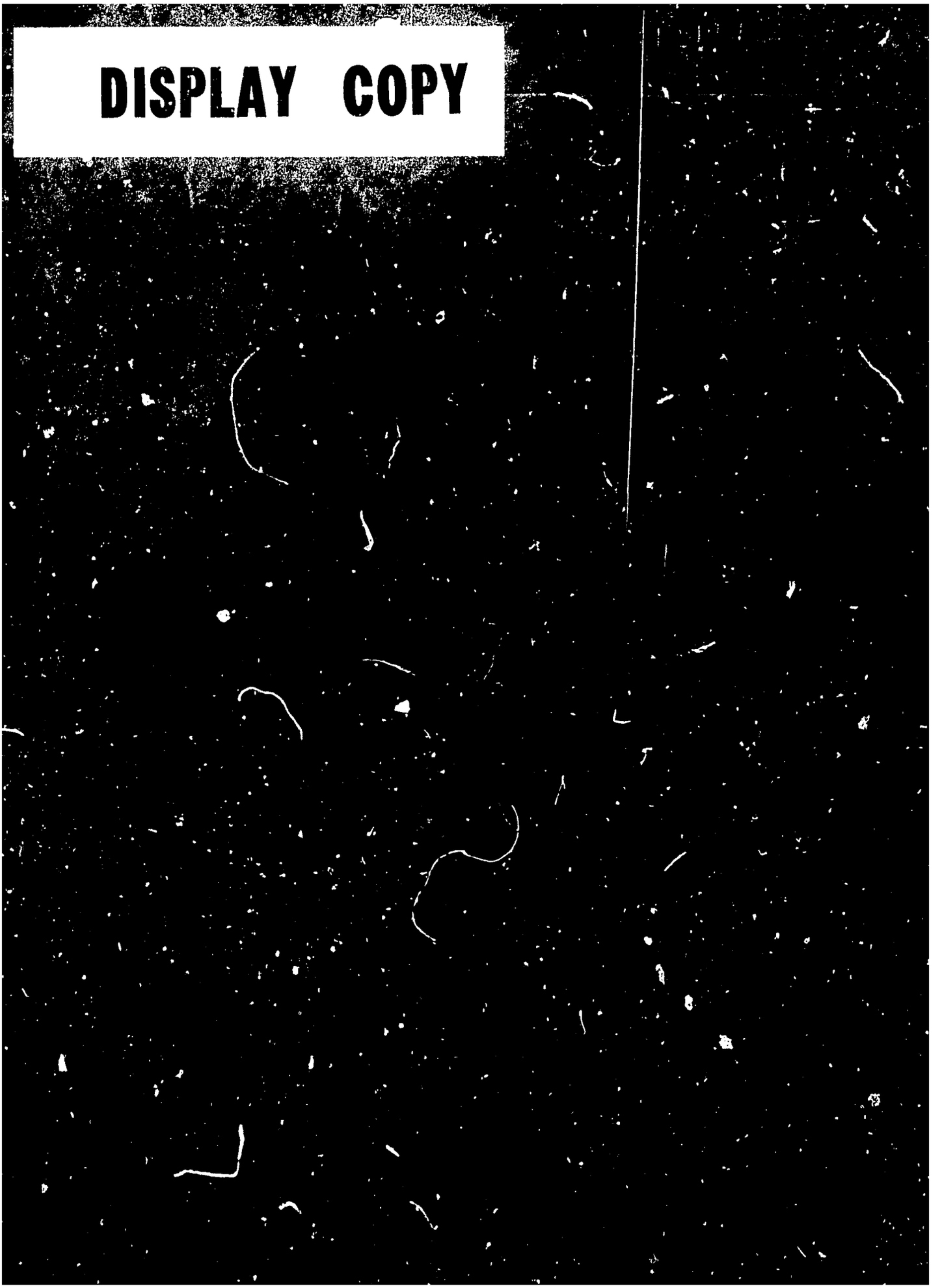
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DRAFT

Environmental Profile

of

BURUNDI

prepared by the

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Tucson, Arizona
85721

AID RSSA SA/TOA 77-1
National Park Service Contract No. CX-0001-0-0003
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December 1981

-Eric J. Arnould, Compiler-

THE UNITED STATES NATIONAL COMMITTEE FOR MAN AND THE BIOSPHERE
Department of State, IO/UCS
WASHINGTON, D. C. 20520

An Introductory Note on Draft Environmental Profiles:

The attached draft environmental report has been prepared under a contract between the U.S. Agency for International Development (AID), Office of Forestry, Environment, and Natural Resources (ST/FNR) and the U.S. Man and the Biosphere (MAB) Program. It is a preliminary review of information available in the United States on the status of the environment and the natural resources of the identified country and is one of a series of similar studies now underway on countries which receive U.S. bilateral assistance.

This report is the first step in a process to develop better information for the AID Mission, for host country officials, and others on the environmental situation in specific countries and begins to identify the most critical areas of concern. A more comprehensive study may be undertaken in each country by Regional Bureaus and/or AID Missions. These would involve local scientists in a more detailed examination of the actual situations as well as a better definition of issues, problems and priorities. Such "Phase II" studies would provide substance for the Agency's Country Development Strategy Statements as well as justifications for program initiatives in the areas of environment and natural resources.

Comments on the attached draft report would be welcomed by USMAB and ST/FNR and should be addressed to either:

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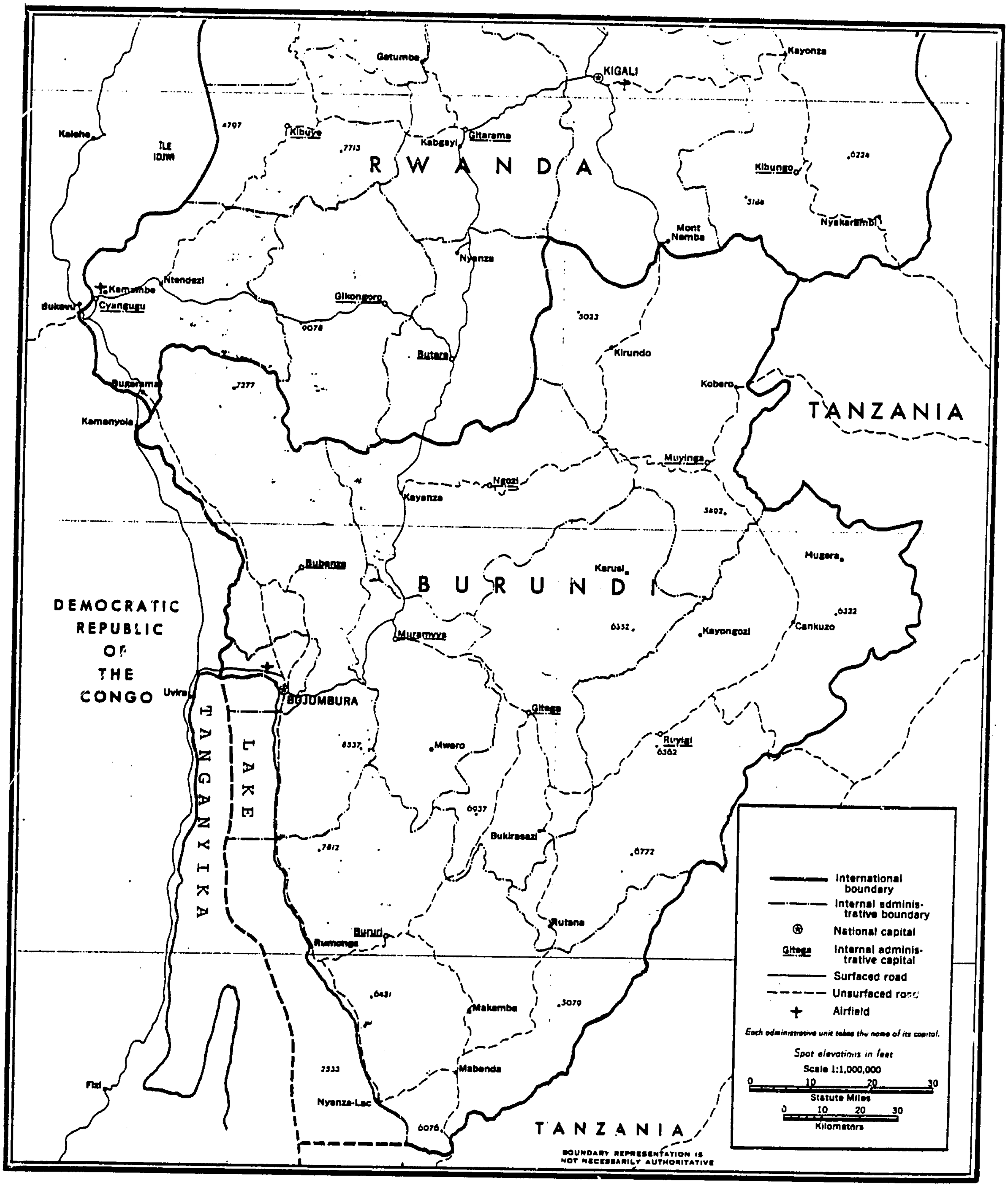
TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (continued)


RWANDA
BURUNDI
TANZANIA
DEMOCRATIC REPUBLIC OF THE CONGO
LAKE TANGANYIKA
KIGALI
BUJUMBURA
Gatumba
Kayonza
Kibuye
Gitarama
Kabgayi
Kibungo
Nyakarambi
Mont Nemba
Nyanza
Gikongoro
Butare
Kamembe
Ntendezi
Cyangugu
Bukavu
Kalehe
ILE IDJWI
Bugarama
Kamanyola
Kirundo
Kobero
Muyinga
Ngozi
Kayanza
Bubanza
Karusi
Hugera
Muramvya
Kayongozi
Cankuzo
Uvira
Gitega
Mwaro
Ruyigi
Bukirasazi
Rutana
Bururi
Rumonge
Makamba
Mabanda
Nyanza-Lac
Fizi
International boundary
Internal administrative boundary
National capital
Internal administrative capital
Surfaced road
Unsurfaced road
Airfield
Each administrative unit takes the name of its capital.
Spot elevations in feet
Scale 1:1,000,000
Statute Miles
Kilometers
BOUNDARY REPRESENTATION IS NOT NECESSARILY AUTHORITATIVE

SUMMARY

A small country located in the heart of central Africa, Burundi has a temperate climate and an annual rainfall which is generally adequate for two growing seasons. Burundi has also the advantages of a long history of centralized administration and a single language shared by all its citizens. However, Burundi is a strictly agricultural country and lacks significant mineral resources. It has neither an outlet to the sea to facilitate agricultural exports nor sufficiently developed internal transport facilities. The nation has a rapidly growing population which is already the second most dense in Africa, and possesses very limited land resources. Given its rapid population growth and limited natural resources, Burundi faces a number of serious environmental problems.

Rapid population growth. Burundi's population, which is 95 percent rural, is growing so rapidly that by the year 2000 arable land will be absolutely saturated. Associated with this rapid growth are problems of rural underemployment, lack of training in modern agricultural techniques, lack of urban, industrial employment opportunities, and ethnic and regional strife, all of which act to increase the pressure on agricultural lands.

Deforestation. At one time Burundi's forests were an important climatic regulator, and they remain essential to rainfall catchment in this hilly country. However, the need for new agricultural land, coupled with the demand for firewood and construction wood, are placing an intolerable burden on the tiny forest preserves. Reforestation efforts are required on a more massive scale than those currently being undertaken, and the rapid development of alternative fuel resources (peat and hydroelectric power) will be necessary if Burundi's forests are not to be completely eliminated in 20 years.

Livestock and pastures. Livestock competes with Burundi's human population for land. There are far too many animals, they are of very low productivity, and they remain in poor general health. Animal trypanosomiasis, theilerosis, and malnutrition are among the serious problems affecting Burundi's cattle. Pasture lands are subject to extreme overgrazing. Quality grasses have been replaced with less nutritious species over large areas. The effects of overgrazing, furthermore, are aggravated by indiscriminate burning of pasture lands. Programs of stock reduction, improved herd management, and improved breeding must be undertaken on a more massive scale in order to preserve and restore pasture lands.

Erosion and soil fertility. Deforestation, overgrazing, shortened fallow periods, and traditional methods of food crop cultivation on Burundi's hilly terrain threaten the fertility of Burundi's fragile soils. Lack of adequate erosion control measures has caused serious erosion of precious top soils. Pilot programs of ecologically-oriented agriculture and agricultural resettlement schemes, while promising, concern far too few of Burundi's farmers to alleviate erosion and declining soil quality.

Rural health. Endemic sleeping sickness below 1,500 m, malaria, unprotected and contaminated rural water supplies, and chronic protein-calorie malnutrition are serious problems for most Burundians. These factors limit human productivity and no long-term solutions to them have been found. Certain development projects intended to reduce environmental problems such as swamp clearance, reforestation and irrigation, are likely to worsen some of the health problems by extending the environments suitable to disease-carrying vectors.

Flora and fauna. Burundi has no national parks. Lack of land, failure to enforce environmental legislation, and insufficient funds have inhibited efforts to conserve native flora and fauna. Numerous proposals for the establishment of wildlife preserves have been made over the years, most recently (1979) by the International Union for Conservation of Nature and Natural Resources (IUCN) and the UNESCO-sponsored Man and the Biosphere (MAB) project (Maldague 1980). According to these studies, small preserves could be established around Mount Teza, in the lower Rusizi River valley, and in the Ruvubu River valley. Without such measures, many of the rare and endangered species in Burundi are likely to become extinct.

1.0 Introduction

This draft environmental profile summarizes information concerning the natural resources of the Republic of Burundi. The study relies primarily upon research reported in European, U.S., and United Nations publications. Scholars at the national research insitution, Burundi Institute of Agricultural Science (ISABU), have been engaged actively in environmentally oriented research for two decades, but most of the documentation they have produced remains unavailable in this country.

The draft report constitutes a first step towards creation of an environmental profile for use by the U.S. Agency for International Development and Burundi government administrators. The data and interpretations provided in this report are preliminary and are neither sufficiently detailed nor accurate enough for serious development planning. The second step in this process should therefore be a series of coordinated field studies which would evaluate the information compiled here, gather new information, and define issues, problems and priority actions. A more complete environmental profile could then, in a third step, provide direction for efforts to manage, conserve, and rehabilitate the environment and natural resources of Burundi.

This report represents a cooperative effort by the Man and the Biosphere (MAB) project staff of the Arid Lands Information Center. The primary research, writing, and analysis of the Burundi profile was done by Eric J. Arnould. The cooperation of James Corson, AID/MAB Porject Coordinator, and James Hester, AID Africa Desk Officer, is gratefully acknowledged.

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2.0 General Description[1]

Burundi is a small landlocked country covering 27,834 sq km in the heart of south central Africa. To the north, it borders Rwanda, with which it is affiliated culturally; it borders Zaire to the west, and Tanzania to the south and east. National borders fall between 2¼ and 3½ degrees south latitude, and between 29 and 31 degrees east longitude. Most of the country lies between the 1,500 and 2,000 meter isohypses, but Mounts Teza, Twinyoni, Kawumu, and Heha on the Zaire-Nile crest rise above 2,500 m, while the Rusizi River plain lies at about 800 m. Lake Tanganyika (775 m) forms Burundi's frontier with Zaire. Due to high relief associated with the western branch of the great East African Rift system, the nominally equatorial climate is quite moderate, and is suitable for two growing seasons.

Burundi's limited natural resources are under extreme pressure. Although this rural nation of peasant farmers is unified by a common language (Kirundi), political history , and cultural traditions, high human and animal population densities, dispersed settlement patterns, and lack of encadrement limit the scope of development interventions. Ethnic and regional cleavages have assumed tragic and violent proportions in the recent past. These internal schisms and the economic dislocations which have resulted from them create major obstacles to effective implementation of environmental policies. (Lemarchand 1977; Weinstein and Shrire 1975). Key economic indicators for Burundi are included in Appendix I.

2.1 Geography and Climate

2.1.1 Geographical Regions

There are four natural ecological regions in Burundi: the Imbo, the Zaire-Nile Massif, the Central Plateau, and the Bweru and Kumoso Depressions. There are, in addition, ten geographic subdivision as shown in Figure 1.

The Imbo. The Imbo region (Figure 2) is a narrow savannah-covered subsidence plain lying west of the mountains and extends along the Rusizi River and the north bank of Lake Tanganyika. This plain, which is made up of lacustrine deposits left by the progressive retreat of Lake Tanganyika in the Quaternary epoch and recent alluvia from the affluents of the Rusizi, occupies the northeastern part of the Tanganyika graben of the western Rift system.

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[1] Sources: McDonald et al. 1969.
Cazenave-Piarrot et al. 1979.

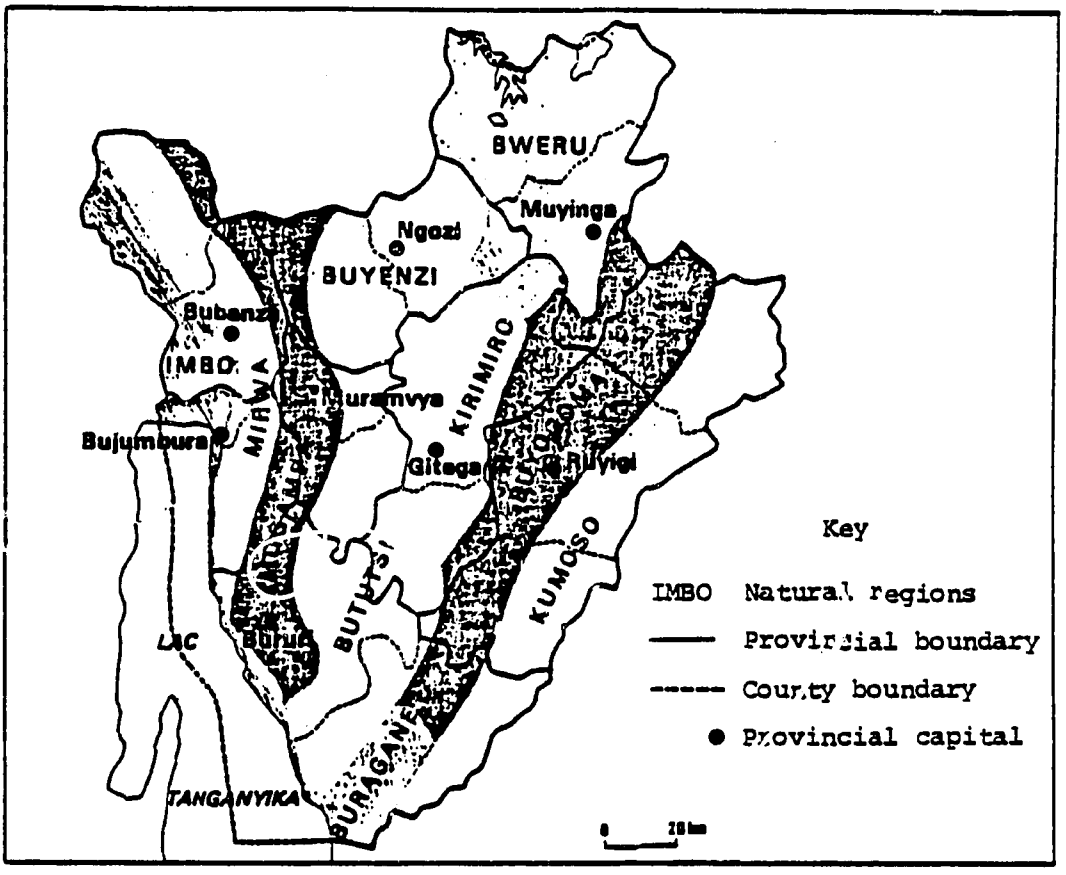

Figure 1. Geographical Subdivisions

Source: Cazenave-Piarrot et al. 1979.

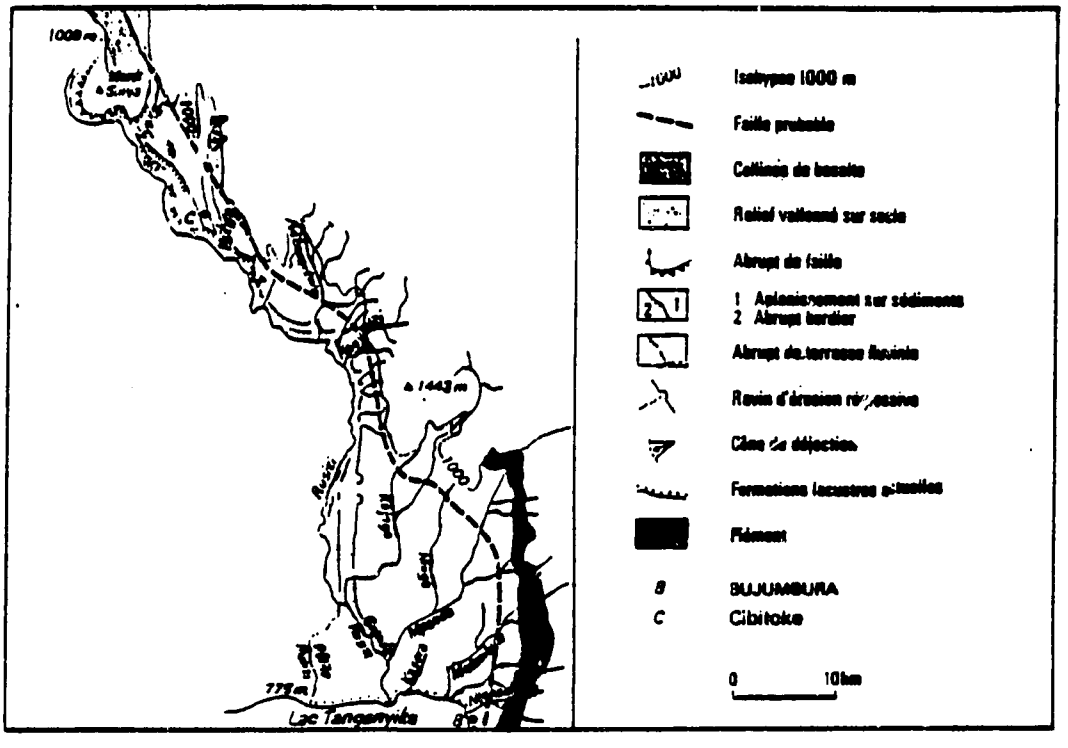

Figure 2. The Imbo Region

Source: Cazenave-Piarrot et al. 1979.

The relief slopes gently from Ruhwa in the north (1,000 m) to the Rusizi delta (775 m). In the north, the relief is contrasting, and the Rusizi flows over narrow rapids. In the center of the region the plain narrows, but south of the confluence of the Rusizi and Nyamita Rivers it broadens to become a marshy delta. This region has emerged from Lake Tanganyika only within the last century, and is frequently inundated during the rainy season. Important coastal plains belonging to the Imbo region lie along the shores of Lake Tanganyika near the capital, Bujumbura, and near Rumonge, and Nyanza-Lac.

At the foot of the Mirwa escarpment, where mountain streams originating in the Zaire-Nile massif flow onto the plain, piedmont terrain is found. There, farmlands alternate with deep gullies and rough valley, some of which still possess gallery forests.

Until 1950 the Imbo was open acacia savannah often described as a wildlife paradise, but since that time it has been converted to a vast agricultural settlement zone on which cotton, irrigated rice, groundnuts, and vegetables are grown (Verschuren 1978; Jeune Afrique 1977).

The Zaire-Nile Massif. Rising east of the Imbo plains, the Zaire-Nile mountain massif divides the drainage systems of those two great rivers. The massif consists of a series of elongated folded ridges which rises sharply some 1,500 m above the Imbo, but whose eastern slopes merge into the central plateau at around 2,100 m. The four summits which exceed 2,500 m probably owe the similarity of their elevation to erosion during the Secondary Epoch. Remnants of primary montane forests occur within these mountains, but most of the terrain is devoted to cultivation of peas, maize, wheat, and at Teza, tea.

The Central Plateau. All of central Burundi as far east as the towns of Kirundo, Muyinga, and Cankuzo belongs to this geographic region. The land slopes from west to east and from north to south. The Buyenzi and Kirimiro regions are also hilly with summits reaching 1,800 m and 2,000 m. To the east, the hills become more elongated; in the southwest the higher hills of the Bututsi region, present a more solid, less dissected relief. Around Buyogoma, long narrow plateaus lie in parallel rows between 1,700 and 1,800 m in elevation. They are separated by marshy valleys. Streams which generally run parallel to the hills along a northeast-southwest axis have cut occasional narrow transverse valleys across the plateaus, giving the region an Appalachian appearance.

More than half of the population of Burundi lives within this region in thousands of dispersed homesteads. Above 1,300 m, cattle herds compete with heavily farmed croplands on which wheat, sorghum, maize, beans, peas, cassava, and bananas are grown. Coffee, the most important commercial crop, is also grown here.

The steep slopes of the central plateau are frequently eroded due to intense runoff from the open ground, and to resultant mudslides. Because of the inversion of the Nile drainage system, valley bottoms are usually marshy, and in the north extensive peat bogs are found along the Akanyaru River and its affluents. Wider valleys support large papyrus swamps. On the modern alluvia the streams meander, presenting evidence of renewed erosion of the valley floors.

The Bweru and Kumoso Lowlands. In the extreme north flat monotonous countryside lies between 1,000 and 1,500 m. It is hotter and drier than in the western regions. Lake Cohoha, a finger lake, and Lake Rweru, both fringed with papyrus *(Cyperus papyrus)*, are the most notable features of the Bweru region. Seasonal flooding of the tributaries of the Kagera River is characteristic.

The Kumoso depression, below a pronounced escarpment, runs the length of the Tanzanian frontier. This depression contains the Malagarazi River, which follows a meandering course to the northeast.

The plains are less heavily populated than the central plateau, but immigrants into the region, beginning in the 1960s, have brought much of the Kumoso region under cultivation. Only the Ruvubu River valley remains relatively undisturbed by human occupation (Verschuren 1978). Tsetse fly-borne trypanosomiasis, originating in Tanzania, is a problem in this region (Van den Berghe and Lambrecht 1952). Outside the settlements, the savannahs and swamps contain remnants of once extensive fauna populations.

2.1.2 General Climatic Features[2/]

Burundi has an equatorial montane climate characterized by mild and stable temperatures, moderate and generally well-distributed rainfall, and altitudinal zonation. The climate resembles that of the plateau regions of the Horn of Africa and the equatorial Andes. Neither temperate nor tropical, Burundi's climate reflects local variations in rainfall and relief. The eastern area of the

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[2] Sources: Bultot. 1972
Cazenave-Piarrot et al. 1979

country is semi-arid, while the Zaire-Nile massif is very wet. Climatic data for Bujumbura and other locales are provided in Appendix II.

2.1.3 Rainfall

The timing of precipitation in Burundi is governed by the confrontation between the dry tropical air propelled by the South African anticyclone and a mass of moist tropical air driven by the western trade winds blowing from the Indian Ocean. The alignment of this front and the timing of rainfall are linked to the solar cycle. There are thus two rainfall maxima, one at each equinox, as shown in the sample rainfall profiles in Figure 3. When humid air penetrates the continent between September and December, convective cloud formation occurs and permits rainfall. In December and January, the northeastern trade winds penetrate the southern hemisphere propelling an arid air mass over Burundi, causing the short dry season. From February through May, the Indian Ocean current again dominates; March and April are the rainiest months. In summer, the wet trade winds are reoriented towards the northeast and do not penetrate the interior of Africa; the long dry season occurs.

Despite its tropical latitude, rainfall is less than might be expected at such close proximity to the Zaire basin. Most of Burundi lies within the 1,000 and 1,600 mm isohyets (Figure 4). However, relief and surface turbulence result in pronounced local and annual variation in rainfall. For example, due to orographic effects, rainfall in the Zaire-Nile summit is greater than in the rest of the country. Most of this precipitation falls on the western part of the massif at moderate altitudes. Butara (1,563 m) receives 1,837 mm; Muisama (1,600 m) receives 1,818 mm; Ndora (2,120 m) receives 1,738 mm; and Mwegeru (2,137 m) receives 1,633 mm.

The *föhn* (a hot dry wind blowing downslope) prevents cloud formation on the western slopes of the Zaire-Nile massif, and the Rusizi valley lies in its rainshadow. Thus, Cibitoke (941 m) gets 967 mm of rainfall annually, while Gihanga (832 m) receives just 760 mm. Rainfall on the central plateau is moderate, from 1,500 mm to 1,000 mm, and declines slightly from west to east. The north and eastern lowlands

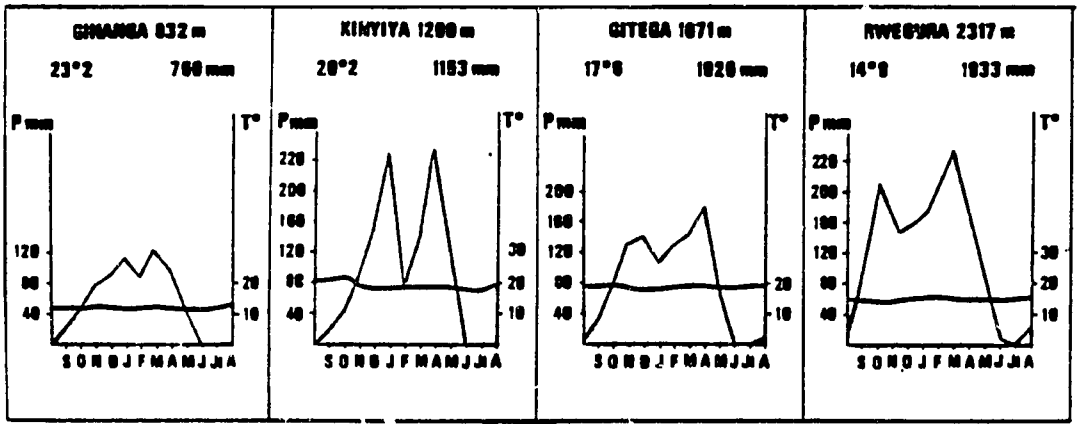

Figure 3. Average Monthly Rainfall at Selected Locales

Source: Cazenave-Piarrot et al. 1979.

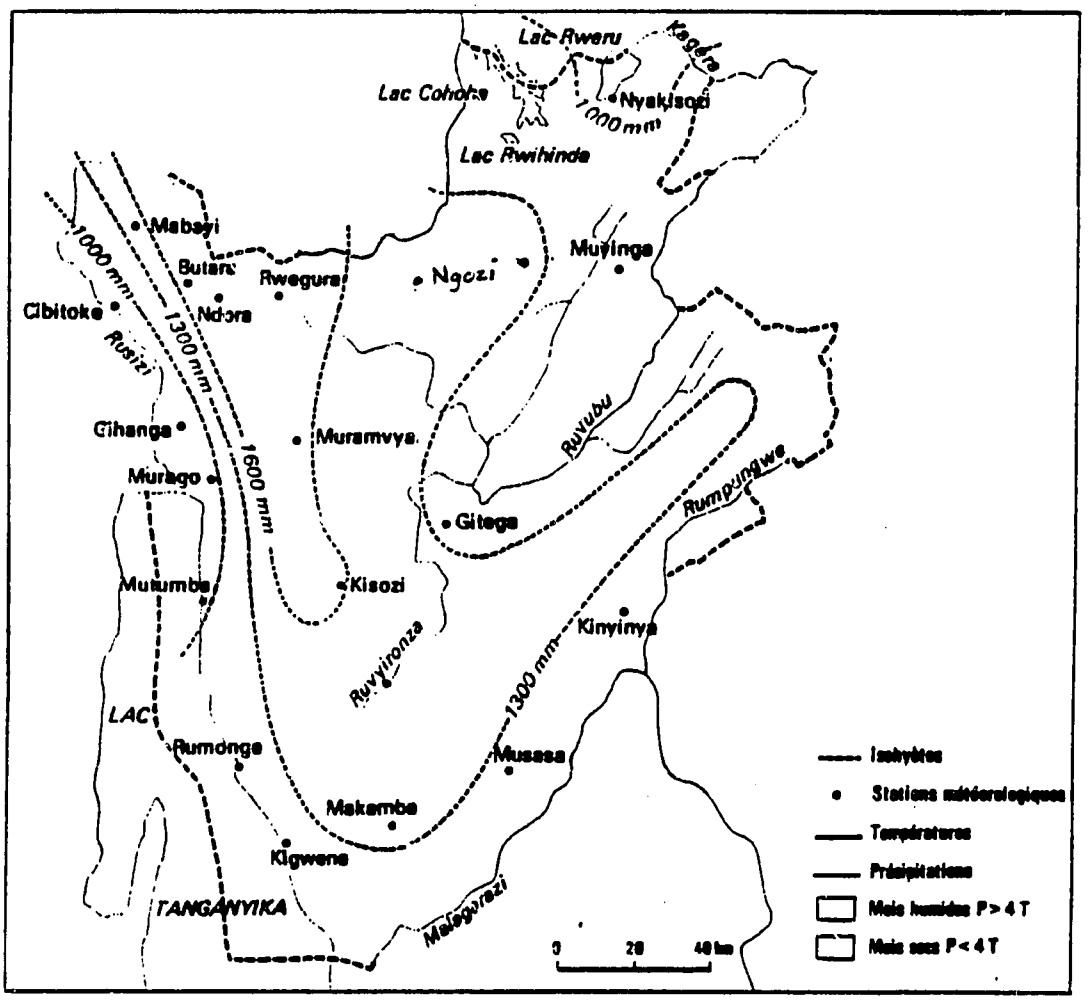

Figure 4. Isohyets

Source: Cazenave-Piarrot et al. 1979.

are quite dry, and like the Imbo region, receive 750 to 1,000 mm of rainfall. The Indian Ocean winds circulate at considerable altitude, and without notable relief to stop them, they release little moisture. Thus, at Kinyinya (1,200 m) annual precipitation amounts to 1,153 mm (Figure 3).

2.1.4 Evapotranspiration and Drought

The existence of a pronounced dry season in June-August and a hiatus in rainfall in December-January confirms Burundi's tropical status. Normally the long dry season lasts between 75 and 90 days on the Zaire-Nile crest and begins at the end of May. On the central plateau, the dry season begins in June and lasts three to four months. The length of the dry season increases inversely with altitude. Thus in the Buyogoma region, it may last five months, and in the Kumoso depression, six months. In the lower Rusizi, seven to eight month droughts are not unknown.

Due to high solar radiation, evapotranspiration rates are 80 to 90 percent on the central plateau, 65 percent on the Zaire-Nile crest, and close to 100 percent in the Imbo region. At Kisozi in the mountains, rainfall exceeds evaporation by 342 mm, while at Ngozi on the east central plateau, evaporation exceeds precipitation by 218 mm (Norconsult-Electrowatt 1976), and at Bujumbura, evaporation exceeds precipitation by over 500 mm. Even when rainfall is normal, high evapotranspiration rates cause rapid drying of exposed soils in the dry season. Unpredicted drought is a serious problem and irrigation is desirable if agricultural production is to be reliable in the regions of more marginal rainfall.

2.1.5 Temperature, Humidity, and Wind

Temperature. Due to its elevation, Burundi is temperate over most of its area. The average daily temperature is between 17 and 20 degrees C. On the Zaire-Nile massif, average daily temperature is lower at approximately 14 degrees C. Mean temperature on the central plateau is around 18 degrees. At Burasira, the daily average is around 17.6 degrees C; in the Kumoso region temperatures are higher--around 20 degrees C at Kinyinya and Musasa, and even higher in the Mosso district (Van den Berghe and Lambrecht 1952). Predictably, mean temperatures in the Imbo region are higher than elsewhere, around 23.5 degrees C.

Typically in equatorial climates, mean daily temperatures fluctuate less than 2 degrees C. However, the thermal amplitude in the Kumoso region reaches 3.1 degrees at

Kinyinya and 3.8 degrees at Musasa. Temperature regularly declines 0.50 to 0.65 degrees C with every 100 m of elevation. Temperatures at the mountain summits thus register below 0 degrees C in the cold season, as they do in the high altitude marshes. Variation in temperatures, associated with altitude, is an important determinant of the distribution of Burundi's food and export crops (Chrétien 1979).

Humidity. Mean monthly relative humidity varies from 55 to 85 percent on the plateau and in the Rusizi valley; it reaches 72 percent in some Imbo regions, and falls between 60 to 90 percent in the mountains. Mists are common on the Zaire-Nile crest.

Wind. Burundi is generally swept by breezes of relatively high velocity, from 5 to per hour. In the dry season, these are the swift west southwesterly flows, reinforced by the South African anticyclone. Northeasterly to easterly currents dominate the rainy months. Violent gusts are sometimes provoked by squalls. The highest recorded windspeeds are 75-90 km per hour.

2.2 Population

2.2.1 Historical and Cultural Background[3/]

The Batwa, a pygmoid people, were probably the original human inhabitants of the country. They practiced a hunting and gathering mode of subsistence which seemingly had little destructive effect upon the environment. Probably never numerous, they now comprise less than one percent of the population. They form the bottom of the caste and ethnic hierarchy in Burundi. Formerly, they were a pariah group, though they were noted for their pottery and their skill in dance.

Between the 7th and 10th centuries, A.D., Burundi was repopulated by Bantu-speaking Bahutu agriculturalists who pushed the Batwa into inaccessible forested areas (Europa 1978). The Bahutu developed a complex system of shifting cultivation which has become more intensive as American and Asiatic crops have been added to the African ones, a process which began in the 16th century (Chrétien 1979). Their basic system of social organization and access to productive

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[3] Sources: Albert. 1960.
Europa. 1978.
Jeune Afrique. 1977.
Jeune Afrique. 1979.
Lemarchand. 1970.

resources has revolved around patrilineal clans whose members reside upon contiguous hillsides in extended family households. Some small-scale chiefdoms probably developed by the 16th century.

Sometime in the 15th and 16th centuries, Batutsi and Hima pastoral peoples migrated into Burundi from the north and east. They practiced an economy based upon seasonal transhumance of zebu cattle. Initially, the Batutsi and Hima probably entered into exchanges of specialized products with the Hutu. The Batutsi, however, had greater experience with complex political organization than the Bahutu. Consequently, by the middle of the 18th century the Batutsi had established a centralized tributory kingdom which endured until the 1960s.

At the core of the political system was a web of ties of clientship linking members of the society. It was these ties, which still persist, rather than the defense of a "national territory" which defined the frontiers of the nation. Fundamental to this decentralized and personal network was the institution of *bugabire,* the cattle contract. This precarious relationship between patron and client involved the exchange of cattle and agricultural produce. Hutu received cattle from Tutsi-Hima and became their vassals, giving agricultural produce in exchange.

In Burundi, the clientage system overlapped with, but remained separate from, the system of decentralized authority invested in political office. Local administration was in the hands of the *ganwa,* or royal relatives of previous kings whose authority had been based upon heredity claims. Some areas were dominated by Hutu chiefs, but all chiefs, *ganwa* or Hutu, owed nominal allegiance to the king, or *mwami*. This system provoked regional and factional strife. Among the majority of Barundi, or residents, clientship and allegiance to a territorial chieftancy became alternate means to obtain protection or valued products from powerful leaders (Lemarchand 1970).

The clientage system also encouraged the expansion of agriculture and livestock production. The latter benefited particularly as cattle became the symbol, *sine qua non,* of successful manipulation of the patronage system and of wealth in general. Intensification of agriculture, the other chief resul

of clientage has had a major impact upon floral succession and soils in Burundi. The clientage system also favored the development of persistent cultural stereotypes of inferiority and superiority, attached to Hutu and Tutsi-Hima, respectively.

European colonialism which intruded into this state of affairs lasted from about 1900 until 1962. Germany, the first colonial power, ruled until 1916. Its policy of indirect rule was not entirely successful as it exacerbated regional factionalism and made the monarchy an appendage of the colonial power. From 1924 until 1962, Belgium held first a League of Nations, then a United Nations Mandate for the combined territories of Rwanda and Burundi. The Belgians encouraged missionary activity and initiated the development of the Imbo paysannats. During the Belgian period, the monarchy reemerged as a symbol of national unity.

During the period just before and after independence was achieved in 1962, the major political events were the emergence of social conflict between the privileged oligarchy represented by the royalty, and a growing Western-educated elite of mixed origins which revolted against the barriers to development posed by the crown. However, the UPRONA (Union et Progrès National) movement which sought national unity and progress could not control the ethnic and regional tensions which cut through the nation's political system. These tensions ultimately cost the crown its legitimacy. In 1966 the monarchy was abolished through a coup d'état which concentrated power in the hands of a military elite, composed mainly of Tutsi-Hima elements from Bururi prefecture. An incipient Hutu-led uprising against the regime in 1972 resulted in the slaughter of nearly 100,000 Hutu, including almost all literate elements of this group. In 1976, in reaction to corruption and mismanagement, a second coup d'état brought a new group of Tutsi-Hima officers to power; they too were predominantly from the south of the country.

While the regime has been formally committed to racial justice and national reconstruction, the climate of ethnic and class hatred and regional factionalism engendered by the events of the last two decades is likely to make realization of new systems of natural resources management difficult. The UPRONA structures are still in existence, however, and through them, a new program of social mobilization possibly may be achieved (Europa 1978; Jeune Afrique 1977; Jeune Afrique 1979).

2.2.2 Population Size, Growth, and Distribution[4/]

There has been no precise enumeration of Burundi's population since 1965. According to most estimates, Burundi is second only to Rwanda in population density in Africa. In 1970 average density was 134 persons per sq km, but by 1978 this figure had risen to 144 persons per sq km.

The population numbered only about 2.2 million in 1922; recurrent famine limited population to between 1.7 and 2.4 million in 1949-1950. Thereafter, rapid growth of over 2.4 percent per year occurred, bringing Burundi's population to 3.6 million by 1970. In 1978, the World Bank placed the population at about 4.15 million, an average annual growth of 1.9 percent for 1970-1978; other estimates have placed it at 3.6 million. At that estimated annual rate of increase the population doubles within 35 years. This rate of increase causes serious concern in Burundi, where land is already very scarce. The crude birth rate (CBR) is estimated at between 42 and 50 per 1,000. This is an expectable dynamic in a country where 49.5 percent of the population is under 18 years of age. The crude birth rate, however, contrasts with a relatively high crude death rate of 21 to 23 per 1,000. The infant mortality rate is one of the highest in the world, 138 per 1,000. Total mortality for the under 15 age cohort is 300 to 350 per 1,000. High death rates explain the moderate natural rate of increase and maintain life expectancy at about 42 years.

Figure 5 and Table 1 illustrate the geographic distribution of the population. There are two regions of high density and one of much lower density. The northern portion of the central plateau has the highest density, surpassing 250 habitants per sq km in Ngozi Prefecture, for example. This is the traditional heartland of Burundi. Despite high densities, the countryside lacks small towns.

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[4]Sources: Cazenave-Piarrot et al. 1979.
Le Vis et al. 1975.
Weinstein and Shrire. 1975.
World Bank. 1980.

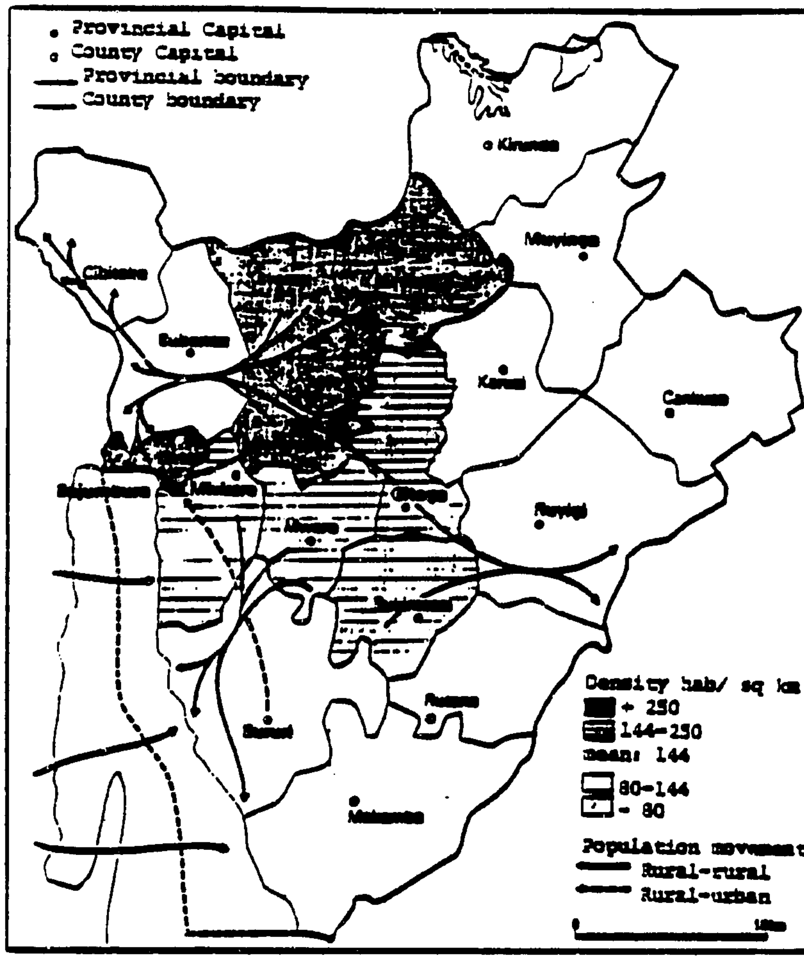

Figure 5. Population Density and Movements

Source: Cazenave-Piarrot et al. 1979.

Table 1. Geographic Distribution of Population

Province	County	Area (sq km)	Population	Density (hab/sq km)
Bubanza	Bubanza	1 190	123 387	108
	Cibitoke	1 480	182 834	111
Bururi	Bururi	2 240	270 098	120
	Makamba	2 440	128 816	53
Bujumbura	Bujumbura	270	140 313	542
	[illegible]	985	239 728	243
Gitega	Bukirasazi	1 025	212 729	207
	Gitega	1 065	241 938	227
	Karusi	1 230	157 409	128
Muyinga	Kirundo	2 080	282 888	137
	Muyinga	1 475	211 934	143
Muramvya	Muramvya	685	170 916	257
	Mwaro	846	171 888	203
Ngozi	Ngozi	1 285	318 879	252
	Kayanza	1 330	395 467	297
Ruyigi	Cankuzo	1 815	93 888	52
	Rutana	1 386	104 251	75
	Ruyigi	2 236	148 989	67
Total and mean		25 010	3 589 434	144

Source: Cazenave-Piarrot et al. 1979.

The region of Bujumbura, the capital, is the second high density zone. It owes its high density to the rural exodus of persons seeking wage employment in the port and in the city's few industries. Density now surpasses 540 habitants per sq km. The growth of the capital has been particularly rapid since 1965 when the population was 71,000. Now, residents number more than 120,000.

The high population densities, particularly in the central plateau, are the result of several factors. One element is historical. The monarchy in Burundi lasted uninterrupted for nearly 500 years. Its temporal permanency, supported by hierarchial social structures, made it possible for the political elites to exert efficient control over the farming majority. The resulting stability encouraged population growth. A second factor is ecological. The high altitude climate is relatively salubrious. High rainfall and moderately fertile soils have permitted two, and sometimes three, harvests a year. In addition, a number of the endemic tropical illnesses (for example, bilharzia, gastroenteritis, pneumopathy, malaria, and sleeping sickness) are absent or less serious in Burundi than elsewhere in Africa (Le Vis et al. 1975). A third reason concerns the labor regime. Labor intensive production methods are rewarded with improved yields and, thus, place a premium on utilizing a large labor force to farm each land holding. As the extent of the cooperating work force is more or less limited to the household, however, large families are favored. Currently, life remains precarious due to chronic agricultural underproduction and as a result of political instability and lack of public social security measures. Large family size remains a favored source of farm labor and social security (Cazenave-Piarrot et al. 1979).

There is little internal migration in Burundi; most people are attached to that portion of the countryside over which they exert usufructuary rights. Nevertheless, there are two types of migration: rural-rural, and rural-urban. Between 1950 and 1960, 9,000 families moved to the newly irrigated regions of the lower Rusizi delta. There is slow but steady immigration in the Kumoso lowlands and to Rumonge, devastated in the civil strife of 1972. Apart from this rural movement, there is a steady influx of people to Bujumbura, the capital and only urban agglomeration in the country, and the center of industrial and political activity.

Only 2.3 percent of the population is urbanized, and the urban growth rate is just 3.2 percent. Eighty-four percent of the people work in agriculture, five percent in industry, and 11 percent in service industries (World Bank 1981). Burundi, therefore, remains a profoundly rural country. Due to rapid population growth and to the primary importance of traditional agriculture, almost half the population is economically active and, thus, the overall dependency ratio is low--one dependent per worker. Only one quarter of the population is literate, moreover, and just 23 percent of school-age children are in school. Dropout rates at the primary and secondary levels are extremely high (Greenland 1974). In short, the country is not preparing enough cadre to implement development goals, nor training future farmers in improved techniques. Many of Burundi's schools, furthermore, are still mission run (see Appendix III).

2.2.3 Health and Nutrition

Burundi has a relatively large number of small hospitals, nine of which are government subsidized and eight of which are run by missionary societies (Appendix III), plus some 72 clinics. These facilities are concentrated in nine towns, leaving the rural areas almost without medical help. There is one hospital bed for every 800 persons, but only one doctor for every 45,000 citizens (McDonald et al. 1969; World Bank 1981).

Basic sanitary conditions in Burundi vary between natural regions. In the Imbo region water and sanitation systems are not well developed, while on the plateau many sources of water are more or less well maintained, although sewage treatment facilities do not exist.

On the Imbo plain, due to the hot, wet climate and to the irrigation system, malaria and schistosomiasis are common. Intestinal parasites and dysentary are transmitted by polluted water. In the elevated regions, more common endemic environmentally based illnesses include exanthematic typhus, pulmonary ailments, and articulatory rheumatism.

Because of superior hygienic conditions in the plateau region, the cholera epidemic of 1978, which affected 600,000 persons (250 deaths) was less severe there than in the plains. Research in the lowlying prefectures of Bururi and

Bubanza has turned up several species of black fly, the vector responsible for the transmission of onchoceriasis, or river blindness. However, the incidence of infection with *Onchoceria volvulus* is low, and the clinical symptoms of infection are not very notable, nor is there any ocular trouble reported. Ambient temperatures at the higher altitudes may be too low for the parasites to develop satisfactorily in potential vectors (Raybould and White 1979; Lukelenge Mapumba et al. 1979).

In the Kumoso region human and animal tryponosomiasis is an endemic health problem The infected areas are those contiguous to the Tanzanian fly belt of *Glossina moristans*, where *Isoberlinia-Brachystegia* woodlands provide an environment suitable for the flies' wildlife hosts. It is said that *Trypanasoma gambiense* exists in the western part of the country, but there is no information concerning its incidence (Van den Berghe and Lambrecht 1952; Onyango 1971).

In 1979, the presence of *Pulex irritans*, the flea responsible for the transmission of plague to rats and humans, was first recorded in dwellings at the two climatic extremes of Burundi. The flea also carried viruses, including encephalitis. There is a risk that plague, previously unknown, may become epidemic (Guiguen and Beaucornu 1979). And, as in Rwanda, measles is prevalent and deadly in Burundi, particularly among children (Le Vis et al. 1975).

Nutritional disease is a commonplace problem throughout the country among the rural poor who comprise the majority of the population. Adult anthropometry is less than normal (May 1965). Protein and calorie consumption is 85 to 90 percent of FAO prescriptions (Le Vis et al. 1975). Starches are abundant, thanks to the introduction of cassava and sweet potato in the 1920s, as are vegetable proteins. Animal protein, except in the Lake region, and fats do not form an adequate part of the diet (May 1965; Anonymous 1970; Le Vis 1975).

The cause of most malnutrition is insufficient food consumption rather than lack of dietary diversity. This condition results from an imbalance in the ratio of population to available land. May (1965) found that nearly three-quarters of Barundi ate only two meals each day. In another study conducted among school children, it was found that 33 percent did not eat in the morning, 45 percent did not eat at midday,

and 15 percent did not eat in the evening (Speed 1970). At least twenty percent of children are malnourished and kwashiorkor is commonplace among three to four year-olds. Malnutrition among mothers is aggravated by the perpetual round of pregnancies and nursing, and by their disproportionately high contribution to agricultural labor. Maternal malnutrition results in the retarded growth of infants (by European standards). Dietary taboos and common practices such as boiling food and consuming three-quarters of the banana, sorghum, and millet crops in the form of beer contribute to poor nutrition (May 1965; Anonymous 1970).

In addition to kwashiorkor, almost all deficiency diseases are observed in Burundi. Endemic goiter occurs in the volcanic region of iodine-poor soils. Vitamin B-deficient neuralgia is reported, as is ocular Vitamin A-deficiency. Both peptic and gastric ulcer, each of which may have a nutritional aetiology are common. Numerous blood protein deficiencies are also reported (May 1965; Hamber and Von Bergen 1971, 1973; Le Vis et al. 1975). Helminthiasis is a common complication among kwashiorkor patients.

2.3 Land Use[5/]

Table 2 summarizes land use in Burundi. Agriculture is the most important use to which land is put. Nearly 90 percent of the population lives from agriculture and cultivates about 64 percent of the arable land (Table 2). Some observers had predicted that close to 100 percent of the arable land suitable for cultivation without major technological inputs would have been brought under cultivation by 1980 (Anonymous 1970). Data from Table 2, however, indicate that perhaps as much as 36 percent of Burundi's arable land remains unexploited.

There are three basic types of agricultural land use. The vast majority of cultivators live in dispersed homesteads called *rugo* and cultivate an average of 1.3 hectares of hillside land (Figs. 6 and 7). Hand tools and green manuring techniques are employed; cooperation is generally restricted to the members of the extended family household (McDonald et al. 1969).

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[5] Sources: Anonymous. 1970.
Autrique. 1974.
Cazenave-Piarrot et al. 1979.
Jeune Afrique. 1979.
McDonald et al. 1969.

Table 2. Land Use in Burundi, c. 1970

Row No.	Land Use	Area (ha)	Pctage. of Exploited or Unexploited Land	Pctage. of Total Land Area
1	Exploited Land (2+3+4+5+6)	1,726,471	100.0	67.0
2	Commercial agriculture	48,000	2.8	1.9
3	Subsistence agriculture	955,777	55.4	37.1
4	Pastures and fields	627,538	36.3	24.4
5	Forests	69,206	4.0	2.7
6	Built-up or paved	25,950	1.5	1.0
7	Unexploited Land (8+9+10)	848,606	100.0	33.0
8	Arable	568,062	66.9	22.1
9	Potential woodland	146,472	17.3	5.7
10	Wasteland	134,072	15.8	5.2
11	Total Arable Land (2+3+8)	1,571,839	----	61.0
12	Total Land (1+7)	2,575,077	----	100.0
13	Lakes	218,360	----	----
14	Total Area (12+13)	2,793,437	----	----

Sources: Anonymous. 1970.
Jeune Afrique. 1979.

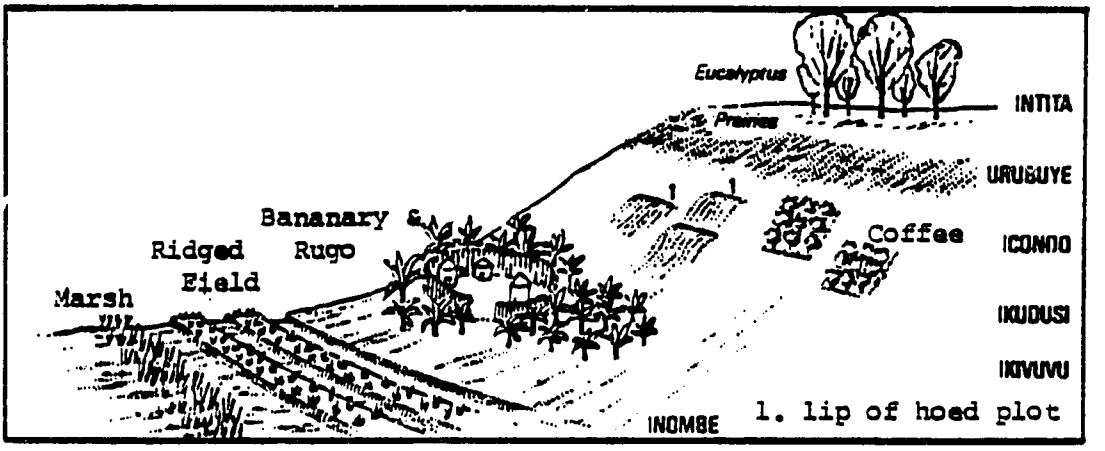
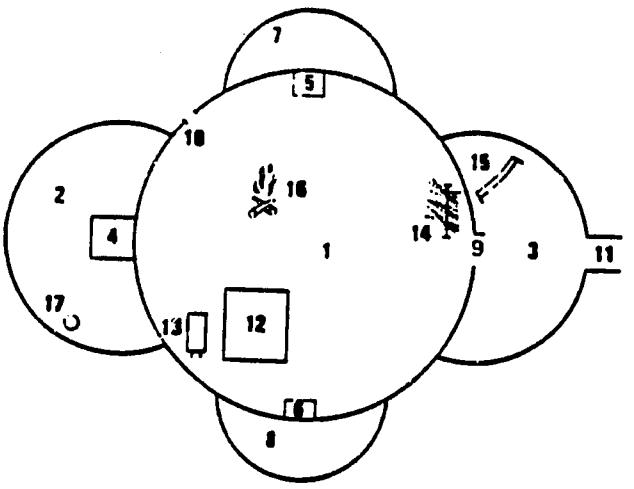


Figure 6. Cultivated Hillside in the Kirimiro Region

Source: Cazenave-Piarrot et al. 1979.



Key

1- the *rugo*
2- the *ikigo:* father's rear courtyard
3- the *ikiguru:* outer courtyard
4- father's house
5- first son's house
6- second son's house
7- *ikigo* of the first son
8- *ikigo* of the second son
9- entryway
10- small entryway (*irembo*)
11- *umuhora*
12- the *ikigangara:* stable
13- the *ikigega:* granary
14- the *imyugariro:* bars to close the courtyard at night
15- manger
16- the *ikicaniro:* deticking fireplace
17- the *umusarani:* latrine

Figure 7. Traditional Homestead *(rugo)*

Source: Cazenave-Piarrot et al. 1979.

Once a wildlife refuge, all of the Rusizi Plain within Burundian territory and certain regions of the Kumoso lowlands are now occupied by agricultural resettlement schemes covering nearly 40,000 hectares (Fig. 8) and housing over 9,000 families. The paysannats are of two varieties: cotton growing ones, which are the most extensive; and rice growing ones, which are restricted to the region north of Bujumbura. Figure 9 illustrates a typical aligned-allotment of four ha ascribed to a single family in a cotton-growing paysannat in the Imbo region. A crop rotation scheme, the predominance of cassava and cotton, and the integration of a woodlot into the family holding are all fundamental to this highly planned, geometrical system of land use. Rice-growing paysannats are restricted to less than 2,000 ha (1,500 ha in 1978); individual plots combining rice and food crops cover just 1.5 ha. The waters of rivers flowing out of the Mirwa escarpment are employed for irrigation purposes. In recent years, declining production on the Imbo paysannats has prompted renewed activity there. For example, 5,000 ha of rice have recently been irrigated using Mpanda river water in Mugwero with European Development Fund assistance. Each peasant controls 50 irrigated ares (5,000 sq m or 0.5 ha) and 25 dry ares of land.

In 1957, the Kumoso paysannats were inaugurated, and supported 1,138 families during their apogee. After a period of decline, some 2,000 ha in the Gihofi region are being revitalized for sugarcane production. Figure 10 shows the location of the Rusizi and Kumoso paysannats.

Plantations. Plantations comprise the second type of planned agricultural system in Burundi, as shown in Figure 10. Three industrial plantations of *Robusta* variety coffee, controlled by SOBUMINES, cover 565 ha and employ modern production techniques and paid labor. Three industrial plantations of tea at Teza, Rwegura, and Tora, in the forested Mugamba region of the Zaire-Nile massif, occupy 1,807 ha; an additional 3,200 ha are to be brought into tea production in the near future (Jeune Afrique 1979).

Both *Arabica* variety coffee and tea are grown on family holdings. The former crop thrives under the thermal and pluviometric regime of the central plateau (Buyezi and Kirimiro) in small (average 400 sq m) plots. Use of mineral fertilizers containing nitrogen and magnesium is particularly recommended, although few peasants can afford the expense. Tea, on the other hand, is grown in three zones contiguous to the industrial plantations on family-controlled plots of 15 to 30 ares each. These three zones together cover 1,250 hectares.

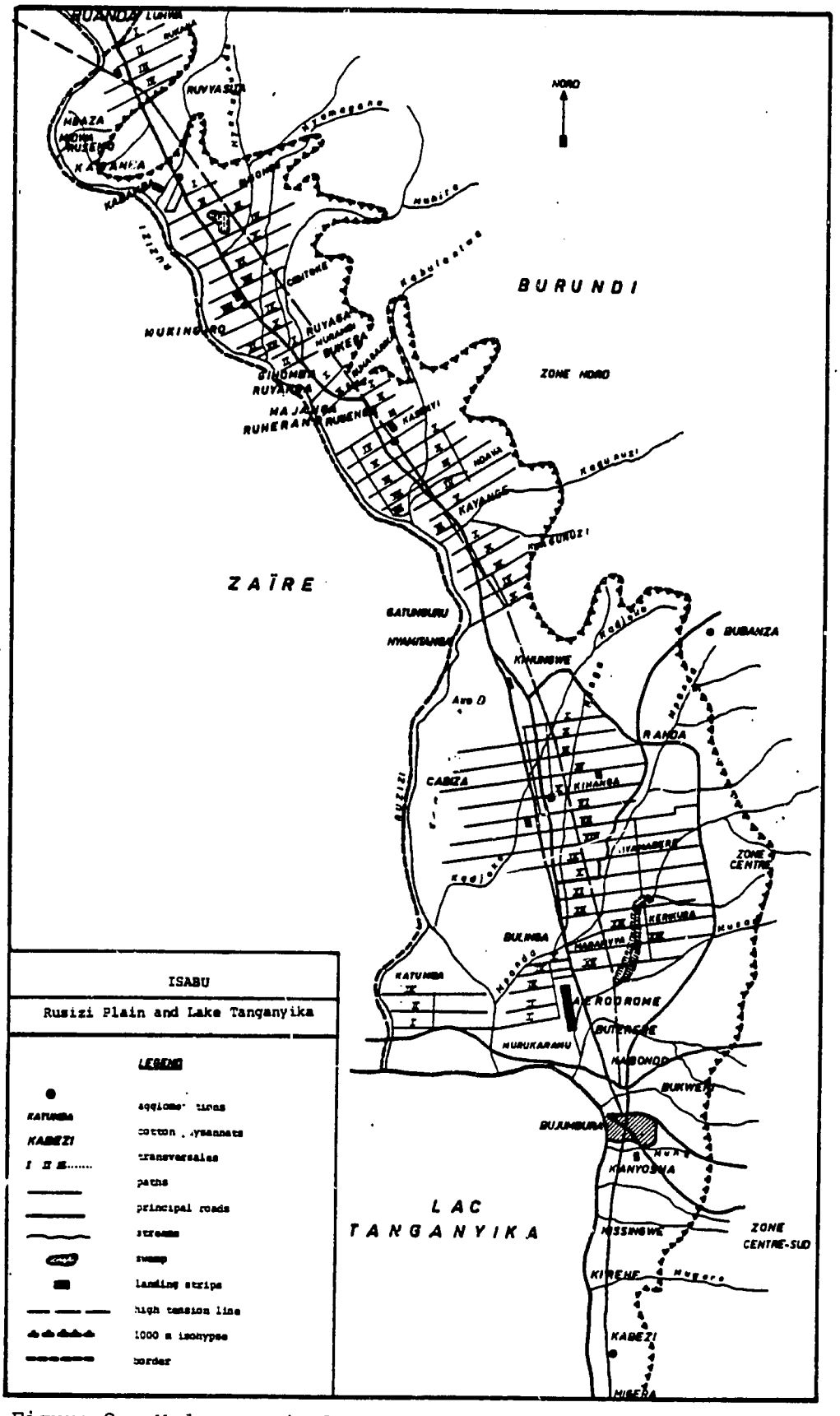


Figure 8. Modern Agricultural Development in the Imbo Region

Source: Autrique. 1974.

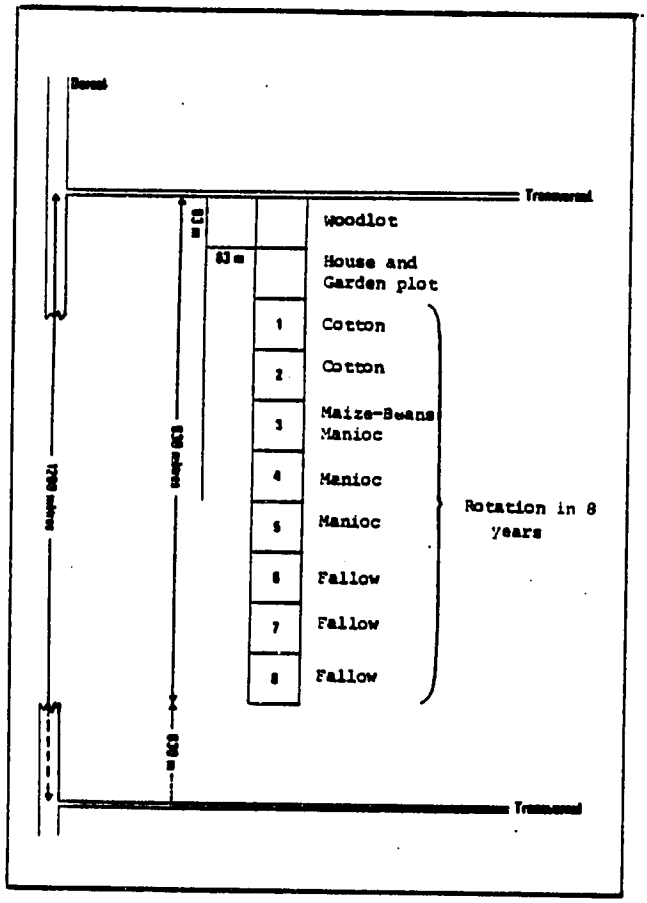
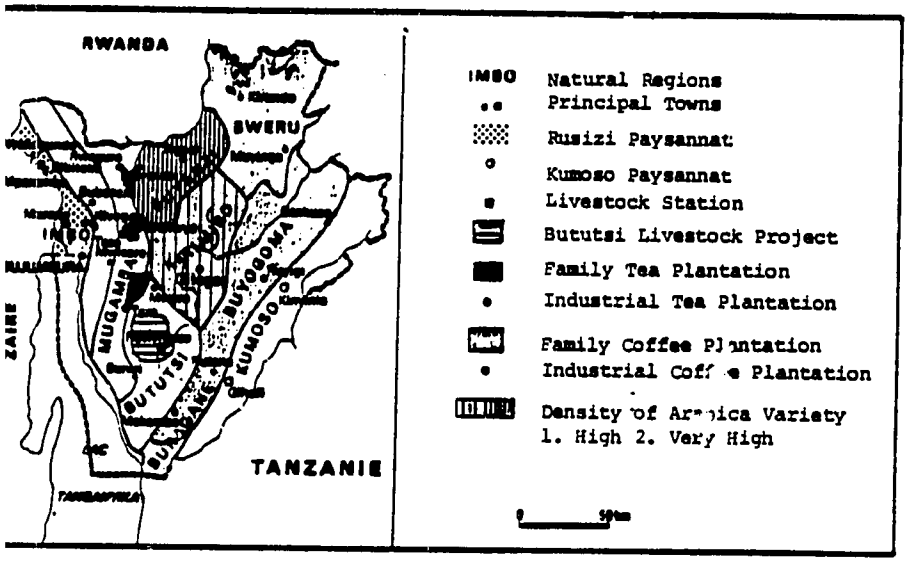


Figure 9. Typical Aligned Allotment in a Rusizi Plain Paysannat

Source: Cazenave-Piarrot et al. 1979.



igure 10. Modern Agricultural Projects

ource: Cazenave-Piarrot et al. 1979.

Pastoral Land Use. Aside from cropland, there are some 627,500 ha of pastures and meadows in Burundi, in addition to the fallow lands, marshes, and forests, where extensive livestock raising is practiced. The five prefectures of Muramvya, Mwaro, Bururi, Bukirasazi, and Kayanza harbor 45 percent of the nation's livestock on pastures of *Exotheca abyssinica*, *Eragrostis curvula*, and *Hyparrhenia bracteata*. The load upon these pastures varies from an optimal rate of 240 kg of live weight per ha around Luviroza, to 560 kg of live weight per ha in Gitega County where pastures are very degraded (Compère 1968). Favorable pluviometry, the absence of bovine trypanosomiasis, and the historical association of pastoralism with this region account for the importance of pastures.

The chemical composition of *Exotheca abyssinica* and *Eragrostis boehmii* pastures is given in Table 3. Results of the table can be summarized as follows: protein content is a function of the proportion of *E. boehmii* in the grass cover. It falls as low as three to four percent of dry weight in the dry seasons. The high level of cellulose adversely affects the palatability and digestibility of the pasture. Both the quantity of phosphorus and that of calcium are insufficient for good bovine nutrition. The sodium content is typical of high altitude zones. Mineral supplements of copper and cobalt are indispensable to good nutrition.

Due to the low quality of higher altitude pastures, dry season transhumance to the more abundant pastures of the Buyogoma, Burgane, and Kumoso regions is imposed upon herders (Compère 1968). There are some 500,000 ha of *Braccharia* sp. and *Chloris* sp. pastureland there.

Ranching Projects. The modern Bututsi-Mugamba rural livestock improvement project extends over 18,700 ha and involves 15,000 people and 13,880 animals (Figure 10). This project employs a system of rotation grazing in fenced paddocks covering 54 ha (Compère 1968). A commercial ranch covering 680 ha in the lower Rusizi Plain now supplies Bujumbura with animal products, after having failed as a livestock improvement station.

Belgian technical assistance is helping to manage a 300 ha paddocking project west of the Rusizi. Local *Braccharia sp.* and exotic grasses have been planted. Rotational grazing permits year-round sedentary livestock rearing. The project may be expanded to encompass 4,000 ha.

Table 3. Chemical Composition of Permanent Prairies of *Exotheca abyssinica* and *Eragrostis boehmii*

a. Percentage of dry material

	Rural pastures in the [illegible] region of variable quality		Degraded pastures in Gitega dominated by *E. boehmii*		
	Mean rainy season	Min.-Max.	Mean rainy season	Mean dry season	Min.-Max.
Ash	6.4	5.76- 6.91	3.94	4.87	3.48- 5.62
Cellulose	34.33	33.48-34.86	38.84	36.86	35.72-39.36
Total Protein	9.04	8.41- 9.72	4.36	3.07	2.16- 4.92
Etherial Extracts	1.79	1.72- 1.86	2.17	1.18	1.67- 2.29
Nonnitrogenous Elements	48.45	47.04-49.11	50.69	53.39	50.17-53.85

b. Ratio of Mg/kg of dry material

Ca	4.21	3.65-4.89	2.46	2,789	2.16-3.18
P	2.13	1.29-2.59	856	291	251-1,119
Mg	1.74	1.56-1.96	1.38	723	648-1,566
K	6.2	5.45-7.98	2.81	2,232	2,049-2,977
Na	.75	556-932	886	745	668-1,216
Fe	1.0	695-1,355	507	536	345-595
Cu	7.6	6.1-10.1	5.1	5.6	3.7-6.9
Mn	172.8	145.9-220.6	50.1	43.9	24.3-55.0
Co	0.09	Traces-0.19			

Source: Compère. 1968.

Forestry. Forests no longer comprise an important component of land use in Burundi, although wood consumption amounts to one million steres per year. Burundi has a maximum remaining forested area equal to less than six percent of the national territory--between 100,000 and 160,000 ha, of which 30,000 ha are comprised of reforested woodlots. Table 2 gives the truly forested area as only 69,206 ha. At best, this forest could produce one million cubic meters of wood annually, an amount barely sufficient to meet Burundi's needs for firewood and timber. Currently only 500 cubic meters are produced by Burundi's moribund lumber industry (Pouilloux 1976; Gaudet 1980).

Peat Bogs. Burundi has extensive peat bogs which have an important energy producing and agricultural potential. The location of six commercially exploited peat bogs is shown in Figure 11. These bogs have a combined exploited area of 297 ha (Table 4). The vast Grand Marais is also a potential source of peat fuel. Peat has been harvested in Burundi since 1971, at the rate of about 143 tons per hectare. Annual production was projected to reach 50,000 tons by 1985. Production of 50,000 tons per year should provide a substantial complement to Burundi's other energy resources without creating serious environmental consequences in the producing zones (Gaudet 1980).

Table 4. Commercial Peat Bogs in Burundi

Bog	Area to be exploited (ha)	Altitude	Production (tons) 1979	1985*
Kivogero	2	2,250	-	-
Kashiru	15	2,410	1,700	3,400
Kuruyange	37	2,155	1,800	6,000
Kishubi	54	2,073	-	8,000
Kitanga	89	2,081	-	18,000
Nyacijima	100	1,800	-	5,000

*Expected production may be 15% higher if waste residue is added to peat.

Source: Gaudet. 1980.

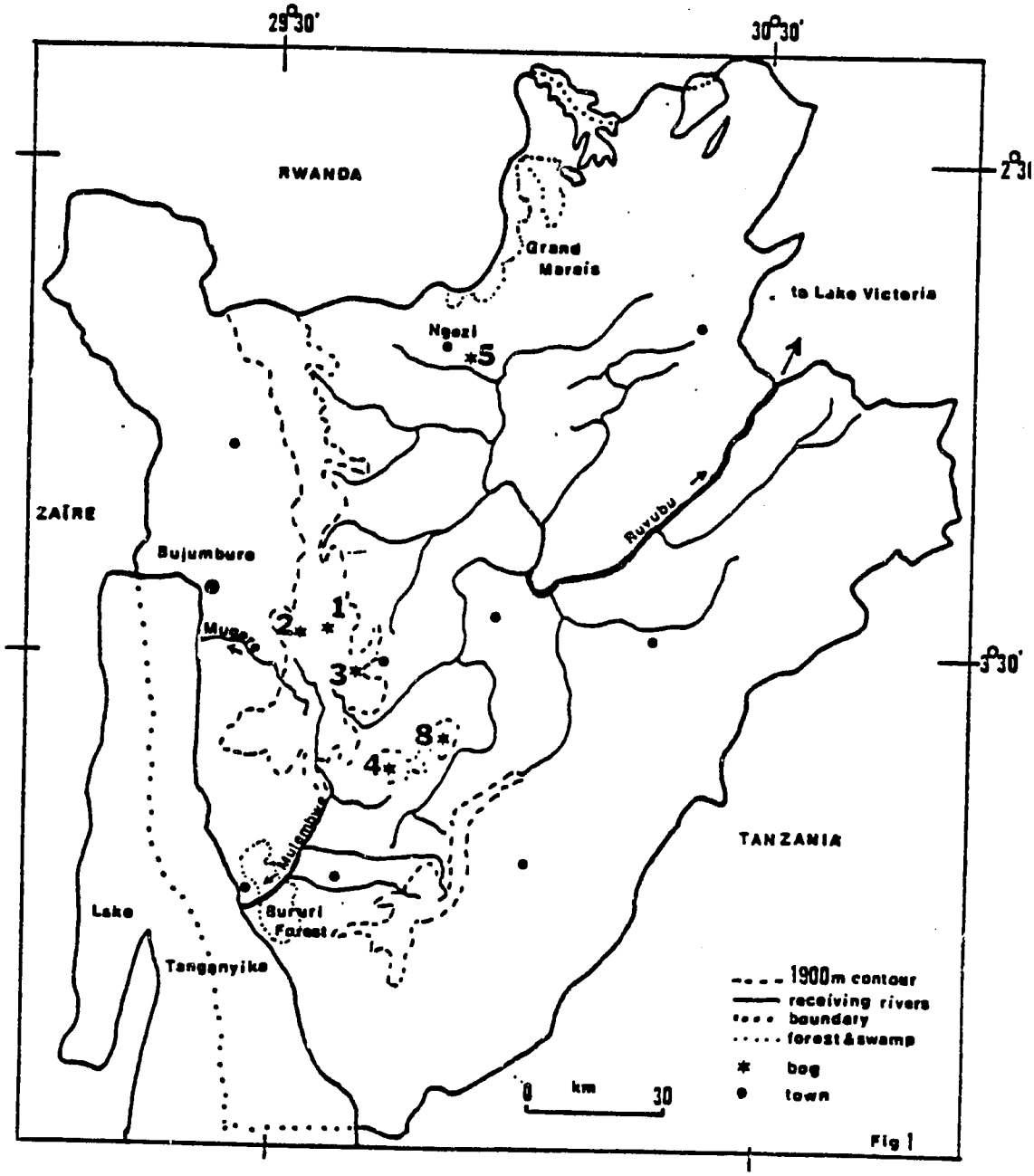


Figure 11. Bog Locations and the Major Receiving River Basins. Source: Gaudet. 1980.

Substantial changes in land use have occurred in the past 30 years in Burundi. The creation of the Imbo paysannats involving thousands of hectares of land destined primarily for cotton and rice production, and the introduction of the industrial coffee and tea plantation contrast with the complex small-scale systems of labor intensive polyculture still practiced by most Barundi. These schemes have been very beneficial to the government in terms of the augmentation of national revenues, but of less value to the majority of residents. In just 30 years, moreover, the Imbo projects have had a very negative effect upon native flora and fauna. The long-term consequences of dumping fertilizer and pesticides from these projects into the Rusizi River and, ultimately, into Lake Tanganyika have not been assessed.

For the majority of Barundi, sheer subsistence remains the main issue. Insufficient cadre and political instability inhibit animation efforts. A less dramatic development than the paysannat projects, but no less important is the regular increase in population densities without corresponding increases in agricultural productivity, revenues, or available land.

Land Tenure. Under the monarchy, the king *(mwami)* was the sole proprietor of all land. One form of land grant under this system conferred the right to farm a plot of land. A second form of grant included not only this right, but the right to tax other households. The Belgians preserved the traditional system, but extended European law over foreigners. Currently, foreigners and Barundi acquiring land by non-customary means may formally register their title. Customary right prevails in the countryside, while the state assumes control of land such as pastures, bogs, and forests, considered to be a collective resource.

Grants of plots on the paysannats constitute a new form of usufructuary tenure in which the state acts as the grantor. Rights over the land are contingent upon work performed. This new system has allowed some families to escape from traditional patron-client obligations and to move from saturated zones to less populated areas.

Traditionally, pastures were distributed by political authorities among herders, who merely exerted usufructuary rights over them. Today, pastures are considered a collective

good. Declining quality and population pressure, however, have encouraged private appropriation of pastures particularly in the Bututsi region which has the greatest concentration of ethnic Tutsi-Hima people.

2.3.1 Crops[6/]

Approximately 85 percent of Burundi's agricultural production consists of noncommercial food crops while the remaining 15 percent is made up of commercial export crops: coffee, cotton, and tea (Jeune Afrique 1979). The nation's food crop production includes African, American, and Asian crops (Table 5) grown according to a complex agricultural calendar (Figure 12). Chrêtien (1979) argues that the addition of maize and beans in the 18th century, and cassava more recently, are the chief factors responsible for the high population densities achieved during precolonial times on the central plateau. For the past decade growth in production of food crops has been incremental, suggesting that advances in production are due primarily to small, regular increases in the amount of area cultivated (Table 5). Nonetheless, yields of food crops remain quite high compared to production from traditional cultivation elsewhere in Africa (Table 6).

Table 5. Food Crop Production

	Production (metric tons)				
PRODUCT	1973	1974	1975	1976	1977
Bananas					
-- Fruits	460 100	462 000	464 700	474 000	488 400
-- Beer	790 200	780 000	798 100	815 200	831 600
Subtotal	1 250 300	1 242 000	1 262 800	1 289 200	1 320 000
Tubers					
-- Cassava	386 800	389 400	390 800	400 000	400 000
-- Sweet Potatoes	398 600	318 900	402 600	412 300	415 000
-- Potatoes	31 300	35 500	28 400	36 850	38 000
-- Cocoyams	100 000	80 400	101 500	103 700	105 500
-- Yams	6 000	4 800	6 100	6 200	10 000
Subtotal	922 700	829 000	929 200	958 850	968 500
Legumes					
-- Beans	291 100	231 900	294 000	299 900	307 000
-- Peas	31 400	25 200	31 900	32 550	33 000
-- Groundnuts	7 800	8 400	9 000	9 500	9 500
Subtotal	330 300	265 500	334 800	341 950	349 500
Cereals					
-- Maize	135 800	108 600	137 100	139 900	140 000
-- Sorghum	20 900	16 700	21 100	21 550	22 000
-- Eleusine	9 200	7 400	9 300	9 500	10 000
-- Rice	4 800	6 200	6 700	6 700	7 500
-- Wheat	5 100	4 100	5 200	5 300	6 000
Subtotal	175 800	143 000	179 400	182 950	185 500
Total	2 679 100	2 479 500	2 708 200	2 772 950	2 823 500

Source: Cazenave-Piarrot et al. 1979.

[6] Source: Cazenave-Piarrot et al. 1979.
Chrêtien. 1979.

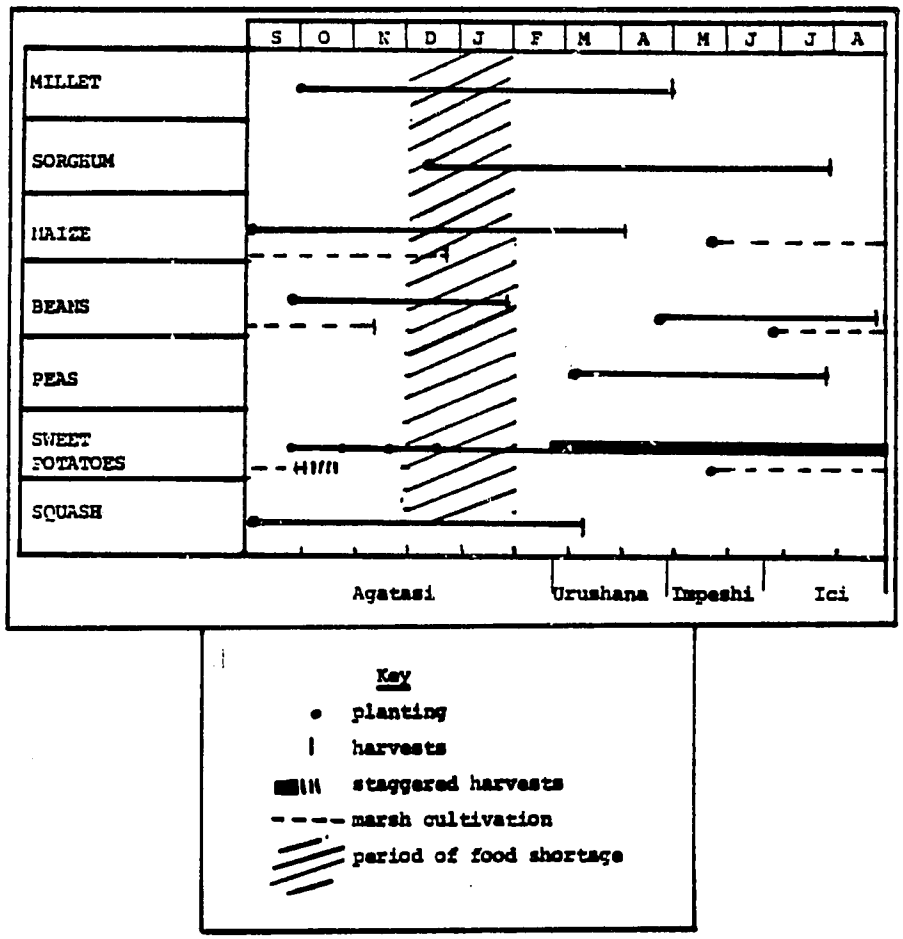


Figure 12. Agricultural Calendar, Central Plateau

Source: Chrétien, 1979.

Table 6. Yields of Crops in Pure Stands

Yields of Crops in Pure Stands

	Yields (tons/ha)				
Crop	Buyenzi	Kirimiro	Bweru	Buyogoma	Kumoso
Maize	4.25	8.5	3.5	6	
Beans	9	7.75	6	10.8	7
Sweet Potato	6.4	6.9	5.9	4.8	5.5
Peas				7.5	
Potato				82.7	
Cassava	5.9	4	6	5.3	7.8
Banana	7.6	11.5	11.7	10.5	8.4

Source: Cazenave-Piarrot et al. 1979.

Tonnage of bananas surpasses that of all other food crops. Production of tubers, legumes, and cereals are next in order (Table 5). Nationally, area cultivated in legumes (particularly in beans, to elevations of 1,800m), however, exceeds areas of all other crops (Fig. 13). The same is true regionally, on the central plateau (Table 7). Although sorghum was once probably the most widely grown cereal (Fig. 13), maize now surpasses sorghum both in area cultivated and tonnage produced, and has become the most important cereal crop. Among tubers, cassava and sweet potato, both American cultigens, are the most important in terms of area and tonnage produced, having largely replaced yams, cocoyams, and more ancient tubers, like coleus, in the diet.

Table 7. Percentage of Crops Cultivated in the Central Plateau

Crop	Percent
Beans	26.7
Maize	25.1
Banana	13.5
Sorghum	12.1
Cassava	7.4
Peas	5.3
Sweet Potato	3.4
Millet	2.1
Cocoyams, groundnuts, potatoes	4.2

Source: Cazenave-Piarrot et al. 1979.

From a nutritional standpoint, beans, banana, cassava, and sweet potato are probably the most significant crops. Beans are the main source of vegetable protein. Banana *(Musa triploides acuminata)*, known in nine varieties in the area, not only is available to the farmer and consumer throughout the year, but is converted to beer and consumed at most social occasions. Many persons commonly make a meal of nothing but this drink. As shown in Table 5, two-thirds of the crop is consumed as beer.

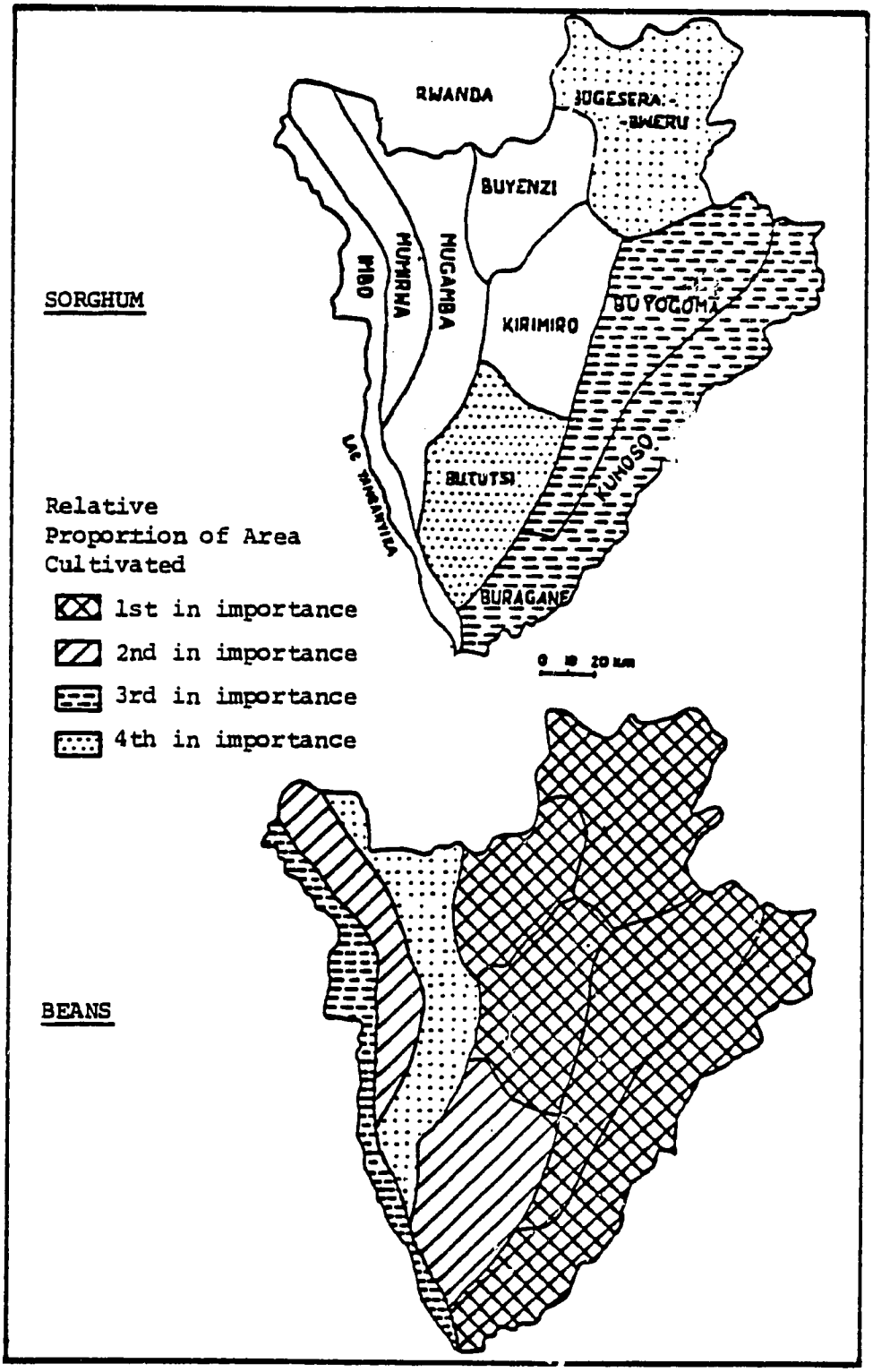


Figure 13. Regional Distribution of Food Crops, c. 1950

Source: Chrétien. 1979.

In addition to food crops, coffee, cotton, and tea are grown; the first primarily in the Imbo, the second primarily in Buyenzi and Kirimiro, and the third on the Zaire-Nile crest. The plantations produce 75 percent of the *robusta* variety, the family farms the remainer in addition to all the *arabica* variety coffee. Coffee provides peasants with most of their money revenues. Due to parasite damage and to irregular care, yields vary from 100-600 kg per ha to more than one ton per ha. Coffee production has shown irregular growth over the past two decades due to fluctuations in world demand (Table 8). The government had planned to replace old stock with 40 million young plants in order to bring production of coffee to 40,000 tons in 1979. As of 1980, this objective had not yet been met (Jeune Afrique 1978). However, coffee remains the main export crop, accounting for 93 percent of the value of exports in 1979, worth almost nine billion Burundi francs (Banque de la République du Burundi 1980).

Cotton, an extremely important crop prior to independence has undergone a long decline due to a relaxation of agricultural discipline on the paysannats, several years of floods in the 1960s, contamination by parasites, and political upheaval in the 1970s (Autrique 1974, 1979). Raising the producer price, improvement of antiparasite measures, and construction of a textile mill in Bujumbura with Chinese aid have created the conditions necessary for a revival of cotton production.

In the Mugamba region high rainfall (1,500 mm per year), cool climate (15 to 17 degrees C), and the eutrophic brown soils provide conditions necessary for tea production in once forested regions. Combined industrial and household production has increased regularly since 1969 (92 tons) to 1,722 tons in 1978 (Table 8). Tea production is destined for further expansion. Drought resistant strains are being tested for eventual planting (Bonte 1967).

Agriculture production data are summarized in Appendix IV.

Table 8. Commercial Crop Production

a. Coffee Production (metric tons)

Year	arabica	robusta	Total
1966	14,094	917	15,011
1967	17,929	753	18,682
1968	15,516	1,023	16,539
1969	13,299	1,255	14,554
1970	21,218	900	22,118
1971	23,271	1,780	25,051
1972	17,901	1,502	19,403
1973	19,600	1,795	21,395
1974	26,446	1,694	28,140
1975	14,016	1,908	15,924
1976	19,982	1,446	21,428
1977	15,174	1.856	17,030
1978	21,007	1,776	22,783
1979	25,137	2,000	27,137
1980[1]	17,000	2,000	19,000

b. Cotton Production (metric tons)

	1971	1974	1975	1976	1977	1978	1979
Cotton seed	8,709	4,526	3,818	3,010	5,161	6,148	4,000
Cotton fiber	3,318	1,653	1,422	1,109	1,839	2,213	2,000
Hectares planted	8,614	8,203	6,918	6,559	8,026[2]		
Yield (kg/ha)	1,011	552	552	458	375		

c. Tea Production (metric tons)

1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
92	157	322	485	657	906	787	1,227	1,474	1,722

Notes: 1 UNCLDC. 1981.

2 Autrique. 1979.

Source: Cazenave-Piarrot. 1979.

2.3.2 Livestock

Although the economic role of livestock in Burundi is limited, the social and political importance of cattle cannot be underestimated. Cattle were the means by which the Tutsi established political sovereignty over Hutu agriculturalists in the precolonial period. Patron-client contracts between Tutsi and Hutu were sealed by transfers to the Hutu of usufructuary rights over cattle. Cattle continue to be a symbol of prestige and wealth in rural life. Nevertheless, animal products constitute less than 10 percent of the gross domestic product. Milk production amounts to only 600 liters per cow per year, half of it consumed by the calf. Meat consumption is about three kg per person per year. Cattle numbered more than 792,000 head in 1978, an increase of 200,000 since 1966. Both long and short-horned varieties belong to the Ankole variety of zebu cattle. Experiments with crossbreeding Jersey and Sahiwal cattle are currently underway (Lemarchand 1970; McDonald et al. 1969; Cazenave-Piarrot et al. 1979; European Community Commission 1974).

Table 9 and Figure 14 illustrate the distribution of cattle by country and by prefecture, respectively. Figure 14 also indicates the principal dry season patterns of transhumance. About 50 percent of the herd consists of cows, but 20 percent of the cows are generally old and sterile. A five year old animal typically weights about 250-300 kg, but only 47 percent of its weight is meat.

Table 9. Distribution of Cattle by County

County	Number	Head/ sq km	Head/100 Persons	County	Number	Head/ sq km	Head/100 Persons
Bujumbura	8 087	28.8	4.3				
Muramvya	37 048	37.8	19.4				
Bubanza	41 691	34.9	38.0	Muyinga	34 110	23.7	15.9
Cibitoke	22 756	15.3	16.9	Kirundo	33 001	16.0	12.4
Gitega	34 086	31.9	13.1	Ruyigi	32 586	14.7	16.0
Bururi	49 887	48.4	19.7	Cankuzo	34 182	15.8	38.9
Karuzi	44 546	36.2	27.3	Rutana	49 307	38.3	43.7
Ngozi	38 795	30.6	11.7	Bururi	137 889	61.5	43.3
Kayanza	61 605	46.3	13.8	Makamba	33 216	13.6	28.9
Muramvya	42 298	63.6	20.2				
Muyinga	58 782	57.2	24.1	Total et moyenne	791 849	31.7	20.7

Source: Cazenave-Piarrot et al. 1979.

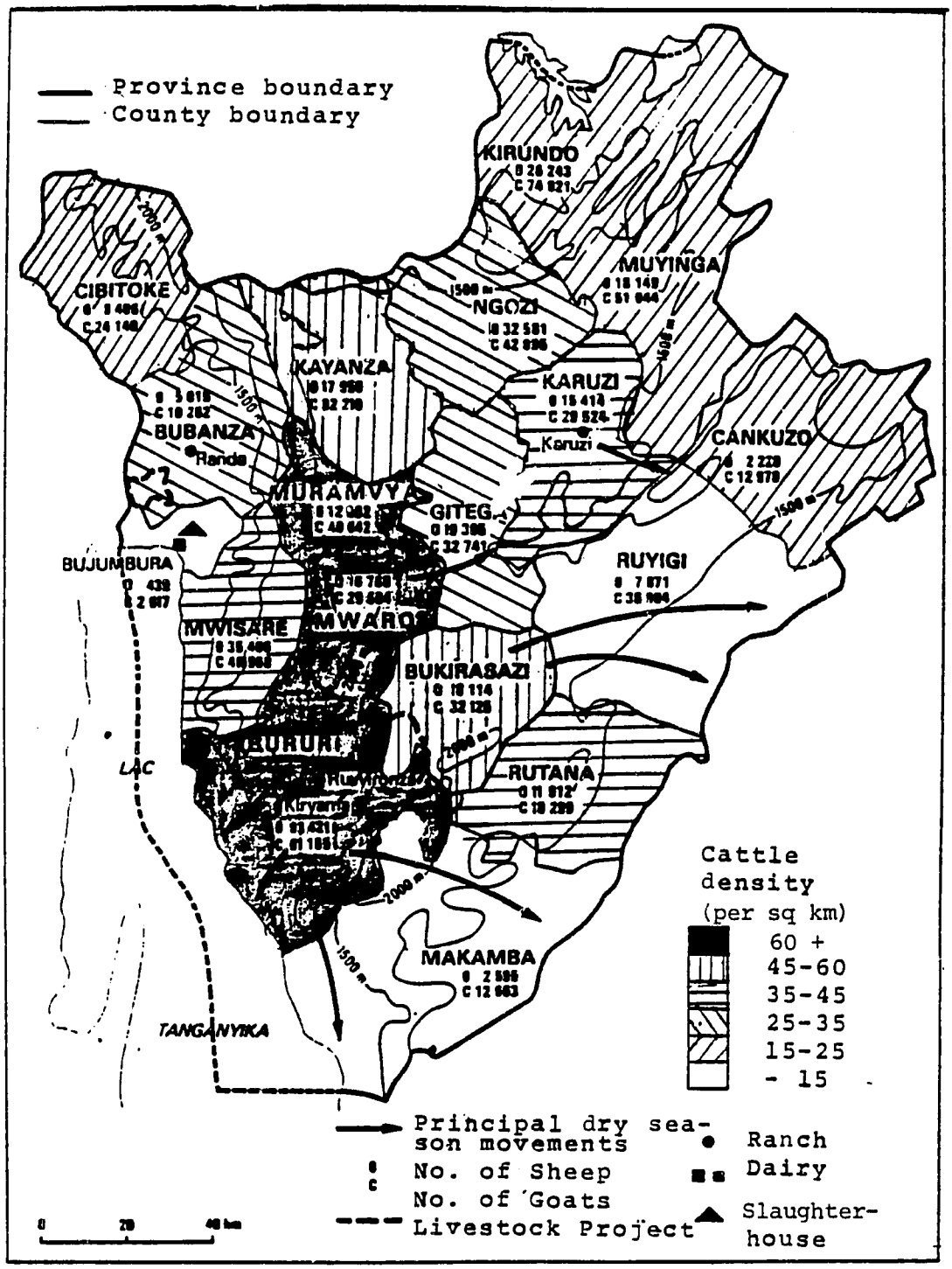


Figure 14. Distribution of Cattle by Prefecture

Source: Cazenave-Piarrot et al. 1979.

The health of the cattle is mediocre. Juvenile mortality reaches 40 percent, although the great epidemic killers (bovine plague, brucellosis, and anthrax) have almost disappeared. Theilerosis (East Coast Fever), transmitted by ticks, is responsible for a large number of the juvenile deaths. However, tick baths need to be given very frequently to effectively combat this disease (Kiltz 1979). Below 1,500 m bovine trypanosomiasis causes serious losses. Parasites attacking the liver, intestines, lungs, and muscles (cysticercosis) are another cause of loss. Around Bujumbura, canine distemper strikes an increasing number of beasts. Malnutrition is a common problem among cattle, particularly during the dry season, and gives rise to seasonal transhumance. To maintain its weight, an adult animal must eat 5.5 kg of dry material per day. However, on most rural pastures animals can obtain only 3.5 kg of dry material per day (*Eragrostis boehmii, Hyparrhenia bracteata, Loudetia simplex*), to 5.0 kg of dry material per day (*E. boehmii, H. bracteata*), even in the rainy season.

Small livestock are also raised in Burundi, particularly by Hutu farmers. There were about 570,567 goats of the small Sahelian type, and about 305,036 sheep of a Guinean fat-tailed hybrid variety which do not produce wool. The number of goats and sheep has increased by about 170,000 and 700,000 head respectively, since 1966. Because of the devastation they cause upon young crops and trees, small livestock are frequently picketed in the family compound (*rugo*).

Aside from these animals, pigs (30,000) and fowl are raised, and large numbers of beehives of traditional construction are maintained. A hive yields about one kg of honey per year.

2.3.3 Forest Exploitation

The natural vegetation is constantly being diminished by cutting and clearing, and less than five percent of the national area retains a forest cover. Legislation now requires permits for cutting and for charcoal manufacture, but uncontrolled cutting continues.

Management practices are currently geared to adding to the 30,000 ha reforested during the colonial period. Reforestation efforts include creation of plantations of both exotic species (*Limba* sp., *Grevillea* sp., *Aerocarpus* sp., *Pinus patula*), and native species (*Podocarpus usambarensis, P. milanjianus, Strombosia scheffleriі, Symphonia globulifera,* and especially *Entandrophragma excelsum*). Nursery management techniques for these species have not, however, been perfected.

Among major reforestation projects, three may be cited. In the mid-1970s the Direction des Eaux et Forêts (DEF) was preparing to reforest 15,000 ha of the most degraded areas in Mugamba. *Callitus calcarata* and *Cystisus proliferes* were to be planted. French foreign assistance was also working on a five-year project to reforest 3,000 ha in 1,000 ha blocks on degraded communal pastures. *Pinus* sp. was to be employed. The project also envisioned the creation of experimental stations to determine species suitable for different soils and altitude zones. Finally, extremely degraded forests of *Hagenia* sp., *Macaranga* sp., and *Brillantesia* sp. around the tea plantations at Teza and Rwegura were replaced with plots of Eucalyptus destined for use in the tea drying factories.

3.0 Environmental Resources and Policy

3.1 Geology, Minerals, and Energy Resources

3.1.1 Basic Structure

Burundi is underlain primarily by pre-Cambrian rocks of the Rusizian (1,850 Myrs) and the Kibaran-Burundian (1,240 - 1,310 Myrs) series (Cahen et al. 1966; Cahen and Lepersonne 1967), with Malagarasian series rock along the southern border. The rocks are essentially crystalline, the degree of metamorphism in Rusizian series rock varying with the proximity of the Burundian granite outcrops. The basement structure has undergone pronounced transverse warping and folding due to tectonic and volcanic activity associated with the Great Western Rift valley. The rock follows the north-east-southwest orientation of the rift which punctuates the discordance between the east-west orientation of the Rusizian rocks and the north-south orientation of the Burundian series. Lake Tanganyika lies in the graben between the two hörsts created by faulting in the rift zone (Figs. 15 and 16).

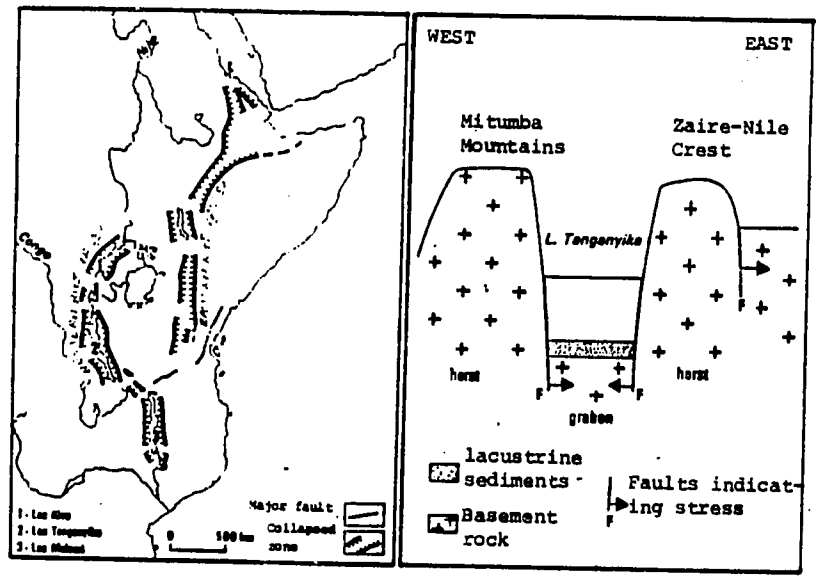


Figure 15. Hörst and Graben Structure of the Rift Valley

Source: Cazenave-Piarrot et al. 1979.

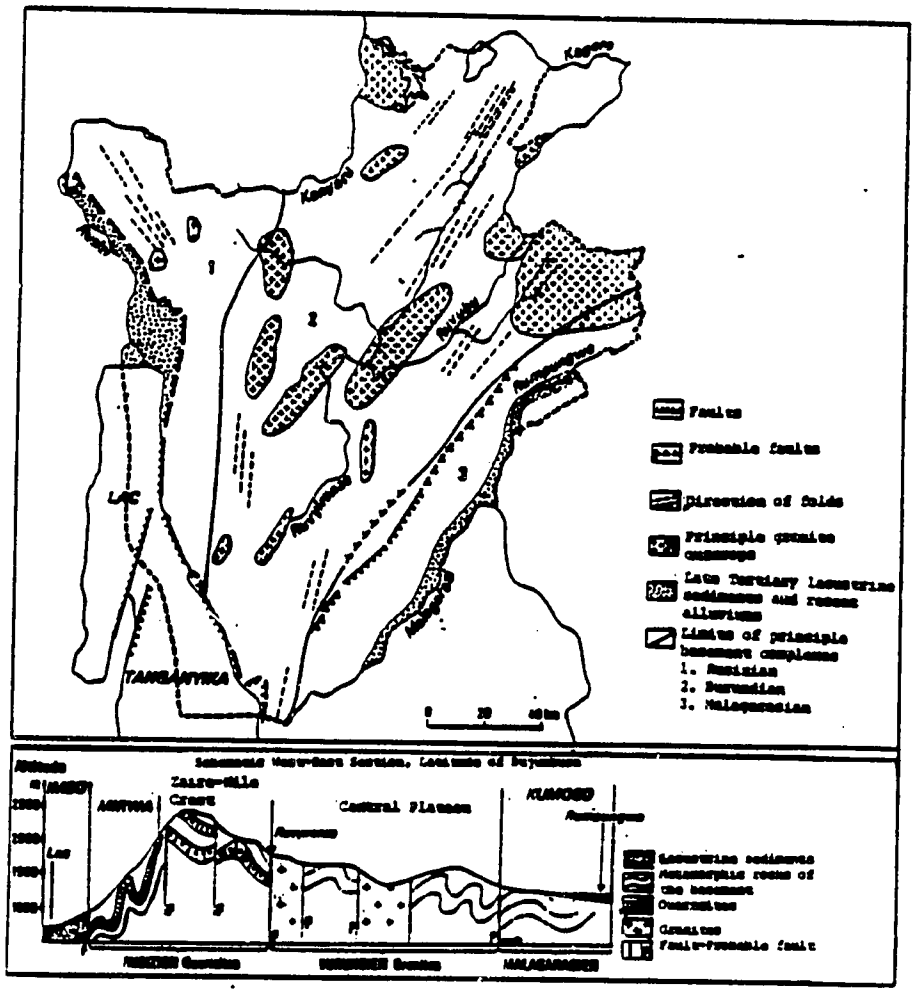


Figure 16. Major Geological Features

Source: Cazenave-Piarrot et al. 1979.

Rusizian series rocks are most apparent in the west of the country. Mica schists, gneiss, and granite-gneiss predominate. Pegmatites and bastnasite are characteristic mineral intrusions in these rocks. At Karonge the latter occurs in veinlets filled with younger brecchia. Burundian rock occurs in the central regions and primarily takes the form of quartzite and schist. Granite batholites occur sporadically (Fig. 16). These granites belong to the potassic-alkali series of rocks. Malagarasian rocks are more recent sedimentary structures composed of clearly stratified quartzites, limestones, sandstones, and clay. Late Tertiary and Quaternary alluvial fill cover parts of the Imbo, the Bweru, and Kumoso depressions and the lower Ruvubu River valley.

3.1.2 Geological Formations

Burundi is composed of three distinct geological formations (Figs. 15 and 16). The first, which comprises the north part of the Tanganyika graben is, in fact, the collapsed Imbo plain. Here the faults are of northwest-southeast orientation. The Rusizi River channels follow their course toward Lake Tanganyika.

The second geological formation consists of a disymmetrical hörst: the Zaire-Nile massif. Here Rusizian quartzite surfaces have been violently raised and fractured. The steep broken Mirwa encarpment is adjacent to the eastern graben fault.

The third geological formation is the eastern half of the hörst and includes the central plateau and eastern depressions. The faults are oriented northeast-southwest and define the hydrological reservoir.(Fig. 17). Instead of major faults, the terrain is marked by dense microfracturation which has finely splintered the basement rock. Tertiary tectonic movements deformed the ancient erosion surfaces formed by this microfracturation.

The Kumoso lowland is formed by a depression in the basement rock which here forms part of the Malagarasian series. Its western border is marked by a large fault (Fig. 17) of north-southwest orientation. More or less marked cliffs occur, especially near Karana. A dense secondary fracturation (Fig. 16) which runs perpendicular to the principal fault governs erosion patterns.

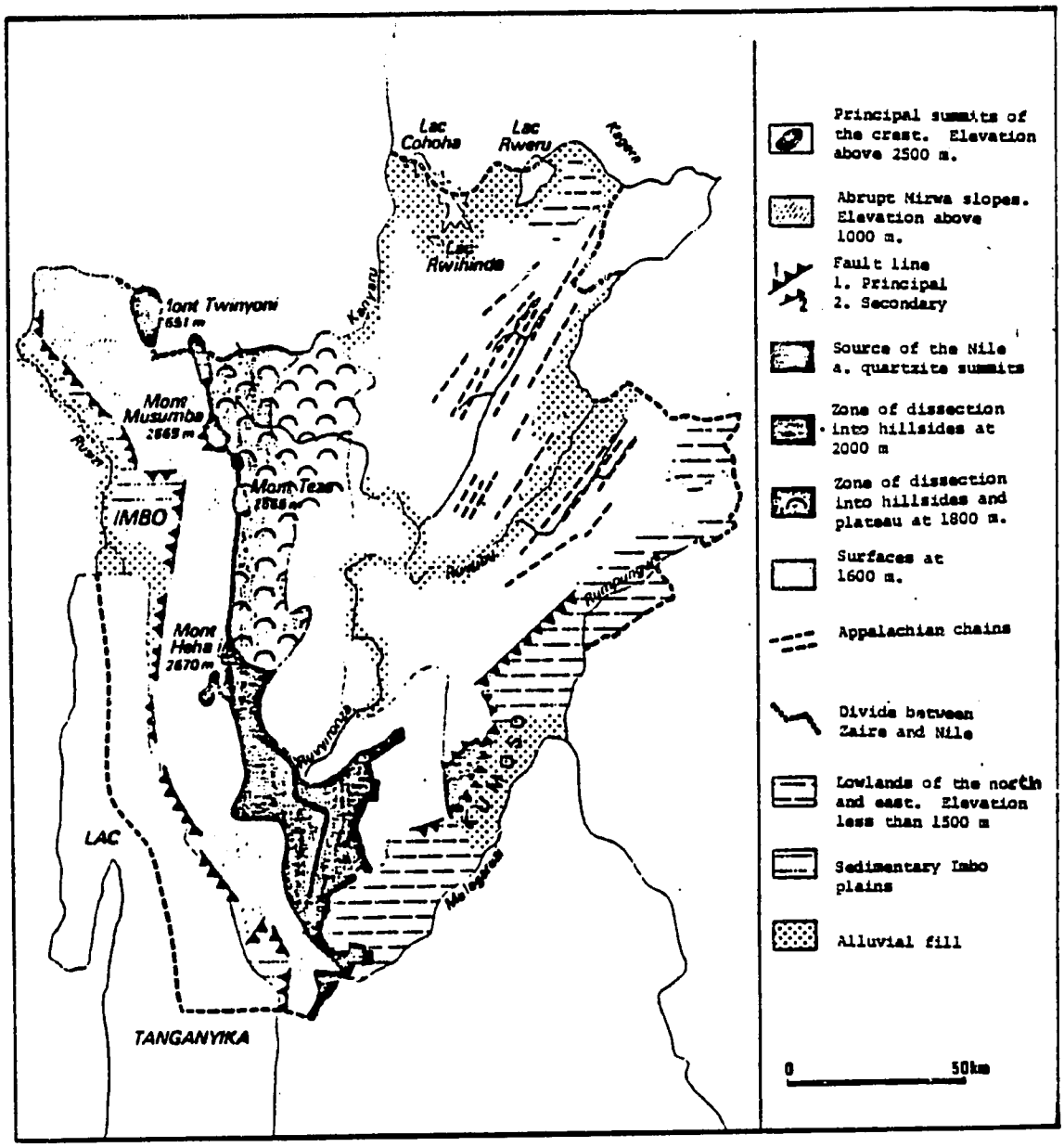


Figure 17. Topographic Features

Source: Cazenave-Piarrot et al. 1979.

3.1.3 Mineral Resources

Along the fault lines which demarcate the zones of Burundian and Malagarasian rock (Fig. 16) there occurs a zone of ultrabasic intrusive rocks, the largest of which is at Musongati with another at Nyabikere (Fig. 18). The Musongati instrusion has a surface area of 30 sq km.

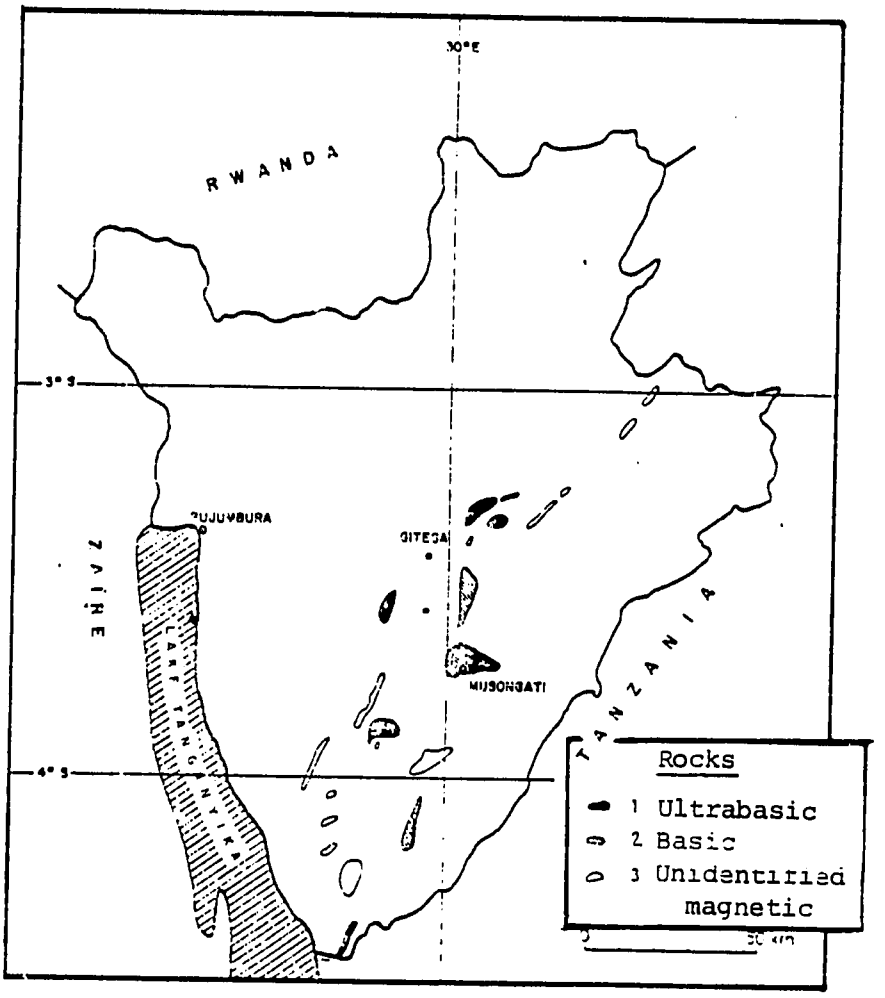


Figure 18. Zone of Basic and Ultrabasic Rocks

Source: Peric. 1981.

Lateritic strata characterize the region and show a complete profile with four horizons (Fig. 19). The saprolite horizon contains nickel-bearing minerals of up to six percent enrichment, but generally between 1.5 and two percent. Estimated at 280 million tons, these are the largest nickel deposits in Africa. Below these deposits is significant copper, cobalt, and platinum mineralization (Jolly et al. 1947; Cazenave-Piarrot et al. 1979; Peric 1981). Initial capital costs associated with production are estimated to reach U.S. $800 million. Elevated transport costs and low world market prices have not permitted commercial, that is to say, cost effective, exploitation of Burundi's nickel reserves.

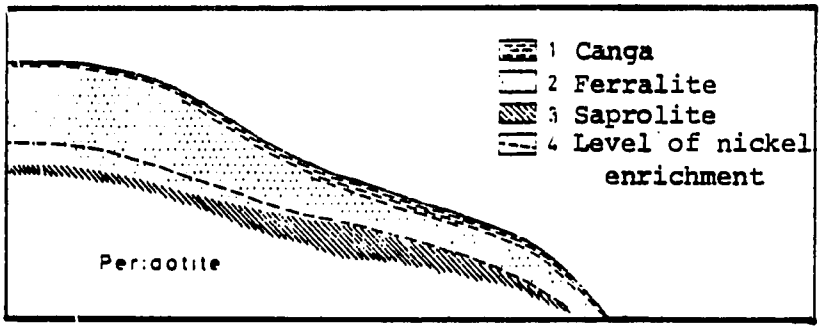


Figure 19. Generalized Profile of Musongati Mineral Deposit

Source: Peric. 1981.

In addition to nickel, Burundi claims a number of small mineral deposits of gold, bastnasite, tungsten, columbium-tantalite, and cassiterite (tin ore). The location of these and other minerals is shown in Figure 20. Production figures for the 1970s are summarized in Table 10. Subsea Development Corporation (SDC) was also reportedly searching for oil in the Rusizi and Lake Tanganyika plains and there were some positive indications. Production of bastnasite was halted in 1978 due to a declining volume of ore, and production of cassiterite fell precipitously during the recent civil unrest in Uganda (Anonymous 1979b).

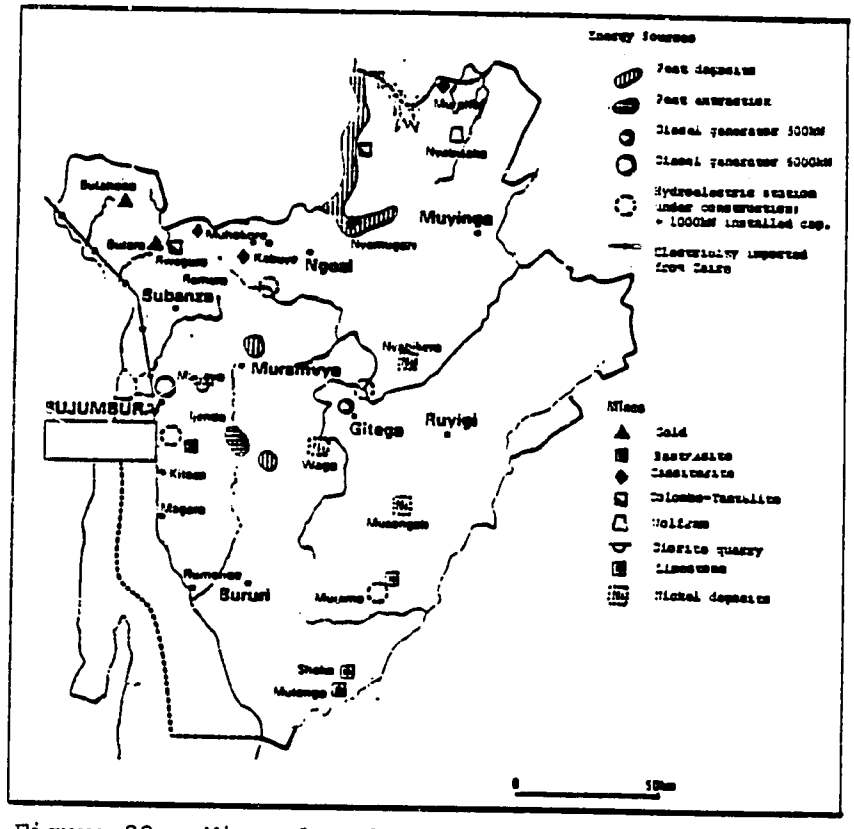


Figure 20. Mineral and Energy Resources

Source: Cazenave-Piarrot et al. 1979.

Table 10. Mineral Production in Burundi

Mineral	Production (metric tons)						
	1972	1973	1974	1975	1976	1977	1978
Gold (Troy ounces)	---	157	360	568	425		
Rare earths (Bastnaesite)	250	176	273	82	139	Abandoned	
Lime	150(Est.)	224	630(Est.)	792	622		
Clays, kaolin	---	---	---	---	2,362		
Tungsten			1(Est.)	1(Est.)	2		
Colombium-Tantalite (kgs)					4,000		
Tin ore and concentrate							
Gross weight	154	141	113	80	50		
Tin content	111	99	80	56	33	82	27 (1st Qtr.)

Sources: Jolly et al. 1974
Marble et al. 1975.
Anonymous. 1979b.

A study carried out by the U.N. Industrial Development Organization (UNIDO) in 1975 found that supplies of kaolin were abundant in the northern part of Burundi near Murumbu. Kaolin is used as a diluting agent with active ingredients for preparations required to control insects. Large deposits of kaolin in Burundi will enable the state to manufacture its own pesticides, thereby saving millions of dollars in imports over the years while protecting its coffee and cotton industries.

Urgent local needs justified setting up an insecticide plant. A company, SAVANOR, financed by both government and private sources, has been established and construction of a plant has begun. This plant was to have commenced operations early in 1976. It will have an annual output of 2,255 tons of pesticides--in the form of DDT, malathion, and HCH-based preparations--of which 1,000 tons will be exported to neighboring countries such as Rwanda and Zaire.

More than 1,000 tons of pesticides are imported each year by Burundi, mainly for the country's coffee growers. Home-produced kaolin will bring a substantial reduction--both in overall costs and in use of foreign currency while providing jobs for local residents (UNESCO 1975).

3.1.4 Mining Policy

In 1976, a mining and petroleum code was established. Under its terms, concession rights are granted for periods of 25 years, with two ten-year extensions possible. It also grants five-year permits for mining, with two successive extensions possible. Based upon available information, it is not known whether the code incorporates environmental concerns (Schreck et al. 1976).

3.1.5 Energy Resources

Most of the electricity used in Burundi is imported, although the nation has a potential to produce its own power. A company, REGIDESO, currently imports power from Zaire, although both Bujumbura and Gitega are equipped with diesel generating plants (Table 11).

Table 12 shows that Burundi has a hydropower potential of some 400 MW, primarily on the Ruvubu and rivers falling from the Zaire-Nile crest into the Rusizi River and Lake Tanganyika. However, only one small hydro-electric generator of 370 KW capacity which supplies the tea factory at Teza is currently functioning. Two other plants with a combined capacity of 9,275 KW are under construction, but nine additional small stations are to be brought into production by 1985 (Thomann 1979; Cazenave-Piarrot et al. 1979). The location of three of these is indicated in Figure 20.

Table 11. Electric Power Stations in Burundi with Capacity of more than 100 KW

Name	Source of power	Capacity	River	Owner	Phase
Bujumbura	Diesel	6000 KW	-	REGIDESO	Reserve
Gitega	Diesel	540 KW	-	REGIDESO	"
Bujumbura	Water	200 KW	Ndahangwa	REGIDESO	Out of operation
Teza	Water	370 KW	Nyabigondo	Tea Plantation	Operating
Gitega	Water	1275 KW	Ruvyironza	REGIDESO	Under construction
Mugere	Water	8000 KW	Mugere	Textile mill	Under construction

Source: Thomann. 1979.

Table 12. Hydropower Potential of Burundi's Rivers

River	Hydro power potential	Existing hydro power plants	Hydro power plants under construction
Rusizi	0	0.0	0.0
Tributaries to the Rusizi	120	0.0	0.1
Rivers falling into Lake Tanganyika	150	0.2	8.0
Malagarazi with tributaries	25	0.0	0.0
Akanyaru with tributaries	5	0.0	0.1
Ruvubu	70	0.0	0.0
Tributaries to the Ruvubu	30	0.4	1.3
Burundi	400	0.6	9.5

Source: Thomann. 1979.

Some 200 million tons of peat reserves in medium altitude sedge bogs *(Cyperus latifolius and Miscanthidium* sp.) exist in Burundi. The principal location of the bogs are marked in Figures 11 and 20. Currently 295 ha of bogs are mined by the state-owned company, ONATOUR. Dessication of bogs and nutrient dumping are potential environmental problems stemming from peat cutting. They appear to be resolvable with minimal safeguards. Peat provides a low cost, low pollutant (0.23 - 0.40 percent sulfur) alternative fuel to wood and charcoal for heating and cooking in schools and other institutions. Peat can be burned as is, or transformed into briquettes. It can alleviate Burundi's critical shortage of wood and its lack of other fossil fuels. One of the major constraints to employing peat for domestic use is that its price per caloric unit is greater than that of firewood gathered around the homestead (Cazenave-Piarrot et al. 1979; Jeune Afrique 1979; Gaudet 1980).

3.2 Soils

Eight major groups of soils can be defined for Burundi. Those categories, however, are modified by the proximity of local basement rock, slope, altitude, use, hydrological features, and vegetation cover.

In the Imbo region three types of soils are found: sandy formations, undifferentiated vertisols of topographic depressions, and halomorphic alkaline or saline soils (Fig. 21). The vertisols are the product of alluvial deposition. The halomorphic soils are derived primarily from the surrounding slopes from which they obtain their insoluble constituents. The clay fraction consists largely of amorphous gels and the soils are generally low in organic materials, but with a high reserve of weatherable materials. They are rich in calcium, sodium, magnesium, and potassium. The cation exchange capacity is high. At a shallow depth there is a hard clay horizon which inhibits root penetration and water percolation. The vertisols have a higher organic component. The halomorphic soils and the vertisols often have poor internal drainage which, in conjunction with the high rates of potential evapotranspiration in the Rusizi River valley, favor the accumulation of water-borne salts from the Rusizi River. Details of the formation and chemistry of these soils can be found in Frankhart and Herbillon (1971). Some details of their association and formation are provided in Figure 22.

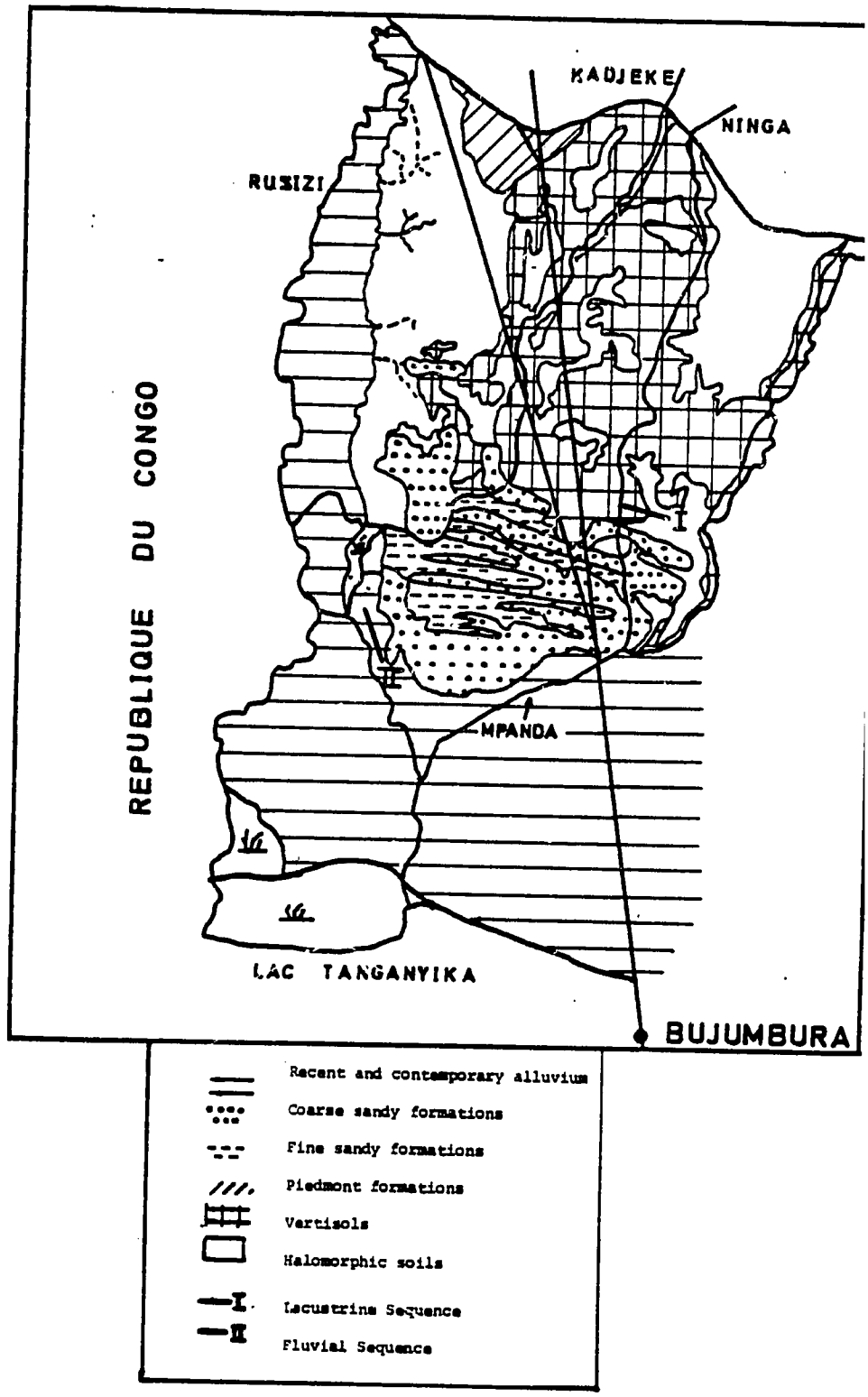


Figure 21. Geographic Distribution of Vertisols and Hydromorphic Soils in the Imbo Region

Source: Frankhart and Herbillon. 1971.

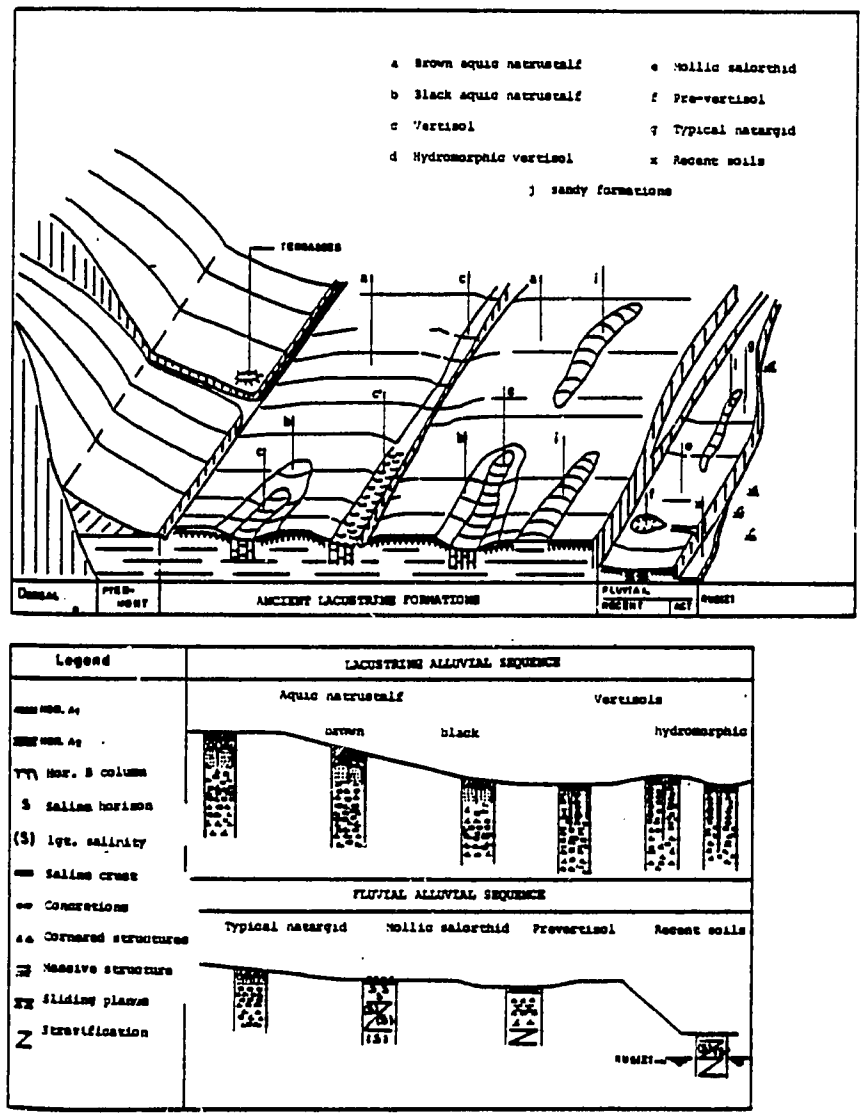


Figure 22. Soil Formation and Associations in the Imbo Region

Source: Frankhart and Herbillon. 1971.

Extending from the Rwanda-Burundi border to the region of Bujumbura, northeast of Lake Tanganyika around the 1,500 m isohypse, is a zone of humic ferrosols on extremely steep slopes. In their natural state these soils have an A-horizon thicker than 10 cm, good structure, an organic carbon content greater than two percent, a fairly high exchangeable base content, and are relatively fertile. They are suitable for tea, quinine *(Chinchona* sp.), coffee, and food crops.

On the Zaire-Nile massif two zones of soils occur. The one in the north consists of undifferentiated lithosols of poor quality. Above Lake Tanganyika, around Mt. Teza and in the Bururi forest, eutrophic brown tropical soils occur. Such soils are sometimes termed andosols. Samples of them from Kora and Ruhengeri in Rwanda show the presence of large amounts of hydrous aluminum silicates. The soils have these additional characteristics: high natural moisture, low bulk density, large amounts of organic matter, high cation exchange capacity, high phosphate sorption but low P-retention, high potassium content and, if improperly cultivated, a propensity to undergo irreversible drying due to the presence of the silicates. These soils are fragile and if improperly cultivated are easily transformed into bare stony plains by erosion (Andriesse et al. 1976; Gotanegre et al. 1974; Cazenave-Piarrot et al. 1979).

On the central plateau, undifferentiated humic ferralitic soils and undifferentiated ferralitic soils with a dark horizon cover a large area which does not, however, include the Ruvubu River valley. In the eastern portion there are also weakly developed lithosols on ferruginous crusts. Humic red ferralitic soils are of fair quality with a naturally rich A-horizon of about 10 cm thickness, and contain more than two percent carbon. Their quality depends upon the degree of erosion to which they are subject. Such soils are the product of superficial alteration and decomposition of the rock. Soils without the dark horizon are found above 1,400 m. At the higher elevations the organic reserve remains relatively stable, but on the savannahs the organic matter is frequently incinerated. Soils with a dark horizon are found above 1,300 m on very weathered parent material. They are quite infertile. The presence of the dark horizon indicates

an increase in the carbon to nitrogen ratio of at least one unit greater than the associated ferralitic soils.

The eastern region of Burundi contains weakly developed lithosols on ferruginous crusts at the highest elevations, below which are humic ferralitic soils and ferralitic soils with a dark horizon. The ancient ferruginous crusts, composed of iron and aluminum oxides, are characteristic of Tertiary surfaces in Africa. They are the product of erosion under successive climatic regimes. The consensus of opinion is that they are in the process of degradation, although some remain quite thick.

The soils of the Buyogoma region are characterized by the weakness of the humid horizon and the presence of a hard lateritic bed which sometimes assumes the form of a cuirasse, but more often that of a gravel bed (Cazenave-Piarrot et al. 1979).

In the far eastern region including the Ruvubu basin and the Kumoso depression undifferentiated ferrisols and undifferentiated red and yellow ferralitic soils on various parent materials occur. Undifferentiated yellow and red ferralitic soils are found here on both quartz and basaltic parent materials. Figure 23 illustrates a typical pedological sequence for the region and illustrates the topographic zonation of various catenas. Typically, higher ground exhibits red soils, slopes have yellow soils, leached kaolisols are found just above the valleys, and the valleys have brown tropical soils (vertisols) or hydromorphic soils. The red soils exhibit an A-C profile. Ferralitic sequences show A-C or A-D profiles on the upper slopes, and both these two profile types and A-B-C or A-B-D profile development on the lower slopes. Vertisols may have an A-B-C profile (Troupin 1966).

On these soils naturally occurring forest and wooded savannah can be quite dense. The poverty of the chemical substrates is then somewhat compensated by the mineral reserves of the vegetation and superficial soil layers. Forested soils of this type are generally of better quality than the savannah soils.

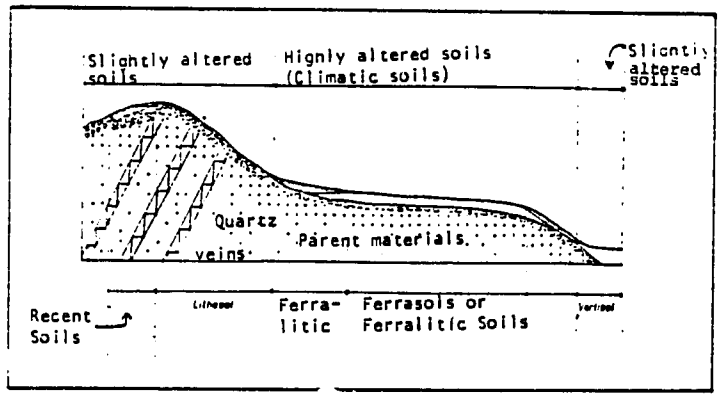


Figure 23. Topographic Sequence of Soils influenced by Quartz or Quartzite Parent Materials

Source: Troupin. 1966.

Detailed soils surveys have been conducted in the Ngozi-Kayanza region as part of the Kagera Basin development program. Details of these investigations including uses of the soils are included in Appendix V.

Scattered in valley bottoms throughout Burundi, but particularly in the drowned valleys created by the reorientation of the Nile drainage system, are found hydromorphic soils of fluvial and lacustrine marshes, that is, peat soils. They cover about five percent of Burundi's territory. These soils frequently contain over 80 percent organic matter, are of coarse texture, highly acidic, sometimes deficient in available nitrogen and phosphorus have a high carbon to nitrogen ratio and, if improperly drained, are subject to irreversible drying.

3.2.1 Agricultural Suitability and Use of Soils

While the agricultural potential of the soils of Burundi varies, most soils have limited potential at the current level of development of agricultural technique and technology. All would benefit from green manuring and from inputs of micronutrients (Sys 1975). Nonetheless, new land continues to be brought under cultivation, usually via traditional methods (Cazenave-Piarrot et al. 1979).

Eutrophic brown soils are suited for intensive cultivation of tea at higher elevations; at lower and medium elevations these soils have already been exploited for bananas and coffee. They are suitable for potatoes, sorghum, and wheat, especially at elevations above 1,800 m. The lithosols do not have high agricultural potential but need to be protected from erosion. On slopes of less than 30 percent *Setaria* hedges are recommended, and on slopes of greater than 30 percent dikes, ditches, and *Setaria* plantings should be emplaced to slow runoff.

The humic ferrasols found in the west of Burundi are of fair agricultural quality when they are derived from basaltic parent materials, and better when derived from quartzes. They respond well to intensive cropping when green mulch, compound sweepings, and manure are added. This type of cultivation can increase chemical nutrients in the soil, and the addition of calcium and magnesium further enriches the soil. Even under extensive regimes, bananas and coffee thrive on the high convex slopes, while tea flourishes on the concave surfaces and marsh bottoms above 1,500 m (Frankhart et al. 1974).

In the Rusizi, reclamation of halomorphic soils must be carefully engineered. The water table must be lowered by installation of drainage systems to facilitate percolation, and the arable layer needs to be desalinized by the application of excess soft water (d'Hoore 1964). Irrigated rice, cotton, and groundnuts do well here.

The humic ferralitic soils of the north central plateau are heavily used for traditional agriculture. The fertility of the soils depend on the thickness of the epipedon, or surface horizon, and the quality of superficial organic matter. Frequent extensive cropping, limited fallowing, the vertical pattern of agricultural zonation, and extensive erosion threaten the integrity of these soils. Rice and sugarcane may be profitably grown in some of the valleys, and protective tree crops and tea can be grown at higher elevations.

The entire eastern 45 percent of the country shares soils which are variants of those pictured in the profile in Figure 23. These soils have limited agricultural potential. Though heavy and containing occasional calcareous layers, valley vertisols are sometimes suitable for sweet potatoes. Groundnuts could be grown on the intermediary slopes, and coffee could be planted on the higher ground where no cuirasses exist. Irrigation would increase the agricultural potential, although hydrological resources on secondary rivers such as the Karuzi and Nyabihu may not support year-round systems (Bodeux 1972).

3.2.2 Soils and Human Occupation

In the area immediately surrounding most traditional homesteads there are banana groves which receive large amounts of organic fertilizer (Fig. 7). A decade or so of continuous cultivation can improve the nutrient and moisture content of the original soils (Champion 1970; Frankhart et al. 1974). Banana grove soils have been termed "humic anthropoic soils." Outside the banana grove is a two-tiered zone of permanently cultivated "integrated anthropoic soils," where sorghum, beans, and coffee are grown, below 1,800 m; or where peas, maize, wheat, cabbage, and tea are grown above 1,800 m. Some organic manure is applied, but the soils are often deficient in boron and zinc and the phosphorus-retention qualities fall below those of banana plantations. Soils beyond this zone are "weak humic ferrasols" or ferrisols which are less intensively worked and may be fallowed (Frankhart et al. 1974). Nutrient content is less than that of soils in the other cultivation zones or than that of similarly derived soils under permanent savannah or forest regrowth. Iron deficiency is a common limiting condition on plant growth in unfertilized soils used for extensive cultivation (Sys 1975). On bottom land below 1,800 m vertisols are brought into seasonal cultivation of sweet potatoes, sugarcane, manioc, and fruit crops.

The hydromorphic soils of the fluvial marshes, that is, the peat bogs, offer agricultural promise through reclamation (Gaudet 1980). Peasant farmers have successfully used the marshes for dry season cultivation of sweet potatoes. *Cyperus latifolius*, a major organic constituent of these soils like *Cyperus papyrus*, may have a nitrogen-fixing potential (Moore 1980). Typically, bog soils are brought into cultivation after lowering the water table through installation of a drainage network (Fig. 24). The soil from the rib drains is spread upon the fields, and sweet potatoes or other crops are set. Rice farming is possible in the rainy season when the bogs are inundated. Paddy yields of 1,500 to 2,700 kg per ha have been achieved by ISABU in trials around Ngozi. Because it withstands waterlogging, tea is another potentially viable marsh crop at higher altitudes. Fodder grasses, *Echinochloa* sp., *Hemarthia altimissa*, and *Brachiaria motica* may also be worth growing in order to provide dry season supplements for cattle (Norconsult-Electrowatt 1976).

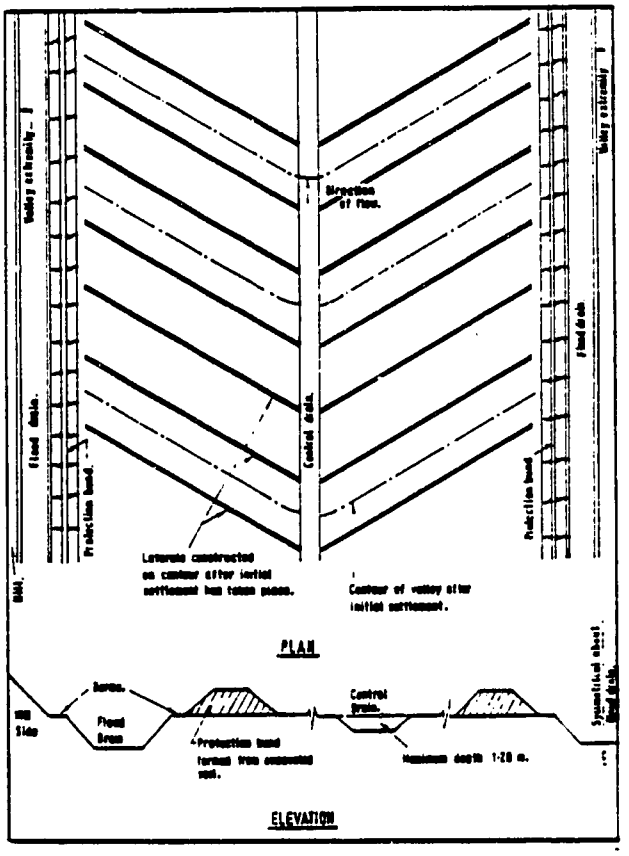


Figure 24. Typical layout of Drainage Network in Peat Soils

Source: Norconsult-Electrowatt. 1976.

Many unresolved issues remain concerning the use of peat soil. Appropriate fertilizer applications need to be determined and strictly adhered to if these soils are to be used productively. High initial capital outlays are required to drain large bogs and soils must be monitored constantly to avoid irreversible drying. In addition, considerable costs are associated with maintaining canals, sluices, and drains. Soil shrinkage and waterlogging are unpredictable. Figure 25 illustrates the steps necessary to maintain a drainage project in Rwanda. In the Nyamusaga valley in Ngoza Prefecture, Norconsult-Electrowatt (1976) determined that reclamation of peat soils would not be viable due to initial costs and maintenance expenses.

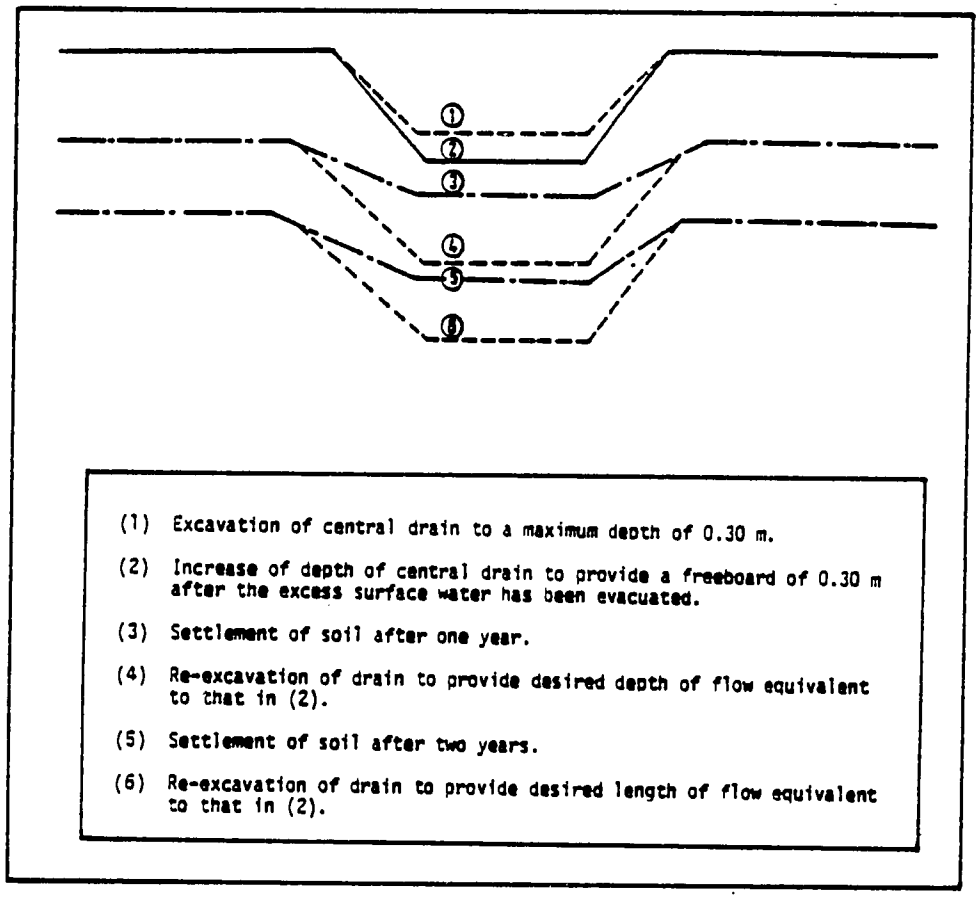


Figure 25. Settlement of Drains Constructed in Peat Soils

Source: Norconsult-Electrowatt. 1976.

3.3 Water Resources

3.3.1 Groundwater

Data concerning groundwater in Burundi were not found. It is likely, that as in neighboring Rwanda, supplies are adequate. Only Bujumbura has an extensive system of piped water which is used for domestic, institututional, and industrial purposes. These supplies are relatively sanitary. Most rural residents draw water from locally managed springs located along lower hillslopes, and seeps located in valley bottoms. Water from these sources are of good quality. Despite the fact that homesteads have latrine facilities, unprotected downslope water points are frequently contaminated from human and animal wastes resulting from heavy traffic (White et al. 1972).

3.3.2 Surface Waters[7/]

Tectonic deformations of the bedrock have created two types of rivers. A dense network of torrential streams descend the Mirwa escarpment and the entire western slope of the Zaire-Nile massif into the Rusizi River (150 km long) or into Lake Tanganyika. River gorges follow ancient fault lines. Rivers include the Mwambwe, Nyamagana, Kagunuzi, Mpanda, and Mwembwe, and Kaburantwa, many of which have hydroelectric potential.

Throughout the eastern half of the country slow streams flow through the valley bottoms. The very gradual slopes of these rivers cause alluvial blockage in many, and in the Quaternary led to the formation of Lakes Cohoha and Rweru along the Akanyaru River. Streams in the north and center of the country flow into the Ruvubu, the Akanyaru (90 km long) or the Kagera on their way to Lake Victoria. The Ruvironza is the most southerly source of the Nile. Streams in the southeast flow into the Malagarazi (475 km long) which flows along the eatern border before turning into Tanzania. Eventually it returns to Lake Tanganyika.

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[7] Sources: Bodeux. 1972
Cazenave-Piarrot et al. 1979.
Kiss. 1977.
Neel. 1974.
Norconsult-Electrowatt. 1976.
Thomann. 1979.

Detailed hydrological data on Burundi's rivers were unavailable. However, annual hydrographs of some rivers, which illustrate how water level is tied to the annual rainfall cycle, are presented in Figure 26. Streams reach their maximum levels during the long rainy season, then fall to their minima during the driest months. These hydrographs illustrate the dependence of river flow on runoff, a characteristic of Burundi due to its relief and lack of forest cover.

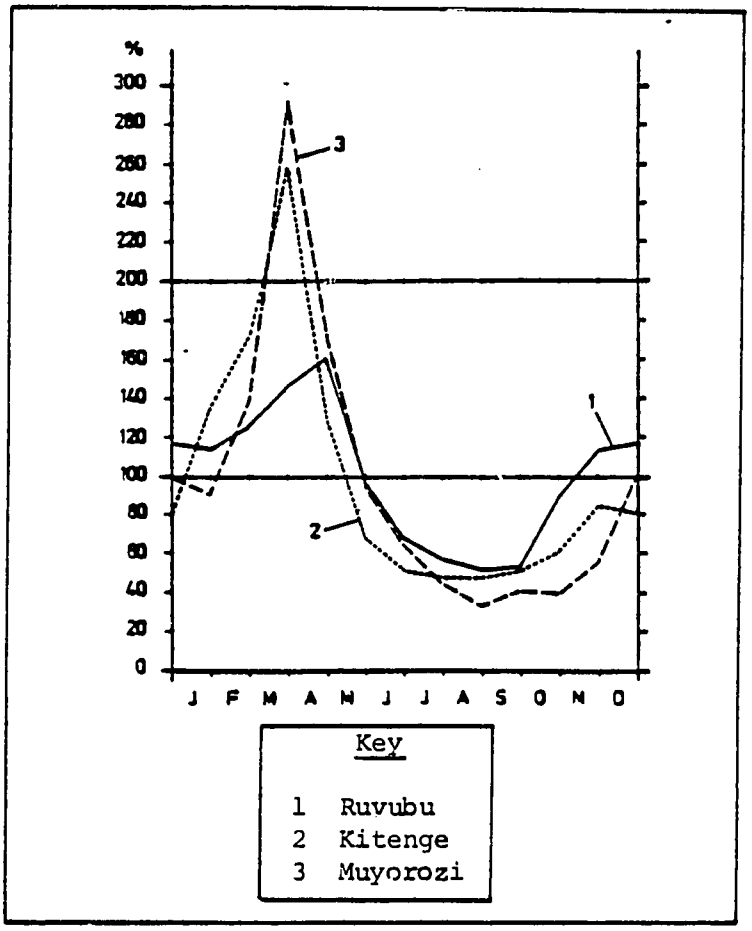


Figure 26. Typical Hydrographs

Source: Thomann. 1979.

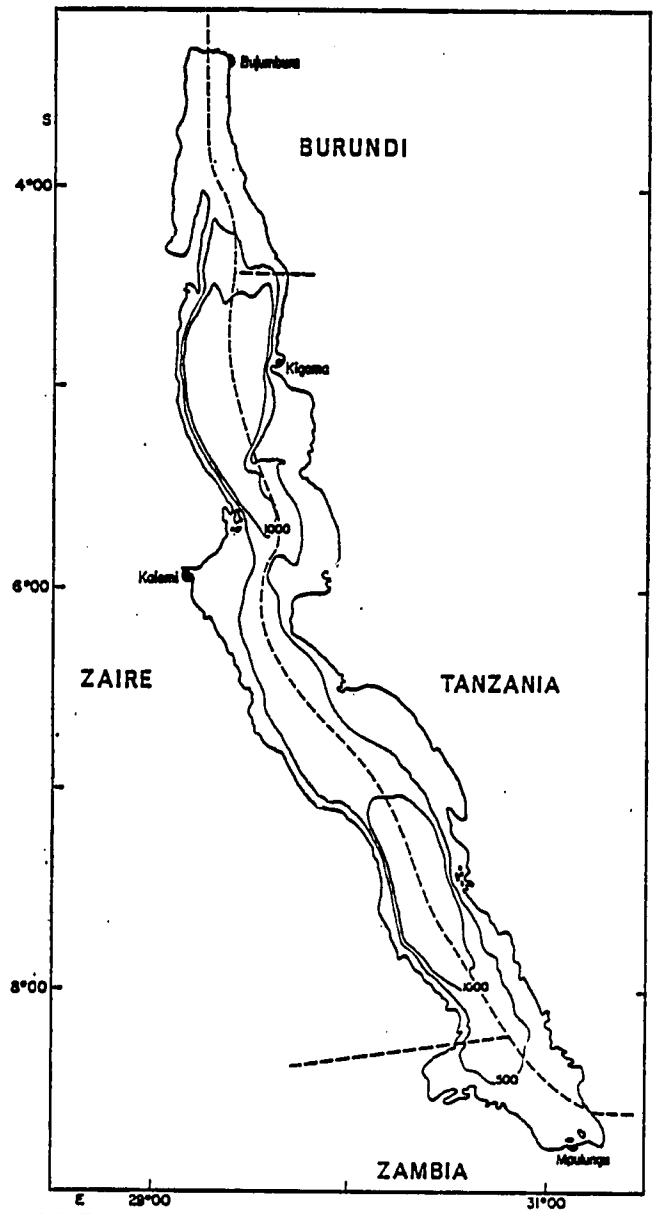
Some hydrological data are available on several smaller rivers in the eastern part of the country. The maximum depth of the Karuzi at its confluence with the Ruvubu, for example, is 2.5 m, the minimum depth, 0.40 m. The Nyabihu River attains 1.75 m in depth in peak season, and falls to 0.75 m during the dry period. In Ngozi Prefecture, the Nyamuswaga River and its tributaries, the Nyakijima, the Nyakazati, as well as the Byongwe drain . 160,000 ha. Maximum discharge on the first three rivers is 23 cu m per second, 4.4 cu m per second, and 4.3 cu m per second, respectively, while minimum discharge is 2.8 cu meters per second, 0.35 cu meters per second, and 0.35 cu meters per second, respectively. Mean discharge on the Byongwe is 2.4 cu m per second. Many of these small rivers would permit limited dry season irrigation, either at the end or beginning of the period. Table 13 summarizes chemical analyses of the Rusizi River.

Table 13. Chemical Analysis of the Rusizi River

Meq/l	Lake Kivu Aug 1948	Below gorges at km 115	Great Ruzizi		Lesser Ruzizi		Lake Tanganyika
			Aug 1948 at km 50	April 1954 at km 55	Aug 1948 at km 2	April 1954 at km 2	Aug 1948
Ca^{++}	0,52	0,47	0,45	0,30	0,57	0,55	0,53
Mg^{++}	8,36	8,09	5,78	2,51	5,29	2,01	3,80
K^{+}	2,53	2,68	1,87	0,83	1,82	0,80	1,06
Na^{+}	4,58	6,00	4,72	2,04	4,35	1,69	2,65
Cl^{-}	1,02	0,94	0,71	0,34	0,68	0,24	0,78
SO_4^{--}	0,40	0,69	1,00	0,16	0,75	0,10	1,00
HCO_3^{-}	10,05	10,42	7,89	5,05	7,76	4,74	5,01
CO_3^{--}	5,36	5,32	3,46	0,52	2,66	0,00	2,43
Σ	16,41	17,30	12,95	5,87	11,94	5,06	8,13
R.S.C.	6,53	7,18	4,14	2,77	4,56	2,18	7,01
pH [4]	9,01	9,21	9,18	—	9,18	—	8,85
S.A.R.	2,32	2,90	2,67	1,72	2,45	1,49	1,80

Source: Frankhart and Herbillon. 1971.

There are 218,360 ha of lakes in Burundi (Table 2). The part of Lake Tanganyika which lies within Burundi covers 200,000 ha, is 700 m deep, and is the largest body of water in the country (Fig. 27; Kiss 1977b). The level of the lake fluctuates several meters according to rainfall. After several wet years the Lukuga channel,



. Lake Tanganyika. International boundaries are shown by the broken line. Depth is indicated by isobaths of 500 m and 1000 m. Total lake area is 32 900 km².

Figure 27. Lake Tanganyika

Source: Coulter. 1976.

which drains the lake, becomes incapable of evacuating the increased volume of water. As a result, in 1964 the port of Bujumbura and the lower Rusizi delta were flooded.

The limnology of Lake Tanganyika is fairly well known (Neel 1974; Kiss 1977b). From mid-April to the end of August, the thermocline is deep and sharply deliniated due to the effect of the southerly dry season winds. In September, due to the action of internal waves, the isotherms climb toward the surface and reheating begins in October. The northerly movement of the epilimnion during this period brings fish to the Burundian shores. Between October and April (the rainy season) the thermocline is less deep and less clearcut at around 50 m. Due to the internal waves the thermocline oscillates by as much as 30 m, and between April and July these oscillations become quite regular with a periodicity of 12 to 15 days.

The vertical distribution of oxygen follows the isotherms. There is plenty of oxygen above the thermocline, none below. Oxygen disappears between the 24°C and 24.5°C isotherms. Variations in conductivity likewise are associated with temperature. The conductivity of the epilimnion varies between 630 and 650 µmho.

Transparency of lake waters varies with the degree of phytoplankton present, which in turn seems to be related to the depth of the thermocline. Using a Secchi disk, visibility was measured at 10-17 m from December through April, and thereafter regularly diminished to a low of 2.5 m by mid-October.

Lake Rugwero (Rweru) covers about 80 sq km in Burundi. Its average depth is 2.1 m and it contains about 210 million cubic meters of water. Papyrus *(Cyperus papyrus)* crowds the shore and forms floating islands. In February the temperature of the water at 2-3 m was 21.7°C. Chemical composition of the water is presented in Table 14. The phytoplankton is species poor and monotonous, composed largely

of diatoms and blue algae. The zooplankton is even more species poor; various rotifers are the most common types. Fish are abundant, although the lake is species poor. Twelve kinds are reported. *Haplochromis* sp. and *Clarissa* sp. are native, the other species including the *Tilapia* sp., which comprise 63 percent of the annual catch, were introduced by the Belgians.

Lake Cohoha South covers about 59 sq km in Burundi. The average depth is about 5.2 m, although it is quite variable. It contains about 395×10^6 cubic meters of water. The lake shore is too steep to support much papyrus except in the extreme south. The temperature varies between 24° and 27°C. The chemical composition of the water is presented in Table 14. Its plankton has not been studied, but resembles that of Lake Rugwero.

Table 14. Physiochemical Properties of Lakes Rugwero(Rweru) and Cohoha South[a]

Lake		H µg	Ca mg/l	Mg mg/l	Na mg/l	K mg/l	Cl mg/l	CO_3 mg/l	Transp. m
Rugwero	8.80[b]	156	4.40	6.07	13.40	6.35	5.40	91.51	0.3-0.4
	7.50[c]	158							
Cyohoha South	8.98[b]	296	9.00	10.85	25.75	9.55	4.30	152.52	0.7-0.8
	7.20[c]	319							

Notes: [a]At 25°C.
[b]Surface measures.
[c]Lower levels.

Source: Kiss. 1977a.

The icthyofauna of Lake Cohoha is less rich than that of either Lake Rugwero or Lake Tanganyika, comprising only seven species. A cooperative fishery at Yanarda takes about 1.8 tons per year. Both lakes are underfished, although Lake Rugwero was almost fished out some 20 years ago (Kiss 1977a).

3.3.3 Policy

Water law and policy derive from Belgian traditions which are close to French law, and both spring from the Napoleonic code. In Burundi, groundwater belongs to the owner of the land, except where such water is subject to legislation concerning mining or the protection of public drinking water. Surface waters are treated two ways: private appropriation of small pools or streams is recognized, while running water is publicly appropriated. Navigable waters are part of the public domain.

The statutes provide for fishing, navigation, and industrial use of water. While customary fishing rights are recognized, individual, artisanal, and industrial permits are granted on Lake Tanganyika. Fishing is curtailed in protected zones such as the Rusizi, and may be halted in areas considered saturated, or where it interferes with the potable water supply. Navigation on Lake Kivu and Lake Tanganyika is controlled by international treaty.

Several items of legislation protect water quality. Water pollution is prohibited. Accordingly, persons are required to prevent accumulation of stagnant water in settlements, and licenses to discharge polluted effluent are regulated by revokable ministerial decree. Water pollution caused by tanneries, shoe factories, and coffee processing mills is also regulated. Downstream litigants may be awarded damages and compensation. A ministerial decree is required when industrial water use involves machinery of more than 5,000 hp, or when the rate of water use is more than 25 cu m per second. Enforcement of water quality legislation probably has not been effectively carried out in rural area (White et al. 1972)

Several areas of legislation remain unclear or incomplete. There are few provisions concerning flood control, although erosion is subject to control under reforestation statutes. Water quality legislation is incomplete as is that concerning groundwater management. In addition, the actual bearer of ministerial authority is left vague in most of the documents, although the Ministries of Natural Resources,

Mining, and Industry; Health; Public Works and Housing; and Planning are all interested parties (Caponera 1979).

Current planning focuses upon the development of hydroelectric resources, fisheries, marshes, and possibly large-scale management of the water, power, and mineral resources of the Kagera Basin, and development of the navigational potential of the major lakes. A hydroelectric station is located at Mururu on the Rusizi and one is planned at Mukungwa. There are nine other installations planned. A list of key legislation concerning water resources is included in Appendix VIII.

3.4 Vegetation

Four main vegetation zones have been distinguished in Burundi: (1) undifferentiated montane communities (1,200 m to 2,000 m) with Afro-Alpine communities (above 2,500 m) occur above Bujumbura on the Zaire-Nile crest (this region is marked Fo in Fig. 28); (2) montane grasslands are found on the central plateau and in the Bweru, Burgane, and Buyogomba regions (these regions are marked Sh Ex, and SA in Fig. 28); (3) undifferentiated relatively moist woodlands and savannahs in which *Combretum* sp., *Anona* sp., and *Piliostigma thoningii* are found with a variety of *Acacia* spp. (these regions are marked as Sa Mu, and Sa Hy in Fig. 28); and (4) classical *Brachytegia* sp., and *Julbernardia* sp. woodland occur in the southwest (this is marked as Sa Mo in Fig. 28). In addition, there are swamp and lacustrine associations found around the lakes and the Rusizi, Ruvubu, Malagarasi, and Akanyaru Rivers.

3.4.1 Undifferentiated Montane Communities[8/]

Only a few stands of primary forest remain on the Zaire-Nile crest north of Muramvya, around Mount Teza, and in the Bururi forest. Primary forest occurs in association with secondary, recolonizing species.

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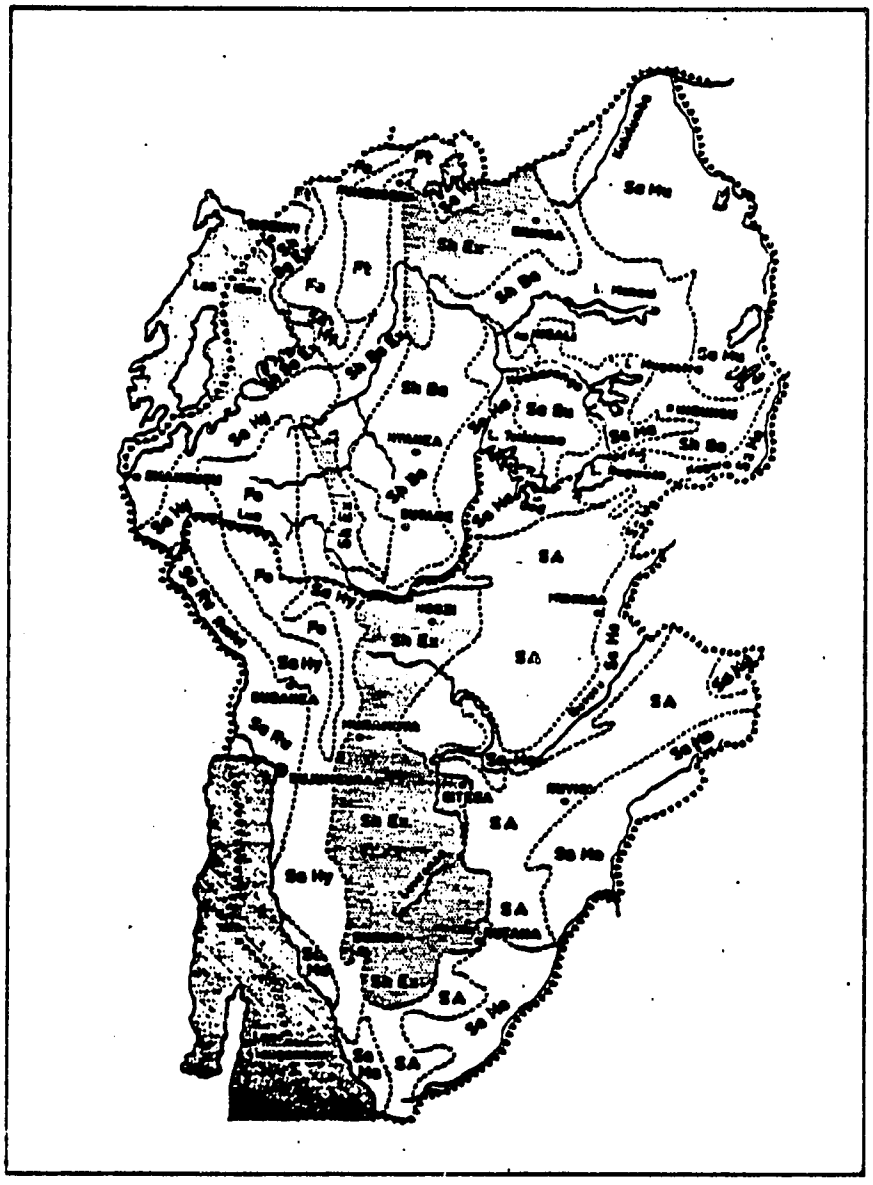
[8] Sources: Cazenave-Piarrot et al. 1979.
IUCN. 1979.
Maldague. 1980.
Pouilloux. 1976.



Legend

Fo : Ombrophilic mountain forest
Sa Hy : Wooded savanna with *Hyparrhenia diplandra*, *Pteridium aquilinum*. Forest regrowth
Sa Mu : Wooded savanna of Mutara
Sa Bu : Wooded savanna of Bugesera
Sa Ma : Wooded savanna of the Maasi
Sa Mo : Wooded savanna of the Moso
SA : Secondary savanna with Andropogon grasses
Sh Ex : Herbaceous savanna with *Exotheca abyssinica*
Sh Ba : Herbaceous savanna with *Brachiaria platynota*
Sh Ba
Ex : Herbaceous savanna with *Brachiaria platynota*, *Hyparrhenia filipendula*. Slopes with *Eragrostis boehmii*.
Ft. : Prairie with *Pennisetum clandestinum*

Figure 28. Expansion of Permanent Prairies of *Exotheca abyssinica* and *Eragrostis boehmii* in Burundi and Rwanda

Source: Compère. 1968.

Between 1,600 and 1,900 m, in regions having an annual precipitation of 1,400 mm, vegetation exhibits indistinct stratification. Dominant arborescent species include *Anthonotha pynaertii*, *Parinaria excelsum*, *Albizia gummifera*, and *Prunus africana*. The shrubs include *Carapa grandiflora*, *Securidaca welwitschii*, and *Schefflera barteri*. Numerous epiphytes and ferns coexist with the trees.

Between 1,900 and 2,500 m, with 1,450 mm of annual rainfall, vegetative strata are clearly marked. The following vegetation is typical of Mount Teza. In the arborescent stratum *Entandophragma excelsum*, an endangered species, *Prunus africana*, and *Parimari excelsa* are found with the secondary species *Polyscias fulva*. Smaller trees include *Tabernaemontana johnstonii*, *Symphonia globulifera*, *Strombosia scheffleri*, *Neuboutonia macrocalyx*, *Xymalos monospora*, and *Macaranga neomildbraediana*, a secondary species. Shrubs include *Dracaena afromontana*, *Galiniera coffeoides*, and *Allophyllus oreophilus*. There are liana such as *Culcasia scandens*, epiphytes, and mosses.

Between 2,250 and 2,450 m on Mount Teza, where 1,450 mm of rain falls, the following vegetation occurs: the arborescent stratum includes *Syzigium parvifolium* and *Ficalhoa laurifolia*; shrubs. include *Monanthotaxis orophila*, *Maytenus acuminatus*, and *Rapanea pulchra*.

Among the epiphytes, *Usmea* spp., lichens, and *Huperzia afromontana* and *H. mildbraedii* occur. The grass cover is species poor, and discontinuous. In the high Mpanda valley there is a large stand of the bamboo *Arundinaria alpina*.

Above 2,500 m there is humid fog forests in which are found the tree ferns *Philippia benguellensis*, *Protea welwitschii*, *Erica kingaensis*, *Faurea saligna*, *Blaeria kivuensis*, and *Agauria salicifolia*; *Braunia* sp. may occur. Grasses include *Eragrostis olivcea*, *Xyris* spp., *Asplenium friesiorum*, *Cyanotis lantana*, and *Ultricularia troupinii*. Here the soils are thin, leached, and without humus.

3.4.2 Montane Grasslands[9/]

In the southern part of the Zaire-Nile crest and on the Central Plateau of Bututsi, Buyenzi, Kirimiro, and Buyogoma, virtually no natural vegetation remains. *Ficus* sp. is the sole surviving indigenous tree. Stands of *Eucalyptus* sp., *Grevillea robustus,* and rather sickly *Cupressus* sp. are seen. Vast expanses of short prairie grasses contain ferns in uncultivated areas. These pastures are less diverse and more degraded than those in neighboring Rwanda (Fig. 28).

At one time these high altitude (1,800 - 2,500 m), well watered (1,250 mm) pastures supported *Themeda diplandra.* and *Pteridium aquilinum* which still survive on the forest margins. However, as a result of overgrazing and too frequent burning of the grasslands, *Exotheca abyssinica* has become dominant. With continued overgrazing and burning, *E. abyssinica* is replaced by *Hyparrhenia bracteata* and *Eragrostis boehmii.* On dry and eroded terrain, particularly on lateritic summits, a thin cover of *Loudetia simplex* survives. The dominant species, however is *E. abyssinica* covering 80 percent of the terrain; *Themeda triandra, Hyparrhenia bracteata, Setaria triumvera,* and *Trifolium simerse* are also found.

In the Bweru region and along the border between Buyogoma and the Kumoso regions, Sudanic-like vegetation is found. *Andropogon* sp. grasses predominate with *Acacia* sp.

3.4.3 Undifferentiated Moist Woodlands and Savannahs

There are a variety of savannah associations in Burundi. On recent sediments in the Rusizi, *Hyphaene benguellensis* var. *ventricosa* occurs over thousands of hectares (Fig. 29). On other soils *Euphorbia candelabrum, Sanseviera dawei,* thickets of *Cadaba grandiflora, Commiphora* spp., and numerous spiny plants occur. Guinean type forest is found at Kigwera; *Stychnos potatorum* savannah occurs but is threatened due to fires. The low piedmonts in the northern part of the plain are dominated by *Brachystegia* sp. woodlands. Locations and vegetative associations found along two transects across the Rusizi plain are shown in Figure 29.

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[9] Sources: Compère. 1968
Rattray. 1960.

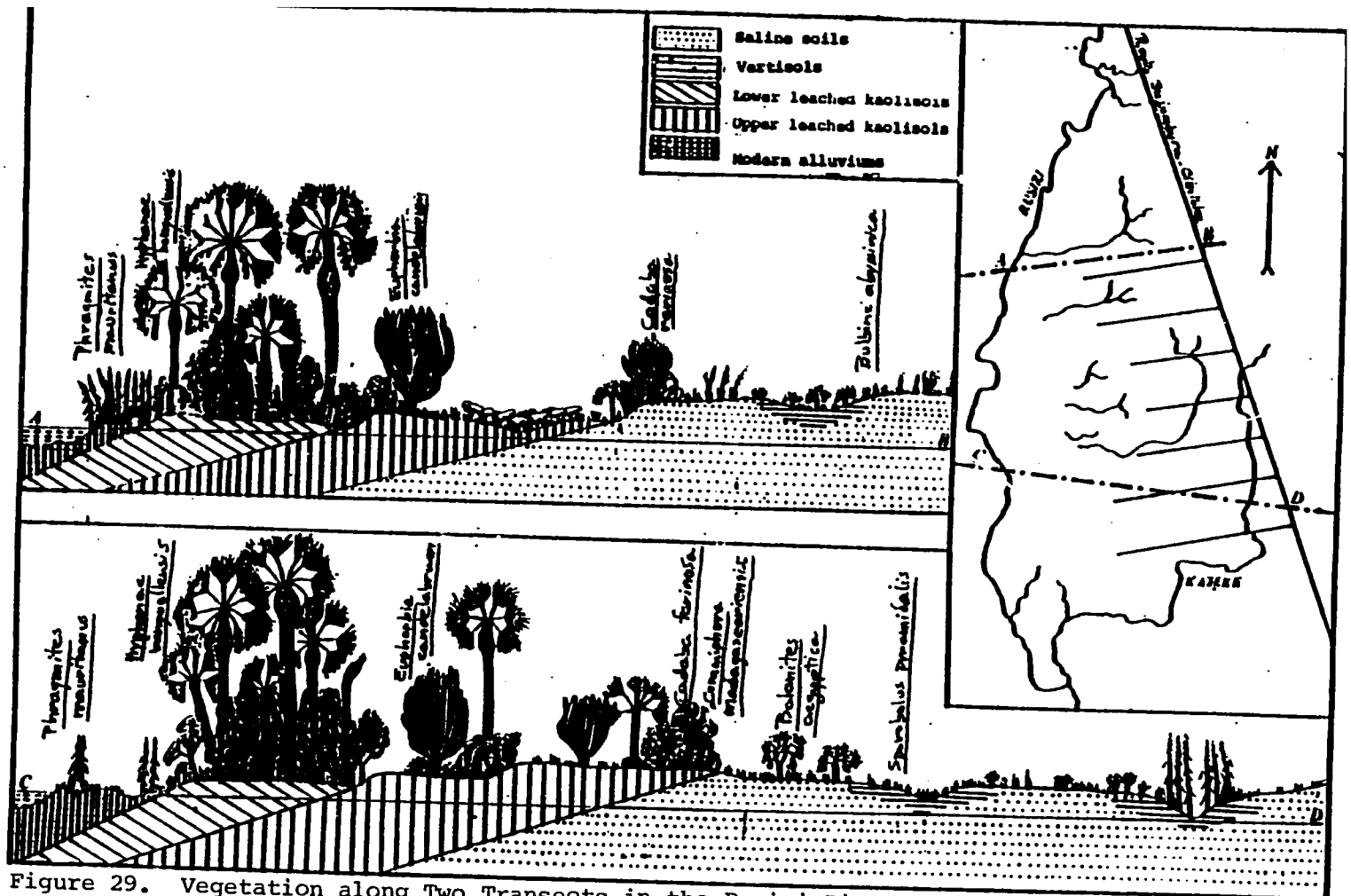

Figure 29. Vegetation along Two Transects in the Rusizi River Valley

Source: Maldague. 1980.

In the Mugamba region, climax forest has given way to secondary formations. North of Muryamva a few remnants of gallery forest remain and include *Pycnanthus angolensis, Albizia* sp., and *Chlorophora* sp. The dominant grass species are *Pteridium aquilinum, Hyparrhenia diplandra, Eragrostis boehmii,* and *Kotshya* sp..

Along the Ruvubu River, which has stands of papyrus, *Phoenix reclinata, Acacia seyal, Combretum* sp., and *Terminalia* sp. are found (IUCN 1979).

3.4.4 Classical *Brachystegia* and *Julbernardia* Woodlands[10/]

These wooded savannahs occur in the Kumoso region, where land has not yet been cultivated. *Brachystegia spiciformes, B. boehmii, B. hockii, Julbernardia globiflora,* and *J. pariculata* are the signature species of this Zambezian vegetation. Spiny shrubs such as *Acacia* sp., *Caffra* sp., *Albizia* sp. attain 10-15 m in height and assume a parasol-like shape. *Ficus* sp. and *Euphorbia* sp. also occur with grass cover between the stands of trees. Commonly, this grass is *Hyparrhenia* spp. In the northern part of the lowlands the laterite cuirassed hills support large stands of the bamboo, *Oxythanantra abyssinica.*

From the standpoint of vegetation, the best known part of the Kumoso is around Nyanza-Lac (Shantz and Turner 1958). Studies conducted in 1920 and 1957 provide knowledge of floral succession under human influence, associated with a decrease in cultivation, an intensification of grazing, and overburning,

Brachystegia hockii, Acacia albida (a nitrogen-fixing tree), *Diplorrhynchus* sp., *Brachiaria brizantha* (a rhizomatous grass up to 75 cm in height), *Panicum maxicum, Hyparrhenia* sp., and *Cymbopogon* sp. were seen in 1920 at about 1,000 m.

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[10] Sources: Cazenave-Piarrot et al. 1979.
Keay. 1979.
Pouilloux. 1976.
Shantz and Turner. 1958.

In 1957 the same region exhibited an exceptional recovery of small trees in addition to the aforementioned species. Small trees included: *Pilostigma thoningii, Grewia mollis, Aussonia spicata, Anona chrysophylla, Securidaca longipedunculata, Combretum binderanum,* and *Acacia* spp. Invading grasses included: *Brachiaria brizantha, Hyparrhenia dissoluta, Loudetia kagerensis,* and *Digitaria diagonalis.*

In 1920 at 1,100 m, *Acacia albida, Albizia* sp. *Acacia* sp., *Erythrina* sp.,*Rhus vulgaris,* and *Heliochrysum* sp. were identified. The shrubs *Anisophylla pomifera* and *psorospermum febrifugum* were seen on hill slopes, along with *Protea tricanthera, P. congensis,* and *Hyparrhenia* sp. grass.

By 1957, erosion had denuded some of the same hillslopes. *Eragrostis racemosa* was the dominant grass. Scattered shrubs had grown up, including *Vitex fischeri, Grewia mollis, Anona chrysophylla, Combretum binderanum, Anisophylla pomifera,* and *Psorosperum febrifugum.*

In 1920 on a hill at 1,600 m, the shrubs *Anisophylla pomifera,* and *Albizia gummifera* grew in association with *Hyparrhenia familiarus, H. filipendula, H. diplandra,* and the forb *Helichrysum* sp.

In 1957 tall grasses had been replaced by less desirable short ones, including *Eragrostis racemosa* and *Digitaria maitlandi,* and the unpalatable forbs *Bulbostytis astrosanguinia, Protea tricantha,* and *Otiophora caerula. Psorospermum febrifugum* shrubs had grown up as well.

3.4.5 Swamp Vegetation

In addition to the four major vegetation associations discussed above, swamp and bog vegetation occurs. The northern river valleys are choked with papyrus *(Cyperus papyrus)* reaching 1.5 m in height.

Bogs along the Nyakajima and Nyamuswaga Rivers in Ngozi Prefecture mostly contain *Cyperus papyrus*, but include *C. denudatus, C. latifolius, Pycreus lanceus, Cyclosorus striatus, Polygonum richardii,* and *Nymphaea coerula;* swamps along the Akanyaru River probably contain similar species. Much of this swampland has been reclaimed for agriculture by local farmers (Norconsult-Electrowatt 1976).

A second major type of bog vegetation is found at the higher altitudes (2,000 - 2,500 m) where the mean annual temperature is about 16°C., and rainfall averages 1,200 - 1,500 mm annually. These bogs resemble the boreal bogs of Europe in that the dominant vegetation consists of sphagnum moss, sedges, grasses (like *Carissa* sp.), and evergreen shrubs. *Cyperus latifolius* is the most common plant. *Miscanthidium violaceum* is also present, as are *Erica* sp. shrubs. The rush, *Xyris* sp., is found in the southern bogs. At one time, *Erica kingaensis* spp., *Lobelia milbraediana,* and *Sphagnum* sp. were probably the dominant plants. A more thorough discussion of Burundi's bog vegetation can be found in Gaudet (1980).

Many of Burundi's plants are employed in traditional medical practice. A list of these plants is provided in Appendix VI.

3.5 Fauna

Until very recently, Burundi had a large and diverse population of native terrestrial fauna and avifauna concentrated in the Imbo region, the Zaire-Nile crest, the Ruvubu River valley, and the Kumoso lowlands. Nonetheless, the fauna has not been carefully studied. In recent years the lack of national parks, nonenforcement of hunting and poaching laws (Appendix VIII), and rapid population growth have greatly diminished areas available to wildlife. The creation of the Imbo paysannats, beginning in the 1950s, on thousands of hectares of virgin land has had a destructive impact on wildlife. Only one percent of the country could still be considered virgin habitat, and wildlife survives only in the ten percent of the national territory where agriculture remains sporadic (Curry-Lindahl 1974;

IUCN 1979; Verschuren 1977a, 1977a, 1978). In general, aquatic wildlife has survived better than terrestrial fauna. The hippopotamus, for example, is extremely successful and is found both along the shoreline near Bujumbura and in the Ruvubu River valley. The river, in fact, takes its name from this beast which successfully manages its population and grazing grounds. However, both the African Slender Snouted Crocodile, which inhabits Lake Tanganyika, and the Nile Crocodile, which may have lived on the Akanyaru or Kagera Rivers, are endangered species (IUCN 1975).

Lists of selected fauna are included in Appendix VII.

3.5.1 Terrestrial Fauna

On the Zaire-Nile divide, primates were once common. These included the now locally extinct Mountain Gorilla, Bosman's Potto (*Perodicticus potto*), Thick-tailed Bushbaby (*Galago crassicaudatus*), Yellow Baboon (*Papio cynocephalus*). Diadem Guenon (*Cercopithecus mitis*), Angolan Black and White Colobus Monkey (*Colobus polychromos*, and around Mt. Teza, chimpanzees (*Pan troglydytes*). Buffalo, elephant, Giant Forest Pig, serval, mongoose, and Genet were also common, as were several species of *Muridae* (IUCN 1979; Verschuren 1978).

In the lowlands, until the 1950s there were hundreds of elephants in the Imbo region; these have now disappeared. Today some non-anthrophobic species including bushbuck, 200 hippopotami, some Sitatunga, wild hogs, and baboons survive. The Kumoso, Busomi, and Ruvubu valleys were all zones in which wildlife was once abundant. But only the Ruvubu valley, which remains uncultivated over some 125 km, supports significant populations of native fauna today. Lions, jackals, hyenas, warthogs, and wild dogs may be found in small numbers. Defassa's Waterbuck, Roan Antelope, Impala, Sitatunga, buffalo, and elephant are among the large ungulates which are still sighted. Additionally, a large colony of fruit bats (*Eidolon helvum*) lives in Bujumbura (Verschuren 1978).

A large number of reptilian genera are present in Burundi. These include snakes, Nile Crocodiles, lizards, chameleons, and geckos (Derleyn 1977, 1978a, b). A list of selected reptiles is included in the faunal surveys in Appendix VII.

3.5.2 Economic Uses of Wild Ungulates

Ranching of wild ungulates provides an alternative for combining economic productivity and conservation of wildlife (Lambrecht 1966; Spinage 1969-70; Norconsult-Electrowatt 1976). Advantages of raising wild ungulates rather than domesticated animals in the underused eastern region between Ruyigi and Muyinga include:

(1) decreased water dependence of wild ungulates;

(2) greater diversity of forage plants exploited by wild ungulates;

(3) more rapid weight gain, earlier fecundity, and higher birth rates of wild ungulates;

(4) decreased susceptibility of wild ungulates to animal trypanosomiasis; and,

(5) absence of social and aesthetic values inhibiting optimum commercialization of domesticated livestock.

Because of endemic trypanosomiasis, theilerosis, other illnesses, and the poor quality of fodder on the eastern plains, the biomass of small domesticated ruminants which can be supported there is only about 900 to 1,300 kg per square km. By contrast, the wild ungulate biomass in unspoiled areas of the Akagera Park in neighboring Rwanda is 15,000 to 18,000 kg per square km which is close to the maximum, given the current state of pastures in the Mutara region (Lambrecht 1966; Spinage 1969-70). About 20 percent of an ungulate biomass of this density could be harvested annually (3 to 5.3 tons of meat per sq km). This figure far exceeds those obtained by current harvesting of domesticated animals (Norconsult-Electrowatt 1976). Because wild

animal ranching has proven successful elsewhere in East Africa, it is likely that wild ungulates can be ranched in Burundi as well (Lambrecht 1966).

Problems associated with wild ungulate ranching include establishment of infrastructure, training of personnel, refrigeration and transport of butchered animals, creation of a demand for game within Burundi, and competition with other sources of supply on world markets.

3.5.3 Avifauna

In contrast to terrestrial fauna, the avifauna appears to have survived relatively well, although it has not been closely studied (Maldague 1980). Some 594 species, including many northern migrants such as *Larus fuscus* and *Acitis hypoleucos*, have been reported. Many large African water birds live in the swampy areas, the Imbo region, and along the Ruvubu River. Lake Rwihindi, once the nesting site for thousands of stork and ibis (for example, *Ardea melanocephala, Nycticorax nycticorax)*, has declined in importance due to a change in the water level of the lake. Notable species in the Imbo delta include the Yellow-Billed Stork, the Saddle-Billed Stork, the Lesser Flamingo, and the African Skimmer which nests there.

The beaches and lagoons of Lake Tanganyika are populated by *Charodrius pecuarius, Glareola protinioda,* and *Bubulous ibis,* the ubiquitous Cattle Egret. On the woody savannas, pigeons *(Columba)* are found, as are lapwings *(Vanellus coronatus* and *V. rugubris)*. Numerous species of sparrows inhabit the dry gallery forests. Marshes shelter numerous species including *Mycteria ibis, Platalea alba, Himantopus himantopus,* and, at certain periods, Lesser Flamingos *(Phoeniconaias* sp.) and Glossy Ibis *(Plegadis falcinellus)*. Over 1,000 pelicans *(Pelecanus oncrotalus)* have been observed on the Ruvubu River, along with *Tantales ibis* and *Leptoptila crumenofecus*.

Many species, especially the francolins, pigeons, and *Balearica negulorum* are subject to heavy poaching by foreign hunters. Most Barundi respect birdlife and tend to avoid poaching.

3.5.4 Icthyofauna and Fisheries[11/]

Both Lake Tanganyika and the smaller Lakes Rweru and Cohoha contain important populations of fish. Three *Lates* species. *L. mariae, I . microlepis, L. angustrifrons,* and *Luciolates stappersii,* which belongs to a monotypic genus, occur only in Lake Tanganyika. They are the principal predators in the pelagic and benthic fish communities. After a post-larval pelagic phase, each *Lates* sp. spends one year in littoral weed. Thereafter, *L. mariae* adopts a benthic habitat moving into deep water, *L. microleps,* becomes exclusively pelagic and *L. angustifrons* is found from the littoral to the limit of the oxygenated zone. Cycles in breeding correspond to seasonal maxima in clupeid prey, and changes in growth rate within a year are probably related to physiological cycles rather than to variations in the physical environment.

Local abundance and vagility of *Lates* stocks seems related to basin morphometry and depth of the oxygenated layer. *L. microlepis* has the most vagility. The *Lates* appear highly susceptible to intensive fishing with purse-nets, and have been depleted. With reduced predation, the clupeid biomass has increased. The change to dominance of small species may be accomplished rapidly in Lake Tanganyika under conditions of intensive exploitation. However, the type of species successions well-known in large temperate lakes are unlikely to occur because of the high degree of specialization among small fishes. A simplified pelagic community foreseen by Coulter (1976), would consist almost entirely of clupeids and *Luciolates.* The total fish biomass of such a community would be determined above some intensive level of fishing, and from year to year by the environmental factors controlling survival of young and planktonic food supply.

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[11] Sources: Cazenave-Piarrot et al. 1979.
Chapman and van Well. 1978.
Coulter. 1976.
Dunn. 1977.
Neel. 1974.
Kiss. 1977b.

The community may be sufficiently robust by reason of its rapid turn-over rates to permit a largely empirical approach to management (Coulter 1976). Distribution and density of the pelagic fish biomass in Lake Tanganyika is graphically represented in Figure 30. Altogether there are 133 species of fish, including several *Siluridae*, in Lake Tanganyika. In Lake Rweru and Lake Cohoha *Tilapia nilotica* and other *Tilapia* species are dominant, although they are less common in Lake Tanganyika. Details of the biology of these cichlid fish are reported in Kiss (1977a).

Lake Tanganyika appears to be the only Burundian site of an important fishery. The smaller lacustrine fisheries provide only two to three percent of the total annual catch. Research into the fish biomass of Lake Tanganyika has determined that the optimum catch is about 20,000 tons per year. This tonnage was attained for the first time in 1976. The government was subsequently obliged to limit the number of active industrial fishing flotillas to 18 at a time. The best fishing occurs between August and January, overlapping the dry season months.

Three types of fishing are practiced on Lake Tanganyika: traditional, artisanal, and industrial. On the smaller lakes, only traditional fishing is practiced (Dunn 1977). Statistics summarizing annual catches on Lake Tanganyika between 1950 and 1976 are given in Table 15. Traditional fishing takes place in shallow waters, where small nets are employed. Both day and night fishing are practiced. Some 1,500 to 2,000 part-time fishermen employ 700 to 800 pirogues. Artisanal fishing was developed beginning in 1957 under government auspices. Metal-hulled catamarans, nets of 288 cubic meters, and pressure lamps are employed in night-time fishing. About 2,500 to 3,000 persons divided into groups of four and five men are involved in artisanal fishing. Annual catches average ten to fifteen tons per team. Industrial fishing was inaugurated in 1954 by Greek immigrants who employed techniques similar to those used in Mediterranean sardine fishing. Like the other two methods it is done at night. Each flotilla comprises a large metal-hulled boat which handles the net and the catch, a whale boat which keeps the net untangled in the water,

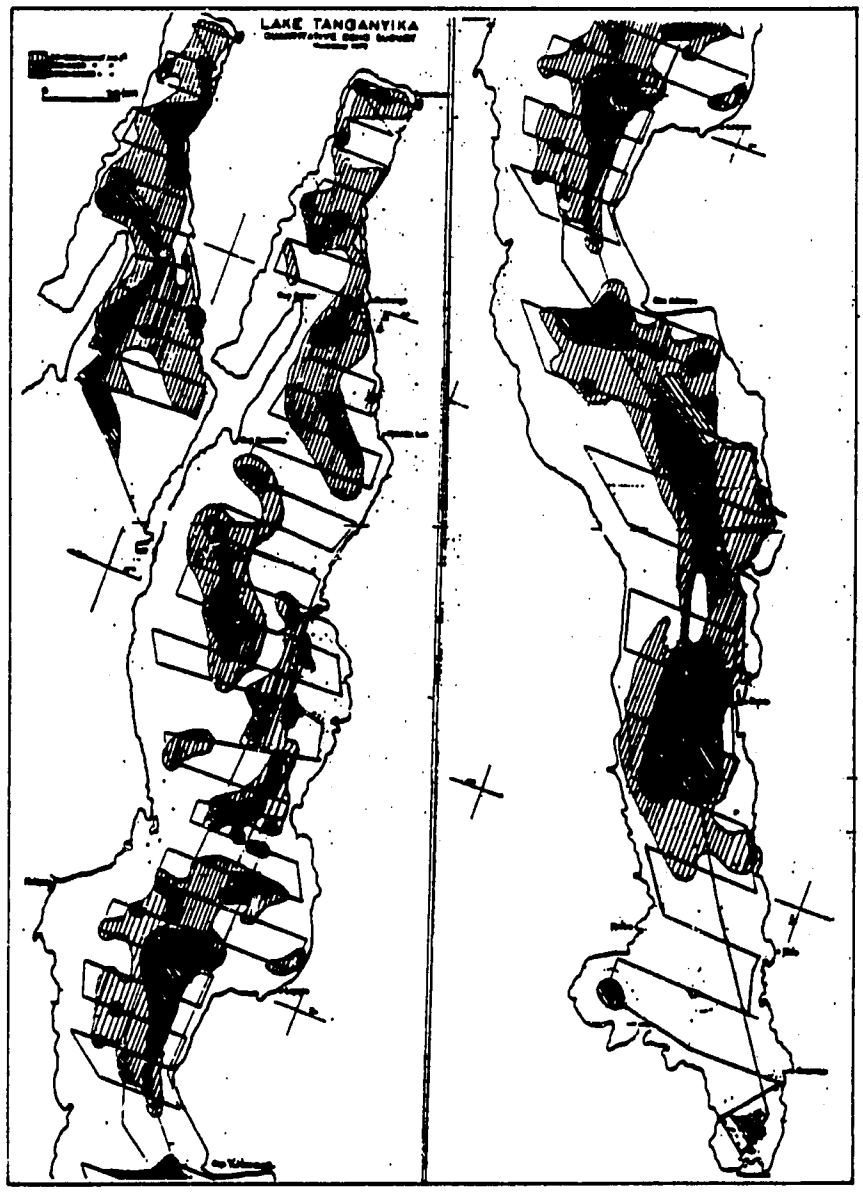

Figure 30. Distribution and Density of Pelagic Fish in Lake Tanganyika

Source: Neel. 1974.

Table 15. Summary of Pelagic Fish Catches in Burundi, 1950-76

	TRADITIONAL FISHING			ARTISANAL FISHING			INDUSTRIAL FISHING				TOTAL (Tons)
	No. of Teams	NDAGALA	OTHER FISH (Tons)	No of Teams	NDAGALA	OTHER FISH (Tons)	No. of Teams	NDAGALA	SAMBAZA (Tons)	NUKERE	
1950	NR	1 010									1 010
1951	NR	1 500									1 500
1952	1 380	2 500	500								3 000
1953	NR	3 000	220								3 220
1954	1 512	4 000	600				2		317		4 917
1955	1 578	4 200	500				2		482		5 182
1956	1 350	2 675	400				4	1 250	272	280	4 892
1957	1 572	5 065	500	18	NR	NR	7,75	1 648	729	535	8 477
1958	1 500	6 176	500	32	NR	NR	12	1 038	2 332	287	10 333
1959	1 475	5 217	500	32	600	20	12	1 617	1 489	240	10 083
1960	1 488	4 412	500	32	304	23	12	1 454	868	559	8 120
1961	1 458	2 617	250	59	397	13	8	1 326	378	259	5 240
1962	1 458	3 635	300	56	939	82	8	1 114	287	794	7 131
1963	1 343	7 089	250	82	821	75	9	936	259	1 201	10 624
1964	1 343	6 31[illegible]	46	[illegible]	1 415	64	[illegible],42	1 974	230	394	10 433
1965	1 680	15 367	[illegible]	[illegible]	2 041	93	[illegible],17	2 376	95	215	20 207
1966	1 624	9 983	118	[illegible]	2 549	108	9,25	3 320	210	409	16 697
1967	1 624	6 578	55	121	1 [illegible]	40	8,25	3 677	319	945	13 521
1968	1 624	5 556	193	[illegible]	1 422	71	9,75	3 437	396	1 213	12 288
1969	1 459	6 230	67	506	4 489	[illegible]34	11	2 367	431	1 340	15 538
1970	1 459	4 064	10	516	3 473	287	13,08	3 686	544	1 227	13 291
1971	1 459	5 963	3	516	4 693	183	14,92	5 511	363	180	16 896
1972	1 091/394*	1 858	588	418/53*	1 238	32	13	3 763	248	316	7 445
1973	362/351*	1 145	423	66/128*	1 312	24	13,92	4 655	259	707	8 525
1974	408/473*	1 640	185	154/202*	3 099	28	14,92	5 087	157	967	11 103
1975	729/765*	3 567	261	250/390*	4 418	141	17,83	4 037	319	1 788	14 531
1976	707/633*	2 616	1 077	451/540*	6 834	1 091	22,62	4 876	472	3 354	20 320

*Figures obtained from surveys taken in March-April and September-October, respectively.

Source: Kiss. 1977b.

and several small boats which shine lights over the net. Each industrial fishing team includes some 30 men. In all, 600 to 700 persons are directly involved; women often market the fish.

Environmental problems related to the fishing industry include overfishing, unsanitary drying and packing facilities, lack of fuel to permit smoking, and abnormal concentrations of pesticides in the tissues of the fish (Neel 1974).

Given the chronic protein shortage in the diet of the majority of Barundi, continued development of the fishing industry is being actively encouraged by the government. Current production theoretically provides an average of 2.2 kg of fish per person per year, but in fact most of the fish is consumed in the Imbo region (Jeune Afrique 1979).

3.5.5 Protection and Reserves

The establishment of national parks and preserves has been debated. Laws dating to 1933 and 1951 established the Zaire-Nile divide and the Bururi forest as reserves. Neither "reserves", however, have been protected, nor have new ones been established. It is now too late to save the fauna over large parts of the Kumoso and Busomi regions, the valley of th Malagarasi, the Imbo or the Zaire-Nile crest. Nevertheless, proposals have been made by IUCN (1979) and others to establish small preserves around Mt. Teza and in the remaining Bururi forest, as well as in the Ruvubu Valley where important concentrations of representative fauna remain. It would also be desirable to preserve some part of the unusual *Hyphanae benguellensis* var. *ventricosa* savannah in the Imbo region. A park in the Ruvubu region could be of even greater interest than the Akagera Park in neighboring Rwanda because it enjoys higher rainfall and is more lush. There is also talk of extending Itombwe Park in Tanzania, where chimpanzee populations are preserved, over the border into Burundi.

Without protection from poaching and cultivation in the remaining refuges, many species of mammals and birds are likely to become extinct in the very near future.

Except for some Twa groups, most Barundi are not avid hunters themselves. The extension of cultivation, however, has a serious detrimental effect upon many species (IUCN 1979; Verschuren 1978).

4.0 Environmental Problems

In Burundi, uncontrolled human pressure exerted on ecosystems threatens natural balances and has initiated undesirable ecological successions. There is a diminishing diversity of species, particularly of large mammals and useful plants, and lower overall systemic productivity (Norconsult-Electrowatt 1976). The nation, however, is faced with the difficult tasks of increasing agricultural production in the next twenty years for a projected 6 million persons, and of diversifying its production to provide export earnings to fund nonagricultural development (UNDP 1978). Intensification and diversification of agriculture are certain to increase pressure upon Burundi's limited natural resources. Assessment of environmental problems is therefore a necessary component of national planning.

4.1 Agricultural Land Use

Burundi's soils, although suitable for extensive cultivation are extremely fragile. They are mineral-poor, needing regular inputs of nitrogen, have poor phosphorus-retention qualities, are highly silaceous, and thus have poor water-retention capacity and a propensity towards irreversible drying (Coussement et al. 1970; Andriesse et al. 1976; Sys 1975; Frankhart et al. 1974). These soils need fertilizer, but because of the high relief, agricultural intensification and increased fertilizer use tend to increase downstream pollution. Remaining virgin soils are often located on slopes of over 30 degrees or in marshes. The former soils are highly subject to erosion and can therefore be safely brought into cultivation only with large investments in erosion control. Marsh soils must be drained and are frequently acidic. Heavy investments in drainage systems and soil conditioners are necessary, but the need for high quality maintenance will require massive extension, credit, and education if they are to be successful. In the Ngozi region, the cost of such investments in small areas was not found to be cost-effective (Norconsult-Electrowatt 1976).

Another environmental problem associated with farming is the extremely small size of family plots. This renders mixed cropping, rotation with leguminous nitrogen-fixing crops, and growing forage crops difficult due to competition with food crops. Complex overlapping patterns of land tenure, and the nearly complete occupation of agricultural land make it difficult to implement innovations in the structure of farming (Norconsult-Electrowatt 1976). Improper terracing, moreover, a consequence of the vertical system of landholding, encourages soil erosion along paths.

One response to the crisis in agriculture has been the creation of agricultural settlement zones for poor farmers in some regions where a rational system of land allocation is employed along with new technique (Giban 1978). Diversification and intensification of agriculture, and employment of volunteer labor for public works like erosion control provide only a partial solution to the overexploitation of farmlands.

Current plans call for revolutionary changes in agriculture. A key component is the planned development of irrigation facilities and increased use of fertilizers (Norconsult-Electrowatt 1976). In trials such techniques have led to two-fold increases in yield (Neel 1974; Welsh 1980). The beneficial effects of irrigation include replenishment of the aquifer, facilitation of reforestation on marginal land which can be freed from use, growth of fodder crops, and agricultural diversification.

Failure to adequately manage irrigation and improper fertilizer application can result in crop loss, and downstream dumping of fertilizers and insecticides. Irrigation also extends environments favorable to vectors responsible for schistosomiasis, dysentary, and other infectious diseases (Lambrecht 1981).

Another key component of agricultural development is the expansion of tea plantations. These preserve and protect the soil and help control erosion while remaining relatively undemanding in terms of soil quality (Bonte 1967; Kourzon et al. 1977). Extension of tea seems to be limited by the lack of available land and of a variety of tea suited to the periodic droughts affecting Burundi. Research

on this latter problem is underway (Renard et al. 1979).

By contrast, cotton and other irrigated crops in the Imbo region suffer from problems whose resolution may provoke unforeseen consequences (Autrique 1979; Giban 1978). Cotton crops in the Imbo region have been heavily damaged by insect pests, particularly *Lygus vosseleri, Aphis gossypii, Hemitarsoneums latus, Heliothis armigera, Eanias insulana,* and *Cryptophlebia levcotreta*. Autrique (1974) provides a detailed study of cotton parasites. Crop losses vary from 15-20 percent in the north, to 30-50 percent in the south. Four to five aerial sprayings per season employing a presticide mix (Triazophos DDT) has been effective against these parasites. Constant application of pesticides risks breeding of resistant species, while contaminating animals and human beings. In addition, these pesticides run off into Lake Tanganyika. Interest in the use of nonpollutant pyrethroids and development of a local pyrethrum industry should be encouraged.

Irrigated cultivation of rice and corn on 3,000 ha of paysannat land in the Rusizi flood plain, an activity supported by European Development Fund (EDF) monies, has encountered major problems with three rodent pests: *Mastomys natalensis, Pelomys fallax,* and *Lemniscomys striatus*. Of these, *Mastomys,* a multimammate rat is the worst pest. To date, two solutions to the infestation have been employed: (1) coordination of planting with the reproductive cycle of the rodent so as to avoid the coincidence of rice and corn harvests with peak rodent populations; and(2) the use of chlorophacinone baits (0.005 percent concentration) on corn paraffin blocks which have proved 80 to 95 percent effective with two to three kg of bait per ha. The first solution is less costly and more environmentally sound as it avoids the problem of pesticide dumping. Higher rates of crop damage can be mitigated by planting two crops annually (Giban 1978).

Development of Burundi's peat bogs for agriculture poses the potential problem of nutrient loading of Burundi's sluggish eastern rivers. Table 16 summarizes data on nutrient loading for six bogs. Projected levels remain low, especially because the mineral nutrients are not dissolved, but remain in particulate form. There is also a likelihood that small amounts of organic loading from the bogs will be dissipated by the self-cleaning effects of the river, although monitoring is advisable (Gaudet 1980).

Table 16. Summary of Nutrient Loading

Bog	Receiving river basin	Loading (%) Nitrogen	Phosphorus	Increase in concentration (Mg/Liter) Nitrogen	Phosphorus
Kivogero	Ruvubu	0.2	0.1	0.005	0.0002
Kashiru	Mugere	6.1	1.1	0.158	0.0026
Kuruyange	Ruvubu	0.5	0.0	0.013	0
Kishubi	Mulembwe	0.0	0.2	0	0.0005
Nacijima	Ruvubu	0.8	0.1	0.021	0.0002
Kitanga	Mulembwe	1.0	0.2	0.026	0.0005

Source: Gaudet. 1980.

4.2 Pastures and Animal Husbandry

The pastures of Burundi, generally degraded due to overgrazing, are managed by local authorities. Despite local reseeding programs *Eragrostis* has succeeded *Themeda* grassland. Good grasses are grazed before they have a chance to get established, and this encourages growth of hardier and less nutritious species. Overgrazing, overstocking, and underharvesting of livestock create severe pressures upon grasslands (Shantz and Turner 1958; Compère 1968).

Burning is a more severe problem than overgrazing. Savannah ecologists generally agree that fire damages the most nutritious grasses and favors proliferation of species of less value to both wild and domesticated ungulates (Norconsult-Electrowatt 1976). Burning of hill tops at the end of May, furthermore, causes extension of habitats favorable to animal and human trypanosomiasis vectors. Burning of wet lowlands in July and August retards growth of woody vegetation and stabilizes open, woody grass species. Extension of short grass savannah is prejudicial to the survival of gregarious wild grazers like Topi and Zebra, forcing them into more restricted grazing zones. Woody grasses are also unsuitable for cattle nutrition.

Rural range management practices such as burning, overstocking, and restriction of livestock to rocky pastures are detrimental to the environment and to the livestock.

Many animals in Burundi are so undernourished and plagued by so many pathogens acquired in the bush that dipping and spraying against theilerosis is not cost-effective. This conclusion is particularly discouraging since losses due to the latter disease are estimated at 25 to 50 percent of live offspring (Klitz 1979; European Economic Commission 1974).

Cysticercosis affects 50 to 90 percent of livestock and is particularly serious among pigs. The prevalence of the disease stems from the close contact of humans and animals in the homestead (*rugo*), and it will thus remain difficult to control (European Economic Commission 1974).

From a technical standpoint, effective measures to restore pastures and improve livestock health include programs of more efficient marketing, replacement of Ankole with Ankole-Jersey and Ankole-Sahiwal hybrids forced grazing on undesirable grass species to promote nutritious grass stands, diversification of ungulate population with wild animals foraging on diverse species, eradication of the tsetse fly, development of ranching programs which incorporate range management and livestock health control measures, and stock reduction through government purchase and butchering of nonproductive cows (seven to nine percent of the herd). Such changes are predicated upon a vigorous program to educate farmers about improved practices, and to replace livestock as the main symbol of prestige in rural life. Such a program has yet to be inaugurated.

If current rates of offtake (11 percent) continue in effect through 1985, the nation will suffer an annual deficit of 3,500 tons of meat, even assuming that consumption increases to the relatively moderate rates of 12.8 and five kg per person per year for urban and rural inhabitants, respectively. To meet growing protein malnutrition in a context of very limited pastures, offtake must be improved through more effective use of pastures and improvements in productivity and marketing (European Economic Commission 1974).

4.3 Forest Resources

Burundi's forest resources are under intense pressure and could be exhausted in the near future. Two and one-half times the presently forested acreage is needed just to meet current demand for wood, while erosion associated with deforestation is already a serious problem.

The effects of continued uncontrolled cutting include the loss of the important water catchment effects of the forests, increasing rainfall runoff by 50 percent, ravine formation, creation of mudslides which carry off the soils, transport of sterile sediments to valley bottoms where better soils are covered, and aggravation of the danger of flooding (Kourzoun 1977a).

Problems with reforestation efforts in Burundi are both technical and infrastructural. Research on suitable species for reforestation has only recently begun, and nurseries are just being established. Techniques of production of local and exotic species need to be mastered, as the traditional species used in reforestation, *Eucalyptus* sp. and *Cupressus* sp., are not really desirable. The former dries the soil, the latter is not well adapted to the climate. In addition to these technical problems, cadre are scarce and they generally lack resources such as rolling stock to meet forestry goals (Pouilloux 1976).

A recent MAB-affiliated study of the Zaire-Nile crest forests produced the following recommendations:

(1) create a group of preserves around Mount Teza (Fig. 31);

(2) research the legal status of the preserves;

(3) protect and monitor the preserves; and,

(4) conduct aerial reconnaissance of the preserves and establish the limits of the natural zones in order to conserve the hydrological and climatological function of the forest and to preserve the fauna found there (Maldague 1980).

Most authorities have called for the rapid development of Burundi's peat resources to relieve the pressure on the forests. Service wood used for drying crops and fish, for brick and tile manufacture, and for institutional cooking, could be replaced with peat or low-BTU gas produced from it. These projects, however, are still in the early phases and will provide, at best, a medium-term solution to Burundi's fuel crisis (Gaudet 1980).

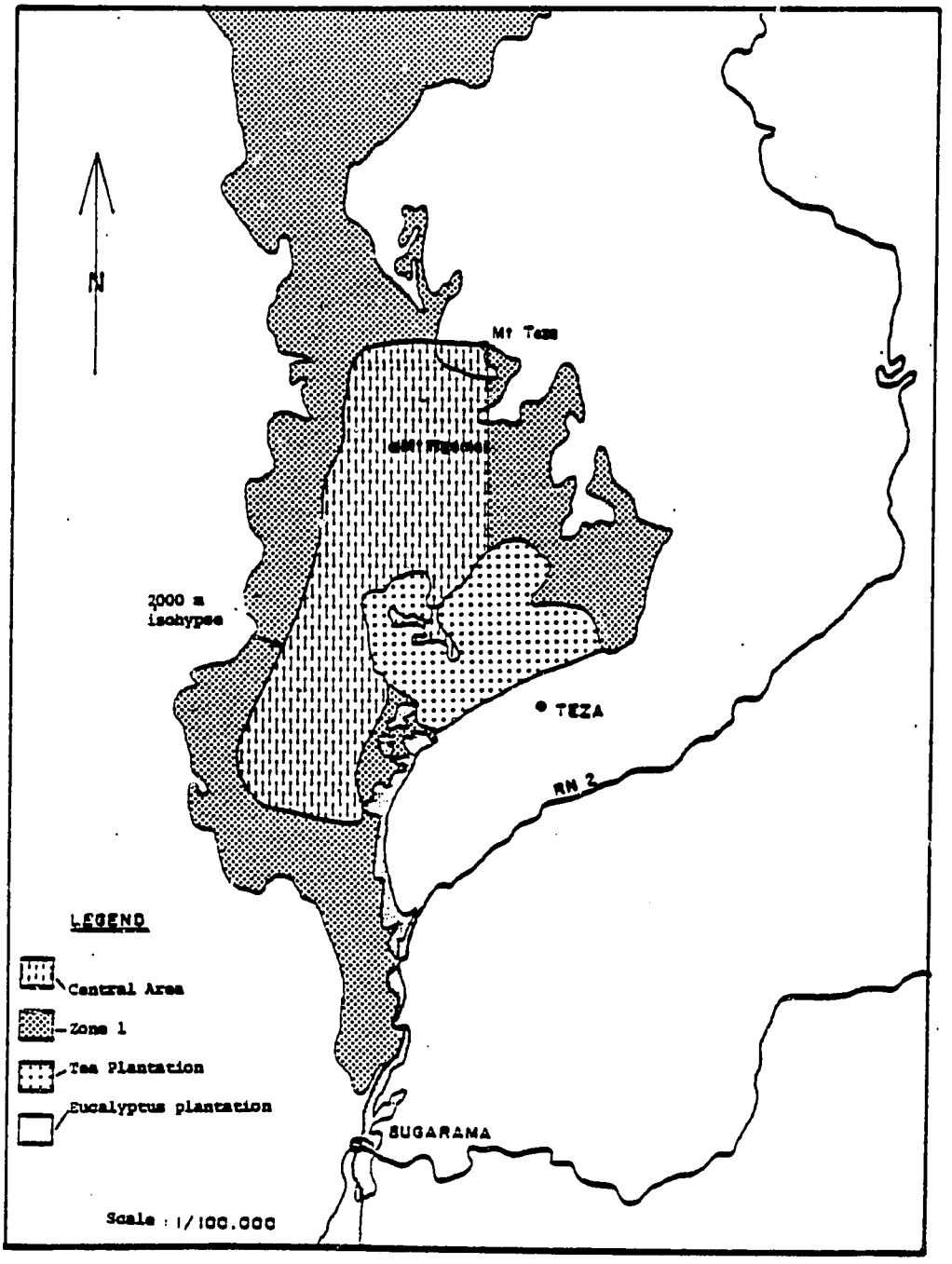

Figure 31. Zone Plan of Proposed Mount Teza Biosphere Reserve

Source: Maldague. 1980.

4.4 Water and Hydroelectric Resources

By the year 2000 some three million cu m of water will be needed every day by the projected six million inhabitants of Burundi for drinking, irrigation, and other purposes. It is not known what steps are being taken to meet this need, although in the aftermath of the 1978 cholera epidemic, many areas of Bujumbura were supplied for the first time with piped water (Storme et al. 1979).

Likely increases in the population and industrial activity of Bujumbura are certain to increase the flow of effluent into Lake Tanganyika. It is not know what sewage treatment facilities, if any, are currently in use in the capital. However, it might be possible to limit effluent flow into the lake by means of controlled development of papyrus *(Cyperus papyrus)* stands below the discharge points (Thompson 1976).

The Kagera River may be called upon to generate power to irrigate family farms (1,700 million KWH), irrigate massive projects (400 million KWH), and run one or more ten-MW fertilizer factories (UNDP 1978). A major unknown in development of the Kagera River dam at Rusomo Falls is the effect of diverting Kagera River water from Lake Victoria and ultimately from the Nile. Because Lake Victoria has risen in recent years and the Kagera is higher than pre-1960 levels, the idea that river water could be diverted without negative effects is an attractive one. However, the causes of changes in river depth are not known, while the effects of a possible decline in water level upon irrigation schemes or the Nile system have not been researched (UNDP 1978).

The effects of water resources development on environmental health need to be considered. Hydroelectric development in the Kagera River Basin would lead to increases of schistosomiasis and malaria. The vectors responsible for these diseases are extremely difficult to eradicate. Fertilizer use, too, remains potentially hazardous. Use of urea or calcium nitrate fertilizers may result in downstream dumping. Yet, without fertilizer, yields on irrigated plots declines (Welsh 1980). Nutrient loading of the Kagera River may have unpredictable effects upon the ecology of Lakes Cohoha and Rweru.

Development of several small hydropower stations, as proposed by Thomann (1976), probably poses fewer environmental risks than the massive project proposed by Norconsult-Electrowatt (1976).

The Rusizi plain and the coastal Imbo plain regularly receive discharges of pesticides. High concentrations have been found in fish in Lake Tanganyika. However, at the current rate of dumping FAO estimates indicate that it would take over 200 years for the pesticides to be detectable by conventional analytic techniques (Neel 1974). The environmental consequences of pesticide dumping thus remain uncertain.

4.5 Fauna

In the interests of preserving remaining local fauna likely to suffer further losses unless some reserves are established, a recent MAB-sponsored study recommended that:

(1) a reserve be created on the Lower Rusizi; and,

(2) a reserve be created in the delta and lagoons of the Greater Rusizi, in addition to forest reserves elsewhere (Maldague 1980).

4.6 Environmental Quality and Human Productivity

Rapid population growth is not necessarily an environmental problem. But when an economic and political infrastructure cannot make productive use of a growing population and allows productivity to fall behind increasing demand, population growth does cause a decline in the quality of life and encroaches upon the environment. This is the situation in Burundi, where an annual population growth rate of over two percent leads directly to deterioration of the environment.

Population growth has an important impact upon human productivity by affecting human health. Chronic protein-calorie malnutrition, particularly among women and children, is already a problem in Burundi and becomes severe during peak agricultural periods (Le Vis et al. 1975; Speed 1970). Diet-related peptic and gastric ulcer and vitamin deficiency are chronic as well. Certain dietary practices could be modified to improve nutrition. For

example, most food is boiled, and thus stripped of many of its nutrients. Consumption of bananas as beer results in a 50 percent loss in food value. Diluting the liquor with polluted ditch or spring water, moreover, contributes to the spread of debilitating parasites and dysentary (May 1965; White et al. 1972).

Human intervention in the natural ecosystem has contributed to a deterioration in public health. Trypanosomiasis and malaria vectors, for example, have been spread through forest clearance and irrigation, especially in the Imbo region. These diseases can only be controlled through vigorous management and education (Van den Berghe and Lambrecht 1952).

Unregulated urban growth, and a lack of sewage facilities resulting in poor water quality were responsible for high urban mortality during the recent cholera epidemic (Storme et al. 1979). Spraying with malathion to control lice has led to the development of malathion-resistant strains. Lice are an important vector in the transmission of typhus and other diseases (Cole et al. 1973).

Without rapid and substantial improvements in the basic level of human health, and necessary political and educational reforms, programs of social animation are not likely to bear fruit (Europa 1978; Greenland 1974; Casse and Magos 1978; Jeune Afrique 1978). However, the current climate of ethnic hatred resulting from the violent civil strife of 1972 hampers cooperative efforts at managing Burundi's natural resources.

4.7 Environmental Impacts of Development Projects

No U.S. AID projects are presently under way in Burundi. Private nonprofit agency projects are summarized in Appendix III.

Burundi is a member of two regional organizations which have set in motion some large-scale projects having profound environmental significance. One organization is the Kagera River Basin Commission (KRBC) consisting of Tanzania, Burundi, and Rwanda. Its primary foci have been a massive hydroelectric project with a high dam at Rusomo Falls on the Kagera River in southeastern Rwanda, and small dams downstream at Kishanda and Kakona.

A proposed 175,000 ton calcium nitrate fertilizer plant near the high dam would use power from the dam, and limestone from Tanzania or Burundi in its operations. The dams are to produce not only power for the region, but also irrigation water for hundreds of thousands of hectares of land, primarily in Tanzania, but also on the dry eastern plains of Rwanda (Norconsult-Electrowatt 1976).

Only one volume of the 13-volume Rusomo Falls Project (RFP) feasibility study treats the environmental consequences of the dam and fertilizer plant. The report evaluates only the effects of changing water levels upon Akagera National Park lands. There is a distinct lack of information concerning the effects of disposal of pesticides and fertilizer-loaded irrigation tail waters on fish and fisheries, the installation of large transmission lines and new roads, and the project on farming and wildlife. Nor does the report discuss the degree to which habitats suitable for mosquitos, tsetse flies and shistosome-bearing snails will be extended; or the potential changes in river dynamics, especially regarding sediment transport and deposition rates behind and below the dams.

The second major regional organization to which Burundi belongs is the Economic Community of the Great Lakes (CEPGL) which also includes Rwanda, and Zaire. Activities of the CEPGL include economic and development cooperation such as: plans for a regional investment bank, free movement of goods and people across borders, and a major plan to ease the high transporation costs of import and export (U.S. AID 1980). According to the intraregional transportation plan, a seven-highway network covering Rwanda, Burundi, and western Tanzania is to be constructed in conjunctin with hydroelectric schemes in southeastern Rwanda. Additionally, one of three proposed railroads will wind through Rwanda and Burundi, taking off from the Kigoma (Zaire)-Dar Es Salaam (Tanzania) line (Anonymous 1981). U.S. AID is considering funding portions of this network (U.S. AID 1980). The environmental impact of this multimillion dollar project, which is likely to be considerable, has not yet been assessed.

Bujumbura a busy port handling cargo from Zaire and Tanzania, but is not yet a major transfer point on regional export routes. Almost all of Burundi's industrial activity is concentrated there. Among new industrial projects is a large textile mill. From cotton grown in the Rusizi plain, this facility will produce cloth to meet most of Burundi's clothing needs. While the factory will help reduce a major component of Burundi's import bill, it will almost certainly create new environmental problems. For example, cotton dust, an inevitable by-product of operations, unless carefully controlled, is a cause of serious pulmonary disease. It is not known whether there is legislation protecting textile and other workers from industrial pollution.

LITERATURE CITED

Albert, E.M. 1960. La Femme en Urundi. Une étude de valeurs sociales. *In* Femmes d'Afrique Noire, D. Paulme, ed. Paris: Mouton. pp. 173-206.

Andriesse, J.P., H.A. von Rosmalen, and A. Muller. 1976. On the variability of amorphous materials in Andosols and their relationship to irreversible drying and P-retention. Geoderma 16:125-138.

Anonymous. 1970. Nutrition in Burundi. *In* Proceedings of the Third African Conference on Nutrition and Child Feeding. Altanta: Center for Disease Control. pp. 16-39.

Anonymous. 1979b. Burundi. *In* Mining Annual Review. pp. 483-484.

Anonymous. 1981. Countries aim at improving transport links. Africa News 16(13):6-8, 10.

Autrique, A. 1974. Parasites du cotonier au Burundi. Butare, Burundi: Institut des Sciences Agronomiques du Burundi (ISABU).

-----. 1979. La lutte contre les déprédations du cotonier au Burundi. Coton et Fibres Tropicaux34(4):349-358.

Bodeux, A. 1972. Hydrologie et bilan de l'eau du bassin versant de la Karuzi au Burundi. Archives de la Mission Karuzi, v.4.

Bonte, E. 1967. La culture du théier au Burundi. Annales de Gembloux 73:105-111.

Bultot, F. 1972. Rwanda and Burundi. *In* World Survey of Climatology, vol. 10: Climates of Africa, J.F. Griffiths, ed. Amsterdam: Elsevier. pp. 349-360.

Cabral, J.C. 1970. As genetas de Africa central (Republica do Zaire, Rwanda e Burundi). Boletin de Instituto Investigaçao Cientifica de Angola 7(2):7-27.

Cahen, L., J. Delhal, and G. Moneyne-Poulaert. 1966. Age determinations on granites, pegmatities and veins from the Kibarian Belt of Central and Northern Katanga (Congo). Nature 210(5043):1347-1349.

Cahen, L., and J. Lepersonne. 1967. The precambrian of the Congo, Rwanda and Burundi. *In* The Precambrian, Vol. 3. K. Roukoma, ed. New York: Interscience (John Wiley). pp. 143-290.

Caponera, D.A. 1979. Burundi. *In* Water Law in Selected African Countries. Rome: FAO. pp. 63-75.

Casse, P., and L. Magos. 1978. L'animation sociale au Burundi. n.p.

Cazenave-Piarrot, F., A. Cazenave-Piarrot, and A. Lopez. 1979. Géographie du Burundi: les Pays et les Hommes. Paris: EDICEF.

Champion, J. 1970. Culture du bananier au Rwanda. Fruits d'Outre-Mer 25(3):161-168.

Chapman, D.W., and P. van Well. 1978. Observations on the biology of *Luciolates stappersi* in Lake Tanganyika (Tanzania). Transactions of the American Fisheries Society 107(4):567-573.

Chrétien, J.P. 1979. Les années de l'éleusine, du sorgho et du haricot dans l'ancien Burundi. Écologie et Idéologie. African Economic History 7(7):75-92.

Cole, M.M., P.H. Clarke, P.H. Washington, F. Ellerbe, and D. L. van Netta. 1973. Resistance to malathion in a strain of body lice from Burundi. Journal of Economic Entomology 66(1):118-119.

Compère, R. 1968. Exploitation rationnelle de la prairie permanente d'altitude a *Exotheca abyssinica* (Anders) and *Eragrostis boehmii* (Hack) au Rwanda et Burundi. Bulletin de Recherches Agronomiques de Gembloux 3(4): 583-604.

Coulter, G.W. 1976. The biology of *Lates* species (Nile perch) in Lake Tanganyika, and the status of the pelagic fishery for *Lates* species and *Luciolates stappersii* (Blgr.). Journal of Fish Biology 9:235-259.

Coussement, S., W. Gaie, F. Warnier, G. Sottiaux, and A. Fogan. 1970. La fumure minérale du caféier d'Arabie au Burundi. Café, Cacao, Thé 14(2):105-143.

Curry-Lindahl, K. 1974. Conservation problems and progress in equatorial African countries. Environmental Conservation 1(2):111-122.

Derleyn, P.P. 1977. Notes sur les serpents du Burundi: les genres *Thrasops, Dendraospis* et *Bitis*. Revue Zoologique Africaine 91(3):525-537.

-. 1978a. Notes sur les serpents du Burundi (2ème partie): Les genres *Geodipsas* et *Thedotornis*. Revue Zoologique Africaine 92(1):208-218.

-. 1978b. Notes sur les serpents du Burundi. (3ème partie): Revue Zoologique Africaine 92(3):728-737.

d'Hoore, J.L. 1964. Explanatory monograph. Soil map of Africa. Scale 1 to 5,000,000. Lagos: U.N. Commission for Technical Cooperation in Africa.

Dunn, L.G. 1977. A tropical African artisanal lake fishery: Lake Rugwero, Rwanda. *In* Proceedings of the Conference on Handling, Processing, and Marketing of Tropical Fish, 1976. London: Tropical Products Institute. pp. 479-483.

Europa. 1978. Burundi. *In* Africa South of the Sahara. London: Europa. pp. 196-205.

European Economic Commission. 1974. Burundi. *In* Possibilités de Création d'Insutries Exportatrices dans les Etats Africains et Malgaches Associés. 4 vols. Brussels, Belgium: European Economic Commission, Direction Générale du Développement et de Coopération, Direction des Échanges Commerciaux et du Développement.

Frankhart, R.P., and A.J. Herbillon. 1971. Aspects de la pédogenèse des sols halomorphes de la Basse Rusizi (Burundi): présence et genèse de l'analcime. Annales du Musée Royal de l'Afrique Centrale. Série In-8. Science Géologique no 71. Tervuren, Belgium: Musée Royal de l'Afrique Centrale.

Frankhart, R., H. Neel, and G. Sottiaux. 1974. Humic mountain soils in Rwanda and Burundi -- evolution under human influence. Pédologie 24(2):164-177.

Gaudet, J. 1980. Environmental Assessment: Burundi Peat Project. Nairobi: U.S.AID.

Giban, J. 1978. Control of the multimammate rat, *Mastomys natalensis* (A. Smith) in the irrigated fields of the Republic of Burundi. Proceedings of The 8th Annual Conference on Vertebrate Pest Control. Davis, CA: University of California. pp. 40-43.

Gotanegre, J.F., C. Prioul, and P. Sirven. 1974. Gèographie du Rwanda. Brussels: A. de Boeck.

Greenland, J. 1974. The reform of education in Burundi: Enlightened theory faced with political reality. Comparative Education 10(1):57-63.

Guiguen, C., and J.C. Beaucornu. 1979. Présence de *Pulex irritans* L. *(Siphonaptera)* au Burundi, région à risque pesteux. Bulletin de la Société de Pathologie Exotique 72(5/6):481-486.

Hamber, G., and M. Von Bergen. 1971. Peptic ulcer in the Burundi Republic and Nile-Congo watershed. Tropical and Geographical Medicine 23(3):213-219.

—. 1973. Gastric ulcer in tropical Africa: clinical features and incidence in Burundi. Tropical and Geographic Medicine 25(1):1-7.

Industry and Trade Commission. 1978. Foreign Economic Trends and their Implications for the United States. Washington, D.C.: U.S. Department of State/U.S. Department of Commerce.

International Union for the Conservation of Nature and Natural Resources (IUCN). 1975. Red Data Book: Amphibia and Reptiles. Morges, Switzerland: IUCN.

—. 1976. Red Data Book: Mammals. Morges, Switzerland: IUCN.

—. 1979. The Distribution of Protected Areas in Relation to the Needs of Biotic Community Conservation in West and Central Africa. Gland: IUCN.

Johnson, H., and J. M. Johnson. 1977. Burundi. *In* Environmental Policies in Developing Countries. Berlin: Erich Schmidt Verlag. pp. 814290/00-07.

Jolly, et al. 1974. Burundi. *In* The Mineral Industry of Other Areas of Africa. Vol. 3. U.S. Bureau of Mines Minerals Yearbook. Washington, D.C.: U.S. Department of the Interior. pp. 1141-1210.

Jeune Afrique. 1977. Supplement A, Burundi. Jeune Afrique 877 (28 October 1977).

-----. 1978. Le programme de redressement. Jeune Afrique 883 (15 February 1978).

-----. 1979. Au centre et en couleurs: Burundi. Jeune Afrique 964 (27 June 1979).

Keay, R.W.J. 1959. Vegetation map of Africa South of the Tropic of Cancer. London: UNESCO/Oxford University Press.

Kiltz, H.H. 1979. Tick control: Rwanda. *In* Tick-Borne Diseases: Survey and Control Methods. Tome: FAO.

Kiss, R. 1977a. Les poissons et la pêche dans le lac Ihema, Rwanda, bassin moyen de l'Akagera. Annales d'Hydrobiologie 17(2):263-318.

-----. 1977b. Hydrobiologie générale au bassin de la Kagera et des lacs Cohoha Sud et Rugwero (3ème et 4ème partie). Rome: FAO.

Kourzoun, V.L., ed. 1977a. World Water Balance and Water Resources of the Earth. U.S.S.R. National Committee for the International Hydrological Decade. Paris: UNESCO. pp. 251-307.

Lambrecht. 1966. Some principles of tse tse control and land use with emphasis on wildlife husbandry. East African Wildlife Journal 4:89-98.

-----. 1981. Dangerous developments. IDRC Report 9(4):4-6.

Lemarchand, R. 1970. Rwanda and Burundi. New York: Praeger.

-----. 1977. Burundi. *In* African Kingships in Perspective, R. Lemarchand, ed. Plymouth, U.K.: Frank Cass. pp. 93-128.

Le Vis, H., M. Bossuyt, P. Hennart, and M. Carael. 1975. The health of mother and child in rural central Africa. Studies in Family Planning 6(12):437-441.

Le Walle, J., and F.M. Rodegen. 1968. Plantes médecinales du Burundi. Quarterly Journal of Crude Drug Research 8(3):1257-1270.

Lukelenge Mapumba, K., A. Fain, J. Bourland, et P. Cosci. 1979. Enquête sur l'onchocercose au Burundi. Annales de la Société Belge de Médicine Tropicale 59:251-258.

Maldague, M. 1980. Les problèmes qui se Posent aux Forêts Ombrophiles Tropicales. Paris: UNESCO/République du Burundi.

Marble, R.A., et al. 1975. Burundi. *In* The Mineral Industry of Other Areas of Africa. Vol. 3. U.S. Bureau of Mines Minerals Yearbook. Washington, D.C.: U.S. Department of the Interior. pp. 1171-1174.

May, J. 1965. Rwanda and Burundi. *In* Studies in Medical Geography, vol. 5: The Ecology of Malnutrition in Middle Africa. New York: Hafner. pp. 139-166.

McDonald, G., et al. 1969. Area Handbook for Burundi. Washington, D.C.: G.P.O.

Moore, P.D. 1980. Exploiting papyrus. Nature 284:510.

Neel, H. 1974. Soils of High Altitude Lands in Rwanda: Trials for Increasing their Productivity. Technical Report 1973-1974 of the Burundi Program. Rome: FAO.

Norconsult-Electrowatt. 1976. Kagera River Basin Development, Phase II: Technical Report. 13 vols. Hovik, Norway: UNDP/Norconsult-Electrowatt.

Onyango, R.J. 1971. The present distribution of human trypanosomiasis in Africa. *In* Health and Disease in Africa -- the Community Approach. G. C. Gould, ed. Dar Es Salaam: East Africa. pp. 105-110.

Peric, M. 1981. Exploration of Burundi nickeliferous laterites by electrical methods. Geophysical Prospecting 29:174-187.

Pouilloux, C. 1976. Problèmes forestiers au Burundi. Bois et Forêts des Tropiques. 170:21-34.

Rattray, J.M. 1960. The grass cover of Africa. FAO Studies No. 49. Rome: FAO.

Raybould, D.N., and G.B. White. 1979. The distribution, bionomics and control of onchocersosis vectors (*Dipthera: Simuliidae*) in eastern Africa and the Yemen. Tropenmedizin und Parasitologie 30:505-547.

Renard, C., J. Glemal, and D. Barampana. 1979. Évaluation de la résistance à la sécheresse chez le théier au Burundi. Café, Cacao, Thé 73(3):175-182.

Shantz, H.L., and B.L. Turner. 1958. Vegetational Changes in Africa over a Third of a Century. Tucson, Arizona: College of Agriculture, University of Arizona-

Spinage, C.A. 1969-70. Report of the Ecologist to the Rwanda National Parks. London: Ministry of Overseas Development.

Speed, D.E. 1970. Population crisis in central Africa: Rwanda and Burundi. *In* Health and Disease in Africa -- the community approach. Proceedings of the East African Medical Research Council Scientific Conference. G.C. Gould, ed. Nairobi: East African Literature Bureau. pp. 243-246.

Storme, B., et al. 1979. L'épidémie de choléra au Burundi en 1978. Annales de la Société Belge de Médecine Tropicale 59:413-425.

Sys, C. 1975. Savannah soils of Central Africa, their classification and management. Paper No. 15 of the International Soils Science Society Meeting. Temra, Ghana, 1975.

Technical Assistance Clearing House (TAICH). 1979. Burundi. Development Assistance Programs of U.S. Non-profit Agencies. New York: American Council of Voluntary Agencies for Foreign Service Technical Assistance Information Clearing House.

Thomann, G. 1979. Hydropower potential of Burundi: unexploited wealth of a developing country. *In* Third World Congress on Water Resources, vol. II. Mexico City: International Water Resources Association. pp. 779-788.

Thompson, K. 1976. Swamp development in the headwaters of the White Nile. *In* The Nile: Biology of an Ancient River. J. Rzoska, ed. Amsterdam: W. Junk pp. 177-196.

Troupin, G. 1966. Étude Phytocénologique du Parc National de l'Akagera et du Rwanda Oriental: Recherche d'une Méthode d'Analyse appropriée à la Végétation d'Afrique Intertropicale. Publication No. 2. Butare, Rwanda: Institut National de Recherche Scientifique.

UNCLDC. 1981. Summary of the Country Presentation for Burundi. Geneva: Secretariat, U.N. Conference on the Least Developed Countries.

UNESCO. 1975. Kaolin in Burundi. *In* UNESCO Features No. 687688. Paris: UNESCO. p. 25.

United Nations Development Program (UNDP). 1978. Examination Report of the Technical Report "Development of the Kagera River Basin, Phase II, Vol. 3 (April 1976)." New York: UNDP.

U.S. Agency for International Development (U.S.AID). 1980. All Data Currently Available on Burundi. Washington, D.C.: U.S.AID/DIU/ESDS.

Van den Berghe, L., and F.L. Lambrecht. 1952. *G. Moristans* et la trypanosomiose dans le Mosso-Sud (Urundi). Anais do Instituto de Medecina Tropicale IX(3):859-879.

Verschuren, J. 1977a. Les grands mammifères du Burundi. Mammalia 42(2):209-224.

-----. 1977b. Note sur la faune ornithologique du Burundi; principalement près de Bujumbura. Le Gerfaut 67:3-20.

-----. 1978. Burundi and wildlife: problems of an overcrowded country. Oryx 14(3):237-240.

Weinstein, W., and R. Shrire. 1975. Ethnic strategies and the primacy of ethnic survival: The case of Burundi. International Review of Modern Sociology 5(2):185-192.

Welch, J.L. 1980. Report on Irrigation, Kagera River Basin. Kigali, Rwanda: U.S.AID/UNDP.

White, G.F., D.J. Bradley, and A.V. White. 1972. Drawers of Water: Domestic Water Use in East Africa. Chicago: University of Chicago Press.

World Bank. 1980. Burundi. World Tables, 2nd ed. Baltimore: Johns Hopkins. pp. 52-53.

-----. 1981. World Development Report. Washington, D.C.: World Bank. 192 pp.

APPENDIX I

Key Economic Indicators, 1976-1978

Appendix I. Key Economic Indicators, 1976-78

BURUNDI: KEY ECONOMIC INDICATORS

(All values in U.S. million dollars[1] and represent end-of year averages unless otherwise indicated.)

	1976	1977	Percent Change	Estimate For 1978[2]
Income and Production[3]				
Gross Domestic Product at 1976 Prices	434.4	492.4	13.4	510.3
Domestic Demand at 1976 Prices:	447.9	485.8	8.5	542.6
Private Consumption	346.2	366.3	5.8	357.3
Public Consumption	58.1	60.3	3.8	62.5
Gross Fixed Capital Formation	43.6	59.2	35.8	122.8
Value Added by Sector, at 1976 Prices[4]	398.6	421.0	5.6	444.5
Primary (agricultural)	235.6	249.0	5.7	258.0
Secondary (industrial)	61.4	63.7	3.7	71.5
Tertiary (service)	101.6	108.3	6.6	115.0
Balance of Payments and Trade				
Foreign Exchange Reserves (Gross)	42.7	85.5	100.2	132.9
External Public Debt (Disbursed only)	21.2	34.0	60.4	54.4[5]
Annual Debt Service	2.9	3.0	3.4	4.1[5]
Overall Balance of Payments[6]	18.4	39.6	115.2	46.9
Balance of Trade[6]	1.4	29.7	-	-
Exports, FOB Kigoma, Tanzania	43.6	95.1	118.1	-
U.S. Share	20.1	40.2	100.0	NA
Imports, CIF Bujumbura, Burundi	56.1	74.5	32.8	-
U.S. Share[7]	2.9	NA	NA	NA

1/ All currency conversions were performed at the rate of $1 = 90 Burundi francs, the central rate which was communicated to the International Monetary Fund on May 3, 1976.

2/ Figures taken from the Five-Year Plan for the Economic and Social Development of Burundi: 1978-82.

3/ All data for income and production are estimates derived by experts of international organizations.

4/ Excluding indirect taxes less subsidies, hence GDP at factor cost.

5/ From the Extraordinary Budget: 1978, Ministry of Economics and Finance.

6/ In absolute amount.

7/ In 1976 the imports from the United States were mostly used clothing and textile remnants, hardware and small tools, flour and vegetable oil.

Source: Industry and Trade Commission. 1978.

APPENDIX II

Selected Climatic Data

Appendix II. Table of Contents

Table 1. Climatic Data for Bujumbura and Kisozi

CLIMATIC TABLE FOR BUJUMBURA, BURUNDI
Latitude 03°23'S, longitude 29°21'E, elevation 805 m

Month	Mean sta. press. (mbar)	Temperature (°C)				Relat. humid. (%)	Precipitation					Wind		Averages			
		mean		extreme			mean (mm)	max. (mm)	min. (mm)	days ≥ 0.1 mm	max. 24 h (mm)	aver. speed (km/h)	preval. direct.	cloud-iness (oktas)	sun-shine (h)	radi-ation (Ly/day)	evap. (mm)
		max.	min.	max.	min.												
Jan.	919	28	19	30	19	79	94	161	23	15	65	6	SW	5	159	421	129
Feb.	920	28	19	30	18	79	109	223	48	14	128	6	SW	5	140	410	117
Mar.	920	28	19	30	19	81	121	225	40	17	60	6	SSW	4	171	415	129
Apr.	920	28	19	30	18	82	125	226	53	18	54	6	SSW	5	153	416	125
May	921	28	19	29	19	78	57	123	12	10	49	8	SSW	4	196	441	140
June	922	29	18	29	17	67	11	104	0	3	83	7	SSW	3	242	455	145
July	921	29	17	30	16	62	5	42	0	1	33	8	SSW	2	269	432	139
Aug.	921	30	18	31	17	55	11	89	0	2	39	8	SSW	3	247	440	149
Sept.	920	31	19	32	18	59	37	106	3	8	30	5	WSW	4	202	467	162
Oct.	920	30	20	32	19	65	64	121	18	12	34	8	W	4	174	407	144
Nov.	920	28	19	30	19	75	100	169	49	19	64	7	W	5	141	420	129
Dec.	920	28	19	29	19	78	114	194	40	19	62	6	SW	5	148	410	128
Annual	920	29	19	32	16	72	848	1,106	632	138	128	7	—	4	2,242	428	1,636
Rec. (yrs.)	6	10	10	10	10	3	30	30	30	30	30	2	2	9	9	2	2

CLIMATIC TABLE FOR KISOZI, BURUNDI
Latitude 03°33'S, longitude 29°41'E, elevation 2,155 m

Month	Temperature (°C)				Relat. humid. (%)	Precipitation					Wind		Averages			
	mean		extreme			mean (mm)	max. (mm)	min. (mm)	days ≥ 0.1 mm	max. 24 h (mm)	aver. speed (km/h)	preval. direct.	cloud-iness (oktas)	sun-shine (h)	radi-ation (Ly/day)	evap. (mm)
	max.	min.	max.	min.												
Jan.	22	12	23	11	83	167	295	71	21	61	7	NE	5	149	438	113
Feb.	22	12	23	11	84	160	248	45	19	69	7	NE	5	126	434	98
Mar.	22	12	24	11	84	196	386	93	22	72	7	NE	4	166	445	112
Apr.	22	12	23	11	88	228	324	58	23	103	7	SE	5	152	467	115
May	21	11	23	10	87	120	313	40	17	51	7	SE	5	150	465	118
June	21	9	22	8	78	12	56	0	3	28	8	SE-SW	3	217	471	111
July	22	9	23	7	70	6	36	0	1	31	8	SE-SW	3	237	469	118
Aug.	23	10	24	8	67	16	75	0	3	36	9	SE-SW	3	231	454	118
Sept.	23	11	25	9	62	64	177	6	8	45	8	SE	4	203	481	129
Oct.	23	11	24	11	72	115	194	39	14	67	8	SE	4	183	461	124
Nov.	22	12	23	11	80	174	348	72	22	70	7	NE	5	152	429	106
Dec.	22	12	23	11	85	189	349	71	22	60	7	NE	5	138	424	105
Annual	22	11	25	7	78	1,447	1,709	1,154	175	101	7	—	4	2,104	453	1,367
Rec. (yrs.)	9	9	9	9	3	30	30	30	30	30	2		6	6	2	2

Source: Bultot. 1972.

Table 2. Monthly Precipitation and Evaporation

	Amount (mm)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	An-nual
Average rainfall at Ngozi 1940-59	125	103	144	208	121	9	8	26	58	137	169	155	1,263
Open pan evaporation at Rubona 1972	107	95	129	100	89	111	148	159	161	136	113	138	1,481
Rainfall exceeds evaporation	18	8	15	108	32	-	-	-	-	-	56	17	-
Evaporation exceeds rainfall	-	-	-	-	-	102	140	133	103	1	-	-	
Annual Deficit													218

Source: Norconsult-Electrowatt. 1976.

Table 3. Temperature Data for Burasira, 1966-68

	Temperature (°C)												
	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Average daily minimum	12.0	12.5	13.4	14.0	12.6	8.7	7.6	8.2	10.8	11.8	13.3	13.0	11.5
Absolute minima	7.0	8.1	9.9	11.0	7.7	4.0	2.5	3.5	4.5	4.5	10.8	9.9	-
Daily average	18.0	18.0	18.2	18.[illegible]		16.2	16.2	17.1	17.8	17.8	17.7	18.0	17.6
Average daily maximum	26.3	26.1	26.1	25.8	26.0	25.7	26.7	27.7	27.3	26.3	24.7	25.8	26.2
Absolute maxima	28.8	29.6	29.1	28.5	28.4	28.4	29.7	32.0	31.4	29.6	28.3	28.4	-

Source: Norconsult-Electrowatt. 1976.

Table 4. Monthly Precipitation at three stations in the Nyamuswara Valley Area

	Precipitation (mm)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Ngozi	125	103	144	208	121	9	8	26	58	137	169	155	1,263
Musenyi	137	107	139	198	101	15	5	22	52	105	166	159	1,206
Kisanze	116	104	120	180	89	19	7	14	50	92	143	117	1,051

Station altitudes: Ngozi el. 1,850 m
Musenyi el. 1,720 m
Kisanze el. 1,800 m

Source: Norconsult-Electrowatt. 1976.

Table 5. Temperature and Precipitation for Mparambo, Gisozi, and Burasira

MPARAMBO (893 m d'altitude)

Mois	Températures (en °C)	Précipitations (en mm)
Septembre	23,7	22,2
Octobre	23,6	128,1
Novembre	22,9	85,8
Décembre	22,8	118,1
Janvier	23	70,6
Février	22,8	83,5
Mars	22,7	84,4
Avril	22,5	166,3
Mai	23,2	156,4
Juin	23,1	5,7
Juillet	22,5	14
Août	23	36,
Année	23	1 057,5

GISOZI (2 094 m d'altitude)

Mois	Températures (en °C)	Précipitations (en mm)
Septembre	14,6	27,1
Octobre	14,8	64,2
Novembre	14,6	118,5
Décembre	14,6	168
Janvier	14,8	226,8
Février	15,5	106,4
Mars	14,9	111,9
Avril	15	323,7
Mai	14,2	276,2
Juin	13,2	3,3
Juillet	13	22,5
Août	13,7	8,9
Année	14,4	1 457,5

BURASIRA (1 536 m d'altitude)

Mois	Températures (en °C)	Précipitations (en mm)
Septembre	17,7	41,9
Octobre	18,3	41
Novembre	18,5	125,2
Décembre	18,7	106,5
Janvier	18,5	191,1
Février	18,7	58
Mars	18,4	85
Avril	18,5	179,3
Mai	18,4	119,2
Juin	16,7	0
Juillet	15,9	8,2
Août	16,9	137
Année	17,9	1 082,4

APPENDIX III

Development Assistance Programs of U.S. Nonprofit Organizations, 1979

Appendix III. Table of Contents

Table 1. Summary of Assistance Programs

AGENCIES	Communications	Community Development	Construction, Housing & Planning	Cooperatives, Credit Unions & Loans	Economic & Development Planning	Education	Equipment & Material Aid	Food Production & Agriculture	Industrial Development	Medicine & Public Health	Nutrition	Population & Family Services	Public & Business Administration	Social Welfare	Women	Youth
AFL-CIO African-American Labor Center	●								●							
Missionary Sisters of Our Lady of Africa		●				●				●				●		
African American Institute						●										
Catholic Medical Mission Board							●			●						
Catholic Relief Services		●					●	●		●						
Christian Children's Fund						●				●	●			●		●
Free Methodist Church of North America	●					●				●						
MAP International							●			●						
Mid-America Yearly Meeting of Friends	●	●	●			●	●			●					●	
Salesians of St. John Bosco						●										
Seventh-day Adventist World Service							●									
United Methodist Committee on Relief						●										
World Gospel Missions	●					●				●						
World Vision Relief Organization		●						●		●	●					

Source: TAICH. 1979.

Table 2. List of Organizations Providing Assistance

AFL-CIO (AMERICAN FEDERATION OF LABOR AND CONGRESS OF INDUSTRIAL ORGANIZATIONS)
African-American Labor Center
1125 15th Street, N.W., Washington, D.C. 20005 -- (202) 293-3603

Address of contact: Hy Hoffman, Representative
B.P. 1788, Kinshasa, Zaire

INDUSTRIAL DEVELOPMENT & MANAGEMENT: Provided equipment and supplies to enable the Union des Travailleurs du Burundi (UTB) to publish a trade union newspaper on a continuing basis.

PROGRAM INITIATION: 1978.

(Program information received September 1979)

MISSIONARY SISTERS OF OUR LADY OF AFRICA
White Sisters of Africa, American Headquarters
5335 16th Street, N.W., Washington, D.C. 20011 -- (202) 882-3068

Address of contact: c/o Missionary Sisters of Our Lady of Africa
B.P. 186
Bukavu, Kivu, Zaire

Assists with the following program of the international organization:

COMMUNITY DEVELOPMENT: Educational, medical, social, and community development works in the areas around Bujumbura, Gitega, Ngozi, and Ruyigi.

PERSONNEL: 47 international Sisters.

(Program information received June 1979)

* AFRICAN-AMERICAN INSTITUTE
833 United Nations Plaza, New York, New York 10017 -- (212) 949-5666

EDUCATION: Burundi participates in the African Graduate Fellowship Program (AFGRAD), which provides fellowships for African students to pursue graduate study in the United States. In the 1978/79 academic year, there was one Burundi participant in this program.

COOPERATING ORGANIZATIONS: Government of Burundi, U.S. Agency for International Development, U.S. Council of Graduate Schools, individual U.S. universities.

(Program information received June 1979)

Source: TAICH. 1979.

Table 2. Continued

CATHOLIC MEDICAL MISSION BOARD, INC.
10 West 17th Street, New York, New York 10011 -- (212) 242-7757

MEDICINE & PUBLIC HEALTH: In CY 1978 sent medical goods valued at $10,355 to applicants operating medical facilities throughout Burundi.

(Program information received March 1979)

*+ CATHOLIC RELIEF SERVICES - UNITED STATES CATHOLIC CONFERENCE
1011 First Avenue, New York, New York 10022 -- (212) 838-4700

Address of contact: Rev. Laurence Olszewski, Program Director
Catholic Relief Services, USCC
B.P. 665, Bujumbura, Burundi
(Via Brussels, Belgium)

COMMUNITY DEVELOPMENT: Supports welfare, agricultural training and health education projects. Expenditures for these activities for FY ending 6/30/78 are estimated to be approximately $81,000. Currently provides food to use in 32 rural self-help projects, including road construction, terrace farming, reforestation, installation of a water system and establishment of a model village.

EQUIPMENT & MATERIAL AID: Provided used clothing valued at $204,000 to rural communities.

FOOD PRODUCTION & AGRICULTURE: Provides agricultural services by means of model gardens for demonstration of improved planting and cultivation techniques in order to encourage food self-sufficiency. With financial assistance from U.S. Agency for International Development and other sources, is starting a two-year project on the development of peat as a rural energy source.

MEDICINE & PUBLIC HEALTH: Through rural self-help, pre-school, and mother/child health program distributed 3,300 metric tons of U.S. Government-donated PL 480 Title II food valued at $1.7 million for FY ending 6/30/78 to 45,000 recipients per month. Supplies technical assistance in training health center personnel in program operations and in purchasing base equipment (scales, weight charts, education materials, etc.).

PERSONNEL: 2 U.S. (program director, project manager); 9 local.

PROGRAM INITIATION: 1975.

FINANCIAL DATA: Value of program for FY ending 6/30/78: $3,138,468.

COOPERATING ORGANIZATIONS: Government of Burundi, U.S. Agency for International Development.

(Program information received May 1979)

Table 2. Continued

*+ CHRISTIAN CHILDREN'S FUND
P.O. Box 26511, Richmond, Virginia 23261

Address of contact: Joseph Rainer
Christian Children's Fund, Inc.
P.O. Box 14038, Nairobi, Kenya
Tel. 60728

The purpose of the program is to provide rural families and children with health care, opportunity for education, and social services which enhance their economic and personal development.

EDUCATION: Provides funds for six day schools for students from kindergarten to secondary level which provide education services, nutritional meals, and vocational training.

SOCIAL WELFARE: Through a sponsorship program, maintains affiliation with 15 community centers which provide a variety of services to children and families, including group dynamics; adult education; subsidies for food, clothing and education; health and nutrition education; and income generating projects. Also is affiliated with two centers which offer rehabilitation services, education and vocational training to physically handicapped children.

FUTURE PLANS: To enlarge the program and administer it from a new regional office in Rwanda.

PROGRAM INITIATION: 1972.

FINANCIAL DATA: Expenditures for FY ending 6/30/79: $282,190
Budget for FY ending 6/30/80: $338,640

COOPERATING ORGANIZATIONS: Diocese of Bujumburo; Free Methodist Mission; Government of Burundi, Social Services Division; White Fathers of Africa.

(Program information received March 1979)

FREE METHODIST CHURCH OF NORTH AMERICA
General Missionary Board
901 College Avenue, Winona Lake, Indiana 46590 -- (19) 267-6278/7656

Address of contact: Dr. David Crandal
B.P. 73, Gitega, Burundi

COMMUNICATIONS: In cooperation with the Mid-America Yearly Meeting of Friends (Friends Africa Gospel Mission) and the World Gospel Mission, operates the Grace Memorial Press in Mweva and the Burundi Literature Center in Gitega. In addition to the distribution of Christian literature, the Center is the publishing agency for Kirundi literature in Burundi, serving schools all over the country.

Table 2. Continued

EDUCATION: Operates a technical school at Muyebe. Cooperates with other mission groups in the operation of Kibimba Normal School, which includes a six-year secondary curriculum.

MEDICINE & PUBLIC HEALTH: Operates a 35-bed hospital staffed by a doctor and 2 nurses at Kibuye and 2 dispensaries each supervised by a nurse at Muyebe and Rwintare.

PERSONNEL: 8 U.S.; 12 local.

PROGRAM INITIATION: 1935.

COOPERATING ORGANIZATIONS: Friends Africa Gospel Mission; Government of Burundi provides funds for the educational program; World Gospel Mission.

(Program information received August 1979)

*+ MAP INTERNATIONAL
327 Gundersen Drive, Carol Stream, Illinois -- (312) 653-6010
Mailing Address: P.O. Box 50, Wheaton, Illinois 60187

MEDICINE & PUBLIC HEALTH: Assists missionary groups in finding doctors and makes periodic shipments of donated drugs and medical supplies in response to the requests of missionary doctors.

FINANCIAL DATA: In CY 1978 shipped 50 pounds of medicines and supplies with a value of $4,409.

(Program information received June 1979)

MID-AMERICA YEARLY MEETING OF FRIENDS
Board of Missions
2018 Maple Street, Wichita, Kansas 67213 -- (316) 267-0391/0681

Address of contact: James Morris, Field Superintendent
Mid-America Yearly Meeting
B.P. 1198 Bujumbura, Burundi

The Mid-America Yearly Meeting of Friends sponsors the Friends Africa Gospel Mission which operates the following projects:

COMMUNICATIONS: Participation in literature centers in Gitega and Bujumbura. Operation of print shop in Mweya cooperatively with Free Methodist Church and World Gospel Mission.

Table 2. Continued

COMMUNITY DEVELOPMENT: Conducts community development program at Kwisumo Station, with assistance by World Vision.

CONSTRUCTION, HOUSING & PLANNING: Provision of support for school construction in Kibimba, Kwibuka, Mutaho, and homes for teachers.

EDUCATION: Supervision of schools at request of the Protestant Alliance of Burundi. Operation of elementary schools in Kibimba, Mutaho, Kwibuka and Kwisumo, enrolling 1,000 students -- grades 1-7, up to 16 years of age. Aid in administering Kibimba Normal School enrolling 150 students. Maintenance of classes for women and girls in sewing, homemaking, and social and economic training, enrolling 450 persons. Operation of a training program in woodworking, auto mechanics and building construction, as personnel are available.

MEDICINE & PUBLIC HEALTH: Operation of a hospital dispensary in Kibimba with surgical, maternity and clinical departments for 100 in-patients and 800 out-patients monthly. Operation of dispensaries in Kwisumo, including material aid distribution (children's clothing).

FUTURE PLANS: To up-grade training program with goal of preparing nationals for all program positions.

PERSONNEL: 14 U.S. (4 nurses, 2 teachers, 3 builder-technicians, 1 agronomist, 3 domestic arts teachers, 1 accountant).

PROGRAM INITIATION: 1934.

FINANCIAL DATA: Expenditures for FY ending 6/30/78: $175,304
Budget for FY ending 6/30/79: $186,954

COOPERATING ORGANIZATIONS: Christian Medical Missions; Evangelical Friends Church; Free Methodist Church of North America; Friends Foreign Mission Society, Eastern Region; Government of Burundi (salary subsidies in education and health programs); MAP International; Protestant Alliance of Burundi; World Gospel Mission.

(Program information received April 1979)

SALESIANS OF ST. JOHN BOSCO (S.D.B.)
(Province of St. Philip the Apostle)
148 Main Street, New Rochelle, New York -- (914) 633-8344
Mailing Address: P.O. Box 30, New Rochelle, New York 10802

Address of contact: Rev. Giovanni Dingenen, S.D.B.
c/o Centre des Jeunes
Gikondo, B.P. 468
Kigali, Rwanda

Table 2. Continued

U.S. Salesians provide financial and some personnel assistance to the International Salesian Society, which finances and administers the following projects:

EDUCATION: Elementary and secondary school in Ngozi.

PROGRAM INITIATION: 1962.

(Program information received July 1979)

*+ SEVENTH-DAY ADVENTIST WORLD SERVICE, INC.
6840 Eastern Avenue, N.W., Washington, D.C. 20012 -- (202) 723-0800

EQUIPMENT & MATERIAL AID: In CY 1978 shipped $51,791 worth of clothing.

(Program information received July 1979)

UNITED METHODIST COMMITTEE ON RELIEF
475 Riverside Drive, New York, New York 10027 -- (212) 678-6281

EDUCATION: In CY 1979 made a grant of $15,000 to continue support for schools for refugees from Rwanda who are living in Burundi.

PROGRAM INITIATION: 1977.

FINANCIAL DATA: Expenditures for CY 1978: $15,000
Budget for CY 1979: $15,000

COOPERATING ORGANIZATIONS: Burundi churches, Government of Burundi, United Nations High Commissioner for Refugees, World Council of Churches.

(Program information received September 1979)

WORLD GOSPEL MISSION
P.O. Box 948, Marion, Indiana 46952 -- (317) 664-7331

Address of contact: Rev. Donald Hohensee, Superintendent
B.P. 113, Gitega, Burundi

COMMUNICATIONS: In cooperation with the Mid-America Yearly Meeting of Friends and the Free Methodist Church of North America, operates the Grace Memorial Press in Mweya and the Burundi Literature Center in Gitega. In addition to the distribution of Christian Literature the Center is the publishing agency for Kirundi Literature in Burundi, serving schools all over the country.

Table 2. Continued

EDUCATION: Supervises 32 primary schools operated by nationals in Murore, Kayero, Murehe and surrounding rural areas for a total of over 1,500 students.

MEDICINE & PUBLIC HEALTH: Maintains dispensaries in Murore, Kayero and Murehe.

PERSONNEL: 15 U.S.

PROGRAM INITIATION: 1939.

COOPERATING ORGANIZATIONS: Free Methodist Church of North America, Mid-America Yearly Meeting of Friends (Friends Africa Gospel Mission).

(Program information received March 1979)

* WORLD VISION RELIEF ORGANIZATION
919 West Huntington Drive, Monrovia, California 91016 -- (213) 79-7979

Address of contact: Dr. Bryant L. Myers, Associate Regional Director
2nd Floor, AGIP House
Corner Haile Salassie Avenue and Harambee Lane
Nairobi, Kenya
Mailing: World Vision/Africa
P.O. Box 58378, Nairobi, Kenya
Tel. 331-019, 332-152

COMMUNITY DEVELOPMENT: Supports a program of income generation, nutrition education, health care and training, agricultural improvement, animal husbandry for 550 people.

MEDICINE & PUBLIC HEALTH: Supplies medicines to a local hospital and dispensaries in Burundi.

PROGRAM INITIATION: 1975.

FINANCIAL DATA: Expenditures for FY ending 9/30/79: $22,725.

COOPERATING ORGANIZATION: Mid-America Yearly Meeting of Friends.

(Program information received April 1979)

APPENDIX IV

USDA Estimates of Agricultural Production

Appendix IV. USDA Estimates of Agricultural Production

PRODUCTION BY COMMODITY, VALUE AND INDICES OF TOTAL AGRICULTURAL AND FOOD PRODUCTION, AVERAGE 1961-65, ANNUAL 1970-79

COMMODITY	PRICE WEIGHT	AVERAGE 1961-65	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
	DOLLARS	----------	----------	----------	----------	(1,000 METRIC TONS)	----------	----------	----------	----------	----------	----------
WHEAT	30	7	13	8	8	6	11	13	4	5	5	5
RICE, PADDY	188	3	12	8	3	5	6	6	7	9	8	9
CORN	50	98	182	247	250	184	225	258	254	255	248	235
MILLET	35	19	34	22	35	40	19	25	29	38	38	40
SORGHUM	35	99	96	83	107	108	161	129	120	104	110	94
BEANS, DRY	188	118	156	158	158	156	95	158	158	158	106	138
DRY PEAS	188	34	44	45	45	46	26	45	45	45	48	42
POTATOES	33	72	78	88	75	80	68	88	88	88	88	88
CASSAVA	25	854	958	965	968	948	935	975	975	975	1,288	1,288
SWEETPOTATOES	30	615	808	828	848	860	808	818	842	873	905	958
COTTON	488	3	3	3	3	1	2	1	1	2	2	2
COTTONSEED	48	5	6	6	5	2	4	3	3	4	4	4
PEANUTS, IN SHELL	116	2	22	21	22	22	7	15	18	18	18	19
PLANTAINS	46	1,141	1,458	1,458	1,458	1,458	1,158	1,475	1,458	1,475	1,498	1,588
COFFEE	475	15	22	24	21	21	27	17	22	17	23	22
MEATS	378	11	15	16	16	16	16	16	16	16	16	16
	188	13	16	16	16	16	13	15	15	15	15	15
AGGREGATES OF PRODUCTION		----------	----------	----------	----------	(MILLION DOLLARS AT CONSTANT PRICES)	----------	----------	----------	----------	----------	----------
CROPS		133.4	171.5	176.5	176.5	174.9	154.6	175.2	177.1	177.6	182.8	186.4
LIVESTOCK		5.4	7.2	7.5	7.5	7.5	7.2	7.4	7.4	7.4	7.4	7.4
TOTAL AGRICULTURE		138.8	178.7	184.8	184.8	182.4	161.8	182.6	184.5	185.0	190.2	193.8
TOTAL FOOD		138.8	167.8	171.4	173.2	172.9	148.2	174.1	173.6	176.1	178.5	182.5
INDICES OF PRODUCTION						(1961-65 = 100)						
CROPS		100	129	132	132	131	116	131	133	133	137	140
TOTAL AGRICULTURE		100	129	133	133	131	117	132	133	133	137	140
TOTAL FOOD		100	120	131	132	131	113	133	133	135	136	140
PER CAPITA AGRICULTURE		100	110	121	120	117	102	112	111	109	109	109
PER CAPITA FOOD		100	117	119	120	117	99	113	111	110	109	109
INDEX OF POPULATION												
1961-65 POPULATION= 3,889,000		100.0	108.7	109.7	110.6	112.3	114.8	117.4	119.9	122.7	125.3	127.9

Source: USDA. 1980.

APPENDIX V

Soils in the Byongwe Valley

Appendix V. Soils in the Byongwe Valley

Figure 1. Map of Soil Groups

Figure 2. Map of Land Soil Characteristics

Table 1. Soil Groups, Units, and Characteristics

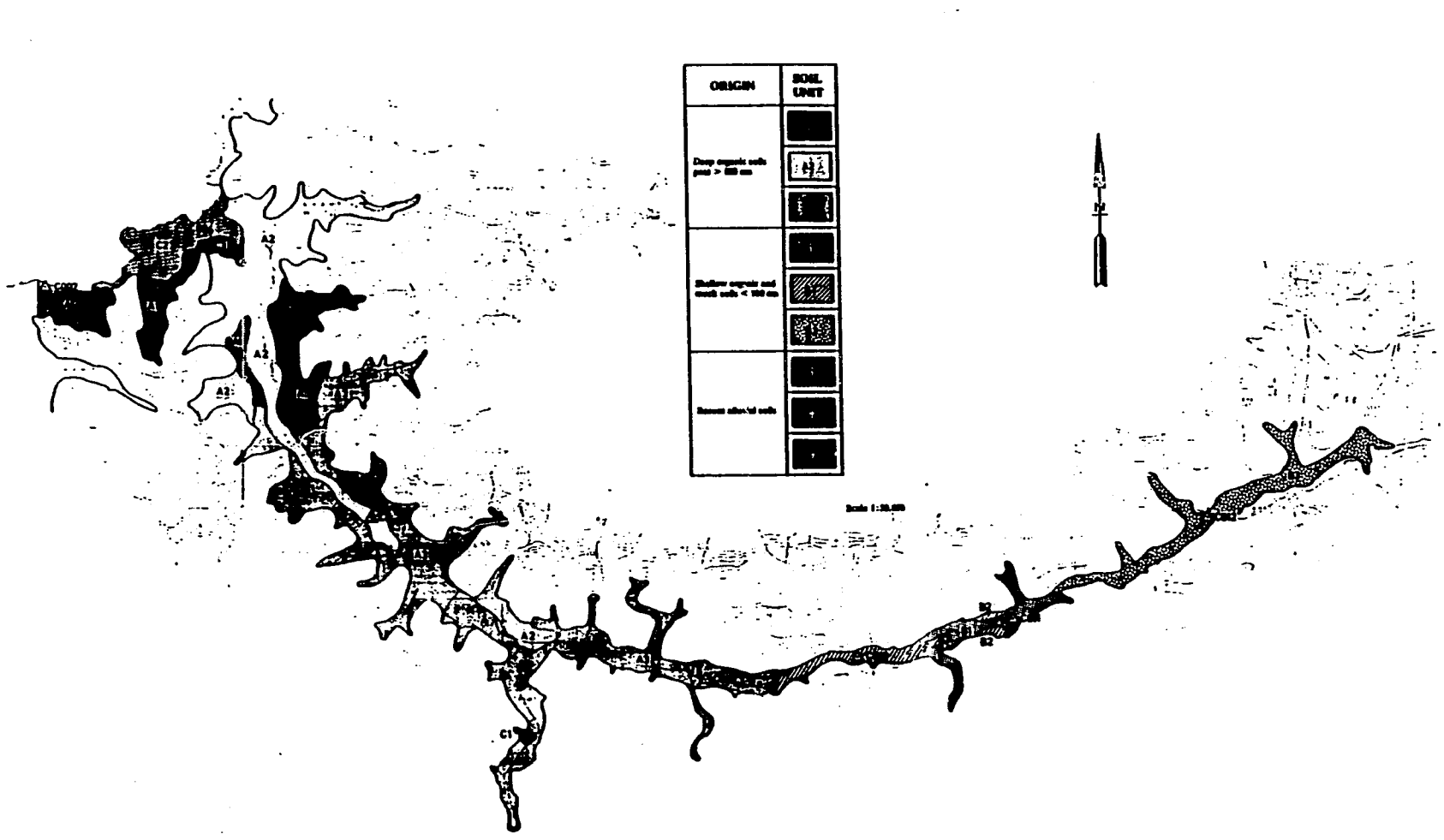

Figure 1. Map of Soil Groups

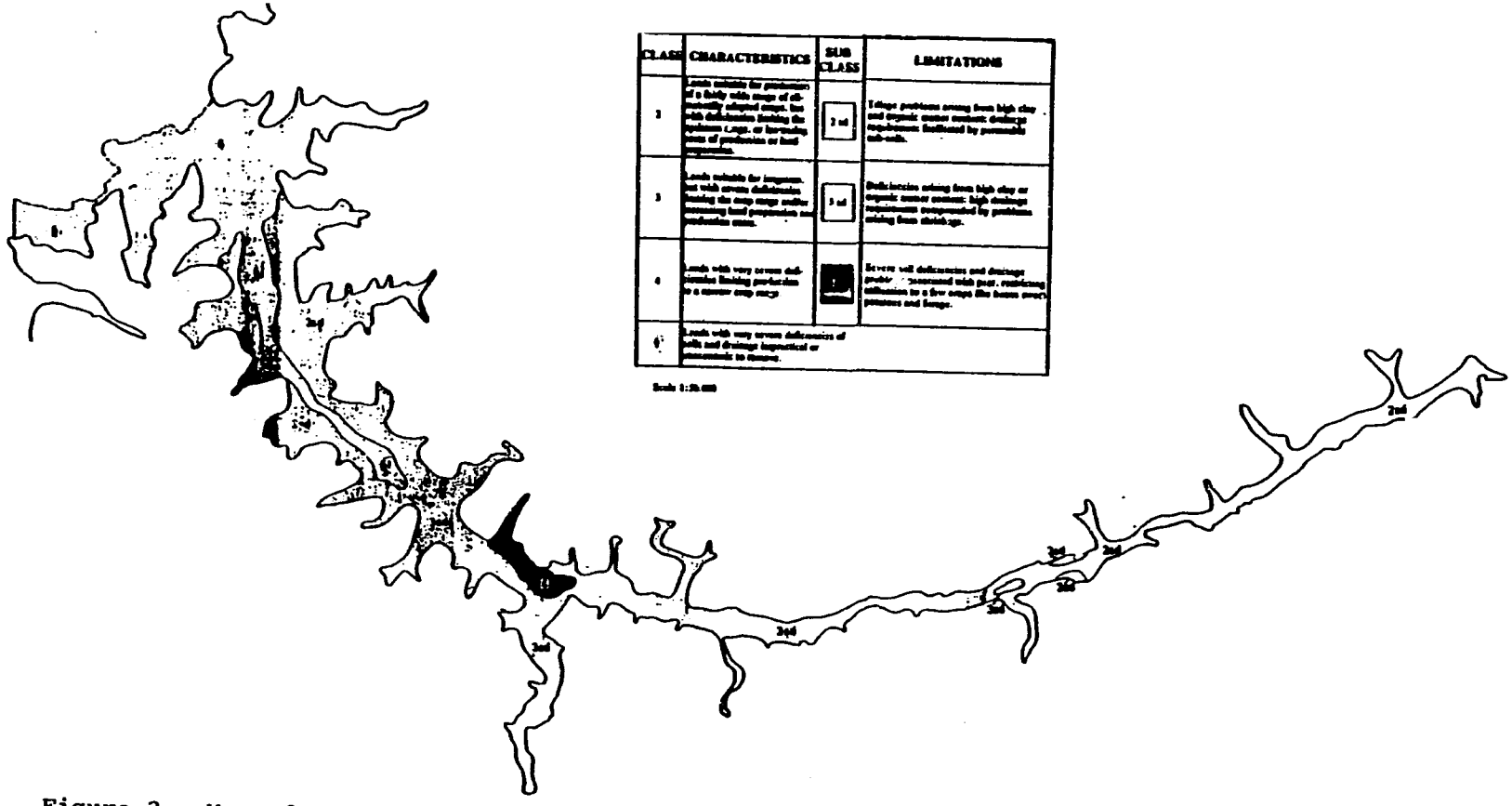

Figure 2. Map of Soil Characteristics

Table 1. Soil Groups, Units, and Characteristics

Group	Soil Unit	Characteristics
Peat soils containing at least 65% organic matter and less than 25 cm of any overlying alluvium, more than 100 cm deep	A1	Very poorly decomposed throughout
	A2	Poorly decomposed in upper 25 cm
	A3	Moderately decomposed in upper 50 cm
Muck soils containing 35-65% organic matter for at least 25 cm. Generally less than 100 cm deep	B1	25-50 cm of muck overlying fine textured alluvium
	B2	50-100 cm of muck overlying fine textured alluvium
	B3	25-50 cm of muck overlying coarse textured alluvium
Mineral soils with less than 35% organic matter for at least 25 cm	C1	Deep mineral soils, more than 100 cm deep
	C2	Mineral soils 50-100 cm deep overlying organic material
	C3	Mineral soils 25-50 cm deep overlying organic material

APPENDIX VI

Medicinal Plants of Burundi

Appendix VI. Medicinal Plants of Burundi

ACANTHACEAE
- *Blepharis buchneri*

AMARANTHACEAE
- *Celosia stuhlmanniana*
- *Cyanthula unicinulata*

APOCYNACEAE
- *Carissa edulis*

BALANITACEAE
- *Balanites aegyptica*

BURSERACEAE
- *Commiphora africana*

CAESALPINACEAE
- *Cassia dydimobotrya*
- *Cassia occidentalis*
- *Sebania macracantha*

COMPOSITAE
- *Dicoma anomala*
- *Erlangea spissa*
- *Guizotia scabra*
- *Microglossa pyrifolia*
- *Sphaeranthus suaveolens*
- *Vernonia amygdalina*

CRASSULACEAE
- *Crassula abyssinica*
- *Kalanchoe lateritia*

CUCURBITACEAE
- *Oreosyce africana*
- *Peponium vogelii*

EUPHORBIACEAE
- *Bridelia atroviridis*
- *Bridelia scleroneuroides*
- *Clutia abyssinica* var. *pedicellaris*
- *Clutia usambarica*
- *Euphorbia candelabrum*
- *Hymenocardia acida*
- *Ricinus communis*
- *Tragia brevipes*

GENTIANACEAE
- *Faroa aca ulis*
- *Faroa graveolens*

GRAMINEAE
- *Cynodon dactylon*
- *Hyparrhenia variabilis*
- *Hyparrhenia welwitschii*
- *Panicum maximum*
- *Rynchelytrum roesum*

GUTTIFERAE
- *Psorospermum febrifugum*

IRIDACEAE
- *Gladiolus psittacinus*

LABIATAE
- *Englerastrum schweinfurthii*
- *Homalcheilus ramosissimus*
- *Pycnostachys erici-rosenii*
- *Ocimum sp., Ocinum americanum*

MELASTOMATACEAE
- *Dissotis brazzae*
- *Biophytum petersianum*
- *Biophytum sensitivum*

PAPILIONACEAE
- *Aeschynomene leptophylla*
- *Alysicarpus rugosus ssp. perennirufus*
- *Alysicarpus zeyheri*
- *Eriosema montanum*
- *Glycine javanica*
- *Kotschya strobilantha*
- *Neorantanenia pseudopachyrhiza*
- *Sphenostylis marginata*
- *Zornia pratensis*

PEDALIACEAE
- *Sesamum angolense*

PHYTOLACCACEAE
- *Phytolacca dodecandra*

POLYGONACEAE
- *Polygonum senegalense*

PROTEACEAE
- *Protea madiensis*

RANUNCULACEAE
- *Clematis simensis*

ROSACEAE
- *Parinari mobola*

RUBIACEAE
- *Pavetta ternifolia*
- *Pentas longiflora*
- *Virectaria major*

SAPINDACEAE
- *Dodonae viscosa*

SCROPHULARIACEAE
- *Hebenstreitia dentata*

SOLANACEAE
- *Solanum aculeastrum*

TILIACEAE
- *Triumfetta rhomboidea*

ZINGIBERACEAE
- *Costus spectabilis*

Source: LeWalle and Rodegen. 1968.

APPENDIX VII

Fauna

Appendix VII. Fauna

Table 1. Major Mammal Species Reported in Burundi

Table 2. Selected Bird Species in Burundi

Table 3. Fish Species in Lake Rwegero (Rweru) and Lake Cohoha South

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Sources: Cabral. 1970.
Derleyn. 1977.
Derleyn. 1978a.
Derleyn. 1978b.
IUCN. 1975.
IUCN. 1976.
IUCN. 1979.
Kiss. 1977a.
Verschuren. 1977a.
Verschuren. 1977b.
Verschuren. 1978.

Table 1. Major Mammal Species Reported in Burundi

	Remarks
Primates	
Gorilla gorilla beringei	extinct since 1977
Pan troglydytes	perhaps 20 individuals in the Teza forest
Colobus polykomos adolfi-friederici	poached for skins
Cercopithecus lhoesti rustishuricus	poached for skins
Cercopithecus mitis	
Colobus badius	
Cercopithecus aethiops centralis	seen on the eastern savanna near Ruyigi
Papio doguera tessalatus	wide ranging, farm pest
Felids	
Panthera leo	wiped out except for stragglers from Tanzania
Panthera pardus	hides regularly sold in Bujumbura
Genetta pardina shoudetodeni ?	seen in the Bururi forest
Acinonyx jubatus	may persist in the Mosso region
Osbornictis piscivorus	very rare aquatic genet found in marshes
Canines	
Crocuta crocuta habessinica	relatively common
Thos adustus	becoming less common
Lycaon pictus	rapidly becoming extinct
Ungulates	
Orycteropus afer	extinct
Loxodonta africana	10 in the Mobaye forest, severely poached
Equus burchelli	extinct, once found near Busoni
Diceros bicornus	extinct, once found in the Mosso
Hippopotamus amphibus	abundant and successful; over 1200 individuals
Phacochoreus aethiopicus	absent from its ranges on the Rusizi and Ruvubu
Potamochoerus porcus	abundant, farm pest
Hylochoerus meinertzkageni	may persist in the mountains
Tragelaphus scriptus	quite common
T. spekei	survives in the papyrus zone and marshes
Sylvicarpa grimmia	quite common
Redunca redunca wardi	found in the Ruvubu; extinct in the Rusizi
Damaliscus lunatus	may persist on the lower Kayongonzi
Alcelaphus, sp.	found in the Mosso
Hippotragus equinus	extinct
Aepyceros melampus	extinct
Cephalophus nigrifons kivuensis	regularly sold at Bugarama
Kobus defassa	most successful of large antelope
Oreotragus oreotragus	no recent evidence; once very common
Syncerus caffer	herds of 20+ individuals seen
Hystrix, sp.	quite abundant
Lepus, sp.	

Table 2. Selected Bird Species in Burundi

	Remarks
Tachybaptus ruficollis	inhabits northern marshes
Pelecanus rufescens	quite common
P. onocrotalus	1000 seen on the lower Ruvubu
Phalacrocorax africanus	quite common
Anhinga rufa	common on the Ruvubu andaround L. Tanganyika
Nycticorax nycticorax	rare
Bubulcus ibis	extremely common around Bujumbura
Egretta ardesiaca	
E. alba	
E. garzetta	
Ardrea cinerea	common at L. Rwihindi and Bujumbura
A. melanocephala	
A. goliath	
Scopus umbretta	
Ephippiorhynchus senegalensis	
Anastomus lamelligerus	
Myctaria ibis	common
Threskiornis aethiopicus	
Bostrychia hagedash	
Plegadis falcinellus	
Platalea alba	
Phoenicopterus ruber	Pink flamingos may be new to Burundi
P. minor	Lesser flamingos may likewise be new to Burundi
Alopochen aegyptiacus	
Dendrocygna viduata	extremely common duck
Plectropterus gambensis	
Gypohierax angolensis	almost the only vulture seen in Burundi
Haliaeetus vocifer	
Elanus caeruleus	
Milvus migrans	
Francolinus, sp.	extremely heavily poached, becoming rare
Balearica regulorum	poached for pets by non-Burundians
Vanellus coronatus	
V. lugubris	
Charadrius pecuarius	
Numenius arquata	
Actitis hypoleucos	
Tringa nebularia	
Arenaria interpres	
Himantopus himantopus	
Rhinoptilus chalcopterus	
Glareola pratincola	
Larus cirrocephalus	
L. fuscus	
Rynchops flavirostris	
Childonias leucopterus	extremely common water bird in the Rusizi
Columbidae, spp.	many pigeon species are found in Burundi; poached
Centropus supercilious	anthrophilic
Merops nubicus	
Macrodipteryx vexillarius	
Motacilla aguimp	extremely anthropohilic
Tchagra senegala	very common in gardens in Bujumbura
Corvus albicolis	common in cultivated regions
Leptopilos crumeniferus	

Table 3. Fish Species in Lake Rugwero (Rweru) and Lake Cohoha South

Barbus altianalis

Labeo victorianus

Clarias mossambicus

Clarias ssp. *mossambicus*

Syndontis afro-fischeri

Syndontis sp.

Tilapia nilotica

T. variabilis

T. esculenta

T. rendalli

Haplochromis nubilus

H. multicolor

Haplochromis sp.

Source: Kiss. 1977a.

APPENDIX VIII

Environmental Legislation

Appendix VIII. Environmental Legislation

Table 1. Water

Table 2. Soils

Table 3. Fauna

Table 4. Flora

Table 5. Human Settlements and Housing

Table 6. Protected Areas

Sources: Caponera. 1979.
Johnson and Johnson. 1977.

Table 1. Water

1. Agreement between the Belgian Government and the Government of the United Kingdom of Great Britain and Northern Ireland regarding Water Rights and the Boundary between Tanganyika and Rwanda-Urundi, signed at London, 22 November 1934, C.L.B. 699 1/
2. Civil Code, Livre II, ss. 16-20, 26, 27, C.L.B. 53
3. Criminal Code, s. 144, C.L.B. 180
4. Judiciary Code, ss. 137, 149, C.L.B. 221
5. Legislative Ordinance 409/TP/U.N., 30 November 1943, Inquiry Commission on Rivers and Lakes Navigation, C.L.B. 832.
6. Decree-Law 1/196, 2 October 1968, Regideso, C.L.B. 703.
7. Order of 9 August 1893, Sale and Renting of Public Ownership, s. 7, C.L.B. 953.
8. Order of 12 July 1932, Fishing Grants Regulations, s. I, III, C.L.B. 616.
9. Order of 21 April 1937, Hunting and Fishing, s. II, III, C.L.B. 606.
10. Order of 5 January 1949, Sales Taxes, ss. D., C.L.B. 939.
11. Order of 6 May 1952, Servitudes on Ground Waters, Rivers and Lakes, and Respecting Their Uses, C.L.B. 694.
12. Order of 6 May 1952, Rivers and Lakes Waters Administration and Grants, C.L.B. 697.
13. Ordinance, 17 October 1911, Packaging, Preparation and Manufacture of Foods, C.L.B. 548.
14. Ordinance 127/6, 15 June 1913, Regulation Respecting Buildings in Urban Areas, C.L.B. 629, ss. 7-16, 31.
15. Ordinance of 1 July 1914, Rivers, Lakes, Sources Pollution and Contamination, C.L.B. 698.
16. Ordinance 5/TP of 25 December 1924, Lakes Navigation Policy and Survey, C.L.B. 836.
17. Ordinance 79/A.E. of 2 October 1930, Mineral Waters, Lemonades, Extracts or Syrups for Drinking or to be mixed with Waters in order to produce Lemonades, C.L.B. 700.
18. Ordinance 375/Hyg. of 10 October 1940, Health, C.L.B. 741.
19. Ordinance 52/442 of 21 December 1952, Local Associations provided for in Decree of 6 May 1952 dealing with Servitudes respecting Rivers, Lakes and Underground Waters, C.L.B. 696.
20. Ordinance 52/443, 21 December 1952, Provisions in order to preserve Sources, Aquifers, Lakes and Rivers, to prevent Water Waste and Pollution, to control Use Rights and Granted Occupancy Rights, C.L.B. 699.
21. Ordinance 64/560 of 22 December 1958, Navigation Policy and Survey - Measures of Waterways, Works and Harbour Structures Conservation, C.L.B. 839.
22. Ordinance 44/139 of 11 March 1959, Rates respecting Lands, Mines, Water-flow, and Registry of Land Titles, C.L.B. 102, s. V.
23. Ordinance 42/12 of 9 January 1950, Private Properties Measure and Marking out, C.L.B. 38.
24. Ordinance 74/335 of 28 June 1959, Public Health in Urban Communities, C.L.B. 738 annexe.
25. Rwanda-Urundi Ordinance 41/78 of 28 May 1956, respecting Unhealthy and Dangerous Buildings, C.L.B. 716.
26. Rwanda-Urundi Ordinance 5520/186, Ruzizi Fishing Regulation, C.L.B. 619.
27. Rwanda-Urundi Ordinance 221/259 of 13 December 1958, Water Sports Regulation, C.L.B. 843.
28. Rwanda-Urundi Ordinance 111/23 of 18 January 1961, Drinking Water Supply Restrictions, C.L.B. 741.
29. Minister's Ordinance 060/269 of 22 May 1967, International Navigation on Lake Tanganyika with Burundi Flag, C.L.B. 843.
30. Minister's Ordinance 040/78 of 13 June 1969, Water and Housing Electricity Sale Price, C.L.B. 899.
31. Ministerial Order 050/44 of 16 December 1961, Fishing Regulation in Lake Tanganyika, C.L.B. 618.

Table 2. Soils

1. Decree-Law 1/72, 1967, Abrogates Ordinance No. 551/254, 1959, which created a R-B Soil Committee and institutes instead a National Soil Committee.

2. Decree, 1958, Conservation and Utilization of Soils.

Table 3. Fauna

1. Ordinance 52/82, 1965, Protection of Zebra and Black Buffalo.

2. Ordinance 52/63, 1954, Protection of *Tendunca arundivum*.

3. Ordinance 52/88, 1951, Protection of Chtah.

4. Ordinance 35/Agri, 1942, Protection of the *Francolinus camerunensis*.

5. Ordinance 33/Agri, 1939, Protection of the "Rouanne" Antelope.

6. Ordinance 050/139, 1969, Regulation of Hunting and Protection of Specific Species.

7. Decree 1937, Hunting and Fishing.

8. Ministerial Decree 050/348, 1964, Closing of Hunting in the Rusizi Plain.

9. Ordinance 5520/237, 1958. Closing of Hunting.

10. Ordinance 52/111, 1956, Prohibition of Bird Hunting on the Rwihinda Lake.

11. Ordinance 52/79, 1955, Prohibition of Use of Certain Hunting Implements.

12. Ordinance 103/Agri, 1937, Hunting, Fishing and Protected Animals, Decree 1937.

13. Ordinance 53/Agri, 1934, Fight Against Invasions of Locusts.

14. Ordinance Ministerial 026/29, 1971, Acceptance of "Fishes of Burundi" as a priority enterprise.

15. Ministerial Decree 050/44, Regulate Fishing in Lake Tanganyika.

16. Ordinance 5520/97, 1959, Prohibition of Certain Type Fishing in Lakes, Except Lake Tanganyika.

    Ordinance 52/160, 1955, Regulates fishing in the preceding lakes.

17. Ordinance 52/25, 1955, Prohibition of Fishing in a Certain Manner.

18. Ordinance No. 326/Agri, 1947, Prohibition of Introduction of Strange Fish Species to Local Farms. Ord. 18/Agri, 1944.

Table 4. Flora

1. Ordinance 52/173, 1953, Bush Fires.
2. Decree 1930, Regulates Cutting of Wood.
3. Decree 1926, Protection of *Elaeis* palms.
4. Legal Ordinance 29/129, 1923, Protection of *Santal*.
5. Ordinance 53/15, 1915, Rule for Conservation and Preservation of Trees.

Table 5. Human Settlements and Housing

1. Legislation Decree, 1957, Urbanism.

   Ordinance 6601/11, Relates to Physical Publicity in Advertising

Table 6. Protected Areas

1. Ordinance 52/136, 1951, Creation of Two Forest Reserves in Bururi Province.
2. Decree 1939, Protection of Monuments and Sites.
3. Ordinance 63bis/Agri, Creation of a Forest Reserve at the Boundary of the Congo-Nile.

APPENDIX IX

Acronyms Used in this Report

Appendix IX. Acronyms Used in this Report

ALIC: Arid Lands Information Center, University of Arizona

CBR: Crude Birth Rate

CEPGL: Economic Community of the Great Lakes

DEF: Direction des Eaux et Forêts

EDF: European Development Fund

FAO: Food and Agricultural Organization (U.N.)

ISABU: Burundi Institute of Agricultural Science

IUCN: International Union for Conservation of Nature and Natural Resources

KRBC: Kagera River Basin Commission

MAB: Man and the Biosphere

RFP: Rusomo Falls Project

SDC: Subsea Development Corporation

UNCLDC: United Nations Conference on the Least Developed Countries

UNDP: United Nations Development Program

UNEP: United Nations Environment Program

UNESCO: United Nations Educational Scientific and Cultural Organization

UNIDO: United Nations Industrial Development Organization

UPRONA: Union et Progrès National

U.S. AID: U. S. Agency for International Development

USDA: U. S. Department of Agriculture

APPENDIX X

Selected Bibliography

Appendix X. Selected Bibliography

1. Agriculture
2. Anthropology and Sociology
3. Climate, Geology, and Soils
4. Ecology, Conservation, and Development
5. Economy
6. Fauna and Fisheries
7. Flora and Forestry
8. Health
9. Water Resources

1. Agriculture

Anonymous. 1975. Efforts d'amélioration de la cafeiculture. Marchés Tropicaux et Méditerranéens 31:108.

Autrique, A. 1974. Parasites du cotonier au Burundi. Butare, Burundi: Institut des Sciences Agronomiques du Burundi (ISABU).

-. 1979. La lutte contre les déprédations du cotonier au Burundi. Coton et Fibres Tropicaux 34(4):349-358.

Bonte, E. 1967. La culture du théier au Burundi. Annales de Gembloux 73:105-111.

Champion, J. 1970. Culture du bananier au Rwanda. Fruits d'Outre-Mer 25(3):161-168.

Coussement, S., W. Gaie, F. Warnier, G. Sottiaux, and A. Fogan. 1970. La fumure minérale du caféier d'Arabie au Burundi. Café, Cacao, Thé 14(2):105-143.

Gaudet, J. 1980. Environmental Assessment: Burundi Peat Project. Nairobi: U.S.AID.

Giban, J. 1978. Control of the multimammate rat, *Mastomys natalensis* (A. Smith) in the irrigated fields of the Republic of Burundi. Proceedings of The 8th Annual Conference on Vertebrate Pest Control. Davis, CA: University of California. pp. 40-43.

Institut des Sciences Agronomiques du Burundi (ISABU). 1975. Rapport Annuel de l'ISABU. 2 vols. Burundi: Institut des Sciences Agronomiques du Burundi.

-. 1976. Rapport Annuel de l'ISABU. 3 vols. Burundi: Institut des Sciences Agronomiques du Burundi.

Renard, C., J. Flemal, and D. Barampana. 1979. Évaluation de la résistance à la sécheresse chez le théier au Burundi. Café, Cacao, Thé 73(3):175-182.

2. Anthropology and Sociology

Albert, E. M. 1960. La Femme en Urundi. Une étude de valeurs sociales. *In* Femmes d'Afrique Noire, D. Paulme, ed. Paris: Mouton. pp. 173-206.

Casse, P., and L. Magos. 1978. L'animation Sociale au Burundi. n.p.

Greenland, J. 1974. The reform of education in Burundi: enlightened theory faced with political reality. Comparative Education 10(1):57-63.

l'Hertfelt, M., A.A. Trouwhorst, and J.H. Scherer. 1962. Les anciens royaumes de la zone interlacustre méridionale: Rwanda, Burundi, Buha. Tervuren, Belgium: Koninklijk Museum voor Midden-Africa.

Lemarchand, R. 1970. Rwanda and Burundi. New York: Praeger.

-----. 1977. Burundi. *In* African Kingships in Perspective, R. Lemarchand, ed. Plymouth, U.K.: Frank Cass. pp. 93-128.

McDonald, G., et al. 1969. Area Handbook for Burundi. Washington, D.C.: G.P.O.

Weinstein, W., and R. Shrire. 1975. Ethnic strategies and the primacy of ethnic survival: the case of Burundi. International Review of Modern Sociology 5(2):185-192.

Andriesse, J.P., H.A. von Rosmalen, and A. Muller. 1976. On the variability of amorphous materials in Andosols and their relationship to irreversible drying and P-retention. Geoderma 16:125-138.

Anonymous. 1975. Geomines enlightened cooperation (mining in Burundi, Rwanda and Zare). Mining Journal 285(7323):498-499.

Anonymous. 1979a. Burundi potential (nickel). Mining Journal 293(7509):40.

Anonymous. 1979b. Burundi. *In* Mining Annual Review. pp. 483-484.

Bultot, F. 1972. Rwanda and Burundi. *In* World Survey of Climatology, vol. 10: Climates of Africa, J.F. Griffiths, ed. Amsterdam: Elsevier. pp. 349-360.

Cahen, L., J. Delhal, and G. Moneyne-Poulaert. 1966. Age determinations on granites, pegmatites and veins from the Kibarian Belt of Central and Northern Katanga (Congo). Nature 210(5043):1347-1349.

Cahen, L., and J. Lepersonne. 1967. The precambrian of the Congo, Rwanda and Burundi. *In* The Precambrian, Vol. 3. K. Roukoma, ed. New York: Interscience (John Wiley). pp. 143-290.

d'Hoore, J.L. 1964. Explanatory monograph. Soil map of Africa. Scale 1 to 5,000,000. Lagos: U.N. Commission for Technical Cooperation in Africa.

Frankhart, R.P., and A.J. Herbillon. 1971. Aspects de la pédogenèse des sols halomorphes de la Basse Rusizi (Burundi): présence et genèse de l'analcime. Annales du Musée Royal de l'Afrique Centrale. Série In-8. Science Géologique no. 71. Tervuren, Belgium: Musée Royal de l'Afrique Centrale.

Frankhart, R., H. Neel, and G. Sottiaux. 1974. Humic mountain soils in Rwanda and Burundi -- evolution under human influence. Pédologie 24(2):164-177.

Gerards, J. 1973. Esquisse géologique du bassin méridional de l'Akanyaru, au nord de Ngozi. Rapport Annuel pour l'Année 1972 du Département de Géologie et de Minéralogie du Musée Royal de l'Afrique Centrale. Tervuren, Belgium. Musée Royal de l'Afrique Centrale. pp. 62-70.

Gerasmouskii, U.A., and E.N. Savinova. 1975. Flourine in the extensive rocks of the East African Rift Valley. *In* Recent Contributions to Geochemistry and Analytic Chemistry. A.I. Tugarinov, ed. New York: John Wiley. pp. 329-334.

Gotanegre, J. F., C. Prioul, and P. Sirven. 1974. Géographie du Rwanda. Brussels: A. de Boeck.

Jolly, et al. 1974. Burundi. *In* The Mineral Industry of Other Areas of Africa. Vol. 3. U.S. Bureau of Mines Minerals Yearbook. Washington, D.C.: U.S. Department of the Interior. pp. 1061-1126.

-----. 1976. Burundi. *In* The Mineral Industry of Other Areas of Africa. Vol. 3. U.S. Bureau of Mines Minerals Yearbook. Washington, D.C.: U.S. Department of the Interior. pp. 1141-1210.

Lambeau, J-C. 1970. Une coupe géologique dans les terrains Burundiens au Sud de Gitega. Rapport Annuel de l'Année 1969 du Département de Géologie et de Minéralogie du Musée Royal de l'Afrique Centrale. Tervuren, Belgium: Musée Royal de l'Afrique Centrale. pp. 31-33.

Lambeau, J-C., and A. Waleffe. 1970. Roches d'aspects conglomératiques et roches carbonatées au nord de Bujumbura. Rapport Annuel de l'Année 1969 du Département de Géologie et de Minéralogie du Musée Royal de l'Afrique Centrale. Tervuren, Belgium: Musée Royal de l'Afrique Centrale. p. 33.

Marble, R.A., et al. 1975. Burundi. *In* The Mineral Industry of Other Areas of Africa. Vol. 3. U.S. Bureau of Mines Minerals Yearbook. Washington, D.C.: U.S. Department of the Interior. pp. 1171-1174.

Neel, H. 1974. Soils of High Altitude Lands in Rwanda: Trials for Increasing their Productivity. Technical Report 1973-1974 of the Burundi Program. Rome: FAO.

Neel, H., and H. de Prins. 1974. Essai d'amélioration des sols des prairies d'altitude à Mata: résultâts obtenus entre 1971 et 1978. Bulletin Agricole du Rwanda 7(4):281-283.

Peric, M. 1981. Exploration of Burundi nickeliferous laterites by electrical methods. Geophysical Prospecting 29:174-187.

Sys, C. 1975. Savannah soils of Central Africa, their classification and management. Paper No. 15 of the International Soils Science Society Meeting. Temra, Ghana, 1975.

UNESCO. 1975. Kaolin in Burundi. *In* UNESCO Features No. 687688. Paris: UNESCO. p. 25.

U.S. Army Map Service. 1962. Ruanda-Urundi, 1:200,000. 2nd ed. No. Z522. Washington, D.C.: U.S. Army Map Service.

van Wambeke, L. 1977. The Karonge rare earth deposits, Republic of Burundi: new mineralogical-geochemical data and the origin of mineralization. Mineralium Deposita 12:373-380.

Waleffe, A. 1968. Les séries inférieures et moyennes du Burundi dans la partie occidentale de la feuille de Mwishanga (Burundi). Rapport Annuel de l'Année 1967 du Département de Géologie et de Minéralogie du Musée Royal de l'Afrique Centrale. Tervuren, Belgium: Musée Royal de l'Afrique Centrale. pp. 44-48.

-. 1969a. Le massif de Mulehe (Burundi). Rapport Annuel de l'Année 1968 du Département de Géologie et de Minéralogie du Musée Royal de l'Afrique Centrale. Tervuren, Belgium: Musée Royal de l'Afrique Centrale. pp. 41-42.

-. 1969b. Observations complémentaires sur le Malagarasien de la région du Mosso (Burundi). Rapport Annuel de l'Année 1968 du Département de Géologie et de Minéralogie du Musée Royal de l'Afrique Centrale. Tervuren, Belgium: Musée Royal de l'Afrique Centrale. pp. 42-44.

-. 1970a. Présence de dolomie cristalline dans le massif du mont Djina (Burundi). Rapport Annuel de l'Année 1969 du Département de Géologie et de Minéralogie du Musée Royal de l'Afrique Centrale. Tervuren, Belgium: Musée Royal de l'Afrique Centrale. pp. 33-36.

-. 1970b. Reconnaissance géologique du massif de Wakirari (Burundi). Rapport Annuel de l'Année 1969 du Département de Géologie et de Minéralogie du Musée Royal de l'Afrique Centrale. Tervuren, Belgium: Musée Royal de l'Afrique Centrale. pp. 36-38.

-. 1973a. Présence de roches ultrabasiques dans le massif gabbroique de Buhoro-Musongati (Burundi). Rapport Annuel pour l'Année 1972 du Département de Géologie et de Minéralogie du Musée Royal de l'Afrique Centrale. Tervuren, Belgium: Musée Royal de l'Afrique Centrale. pp. 81-82.

-. 1973b. Une formation sédimentaire mouvelle dans le nord-ouest du Burundi. Rapport Annuel pour l'Année 1972 du Département de Géologie et de Minéralogie du Musée Royal de l'Afrique Centrale. Tervuren, Belgium: Musée Royal de l'Afrique Centrale. pp. 83-86.

4. Ecology, Conservation and Development

Cazenave-Piarrot, F., A. Cazenave-Piarrot, and A. Lopez. 1979. Géographie du Burundi: les Pays et les Hommes. Paris: EDICEF.

Chrétien, J.P. 1979. Les années de l'éleusine, du sorgho et du haricot dans l'ancien Burundi. Ecologie et Idéologie. African Economic History 7(7):75-92.

Curry-Lindahl, K. 1974. Conservation problems and progress in equatorial African countries. Environmental Conservation 1(2):111-122.

Due, J.F. 1979. The problems of rail transport in tropical Africa. Journal of Developing Areas 13(4):375.

Europa. 1978. Burundi. *In* Africa South of the Sahara. London: Europa. pp. 196-205.

Jeune Afrique. 1977. Supplement A, Burundi. Jeune Afrique 877 (28 October 1977).

-. 1978. Le programme de redressement. Jeune Afrique 883 (15 February 1978).

-. 1979. Au centre et en couleurs: Burundi. Jeune Afrique 964 (27 June 1979).

Johnson, H., and J.M. Johnson. 1977. Burundi. *In* Environmental Policies in Developing Countries. Berlin: Erich Schmidt Verlag. pp. 814290/00-07.

Lambrecht, F.L. 1952. Anophélisme dans le Mosso-Sud (Urundi). Annales de la Société Belge de Médicine Tropicale 32(3): 243-246.

-----. 1966. Some principles of tse tse control and land use with emphasis on wildlife husbandry. East African Wildlife Journal 4:89-98.

-----. 1981. Dangerous developments. IDRC Report 9(4):4-6.

Ministère du Plan. 1968. Plan Quinquennal de Développement Economique et Social du Burundi. Bujumbura, Burundi: République du Burundi, Ministère du Plan.

Norconsult-Electrowatt. 1976. Kagera River Basin Development, Phase II: Technical Report. 13 vols. Hovik, Norway: UNDP/Norconsult-Electrowatt.

Spinage, C.A. 1969-70. Report of the Ecologist to the Rwanda National Parks. London: Ministry of Overseas Development.

Technical Assistance Clearing House (TAICH). 1979. Burundi. Development Assistance Programs of U.S. Non-profit Agencies. New York: American Council of Voluntary Agencies for Foreign Service, Technical Assistance Information Clearing House.

UNCLDC. 1981. Summary of the Country Presentation for Burundi. Geneva: Secretariat, U.N. Conference on the Least Developed Countries.

United Nations Development Program (UNDP). 1978. Examination Report of the Technical Report,"Development of the Kagera River Basin, Phase II, Vol. 3 (April 1976)." New York: UNDP.

Van den Berghe, L., and F.L. Lambrecht. 1952. *G. Moristans* et la trypanosomiose dans le Mosso-Sud (Urundi). Anais do Instituto de Medicina Tropicale IX(3):859-879.

5. Economy

Anonymous. 1981. Countries aim at improving transport links. Africa News 16(13):6-8, 10.

Banque de la République du Burundi. 1980. Le commerce extérieur du Burundi en 1979. Bulletin Trimestriel 73:5-43. Bujumbura, Burundi: Banque de la République du Burundi.

European Economic Commission. 1974. Burundi. *In* Possibilités de Création d'Industries Exportatrices dans les Etats Africains et Malgaches Associés. 4 vols. Brussels, Belgium: European Economic Commission, Direction Générale du Développement et de Coopération, Direction des Échanges Commerciaux et du Développement.

Industry and Trade Commission. 1978. Foreign Economic Trends and their Implications for the United States. Washington, D.C.: U.S. Department of State/U.S. Department of Commerce.

U.S. Agency for International Development (U.S.AID). 1980 All Data Currently Available on Burundi. Washington, D.C.: U.S.AID/DIU/ESDS.

6. Fauna and Fisheries

Aellen, P. 1964. Beitrag zur chenopodiacen - flora von Congo, Rwanda und Burundi. Bulletin du Jardin Botanique de l'État 34(4):491-494.

Aurélien, F. 1957. Rwihindi, lac aux oiseaux. Groupe Scolaire Astrida. Astrida, Rwanda-Urundi.

Cabral, J.C. 1970. As genetas de Africa central (Republica do Zaire, Rwanda e Burundi). Boletin de Instituto Investigaçao Cientifica de Angola 7(2):7-27.

Chapman, D.W., and P. van Well. 1978. Observations on the biology of *Luciolates stappersi* in Lake Tanganyika (Tanzania). Transactions of the American Fisheries Society 107(4):567-573.

Coulter, G.W. 1976. The biology of *Lates* species (Nile perch) in Lake Tanganyika, and the status of the pelagic fishery for *Lates* species and *Lucioloates stappersii* (Blgr.). Journal of Fish Biology 9:235-259.

Derleyn, P.P. 1977. Notes sur les serpents du Burundi: les genres *Thrasops, Dendraospis* et *Bitis*. Revue Zoologique Africaine 91(3):525-537.

-. 1978a. Notes sur les serpents du Burundi (2ème partie): Les genres *Geodipsas* et *Theodotornis*. Revue Zoologique Africaine 92(1):208-218.

-. 1978b. Notes sur les serpents du Burundi (3ème partie): Revue Zoologique Africaine 92(3):728-737.

Dunn, L.G. 1977. A tropical African artisanal lake fishery: Lake Rugwero, Rwanda. *In* Proceedings of the Conference on Handling, Processing, and Marketing of Tropical Fish, 1976. London: Tropical Products Institute. pp. 479-483.

Gaugris, Y. 1976. Contribution à l'inventaire des oiseaux du Burundi. L'Oiseau et R.F.O. 46:172-189.

International Union for the Conservation of Nature and Natural Resources (IUCN). 1975. Red Data Book: Amphibia and Reptiles. Morges, Switzerland: IUCN.

-----. 1976. Red Data Book. Mammals. Morges, Switzerland: IUCN.

-----. 1979. The Distribution of Protected Areas in Relation to the Needs of Biotic Community Conservation in West and and Central Africa. Gland: IUCN.

Kiltz, H.H. 1979. Tick control: Rwanda. *In* Tick-Borne Diseases: Survey and Control Methods. Rome: FAO.

Kiss, R. 1977a. Les poissons et la pêche dans le lac Ihema, Rwanda, bassin moyen de l'Akagera. Annales d'Hydrobiologie 17(2):263-318.

Schoudeten, H. 1966. La faune ornithologique du Burundi. Documentation Zoologique 11:1-81. Tervuren, Belgium: Musée Royal de l'Afrique Centrale.

Verschuren, J. 1977a. Les grands mammifères du Burundi. Mammalia 42(2):209-224.

-----. 1977b. Note sur la faune ornithologique du Burundi; principalement près de Bujumbura. Le Gerfaut 67:3-20.

-----. 1978. Burundi and wildlife: problems of an over-crowded country. Oryx 14(3):237-240.

Compère, R. 1968. Exploitation rationnelle de la prairie permanente d'altitude à *Exotheca abyssinica* (Anders) and *Eragrostis boehmii* (Hack) au Rwanda et Burundi. Bulletin de Recherches Agronomiques de Gembloux 3(4):583-604.

Geerinck, D. 1976a. Notes taxonomiques sur des Orchidacies d'Afrique Centrale III. Bulletin de la Société Royale Botanique Belge 109(2):173-178.

1976a. Notes taxonomiques sur des Orchidacies d'Afrique Centrale IV. Bulletin de la Société Royale Botanique Belge 109(2):179-194.

Haunan, L. 1960. Quelques malracées nouvelles du Congo et du Rwanda-Urundi. Bulletin du Jardin Botanique de l'État 31(1):85-90.

Keay, R.W.J. 1959. Vegetation map of Africa South of the Tropic of Cancer. London: UNESCO/Oxford University Press.

Le Walle, J., and F.M. Rodegen. 1968. Plantes médecinales du Burundi. Quarterly Journal of Crude Drug Research 8(3):1257-1270.

Liben, L. 1965. Notes sur quelques *Combretaceae* (*Combretum* Loeffl., *Terminalia* L. et *Stephonema* Hook. F) du Congo, du Rwanda et du Burundi. Bulletin du Jardin Botanique de l'État 35(2):167-184.

-. 1973. Spermatophytes. *Oliniaceae,* Flore d'Afrique Centrale (Zaire-Rwanda-Burundi). Brussels: Jardin Botanique National de Belgique.

-. 1965. Spermatophytes *Oleaceae,* Flore d'Afrique Centrale (Zaire-Rwanda-Burundi). Brussels: Jardin Botanique National de Belgique.

-. 1977. Flore d'Afrique Centrale (Zaire-Rwanda-Burundi) Spermatophytes. *Bignoniaceae.* Brussels: Jardin Botanique National de Belgique.

Maldague, M. 1980. Les Problèmes qui se Posent aux Forêts Ombrophiles Tropicales. Paris: UNESCO/République du Burundi.

Moore, P.D. 1980. Exploiting papyrus. Nature 284:510.

Pouilloux, C. 1976. Problèmes forestiers au Burundi. Bois et Fôrets des Tropiques. 170:21-34.

Rattray, J.M. 1960. The grass cover of Africa. FAO Studies No. 49. Rome: FAO.

Robyns, A. 1975. Flore d'Afrique Centrale (Zaire-Rwanda-Burundi) Spermatophytes. *Thymelaeceae*. Brussels: Jardin Botanique National de Belgique.

Robyns, W., and A. Lawalree. 1961. Nouvelle contribution à l'étude des Thesium (*Santalaceae*) du Congo et du Rwanda-Urundi. Bulletin du Jardin Botanique de l'État 31(4): 511-528.

Shantz, H.L., and B.L. Turner. 1958. Vegetational Changes in Africa over a Third of a Century. Tucson, Arizona: College of Agriculture, University of Arizona.

Troupin, G. 1961a. Plantae africanae VI: le genre *Aloe* L. (*Liliaeceae*) au Rwanda-Urundi. Bulletin du Jardin Botanique de l'État 31(3):407-412.

-----. 1961b. Plantae africanae VII: *Aponogetonaceae, Commelinaceae, Gramineae, Liliaceae, Mimosaceae*. Bulletin du Jardin Botanique de l'État 31(3):413-418.

-----. 1965. Plantae africanae VII: notes sur des *Mimosaceae* du Congo, du Rwanda et du Burundi. Bulletin du Jardin Botanique de l'État 35(4):449-462.

-----. 1966. Étude Phytocénologique du Parc National de l'Akagera et du Rwanda Oriental: Recherche d'une Méthode d'Analyse appropriée a la Végétation d'Afrique Intertropicale. Publication No. 2. Butare, Rwanda: Institut National de Recherche Scientifique.

Wilozek, R. 1963. Novitates africanae VIII. *Tiliaceae*. Bulletin du Jardin Botanique de l'État 33(4):459-469.

8. Health

Anonymous. 1970. Nutrition in Burundi. *In* Proceedings of the Third African Conference on Nutrition and Child Feeding. Atlanta: Center for Disease Control. pp. 16-39.

Cole, M.M., P.H. Clarke, P.H. Washington, F. Ellerbe, and D.L. van Netta. 1973. Resistance to malathion in a strain of body lice from Burundi. Journal of Economic Entomology 66(1):118-119.

Fokom, P., and G. Houssou. 1974. Mortalité et fécondité en Afrique Centrale. Yaoundé, Cameroun: Institut de Formation et de Recherches Démographiques (IFORD).

Guiguen, C., and J.C. Beaucornu. 1979. Présence de *Pulex irritans* L. *(Siphonaptera)* au Burundi, région à risque pesteux. Bulletin de la Société de Pathologie Exotique 72(5/6):481-486.

Hamber, G., and M. von Bergen. 1971. Peptic ulcer in the Burundi Republic and Nile-Congo watershed. Tropical and Geographical Medicine 23(3):213-219.

1973. Gastric ulcer in tropical Africa: clinical features and incidence in Burundi. Tropical and Geographic Medicine 25(1):1-7.

Hiernaux, J., and A. Schweich. 1979. Variation of blood pressure and heart rate in and between 18 ethnic groups of Rwanda, Burundi and Zaire. Journal of Human Evolution 8(8):767-771.

Le Vis, H., M. Bossuyt, P. Hennart, and M. Carael. 1975. The health of mother and child in rural central Africa. Studies in Family Planning 6(12):437-441.

Lukelenge Mapumba, K., A. Fain, J. Bourland, et P. Cosci. 1979. Enquête sur l'onchocercose au Burundi. Annales de la Société Belge de Médicine Tropicale 59:251-258.

May, J. 1965. Rwanda and Burundi. *In* Studies in Medical Geography, vol. 5: The Ecology of Malnutrition in Middle Africa. New York: Hafner. pp. 139-166.

Onyango, R.J. 1971. The present distribution of human trypanosomiasis in Africa. *In* Health and Disease in Africa -- the Community Approach. G.C. Gould, ed. Dar Es Salaam: East Africa. pp. 105-110.

Raybould, D.N., and G.B. White. 1979. The distribution, bionomics and control of onchocercosis vectors (*Diptera: Simuliidae*) in eastern Africa and the Yemen. Tropenmedizin und Parasitologie 30:505-547.

Speed, D.E. 1970. Population crisis in central Africa: Rwanda and Burundi. *In* Health and Disease in Africa -- the community approach. Proceedings of the East African Medical Research Council Scientific Conference. G.C. Gould, ed. Nairobi: East African Literature Bureau. pp. 243-246.

Storme, B., et al. 1979. L'édpidémie de choléra au Burundi en 1978. Annales de la Société Belge de Médecine Tropicale 59:413-425.

World Bank. 1980. Burundi. World Tables, 2nd ed. Baltimore: Johns Hopkins. pp. 52-53.

-----. 1981. World Development Report. Washington, D.C.: World Bank. 192 pp.

Bodeux, A. 1972. Hydrologie et bilan de l'eau du bassin versant de la Karuzi au Burundi. Archives de la Mission Karuzi, v.4.

Caponera, D.A. 1979. Burundi. *In* Water Law in Selected African Countries. Rome: FAO. pp. 63-75.

Kiss, R.B. 1977b. Hydrobiologie générale du bassin de la Kagera et des lacs Cohoha Sud et Rugwero (3ème et 4ème partie). Rome: FAO.

Kourzoun, V.L., ed. 1977a. World Water Balance and Water Resources of the Earth. U.S.S.R. National Committee for the International Hydrological Decade. Paris: UNESCO. pp. 251-307.

1977b. Atlas of World Water Balance. U.S.S.R. National Committee for the International Hydrological Decade. Paris: UNESCO: Maps 23-30.

Thomann, G. 1979. Hydropower potential of Burundi: unexploited wealth of a developing country. *In* Third World Congress on Water Resources, vol. II. Mexico City: International Water Resources Association. pp. 779-788.

Thompson, K. 1976. Swamp development in the headwaters of the White Nile. *In* The Nile: Biology of an Ancient River. J. Rzoska, ed. Amsterdam: W. Junk pp. 177-196.

Welsh, J.L. 1980. Report on Irrigation, Kagera River Basin. Kigali, Rwanda: U.S.AID/UNDP.

White, G.F., D.J. Bradley, and A.V. White. 1972. Drawers of Water: Domestic Water Use in East Africa. Chicago: University of Chicago Press.