BIBLIOGRAPHIC DATA SHEET	1. CONTROL NUMBER	2. SUBJECT CLASSIFICATION (695)
	PN-AAJ-206	DA00-0000-G130

3. TITLE AND SUBTITLE (240)

Environmental profile of the Republic of Zaire, phase 1

4. PERSONAL AUTHORS (100)

5. CORPORATE AUTHORS (101)

Library of Congress. Science and Technology Div.

6. DOCUMENT DATE (110)	7. NUMBER OF PAGES (120)	8. ARC NUMBER (170)
1980	94p.	CG33Ø.9675.L697

9. REFERENCE ORGANIZATION (130)

LC

10. SUPPLEMENTARY NOTES (500)

(Sponsored by AID through the U.S. National Committee for Man and the Biosphere)

11. ABSTRACT (950)

12. DESCRIPTORS (920)

Zaire	Conservation
Renewable resources	
Environmental management	Soil conservation
Pollution	Environmental factors
Water supply and health	Natural resources
Wildlife	Forest land

13. PROJECT NUMBER (150)

14. CONTRACT NO.(140)

SA/TOA-01-77

15. CONTRACT TYPE (160)

16. TYPE OF DOCUMENT (160)

AID 590-7 (18-79)

PHASE 1 ENVIRONMENTAL PROFILE

OF

THE REPUBLIC OF ZAIRE

prepared by the

Science and Technology Division
Library of Congress
Washington, D.C.

AID Contract No. SA/TOA 1-77
With the U.S. Man and the Biosphere Secretariat
Department of State
Washington, D.C.

June, 1980

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 (A.I.D.), Office of Science and Technology (DS/ST) 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 A.I.D. 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 A.I.D. 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 DS/ST and should be addressed to either:

Jim Corson
AID/MAB Project
Department of State
Room 515, SA-2
Washington, D.C. 20520

OR

Molly Kux
Office of Science & Technology
U.S. A.I.D.
Washington, D.C. 20523

PREFACE

This draft environmental report is the result of an eight week review of information available in the United States on the natural resources and environment of the Republic of Zaire. It is the first step in a two-phase process of developing an environmental profile for use by AID and host government officials. It is intended that the next step be a field study, approximately equivalent in effort to a sector assessment, which would validate the information contained herein, obtain additional information, define issues, problems and priorities, and orient AID as well as the host government's efforts to deal with the management, conservation, and rehabilitation of the environment and natural resources. The scope of work for the field level profile is still to be developed, through consultations with AID staff in Washington and in the field. However, the field level study will generally follow the organization of the present draft report.

The information and interpretations presented in this report are preliminary in nature, and not intended to attain the detail and accuracy needed for development planning.

The development of environmental profiles is being undertaken for all AID receiving countries. The procedure consists of an initial desk study, or review of existing literature, followed by a field level study. The field level study should provide the basis for identifying projects and developing the corresponding project identification documents (PID's). The information contained in the profiles should also be helpful in the formulation of program strategies for individual countries, and in the development of Country Development Strategy Statements. In some instances the profile, when taken to the field level phase, may provide orientation and justification for host government efforts to more effectively deal with environmental and natural resource problems. The information in the profile may also be of value to local non-governmental organizations in their attempts to find useful roles and activities.

This phase 1 environmental profile has been prepared by Peter Hazlewood of the Science and Technology Division, Library of Congress for the Office of Science and Technology, Development Support Bureau, AID in cooperation with the U.S. Man and the Biosphere Program.

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Figure 1. General map of Zaire.

SUMMARY

The Republic of Zaire is a largely landlocked country centrally located in equatorial Africa. The major geographical features of the country include the Zaire river system and basin, the northern and southern uplands, and the eastern highlands and Rift valley. Zaire forms part of the Guineo-Congolian floristic region, with roughly 45% of the country lying in the belt of tropical rain forest stretching from Sierra Leone to the Rift valley. The entire country falls within the torrid climatic zone.

The 1979 population of Zaire has been estimated at 27,048,000 which yields an average population density of 12 persons per square km. Though relatively low, this figure does not provide an accurate picture of the significant variations in density across the eight national regions and Kinshasa. Zaire is undergoing rapid urban growth due primarily to migration from rural areas. Over 25% of the total population now resides in urban areas. Average life expectancy was estimated at 43.5 years in 1973.

From a macro point of view, Zaire's troubled economy and relatively low population pressure have combined to prevent any serious near-term threats to the country's renewable natural resource base. Unless major shifts occur in present patterns of exploitation, it is believed that Zaire's vast forest reserves will likely remain little changed for the next 10-20 years. With forested lands remaining largely intact, pressure on other renewable natural resources (soils, water, and fauna) will be kept at a sustainable level. Thus, Zaire has the opportunity to anticipate, rather than react to, potential problems related to the management of its renewable natural resources.

However, from a micro point of view, Zaire is already experiencing significant renewable natural resource problems around its major urban population centers. Most important is the rapidly rising demand for fuelwood around these areas, which has led to extensive forest clearing and attendant soil and water problems.

In addition to problems associated with renewable natural resource management, the following are the major environmental problems facing Zaire today:

(i) Development and coordination of legislative and institutional mechanisms for environmental management;

(ii) Problems associated with unregulated urban expansion, such as the provision of adequate housing and services;

(iii) Rural water supply and sanitation;

(iv) Pollution effects of mineral exploitation, including offshore drilling for petroleum.

I. INTRODUCTION

A. Physical Characteristics

The Republic of Zaire is a largely landlocked country centrally located in equatorial Africa. With a 40 km (25 mi) coastline on the Atlantic Ocean, it is bordered by the Cabinda enclave of Angola and the People's Republic of the Congo on the west; the Central African Empire and the Sudan on the north; Uganda, Rwanda, Burundi, and Tanzania on the east; Zambia on the southeast; and Angola on the south. With an area of 2,344,885 sq km (905,365 sq mi), it is the third largest country in Africa and is roughly equal in size to the United States east of the Mississippi.

Geography

Zaire can be divided into three major geographic regions defined in terms of terrain and vegetational distribution: the cuvette centrale (central basin), the northern and southern uplands, and the eastern highlands and Rift valley (see Fig. 2).

The Cuvette Centrale. The Zaire (or Congo) river system and its basin constitute the dominant physical feature of Zaire and give the country a certain geographic unity. The basin, known as the "cuvette centrale," covers an area of about 800,000 sq km or about a third of Zaire. The cuvette centrale is a broad, flat basin that constitutes a slight depression of the African continental platform. It is the most clearly distinguished of the various geographic depressions situated between the Sahara to the north, the Atlantic Ocean to the south and west, and the eastern highlands; and may once have been an inland sea whose vestiges are the lakes of Tumba and Mai-Ndombe. Both relief and geologic formation are basin shaped, demonstrating a persistent tendency to subsidence in this part of the continent that is compensated for by a corresponding uplifting at the rim of the basin, especially in the east and southeast (hence, the name "cuvette" or saucer). The rims of the cuvette are at 1500 m on the south, 1000 m on the north and west, and nearly 3000 m on the east. The floor of the cuvette has an average altitude of 400 m; Lac Mai-Ndombe marks the lowest point at 338 m. The monotonous basin plains and terraced plateaus have some elevations, such as the hill country around Zongo and Mobayi-Mbongo in the north which reach elevations of 700 m. The cuvette is filled with alluvial deposits from a number of large tributaries of the Zaire River such as the Ubangi, Lualaba, and Kasai rivers.

Extensive depressions occur along some portions of the Zaire River that give rise to swampy areas. Some of these depressions may be considered ancient lakes that have evolved from the endorheic into the exorheic type, later becoming swamps after changes in the climate from dry to wet and the acquisition of an outlet to the cuvette centrale. A prominent example is the Kamolondo depression in northern Katanga, a swampy area of about 10,000 square km inundated during the rainy season by the overflow of various affluents. Another significant depression of this type is the Bangweulu Lake area in northern Zambia,

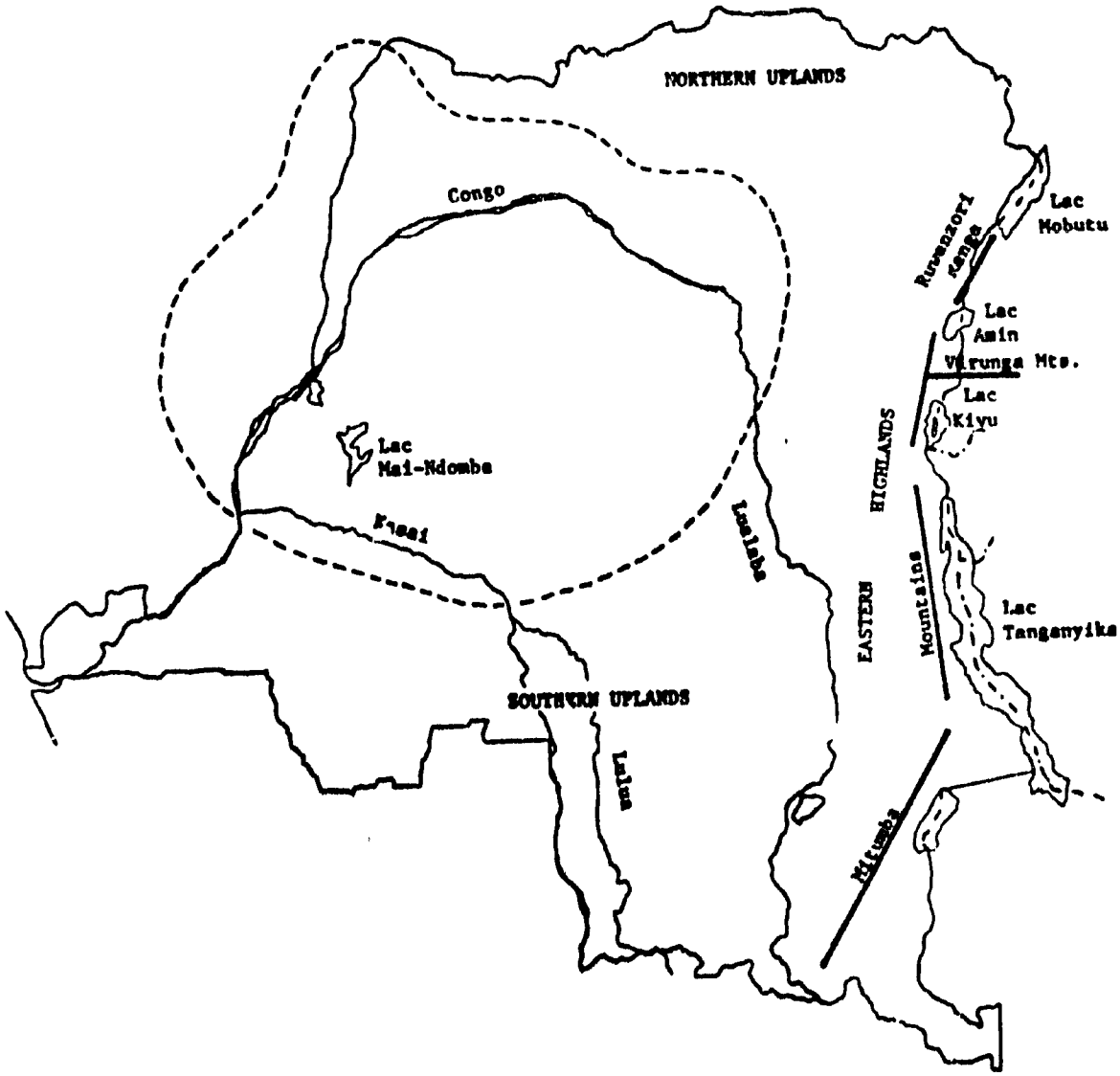

Figure 2. Major geographic features of Zaire.

which drains into the Lualaba-Zaire system through the Luapula, Lake Mweru, and the Luvua. The Bangweulu depression lies at an elevation of 1148 m and is 4150 sq km in area. The Bangweulu-Luvua watershed has an area of over 218,000 sq km.

The Northern and Southern Uplands. This region includes a varierty of mostly dissected high plateaus and some minor mountainous areas which completely surround the cuvette centrale, to which almost the entire region drains. To the south is the southern uplands region, which covers an additional third of the country. The northern part of this region slopes from south to north, starting at about 1000 m and descending to about 500 m as it approaches the basin. In

the southeast the peaks of the Shaba plateaus, comprising somewhat higher plateaus and low mountains, tower over the entire area and extend as far north as the Lukaga River. A small part of southeasternmost Zaire lies in the Zambezi River Basin, which drains into the Indian Ocean. The northern escarpment of the Angolan plateau rises in the southwest. In the westernmost section of Zaire is the coastal region, an extension of the southern uplands that drops sharply to a very narrow shore. The coastal region is comprised of a fairly low plain that runs inland from the Atlantic Ocean to the Bangou-Mokaba highlands, which are deeply dissected by the Zaire River and its tributaries. It is through these mountains that the Zaire cuts its way from the central basin to the Atlantic Ocean.

The northern uplands are composed of the undulating Ubange-Uele plateaus, rising to as high as 900 m where they meet the western edge of the eastern highlands. Together with the Bongo Mountains in the Central African Republic, this region forms a watershed between the drainage basins of the Nile, Zaire and Lake Chad systems.

The Eastern Highlands and Rift Valley. The western Rift valley and highlands terminate the western arm of the east African plateau system (part of the Great Rift Valley), a depression extending discontinuously from the Zambezi valley in central Mozambique northward to the Red Sea. Along its Zaire section, the depression contains Lakes Mweru, Tanganyika, Kivu, Amin, and Mobutu, which are separated from each other by plains situated between high mountain ranges. The trough-like depression of Lake Tanganyika attains a depth of more than 1400 m and is the world's second deepest lake. Its surface, at 779 m altitude, lies more than 150 m below the surrounding country, which is deeply incised by the streams flowing to the lake.

The eastern highlands of Zaire, dominated by the Mitumba Mountains, run parallel to the rift system and extend over 1,500 km from the southern tip of Shaba below Lubumbashi to above Lake Mobutu. This is the highest region of the country, ranging in altitude from about 1000 m to over 5000 m. The eastern plateau in Zaire also forms part of this area.

The snow-covered peaks of the Ruwenzori Range form the highest point of the region. The Range runs parallel to the rift system, to which it drops steeply. The descent to the uplands of western Uganda is more gradual. At its base the range is 120 km long. The summit zone contains six distinct mountain massifs, which are separated by well-defined passes and deep river valleys.

The Virunga (or Nufumbiro) Mountains are a string of volcanoes which, together with their associated lava fields, extend from west to east for nearly 80 km across the Rift from Zaire to Rwanda and Burundi. Lying between Lake Kivu to the south and Lake Amin to the north, they divide the drainage basin of the Nile River from that of the Zaire River. Lakes Kivu and Tanganyika thus drain via tributaries of the Zaire to the Atlantic Ocean, and Lakes Amin and Mobutu drain via the Nile into the Mediterranean. Of the eight principal volcanoes, Nyamulagira, Nyiragongo, and Mikeno lie within Zaire. Karasimbi, the highest of the peaks at 4507 m, is on the Zaire-Rwanda frontier, and Sabinio is at the juncture of the boundaries of Zaire, Rwanda, and Uganda. The crater of Mikeno has disappeared and erosion has imposed a jagged relief. However, the lava

fields of Nyamulagira and Nyiragongo have remained active, and successive lava flows have reached as far as Lake Kivu. Significant eruptions have occured in 1912, 1938, and 1948.

Geology and Lithology

The Cuvette Centrale. The occurence of Karroo-age sediments in the Zaire basin indicates that its formation began during the Palaeozoic as a downwarp in the Precambrian floor, despite the fact that there was probably no real basin at the time of deposition. Toward the west the basin is bordered by metamorphic lower Precambrian rocks and by the cuestas of the sandstone Bateke plateau. The plateau has a mean altitude of 600 m which decreases toward the south. It is composed of lower Cenozoic polymorphic sandstone. Toward the north and east the basin is bordered by upper Precambrian sandstone.

In the basin the Precambrian rocks are covered by sediments which consist of continental deposits ranging from Palaeozoic to recent age and are believed to be 3500 m thick. They comprise the Karroo beds, "continental interclaire," "continental terminal," and the Quaternary sediments, which cover a 150,000 sq km alluvial plain in the center of the basin (and often show lateritic agglomerations near the surface).

The "continental intercalaire" is a 100 m thick sand deposit which is mostly silicified. It consists of layers of fine-grained quartz and chalcedony which are often very hard. At the base a conglomerate occurs. The plateau sands are slightly consolidated or non-consolidated. The sands in the lower level are often calcareous and the base is formed by a calcrete. In the center of the basin the Quaternary deposits are of fluviatile and lacustrine origin. They are often covered with a Pleistocene duricrust. Recent alluvial deposits are found along the main streams.

The Northern and Southern Uplands. This region forms part of the central African basement complex. This basement complex is mainly composed of highly metamorphic and granitized crystalline rocks. Slightly metamorphic, sedimentary, intrusive and volcanic rocks (in the east) also occur. The granitized part of the basement complex is believed to be of lower Precambrian age. It includes granite, gneiss, and migmatite. The part which has not been affected by granitization consists of schist, quartzite, syenite, and dolerite. The upper Precambrian rocks around the Zaire basin are slightly metamorphic sandstone, quartzite, and schist. The northern edge of the Zaire basin is formed by upper Precambrian non-metamorphic sandstone and shale.

The Eastern Highlands and Rift Valley. During the Tertiary, risings and sinkings formed the mountains and depressions of the eastern highlands. The western Rift is an arcuate fault system extending from Sudan to Lake Malawi. The faults bordering the western Rift zone tend to follow pre-existing Precambrian structures. Later phases of faulting have produced steep scarps flanking the edges of the lakes. Faulting played an important part in the formation of Mt. Ruwenzori, which may be considered a horst (a block of the earth's crust separated by faults from adjacent relatively depressed blocks). Its position in the Rift valley axis and the striking absence of volcanism indicate that it was uplifted

by vertical pressure or compression. Between Rutshuru and Goma is a volcanic dam on the floor of the Rift which diverted the northward outflow of a former river system to form Lake Kivu. In the Kivu ridge the middle Precambrian rocks comprise strongly metamorphosed gneiss, amphibolite, quartzite, and micaschist as well as granitic intrusives. The western Rift valley is mainly filled with Quaternary sediments.

Climate

About 30% of Zaire lies north of the equator, and the country is entirely within the torrid climatic zone. Four major wind systems largely determine the different seasons and temperatures. The hot, dry trade winds of the northeast blow across Zaire from Egypt and the Arabian Peninsula, passing over the Sudan. The southeastern trade winds are also hot and dry; they originate from the western subtropical winds and blow up along the Mozambique Channel, losing a great deal of humidity along the Southern African coast. The hot and relatively dry east equatorial current blows from the Indian Ocean over east Africa. The humid Atlantic monsoon originates in the south Atlantic and is diverted toward the central African continent. There are four major climatic zones that correspond to the geographic regions described above: equatorial, coastal, tropical, and highland (see Appendix 3 for additional climatic data).

Equatorial zone. The equatorial zone covers the cuvette centrale (located roughly between 4N and 4S latitudes), but is skewed to the north because of the greater northern land mass. The zone is characterized by high rainfall of 1300-2000 mm distributed over a 10-12 month period annually, and year-round hot temperatures averaging 24 degrees C with about 1 degree C annual variation. Humidity is always high at 65% or more.

Coastal zone. Though located within the equatorial zone, the climate of the coastal lowlands is somewhat cooler and drier due to the modifying influences of low altitude and the cold Benguela Current of the Atlantic. On the coast the average annual temperature is 25 degrees C, and rainfall averages about 760 mm annually.

Tropical zone. The tropical or subequatorial zone occurs to the north and south of the equatorial zone and has a wider temperature range with distinct rainy and dry seasons. The rainy seasons are hot and humid, and occur from November through March south of the equator and April through October north of it. The dry seasons are cooler with overcast skies but little or no rain. Temperatures range annually between 22-27 degrees C in lowland areas and 24-26 degrees C in upland areas. Rainfall averages between 1000-1600 mm annually.

Highland zone. The highland climate occurs in the eastern high plateaus and mountains and is closer to a temperate range. Temperatures range between 18-24 degrees C and rainfall averages between 1200-1800 mm annually. The prevailing southwest winds in the Shaba region lead to greater seasonal variation, and frost may occur during the dry season. The highland lake area has a humid climate. Humidity tends to increase with elevation and a constant mist prevails in some mountain and alpine locations.

B. Demographic Characteristics

Introduction

The population of Zaire, encompassing over 200 ethnic groups and speaking more than 200 distinct languages, represents a rich, varied, and often conflicting ethnic, religious, and cultural heritage. Exact population size and characteristics are not known, and existing estimates are varied and contradictory. The official source of current national population data is an administrative census conducted in 1970; the last demographic survey having been undertaken between 1955-57. The 1979 population of Zaire has been estimated at 27,048,000. The population growth rate has increased rapidly, from an average annual rate of 2.0% between 1950-55 to about 2.7% today. The most striking feature of the population is its young age structure, with about 43% of the population under 15 years of age (see Appendix 1 for additional demographic statistics). 1/

Spatial distribution

Zaire's estimated average population density of 12 persons/sq km, though relatively low, does not provide an accurate picture of the significant variations in population density across the eight national regions and Kinshasa (see Fig. 3). It has been estimated that 75% of the rural population occupies roughly one-third of the total land area. Although no analysis of the relation between rural population densities and the physical environment has been undertaken, the pattern of settlement seems to have been significantly influenced by geographic and climatic conditions. The generally adverse conditions in the swamplands and dense equatorial rain forest of the central Zaire river basin system including torrential rains, high temperatures and humidity, and numerous vectors of disease have severely limited settlement in these areas. In addition to the cuvette centrale, these areas include that part of Haut-Zaire covered by equatorial forest, the central part of the northern uplands, scattered parts of the the southern uplands, and Shaba except for an area around Lubumbashi. The most densely settled areas include a zone stretching from the western coastal area intermittently through the savanna of the southern uplands to Mbuji-Mayi and its environs in Kasai-Oriental; and a zone which extends along a north-south strip of the eastern highlands, ending at the northern tip of Lake Tanganyika. The higher population density of the eastern highlands is due to the relatively temperate climate, adequate to heavy rainfall, and fertile soils. 2/

Population in the urban centers is increasing much more rapidly than the national rate, due to migration from rural areas. Government planners estimate that the ratio of agricultural producers to urban consumers will have declined to 1.3:1 by this year. The proportion of the population living in urban areas in 1975 was estimated at 25%, and is projected to reach 47.4% by 2000. In terms of population sizes, this translates into an increase of 14.8 million living in urban areas by 2000. 3/

1/ Tsui, 1979.
2/ Kaplar, 1979.
3/ Tsui, 1979.

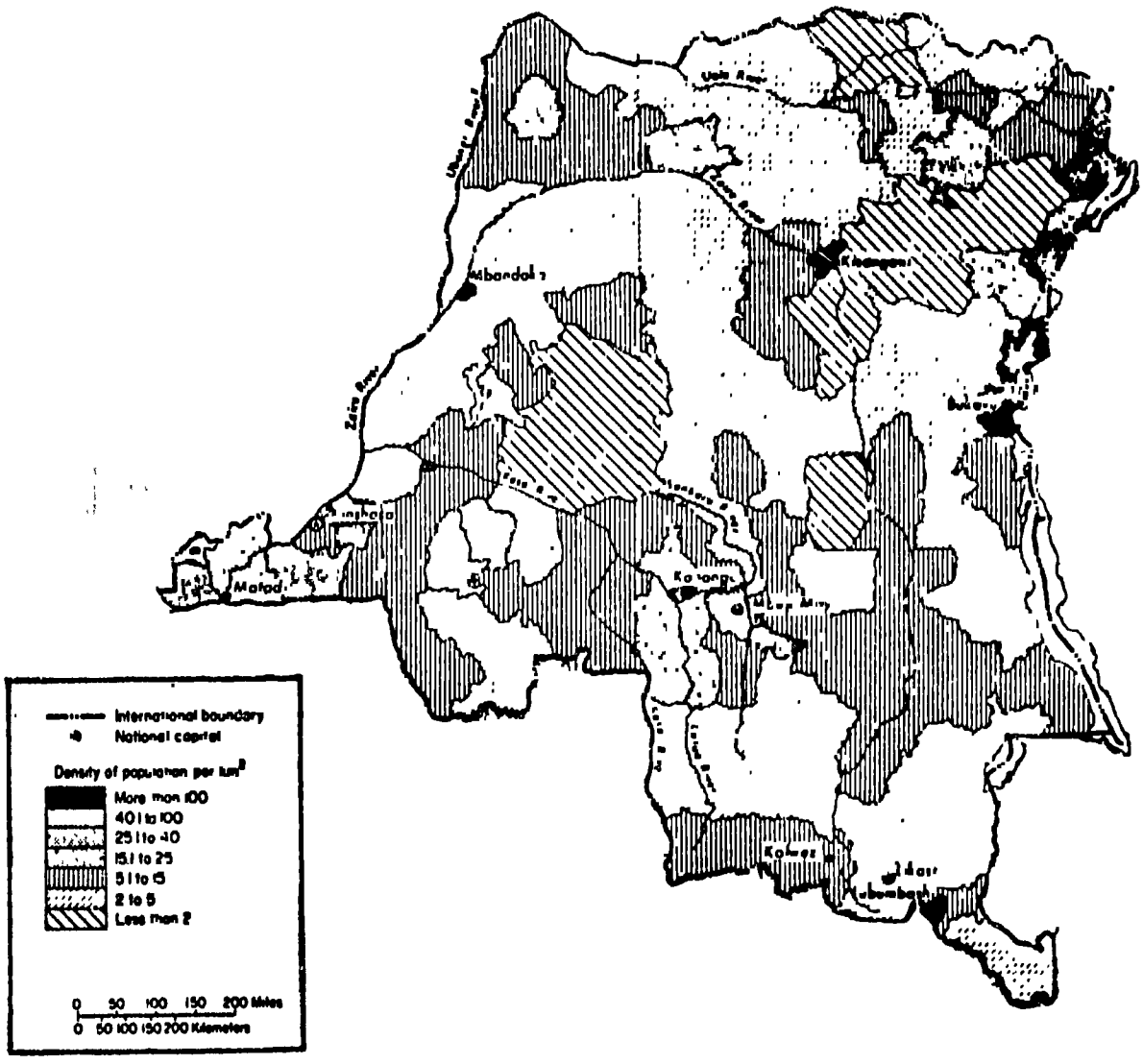

Figure 3. Population density, 1970.

Language and Ethnicity 1/

Zaire's population comprises over 200 principal African languages and ethnic groups; though the number of languages spoken corresponds only approximately to the number of ethnic groups. Four major language groupings occur in Zaire: Bantu (comprising by far the majority of languages), Adamawa-Eastern, Eastern Sudanic and Central Sudanic. The languages included in Adamawa-Eastern are spoken along the entire northern portion of Zaire, and are interspersed in the east along the Uele river with Central Sudanic languages. In the far northeast (from Lake Mobutu north) are the few Eastern Sudanic languages spoken in Zaire, interspersed with Central Sudanic, Adamawa-Eastern, and an occasional Bantu language.

1/ Kaplan, 1979.

The official language of Zaire is French, but to facilitate communication between groups four Bantu languages were given special status by the Government as national languages and are widely used. These are liNgala (spoken from Kisangani to Kinshasa and in the armed forces, is preferred by the Government), kiKongo (Bas-Zaire), tshiLuba (south central area), and kiSwahili (in its Zairian dialect, kiNgwana, spoken in the east). A fifth Bantu language, loMongo, is spoken in much of the cuvette and adjacent areas (see Fig 4 below).

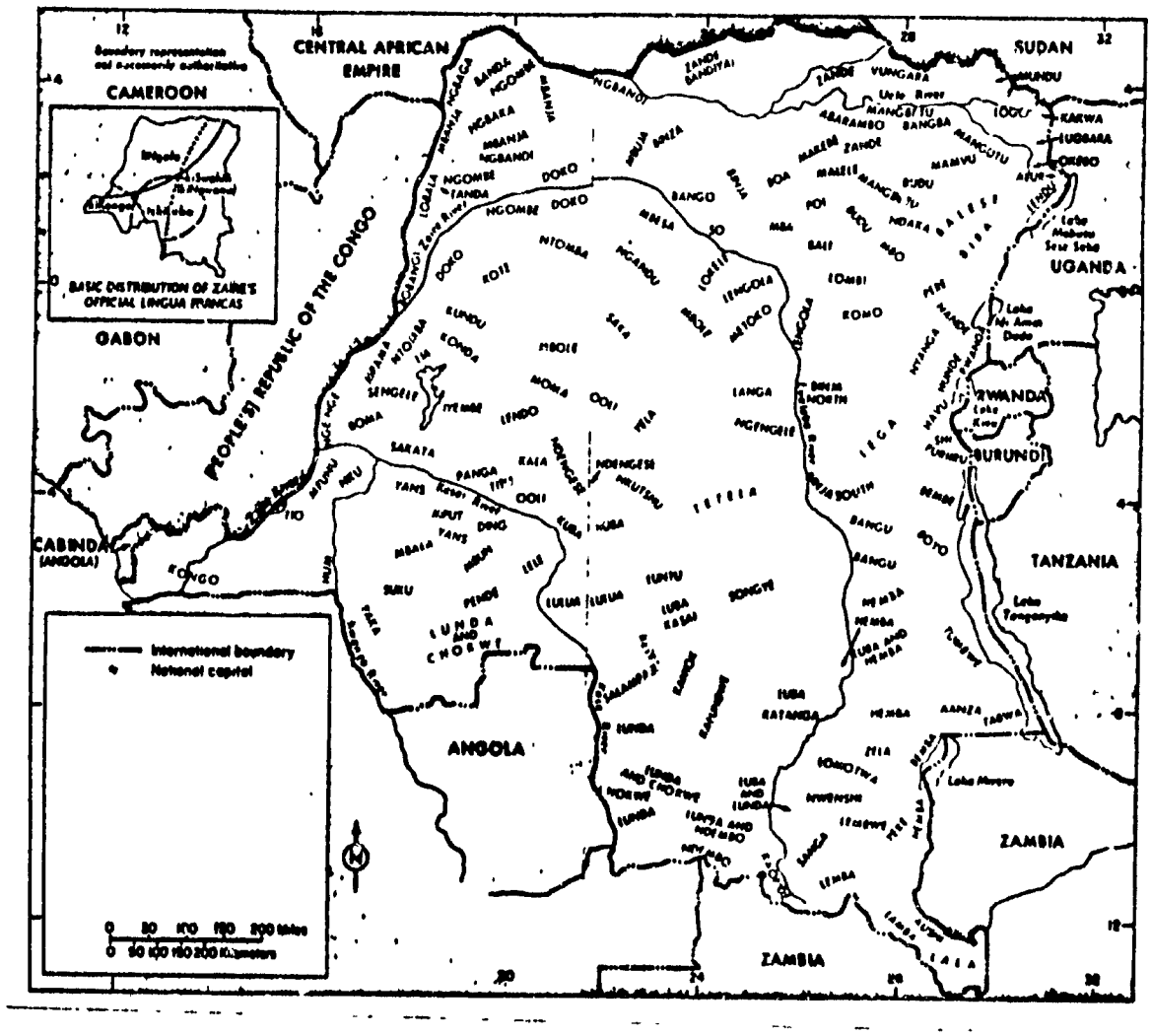

Figure 4. Selcted ethnic groups and linguistic distribution.

Almost everyone, including the urban dweller, identifies himself as a member of an ethnic group. Loyalty to the family probably surpasses all of an individual's other commitments. No single ethnic group is dominant nationally. The non-Bantu peoples, roughly 20% of the population, occupy the northern uplands from the Ubangi river to the far northeast. Most live in the savanna, but a large minority are in the equatorial forest. The northwest (northern Equateur)

is occupied by diverse peoples most of whom speak languages of the Eastern section of the Adamawa-Eastern family. The larger ethnic groups include the Ngbandi, the Ngbaka, and the Banda-speaking groups. To the east live a heterogeneous people called the Zande, who also speak a language of the Eastern section of Adamawa-Eastern. Further east in the equatorial forest to the north and northeast of the cuvette centrale are groups that speak Central Sudanic languages. The most important of these groups are the Mangbetu and the Mamvu. In the highlands of the far northeast live a collection of groups speaking languages belonging to each of the four families found in Zaire. Among these groups are the Alur, who are the only significant group in Zaire that speak an Eastern Sudanic language.

Throughout the rest of the country live the Bantu-speaking peoples, who comprise about 80% of the population and thus represent the largest ethnic entity in Zaire. The major cultural clusters of the Bantu include the Mongo (in the central basin and adjacent areas), Kongo (Bas-Zaire), Luba (south central), Lunda (south), Bemba and Kamba (southeast), and the Kwango and Kasai (southwest). The Pygmies are considered to be the earliest inhabitants of the central basin, having settled the area possibly during the Late Paleolithic period. The 80,000 to 100,000 remaining Pygmies inhabit the tropical rain forests of Kibali and Ituri, the regions of Lakes Kivu and Tanganyika, and the Lualaba, Tshuapa, Sankuru, and Ubangi rivers. They lead a semi-nomadic hunter-gatherer existence. Though the pygmies of the forest are true hunter-gatherers, they cannot be considered a completely isolated people. They have a dependent relationship with Bantus living in villages at the forest fringe, and emerge from time to time to barter wild meat for the agricultural products of the Bantu. 1/

Health

Reliable health statistics are generally unavailable as the country lacks a viable national health data collection system (see Appendix 2 for basic health data). Health problems range from malnutrition, perhaps the most serious health problem in Zaire, to a long list of communicable and parasitic diseases, which are often engendered or exacerbated by the state of malnutrition and poor sanitation. Though data are lacking, malnutrition appears to be most acute among the urban poor. Food intake was estimated in the late 1960's at 2370 calories per day per capita, with 80% from starches and fats. The most important foods are cassava, corn, and rice. 2/ Major diseases include: 3/

Malaria. Malaria is endemic in the lowland areas and can occur in epidemic form in the highlands up to 2000 m. Thus, virtually the entire population is affected. Repeated cases are common and almost all children in the lowland areas have had at least one attack before the age of ten. Statistical data on the incidence of infection and mortality are lacking.

1/ Unesco, 1978.
2/ Agency for International Development, 1979c.
3/ Agency for International Development, Office of Foreign Disaster Assistance, 1977.

Trypanosomiasis. The "at risk" population is centered in eastern Bas-Zaire, Equateur, Haut-Zaire, Kasai, and northern Shaba Provinces, comprising approximately 6 million persons. The number of new cases appears to be declining, but the area of endemicity is growing.

Onchocerciasis. This disease is endemic in many areas. Kasai Province is the most heavily affected with a 100% infection rate in some villages. A Government vector eradication program was begun in 1974.

Measles. Measles is one of the four major causes of infant mortality for children under the age of five.

Schistosomiasis. Schistosomiasis is prevalent and may be spreading throughout the country. Both the intestinal form and the urinary form are known to produce high human infection rates in areas such as Bas-Zaire (where it is a leading cause of mortality among infectious diseases). The high rates of infection are unlikely to decrease due to the expense of a prevention campaign and cultural habits which foster infection such as swimming and bathing in infested areas.

Tuberculosis. Tuberculosis is prevalent, particularly in overcrowded areas. Mortality is estimated at 10% and high reinfection rates have been recorded.

Skin diseases. These are common throughout the country, with the whole population affected at one time or another. Chigger fleas and flies, common insect parasites, live under or on the skin and often serve as entry points for secondary bacterial infection.

Leprosy. Leprosy is common in the Equateur and Oriental regions. There was a mid-1960 infection rate of 1,500-2,000 per million population.

Hookworm and other parasitic diseases. Almost the entire population has at least one parasitic disease and multiple infections are common. There is a high incidence of anemia which is directly related to high hookworm infection levels.

Dysentery and other diarrheal diseases. These are common to most of the population.

Typhoid and paratyphoid. The former is endemic with occasional epidemics. The highest levels occur during the dry season.

Functional Population Projections 1/

The population is projected to increase 80.2% to 44,069,000 by the year 2000. This is based on a projected decline in total fertility rates from 5893 to 3982 between 1975 and 2000, and an increase in female and male life expectancies to 55.0 and 54.4 respectively over the same period. Zero net migration is also as-

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1/ Tsui, 1979.

sumed for this period. This implies a tremendous increase in demands on services, facilities, and resources of all kinds over the next two decades. For example, to achieve the health care standards of the developed world by the year 2000, Zaire will need 21,230 physicians, 197,864 hospital beds, and 1,029 hospitals; its present health resources include 875 doctors, 56,489 hospital beds, and 338 hospitals.

Maternal-child health/family planning services

There is no population program of any significance now in effect. The Government is in the process of developing a national delivery system for maternal-child health/family planning (MCH/FP) services. Traditionally, many families have ten to fifteen children in order to assure having five survive to adulthood. Government health policy calls for the spacing of children, together with comprehensive MCH/FP services. This policy is considered a health measure and is not directed at limiting family size. Nevertheless, its existence has led to the open introduction of modern contraceptive methods and the establishment of approximately 80 small family planning service outlets, well distributed throughout Zaire. 1/ Demand for the family planning element of the proposed MCH/FP program is most obvious in the large population centers where economic considerations and physical crowding have combined to stimulate an awareness of the need for spacing births and limiting family size. 2/

C. Economic and Social Characteristics

Economic Overview

Zaire has a dual economy based on agricultural production of a wide variety of crops and a substantial mining and extractive industries sector. In addition to its extensive mineral resources, Zaire has abundant renewable natural resources including forests, fresh water fisheries, and approximately one-tenth of the world's hydroelectric potential. However, despite this enormous economic potential, Zaire remains among the poorest countries of the world. The development of the economy since independence in 1960 can be divided into three periods:

- The years 1960-67, which were marked by economic turmoil;
- The growth years of 1968-74, facilitated by high copper prices. This period was characterized by the accentuation of structural imbalances in the economy: investment was concentrated in the modern sectors (mining and manufacturing) and in services benefiting mostly urban centers, which grew considerably during this period, at the expense of agricultural production;
- The crisis years beginning in 1975 when commercialized GDP fell by 6.8%. 3/

1/ Agency for International Development, 1979c.
2/ Agency for International Development, 1975a.
3/ World Bank, 1979.

The downswing in the economy that began in 1975 persists today. Though the downswing was caused by a number of both external and internal factors, the decline in Zaire's terms of trade due to the fall in the price of copper stands out as the major contributor to both the severity and duration of the crisis (see Appendix 2 for economic data).

Mining and Industry. The modern sector of the economy is dominated by mining, which accounted for 80% of total export value, 45-50% of government revenues, and 13-23% of GDP in the early 1970's. Mining consumes about 70% of all electricity produced in Zaire. The transportation system has largely been developed to facilitate the movement of mineral production out of the country. Other industry consists primarily of food and beverage processing, textiles, metal fabricating, and mechanical assembly plants (see Appendix 2 for location of major economic activity).

Agriculture. The agriculture sector is characterized by the sharp division between a large-scale commercial sector often owned by expatriates and using hired labor, and the subsistence sector operated mainly by family labor on small plots utilizing traditional techniques, primarily varying methods of slash-and-burn agriculture. Commercial agriculture was developed under the Belgian administration with the establishment of plantations producing palm products, rubber, robusta coffee, and cocoa as export crops. The agriculture sector, both commercial and subsistence, has been in decline since independence. The commercial plantations were neglected during the period of heavy investment in mining and industry, and population growth has pushed the subsistence farmers further from their villages. 1/ Lack of access to markets because of the deteriorating transportation system has also hampered both sectors (see Appendix 2 agricultural production data and location of agricultural activity).

Land Tenure

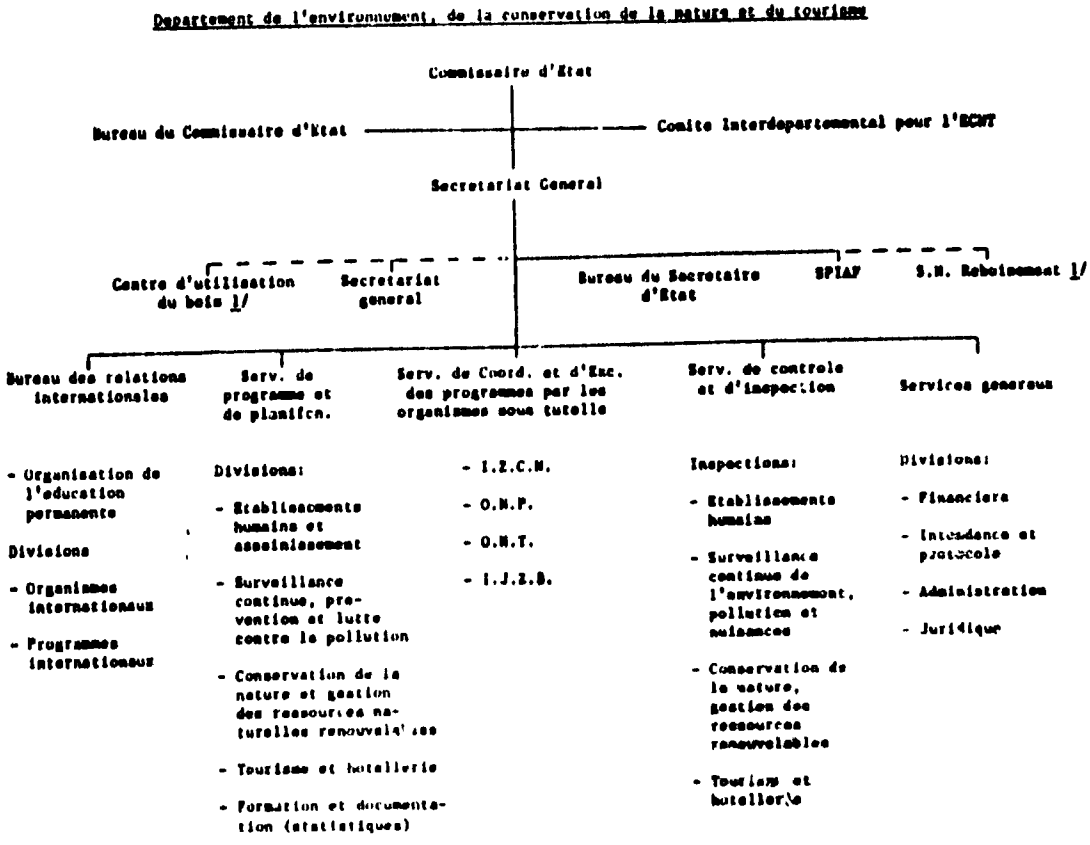
In principle, all land belongs to the state. There is no individual ownership. The Constitution guarantees individual and collective rights (not ownership) to property that has been acquired by virtue of customary law as well as by statutory law. Most land is held by the population under traditional laws of tenure that stemmed from the precolonial period. Under the predominant form of land tenure, effective control of the land is actually exercised by descent groups called lineages. Individuals obtain rights to the land and can pass them on to family members, but they do not possess the right to sell the land. This system varies throughout the country, with differences over acquisition of land, ownership of trees, and allocation to strangers, among others. It is not possible to generalize about the disincentives caused by the land tenure system. In some areas, farmers can make improvements on their land without fear of losing cultivation rights. For other areas and tribes, tenure is less secure. 2/

1/ Agency for International Development, 1979c.
2/ Ibid.

II. RENEWABLE NATURAL RESOURCES - USE AND CONSERVATION

A. Introduction

Legal and Institutional Framework. The Departement de l'Environnement, Conservation de la Nature et du Tourisme (hereinafter referred to as DECNT), created by statute in 1975, is the primary government organization responsible for montoring the exploitation and management of renewable natural resources. DECNT was established under Ordonnance-Loi No. 75-231 of 1975 (completing Ordonnance-Loi No. 69-146 of 1969), which sets out the functions of the Department. DECNT has assumed responsibility for a broad range of activities formerly administered by Agriculture, including renewable natural resources (water, soils, forestry, wildlife), public parks, plant nurseries, horticulture, and green belts. Housing and city planning, sanitation, and housing services - formerly run by Public Works - also have been moved to DECNT. Finally, the Department is responsible for controlling industrial pollution, rural sanitation, and protecting national monuments. In addition to DECNT, an Interdepartmental Committee for the Environment, Conservation of Nature and Tourism was established in 1975 under Ordonnance-Loi No. 75-232 to act as a coordinating and advisory body.



1/ Not yet established as of the end of 1978.

B. Water

Introduction

The Zaire River lies entirely within the intertropical zone. Together with the Amazon, the Zaire constitutes one of the two great rivers of the world that flow out of an equatorial zone subject to heavy rainfall that occurs throughout all or almost all the months of the year. The Zaire watershed, except for its lower course, has the shape of a shallow saucer, the rims of which are at 1500 m on the south, 1000 m on the north and west, and nearly 3000 m on the east. The watershed area of the Zaire per km of river is about 822 sq km.

The Zaire rises in Zambia between Lakes Tanganyika and Nyasa (Malawi) as the Chambezi River at an altitude of 1,760 m above sea level. Its course takes the form of a giant counterclockwise arc, flowing northwest, west, and southwest before draining into the Atlantic Ocean at Banane, Zaire. Though the Chambezi is considered the source of the Zaire in terms of its length, it is the Lualaba River, which rises near Musofi in the Shaba region, that carries the greatest quantity of water and thus can be considered the Zaire's original main stream in terms of water volume. The Zaire consists of three contrasting sections: the upper Zaire, middle Zaire, and lower Zaire.

The Upper Zaire. The upper reaches are characterized by the existence of extensive depressions giving rise to swampy areas in some portions of the basin. An example is the Kamolondo depression in northern Shaba, a swampy area of about 10,000 sq km inundated during the rainy season by the overflow of various affluents. Another depression of this type is the Bangweulu Lake area in Zambia, which drains into the Lualaba-Zaire system through the Luapula, Lake Mweru, and the Luvua. The Bangweulu depression lies at an elevation of 1148 m and is 4150 sq km in area. The Bangweulu-Luvua watershed has an area of over 218,000 sq km. Its output into the Lualaba fluctuates from 300 to over 950 cubic m per per second. Farther downstream, the Lualaba receives the Lukuga, the outlet of the great lakes watershed (244,500 sq km) and, farther north, several minor affluents that originate in the highlands forming the eastern rim of the basin. These tributaries supply a significant amount of water. The combined contribution of the Elila, Ulindi, and Lowa is estimated at between 2000 and 5000 cubic m per second, doubling the volume of the Lualaba between Kindu and Bubundu.

The middle Zaire. Downstream at Kisangani, seven cataracts, known as the Stanley Falls, mark the beginning of the navigable Zaire. This central part of the river flows steadily for over 1600 km to within short distance of Kinshasa. Its course is narrow at first but soon grows wider, after which many islands occur in midstream. This change in the character of the river corresponds to its entry into its alluvial plain. From that point onward, with the exception of a few narrow sections, the Zaire divides into several arms, separated by strings of islands. Beyond the levees (embankments formed by silt deposits) occuring on either bank, some areas are subjected to extensive flooding that increases the river's bounds still further. These areas are often difficult to distinguish from the "rain swamps" in regions lying between rivers.

Along this central reach the Zaire receives its principal tributaries, primar-

ily the Ubangi and the Sangha on the right bank and the Kwa and Kasai on the left bank. The left bank tributaries originate at a little over 500 m and drain the central plain. The right bank tributaries come from the northeastern and northern divides at elevations of about 1000 m. The Ubangi, with a watershed of about 777,000 sq km, is formed by the confluence of the Bomu and the Uele. In its lower course the Ubangi drains a swampy forest area of about 45,000 sq km, the most important of which is known as the Giri swamps. A little downstream from the confluence with the Ubangi, the middle course of the Zaire ends in a narrow section called the "chenal," or channel. Here the banks are no more than 800 to 1000 m wide. At this point the Zaire receives the Kasai, which originates in Angola and is fed by a rich network of affluents in the central and western sections of the central basin. The watershed of the Kasai is about 900,000 sq km and its average discharge is about 1200 cubic m per second, with very large seasonal variation. An enormous increase in the average rate of flow results, rising from less than 7,000 cubic m per second at Kisangani to over 40,000 cubic meters at Kinshasa.

The Lower Zaire - Leaving the chenal, the Zaire divides into two branches, forming a vast lacustrine area called the Malebo (Stanley) Pool which marks the end of the Middle Zaire. Here, its discharge fluctuates between 23,000 and 50,000 cubic m per second. Immediately downstream occur the first waterfalls of the final section of the river's course. Cataracts and rapids are grouped into two separate series, separated by a fairly calm central stretch. Over a distance of about 430 km the altitude drops from a little less than 275 m to just a few meters above sea level. The Zaire is now a deep river (12 to 75m) with a current of 4 to 6 km per hour. Its width is 1800 m and its discharge between 30,000 and 60,000 cubic m per second. From the last rapids to the ocean (about 145 km) the river flows for a certain distance through deep and narrow gorges and, upon reaching the sea, flows through a submarine canyon.

The Zaire has a highly variable slope. From the sources to the rapids above the Kamolondo depression, the inclination is 0.59 m/km. In the rapid section, it is 2.37 m/km. From there to Kinshasa, the last point before the cataracts, the slope is never steeper than 8 cm/km except at the Stanley Falls, where the drop over a distance of 150 km is around 42 m (or about 28 cm/km). With the exception of the maritime section toward the coast, the declivity of the Zaire always exceeds 5 cm/km. 1/

The fluctuation in level of the Zaire is small, due to the presence on the upper course of lakes and swampy depressions that absorb the effects of heavy rains and to the very flat structure of the river banks. The regime of the floods is unimodal on the upper course of the river and rather regular in regions away from the equator. The amplitude of annual fluctuations is rarely in excess of 3 meters (Luapula River, 4 m; Lake Mweru, 1.28 m; Luvua River, 2.65 m; Lake Tanganyika, 4 m; Lukuga River, 1.14 m; Lualaba, upper course, 2.38 m; Bukama upstream from the Kamolondo depression, 2.28 m; Lualaba at Kindu, 2.39 m). 2/

1/ Meggers et al., 1973.
2/ Ibid.

Lakes. Some of the major lakes of Africa and the world are part of the Zaire drainage, including Lakes Kivu, Tanganyika, and Mweru. Lakes Tanganyika, Kivu, Amin, and Mobutu lie within the western Rift valley on the eastern border of Zaire, though none of the four lie completely within Zaire and lakes Amin and Mobutu form part of the Nile drainage system. 1/

Lakes Mobutu and Amin. The northern and southwestern shores of Lake Mobutu are flanked by steep escarpments. There is a considerable lowland area at the northern end of the lake where, about 32 km below Murchison Falls, the Victoria Nile enters the lake, to leave almost immediately as a northward flowing tributary of the Nile. The southern end of Lake Mobutu contains an alluvial flat and a papyrus-choked delta formed by the Semliki River, which carries the outflow from Lake Amin and drainage from the Ruwenzori range. Lake Amin, whose western boundary is under the escarpment, receives the Rutshuru River as its principal tributary. On the northeast it is connected with Lake George in Uganda by the 900 m wide Kazinga Channel.

Lakes Kivu and Tanganyika. Both Lake Kivu and Lake Tanganyika are of tectonic origin. Lake Kivu, at an altitude of 1460 m, was formed quite recently by the emergence of the Mufumbiro (Virunga) range of volcanoes in the valley between it and Lake Amin. This dammed valley, which then filled with water, developed an outlet to the south over a more ancient volcanic sill. This effluent eroded its way southward, creating a channel 500 m deep in the Ruzizi plain and terminating in Lake Tanganyika. With 2370 sq km of free water and 315 sq km of islands, Lake Kivu is about the tenth largest lake in Africa. Its watershed is 7300 sq km. Lake Kivu is characterized by its great depth (475 m) and its very high mineral content (reaching 1430 ppm, with a pH higher than 9). There has been significant volcanic activity since the formation of this lake and recent eruptions have contributed much mineral matter to the water.

Lake Kivu is a typical meromictic lake in that its waters never circulate completely. The superior layers, about 60 m thick, form the epilimnion. The 400 m thick bottom layer is permanently stagnant, devoid of dissolved oxygen and therefore completely azoic. The mineral content of this layer is higher than that of the upper layers and especially rich in methane and carbon dioxide. There are a few unimportant affluents and the sole outlet is the Ruzizi river, a torrential stream with a discharge of about 70 cubic m per second. It drops to an altitude of 900 m over a 30 km distance interrupted by falls and rapids. This upper section has a slope of about 19 m/km. The remainder of the course is comparatively calm and crosses the plain with a slope of 2.3 m/km, reaching Lake Tanganyika at an elevation of 775 m. The Ruzizi is diluted to a final salinity of 600 ppm after receiving a few small tributaries of low mineral content in this section. It makes a major contribution to the mineral content of Lake Tanganyika, being a primary affluent and certainly the most mineralized one.

Lake Tanganyika is the second largest lake in Africa and is second only to the Soviet Union's Lake Baikal in depth. At its highest it is more than 600 m below sea level, with a maximum depth of 1470 m and a mean depth of 572 m. As is

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1/ The following is from Meggers et al., 1973.

typical of the other lakes, Tanganyika is flanked by steep escarpments, which often rise sheer from the lake. The only significant lowland is the lower Ruzizi valley. Lake Tanganyika has few large tributaries, the principal one being the Malagarasi, which drains the east African lowlands south of Lake Victoria and enters Tanganyika almost 40 km south of Kigoma. The other principal tributary is the Ruzizi, and the remainder are torrential streams flowing from the high ranges that line the Tanganyika trough. The latter are often small and have an irregular discharge; some cease to flow during the dry season. The lake is warm at the surface (26-29 degrees C) while most affluents are colder and their waters therefore sink to the bottom of the lake. The loss from evaporation is high (1.6-2.0 m) and approximately balances gain from precipitation and runoff. Due to its depth, the lake water does not mix completely and only the 100 m upper layer in the south and the upper 20 to 80 m in the north circulate continuously. During the dry and colder season there is strong circulation, but the deeper water remains stagnant. Except for the absence of oxygen below 200 m, there is no marked difference between the bottom and surface layers.

Lake Mweru. On its course to the Zaire, the Luapula crosses Lake Mweru, which has an area of 5000 sq km. Unlike the preceeding lakes, it has a shallow basin with a mean depth of under 5 m, never exceeding 15 m in depth. Lake Mweru does not develop true stratification because of its high temperature (annual range of 22.5 to 27.5 degrees C) and the impact of its large affluent, the Luapula, and its equally large outlet, the Luvua. The influence of Lake Mweru on the Luapula-Luvua tributary of the Zaire is small, save for its damping effect on fluctuations of the Luapula water level.

Swamp Lakes. The Kamolondo depression in Shaba region contains many lakes, some of which are merely widened sections of the river. These lakes are under the direct influence of the river and its floods. Lake Upemba is the largest of these lakes and has been the subject of some limnological study. Lake Upemba resembles the other Kamolondo lakes in being a remnant of a large lacustrine expansion that filled the depression before the Lualaba was captured by the Zaire. It is a shallow and swampy area, the freewater portion of which is highly variable. The depression is a labyrinth of true swamps, generally covered with dense stands of papyrus, and of grassland periodically flooded at high water, with thickets of the ambatch tree (Aeschynomene). The swamps also contain floating water plants, such as Nile lettuce (Pistia) and water chestnut (Trapa). Huge swampy areas of this kind may influence the regime and quality of the river in various ways. Evaporation of water has a concentration effect, the abundant humus deposited in the swamps absorbs much mineral matter, and the presence of papyrus and other weeds slows the rate of flow with consequent loss of suspended particles. In addition, the temperature is raised and the productivity of the water is increased by the plankton produced under lacustrine conditions.

Forest Lakes. Another type of lake in the Zaire watershed is the forest lake, found in the lowlands of the central basin. An example is Lake Tumba, which occurs at the lowest point in the central basin. It is located near the equator at an elevation of 350 m and has an area of 765 sq km. It is very shallow, averaging only 3 to 5 m deep, with occassional holes extending to depths of 8 m. It receives several affluents from the south and flows into the Zaire opposite

the mouth of the Ubangi. It is a "lateral lake" derived from damming of an affluent by sediments deposited on the banks of the Zaire. It is never invaded by water from the Zaire due to the length of the Irebu channel and to the simultaneity of flooding in both river and lake. All the affluents of Lake Tumba are black water forest streams and drain a low swampy area that is completely flooded during a considerable part of the year. Lake Tumba never develops stratification. Temperature varies from 28-33 degrees C. Plankton productivity is low.

Man-made Lakes. The upper course of the Lualaba-Zaire now contains several man-made lakes. All are located in Katanga, a little to the south of Lake Mweru. They are intended for energy production and are thus subject to major fluctuations in level. Their thermal behavior is that of monomictic lakes, with a circulation period during the dry season (May-July) and a stagnation period extending from September to April. Area is highly variable and depends on the rate of water consumption by the electric plants. Lake Mwadingusha may be as large as 400 sq km; Lake Koni does not exceed 4.5 sq km; and Lake Nzilo is about 200 sq km.

Status of Information on Water Resources

Hydrological Data

Precipitation	
Total number of stations in 1964	500
Stations equipped with recorders	54
Density of stations/1000 sq km	0.21
Average length of records	56
Evaporation	
Total number of stations in 1964	181
Average length of records	31
Water levels	
Total number of stations in 1964	97
Stations equipped with recorders	3
Density of stations/1000 sq km	0.04
Average length of records	72
Discharge	
Total number of stations in 1964	3
Density of stations/1000 sq km	0.013
Average length of records	49

Table 1. Hydrographic Data on the Zaire River System

	Zaire River System			
	Zaire	Kasai-Kwa	Luapula	Ubangi (Oubangui)
Source	Many sources 1/	Angola, near Villa Luso	Zambia, L. Bangweulu	Zaire, Highlands north of L. Albert
Altitude (m above sea level)	Lualaba 1,340	1,300	1,140	-
Drainage area (sq km)	4,104,500 (incl. Ubangi)	-	-	772,800
Total length (km)	4,700	1,735 (Kasai)	560	1,060
Countries traversed	Angola, Burundi, Cameroon, Central African Rep., Congo, Rwanda, Tanzania, Zaire, Zambia	Angola, Zaire	Zambia, Zaire	Congo, Central African Rep., Zaire
Major tributaries	Alima, Aruwimi, Elila, Irimbiri, Kwa, Lomami, Lowa, Lufira, Lukuga, Luvua, Lulonga, Mongala, Sangha, Ruki, Oubangui	Kasai, Lubilash-Sankuru, Lukenie-Fimi	-	Kotto, Ouaka, Mbari, Chinko
Discharge to	Atlantic Ocean	Zaire River	Lake Mweru, to Lualaba and Zaire Rivers via Luvua River	Zaire River at Liranga
Volume of discharge at mouth (cu. m/sec)	22,000-67,000 (mean 39,160)	-	-	-
Suspended silt load (tons/year)	90,300,000	-	-	-
Flood regime	Peak floods May and Dec.	-	-	[illegible]-Dec. Max. in Oct.
pH	3.6-6.5	-	-	7.0-7.2

1/ The longest continuous stream is the Chambesi River originating in Zambia.
Source: van der Leeden, 1975.

Table 2. Hydrographic Data on Selected Lakes

	Mobutu	Amin	Kivu	Tanganyika	Mweru	Tumba
Altitude (m)	619	914	1,463	773	917	1,000
Depth (m)	58(max) 25(mean)	117(max) 34(mean)	489(max) 240(mean)	1,435(max) 700(mean)	37(max) 6(mean)	3.5(max) 0.3(mean)
Surface area (sq km)	5,600	2,300	2,699	33,900	4,380	530
Volume (cu. m)	140	78.2	-	18,940	34.6	0.9
Drainage basin area (sq km)	-	-	-	249,000	-	-
Conductivity (micromhos)	730	925	345-365	520-610	70-125	145-855
Dissolved solids (mg/l)	365	521	-	-	74	-
pH	8.4-9.5	8.5-9.3	7.6-9.0	7.3-7.8	6.4-9.3	6.4-8.0
Surface temp. range (C)	26-29	[illegible]	26	-	19-30	24-33

Source: van der Leeden, 1975.

Water Use and Management

Legal and Institutional Framework. The division of conservation of nature and management of renewable natural resources within DECNT (see p. 13) oversees water use and management. DECNT has begun a research program on all water resources as a basis for their management and conservation.

A state company, the Regie de distribution d'eau et d'electricite (Regideso), is responsible for the production and distribution of municipal water supply. As of 1976, Regideso had more than 53 water treatment stations.

Irrigation. Though Zaire does not have water quantity problems, there are water management problems that impede agricultural output. Irrigation is virtually nonexistent in Zaire. Thus, output can fall drastically during droughts.

Dams and Impoundments. 1/ The production of energy by hydroelectric dams is one of the main uses of water in Zaire. Zaire's known hydroelectric power potential is estimated at over one million megawatts (mW). The largest site is the lower part of the Zaire River where its course takes it past the Inga plateau about 40 km upstream from the port of Matadi in Bas-Zaire. The first phase of hydroelectric development at Inga (Inga I) began in 1968 and went into operation in 1972. The Inga I plant has a reliable generating capacity of 300 mW. Work is underway on Inga II, which will furnish 1272 mW; an 1800 km high voltage, direct current transmission line will link it to Shaba, providing the energy necessary for the expansion of copper mining. There are three other hydroelectric generating stations in the region; two on the Inkisi River southwest of Kinshasa having a combined capacity of 87 mW, and a small 2 mW plant near Matadi. Bandundu and Equateur regions do not have any hydroelectric installations due to the generally flat terrain. In Haut-Zaire, Kisangani was supplied by a 12.3 mW plant on the Tshopo River, and in Kivu a 12.6 mW station on the Ruzizi River supplied power to Bukavu.

As of early 1978, Shaba still had the largest hydroelectric power generation capacity - close to 530 mW. Four major installations serving the mining and industrial complex of GECAMINES had a combined installed capacity of 467 mW. Two of these plants are on the Lualaba River north of Kolwezi, and the remaining two are on the Lufira River northeast of Likasi. Most other stations are relatively small, including among these a 17.5 mW station that furnishes power to the urban center of Kalemie on Lake Tanganyika.

In 1976 Shaba consumed almost three-quarters of total hydroelectric production in Zaire; the western part of the country, including Kinshasa, Bas-Zaire, and parts of Bandundu, consumed close to 23%; and the remaining 3% was accounted for by the rest of Zaire. The mining and metallurgical industries used more than 68% of total output (in 1975) and other industrial sectors nearly 18%. Home consumption, together with street and other public lighting, accounted for about 11% of the total output.

1/ Kaplan, 1979.

C. Soils

Introduction 1/

The soils of Zaire are predominantly of moderate fertility. At equal temperatures, a Zairian soil is richer in organic matter than a soil from a temperate region. For instance, the amount of vegetable matter returned to the soil is from 12 to 15 tons per hectare in the Yangambi forest, versus 2 to 3 tons in a temperate region. There is neither a winter nor a frost to impede the activity of microbes which break up the organic matter. Here the active agent is lateral erosion and the scouring of humus bearing horizons.

There are two major types of soils: those of the equatorial regions and those of the drier savanna regions (see Appendix for soil map and a more detailed description of soils). The equatorial soils occur in the warm, humid lowlands of the central basin, where rainfall is abundant throughout the year and thick forests predominate. The soils are mainly sandy with much of the minerals leached out by the heavy rainfall. However, the heavy forest cover provides a continuous supply of nutrients that enrich large areas of soils believed to contain varying amounts of clay (the chief factor controlling their fertility), which make them of potential agricultural importance. Under the regular rainfall, these soils are well-suited for the growing of ligneous plants. A known zone of clayey soils of medium fertility occurs in the central basin along, and in broad areas adjacent to, the Zaire River from Kisangani downstream to its conjunction with the Ubangi River. The soils and climate of this zone are particularly suitable for the cultivation of rubber.

In Kwango sub-region of Bandundu and parts of adjacent Kasai-Occidental and Kasai-Oriental lying in the southern plateau zone are other extensive areas of sandy soils similar in origin to those of the central basin, but consisting of almost pure sand. These soils, the Kalaharian sands, are of extremely low fertility and have little potential use for agriculture. Except for this area of sandy soils, the central basin is surrounded by a vast area of lateritic soils that are much more vulnerable to erosion, though the river valleys contain rich and fertile alluvial soils. These are mountainous soils in which the average temperature, which is much lower, has caused an accumulation of organic matter, and where the hilly relief has brought about a rejuvenation of the primary matter. The soils have a lower humus content than those of the forest zone because of the lighter vegetation cover, but less rainfall has also resulted in retention of a higher mineral content. Much of the country's agriculture is found in these savannas.

The richest soils in the country are found in the eastern highlands, notably in Ituri sub-region of Haut-Zaire and Nord-Kivu sub-region of Kivu. There origin is largely volcanic. This highland zone has some of the highest population concentrations in the country.

1/ See Appendix 4 for a general soil map of Zaire.

Status of Information on Soils

Institut National d'Etude Agronomique au Congo (INEAC). INEAC, centered at Yangambi until independence, was one of the leading tropical agricultural research institutions in the world. The infrastructure included a large, well equipped central station at Yangambi and approximately 60 sub-stations scattered throughout the country. Among the major areas of research was the study of soils, and a soils laboratory was maintained that ran up to 15,000 analyses a year.

Inter-African Pedologic Service. In 1953, the Belgian Commission for Technical Cooperation in Africa established, within the framework of INEAC, the Inter-African Pedologic Service at Yangambi. The Service made soil and vegetation surveys of all except the center of the country. Each horizon of the complete profiles of the major soils was described and given complete analysis.

The following are soil maps published by INEAC:

Croegaert, J. and Sys, C. no date. Carte (1:100,000) des sols et de la vegetation du Congo belge et du Ruanda-Urundi, vallee de la Ruzizi.

Denisoff, I. 1954. Carte (1:50,000) des sols et de la vegetation du Congo belge et du Ruanda-Urundi, region de Mvuazi.

Focan, A. 1955. Carte (1:10,000) des sols et de la vegetation du Congo belge et du Ruanda-Urundi, region Kaniama.

Gilson, P. 1954. Carte (1:10,000) de sols et de la vegetation du Congo belge et du Ruanda-Urundi, region de Nioka (Ituri).

Gilson, P., Jongen, P., and van Wambeke, A. 1956. Carte (1:50,000) des sols et de la vegetation du Congo belge et du Ruanda-Urundi, region de Yangambi.

Gilson, P. and van Wambeke, A. 1957. Carte (1:50,000) des sols et de la vegetation du Congo et du Ruanda-Urundi, region de Yangambi (Yambaw).

Pecrot, A. and Leonard, A. 1960. Carte (1:500,000) des sols et de la vegetation du Congo et du Ruanda-Urundi, Dorsale du Kivu.

Sys, C. 1960. Carte (1:5,000,000) des sols et de la vegetation du Congo et du Ruanda-Urundi.

Sys, C. and Berce, J. M. 1958. Carte (1:100,000) des sols et de la vegetation du Congo belge et du Ruanda-Urundi, region de Kwango.

van Wambeke, A. and van Oosten. 1956. Carte (1:100,000) des sols et de la vegetation du Congo et du Ruanda-Urundi, region de Lufira.

van Wambeke, A. Carte (1:100,000) des sols et de la vegetation du Congo et du Ruanda-Urundi, region de Bengamisa.

van Wambeke, A. Carte (1:100,000) des sols et de la vegetation du Congo belge et du Ruanda-Urundi, region du lac Albert.

Institut National d'Etude et Recherche Agronomique (INERA). INERA oversees all agricultural research in Zaire. Within INERA, there are several research stations each of which pursues broad-gauged agricultural research. INERA has a historical bias towards non-food crop research, but is beginning to develop strategies and research activities in soils, food crops, and extension and training.

Regional INERA stations

Station	Region	Ecology
Kimpese	Bas-Zaire	Savanna
Kiyaka	Bandundu	Savanna/forest
Gandajika	Kasai	Savanna/forest
Mulungu	Kivu	Low mountainous
Boketa	Equateur	High rain forest
Yangambi	Haut-Zaire	High rain forest

U.S. Agency for International Development. In 1969 the U.S. Department of Agriculture, under contract to AID, published Etude des Sols pour la Plaine de Kinshasa.

Soil Use and Management

Institutions whose activities are relevant to the use and management of soils include DECNT, Agriculture, Public Works, and Land Affairs (Affaires Fonciers). The author was unable to find any solid information on soil management issues (legal basis for soil protection/conservation, problems of erosion, soil conservation work, other special management problems). Zaire is experiencing increasing erosion of soil due in part to the clearance of vegetation in the search for fuelwood, unregulated urban expansion, and brush and forest burning.

D. Forests

Introduction

Zaire forms part of the Guineo-Congolian floristic region. Roughly 45% of the country lies within the belt of tropical rain forest stretching from Sierra Leone to the Rift Valley and occuring on drained sites throughout most of the Guineo-Congolian region. The natural vegetation is moist lowland forest, some small areas of which can be characterized as evergreen rain forest. Tropical rain forests are most generally mixed forests. Single dominant forests cover a small area, but are widely scattered. Southeastern Zaire extends into the belt of Sudano-Zambezian forest and savanna (miombo woodland). Estimates as to the extent of Zaire's tropical rain forest reserves range from a low of 750,000 sq km (75 million ha) to as high as 1,100,000 sq km (110 million ha); to which can be added the approximately 200,000 sq km (20 million ha) of miombo forest for an estimated total area of between 950,000 and 1,300 000 sq km. Based on what seems to be the most widely used figure of 1 million sq km of tropical rain

forests, Zaire possesses over half of the remaining rain forest area in tropical Africa, and probably around one-tenth of the entire tropical rain forest biome. 1/ No data is available to even make an estimate of the extent of primary forest in Zaire, though the center and the humid zones of the massif have been little affected by man and large areas are still virgin. Appendix 5 provides a more detailed description of the distribution of forest types in Zaire.

Status of Information on Forest Resources

According to Myers in his survey of tropical moist forest conversion rates, "of all countries of tropical Africa, Zaire is exceptionally lacking in adequate documentation ..." on the extent and nature of its forest resources. 2/ Persson, who in 1975 and 1977 conducted the most substantial assessment available of Zaire's forests, states that his best estimate should be regarded as no more accurate than "within 40% either way." 3/ Forestry research is under the direction of the INERA. However, since 1974, all forestry research under INERA has ceased. Most of the old forestry stations - Kipopo in Shaba, Liku in Bas-Zaire, Yangambi in Haut-Zaire, Nioka in Ituri, and Burundu in Kivu - have been closed. Only some areas of Yangambi still have mensuration activities, though the results are not published. A comprehensive review of the forestry sector in Zaire was carried out during 1978 by the World Bank and FAO. The 2-volume report was published by FAO as Report No. 57/58 ZAI.15.

Forest Inventories. The Canadian International Development Agency (CIDA) is currently financing a forestry project called the Service Permanent d'Inventaire et d'Amenagement Forestier (SPIAF), directly under the Secretaire d'Etat de l'Environnement, which deals with forest inventory and managment, including forestry statistics. Between 1974-76, CIDA financed a forerst inventory carried out by the firm of Gauthier, Poulain, and Thierault Ltd. over 5.3 million ha in the cuvette centrale. This was followed by a review carried out by Italconsult on the basis of satellite coverage of 9,140,000 ha in western Zaire. Zaire has concluded an agreement with the U.S. National Aeronautics and Space Administration for a comprehensive survey within the next few years.

Forest Ecology. Publications of the former Institut National d'Etude Agronomique au Congo (INEAC) is a significant source of information (see page), as well as the Bulletin agriculture Congo Belge and the Bulletin de la Societe Royale Botanique Belge.

Species Trials and Growth Rate. A UNDP/FAO-financed fuelwood plantation program carried out between 1972 and 1976 involved the planting of several species of eucalyptus and Pinus in standard pilot plantation trails such as: species provenances; spacing; fertilizer; soil preparation; plantation maintenance, and; nursery techniques. Reports FO:DP/ZAI/70/003 (terminal report), and FO:DP/ZAI/70/003 (Technical Report No. 3) summarize the experience gained during the project.

1/ Myers, 1980.
2/ Ibid.
3/ Persson, 1975 and 1977.

Fuelwood Demand. An extensive investigation to determine Kinshasa's fuelwood (charcoal) demand was carried out by FAO in early 1977. The results and conclusions of this investigation are contained in the Working Paper No. 1 (ref. FO:DP/ZAI/70/003) dated May 1977.

The Forest Resource 1/

Resource Supply. Despite the lack of adequate data, Zaire clearly has enormous forest reserves. Using the estimated figure of 122 million ha, the forest area of Zaire can be divided as follows:

	'000 ha
Dense forest of the Cuvette centrale	101,000
Dense forest of Bas-Zaire (Mayumbe)	240 2/
Gallery forest	760
Dense montane forest	300
Miombo forest of Shaba	20,000
Total	122,300

Dense forest of the Cuvette centrale. This is where the bulk of forest potential lies. Subtracting out swamp forest and areas set aside as national parks, as well as areas that are generally inaccessible, the estimated economically exploitable forest area is about 60 million ha. Fifty-five timber species known worldwide are exploited in Zaire, of which 28 are presently exported. Of these 28, the following 14 species are the principal source of exports: Acajou, Abura, Bubinga, Bosse, Dibetou, Iroko, Kosipo, Niove, Padouk, Sapelli, Sipo, Tchitola, Tiama, and Tola.

The only recent appraisal of the actual potential of this forest area is the CIDA-financed inventory of 5.3 million ha in Equateur region. Based on the results of this inventory, and under the assumption that the commercial value totals 50% of the timber volume of trees more than 62.5 cm in diameter, it is estimated that the annual forestry potential of the 60 million ha of economically exploitable forest in the Cuvette is 9-10 million cubic m (based on an estimated rotation period of 70-80 years).

In addition to these sources of timber are fibrous plants including raffia, sesame, sisal, and punga. Among the climbing vines are Landolphias, which produce rubber. The citronella grass is used in making perfume, and the flower of the pyrethrum is used in the manufacture of insecticide. There are also a number of traditionally used medicinal plants, including cinchona and rauwolfia, as well as copal, rubber, and palm trees. Many edible vegetables grow wild in the forests, grasslands and swamps, notably several types of edible mushrooms.

1/ The World Bank/FAO study of the forestry sector in Zaire is the most comprehensive assessment available of the forest resource and its exploitation.

2/ See description below.

Dense forest of Bas-Zaire (Mayumbe). The forest area of Mayumbe was estimated at about 240,000 ha in the early 1960's. No data exist to estimate the extent of forest area today after 20 years of land clearing for agriculture and over-exploitation of the forest resource. At best, one can state that, according to the forest enterprises still active in the region, the forest area is in the process of total depletion.

The Mayumbe forest area has a great diversity of species due to significant variations in local geologic and anthropologic factors. These populations can be grouped into two principal types:

(i) Secondary forests that vary according to the degree of human intervention, comprising three major groups: Terminalia superba; Xylopia; and Gossweilorodendron balsamiferum; as well as numerous non-differentiated secondary forests, without dominant species;

(ii) Primary forests that subsist where human intervention has been limited by topographic features and very poor soils. One can distinguish in particular: Gilbertiodendron deweivrei; Mytragina stipulosa; and Scorodophleus zeukeri.

The actual richness of the Mayumbe forest area is unknown. However, based on an inventory carried out by some of the forestry enterprises over an area of 37,000 ha, a density of 5.5 cubic m/ha for twenty commercial species has been estimated.

Dense montane forests. Found in the eastern highlands region around Kivu and Ituri. These forests are often limited to altitudes ranging between 2000 m and 2400 m; above 2400 m the vegetation shifts to bamboo. These forests are particularly important for their role in protecting the rich soils of the region.

Miombo. Miombo has traditionally been a source of charcoal, food, medicinal and ichthyotoxic plants, and meat and livestock products. The miombo of the Lubumbashi region produces more than fifty edible plants species. Typical miombo contains species of Brachystegia, Julbernardia, and often Isoberlinia. Miombo still covers 85% of Upper Shaba but is being replaced by savannas.

Demand on Forest Resources. With its extensive forest resources - close to 50% of the forest reserves in tropical Africa - Zaire has the potential to establish itself as the largest producer of timber in Africa. However, despite this vast potential, the forestry sector in Zaire remains largely underdeveloped and plays a negligible role in the national economy and world trade. In 1977 total wood production (in roundwood equivalent or "r") was only about 300,000 cubic m, and wood exports of 126,682 cubic m (r) represented less than 4% of all agricultural exports and less than 1% of all exports. The total recorded timber product of Zaire has probably rarely, if ever, exceeded half a million cubic m per annum. Production has been steadily in decline since the high of 565,000 cubic m recorded in 1973.

Table 3. Industrial Roundwood Production, 1975-77 (cubic m) 1/

Product	1975	1976	1977
Sawnwood			
Local	98,300	63,900	64,400
Export	16,300	14,200	25,900
Total sawnwood	114,600	78,100	90,300
Veneers			
Local	14,400	7,800	6,100
Export	3,700	-	2,400
Total veneers	18,100	7,800	8,500
Other			
Local	6,900	6,810	9,900
Export	2,100	2,500	-
Total	9,000	9,310	9,900
TOTAL, LOCAL AND EXPORT	141,700	95,200	108,700
Roundwood equivalent (r)	332,000	215,000	247,000
Roundwood, exports	2,000	57,000	56,000
TOTAL ROUNDWOOD PRODUCTION	334,000	272,000	303,000

Table 4. Domestic Consumption of Wood and Wood Products, 1975-77 (cubic m)

	1975	1976	1977
Total local production (r)	282,000	179,000	176,000
Imports (tons)			
Sawnwood	60	1,740	80
Veneers	500	870	180
Other	1,850	700	700
Total (r)	8,600	11,800	3,400
TOTAL CONSUMPTION (r)	290,600	190,800	179,400
CONSUMPTION (cubic m/1000 pop)	12.3	7.6	6.9

1/ Reports of the Office national des bois.

The population of Zaire, as is typical of other African countries, relies primarily on fuelwood (firewood and charcoal) to meet its energy needs. Annual consumption of fuelwood is estimated at 13 million cubic m (0.5 cubic m per capita). Uncontrolled felling for firewood and charcoal production has in recent years assumed considerable proportions in certain areas. Kinshasa and most of the larger towns are already experiencing an acute shortage of firewood and charcoal. An extensive investigation to determine Kinshasa's fuelwood (charcoal) demand carried out by FAO in 1977 indicated that demand will increase from a level of 120,000 tons in 1977 to about 400,000 tons annually in 2000, or about 2.4 million cubic m solid wood equivalent. Charcoal has been produced from miombo for a long time and has led to the development of industry and commerce. All charcoal for domestic use is provided by traditional means of exploitation using the forest stack method.

Demand on Forested Lands. No data are available on the extent of the effect of shifting cultivation on forested areas. Myers reports that according to crude calculations, shifting cultivators may be clearing up to 2,000,000 ha of forest per year. However, he goes on to note that, " since Zaire possesses over 6 ha of forest per head of the rural population, it is probable that fallow rotation periods are still long enough to allow forest ecosystems to recover. Nevertheless, intermittent investigations reveal that large areas of primary moist forest are interspersed with patches of secondary forest of various ages. 1/

Natural Forests - Exploitation and Management

Legal and Institutional Framework. New forest legislation has been prepared and was up for approval in late 1978. No information was available to the author on the nature or outcome of this new body of legislation. Exploitation of forests has been regulated by Ordonnance-Loi No. 187 of 1947 as modified by Ordonnance-Loi No. 41/50 of 1957 and Ordonnance-Loi No. 41/? of 1958. Most forested areas are government owned, and cutting rights are based on annual licenses. Forests are classified according to two categories:

(i) Forêts classés (reserved) - 1,130,000 ha;

(ii) Forêts protegées (protected) - 121,700,000 ha.

In the forest reserves, exploitation must be carried out according to a management plan designed to maximize annual production and revenue (intensive exploitation) while preserving the viability of the forest. In the protected forests, extensive type of exploitation is practiced, though subject to certain rules intended to prevent waste. In 1977 the forestry service was shifted from Agriculture to the DECNT.

The number of professional and technical forestry staff is reportedly very small, especially in proportion to the area and needs of the country. A Belgian forestry adviser is attached to the Department, and CIDA has been providing technical assistance to the Governmenmt in the forestry sector for a number

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1/ Myers, 1980.

of years. This assistance includes the development of the Service Permanent d'Inventaire et d'Amenagement Forestier (SPIAF), an administratively and financially independent unit that is directly under the Secretary of State for the Environment and acts as an adviser to the Department. SPIAF was created to train Zairians in forest inventory and management and the collection of forestry statistics. Negotiations were underway in late 1978 with CIDA for assistance in the establishment of a Centre d'utilisation des bois (CUB) modelled after SPIAF. Plans were also underway for a Service national de reboisement (SNR).

Exploitation Patterns and Practices. The forestry industry in Zaire is very concentrated, with the seven largest companies (five of which are nationalized forest companies, or "Societes d'Etat") accounting for 90% of roundwood production, 83% of sawnwood production, and 100% of veneer production in 1977. The largest company in Zaire, SIFORZAL (Danzer, a foreign concern), accounted for 40% of total wood production in 1977. Most of the 50-70 medium/small-scale forest enterprises (known as "petites societes," with annual production of 100-1000 cubic m) and approximately 300 small logging enterprises which operated in 1975 are no longer in business. Most of the remaining medium-sized enterprises are producing at about 30-40% of their capacity. The following are the principal areas of exploitation and industry of the seven largest companies.

Enterprise	Area of Exploitation	Industry	Region
AGRIFOR	Lemba, Lukula, Libenge	Lemba, Lukula Libenge	Bas-Zaire
EXFORKA	Kabenge	Kabenge	Kasai occidental
FORESCOM	Nioki, Buna, Kole	Niobi	Bandundu
IZB	M'vula, Mombongo, Lukolela, Malanga	M'vula, Mombongo Malanga	Bas-Zaire, Haut-Zaire
SIFORZAL	Kodoro, Oshwe, Kisangani	Maluku	Equateur, Bandundu, Haut-Zaire
SOCOBELAM	Dongo, Lukolela	Kinshasa	Equateur
SOKINEX	Lukolela, Mombongo	Kinshasa	Equateur, Bas-Zaire

Forest exploitation, long concentrated in the Mayumbe forest of Bas-Zaire where transport was easiest, is gradually shifting to Bandundu and the Cuvette centrale (Haut-Zaire and Equateur regions). Timber extraction is still largely confined to areas near major rivers.

Reforestation. The rate of Government reforestation programs declined steadily from 1960 up to 1973, when they came to a virtual halt. A National Reforestation Program was to be launched in 1978 with an initial expenditure of Z3.4 million (US$5.2 million), but never really got off the ground due to budget con-

straints. No information was available to the author on the reforestation activities of private companies.

Plantation Forests

According to incomplete Government statistics, a total of about 66,500 ha of plantation forests were established in Zaire, of which 46,500 ha were planted prior to 1960 and 20,000 ha were planted between 1961 and 1972. Of the 66,500 ha planted, 40,000 ha or about 60% are located in three regions: Bandundu (10,000 ha); Haut-Zaire (19,000 ha); and Bas-Zaire (11,000 ha, see Agroforestry below). The principal species planted was Terminalia superba (Limba).

The Government launched a fuelwood plantation program in 1968. As part of this program, a UNDP/FAO-financed project planted several species of Eucalyptus and Pinus in the vicinity of Kasangulu, Maluku, and the Bateke plateau. The most promising of the species was reported to be E. camaldulensis followed by E. tereticornis. Acacia auriculiformis was also reported to be a promising species.

Though no information was available on their extent, there have been experimental plantations in the miombo forests of Shaba. Several species of Eucalyptus have been used including: E. saligna, E. maculata, E. umbellata, E. camaldulensis, and E. citriodora. The plantations always yield more than 300 cubic m/ha at 25 years and sometimes exceed 500 cubic m/ha. The natural coppice, which needs the same care as the stands enriched with Eucalyptus, only produces a a quarter of this. At twelve years of age, one hectare of seedlings can produce six tons of charcoal. 1/

Agroforestry

Agroforestry has been officially practiced in Zaire since 1939/40 with the establishment of plantations of Terminalia superba (Limba) intercropped with banana in the Mayumbe Forest Reserve of Bas-Zaire. The Limba-cum-banana technique (or systeme sylvo-bananier) involves the planting of Limba at a wide spacing (10 m by 10 m) with banana interplanted at about 3 m apart. In 1945 the first major agreement between the forest service and the private sector was signed covering an area of 2000 ha of reserved forest to be converted to bananas and Limba plantations. In 1951 the Government accepted the responsibility to plant tree species in agroforestry schemes

Permission to initiate an agroforestry scheme has to be obtained from the forest service. The forest service delimits the proposed area and the terms and conditions are prescribed in a contract. After a period of about 10 years the area under agroforestry will revert to forest only and become part of the forest reserve.

1/ Unesco, 1978.

Issues

With the lowest population density of any forested area in Africa and a still underdeveloped forestry industry, Zaire's vast forest reserves are not threatened in the near future.

Presently, there appear to be four key issues in the management of the forest resource:

(i) The lack of information on the forest resources of the country;

(ii) The lack of trained Zairians in forest inventory and management;

(iii) The need for a more active role on the part of DECNT in the management of forestry exploitation;

(iv) The effects of the demand for fuelwood on forest resources, especially around large population centers and in the miombo forest ecosystem.

E. Wildlife

Introduction

Terrestrial Wildlife. The extraordinary range of habitats in Zaire support an incredibly varied fauna. Aside from the Cuvette centrale which should remain a last refuge for several decades (though the population of forest-dwelling animals is never great), some regions have abundant wildlife while others are completely void of populations. The Cuvette centrale exhibits little endemism, and has fewer animal species than the eastern and western edges. The most important center of endemism is the northeast, which contains the largest number of mammal species in the African tropical forest zone, 15% of which are endemic. Large mammals include the lowland (western) gorilla (Gorilla gorilla), the mountain (eastern) gorilla (G. beringei), Chimpanzee (Pan troglodytes), pygmy chimpanzee (Pan paniscus), lion (Panthera leo), leopard (P. pardus), cheetah (Acinonyx jubatus), west African manatee (Trichecus senegalensis), elephant (Loxodonta africana), Zebra (Equus burchelli), white rhinoceros (Ceratotherium simum), hippopotamus (Hippopotamus amphibius), giant forest hog (Hylochaerus meinertzhageni), giraffe (Giraffa camelopardalis), okapi (Okapia johnstoni), Lord Derby's eland (Taurotragus derbianus), eland (T. oryx), Bongo (Boocercus euryceros), greater kudu (Tragelaphus strepsiceros), sitatunga (T. spekei), roan antelope (Hippotragus equinus), sable antelope (H. niger), Uganda kob (Kobus (Adenota) kob thomasi), puku (K. vardoni), lechwe (K. (Adenota) leche), waterbuck (K. defassa), reedbuck (Redunca), hartebeest (Alcelaphus and Damaliscus), topi (D. korrigum), impala (?) (Aepyceros), dwarf antelope (Neotragus), (Cephalophidae), (Tragulidae), bushbuck (Tragelaphus scriptus), oribi (Ourebia ourebi), klipspringer (Oreotragus), buffalo (Syncerus caffer), black buffalo, savanna buffalo, Simpson's buffalo (Syncerus caffer simpsoni).

Large birds, such as the birds of prey, large waders, hornbills, etc., are still very numerous. Familiar bird species have become rare in the large towns,

especially Kinshasa due to the extensive use of toxic pesticides. The Semliki delta, even though it has been destroyed for mammals, still has a very abundant bird life.

The following is a brief review of the main wildlife areas throughout the country, both forest and savanna. 1/

Forest. A considerable fauna still exists in forested areas off the main roads and waterways where human population densities are low. Major areas include (see Fig. 5):

A - The Salonga block, which extends unbroken for at least 80,000 sq km, of which 30,000 sq km has been set up as a Nature Reserve.

B - An immense, almost unexplored forest that stretches between the Lualaba and Lomami rivers.

C - The Abumonbazi forest to the north of Lisala above the Zaire river.

D - The forest swamps around Mbandaka, which are almost uninhabited by man.

E - The Ituri forest.

F - The Maniema forest.

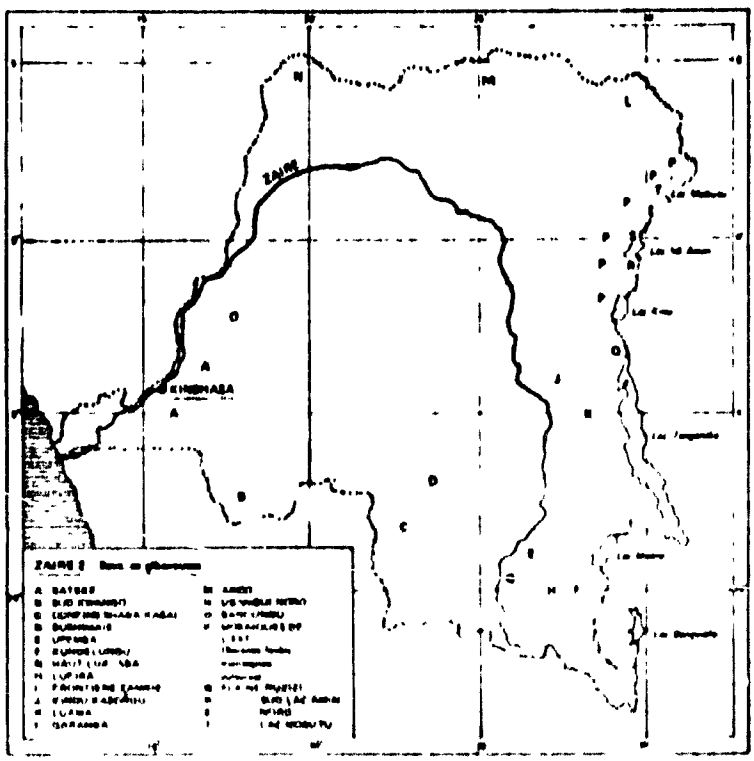

Figure 5. Main wildlife areas.

1/ Based on Verschuren, 1975.

Savanna

Except where the human population is high, parts of the savanna regions still support considerable numbers of wildlife, including (see Fig. 5):

A - Bateke plateaus, which used to support a sizeable fauna but has been heavily poached. Lions still occur.

B - Area south of the Kwango, still relatively intact and contains the rare Simpson buffalo (threatened by poaching).

C & D - Borders of southern Kasai and northwest Shaba are not entirely populated and some wildlife still survives, including the eland Taurotragus oryx. This region has not been extensively surveyed.

E & F - The Upemba and Kundelungus Nature Reserves in the Shaba region support relatively abundant wildlife, especially zebra, roan, and eland.

G & H - The huge papyrus marshes along the Lualaba and Lufira contain numerous elephants and sitatunga, and some lechwe.

I - Between Lakes Mweru and Tanganyika there is still a lot of game that crosses over from Zambia.

J - The fauna of the savanna-forests towards Kindu-Kasongo-Kibombo is little known, but large numbers of elephants are believed to exist there.

K - The Luama valley, due to its inaccessibility, still supports abundant wildlife, notably elephants and pukus (which occur in thousands).

L, M & N - Except for the national parks, the most interesting region in Zaire is the vast savanna north of the rain forest along the frontiers of Uganda and the Central African Republic. In the east is the Garamba National Park with white rhinos and giraffes. To the west is the future Ango National Park with enormous tusked elephants and giant eland. Sparsely populated, this is the only part of the country where game can be seen freely all along the tracks. In the far west above the Ubangui wildlife survive in fair numbers.

O - Between Mushie and Bandundu the vast, heavily wooded savannas remain largely intact supporting wildlife.

P - On most of the mountain sides, especially between 1200 and 2200 m, there is a dense human population which has destroyed most of the natural vegetation and wiped out the wildlife.

Q, R, S & T - Near the lakes in the very dry low plains completely surrounded by mountains occur the highest animal densities. The Borassus dominated plain to the north of Lake Tanganyika (Q) once supported an abundant fauna that has been almost entirely exterminated by hunting and other activities, though some hippos and crocodiles survive in the rivers. The plain south of Lake Amin (R) contains lions, an exceptional abundance of hippos, and thou-

sands of antelopes. The plain to the north of Lake Idi Amin (S) supports a significant fauna, though it is less abundant today due to the 1914-18 war and the 1960-64 rebellion. The wildlife of the plains south of Lake Mobutu (T) was once as abundant as that of Virunga National Park but has been decimated by severe poaching. A nucleus of wild animals - elephants, hippos, antelopes - has subsisted and could re-establish itself.

Fisheries. Fish are abundant in lakes and rivers throughout the country, with over 500 species occuring. The Zaire river system contains the richest freshwater fish fauna in Africa with over 400 species in 24 families. There is a significant difference between the fauna occuring in rivers and lakes due to the origin of the latter. The lakes have not been formed by river action except in rare cases. Tectonic lakes, such as Lake Tanganyika, have been isolated from the rivers for so long that a specialized fauna was able to evolve. The Tanganyikan fauna is very rich in forms that occur nowhere else. These endemic forms are not confined to fish, but include groups as different as water snails and shrimp. A restricted distribution of certain species may also characterize small lakes separated by a geographic barrier from the river or its affluents. For example, Lake Fwa in the Kasai watershed has a fish fauna differing generically from river fish of the same family. 1/ In Lake Kivu fisheries are restricted by the methane gas content of the lake. Very few groups of marine animals thrive in the Zaire, and the fauna is of pure freshwater origin due to the rapids which prevent access to the higher course of the Zaire by marine species.

Status of Information

According to Verschuren, most of the literature published before independence is largely out of date. However, there is an extensive body of literature, notably the work of Schouteden. Curry-Lindahl, Grzimek, Harroy, and Schaller have made notable contributions to the literature since independence. The extensive information possessed by the Zairois Conservators of the reserves has yet to be adequately tapped in published form. 2/

The most recent survey of the exploitation and management of wildlife in Zaire was conducted between 1970 and 1976 under a UNDP/FAO project in collaboration with the Institut Zairois pour la Conservation de la Nature (IZCN). A list of Technical Reports and Working Papers is contained in the final report of the project published by FAO (FO:DP/ZAI/70/001).

An additional source of information is the scientific research being carried out in the National Parks. In the Parc National des Virungas there is a station at Lulimbi for ringing palearctic migrants, which is one of the most important in Africa (30,000 birds have been ringed in three years). Studies are being carried out on the structure of hippo populations and their impact on the environment as a basis for the development of improved management techniques. The giant forest hog Hylochoerus meinertzhageni, an almost unknown animal, is

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1/ Meggers et al, 1973.
2/ Verschuren, 1975.

also the subject of detailed study. Elsewhere, okapis and elephants are being studied at the Epulu and Gangala na Bodio stations. 1/

Rare and Endangered Species

The "Red Data Book" compiled by the Survival Service Commission of the International Union for Conservation of Nature and Natural Resources lists the following threatened species occuring in Zaire.

Mammals

Common name: Chimpanzee.
Scientific name: Pan troglodytes.
Status: Vulnerable.
Habitat: No information given.

Common Name: Pygmy chimpanzee.
Scientific name: Pan paniscus.
Status: Vulnerable to human occupation of its limited range in Zaire. Numbers are being reduced and available habitat is diminishing.
Habitat: Confined to the rain forest, where it is found in primary, secondary, and swamp forests.

Common name: Gorilla.
Scientific name: Gorilla gorilla.
Status: Vulnerable; as a result of constantly shrinking range and pressure from an increasing human population.
Habitat: Several major types of forests; lowland rain forest, montane rain forest, and bamboo forest. It frequents floristically diverse types of forests which range in altitude from near sea level to more than 3000 m. The habitats utilized are similar in being lush and damp with an abundance of forage near ground level throughout the year.

Common name: Mountain gorilla.
Scientific name: Gorilla gorilla beringei.
Status: Endangered. Restricted to the Virunga chain of volcanic mountains and Mt. Kahuzi in Zaire. Although most of its range is included within national parks or game reserves, populations in the Virunga chain have continued to decline as a result of human interference and encroachment within their habitat. Populations in Kahuzi-Biega are considered to be relatively stable at present.
Habitat: Occurs in high altitude areas of montane rain forests, bamboo, Hagenia woodland and, less frequently, in areas of Hypericum and giant senecios. In the Kahuzi-Biega National Park they commonly occur in secondary forest, but do not enter grasslands.

Common name: African wild dog.
Scientific name: Lycaon pictus.
Status: Depleted throughout its range. Vulnerable to continued persecution, shrinkage of range and reduction in numbers of natural prey.
Habitat: Open or wooded savanna.

1/ Verschuren, 1975

Common name: Leopard.
Scientific name: Panthera pardus.
Status: Vulnerable. In moderately favorable habitats of the Zaire basin rain forest, it maintains a density of up to 1:3 sq km, and in optimal habitats even 1 to every sq km. In the miombo woodland zone poaching pressure has varied greatly, and in large areas density rises to one animal per five sq km.
Habitat: Inhabit a variety of biomes, including in Zaire tropical rain forest, miombo woodland, and savanna.

Common name: Black rhinoceros.
Scientific name: Diceros bicornis.
Status: Vulnerable.
Habitat: No information given.

Common name: Northern square-lipped rhinoceros.
Scientific name: Ceratotherium simum cottoni.
Status: Endangered.
Habitat: No information given.

Common name: Lechwe.
Scientific name: Kobus leche.
Status: Vulnerable.
Habitat: No information given.

Reptiles

Common name: Nile crocodile.
Scientific name: Crocodylus niloticus.
Status: Endangered. Destruction by poachers is the most important factor.
Habitat: No information given.

Common name: African slender-snouted crocodile.
Scientific name: Crocodylus cataphractus.
Status: Endangered.
Habitat: No further information given.

Birds

Common name: Grauer's cuckoo shrike.
Scientific name: Coracina graueri.
Status: Rare. The species is so far known from fewer than a dozen collected specimens.
Habitat: Appears to be confined to highland forests along the western side of the Rift valley between Djugu and Mongbwalu west of Lake Mobutu south to the Elila River.

Common name: Grauer's green broadbill.
Scientific name: Pseudocalyptomena graueri.
Status: Uncommon.
Habitat: Montane forests below the bamboo zone, west of the Ruzizi River between Lakes Kivu and Tanganyika.

Exploitation and Management

Legal and Institutional Framework. The following is a summary of wildlife legislation.

Decree of 1937, Hunting and Fishing - modified several times, this remains the basic legislation on the subject. In general, hunting is prohibited and scientific research is permitted.

Ordonnance-Loi No. 52/34 of 18 Jan 1958 - regulates fisheries in the Zaire.

Ordonnance-Loi No. 52/273 of 1958 - modifies the 1937 Decree.

Ordonnance-Loi No. 68/074 of 1968 - regarding protection of crocodiles, and modifies some hunting and fishing legislation.

Ordonnance-Loi of 1970 - modifies 1937 Decree.

Regulation (Arrete Departemental No. 00002) of 1973 - regarding rhinoceros horns and and taxation of hunting licenses.

Regulation (Arrete Departemental No. 00003) of 1973 - protection and conservation of cheetahs and leopards.

Regulation (Arrete Departemental No. 00004) of 1973 - regarding special hunting licenses and fixes the list of protected animals.

Zaire is a signatory to the Convention on International Trade in Endangered Species (CITES). All exports of elephant products have been banned.

The DECNT has overall responsibility for wildlife management in Zaire. Other relevant institutions include the Department of Agriculture, IZCN, and the Office National de Peche (fisheries).

Terrestrial wildlife. Outside of the more inaccessible areas of the Cuvette Centrale and protected areas (though these, too, are impacted to varying degrees), there are decreasing populations of fauna throughout Zaire due to: exploitation of their habitat, sport hunting with the use of technologically advanced firearms, and a resurgence in illegal hunting (uncontrolled hunting poses the most serious threat). Verschuren reports that the zones bordering the roads and navigable rivers are subject to intensive poaching, in some cases by hunters coming from distant areas and acting as meat suppliers to the large towns. In Zaire, 75% of animal protein comes from wild sources. 1/ It should be pointed out that throughout most of west and central Africa wildlife is, by tradition, regarded as a regular and God-given source of protein.

1/ de Vos, 1978. This figure is based on an article published in 1973 by Heymans and Maurice entitled "Introduction a l'exploitation de la faune comme ressource alimentaire en Republique du Zaire" (Forum Universitaire, 2) - this was not available to the author.

Fisheries. Fish is the most important source of protein in the national diet, with demand exceeding production. Fish production in Zaire is considered to be below its potential. Imports, mostly of salted fish, are over 100,000 tons a year. Table 5 outlines the nominal fish catch of Zaire from 1972 to 1976.

Table 5. Nominal Fish Catch (metric tons) 1/

Species	1972	1974	1976
Freshwater fishes	111,200F	115,430	110,000
Marine fishes			
Tonguefishes (Cynoglossidae)	100F	180F	79
Cape hakes (Merluccius capensis, M. paradox)	3,100	5,800	2,730
Congers (Congridae)	100F	100F	79
Bigeye grunter (Brachydeuterus auritus)	200F	200F	180
W. African Croakers (Pseudotolithus spp.)	100F	150F	n.a.
Other croakers and drums (Sciaenidae)	200F	200F	79
Dentex (Dentex spp.)	3,200F	2,200F	2,129
Kingklip (Genypterus capensis)	400F	400F	158
Cape horse mackeral (Trachurus capensis)	4,600F	3,200F	1,738
Sardinellas (Sardinella spp.)	700F	700F	395
Various sharks	100F	100F	79
Other marine fishes	200F	150F	234
Total Catch	124,200F	128,810F	117,858

1/ The live weight equivalent of the landings (fish and fish products brought ashore).
F = FAO estimate.
n.a. = data not available.
Source: 1976 FAO Yearbook of Fishery Statistics, 1977.

Modern fish culture was developed in Zaire by the Belgian colonial administration. The program covered most of the country and primarily relied on farming Tilapia melanopleura, a modern productive fish native to the Zaire basin. The best production in indigenous ponds did not exceed 20 kilos per metric are per year. There is significant variation in the natural productivity of ponds in different regions. No precise evaluations are available on the natural productivity of waterways and ponds in Zaire. AID has been active in the development of fish culture in Zaire. An AID pilot project introduced Tilapia nilotica, a faster growth rate fish, plus the modern techniques of pond construction.

Problems associated with fisheries include:

(i) Lack of fishing regulations;
(ii) Use of small mesh nets resulting in the catching of even small fish;
(iii) Pollution of inland waters.

III. PARKS, RESERVES, AND EQUIVALENT PROTECTED AREAS

A. National Parks

Introduction

The movement toward environmental protection and nature conservation in Zaire began in 1925 with the creation of Albert National Park and the subsequent establishment of the Institut des Parcs Nationaux du Congo Belge. Today, Zaire is among those countries in the forefront of African conservation. Nearly all all African biotopes are represented in Zaire, the exceptions being desert, semi-desert, coral reefs, and marine islands. As of 1979, the number of national parks had grown to seven and the total area under protection stood at 7,486,000 ha. It is stated Government policy that 15% of the country (estimated at 300,000 sq km) is to be established as reserves.

Legal and Institutional Framework

The Institut Zairois pour la Conservation de la Nature (IZCN), within the Departement de l'Environnement, Conservation de la Nature et Tourisme, is responsible for the administration of all parks and reserves. Each park is divided into one or more sectors administered by a National Park Conservation officer of the judicial police, who is responsible for his sector to the Director General of IZCN, who in turn is responsible to the President. National Parks are established under Presidential Order on the recommendation of IZCN.

The following is a summary of legislation.

Decree of 1934 - establishment of Albert National Park (now Virunga National Park).

Decree of 1938 - Garamba National Park.

Decree of 15 May 1939 - Upemba National Park.

Ordonnance-Loi No. 52/157 of 1952 - creation of study commission for Upemba National Park.

Ordonnance-Loi No. 70/312 of 30 Nov. 1970 - Maiko National Park.

Ordonnance-Loi No. 70/316 of 30 Nov. 1970 - Kahuzi-Biega National Park.

Ordonnance-Loi No. 70/317 of 30 Nov. 1970 - Kundelungu National Park.

Ordonnance-Loi No. 70/318 of 30 Nov. 1970 - Salonga National Park.

Ordonnance-Loi (No. 75-023) of 1975 - Statute of the Institut Zairois pour la Conservation de la Nature (IZCN).

Description of National Parks

Zaire has a network of seven National Parks: Virunga, Garamba, Upemba, Maiko, Kahuzi-Biega, Salonga, and Kundelungu. Figure 6 below shows the location of national parks in relation to the distribution of biotic communities in Zaire (see the biogeographical map found in Appendix 5 for identification of the biotic areas). 1/

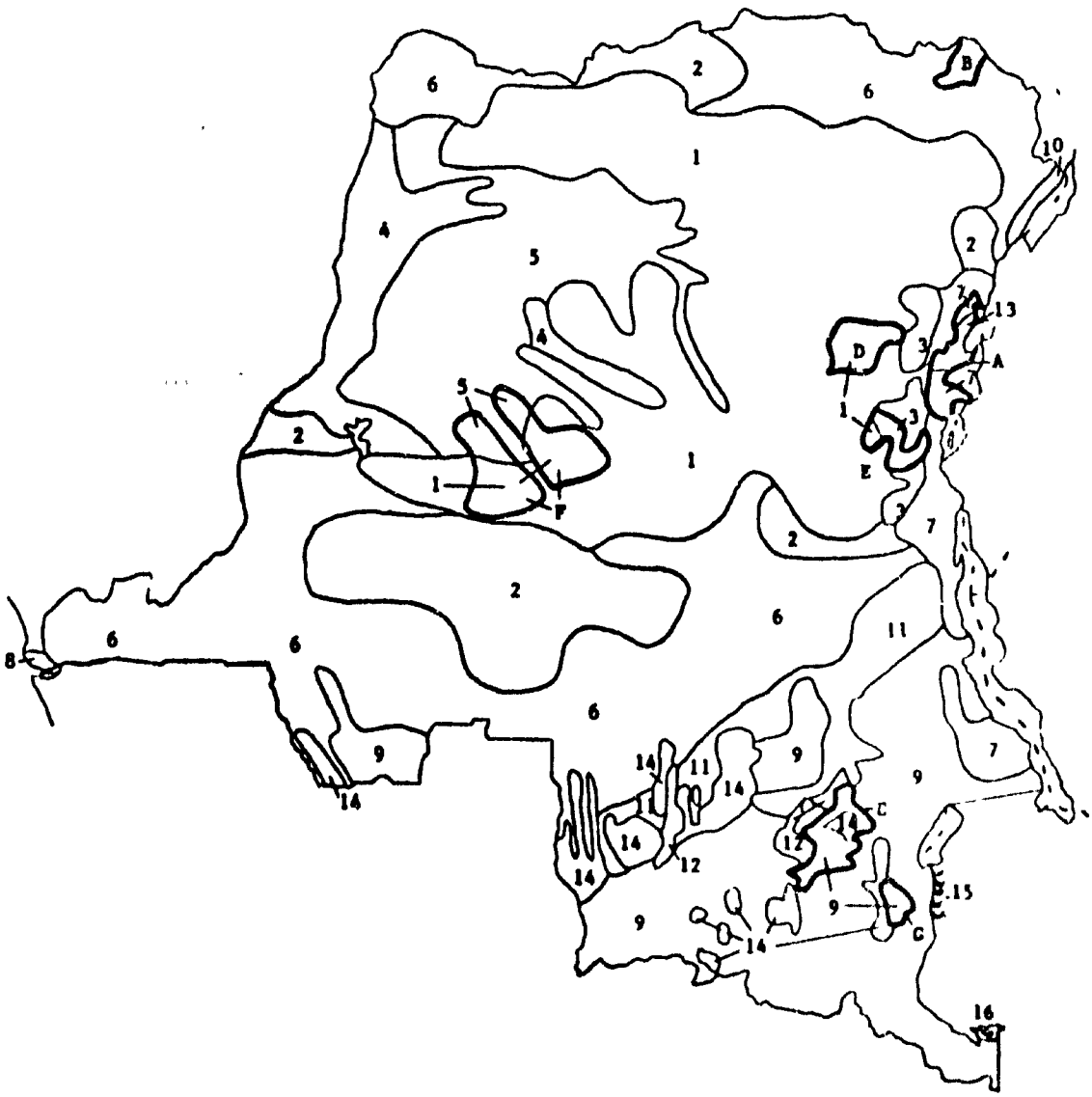

Figure 6. Location of National Parks.

1/ The following descriptions are based on IUCN, 1979, IUCN, 1977, and Harroy and Curry-Kindahl, 1972.

A. Parc National Virunga

Location: The Virunga Mountains in the East African Rift Valley.

Altitude: 750-5000 m.

Area: 809,000 ha.

Description: Virunga presents a very rugged surface and consequently a great diversity of ecosystems, from dense montane rain forest of the Congo-Nile mountain divide forest to glaciers and active volcanoes; including Nyamuragira and Nyiragongo with lava flow and hot springs, and the extinct volcanoes Tshiaberimu and Virunga. The park borders Lake Kivu to the south and Lake Amin along its eastern side.

The park is rich in large mammals, which comprise a fauna characterized by a limited number of species but a significant biomass resulting from increasing populations of the big ungulates due to strict protection. This is especially true of the hippo population, which numbered approximately 26,000 in a 1974 count (up from 19,000 individuals in 1959). There are still mountain gorillas (Gorilla g. beringei) around Tshiaberimu and V'runga. Other mammals include: chimpanzee, elephant, hippopotamus, buffalo, various antelopes, lion, leopard, wild dog, okapi, topi, and aardvark.

Virunga has been designated a World Heritage Site under the terms of the Convention Concerning the Protection of the World Cultural and Natural Heritage.

B. Parc National Garamba

Location: Haut-Uele subregion of Haut-Zaire.

Altitude:

Area: 492,000 ha

Description: No further information was available to the author.

C. Parc National Upemba

Location: Shaba region, on the southeastern side of Lake Upemba.

Altitude:

Area: 1,173,000 ha.

Description: In the miombo woodland, with edaphic grassland on Kalahari sands, fringing forest, and swamp forest. Fauna includes: eland, Burchell's zebra, and hartebeest on the plateau; black antelope in wooded areas. In the Lufira valley there are elephant, hippopotamus, buffalo, and Defassa waterbuck. There is a great variety of birdlife, more than 500 species, especially aquatic types around Lake Upemba.

D. Parc National Maiko

Location: Administrative regions of Kivu and Haut-Zaire, eastern Zaire.

Altitude: 700-1300 m.

Area: 1,083,000 ha.

Description: The park is in the semi-mountainous region between the Cuvette centrale and the mountain ranges of the west side of the Rift Valley at Massisi and Beni. The northern and southern regions are undulating, while the central section is almost flat. This area receives the highest precipitation in the country and there is almost no dry season.

The park is composed of dense humid equatorial forests of low to medium altitude that form a transition zone between the lowland forests of the central basin and the montane forests of the Eastern Highlands. The forest appears to be 90% primary. The forests support typical forest fauna, but the most important and characteristic are three rare species: the mountain gorilla (Gorilla gorilla beringei), the okapi (Okapia johnsoni), and the Zaire 'peacock' (Afropavo congensis). Elephant (Loxodonta africana), duikers, and Cape buffalo (Syncerus caffer) are also present.

Scientific Facilities and Research: In 1975 the IUCN reported that no scientific facilities existed in the park. Studies of the raising of okapi in captivity and on phytosociology were planned.

E. Parc National Kahuzi-Biega

Location: West of the town of Bukavu, eastern Zaire.

Altitude: 1000-3000 m.

Area: 600,000 ha.

Description: The park is in the western mountains of the Great Rift Valley between Walungu and Massisi. The western part is very undulating and forms a belt between the lowland and montane forests. Two-thirds of the park is covered with mixed dense forest, with bamboo Arundinaria alpina at higher altitudes and less dense vegetation at lower levels. The rest of the park consists of mesophytic woodland (requires moderate amounts of moisture for optimum growth) in which Hagenia are particularly striking. Fauna includes chimpanzee (Pan spp.), about 250 mountain gorilla (Gorilla gorilla beringei), colobus and other cercopithedae, giant forest hog (Hylochoerus sp.) in some areas, about 100 elephants (Loxodonta africana), and many antelopes and duikers. There is also abundant bird and insect life. There is some cultivation on the periphery of the park, primarily tea-growing.

Scientific Facilities and Research: None as of 1975. Studies of geology and botany were planned in collaboration with the Institut des Recherches Scientifiques en Afrique Centrale (IRSAC).

F. Parc National de Salonga

Location: Central Zaire basin.

Altitude: 350-700 m.

Area: 3,656,000 ha.

Description: The park encompasses a large section of the central basin of the Zaire River, covering three types of landscape: low plateaux, river terraces, and high plateaux. It is a very isolated region that is only accessible by water transport. The park includes inland forest, fringing forest, and swamp forest. The northern part of the park is covered by grassland. The soils are composed of a thin humus layer over Kalahari sands with several lateritic flushes. The park is divided into two sections by an inhabited zone 40 km wide between the rivers Loile and Luilaka (some pygmy tribes live in the park).

No systematic faunal survey has been made but the park is known to support typical forest fauna. Noteworthy fauna include: pygmy chimpanzee (Pan paniscus, a vulnerable species found only in its Zaire habitats); colobus monkeys (Colobus polykomos angolensis and C. badius); various species of Cercopithecus; leopard (Panthera pardus), pygmy elephant (Loxodonta africana cyclotis and L. africana pumilio); yellow-backed duiker (Cephalophus sylvicultor); water chevrotain (Hyemoschus aquaticus); sitatunga (Tragelaphus spekei); bushbuck (Tragelaphus scriptus); bongo (Taurotragus eurycerus); and pygmy Cape buffalo (Syncerus caffer nanus). Birds include the herons (Casmerodius albus melanorhynchus and Bubulcus ibis); black stork (Ciconia nigra); yellow-billed stork (Ibis ibis); and the Congo peacock (Afropavo congensis, an endemic species). Reptiles include the African slender-snouted crocodile (Crocodylia cataphractus).

Scientific Facilities and Research: There were none in 1975, but a biological station was planned. Phytosociological studies and studies of Pan paniscus had begun prior to 1975 and the IZCN (then the INCN) was in the process of planning a research program.

G. Parc National Kundelungu

Location: Shaba region in southeast Zaire.

Altitude: 1200-1700 m.

Area: 220,000 ha.

Description: The terrain of the park is characteristic of the Shaba region, encompassing a plateau and foothills. The western side of the park is formed by 400 m cliffs which fall perpendicularly to the valley of the Lufira River. On the Lofoi tributary, which runs through the park, are 342 m high falls that are reputed to be the highest in Africa.

The park protects areas of open miombo woodland (dominated by Brachystegia), grassy and woody savanna, and some gallery forests along the drainage lines.

The fauna is especially rich in ungulates, with at least 15 species such as: zebra (Equus burchelli); klipspringer (Oreotragus oreotragus); duikers; reedbuck (Redunca arundinum); defessa waterbuck (Kobus defassa); roan and sable antelope (Hippotragus equinas and H. niger); bushbuck (Tragelaphus scriptus); greater kudu (T. strepsiceros); and eland (Taurotragus oryx). Primates include: vervet diademed (Cercopithecus aethiops); guenon (C. mitis kandti); baboons (Papio cynocephaeus and P. doguera); bushbabies (Galago crassicaudatus, G. demidovi, and G. senegalensis). Felines include leopard (Panthera pardus) and cheetah (Acinonyx jubatus). Birds include wattled crane (Bugeranus carunculatus) and the ground hornbill (Bucorvus leadbeateri).

Scientific Facilities and Research: There were no facilities as of 1975. Studies in geology, petrography, botany, and phytosociology were planned.

Management Issues

An IUCN report on the protection of biotic communities in West and Central Africa made the following evaluation of the protected area system in Zaire: "Zaire has a good network of national parks and reserves and continues to promote an effective policy for the conservation of natural environment and fauna. Special attention should be given to the suppression of poaching and transfrontier trafficking in, for instance, the large quantity of ivory and leopard skins which go to Bangui (Central African Republic) originating officially in Zaire." 1/

With very few exceptions, the management of parks and reserves has been assumed by nationals. The most up-to-date techniques are used in the management of protected areas, including airplanes and radio communication. Each park guard is equipped with a powerful rifle which may be used against offenders. Three additional national parks are due to be established in 1980. The parks are to be located where the majority of elephants occur, and there will be a total ban on hunting within park boundaries. No information was available on the current status of these proposed parks.

Key management issues include:

(i) continued expansion of the protected area system so as ensure adequate coverage of all representative ecosystems;

(ii) reconciling the country's industrialization and rapid urban growth with with the protection of representative ecosystems and historic sites and monuments.

(iii) training of scientific and technical personnel.

B. Reserves

Hunting Reserves

There were 42 hunting reserves of various types in 1977. No further informa-

tion was available to the author.

Biosphere Reserves 1/

Zaire has two biosphere reserves established under Project 8 of the Man and the Biosphere Program (Conservation of natural areas and of the genetic material they contain).

Reserve Floristique de Yangambi

Location: The reserve is part of the State Botanical Forest at Yangambi Station, which is administered by the National Institute for Agronomic Study and Research (INERA). Yangambi lies to the west of Kisangani on the north bank of the Zaire river.

Altitude:

Area: 250,000 ha.

Description: Yangambi was approved as a MAB biosphere reserve in June, 1976. The reserve is on relatively flat terrain made up of firm land with tropical red (ferrous) soils. There is a strict core zone and a monitored floristic zone. The reserve is comprised of dense semi-deciduous rain forest. Noteworthy fauna include koiropotamus, bongo, sitatunga, elephants, and various monkeys (Cynocephali). There has been controlled installation of villages within the reserve, and there is some traditional agriculture and hunting.

Scientific facilities and research: Yangambi Station has an extraordinarily rich and up-to-date herbarium, which could serve as a focal point for other studies. At present there is a chief of the Botanical and Forestry Office, assisted by 30 other personnel.

An integrated ecological research project was launched in the reserve in July 1978. This project concerns a representative sample of a very extensive equatorial forest zone which, for the most part, has undergone very limited transformation. The aim of the research activities is to provide the scientific basis for management of biosphere reserves in the tropics and for assessing the impact of different land use systems (coffee, oil palms, hevea, cocoa) on fundamental processes such as hydrobiological and biogeochemical cycles.

Reserve Floristique de Luki

Location: In Bas-Zaire to the north of the Zaire river about 150 km from the Atlantic coast.

Altitude: 160-350 m.

1/ Unesco Man and the Biosphere Program, 1980. The Congo-Nile mountain divide forest has been proposed as a biosphere reserve.

Area: 33,000 ha.

Description: Luki was established as a forest reserve in 1937 and became a biosphere reserve in May, 1979. Hunting and fishing are forbidden and there has been no felling since 1963. The reserve is composed of gneisses and schists of the Mayumbe system drained by the Luki river and a dense network of tributaries. The mean annual precipitation is 1163 mm, though precipitation is highly variable. The mean annual temperature is 24 degrees C. The reserve has a rich tree flora. Vegetation consists of subequatorial rain forest, now mainly disturbed and secondary, with the following types represented: high forest dominated by Gilbertiodendron and Cossweilerodendron; various secondary, especially of Terminalia superba and savanna. The reserve has a representative fauna that includes elephants.

Scientific research and facilities: The general area has been the subject of considerable research. INERA has assumed management of the reserve so that research on tropical silviculture can be carried out.

IV. ENVIRONMENTAL PROBLEMS AND IMPACTS

A. Introduction

Legal Framework

Zaire is lacking a comprehensive legislative framework for pollution control. The following are existing statutes relating to the environment, but which are largely out of date in relation to the present needs of the country.

General

Decree of 19 July 1926 on public hygiene.
Ordonnance-Loi of 4 June 1926 on public hygiene in cities.
Ordonnance of 2 August 1940 on hygiene in indigenous areas.

Water

Ordonnance-Loi no. 111/Hygiene of 1936 - protection of bodies of water and water shores.
Ordonnance-Loi no. 52/240 of 1953 - protection of bodies of water.
Ordonnance-Loi no. 44/142 of 1957 - protection of bodies of water.
Ordonnance-Loi no. 44/305 of 1957 - protection of bodies of water.

Solid waste disposal

Ordonnance-Loi of 4 June 1929 - public hygiene.
Ordonnance-Loi no. 47/Hygiene of 1931.
Ordonnance-Loi no. 131/Hygiene of 1935.
Ordonnance-Loi no. 48/Hygiene of 1938.
Ordonnance-Loi no. 93/Hygiene of 1946.
Ordonnance-Loi no. 74/499 of 1952.
Ordonnance-Loi no. 74/59 of 1953.
Ordonnance-Loi no. 74/248 of 1953.
Ordonnance-Loi no. 74/125 of 1957.

Hazardous substances

Ordonnance-Loi no. 8/AE of 1938 - transportation by water of calcium carbide.
Ordonnance-Loi no. 43/54 of 1953 - regulates nitrate and potassium.
Ordonnance-Loi no. 43/55 of 1953 - explosives.
Decree of June 1960 - radioactive substances.

Institutional Framework

The Department of Environment, Conservation of Nature and Tourism (DECNT) is the primary institution responsible for pollution control efforts. No information was available on the activities of DECNT in this area. Other relevant or-

ganizations include the Environmental Service (Service de l'environnement), the Departments of Public Health (Sante Publique), Mines (Mines), National Economy, Industry and Commerce (Economie Nationale, Industrie et Commerce), Public Works and Territorial Development, and REGIDESO (the state company responsible for municipal water supply).

Environmental Monitoring

DECNT has a division responsible for environmental monitoring activities (see the organization chart of DECNT on p. 13). No information was available on the monitoring facilities or capabilities of DECNT.

B. Water Supplies and Water Related Disease 1/

The environment of Zairians is characterized by the lack of adequate infrastructures such as water and sanitation systems necessary to facilitate adaptation to an already adverse physical milieu. Zaire's diverse topography and synthesis of tropical climates provides a vast incubator for numerous debilitating disease vectors. These conditions have largely defined the pattern of population settlement. Large geographic areas remain virtually uninhabited, while urban areas are experiencing rapid population growth.

There are few wells in rural areas and water is generally obtained from largely unprotected and often polluted natural water sources such as rivers, streams, and lakes located nearby. Such living patterns are most favorable to the spread of insect and rodent-borne diseases. The provision of water to rural areas is administered by the Rural Development Bureau (Bureau du Developpement) of the Department of Agriculture.

A Technical Water Supply and Sewerage Sector Study was conducted under a program of the World Health Organization and the World Bank in 1974. This study focuses on the water supply situation in the urban areas of Zaire. As of early 1974, only an estimated 1.6 million persons, or approximately one-fourth of the total urban population of the country at the time, had access to a piped water supply system. The ratio of house connections to population has actually been decreasing in recent years. Piped water service is intermittent in most populous areas, and in many newly developed areas of the major urban centers (especially the squatter areas) there is no distribution system at all. In these densely populated areas people continue to rely on nearby wells and rivers to meet water needs, thus increasing the possibility of contaminations and infections (for more detailed information see the WHO/World Bank sector study).

Schistosomiasis, a serious incapacitating disease, is prevalent in many areas throughout Zaire. Both the intestinal form and the urinary form are known to produce high infection rates in areas such as Bas-Zaire and North Shaba. Other areas, including parts of Kasai-Oriental, Haut-Zaire, and Kivu, have high infection rates for the intestinal form. A high infection rate also occurs in

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1/ Based on Lashman, 1975 and Agency for International Development, Office of Foreign Disaster Assistance, 1977.

Kinshasa. Significant levels of infection are unlikely to decline in the near future due to the expense of a prevention campaign and cultural habits which foster infection. U.S. AID is conducting a schistosomiasis control project in selected heavily infected areas.

C. Environmental Problems in Rural Areas

In addition to the problem of water supply is the lack of sanitary facilties in rural areas. The majority of rural villagers have no sanitary facilities and environmental pollution is a major problem. Improper construction and lack of drainage in pit latrines is common and the resultant flooding creates a serious health hazard. The ground surrounding huts is commonly surrounded with excrement, which provides an ideal source of hookworm eggs and larvae, thus spreading incidence of parasites.

D. Environmental Problems in Urban Centers

The increasing rate of migration to urban centers, particularly Kinshasa, and the high rate of population growth in these areas has led to the spread of "bidonvilles" or shantytowns and attendant environmental problems. In addition to the problem of water supply is the lack of adequate sanitation systems. With the exception of small sewers in the major urban centers (generally only covering the heart of the urbanized area), there is no national sewerage system. The problem is particularly acute in two areas: Lubumbashi, where pollution of streams by untreated sewerage is a major health hazard; and Matadi, in which geographic constraints , namely rocky sub-soil and hilly terrain, preclude the use of septic tanks and create a serious waste disposal problem.

The recently created Service de l'environnement, under the Office of the President, is working in the area of basic sanitation and the control of industrial pollution. Its four sanitation engineers have already conducted an environmental study of Kinshasa and in 1975 were studying the problem of industrial waste disposal in Kinshasa.

E. Industrial Pollution

This is an area that requires special attention on the part of the phase II study team as no information was available beyond general references to pollution problems contained in the Government's report to the Stockholm Conference. Those problem areas mentioned include:

(i) Pollution caused by mining industries. Mining is concentrated largely in the southeastern and eastern parts of the country, particularly Shaba Region. In addition, Zaire is now actively pursuing offshore petroleum exploration and production in Bas-Zaire (see the figure on p. 5 of Appendix 2).

(ii) Pollution of surface and ground waters. Lake Kivu was singled out as a pollution problem.

REFERENCES

Agency for International Development (AID)/Zaire. 1975a. Project Paper - Basic Family Health Services. Washington, D.C.: AID.

Agency for International Development/Zaire. 1975b. Project Paper - INERA Suppor . Washington, D.C.: AID.

Agency for International Development. 1975c. Zaire Shelter Sector Analysis. Washington, D.C.: AID.

Agency for International Development/Zaire. 1976a. Project Paper - North Shaba Maize Production. Washington, D.C.: AID.

Agency for International Development/Zaire. 1976b. Project Paper - Endemic and Communicable Disease Control. Washington, D.C.: AID.

Agency for International Development, Office of Foreign Disaster Assistance. 1977. Zaire: A Country Profile. Washington, D.C.: AID.

Agency for International Development/Zaire. 1978. Project Paper - Manioc Outreach. Washington, D.C.: AID.

Agency for International Development. 1979a. FY 1981 Annual Budget Submission - Zaire. Washington, D.C.: AID.

Agency for International Development, PPC/PDPR/ESDS. 1979b. ALLDATA Report on Zaire. Washington, D.C.: AID.

Agency for International Development/Zaire. 1979c. Country Development Strategy Statement, FY 1981 - Republic of Zaire. Washington, D.C.: AID.

Cahens, L. 1954. La Geologie du Congo Belge. Liege: Vaillant Carmanne.

Clark University, Program for International Development. 1978. Background Brief on Zaire: Summary of Environmental Circumstances, Institutions, and Activities. Worcester.

Diallo, S. 1975. Le Zaire Aujourd'hui. Paris: Editions Jeune Afrique.

Food and Agriculture Organization. 1977. Conservation de la Nature en Zaire - Conclusions et Recommandations du Projet. In cooperation with the United Nations Development Program. FO:DP/ZAI/70/001. Rome: FAO. The report contains a list of published project reports completed between 1970 and 1976.

Food and Agriculture Organization and Unesco. 1974. Soil Map of the World, Volume I: Legend. Paris: Unesco.

Food and Agriculture Organization and Unesco. 1977. Soil Map of the World, Volume VI: Africa. Paris: Unesco.

Food and Agriculture Organization and World Bank. 1978. Etude du Secteur Forestier au Zaire. (2 vols.) 57/78 ZAI:15. Rome: FAO.

Hall, G. E. 1975. An Evaluation of Proposed USAID Project for Improvement of Lake Tanganyika's Fishery Resources in Zaire. Prepared for USAID. Washington, D.C.: AID.

Harroy, J.-P. and K. Curry-Lindahl. 1972. National Parks of the World. A publication of the International Union for Conservation of Nature and Natural Resources. New York: Golden Press.

Hutchinson, J. and J. M. Dalziel. 1954-1968. Flora of West Tropical Africa. Second Edition. R. W. J. Keay and F. N. Hepper (eds.). 3 vols. London: Crown Agents.

International Union for Conservation of Nature and Natural Resources. 1976. Red Data Book. Compiled by the Survival Service Commission of IUCN. Morges: IUCN.

International Union for Conservation of Nature and Natural Resources. 1977. World Directory of National Parks and Other Protected Areas. (2 vols.). Morges: IUCN.

International Union for Conservation of Nature and Natural Resources. 1979. The Distribution of Protected Areas in Relation to the Needs of Biotic Community Conservation in West Africa. Gland: IUCN.

Johnson, H. and J. M. 1977. Environmental Policies in Developing Countries. Berlin: Erich Schmidt Verlag.

Kamarck, A. M. 1976. The Tropics and Economic Development. Baltimore: Johns Hopkins University Press.

Kaplan, I. (ed.). 1979. Zaire: A Country Study. Area Handbook Series. Washington, D.C.: American University.

Lashman, K. E. 1975. Syncrisis: The Dynamics of Health - Zaire. Washington, D.C.: U.S. Department of Health, Education, and Welfare, Office of International Health.

Lumpungu, K. 1977. "Land Tenure System and the Agricultural crisis in Zaire." African Environment, vol. II, no. 4 and Vol. III, no. 1.

Matuka, K. 1976. Aspects de la Conservation de la Nature au Zaire. Kinshasa: Institut Zairois pour la Conservation de la Nature.

Meggers, B. J., E. S. Ayensu, and W. D. Duckworth. 1973. Tropical Forest Ecosystems in Africa and South America: A Comparative Review. Washington, D.C.: Smithsonian Institution Press.

Miracle, M. P. 1967. Agriculture in the Congo Basin: Tradition and Change in in African Rural Economies. Madison: Univ. of Wisconsin Press.

Moreau, R. E. 1944. The Bird Fauna of Africa and its Islands. New York: Academic Press.

Myers, N. 1980. Conversion of Tropical Moist Forests. A report prepared for the Committee on Research Priorities in Tropical Biology of the National Research Council. Washington, D.C.: National Academy of Sciences.

Office of the President. 1975. Profiles of Zaire. Kinshasa.

Popelier, G. H. 1977. Nature et Evolution de l'Agriculture Zairoise (1958-1975). Brussels: Centre d'Etude et de Documentation Africaines.

Richards, P.W. 1952. The Tropical Rainforest. Cambridge: Cambridge University Press.

Statistisches Bundesamt Wiesbaden. 1976. Landerkurzberichte: Zaire. Stuttgart: Kohlhammer.

Tsui, A. O. 1979. Illustrative Functional Projections 1975-2000 - Zaire. Community and Family Study Center, University of Chicago.

Unesco. 1978. Tropical Forest Ecosystems: A State of Knowledge Report. Unesco/UNEP/FAO. Paris: Unesco.

Unesco Programme on Man and the Biosphere (MAB). 197/. Final Report: Regional Meeting on Integrated Ecological Research and Training Needs in the Humid Tropics of West and Central Africa. MAB report series, no. 33. Paris: Unesco.

Unesco Programme on Man and the Biosphere (MAB). 1978. List of MAB National Committees. Paris: Unesco.

Unesco Programme on Man and the Biosphere (MAB). 1980. Directory of Bioshpere Reserves - Volume 1. Paris: Unesco.

U.S. Joint Publications Research Service. 1974. Translations on Environmental Quality, no. 53.

U.S. Joint Publications Research Service. 1976. Translations on Environmental Quality, no. GUO 17/76.

U.S. Joint Publications Research Service. 1978a. Translations on Environmental Quality, no. 171.

U.S. Joint Publications Research Service. 1978b. Translations on Environmental Quality, no. FOUO 8/78.

U.S. Joint Publications Research Service. 1978c. Translations on Environmental Quality, no. 191.

U.S. Joint Publications Research Service. 1979a. Translations on Environmental Quality, no. 209.

U.S. Joint Publications Research Service. 1979b. Translations on Environmental Quality, no. 211.

Verschuren, J. 1975. "Wildlife in Zaire - Parts I and II." Oryx.

de Vos, A. 1978. "Game as Food - A Report on its Significance in Africa and Latin America." Unasylva, vol. 29, no. 116, pp. 2-12.

White, F. 1965. "The savanna woodlands of the zambesian and sudanian domains: an ecological and phytogeographical comparison." Webbia, 19.

Woodrow Wilson International Center for Scholars. 1972. The Human Environment, Vol. II: Summaries of National Reports. Washington, D.C.

World Bank. 1979. Zaire Economic Memorandum - The Zairian Economy: Current Situation and Constraints. Washington, D.C.

General References

Bulletin de la Societe Royale Botanique Belgique.

Bulletin Agriculture du Congo Belge.

Publications of the former Institut National d'Etude Agronomique au Congo (INEAC).

Publications of the Institut National d'Etude et Recherche Agronomique (INERA).

Appendix 1 - Demographic Data 1/

Total population, mid-1979 estimate: 27,048,000

Average annual growth rate, 1968-1976: 2.5%

1978: 2.5%

Crude birth rate/1000 population, 1960: 47.0

1977: 46.2

Crude death rate/1000 population, 1960: 25.0

1975: 20.0

Population by age and sex, 1975: 3/

	Female	Male	Total
Less than 1 year ...	470,000	472,000	942,000
1 to 4 years	1,661,000	1,663,000	3,324,000
5 to 14 years	3,151,000	3,136,000	6,287,000
15 to 64 years	6,686,000	6,476,000	13,162,000
Over 65 years	406,000	333,000	739,000
Total	12,374,000	12,080,000	24,454,000

Population density per sq km, 1979: 11.5

Population density per sq km of agricultural land, 1979:

Urban population as % of total, 1977: 30%

1975: 35% 2/

Urban population growth rate, 1974: 8.0% 2/

Projected population in year 2000: 44,069,000 3/

Projected urban population as % of total in year 2000: 47% 3/

The World Bank estimates that Zaire will achieve a net reproduction rate of 1 in 2045.

1/ Unless otherwise noted, figures are from "Selected AID Official Data," in AID, 1979b.

2/ "IBRD Social Data," in AID, 1979b.

3/ Tsui, 1979.

Population, Area, and Population Density by Administrative Area, 1970

Regions and Subregions	Population	% of Total Population	Area (sq km)	Density (per sq km)
Kinshasa 1/	1,308,361	6.1	2,016	649.0
Bas-Zaire	1,519,039	7.0	61,869	24.6
Matadi(urban)	110,436	0.5	110	1,004.0
Bas-Fleuve	522,053	2.4	14,310	36.5
Cataractes	886,550	4.1	47,449	18.7
Bandundu	2,600,556	12.0	295,658	8.8
Bandundu(urban)	74,467	0.3	222	335.4
Kikwit(urban)	111,960	0.5	200	559.8
Mai-Ndombe	429,465	2.0	127,243	3.4
Kwilu	1,370,454	6.3	78,019	17.6
Kwango	614,210	2.8	89,974	6.8
Equateur	2,431,812	11.2	403,293	6.0
Mbandaka(urban)	107,910	0.5	460	234.6
Equateur	340,823	1.6	103,443	3.3
Tshuapa	466,286	2.2	132,957	3.5
Mongala	739,813	3.4	101,508	7.3
Ubangi	776,980	3.6	64,925	12.0
Haut-Zaire	3,356,419	15.5	503,239	6.7
Kisangani	229,596	1.1	1,910	120.2
Haut-Zaire	714,545	3.3	197,657	3.6
Bas-Uele	588,768	2.7	148,331	.8
Haut-Uele	795,619	3.7	89,683	8.9
Ituri	1,027,891	4.8	65,658	15.7
Kivu	3,361,883	15.5	256,662	13.1
Bukavu(urban)	134,861	0.6	60	2,247.7
Nord Kivu	1,473,380	6.8	59,563	24.7
Sud Kivu	1,130,676	5.2	64,789	17.5
Maniema	622,966	2.9	132,250	4.7
Shaba	2,753,714	12.7	496,965	5.5
Lubumbashi(urban)	318,000	1.5	747	425.7
Likasi(urban)	146,394	0.7	235	623.0
Tanganyika	696,363	3.2	135,028	5.2
Haut-Lomami	602,368	2.8	108,204	5.6
Haut-Shaba	394,316	1.8	131,443	3.0
Lualaba	596,273	2.8	121,308	4.9
Kasai-Oriental	1,872,221	8.7	168,216	11.1
Mbuji-Mayi(urban)	256,154	1.2	64	4,002.4
Kabinda	1,118,725	5.2	63,821	17.5
Sankuru	497,352	2.3	104,331	4.8
Kasai-Occidental	2,433,861	11.3	156,967	15.5
Kananga(urban)	428,960	2.0	378	1,134.8
Kasai	833,468	3.9	95,631	8.7
Lulua	1,171,433	5.4	60,958	19.2
Total	21,637,876	100.0	2,344,885	9.2

1/ The area and population of Maluka, Kinshasa's only rural zone, was included in the Cataractes subregion of Bas-Zaire.

Source: Kaplan, 1979 (based on the 1970 administrative census).

Appendix 2 - Social and Economic Data 1/

Social Data

Average life expectancy, 1973: 43.5
Female life expectancy, 1973: 45.1
Male life expectancy, 1973: 41.9

Infant deaths during first year of life/1000 infants, 1972: 160

Population per physician, 1973: 24,710

Population per nursing person, 1972: 11,680 2/

Population per hospital bed, 1973: 330 3/

Rural population per hospital bed, 1973: 1001 3/

Population with reasonable access to safe water supply, 1975: 16%

Population with access to excreta disposal, 1975: 22% 3/

Rural population with access to excreta disposal, 1975: 6.0%

Per capita calorie supply as a % of requirements, 1973: 83%

Average daily per capita protein intake in grams, 1970: 33

Literacy rate, 1972: 17%

Total school enrollment as % of population in age group:
Primary (ages 5-14), 1974: 53.8% Male: 64.1% Female: 43.1%
Secondary (ages 15-19), 1973: 18.2% Male: 26.4% Female: 9.8%
Post secondary (ages 20-24), 1973: 0.9% Male: 1.6% Female: 0.2%

Economic 4/

Per capita GNP (US$, 1974-76 base period), 1977: 130

Average annual per capita real GNP growth rate, 1960-77: 1.1%

Dependency ratio, 1975: 1.1

1/ Unless otherwise noted, figures are from "Selected AID Official Data," in AID, 1979b.
2/ "IBRD Social Data," in AID, 1979b.
3/ "World Bank Economic and Social Data," in AID, 1979b.
4/ For more detailed economic data, see Ibid.

Economic, cont'd.

Proportion of labor force in agriculture, 1977: 76%

Agricultural production as % of GDP, 1976: 25%

Avg. annual per capita agricultural production growth rate, 1970-78: -1.8%

Energy production as % of consumption, 1976: 150%

GNP and GDP (millions of Zaires in constant 1970 prices)

Year	GNP	Annual Growth Rate %	GDP	Annual Growth Rate %
1972	981.4	+0.7	1,034.9	+0.3
1973	1,061.7	+8.2	1,119.8	+8.2
1974	1,110.0	+4.5	1,175.7	+5.0
1975	1,064.5	-4.1	1,105.0	-6.0
1976	1,013.9	-4.7	1,057.6	-4.3

Source: AID, 1979c (based on Annual Reports of the Bank of Zaire).

GNP and GDP per capita (Zaires in constant 1970 prices)

Year	GNP per capita	Annual Growth Rate %	GDP per capita	Annual Growth Rate %
1972	44.6	-0.2	47.0	-0.4
1973	47.8	+7.2	50.4	+7.2
1974	49.6	+3.8	52.5	+4.2
1975	47.1	-5.0	48.9	-6.8
1976	43.5	-7.6	45.4	-7.1

Source: AID, 1979c (based on Annual Reports of the Bank of Zaire).

GDP by Industrial Origin, 1970-76 (millions of zaires at 1970 prices)

	1970	1972	1974	1976
Monetary Sector				
Agriculture	79.0	84.5	88.5	84.1
Mining and metal processing	211.2	226.4	250.1	225.8
Manufacturing	77.5	85.8	100.9	92.8
Construction	30.0	30.7	39.0	44.1
Electricity and water	8.7	9.6	9.4	11.1
Transport and communications	75.9	73.5	91.5	72.5
Trade	106.4	122.9	142.6	137.3
Services 1/	222.7	245.1	311.6	307.1
Less imputed bank service charges	-4.8	-5.7	-11.3	-
Total production	806.6	872.8	1,022.3	974.8
Traditional Sector				
Agriculture	79.8	81.4	86.3	91.6
Construction	15.0	15.3	19.5	19.4
Total production	94.8	96.7	105.8	111.0
GDP at Factor Cost	901.4	969.5	1,128.1	1,085.8
Net Indirect Taxes	50.7	62.9	55.1	23.2
GDP at Market Prices	952.1	1,032.4	1,183.2	1,109.0

1/ Includes government services.
Source: Kaplan, 1979 (based on Annual Reports of the Banque du Zaire).

Production of Commercial Crops, 1970-76 (tons)

Crop	1970	1972	1974	1976
Palm oil	170,494	165,864	145,645	128,600
Palm kernel oil	50,350	37,832	34,563	23,100
Palm oil cake	57,000	45,169	40,176	n.a.
Coffee, robusta	58,500	67,514	69,344	88,700
Coffee, arabica 1/	9,000	12,528	9,046	20,755
Logs (cubic meters)	297,400	263,227	293,976	n.a.
Timber, sawn (cubic meters)	162,206	148,980	130,024	n.a.
Rubber	32,500	40,454	30,917	n.a.
Cocoa	4,460	6,061	4,755	n.a.
Tea	7,301	8,000	6,902	6,400
Cotton, fibers	17,126	16,114	16,479	11,400
Cottonseed oil	1,295	1,324	1,049	n.a.
Cottonseed cake	4,741	3,548	3,044	n.a.
Sugarcane	420,401	451,960	577,733	n.a.
Fibers, jute like	6,000	5,405	3,025	n.a.
Rauwolfia 1/	488	638	243	790
Quinine 1/	635	517	1,216	n.a.
Copal 1/	556	84	40	190
Pyrethrum 1/	9	5	4	n.a.
Tobacco	310	887	1,081	n.a.

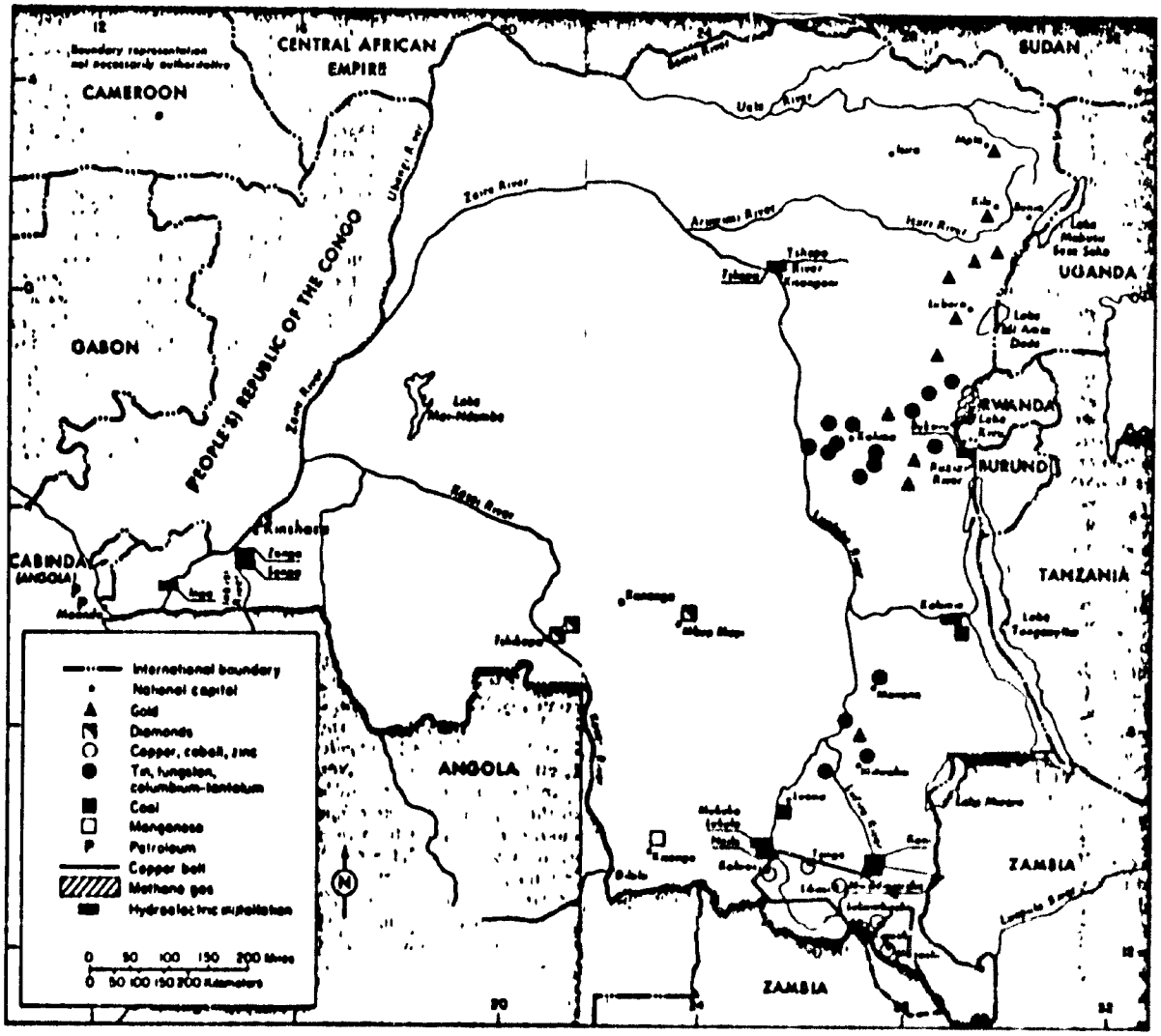
n.a. - not available.
1/ exports only.
Source: Kaplan, 1979 (based on Annual Reports of the Banque du Zaire).

Production of Primary Subsistence Crops, 1975-77 ('000 metric tons)

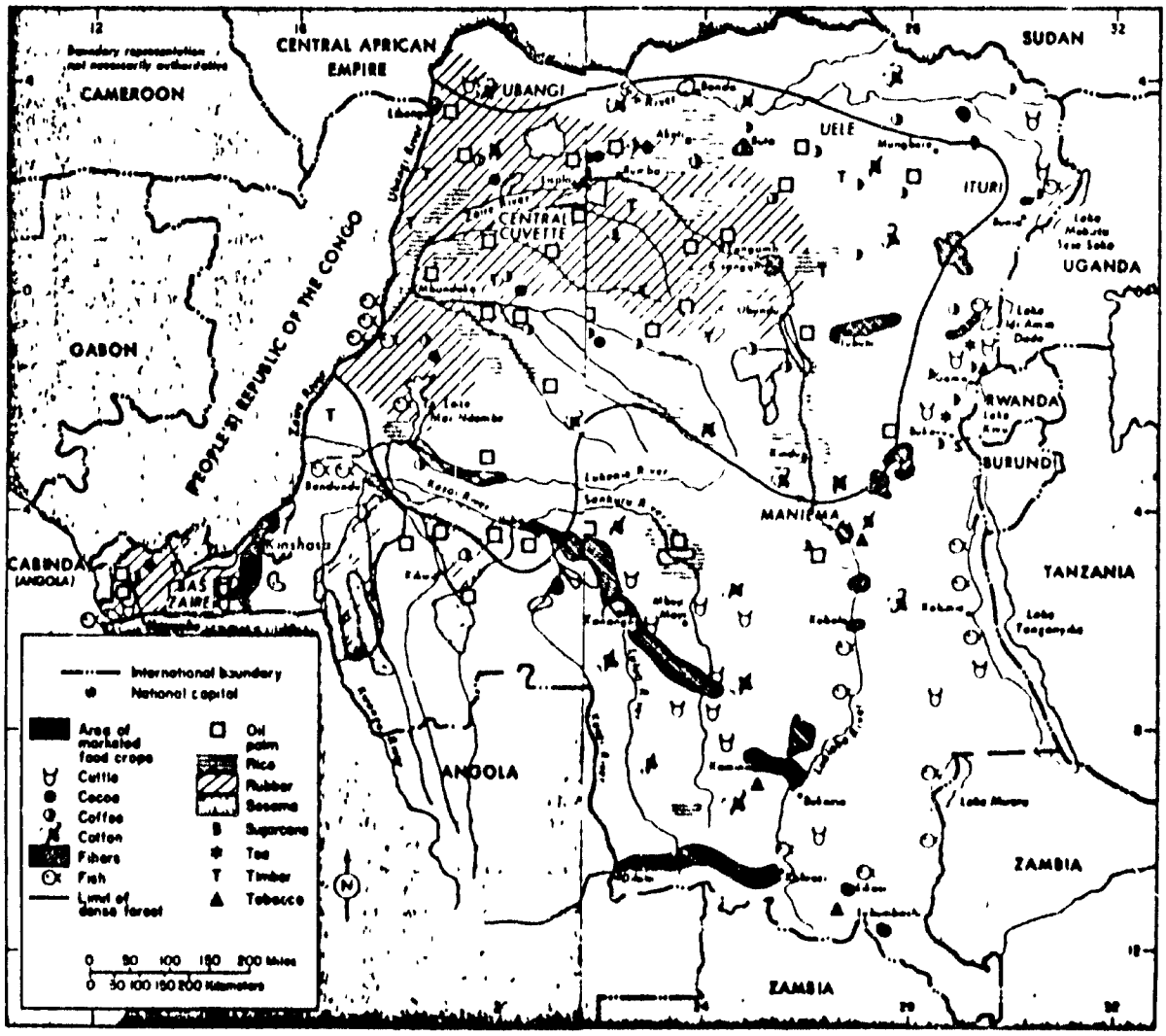
Crop	1975	1976	1977
Rice	208	212	220 1/
Maize	495	510	515 1/
Millet	52	54	55 1/
Sweet potatoes and yams	474	485	495
Cassava (manioc) 3/	11,844	12,130	12,300 1/
Pulses	145	148	151 1/
Groundnuts	308	319	330 1/
Bananas	77 1/	82 1/	83 1/
Plantains	1,620 2/	1,660 2/	1,720 1/

1/ FAO estimate.
2/ Unofficial figure.
3/ Cassava production is currently threatened by an epidemic of three plant diseases, especially in Bas-Zaire and Bandundu.
Source: FAO Production Yearbook.

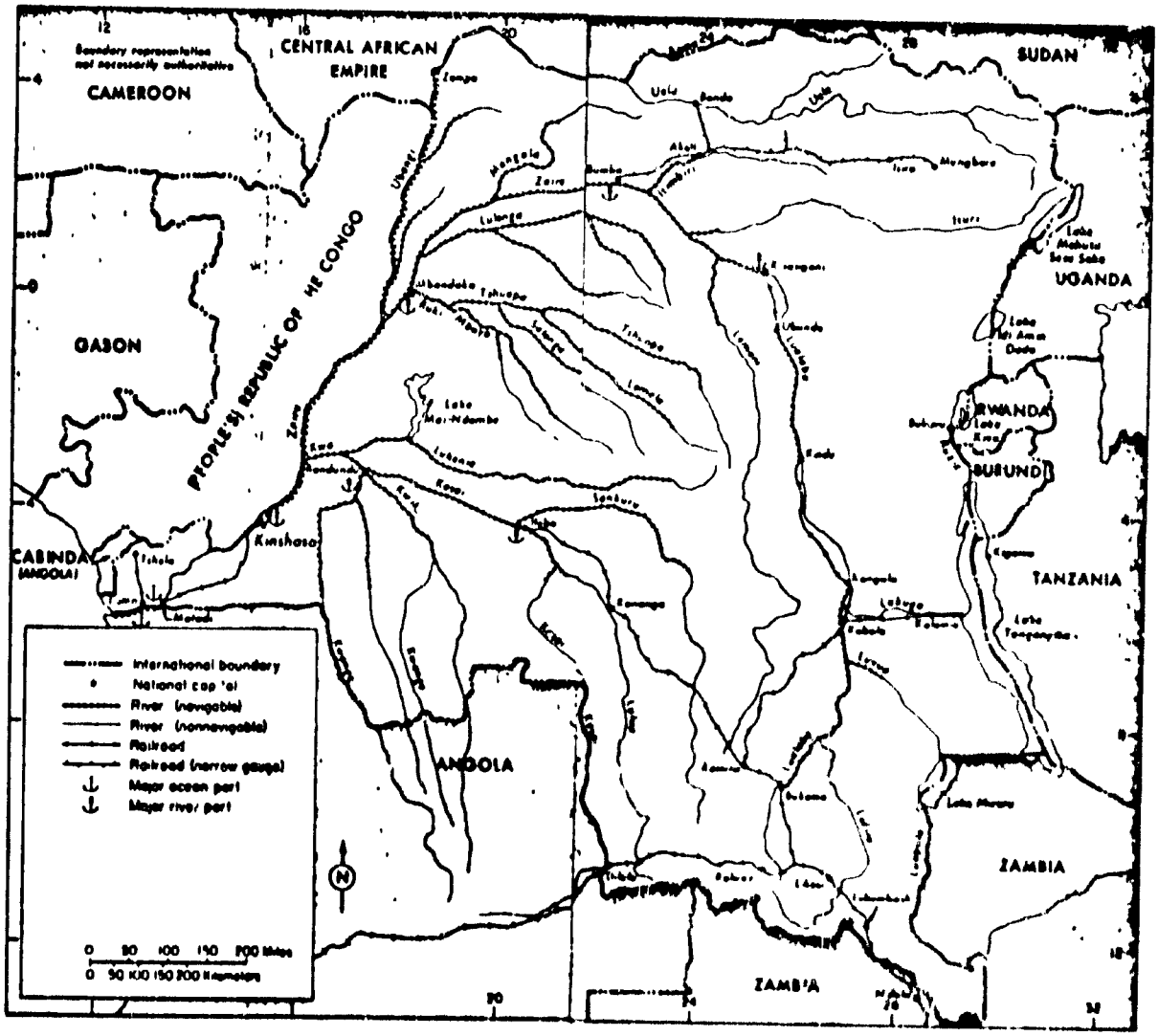
Minerals and hydroelectric facilities



Agriculture



Transportation - Waterways, and Railroads



Appendix 3 - Climatic Data

Maximum/Minimum Temperatures at Selected Stations

Station	Jan	Apr	Jul	Oct	Extreme
Kalemi	85	83	82	87	92
	66	67	58	67	50
Kananga	85	86	85	85	94
	68	68	63	68	57
Kinshasa	87	89	81	88	97
	70	71	64	70	58
Kisangani	88	88	84	86	97
	69	70	67	68	61

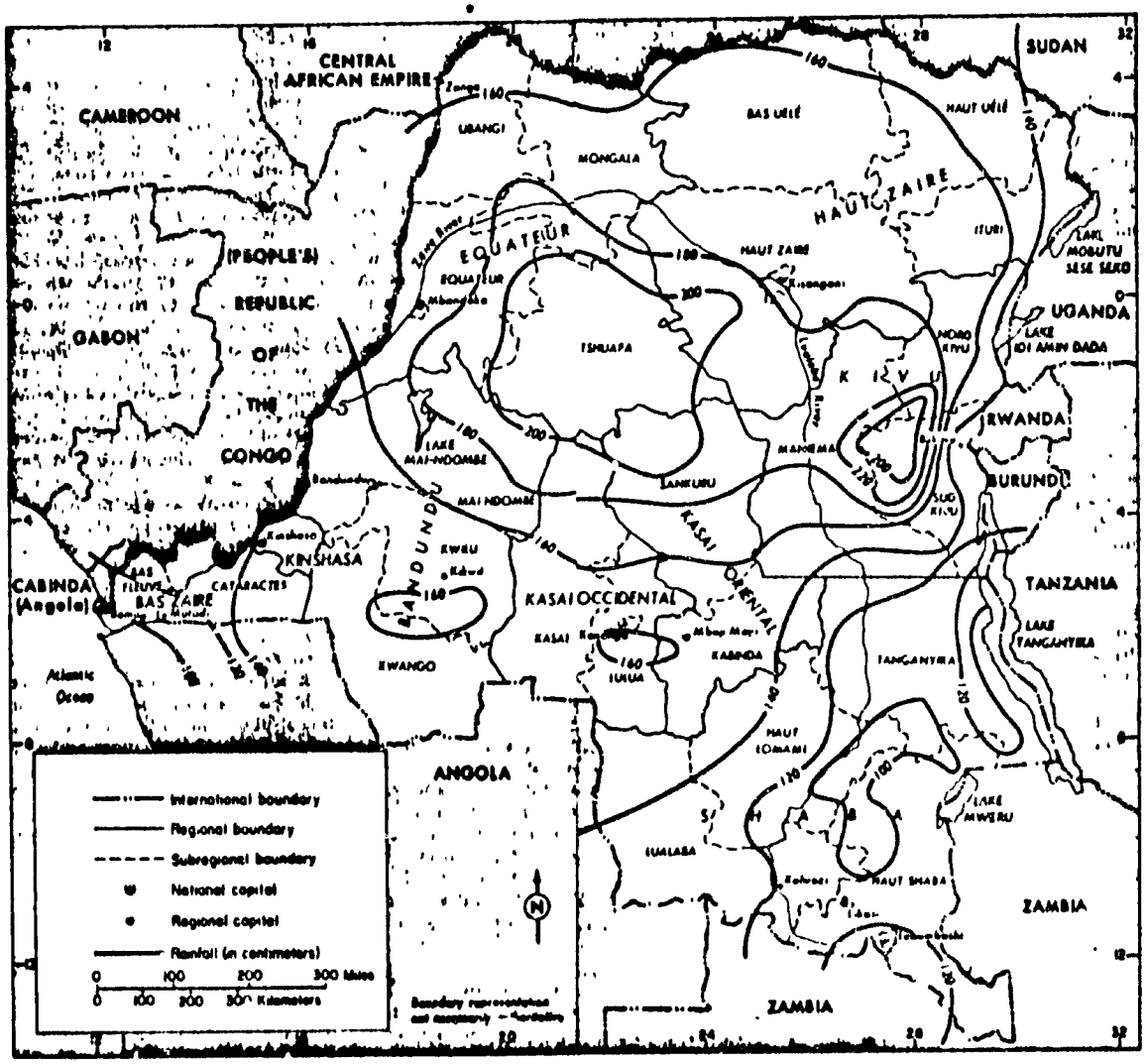
Source: AID, 1977.

Rainfall at Selected Stations

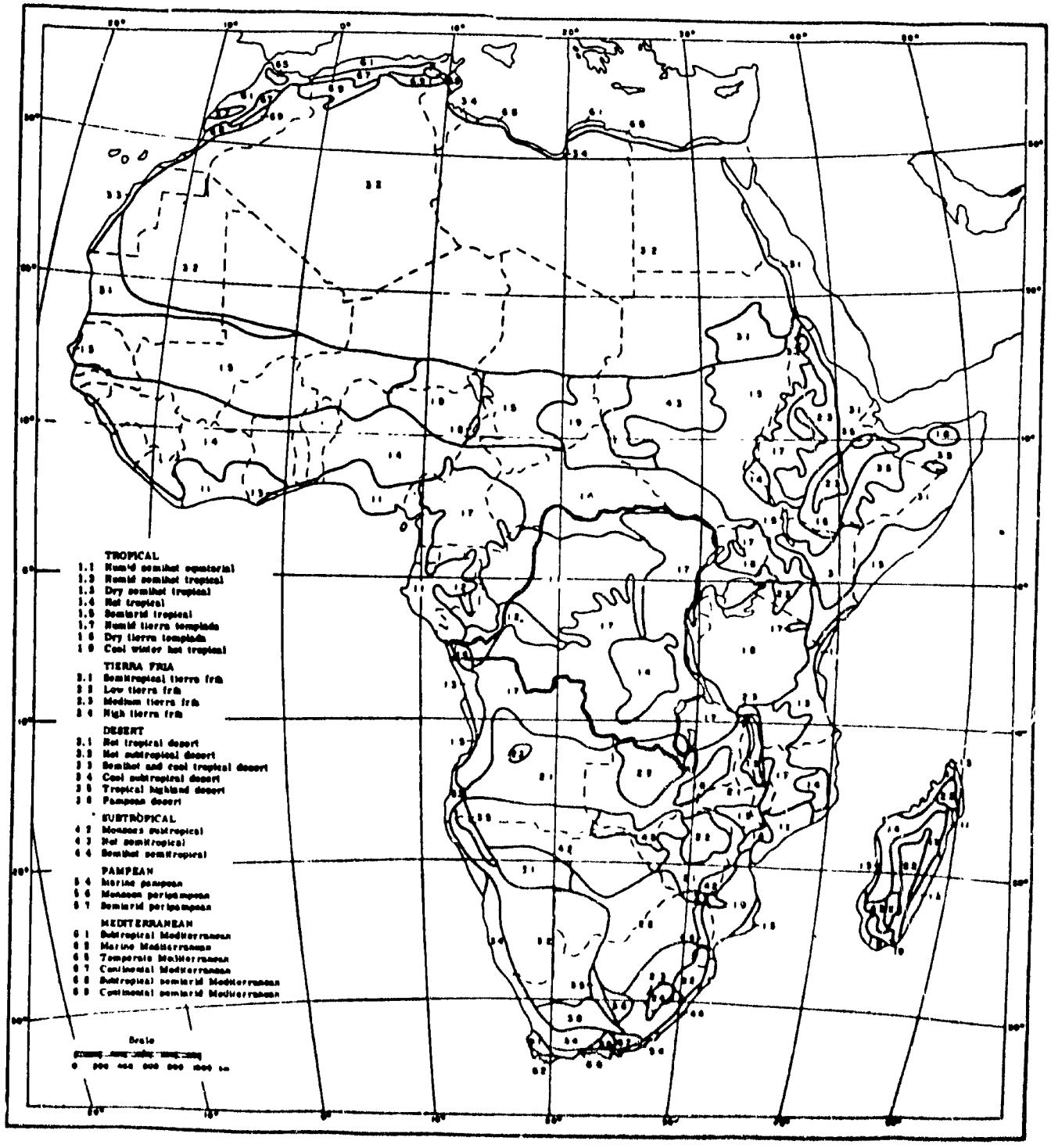
Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Kalemi	4.2	4.7	6.3	8.4	3.3	0.3	0.1	0.3	0.8	2.8	7.9	6.3
Kananga	5.3	5.7	7.7	7.7	6.2	0.3	0.1	0.1	1.3	4.7	8.7	5.6
Kinshasa	5.4	5.6	7.7	7.6	3.3	0.8	0.5	2.3	4.6	6.5	9.1	8.9
Kisangani	2.1	3.3	7.0	6.2	5.4	4.5	5.2	6.5	7.2	8.6	7.8	3.3

Source: AID, 1977.

Distribution of rainfall (mm)



Shown below is the Papadakis climatic map of Africa. The accompanying key provides data on climatic characteristics of areas representative of the climatic regions of Zaire as shown on the map.



Characteristics of representative climatic regions

Tropical

1.1 Humid semihot equatorial - Yangambi, Zaire

Winter type - Warm enough for equatorial crops such as rubber and coconut.
Summer type - Warm enough for cotton.
Annual rainfall - 1710 mm.
Annual evapotranspiration - 1130 mm 1/
Leaching rainfall in humid season - 580 mm 2/
Humid season - March to December. 3/
Dry season - None. 3/

1.2 Humid semihot tropical - Brazzaville, Congo

Winter type - Colder but frostless, too warm for cryophilous plants (wheat)
Summer type - Warm enough for cotton.
Annual rainfall - 1450 mm.
Annual evapotranspiration - 1360 mm
Leaching rainfall in humid season - 500 mm
Humid season - October to April.
Dry season - July to September.

1.4 Hot tropical - Kaduna, Nigeria

Winter type - Colder but frostless, too warm for cryophilous plants (wheat)
Summer type - Warm enough for cotton, summer days very hot.
Annual rainfall - 1250 mm
Annual evapotranspiration - 2050 mm
Leaching rainfall - 600 mm
Humid season - June to September.
Dry season - November to April.

1.7 Humid tierra templada - Kampala, Uganda

Winter type - Colder but frostless, too warm for cryophilous plants (wheat)
Summer type - Warm enough for maize and cotton, nights cool but frostless, good for coffee growing.
Annual rainfall - 1150 mm
Annual evapotranspiration - 1030 mm
Leaching rainfall in humid season - 240 mm
Humid season - March-June, August-December.
Dry season - None.

1/ Potential evapotranspiration is computed month by month on the basis of the maximum daily air saturation deficit by the Papadakis formula.

2/ Leaching rainfall is rainfall minus potential evapotranspiration during the humid season.

3/ A month is "humid" when rainfall exceeds evapotranspiration, it is "dry" when rainfall plus the water stored in the soil covers less than half of the potential evapotranspiration, and "intermediate" when it is neither dry nor humid.

Tierra Fria (possibility of frost)

2.1 Semitropical tierra fria - Broken Hill, Zambia

Winter type - Frost a possibility, but mild enough for citrus, marginal for cryophilous plants.
Summer type - Warm enough for maize and cotton, nights cool but frostless, good for coffee growing.
Annual rainfall - 920 mm
Annual evapotranspiration - 1360 mm
Leaching rainfall in humid season - 470 mm
Humid season - December-March.
Dry season - May-October.

2.2 Low tierra fria - Tananarive, Madagascar

Winter type - Frost a possibility, cool enough for cryophilous plants, but mild enough for citrus.
Summer type - Warm enough for maize and cotton, nights cool but frostless, good for coffee growing.
Annual rainfall - 1340 mm
Annual evapotranspiration - 1000 mm
Leaching rainfall in humid season - 730 mm
Humid season - November-March.
Dry season - June-September.

Appendix 4 - Soils

Shown below is a soil map of Zaire, from the FAO Soil Map of Africa, illustrating the distribution of the dominant soil types throughout the country, followed by a key to the map.

Key to Soil Map

Soil Symbol: Dominant soils, textural class of the dominant soils; associated soils; slope class of the soil association.

Cambisols (163,000 ha)

1. Be52-2/3a: Eutric Cambisols, medium-fine textured; Chromic Cambisols, with Pellic Vertisols; level to undulating.
   Extension: 153,000 ha.
   Vegetation: Tropical semi-deciduous rain forest.
   Lithology: Quaternary alluvial deposits.

2. Bk25-2a: Calcic Cambisols, medium textured; Eutric Cambisols, with Pellic Vertisols and Eutric Planosols; level to undulating.
   Extension: 10,000 ha.
   Vegetation: Highland dry savanna.
   Lithology: Quaternary alluvial deposits.

Ferralsols (137,935,000 ha)

3. Fh4-3bc: Humic Ferralsols, fine textured; Orthic Ferralsols and Humic Nitosols, with Humic Gleysols; rolling to hilly and steeply dissected to mountainous.
   Extension: 997,000 ha.
   Vegetation: Tropical semi-deciduous rain forest.
   Lithology: Basement complex: orthogneiss, granite, migmatite, amphibolite, schist, quartzite, cipolin; granitic batholiths.

4. Fh8-3b: Humic Ferralsols, fine textured; Humic Nitosols, with Gleysols.
   Extension: 447,000 ha.
   Vegetation: Tropical semi-deciduous montane forest.
   Lithology: Basement complex: granitic gneiss, migmatite, schist, quartzite; granitic batholiths.

5. Fo2-2ab: Orthic Ferralsols, medium textured; Ferralic Arenosols; level to undulating and rolling to hilly.
   Extension: 63,000 ha.
   Vegetation: Large-leaved semi-deciduous tree savanna and moist savanna.
   Lithology: Precambrian: granitic gneiss, migmatite, schist, quartzite, syenite, dolerite; granitic batholiths.

6. Fo28-3ab: Orthic Ferralsols, fine textured; Dystric Gleysols; level to undulating and rolling to hilly.
   Extension: 55,581,000 ha.
   Vegetation: Tropical lowland and tropical semi-deciduous rain forest, miombo, and moist savanna.
   Lithology: Basement complex: gneiss, migmatite, schist, quartzite, amphibolite, micaschist, dolerite, syenite; granitic batholiths; limestone, dolomite, and shale sometimes overlain with polymorphic sandstone.

7. Fo51-3a: Orthic Ferralsols, fine textured; Dystric Nitosols; level to undulating.
   Extension: 1,859,000 ha.
   Vegetation: Tropical semi-deciduous rain forest.
   Lithology: Basement complex: granitic gneiss, migmatite, schist, quartzite; granitic batholiths.

8. Fo54-2/3ab - Orthic Ferralsols, medium-fine textured; Dystric Nitosols, with Xanthic Ferralsols and Plinthic Ferralsols; level to undulating and rolling to hilly.
   Extension: 789,000 ha.
   Vegetation: Tropical lowland rain forest.
   Lithology: Precambrian: apyqtallile schist, quartzite, greenstone; granite and diorite intrusives.

9. Fo55-2/3ab: Orthic Ferralsols, medium-fine textured; Eutric Nitosols, with Rhodic Ferralsols and Plinthic Ferralsols; level to undulating and rolling to hilly.
   Extension: 1,352,000 ha.
   Vegetation: Tropical semi-deciduous rain forest.
   Lithology: Precambrian: calcereous schist, dolomite, conglomerate, and tillite.

10. Fo66-2/3b: Orthic Ferralsols, medium-fine textured; Rhodic Ferralsols, with Xanthic Ferralsols, Arenosols, and Lithosols; rolling to hilly.
    Extension: 885,000 ha.
    Vegetation: Tropical semi-deciduous rain forest.
    Lithology: Precambrian: gneiss, schist, quartzite, dolerite, syenite.

11. Fo76-2/3a: Orthic Ferralsols, medium-fine textured; Xanthic Ferralsols, with Gleysols, Lithosols, and Nitosols; level to undulating.
    Extension: 875,000 ha.
    Vegetation: Miombo forest.
    Lithology: Basement complex: granitic gneiss, migmatite, schist, quartzite, limestone, dolomitic shale, sandstone, shale, arkose; granitic batholiths.

12. Fo78-2/3a: Orthic Ferralsols, medium-fine textured; Humic Ferralsols and Xanthic Ferralsols, with Fluvisols and Gleysols; level to undulating.
    Extension: 70,000 ha.
    Vegetation: Miombo forest.
    Lithology: Basement complex: granitic gneiss, migmatite, schist, quartzite, limestone, dolomitic shale, sandstone, shale, arkose; granitic batholiths.

13. Fo86-3ab: Orthic Ferralsols, fine textured; Xanthic Ferralsols, with Rhodic Ferralsols, Gleysols, and Nitosols; level to undulating and rolling to hilly.
    Extension: 1,879,000 ha.
    Vegetation: Tropical semi-deciduous rain forest and miombo.
    Lithology: Precambrian: calcereous schist, dolomite, conglomerate, tillite. Quaternary: alluvial and lacustrine deposits.

14. Fr2-2/3b: Rhodic Ferralsols, medium-fine textured; Lithosols and Dystric Regosols, with Humic Ferralsols; rolling to hilly.
Extension: 139,000 ha.
Vegetation: Tropical semi-deciduous rain forest.
Lithology: Precambrian: schist, quartzite, syenite, and dolerite.

15. Fr14-3a: Rhodic Ferralsols, fine textured; Orthic Ferralsols, with Plinthic Ferralsols and Gleysols; level to undulating.
Extension: 8,859,000 ha.
Vegetation: Miombo forest.
Lithology: Precambrian: limestone and dolomitic shale, schist, quartzite, sandstone, shale, arkose; granitic batholiths.

16. Fr14-3ab: Rhodic Ferralsols, fine textured; Orthic Ferralsols, with Plinthic Ferralsols and Gleysols; level to undulating and rolling to hilly.
Extension: 7,375,000 ha.
Vegetation: Tropical semi-deciduous rain forest and miombo forest.

17. Fx10-2a: Xanthic Ferralsols, medium textured; Orthic Ferralsols, with Gleysols; level to undulating.
Extension: 18,716,000 ha.
Vegetation: Tropical lowland rain forest.
Lithology: Continental Intercalaire: sandstone, shale, conglomerate. Neogene and Quaternary: alluvial, lacustrine, and aeolian deposits.

18. Fx16-2a: Xanthic Ferralsols, medium textured; Plinthic Ferralsols, with Orthic Ferralsols and Gleysols; level to undulating.
Extension: 212,000 ha.
Vegetation: Miombo forest.
Lithology: Precambrian: gneiss, schist, quartzite, dolerite, and syenite.

19. Fx21-2ab: Xanthic Ferralsols, medium textured; Orthic Ferralsols, Rhodic Ferralsols, and Cambic Arenosols, with Gleysols and Plinthic Ferralsols; level to undulating and rolling to hilly.
Extension: 202,000 ha.
Vegetation: Miombo forest.
Lithology: Polymorphic sandstone: consolidated and unconsolidated sand.

20. Fx26-1a: Xanthic Ferralsols, coarse textured; Ferralic Arenosols, with Dystric Gleysols and Cambic Arenosols; level to undulating.
Extension: 44,535,000 ha.
Vegetation: Tropical lowland and tropical semi-deciduous rain forest.
Lithology: Continental intercalaire: sandstone, shale, conglomerate, mostly overlain with Quaternary alluvial and lacustrine deposits.

21. Fx26-1/2a: Xanthic Ferralsols, coarse-medium textured; Ferralic Arenosols, with Dystric Gleysols and Cambric Arenosols; level to undulating.
Extension: 2,998,000 ha.
Vegetation: Miombo forest.
Lithology: Polymorphic sandstone: consolidated and unconsolidated sand.

22. Fx27-2a: Xanthic Ferralsols, medium textured; Plinthic Ferralsols and Gleysols, with Fluvisols; level to undulating.
Extension: 6,477,000 ha.
Vegetation: Tropical lowland rail forest.
Lithology: Quaternary alluvial and lacustrine deposits.

Gleysols (12,036,000)

23. Gd14-2a: Dystric Gleysols, coarse textured; Plinthic Gleysols and Dystric Fluvisols, with Dystric Histosols; level to undulating.
Extension: 9,495,000 ha.
Vegetation: Regularly inundated tropical forest and tropical swamp forest.
Lithology: Quaternary alluvial and lacustrine deposits.

24. Ge33-2/3a: Eutric Gleysols, medium-fine textured; Eutric Fluvisols, with Humic Gleysols and Eutric Histosols; level to undulating.
Extension: 1,199,000 ha.
Vegetation: Reed swamps.
Lithology: Quaternary alluvial and lacustrine deposits.

25. Gh11-2a: Humic Gleysols, medium textured; Xanthic Ferralsols and Dystric Histosols; level to undulating.
Extension: 1,342,000 ha.
Vegetation: Regularly inundated tropical forest and tropical swamp forest.
Lithology: Quaternary alluvial and lacustrine deposits.

Lithosols (361,000 ha)

26. I-c: Lithosols; steeply dissected to mountainous.
Extension: 46,000 ha.
Vegetation: Tropical semi-deciduous montane forest.
Lithology: Precambrian: schist, gneiss, amphibolite, charnockite, quartzite, cipolin.

27. I-Re-Tm-a: Lithosols, Eutric Regosols, Mollic Andosols; level to undulating.
Extension: 308,000 ha.
Vegetation: Tropical semi-deciduous montane forest.
Lithology: Effusive rocks: basalt, rhyolite, dacite, trachyte, pyroclastics, tuff.

28. I-U-c: Lithosols, Rankers; steeply dissected to mountainous.
Extension: 7,000 ha.
Vegetation: Tropical semi-deciduous montane forest.
Lithology: Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, tuff.

Fluvisols (83,000 ha)

29. Je2-2/3a: Eutric Fluvisols, medium-fine textured; level to undulating.
Extension: 30,000 ha.
Vegetation: Inundated savanna.
Lithology: Recent alluvial and coastal deposits.

30. Je10-2/3a: Eutric Fluvisols, medium-fine textured; Regosols; level to undulating.
Extension: 53,000 ha.
Vegetation: Mangroves.
Lithology: Recent alluvial and coastal deposits.

Luvisols (53,000 ha)

31. Lf29-1a: Ferric Luvisols, coarse textured; with Eutric Gleysols, Eutric Regosols, and Pellic Vertisols; level to undulating.
Extension: 20,000 ha.
Vegetation: Dry savanna.
Lithology: Quaternary alluvial and lagoonal deposits.

32. Lf33-1a: Ferric Luvisols, coarse textured; with Orthic Acrisols and Eutric Cambisols; level to undulating.
Extension: 33,000 ha.
Vegetation: Dry savanna.
Lithology: Cretaceous: sandstone, marl, and limestone.

Nitosols (39,539,000)

33. Nd1-3a: Dystric Nitosols, fine textured; level to undulating.
Extension: 1,627,000 ha.
Vegetation: Tropical lowland rain forest.
Lithology: Jurassic sandstone.

34. Nd13-3bc: Dystric Nitosols, fine textured; Eutric Nitosols, with Lithosols; rolling to hilly and steeply dissected to mountainous.
Extension: 331,000 ha.
Vegetation: Tropical semi-deciduous forest.
Lithology: Basement complex: mpthmeleiqq, granite, migmatite, amphibolite, schist, quartzite, and cipolin.

35. Nd23-3c: Dystric Nitosols, fine textured; Orthic Ferralsols, with Humic Acrisols; steeply dissected to mountainous.
Extension: 215,000 ha.
Vegetation: Tropical lowland rain forest.
Lithology: Precambrian: crystalline schist, quartzite, greenstone; granite and diorite intrusives.

36. Nd39-3bc: Dystric Nitosols, fine textured; with Lithosols and Eutric Gleysols; rolling to hilly and steeply dissected to mountainous.
Extension: 335,000 ha.
Vegetation: Highland dry savanna.
Lithology: Effusive rocks: basalt, rhyolite, dacite, trachyte, pyroclastics, and tuff.

37. Nd40-3b: Dystric Nitosols, fine textured; with Eutric Gleysols and Plinthic Gleysols; rolling to hilly.
Extension: 4,536,000 ha.
Vegetation: Tropical lowland and tropical semi-deciduous rain forest.
Lithology: Precambrian: sandstone, quartzite, calcareous schist. Carboniferous: tillite, shale, slate, sandstone.

38. Nd41-3b: Dystric Nitosols, fine textured; Orthic Ferralsols, with Gleysols; rolling to hilly.
Extension: 729,000 ha.
Vegetation: Tropical lowland rain forest.
Lithology: Jurassic sandstone.

39. Nd42-3b: Dystric Nitosols, fine textured; Orthic Ferralsols, with Dystric Cambisols and Gleysols; rolling to hilly.
Extension: 6,109,000 ha.
Vegetation: Tropical lowland rain forest.
Lithology: Precambrian: gneiss, amphibolite, quartzite, micaschist, sandstone, calcareous schist; granitic batholiths.

40. Nd43-2/3a: Dystric Nitosols, medium-fine textured; Orthic Ferralsols and Dystric Gleysols, with Dystric Fluvisols; level to undulating.
Extension: 2,286,000 ha.
Vegetation: Tropical lowland rain forest.
Lithology: Jurassic: sandstone. Karroo: sandstone, conglomerate, and siltstone.

41. Nd44-2/3a: Dystric Nitosols, medium-fine textured; Orthic Ferralsols and Arenosols; level to undulating.
Extension: 15,876,000 ha.
Vegetation: Tropical lowland rain forest, miombo forest, and moist savanna.
Lithology: Carboniferous: tillite, shale, slate, sandstone. Karroo: sandstone, conglomerate and siltstone partly covered with continental intercalaire.

42. Ne27-2b: Eutric Nitosols, medium textured; Humic Nitosols and Dystric Regosols, with Lithosols; rolling to hilly.
Extension: 630,000 ha,
Vegetation: Large-leaved semi-deciduous tree savanna and moist savanna.
Lithology: Precambrian: schist, gneiss, amphibolite, charnockite, quartzite, and cipolin.

43. Ne35-2/3ab: Eutric Nitosols, medium-fine textured; Orthic Ferralsols, with Plinthic Acrisols and Plinthic Ferralsols; level to undulating and rolling to hilly.
Extension: 418,000 ha.
Vegetation: Tropical lowland and tropical semi-deciduous rain forest.
Lithology: Precambrian: sandstone, quartzite, calcareous schist.

44. Nh5-2/3c: Humic Nitosols, medium-fine textured; Humic Cambisols. with Lithosols; steeply dissected to mountainous.
Extension: 3,472,000 ha.
Vegetation: Tropical semi-deciduous montane forest and highland dry savanna.
Lithology: Precambrian: schist, gneiss, amphibolite, charnockite, quartzite, cipolin, sandstone, calcareous schist.

45. Nh6-2/3c: Humic Nitosols, medium-fine textured; Orthic Ferralsols, with Dystric Cambisols; steeply dissected to mountainous.
Extension: 828,000 ha.
Vegetation: Tropical semi-deciduous montane forest and highland dry savanna.
Lithology: Basement complex: orthogneiss, granite, migmatite, amphibolite, schist, quartzite, sandstone, calcareous schist.

46. Nh7-2/3c: Humic Nitosols, medium-fine textured; Humic Ferralsols and Orthic Ferralsols, with Lithosols; steeply dissected to mountainous.
Extension: 2,147,000 ha.
Vegetation: Tropical semi-deciduous montane forest, highland dry savanna, and miombo forest.
Lithology: Precambrian: shale, sandstone, conglomerate, phyllite, schist, quartzite, gneiss, amphibolite, micaschist.

Histosols (40,000 ha)

47. Oe3-a: Eutric Histosols; Gleysols, with Eutric Fluvisols; level to undulating.
Extension: 40,000 ha.
Vegetation: Reed swamps.
Lithology: Quaternary lacustrine deposits.

Arenosols (24,141,000 ha)

48. Qc24-1a: Cambic Arenosols, coarse textured; Regosols, with Gleysols and Podzols; level to undulating.
Extension: 806,000 ha.
Vegetation: Miombo forest and dry savanna.
Lithology: Precambrian: limestone, dolomitic shale, schist, quartzite, sandstone, shale, arkose. Polymorphic sandstone: consolidated and unconsolidated sands.

49. Qf21-1a: Ferralic Arenosols, coarse textured; Ferric Acrisols and Dystric Regosols; level to undulating.
Extension: 53,000 ha.
Vegetation: Tropical semi-deciduous rain forest.
Lithology: Precambrian: dolomitic limestone, calcareous schist, sandstone.

50. Qf22-1a: Ferralic Arenosols, coarse textured; with Ferric Luvisols, Orthic Ferralsols, and Orthic Acrisols; level to undulating.
Extension: 729,000 ha.
Vegetation: Dry savanna.
Lithology: Precambrian: limestone, dolomitic shale, schist, quartzite, sandstone, shale, arkose.

51. Qf23-1a: Ferralic Arenosols, coarse textured; Luvic Arenosols, with Regosols, Orthic Ferralsols, and Rhodic Ferralsols; level to undulating.
Extension: 1,203,000 ha.
Vegetation: Miombo forest.
Lithology: Kalahari: sand, ironstone, chalcedony. Quaternary: lacustrine sediments.

52. Qf25-1a: Ferralic Arenosols, coarse textured; Regosols; level to undulating.
Extension: 305,000 ha.
Vegetation: Tropical lowland rain forest and moist savanna.
Lithology: Kalahari: sand, chalcedony, ironstone, lacustrine sediments. Precambrian: calcareous schist, dolomite, conglomerate, tillite. Polymorphic sandstone and continental intercalaire: sandstone, shale, and conglomerate.

53. Qf26-1a: Ferralic Arenosols, coarse textured; Regosols and Albic Arenosols, with Gleysols and Podzols; level to undulating.
Extension: 16,566,000 ha.
Vegetation: Tropical lowland and tropical semi-deciduous rain forest, miombo forest, and moist savanna.
Lithology: Continental intercalaire: sandstone, shale, conglomerate. Polymorphic sandstone: consolidated and unconsolidated sands.

54. Qf27-1/2ab: Ferralic Arenosols, coarse-medium textured; Orthic Ferralsols, with Regosols and Gleysols; level to undulating and rolling to hilly.
Extension: 119,000 ha.
Vegetation: Moist savanna.
Lithology: Continental intercalaire: sandstone, shale, conglomerate. Polymorphic sandstone and sands.

55. Qf29-1a: Ferralic Arenosols, coarse textured; Ferralsols; level to undulating.
Extension: 33,000 ha.
Vegetation: Miombo forest.
Lithology: Polymorphic sandstone.

56. Qf34-1/2b: Ferralic Arenosols, coarse-medium textured; Orthic Ferralsols, with Gleysols; rolling to hilly.
Extension: 4,310,000 ha.
Vegetation: Miombo forest.
Lithology: Precambrian: gneiss, amphibolite, quartzite, micaschist, sandstone, schist, qyelite, dolomite.

57. Qf36-1a: Ferralic Arenosols, coarse textured; Xanthic Ferralsols and Luvic Arenosols, with Ferralic Cambisols, Dystric Fluvisols, and Dystric Gleysols; level to undulating.
Extension: 17,000 ha.
Vegetation: Dry savanna.
Lithology: Neogene sands and marl.

Regosols (143,000 ha)

58. Rd15-1/2b: Dystric Regosols, coarse-medium textured; Ferralic Arenosols; rolling to hilly.
Extension: 143,000 ha.
Vegetation: Tropical semi-deciduous rain forest.
Lithology: Polymorphic sandstone: consolidated fine sandstone. Continental intercalaire: sandstone, shale, and conglomerate.

Andosols (454,000 ha)

59. Tm8-2/3c: Mollic Andosols, medium-fine textured; Eutric Cambisols and Eutric Nitosols, with Gleysols; steeply dissected to mountainous.
Extension: 391,000 ha.
Vegetation: Tropical semi-deciduous montane forest.
Lithology: Pyroclastic rocks, tuff, and ashes.

60. Tm9-2c: Mollic Andosols, medium textured; Lithosols, with Eutric Fluvisols and Histosols; steeply dissected to mountainous.
Extension: 33,000 ha.
Vegetation: Tropical semi-deciduous rain forest.
Lithology: Tertiary-recent volcanics: basalt, phonolite, nephelinite, pyroclastics, and tuff.

61. Tm14-1/2c: Mollic Andosols, coarse-medium textured; Humic Cambisols and Eutric Regosols, with Lithosols; steeply dissected to mountainous.
Extension: 40,000 ha.
Vegetation: Highland dry savanna.
Lithology: Pyroclastic rocks, tuff, and ashes.

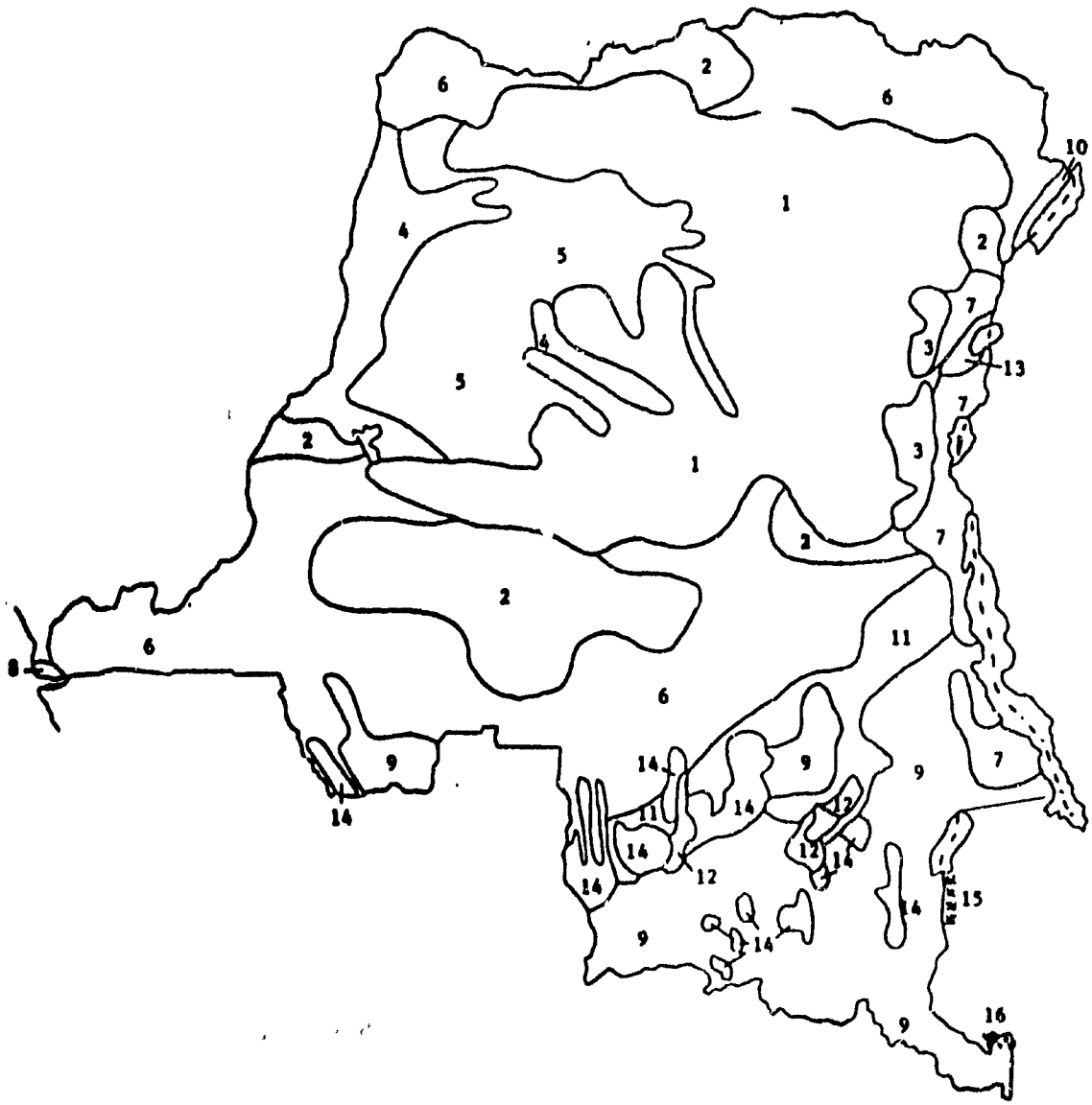
Vertisols (899,000 ha)

62. Vp46-3a: Pellic Vertisols, fine textured; Mollic Solonchaks, with Gleysols; level to undulating.
Extension: 587,000 ha.
Vegetation: Moist and inundated savanna.
Lithology: Quaternary alluvial deposits.

63. Vp50-3a: Pellic Vertisols, fine textured; Chromic Vertisols, with Eutric Gleysols and Eutric Fluvisols; level to undulating.
Extension: 312,000 ha.
Vegetation: Dry savanna.
Lithology: Precambrian: Limestone, dolomitic shale, schist, quartzite, sandstone, shale, and arkose.

Appendix 5 - Biogeographical Map of Zaire

The figure and accompanying key below provide a general description of the distribution of vegetation in Zaire. 1/



1/ Based on IUCN, 1979.

Key to Figure

Tropical Rain Forest

The tropical lowland rain forest of Zaire forms part of the Guineo-Congolian floristic region, a belt of tropical rain forest stretching from Sierra Leone to the Rift Valley and occuring on drained sites throughout most of the region. The annual rainfall is between 1200 mm for the drier types and up to more than 3000 mm for the wetter types. The tropical rain forest belt consists of a continuous stand of trees of several strata, including an upper stratum of large trees which may be 50-60 m high. Although it shows differences in its floristic composition and certain variations in structure, its most remarkable feature is its floristic and physiognomic uniformity.

1 Guineo-Congolian moist evergreen lowland rain forest.

This forest type, which originally covered 40-50% of the country, is scattered in small islands of a few hectares throughout the moist semi-evergreen lowland rain forest in a broad aureole surrounding the central basin.

2 Guineo-Congolian moist semi-evergreen lowland rain forest

This type forms a belt around the central basin, occuring in areas where annual rainfall ranges between 1600 and 2000 mm. Different types occur in the north and south. The flora is very rich with, among the larger trees: Meliaceae (Entandrophragma angolense, E. candollei, E. utile, Guarea cedrata, G. thompsonii, Lovoa trichilioides); Myristicaceae (Coelocaryon preussii); and Chrysobalanaceae (Maranthes glabra). Species that are particularly significant in the Zaire Basin include Oxystigma oxyphyllum and Scorodophleus zenkeri. It is possible that all the semi-evergreen forest is secondary.

3 Afro-montane and transitional rain forest

Occurs on wetter slopes of most high mountains between 1000 and 2500 m. Most species are endemics but belong to characteristic Guineo-Congolian genera. This species type differs physiognomically from lowland rain forest by the occurence of tree ferns (Cyathea spp.) and a few conifers (Podocarpus spp.).

4 Swamp forest

Zaire has more extensive swamp forest than any other country in Africa. Permanent swamp forest is very rich in species. Its canopy is rather open and the tallest trees grow up to 40 m high. Characteristic species include Entandrophragma palustre.

5 Mosaic of swamp forest and evergreen lowland rain forest

6 Guineo-Congolian lowland rain forest - secondary grassland mosaic

Rain forest to the north and south of the central basin is replaced with an abrupt transition to tall grassland. It is generally assumed that this grassland has been derived from the clearing of rain forest for the planting of crops. Grass may invade land that is left to revert to bush fallow, especially where the soil is poor and the fallow period short. It occurs more readily on sandy than on heavier soils and in drier than in wetter regions. If fire resistant species are available, they will colonize the secondary grassland into wooded grassland. These grasslands are dominated by Pancium maximum, Pennisetum purpureum, and Imperata cylindrica.

7 Montane forest - secondary grassland mosaic

8 West African coastal mosaic

Fringing (gallery) forest (not shown on the map)

Fringing forests occur along the banks of larger rivers and are rarely completely evergreen.

Woodland

9 Wetter Zambezian miombo woodland

This forest type occurs in southeastern Zaire, comprising 11% of total land area. Typical miombo contains species of Brachystegia, Julbernardia, and often Isoberlinia. Its distribution is partly determined by climate and partly by soil. Throughout its range, the climate is markedly seasonal with a dry season of 5 to 6 months during which mists do not occur and with annual rainfall between 750-1500 mm. Most miombo woodlands are deciduous. The tree layer is characterized by its light covering and slight density. The trunks are short and twisted; there are no buttresses except in the case of Marquesia macroura, so that well-formed logs are rare.

The miombo is generally not considered as a climatic climax, but is a fire climax. The climatic climax is the very rare and disappearing dense dry forest called "muhulu." Wood cutting and fire have changed it into miombo woodland; and this fire climax still covers 85% of Upper Shaba but is being replaced by savannas. The three stages of this regressive series (dense dry forest-open woodland-savanna) are often referred to as the muhulu-miombo-savanna regression. Savanna formation increases the mean annual temperature, its mean daily amplitude, and decreases the relative humidity. Such changes, on a large scale, may modify the regional climate and the water balance. Moreover, savanna is less effective in protecting the soil than is forest and woodland.

Fire in this region is almost always started by man. Generally it takes place once a year during the dry season (May to September). Early burning (before the end of June) is less intense and less destructive to woody plants than late burning when the grass is drier and there is more tree litter on

the ground and when regrowth may have commenced. Some areas may remain unburnt for one or several years; young trees and climbers grow in these. Burning experiments carried out at Ndola and Lubumbashi show the following species groups: 1/

Fire tolerant species: Parinari curatellifolia, Erythrophleum africanum, Pterocarpus angolensis, Anisophyllea boehmii, Diplorhynchus condylocarpon, Combretum spp., Ochna schweinfurthiana, Ochthocosmus lemairearus, Strychnos innocua, S. cocculoides, S. spinosa, Maprounea africana, Hymenocardia acida, Syzygium guineense subsp. macrocarpum, and Uapaca nitida;

Semi-tolerant species: Baphia bequaertii, Pseudolachnostylis maprouneifolia, Strychnos pungens, Isoberlinia angolensis, Uapaca kirkiana, Bridelia cathartica, Hexalobus monopetalus, Xylopia odoratissima, and Uapaca pilosa;

Fire-tender species: the woodland canopy dominant species of Brachystegia and Julbernardia, Chrysophyllum bangweolense, Garcinia huillensis, and Bridelia duvigneaudii.

10 Undifferentiated Sudanian woodland

Most of the region has been inhabited for centuries and practically all the vegetation has been deeply modified by cultivation, cutting, grass fires, and grazing. Woodland remains only on rocky hills and ironstone plateaux. Larger trees are 8 to 12 m high and typical species include: Anogeissus leiocarpus, Balanites aegyptiaca, Lannea microcarpa, Prosopis africana, and Sclerocarya birrea. The lower tree stratum, about 6 m tall with short boles, includes: Combretum glutinosum, Strychnos spinosa, and Terminalia avicennioides.

Woodland and Transition Mosaic

11 Wetter Zambezian miombo woodland - secondary grassland mosaic

12 Acacia polycantha secondary wooded grassland

Bushland and Thicket Mosaics

13 East African evergreen bushland - Acacia wooded grassland mosaic

Edaphic Grassland

14 Edaphic grasslands on Kalahari sands

Occurs on the Kalahari sands in southern Zaire. The plateau, made up of flat inter-drainages between tributaries of the Zaire River, consists of the mantle of Kalahari sands which locally are waterlogged in the rainy season and dry out in the dry season. Dominant grasses are Loudetia sim-

1/ Unesco, 1978.

plex and Monocymbium ceresiiforme, with species of Eragrostis, Aristida, and Cyperaceae.

Grasslands on heavy metal soils (not identified on the map)

These occur in Katanga and adjacent parts of Zaire where the miombo woodland is broken up by grassy depressions (dambos) and certain hills without, or with very sparse, woody cover. The absence of trees is due to the presence of toxic amounts of heavy metals in the soil, especially copper, cobalt, nickel, and uranium. Characteristic species include Loudetia simplex, Monocymbium ceresiiforme, and Diheteropogon filifolius.

Edaphic Grassland Mosaics

15 Semi-aquatic Vegetation - Edaphic Grassland Mosaic

Azonal Vegetation

16 Semi-aquatic Vegetation

Appendix 6 - National Committee for the Man and the Biosphere Programme

Chairman	Citoyenne LESSEDJINA KIABA LEMA Commissaire d'Etat a l'Environnement, Conservation de la Nature et Tourisme B.P. 12348 Kinshasa 1
Vice-Chairman	Citoyen MANGWAYA BUKUKU Directeur General Departement de l'Environnement, Conservation de la Nature et Tourisme B.P. 12348 Kinshasa 1
Secretary	Citoyen MBUSU NGAMANI Conseiller au Departement de l'Environnement, Conservation de la Nature et Tourisme B.P. 12348 Kinshasa 1
Assistant Secretary	Citoyen LUANIKA NGABU Secretaire General Adjoint Commission National du Zaire pour l'Unesco Education Nationale B.P. 32 Kinshasa/Gombe
Members	Dr. KAKYESSE ONFINE Delegue General a l'Institut Zairois pour la Conservation de la Nature B.P. 4019 Kinshasa 2
	VUVU UMBA di SOLO Directeur de la Politique Scientifique a l'I.R.S. B.P. 3474 Kinshasa 1
	KANKONDE MBUYI Directeur Adjoint Bireau d'Etudes et d'Amenagement Urbain B.P. [illegible] Kinsh[illegible]
	KHONDE [illegible]MBA Chimiste, Service Presidentiel d'Etudes B.P. 9797 Kinshasa 1

LUMU BANDIMAYI
Directeur, Division Chimie-Physique
CREN
B.P. 868
Kinshasa 11

SHAJE TSHILUILA
Anthropologue
Institut des Musees Nationaux
B.P. 13933
Kinshasa 1

SENDWE KASONGO ILUNGA
Charge du Programme ERTS-ZAIRE
Bureau du President
B.P. 3092
Kinshasa

PINI NSAKALA
Sous Directeur
Centre Meteo/Binza
B.P. 4715
Kinshasa 2

Dr. MATUNDU NZITA
Directeur de l'Hygiene Ville
B.P. 120
Kinshasa 1

BEBI DI MANSONI
Delegue General
Institut des Jardins Zoologiques et
Botaniques du Zaire
B.P. 5533
Kinshasa/Gombe

Appendix 7 - Zairian Participants at the Twelfth General Assembly of the International Union for Conservation of Nature and Natural Resources - Kinshasa, 1975

ABOU-ASSAF, Sonia
Universite Nationale du Zaire
B.P. 1825
Lubumbashi

ABRIQUE, L.
Universite Nationale du Zaire
B.P. 854
Kinshasa

AYOBANGIRA, Samura
Institut National d'Etudes et de Recherches Agronomiques
B.P. 1513
Kisangani

M. BAITO
106, Av. Buta
Zone de Kinshasa
Kinshasa

BANGONDA, Isiwawa
Av. des Bourgmiestre 192
Kinshasa-Gombe

BATOKA-FUNZI, Muanda
Departement des Affaires Etrangeres et de la Cooperation Internationale
Kinshasa

BEBY, di Mantsoni
Kinshasa Zoo
B.P. 2122
Kinshasa I

M. BIANGANI
Universite Nationale du Zaire
B.P. 145
Kinshasa

M. BIGOHE
Parc National de la Garamba
B.P. 3
Faradje, Haut-Zaire

BOLIYA, Le-lo-te Ndokwe
Bureau Politique du M.P.R.
B.P. 7715
Kinshasa I

BOURGEOIS, Monique
Universite Nationale du Zaire
B.P. 3106
Lubumbashi

BREYNE, Herman
Institut National d'Etudes et de de Recherches Agronomiques
1, Av. Batetela
Kinshasa

CRABBE, Marcel
Service Meteorologique
Kinshasa-Binza

M. DIMOLEYELE
ISIRO-DUNGU-ANGO
B.P. 4019
Kinshasa II

EKAMBO, Duasenge
Agence France Presse
142B Boulevard du 30 Juin
Kinshasa

EYENGA, Sana
Revue Zaire
12/C Av. Ruakadingi
Kinshasa

FRANSSEN, J.
Universite Nationale du Zaire
B.P. 758
Kinshasa XI

VAN HOWE, Charles
Universite Nationale du Zaire
B.P. 115
Kinshasa

KABALA, Matuka
Departement de l'Environnement
B.P. 11239
Kinshasa

KABEYA, Mpoyi
Universite Nationale du Zaire
B.P. 801
Kinshasa

KABEYA, Mukenyi
Direction de l'Environnement
B.P. 4019
Kinshasa II

KALANDA, Kankenza
Universite Nationale du Zaire
B.P. 190
Kinshasa XI

KALENOLA, Tshimbonko Dikungi
A 40, Av. Victoire
Matonge-Kalamu
Kinshasa

KALISA, Mbanda
Universite Nationale du Zaire
B.P. 145
Kinshasa XI

KANIKA, Mwana Ngombo
Hebdo-Zaire
12/C Av. Rwakadingi
Kinshasa

KAWATA, Ashem
Universite Nationale du Zaire
B.P. 13399
Kinshasa

M. KIMPUNGI
Parc National de Kundelungu
B.P. 1950
Lubumbashi

KINZENZI, Yimbu
Hebdo-Zaire
12/C Av. Rwakadingi
Kinshasa

KITAMBALA, Kulubitshi
520 Boulevard du 30 Juin
Kinshasa

KUPUNA, Nzazi
2191 Tuana
Zone Lemba
Kinshasa

KWETUENDA, Menga Kuluki
Office National de la Recherche
et du Developpement
Av. ex comite urbain No. 33
B.P. 3474
Kinshasa

LESSEDJINA, Kiaba Lema
Commissaire d'Etat a
l'Environnement, Conservation
de la Nature et Tourisme
B.P. 4019
Kinshasa II

LISOWSKI, S.
Universite Nationale du Zaire
B.P. 1655
Kisangani

LUBISHI, Mpanya Kampangala
Eaux et Forets
Departement de l'Agriculture
B.P. 8722
Kinshasa

MAKABUZA, Kabirizi
Parcs Nationaux du Shaba
B.P. 598
Likasi

MANKOTO, Ma Mbaelele
Institut Zairois pour la
Conservation de la Nature
B.P. 4019
Kinshasa II

ARS, Avrand
mbassy of France
.P. 7861
inshasa

M. MASINI
Agence Zaire Presse
Kinshasa

MAYALA, Nsebeng-Kimanese
B.P. 4303
Kinshasa-Ngaliema

MBUSU, Ngamani
Division Ecologie de l'Environnement
B.P. 7083
Kinshasa I

M. MOBE
Universite Nationale du Zaire
B.P. 145
Kinshasa

MOKWA, Vankang Izmtsho
Institut Zairois pour la
Conservation de la Nature
B.P. 4019
Kinshasa II

MONGEKE, Litike
Office Nationale de la Recherche
et du Developpement
B.P. 3474
Kinshasa

M. MOSOLO
Recherche Scientifique
Revue Horizon 80
10 A et B Av. Bakongo
Kinshasa-Gombe

MOTA, Bakajika
Eaux et Forets
152 Place de l'Enseignement
Kinshasa

MUAMBI, Shambuyi
Universite Nationale du Zaire
B.P. 30
Yangambi

MUEMA, Ngoy Toka
Bureau du President de la
Republique
B.P. 3092
Kinshasa

MUMBU-MUKUNA, Nontu
Revue Zaire
12/C Av, Rwakadingi
Kinshasa

MUMBI, Lelo
Universite Nationale du Zaire
B.P. 6062
Kinshasa VI

M. MWANA-NGANAO
104 Av. Kabalo
Zone de Kinshasa
Kinshasa

NSIMBA, Meumu Ndongala
Av. Kindu No. 47
Zone de Barumbu
Kinshasa

NZAZI, Kanda
Av. Tumba No. 1785
Zone de Lemba
Kinshasa

NZUMBI, Ndoluvinalu
Institut des Jardins Zoologiques
et Botaniques
B.P. 3220
Kinshasa

NZUNDU, Masembo
Institut Nationale d'Etudes et
de Recherches Agronomiques
B.P. 1513
Kisangani

PAULUS, J. J.
Universite Nationale du Zaire
B.P. 172
Kinshasa

PINI, Nsakala
Service Meteorologique
Kinshasa-Binza

POUVELS, L.
Universite Nationale du Zaire
B.P. 854
Kinshasa