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PHASE 1 ENVIRONMENTAL PROFILE  
OF  
LIBERIA

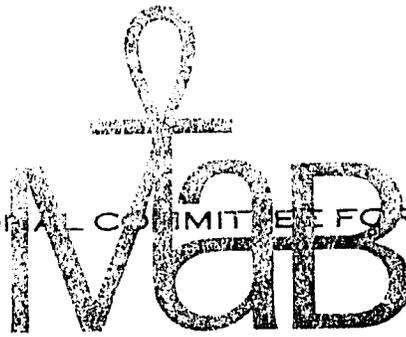
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THE UNITED STATES NATIONAL COMMITTEE FOR MAN AND THE BIOSPHERE



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:

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## PREFACE

This draft environmental report is the result of an 8-week review of information available in the United States on the natural resources and environment of the Republic of Liberia. 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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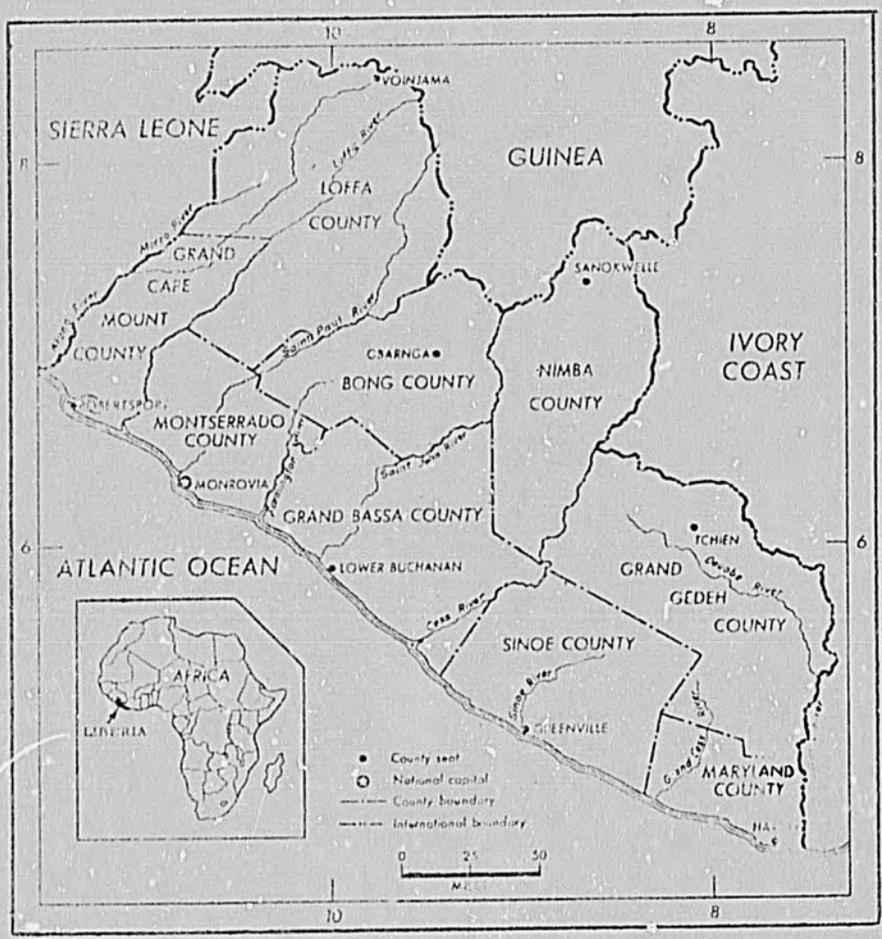


Figure 1. Location and General Map of Liberia.

SUMMARY

The Republic of Liberia is located on the great bulge of Africa's west coast five degrees north of the equator in the tropical zone. The major topographical and biogeographical regions of the country include the coastal plain, the belt of rolling hills, the belt of low mountain ranges and plateaus, and the northern highlands. Liberia lies almost completely within the Guineo-Congolian floristic region, a belt of tropical rain forest stretching from Sierra Leone to the Rift Valley. Rainfall ranges from 2000 to 4500 mm per year, with two short dry seasons for most of the country and a single four-month dry season in the northern section. Liberia's tropical climate favors high forest vegetation. The country is rich in natural resources, notably iron ore, timber, and rubber.

In 1979, Liberia had an estimated total population of 1,776,000. The average annual rate of population growth is estimated at 3.3%. The overall population density of Liberia is relatively low at about 18.5 persons per sq km, but the population is very unevenly distributed. Large parts of the country are still uninhabited or have very scattered populations, especially large sections of the forest belt in the southeastern third of the country and to the west in Lofa County. The proportion of the population living in urban areas is projected to increase from the current level of about 30% to 42% by 2000.

Liberia's renewable natural resource base is coming under increasing pressure due primarily to the effects of forest modification and clearing. Under shifting cultivation, the dominant form of agriculture practiced in Liberia, much if not most of the country's primary forests have been converted to various types of degraded secondary forest, or have been completely cleared. Logging by timber concessions and fuelwood demand constitute the other major causes of forest conversion. Myers (1980) states that these demands on the forest resources of Liberia will likely lead to the complete disappearance of all of the country's remaining primary forests within another ten years at most. Extensive modification or outright clearing of the country's forests is leading to increasing pressures on other renewable natural resources (soils, water, fauna) that exceed sustainable levels.

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

- (i) Development and coordination of legislative and institutional mechanisms for environmental management;
- (ii) Problems associated with unregulated urban expansion, particularly in the capital city of Monrovia, such as the provision of adequate housing and services;
- (iii) Rural water supply and sanitation;
- (iv) Pollution effects of mineral exploitation,

## I. INTRODUCTION

### A. Physical Characteristics

The Republic of Liberia is located on the great bulge of Africa's west coast five degrees north of the equator in the tropical zone. It is bordered by the Atlantic Ocean, Sierra Leone, Guinea, and the Ivory Coast. Liberia has a total land area of approximately 111,370 sq km. The country is rich in natural resources, notably iron ore, timber, and rubber.

#### Geology and Lithology

Liberia lies in the western African basement complex, which forms part of the Precambrian Shield underlying the entire African continent. The shield is an ancient crystalline rock formation that is 2.7 to 3.4 billion years old and composed of granite, gneiss, and schist. In Liberia, the shield has been subjected to intense folding and faulting, and is interspersed with igneous granitic batholiths. Along the coast lie beds of sandstone, while intrusive rock outcrops form such promontories as Cape Mount, Cape Mesurado, and Cape Palmas. Monrovia stands on a ridge of diabase, a basaltic rock. Diabase and gabbro (a dark colored, coarse-grained igneous rock) occur in the interior of the country where, as a result of geological eruptions, they have intruded into fissures in the older rock in long and narrow masses. The Guinean highlands in northern Liberia mark the western edge of the basement complex and are composed of basement rocks.

#### Geography

Liberia has a somewhat complex relief. Contrasts between various parts of the country are primarily a function of this varied relief rather than of any other physical characteristics. The land is well-watered throughout, and a number of narrow, roughly parallel river basins drain the country southwest toward the sea. Although almost all of Liberia was once a region of tropical rain forest, much of the forest along the coast and inland across the center of the country has been modified by cutting, and is either fairly open or covered by secondary woodland. Rainfall decreases progressively from the coast inland, but the yearly pattern is the same. Temperatures are fairly uniform throughout, and there are no great regional differences in the soil. Thus, despite its varied topography, Liberia can be divided into the following four major geographic regions broadly defined in terms of terrain and vegetational distribution: the coastal plain; the belt of rolling hills; the belt of mountain ranges and plateaus; and the northern highlands (see Fig. 2).

The Coastal Plain. The coastal plain averages 40 km in depth and reaches an elevation of between 9 and 30 m. Its sandy surface is flat or very gently rolling with a few isolated hills rising over 46 m. A few points along the shoreline such as Cape Mount, Cape Mesurado, and Cape Palmas have palisades

directly fronting the ocean. Sandstone, beach, and lagoon deposits and fluviatile sediments cover the underlying shield rocks. The surf is normally heavy all along the coast, but is worst at the height of the rainy season. Along the coast are marine lagoons and, a bit inland, mangrove swamps and lagoons formed by estuaries of rivers and streams. There are two types of marine lagoons. The first type is created by the formation of a sand spit which develops between two points on the coastline, thus cutting off a marine waterbody from the ocean. The second type develops under the influence of the ocean tide (the tidal range is moderate). Here the ocean water intrudes onto a flat onshore area through a small, low pass. Behind the pass, outgoing water carries away material from the bottom of the flooded area, carving out an oval-shaped form. Often, other marine conditions will cause the build-up of a beach sandbar that closes off the newly-formed lagoon from the ocean.

The coastal plain is the region of greatest development. Except for some areas in the southeast where the high forest still stands near the sea, almost all of the land has been cleared and is now a mosaic of small farm plots or larger plantations, grassy open spaces, and patches of secondary woodland or thick brush. Bottom lands along the streams are frequently flooded by the rains, and low ground forms many more-or-less permanent swamps.

The Rolling Hills. A belt of rolling hills borders the inner margin of the coastal plain. This region is marked by a distinct transition to a more rugged terrain with a general elevation of 61 to 152 m.

The Mountains and Plateaus. The belt of rolling hills is interrupted by an abrupt change in elevation marked by waterfalls along major streams. Relief is characterized by discontinuous ranges of hills or low mountains, broad, rather shallow valleys, and occasional escarpments or more gradual steps in elevation that break the ground into poorly defined plateaus at irregular distances inland. This region forms the largest part of Liberia. In the western and central parts of the region, the ridge lines between major drainage basins are not prominently defined, but run from the northeast to the southwest in a generally perpendicular line to the coast. However, in the southeast, a major divide crosses the region almost parallel to the coast before turning south to Cape Palmas. Although most of the region is covered by secondary tropical rain forest (with some large stands of virgin forest remaining in the west and southeast), a strip that extends across the center from the direction of Monrovia to the northeast has been denuded of woodlands by continuous clearing and cultivation.

The Northern Highlands. This region, encompassing the northern parts of Lofa and Nimba Counties, extends into the Guinean highlands, which form part of a major watershed between streams that flow across Liberia to the Atlantic Ocean and the great Niger River basin to the northeast. Two important mountain ranges, the Wologizi and the Nimba, dominate this region. The Wologizi Range rises 1000 m above the surrounding terrain, culminating in Mt. Wutuvi at an elevation of 1380 m. These mountains trend northward in the southern part and northeastward in the northern part. The range is approximately 22 km long with spurs extending as much as 5 km on either side of the ridge. Slopes on the ridge are exceedingly steep and in places form sheer cliffs as much as 100 m

high. Bare granitic domes, or inselbergs, that rise with steep sides and rounded tops to as much as 300 m above the surrounding terrain form a distinctive feature in the western and northern parts of the area. East of the Wologizi Range the drainage tends to flow southwest, the major streams following relatively straight courses parallel to foliation, joint, and fault trends. With the exception of the areas cleared for farms, the several small savannas, and the bare inselbergs, the region is covered by dense forest.

The Nimba Range, with an elevation of up to 1372 m, forms part of a mountain chain stretching across Liberia, Guinea, and the Ivory Coast. The Liberian part of the Nimba Range is 20 km long. Except for the Nimba Range and surrounding forested mountainous areas, the land is mostly under intermittent cultivation in small hillside farms. The region is within the drainage basins of the St. John and Cestos Rivers.



Figure 2. Major geographic features of Liberia.

## Climate

South of approximately the fifteenth parallel are east-west climatic regions which become increasingly humid toward the Gulf of Guinea. Most of Liberia falls within the Sudano-Guinean (hot tropical) climatic classification of Aubreville (1949), while the climate along the coast is of the humid equatorial and tropical type, or Guinean zone of Aubreville. This tropical climatic pattern favors high forest vegetation. At present, climatic data are lacking, although it has been reported that instruments for at least one meteorological station are on order.

Liberia's climate is characterized by sustained heat and seasonal rainfall that is heavier than in most regions of West Africa. Since the entire country lies well south of the Tropic of Cancer, days vary less in length and solar radiation received is more intense and uniform than in temperate latitudes. The features of winter and summer mean little; instead, the alternate north-south movements of continental and maritime air masses as they follow the annual migrations of the sun bring about periodic differences in rainfall to distinguish the climatic seasons, although normally every month has some rainfall.

The equatorial low pressure belt, or intertropical front, separates these two air masses of high pressure that circulate over Liberia. The continental air mass is north of the front and has little moisture. Its prevailing northeast wind is the dry, dusty "harmattan" from the Sahara. The maritime air mass south of the front is warm and moist, with prevailing winds from the southwest. The frontal area between these two systems is a belt of instability, with variable winds and calms.

The coastal region has the heaviest annual precipitation, ranging from up to 5080 mm in the northwest to about 2540 mm in the southeast (see Fig. 3). The dry season is very short; temperatures range from 25-27 degrees C and the fluctuation of the temperature is very modest. Inland, precipitation progressively decreases and the climate is characterized by distinct rainy and dry seasons. Each is approximately six months in duration; the rainy season lasting from late April or early May to mid-November, and the dry season from November to April. During the dry season the atmosphere is very stable with little vertical mixing. Haze is prevalent, especially when smoke from land burning is confined within the lower few feet of the atmosphere. Over 80% of the rainfall takes place during the rainy season, when rain squalls increase vertical mixing of the atmosphere. The rainy season is interrupted between July and August by a pronounced drop in precipitation known as the "middle dries" which lasts for about three weeks.

Liberia has a fairly consistent temperature that rarely exceeds 36 degrees C or falls below 20 degrees C. Mean temperatures vary between 24-30 degrees C. Mean diurnal temperature ranges are small in the coastal region, but increase with altitude inland where they may be as much as 40 degrees F, depending on local conditions. Relative humidity is generally high, especially in the coastal region where the average is over 80% and readings seldom fall below 60%. Humidity is almost as great in the interior and mountainous regions, though there is a higher variation. During the dry season, when the harmattan wind is blowing, humidity may fall below 50%.

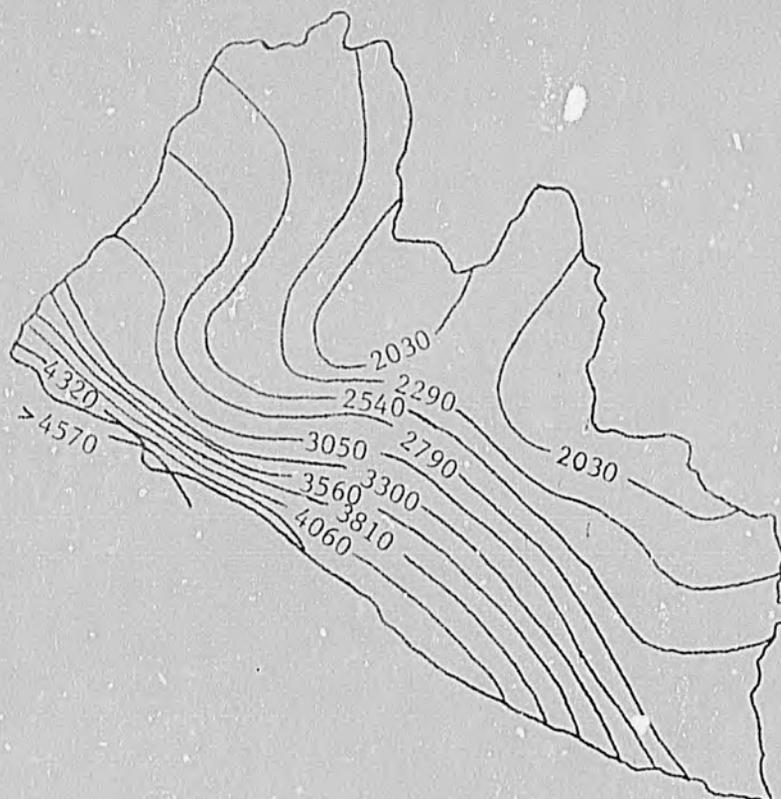


Figure 3. Average annual rainfall (mm).

#### B. Demographic Characteristics <sup>1/</sup>

In 1979, Liberia had an estimated total population of 1,776,000. <sup>2/</sup> Between 1968 and 1978 the population grew at an average annual rate of 3.1%, and is now believed to be expanding at an annual rate of 3.3%. High fertility, a young age distribution, high infant mortality, and low life expectancy characterize the country's population dynamics. Over one-half of the population is under the age of twenty. According to the 1974 census, 29% of the population was urban (communities of 2,000 or more people). Liberia has a diverse population, consisting of the descendants of immigrants from the United States and the descendants of migrants from various areas in central and northeastern Africa. These include 28 ethnic groups, each with its own language or dialect. The largest groups are the Kpelle, Bassa, Gio, Kru, Grebo, and Mano (see Fig. 4). Most of these groups still retain a considerable amount of autonomy and do not identify closely with the nation. Thus, various areas of the country are characterized by distinctive cultural traits and customs. Traditional African religious beliefs and practices are widespread despite intensive Christian missionary efforts.

<sup>1/</sup> See Appendix 1 for further demographic data.

<sup>2/</sup> Agency for International Development, 1979a.



Major language groups

-  Kru
-  Mel
-  Mande
-  Mixed

Figure 4. Major ethnic groups.

### Spatial Distribution

Liberia is divided into fourteen major administrative units - five coastal counties with five coastal territories, and four northern counties (see map, p. iv). The counties vary significantly in size, population, and population density. The population growth rate varies among counties from 1.1% to 4.8%; with Grand Cape Mount, Montserrado and Nimba counties growing significantly faster than the national average and Grand Bassa, Grand Gedeh and Sinoe well below the average.

The overall population density of Liberia is about 18.5 persons per square km, but the population is very unevenly distributed (see Fig. 5). Large parts of the country are still uninhabited or have very scattered populations, especially large sections of the forest belt in the southeastern third of the country and to the west in Lofa county. In the 1974 census, urban areas registered an annual growth rate of 7.9% compared to 3.3% for the population as a whole, reflecting the general trend of migration from rural to urban areas that is evident in every county. The overall trend in migration is from the small villages to the larger villages and towns, and then on to the main center of migration, the capital city of Monrovia. Monrovia is the largest urban area in Liberia, with a density of 1,687 persons per sq km and a phenomenal 8% population growth rate. Close to one-third of Liberia's population lives within a fifty-mile radius of the capital.

### Functional Population Projections

Liberia's population is projected to increase to 3,265,000 by the year 2000. This figure is based on a projected decline in total fertility rates from 5.981 to 4.070 between 1975 and 2000, and an increase in female and male life expectancies to 56.2 and 53.2 respectively over the same period. Zero net migration is also assumed for this period. The proportion of the population living in urban areas is projected to increase to 42% by 2000. This implies a tremendous increase in demands on services, facilities, and resources of all kinds over the next two decades. 1/

### Population/Family Planning

At present, the Government has not promulgated an official population policy aimed at reducing population growth. In 1976 the Government endorsed family planning as an integral part of the country's development plan, whereupon the Ministry of Health announced that family planning was to be integrated into overall health services. The Government also announced that the country's natural increase and fertility were too high. Despite these proclamations, less than 0.1% of the health budget is allocated to family planning. It is expected that the Ministry of Planning will include a population policy statement in the next plan (1980-84) and that the Government will give greater attention to population growth implications in future project and program design. 2/

1/ For further data on projections see Tsui, 1979.

2/ Agency for International Development, 1980.

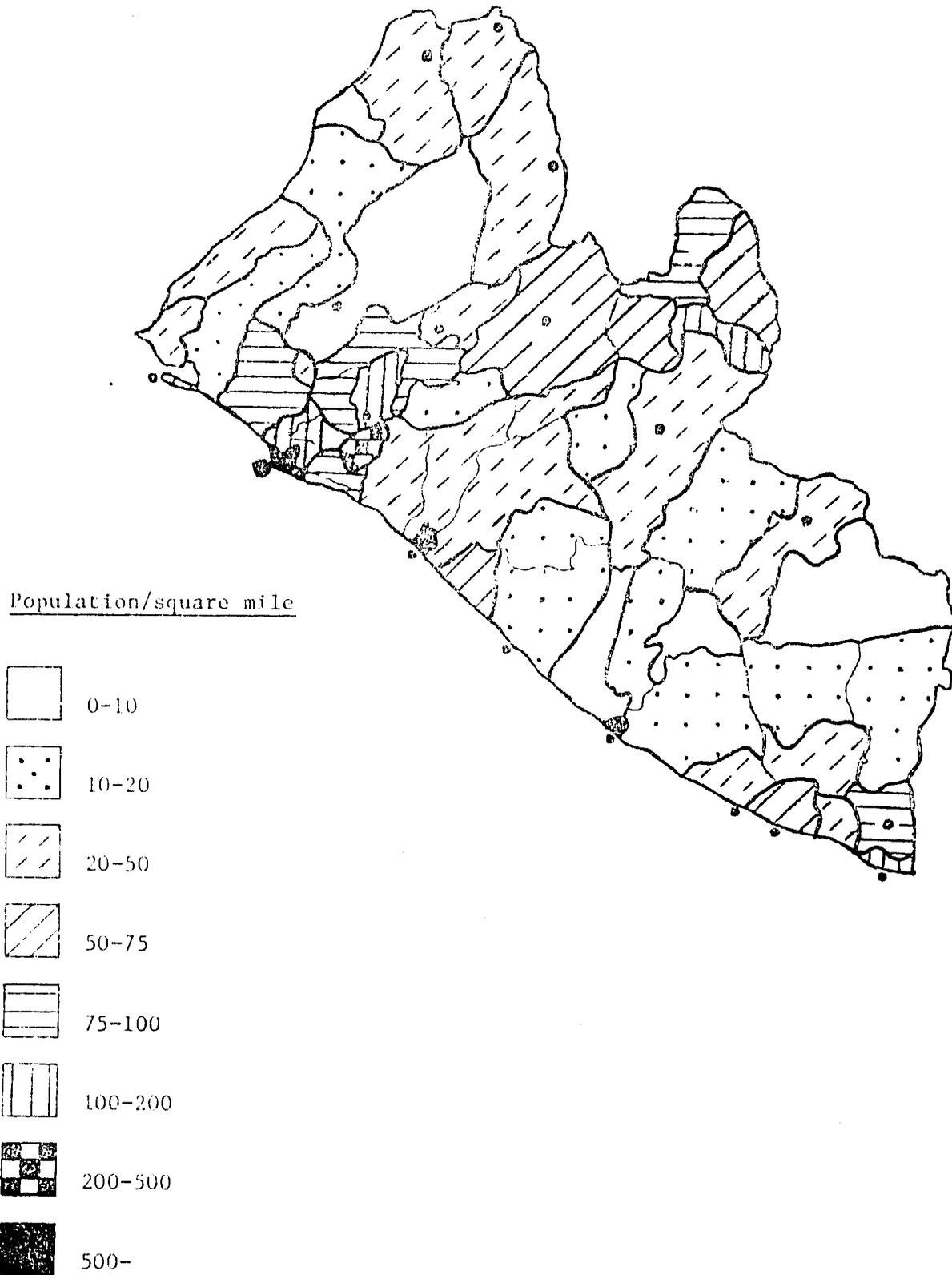


Figure 5. Population density, 1974.

## C. Economic and Social Characteristics

### Economic Overview

Modern Sector. Liberia has a dualistic economy that is characterized by significant differences in production and income distribution between the modern and traditional sectors as well as between foreign-owned concessions and the national economy. The modern sector, dominated by mineral exploitation and large-scale production of rubber, employs roughly 40% of the economically active population and accounts for almost 85% of GDP. The sector is export-oriented and thus is sensitive to fluctuations in the international economy. During the period 1960-1974, Liberia experienced a relatively high rate of overall economic growth as a result of expanding iron ore and rubber production. Between 1960 and 1970 the economy grew at an average annual real rate of 6.4%. However, during the next four years the real rate of growth declined to about 4.2% due to a decline in the growth of iron ore production as full capacity levels were reached and to stagnation in rubber production. The decline in the production of iron ore and other export-oriented commodities such as rubber, forestry products and diamonds has continued as economic recession in the West has reduced demand. The vast export sector of the Liberian economy is almost exclusively controlled by foreign companies, a result of the country's "Open Door" policy encouraging private foreign investment. These export-oriented concessions have had a very limited impact on productive capacity and the production base of Liberia due to their enclave character and limited linkages with the rest of the national economy. <sup>1/</sup>

The mining industry is the most important sector in Liberia's economy, with iron ore the most important product. Iron ore exports account for 60-70% of total export earnings. All mining production, which includes diamonds and gold, is exported. Agriculture is the second largest productive sector in the economy, and the most important economic activity in terms of labor force participation. The rubber industry dominates the agriculture sector, and is characterized by large foreign-owned concessions and Liberian-owned rubber farms. There are six foreign-owned concessions which operate a total of 56,658 ha, utilizing capital intensive modern management techniques. The Liberian-owned private sector developed as an outgrowth of the foreign concessions during World War II. Though these farms comprise one-half of planted acreage, they account for only one third of total rubber production. The generally low yield of these plantations (an average of 5681b/acre compared to 1,2851b./acre on the foreign concessions) is due to poor planting material and low management standards. Aside from mining and agriculture, Liberia has a very limited production base. Figure 6 shows the location of economic activity in the modern sector.

Traditional Sector. The traditional agricultural sector comprises about 93% of the total farming population, who live on one-third of the country's cultivated land. These are small-scale family farms averaging 2-3 ha in size and yielding

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<sup>1/</sup> World Bank, 1978.

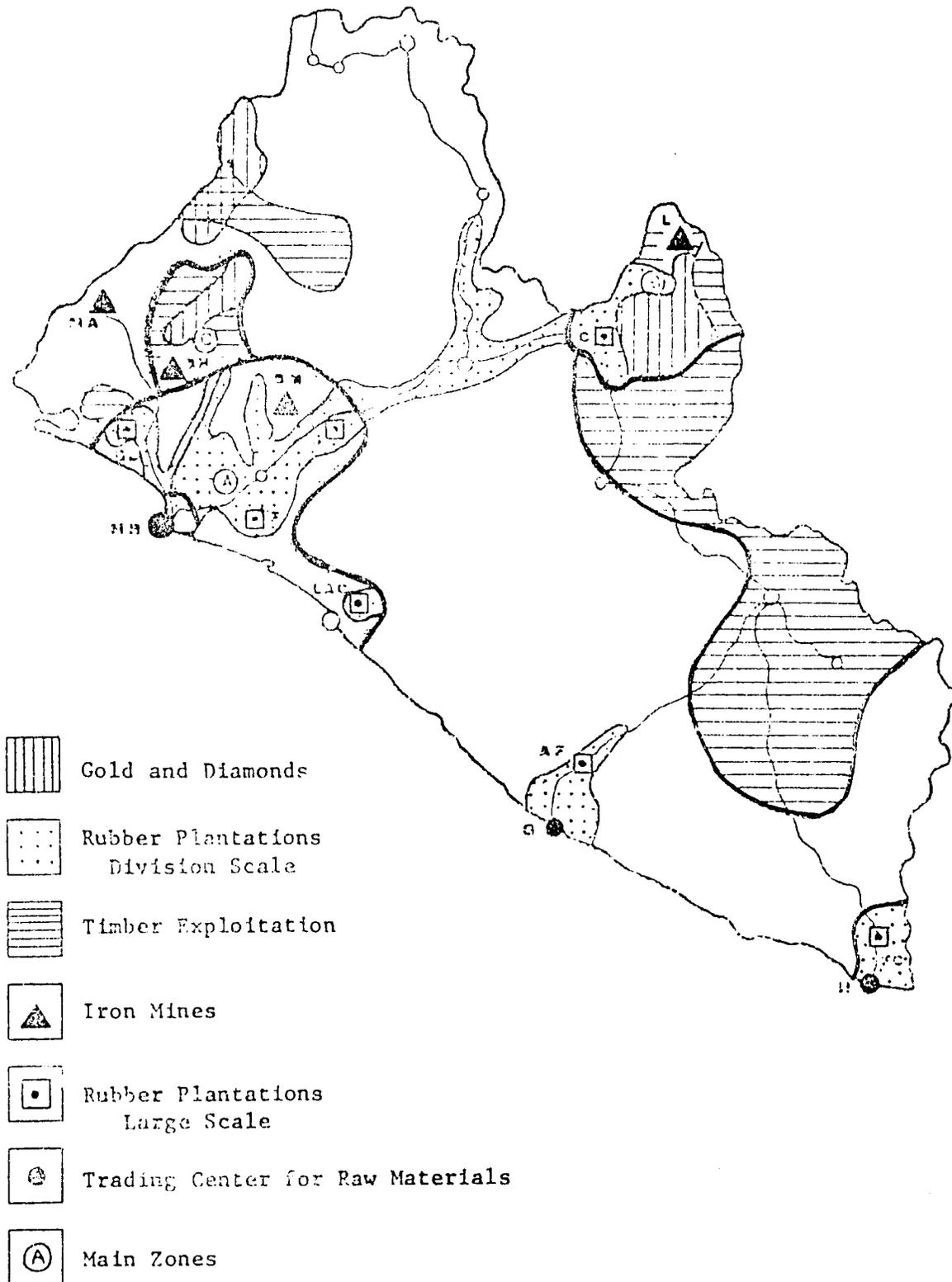


Figure 6. Location of economic activity.

a typical annual income of only \$54-\$70. The sector is based on the cultivation of staple crops of rice, cassava, and vegetables under a system of shifting cultivation. Under this system, a plot of land is cleared, burned, and then farmed for at most 2 to 3 years in a row. It is then left to lie fallow for an average of 7 or 8 years to allow the soil to return to a productive state (though even this period of time is often insufficient to restore the original fertility to the soil). Because of the fallow rotation system, only about 2% of the total land area is under subsistence crops at any one time. There is little infrastructure and farmers have very limited access to credit and other modern agricultural inputs, relying on traditional farming methods that result in low productivity. There is almost no use of organic fertilizer. The Ministry of Agriculture reports that only 1% of Liberian farmers use fertilizer as a rice production process.

Because of tribal differences in tastes and preferences, cassava is more common in the coastal regions than in the interior. In the interior one finds predominantly rice farms, whereas in the coastal areas rice is almost always intercropped with cassava. There is also some production of cash tree crops such as coffee, cocoa, oil palm nuts (mostly wild), sugar cane, and fruits.

Agricultural Land Tenure. There are two distinct systems of land tenure in Liberia; land administered by tribal authority and land held individually, either with title in fee simple or under lease. Liberia has traditionally allocated land in the rural areas to the tribal councils to be administered by the different clan chiefs according to tribal custom. Traditional principles and practices differ in detail among the various ethnic groups, but all share the fundamental concept of collective, rather than individual, proprietorship. This land is informally allocated on the basis of need and length of residence in the area. Normally, once the land is assigned it is not taken back; but since no deed or document is given, there is no guarantee of rights of ownership. Though climate, soil, and topography are not important factors in limiting the use of the land, the existing land tenure system in rural areas is considered a severe constraint on the development of the agricultural sector and the prospect of turning small scale farmers into economic producers.

Land tenure looms as an important issue in the 1980's. Major problems identified in the CDSS for Liberia include:

- The acquisition of tribal lands by those outside of the tribe as new roads penetrate into the interior. Though the extent of this acquisition is not known, the practice is thought to be widespread and growing. No clear documentation exists indicating how much land is being held under each type of tenure and where;
- Information on concessions is not being processed in a coordinated fashion;
- The traditional system is being threatened by the accelerating pace of development in Liberia. Tribal areas still largely contain adequate lands for the practice of shifting agriculture. However, the increasing pressures for land from internal population growth and continuing expansion of the freehold sector for speculation and commercial agriculture, will reduce the ability of tribal people to effectively maintain their viability.

Transportation System. The development of Liberia's transportation system followed the development of the enclave-based economy (e.g. the movement of iron ore and rubber) and is focused on Monrovia. The system is barely able to support the present enclave-based economy and will require extensive development and modernization to meet the Government's objectives of creating a more diversified agriculture-based economy. Improved road transport represents the largest percentage share of planned investment in the current Development Plan. The Government hopes to better integrate the traditional sector into the monetary economy through the improvement of primary roads and the construction of a comprehensive feeder and secondary road system. 1/

Roads. Roads are the basis of Liberia's internal transportation system, and are the principal means of moving both passengers and goods other than iron ore. The road network is very unevenly distributed; more than half of all road transport is concentrated in the Monrovia region and along the Monrovia-Ganta axis. It consists of primary, secondary, and rural roads of varying standards. The total length of the network amounts to 7360 km; i.e. it is one of the least developed systems of west Africa. There are 5120 km of public roads, of which 3040 km are all-weather roads, and 2080 km are roads that are only serviceable during the dry season. There are only 360 km of paved roads, about 7% of the public road network. The remaining 2240 km of roads are private, mostly laterite-surfaced roads built by the rubber and lumber concessions. Many potentially productive areas of the country such as Lofa, Grand Bassa and Grand Gedeh Counties, have only poor and indirect connections to the ports and market centers, and other vast areas, particularly in the southeast, are not served at all. Better feeder and secondary roads are needed in rural areas to improve the movement of rural agricultural products and support government efforts to improve rural health and education. 2/

Rail. There are four railways covering a total distance of 512 km. They are all privately owned by mining companies and cater to the transport of iron ore, carrying some 20-25 million tons of iron ore annually to the ports of Monrovia and Buchanan. However, the LAMCO railway (Nimba-Buchanan) has a contract with the Government to serve the goods traffic to and from Guinea and is often used by the timber companies for the transport of round timber. 3/

Ports. Liberia has four fairly large seaports: Monrovia and Buchanan, which are deep-water ports and handle over 85% of all foreign trade; and Greenville and Harper, both shallow-water ports that handle mainly log exports. Considerable expansion and alterations are planned, particularly for Greenville which handles the timber exports of practically the whole eastern sector. 4/

Figure 7 illustrates the transportation network as of 1977.

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1/ World Bank, 1978.

2/ Ibid.

3/ ATLANTA Industrie, 1977.

4/ Ibid.

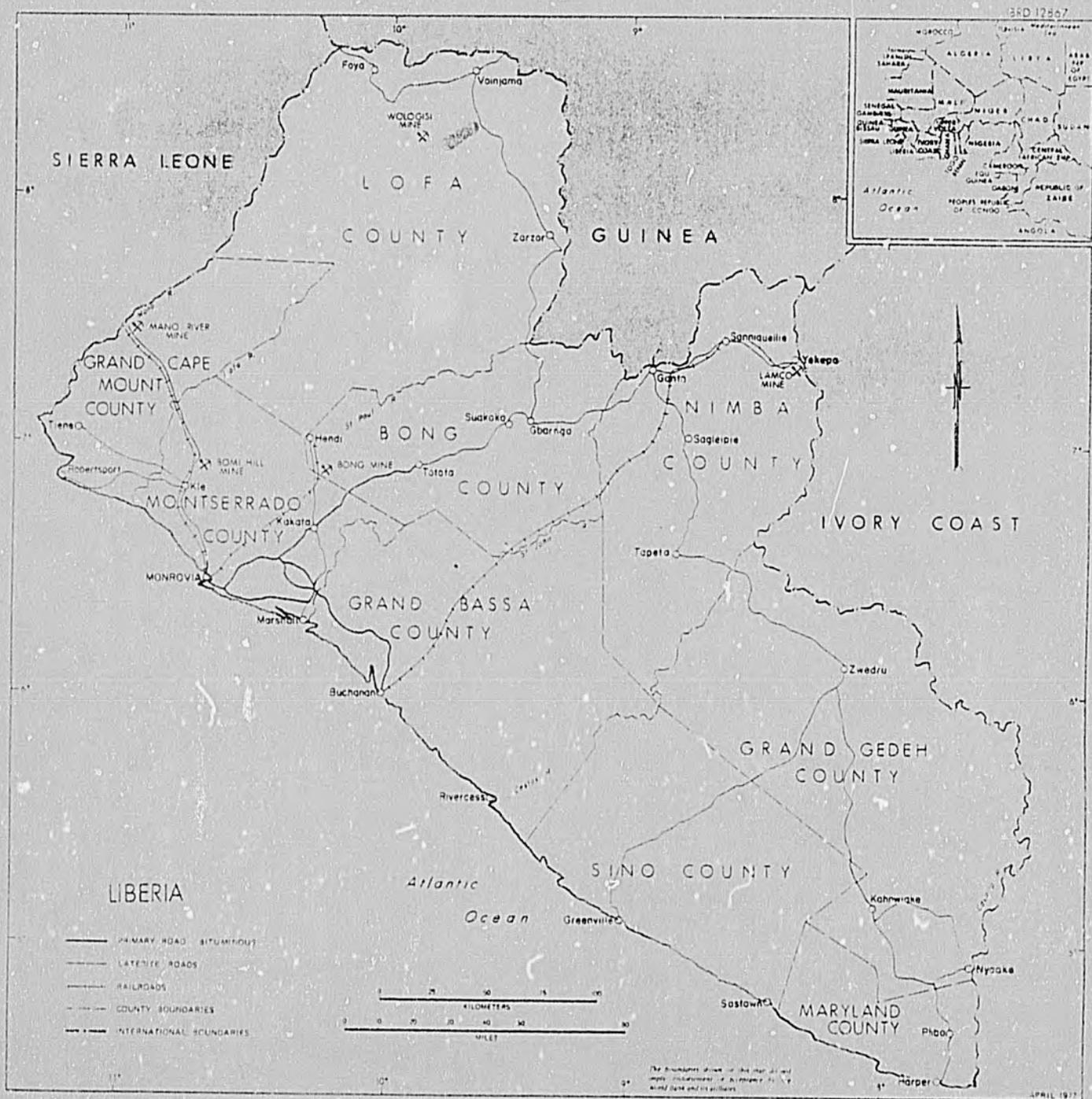


Figure 7. Transportation network, 1977.

### Basic Needs Overview

Nutrition. Information on the overall nutritional status of the Liberian population is inadequate. However, the limited research that has been undertaken, including a National Nutrition Survey carried out between December, 1975 and March, 1976, provides a general picture of the current situation. Protein-calorie malnutrition (PCM) is common. Children, in particular, suffer from high levels of chronic PCM and the various problems associated with a deficient diet. Many factors contribute to the low level of nutrition including the quantity and quality of food, consumption patterns of the population especially as influenced by tribal customs, and economic factors. Problems of particular concern associated with a low level of nutrition include anemia, protein deficiency diseases such as kwashiorkor, various forms of vitamin and mineral deficiency diseases, and problems associated with diarrhea and dehydration. Acute PCM appears to be less of a problem. The prevalence of PCM is greater in marginal farming areas and in the environs of Monrovia. Poor nutritional status is significantly associated with low income, low socio-economic status, polluted drinking water, and birth delivery in the bush or house.

The major staple food of Liberians is rice, even though only two-thirds of consumption is produced domestically. Almost half the production occurs in Bong and Nimba Counties. Manioc is next in importance, especially in the hinterland. Another basic element is the groundnut. The amount of available animal protein is limited due to the small livestock population, depleted wildlife sources, and underutilization of inland fishery potential. Protein deficiencies are more pronounced in areas which tend to rely more on cassava and plantains as their staple food. This is especially so in the coastal counties which have poor soils for rice production. Riboflavins are inadequate in Liberian diets generally and in rural areas specifically. 1/

Health. Although basic health indicators are steadily improving, Liberia lags behind African averages. The highest incidence of ill health is found in children under five years of age and women of reproductive age. Heavy rainfall and high humidity favor insect vectors of disease, water-borne and other intestinal parasites. The major causes of death are malaria and gastro-intestinal disease. Malaria has the highest incidence among communicable diseases and is a severe problem. The infection rate in some parts of rural Liberia is said to be as high as 80-100%. Other significant causes of death and morbidity in infants and young children include prematurity, measles, respiratory infection, and tetanus. Poor sanitation may be the major environmental factor affecting health in Liberia.

Basic health indicators point to a marked disparity, both quantitative and qualitative, in the distribution of health services between rural and urban areas. In fiscal year 1979/80 curative health services accounted for 87% of total expenditure (half of which was claimed by JFK Hospital in Monrovia) compared to 13% for preventive services. 2/

1/ Agency for International Development, 1976b and 1980.

2/ Agency for International Development, 1980 and Gangloff, 1973.

Housing. Little information was available on the shelter sector. In the past, the Government and private sector financial institutions limited themselves to extending housing and home improvement financing to middle and upper income groups. Recently, in response to rising demands of the urban poor, the Government with the support of USAID has initiated programs to provide adequate shelter for low income groups. These programs include home improvement loans channeled through the National Housing and Savings Bank, and sites-and-services schemes developed and administered by the National Housing Authority. 1/

Education. Liberia has achieved significant progress in recent years in expanding access to education and establishing education and training programs to meet the country's extensive manpower requirements. From 1968 to 1978, enrollment in pre-primary and primary education grew from about 120,000 to 190,000 and enrollment in secondary education increased from about 13,000 to 46,000. In addition, the annual output of trained primary teachers has increased from about 100 to 250, agricultural education and training programs have been established at the lower levels, and vocational education and training programs have been established at every level. However, despite this progress, the formal education system remains internally inefficient and out-of-step with the training requirements for development of the rural sector. 2/

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1/ Agency for International Development, 1980.

2/ Ibid.

## II. RENEWABLE NATURAL RESOURCES - USE AND CONSERVATION

### A. Introduction

#### Legal and Institutional Framework

The Liberian Code of Laws of 1956, a codification of all the statutes of Liberia enacted from 1847 to 1958, has been undergoing complete revision. <sup>1/</sup> The new body of law, referred to as the Liberian Code of Laws Revised, incorporates all laws that have been enacted since publication of the old Code as well as revised versions of many of the earlier laws. A draft Natural Resources Law, Title 23 of the revised code, pertains to renewable natural resources management. With the creation of the Forestry Development Authority (FDA) in 1977, the existing natural resources law was repealed. Due to an ongoing debate between the FDA and the Ministry of Agriculture (MOA) on who is to have jurisdiction over conservation in various sectors, the legislature has not yet acted on the new draft law. Thus, all further references to the draft law, as well as as to the draft maritime law, should be treated as tentative.

The draft Natural Resources Law includes chapters on water, soils, forests, and fish and wildlife. Under the new law, Liberia adopts the following policy: "...to conserve, improve, and protect its natural resources and environment and, in order to enhance the health, safety and overall economic and social well-being of the people, to create and maintain conditions which will:

- Assure surroundings which are healthful and aesthetically pleasing;
- Guarantee attainment of the widest range of beneficial uses of the environment without undesirable or unintended consequences;
- Promote patterns of development and technology which minimize adverse impact on the environment."

Responsibility for the management of renewable natural resources rests primarily with the MOA and the FDA. The FDA became fully operational as a public corporation in 1977, taking over administrative areas (forestry and fish and wildlife resources) previously under the jurisdiction of the MOA. The FDA is responsible for all aspects of the management of Liberia's forest resources, and has the right to promulgate, issue, amend, and rescind forestry rules and regulations. The wildlife director for the Government is presently located within the FDA. The MOA oversees soil and water resources.

### B. Water

#### Introduction

Surface Water. Liberia is well watered by numerous rivers and lakes. The river system forms a uniform pattern from one end of the country to the other. All rivers, with the exception of the middle reaches of the Cavalla River, flow

from the interior southwest to the Atlantic, perpendicular to the coast. There are sixteen river basins, of which the six largest are international. The river basins are narrow, and the major streams are spaced at regular intervals across the country. There are no well-developed valleys or flood plains. There are significant variations in the volume of flow of the rivers due to the alternating rainy and dry seasons and rapid runoff in the watersheds. During the rainy season most rivers overflow their banks.

Of the major rivers in Liberia, the Cavalla River forms nearly three-fourths of the border with the Ivory Coast along the eastern side of Liberia. Originating in Guinea and the Ivory Coast northeast of the Nimba Mountains, the Cavalla drains into the Gulf of Guinea a short distance east of Cape Palmas. Moving westward, the upper course of the Cestos River forms part of the border with the Ivory Coast, and drains the eastern side of the Nimba Mountains. A number of narrow basins that drain to the sea are located between the Cestos and Cape Palmas, including the Sangwin, Sinoe, Dugbe, Dubo, and Grand Cess Rivers. The upper course of the St. John is called the Mani River and forms part of the border with Guinea. The St. John originates in Guinea northwest of the Nimba Mountains, and drains in the Atlantic about 40 km southeast of the Farmington estuary. The St. John drains the widest basin among Liberia's rivers. The Farmington River, which flows out of the Bong Range south to the Atlantic, is the only inland waterway of much commercial importance. The headwaters of the St. Paul River are in the mountains of Guinea east of Macenta. The river flows in a southwesterly direction and drains into the Atlantic just north of Monrovia. The Lofa River also has its headwaters in Guinea. The Mano River forms roughly half of the border with Sierra Leone. It originates in the Guinea Highlands and flows southwest through the Gola Forest.

There are several lakes in Liberia, including Lake Piso (or Fisherman's Lake, which is rapidly becoming a tourist resort) and Lake Mawoa in Grand Cape Mount County, and Shepherd's Lake and Lake Klemoweh in Maryland County.

#### Status of Information on Water Resources

According to the Ministry of Lands and Mines, there is a lack of adequate data on the occurrence, availability, and quality of both surface and groundwater and other hydrological parameters. This dearth of information is a major obstacle to maximum beneficial use of this resource. 1/ Van der Leeden lists the following sources of hydrological data in Liberia: 2/

#### Precipitation

Total number of stations in 1964 (1)	17
Stations equipped with recorders (2)	-
Percentage of (2) to (1)	0
Density of stations/1000 sq km	0.153
Average length of records (years)	36

1/ Ministry of Lands and Mines, 1976.

2/ van der Leeden, 1975

Water levels

Total number of stations in 1964 (1)	25
Stations equipped with recorders (2)	4
Percentage of (2) to (1)	16
Density of stations/1000 sq km	0.225
Average length of records (years)	17

Discharge

Total number of stations in 1964	145
Density of stations/1000 sq km	1.3
Average length of records	5

In the report identified above, the Ministry of Lands and Mines lists the following hydrometric stations in operation as of 1976:

Table 1. Hydrometric Stations, 1976

Basin	On main river	On tributaries	Total	No. of automatic stations	No. of stations in operation for last 10 years
Cavalla	1	1	2	1	1
St. John	2	4	6	2	1
St. Paul	2	1	3	-	2
Cestos	1	-	1	-	1
Lofa	1	1	2	2	-
Mano	1	4	5	2	1
Sehkwehn	1	-	1	-	1
Mafa	1	-	1	-	-
Small coastal streams/creeks	2	-	2	1	-
Total	12	11	23	8	7

There are now 29 stations in eight river basins (the location of new stations was unavailable), and additional stations are planned.

Water Use and Management

Legal and Institutional Framework. Chapter 5 of the draft Natural Resources Law directs the Ministry of agriculture to prevent wastage and inadequate utilization of water resources and to develop and control those resources for the improvement of agricultural and forest lands, and to meet the present and future needs of domestic, municipal, commercial, industrial, power, recreational, and other public activities.

Liberia and Sierra Leone have established the Mano River Union to study the development potential of the Mano River basin. A study of the Cavalla River basin for the development of the hydroelectric potential of the river was undertaken on the basis of cooperation between Liberia and the Ivory Coast.

Surface Water. Even at their highest, the rivers of Liberia are not navigable for any significant distances inland because of rocky rapids and narrow channels. In general, the rivers pose an obstacle, rather than a means of, transportation. In fact, little use is made of the major rivers and streams except for subsistence fishing and local water supply, and by mining operations for various purposes. The Cavalla River is used to some extent by the Firestone Cavalla Plantation and people along the Liberian bank. The Farmington, though a small river, is the only inland waterway of much commercial importance in Liberia. The Firestone Plantation Company ships rubber from Harbel (about 24 km upstream) to the sea and on to Monrovia. The Lofa River flows through the Gola and Kpelle Forests and is navigable for about 32 km inland.

The falls and rapids of Liberia's rivers provide a potentially significant source of hydroelectric power. As of 1976, two hydroelectric power projects were in operation in Liberia - a 4 mW project on the Farmington River and the 68 mW Mount Coffee plant on the St. Paul River, opened in 1966. The Liberian Hydrological Service has initiated project studies on possible hydroelectric plants on the Mano (200 mW), St. Paul (130 mW), St. John (100 mW), and Cavalla (360 mW) rivers, as well as on the expansion of the Mount Coffee plant. <sup>1/</sup>

Groundwater. Groundwater is used almost exclusively for domestic purposes, usually from wells dug near villages. Liberia is considered to have abundant springs that offer an easily developed water source for many towns and villages, but these springs have yet to be mapped. A report on groundwater in the Monrovia area revealed that the Edina sandstone may be capable of producing several million gallons of water a day to supplement the present city supply.

### C. Soils

#### Introduction

The lateritic soil that covers most of Liberia is the product of intensive weathering of the Precambrian bedrock, which consists mostly of granites, gneisses, gneissic sandstones, and schists. High temperatures decompose humus faster than the plants can use it for growth, and then heavy rains wash much of this excess away and penetrate deep below the surface to leach out nutrient matter. This process leaves the soil with a low silica content and a high proportion of hydrous oxides of iron and aluminum. The soil is strongly acidic but basically fertile and, because of its thin topsoil, is best suited for tree crops. Along the coast the soil is generally very sandy compared to the lateritic soil found throughout the rest of the country. This soil used to support high forest (the

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<sup>1/</sup> Economic Commission for Africa, 1977.

forest still stretches down to the coast in some places), but a drastic change in vegetation took place after the areas were cleared and burned for agriculture. After harvesting the first crop, the areas produced grass rather than woody species as the sandy soils would not support a second growth of timber. <sup>1/</sup> Below this layer a darker sand, and at times a loamy sand, can be found. The soil becomes increasingly fertile as one moves away from the coast and rainfall decreases. Appendix 3 contains a general soil map of Liberia illustrating the distribution of the the major soil types and their soil associations throughout the country.

#### Status of Information on Soils

Very few soil maps are available in Liberia despite a number of studies done by the Liberia College of Agriculture. R. Fanfant of the Food and Agriculture Organization prepared a provisional map of the country to replace the reconnaissance map prepared by W. E. Reed of the USDA in 1951.

Fanfant, R. 1970a. Physiographic units and main soil groups of Liberia. Rome: FAO. (Unpublished).

Fanfant, R. 1970b. Report to the Government of Liberia on Soil Survey. Rome: FAO.

Worrall, G. A., and Dinkins, E. L. 1965. Soils of the Monrovia District. Liberia College of Agriculture. (With map at 1:20,000).

#### Soil Use and Management

Legal and Institutional Framework. Chapter 4 of the draft Natural Resources Law charges the Ministry of Agriculture with the conservation and improvement of the soil by authorizing measures to:

- Provide for the control and prevention of soil erosion;
- Preserve and improve soil fertility;
- Promote the economic use of land;
- Reduce exploitation and wasteful and unscientific use of national soil resources;
- Protect rivers and harbors against the results of soil erosion in aid of maintaining the navigability of waters and water courses.

Land Use. Under proper management, at least 90% of the land area will support rice and other food crops as well as plantation crops (rubber, oil palm, coffee, cocoa). Slightly less than 5% of the land area is alluvial soil and seasonal swampland. It occurs in all parts of the country in valleys and along stream beds, but is particularly prevalent in the low plateau area of the Central Province. Although little used for farming except in a small area in the

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<sup>1/</sup> Curry-Lindahl, 1969.

northwest corner of the country, with proper drainage this could be fertile cropland exceptionally well-suited to swamp rice culture. The small amount of wasteland - less than 5% of the land area - is made up mostly of some very rocky and rugged hills, permanent salt and fresh water swamps, and sandy coastal areas. However, the latter are not entirely useless for agriculture since they support coconut, oil, and piassava palms. Slightly over 40% of the country is devoted to cultivation of traditional crops, but because of the fallow rotation system practiced, only about 5% of this land or 2% of the total land area is planted to such crops at any one time.

Erosion and land degradation. Though the soil is basically fertile, it is ecologically sensitive to disturbance by man due to the effects of leaching described briefly in the introduction above. Thus, the effects of shifting agriculture, the principal agricultural system in Liberia, can be all the more severe. The clearing and cultivation of forest land under a system of shifting cultivation can disrupt nutrient cycles and lead to further loss of nutrients and degradation of the soil. This process of degradation is increased by the effects of solar radiation and direct precipitation on the ground. When the cultivated area is not left to lie fallow for a period of time sufficient to restore fertility to the soil, erosion is typically the result.

Erosion is not yet a serious problem on a national scale, although some erosion is occurring locally on sloping land which has been deprived of tree cover, primarily through upland rice production. Though no figures were available on the extent of the problem, there is a need for a gradual shift of rice production from uplands to swamps and the planting of tree crops in the uplands. Erosion could become serious if population pressure leads to more intensive as well as extensive use of the land, or if the timber concessions are allowed to practice uncontrolled tree felling. <sup>1/</sup> Under the present system of shifting cultivation, which requires land to lie fallow for a number of years after use, the average family of six needs 12 to 16 ha for its exclusive use simply for subsistence. In areas around Monrovia and along the main road leading north the density now exceeds this figure, and the average fallow period has dropped below that needed to restore the fertility of the soil and permit it to yield a subsistence food crop.

#### D. Forests

##### Introduction

Most of Liberia lies within the Guineo-Congolian tropical lowland rain forest belt of Africa, which extends from Sierra Leone to the Rift Valley. Only the northernmost part of Liberia extends into the belt of Guinean woodland savanna which stretches from Senegal to Sudan. Liberia is one of the last West African countries with significant forest reserves. Tropical rain forest is presumed to have been the natural climax vegetation for at least 10,000,000 ha of the

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<sup>1/</sup> Agency for International Development, 1980.

country. However, due to human encroachment, much if not most of the country's primary forests have been transformed into various types of degraded secondary forest, or have been cleared away altogether. <sup>1/</sup> Persson has estimated the remaining area of primary forest in Liberia to be as little as 2,500,000 ha; in addition to an estimated 2,300,000 ha of "broken forest" in which shifting cultivation has long been widespread. <sup>2/</sup> Appendix 4 provides a more detailed description of the distribution of forest types in Liberia.

#### Status of Information on Forests

The institutional focal point for information on the forest resource is the Forestry Development Authority (FDA). The FDA issues an annual report which reviews the year's activities related to forest management and utilization. In recognition of the country's diminishing forest reserves, the FDA has initiated a country-wide inventory of forest resources. False color aerial photographs at 1:70,000 are being flown at present. The work has been contracted out to Mark Hurd Aerial Survey Inc., Minnesota, and is being financed by the World Bank and monitored by FAO. The photographs are hoped to be the basis for land use and forest type mapping of the entire country, for which maps should be produced at the scales of 1:250,000 and 1:500,000. This inventory is being conducted through the use of aerial photography/Landsat sensing and geodetic/ground-truth surveys.

In addition, the Ministry of Agriculture is undertaking a program to identify forest soils for their agricultural potential, with particular regard to cash-crop plantations, small-scale mixed cultivation, and cattle ranching. These projects are not expected to be completed before sometime in 1980.

Aerial photographs of nearly the whole country were taken in 1952/53 at a scale of 1:40,000. Between 1960 and 1967, inventories of varying intensities were carried out in the National Forest Reserves (approx. 1.6 million ha) by the German Forestry Mission to Liberia and the former Bureau of Forestry and Wildlife Conservation.

#### The Forest Resource

Resource Supply. Liberia still has considerable forest reserves, with an estimated 4.8 million ha of forested land (44% of total land area). About 1.7 million ha of largely primary forest was demarcated in the 1950's as National Forest Reserves. At present, over 70% of the total forest area has been given out as concessions. The FDA reports that 2.4 million ha of these concessions have not yet been worked, much of which may be regarded as primary forest. However, since concessions encompass some secondary forest, it is not possible to state the extent of untouched primary forest within and outside the concession areas. The Forestry Development Authority (FDA) estimates that, with 2.4 million ha of untapped forest resources, the first felling cycle will last on the average for

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<sup>1/</sup> Myers, 1980.

<sup>2/</sup> Persson, 1975.

at least 15 more years. Liberia thus compares very favorably with other west African countries, many of which are already on their second or third felling cycle. 1/

The total standing volume is estimated to be 84.5 million cubic meters, of which 11 million cubic meters are "established" (or "primary") species. 2/ The country's sustained yield is estimated at between 2-3 million cubic meters, of which only a small proportion is presently exported. 3/

Approximately 235 timber species are found in Liberia. Of these, about 150 species occur in volumes suitable for commercial exploitation; however, only 90 are potentially marketable. 4/ Natural stands of a single species are not common. Thus, to be economical, forestry operations (other than plantations) must be based on the exploitation of a number of scattered species. Many timber species, such as red ironwood (Lophira alata) and whismore (Tarrietia utilis), are suitable for construction. There are also cabinet and veneer woods, including several African mahoganies: Lovoa klaineana, Khaya ivorensis, and K. anthotheca. The country's most valuable commercial timber is found in the zone of evergreen and semi-evergreen lowland rain forest, which constitutes the bulk of Liberia's forest reserves.

Demand on Forest Resources. As shown in Table 2, the bulk of wood production is utilized as a source of fuel. Firewood is the prime source of fuel in Liberia, as it is throughout Africa. Though the percentage of wood production devoted to firewood has been steadily declining (from 90% in 1966 to 67% in 1976) due to a significant increase in industrial roundwood production, the total amount of wood being used for fuel has been increasing.

Table 2. Wood Production ('000 of cubic meters) 5/

Product	1966	1970	1976
<u>Total Roundwood production</u>	1,098	1,460	2,051
Total Exports	23	149F	220F
<u>Fuelwood and charcoal</u>	991	1,170F	1,366F
<u>Industrial roundwood</u>	107	290	685
Sawlogs and veneer	42	220	605
Other industrial rw.	65	70F	80F

F = FAO estimate.

- 1/ Forestry Development Authority, 1978.  
2/ ATLANTA Industrie, 1977.  
3/ World Bank, 1978.  
4/ ATLANTA Industrie, 1977.  
5/ Food and Agriculture Organization, 1977.

Demands on Forested Lands. There are two significant demands on forested lands that are adding to the pressure exerted on the forest resource itself by commercial logging and the demand for firewood. First, the Government has undertaken an ambitious land clearing program to establish plantations of fast growing economic species. This land had previously been a national reserve composed of primary and secondary growth. The tree crop development program, under the direction of the Liberia Produce Marketing Corporation (LPMC) is promoting coffee, cocoa, oil palm, and coconut plantations. Up to 1976, about 4,400 ha of cocoa and 1,360 ha of oil palm had been planted (coffee planting was just getting underway). Sixty-nine central nurseries as well as several group nurseries had been established in the main growing areas with improved planting material imported from the Ivory Coast. LPMC's program planned for the annual planting of 4,400 ha over the following five years (no information was available on the progress of this program).

Tree crop development other than rubber is expected to progressively gain in importance as an export earner and as a means to diversify the economy by better utilizing Liberia's natural potential without damaging soil fertility. Coffee and cocoa are to be developed at the level of smallholder farming systems through integrated rural development projects. Oil palm and coconut are suited to development at the plantation level through commodity corporations. Ecological conditions for these crops are favorable and largely similar to neighboring Ghana and the Ivory Coast, where their successful development has contributed to diversification of agriculture in the rain forest belt. 1/

In addition to controlled land clearing is the demand on forested lands exerted by the practice of shifting cultivation, described earlier. Shifting cultivation is rapidly expanding into logged over areas outside reserves as roads are built by the concessions which provide ready access to these areas. While sparsely populated areas feature rotation rates of 15-25 years, sufficient to restore the productivity of the land, the rotation in areas closer to the coast has been reduced to every 2-4 years. Recent estimates suggest that some 30,000 ha of primary forest are converted to degraded forest, or transformed into bushland, by shifting cultivation each year. The FDA estimates that depletion by selective logging is .64 cubic m/ha, while depletion by shifting cultivation runs as high as 60 cubic m/ha.

#### Natural Forests - Exploitation and Management

Legal Framework. Chapter 2 of the Natural Resources Law covers the conservation and extension of the forested lands of Liberia in order to increase timber production, preserve arboreal species, improve water drainage and flood control, prevent soil erosion, protect wildlife, and improve recreational opportunities. The subchapters of the law most relevant to the exploitation and management of natural forests are:

Subchapter B: Forest Reserves. The FDA is empowered to create and establish Government Forest Reserves, Native Authority Forest Reserves, Communal For-

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1/ World Bank, 1978.

ests, and national parks. Government Forest Reserves can be established on publicly or privately owned lands for the free use of all people subject to the restrictions of Subchapter C. Native Authority Forest Reserves embrace forests in areas held communally by one or more Tribal Authorities. Such reserves are to be protected by the FDA as potential Government Forest Reserves. Regulations affecting forest reserves of this type are to be designed to minimize damage to the forests and avoid unnecessary depletion of their resources. Communal Forests are limited to small forest areas immediately adjacent to one or more tribal villages, and their use is confined to the local population. No permits are granted to other persons to hunt, trap, fish or cut trees in any such area as long as it is maintained as a Communal Forest. Communal Forests are administered by the Tribal Authorities concerned. The FDA can create and establish national parks embracing any areas of the country (including privately owned land) having outstanding scenic, recreational, scientific or other pertinent values.

Subchapter C: Restrictions on Use. The following restrictions are placed on the use of Government Forests except in accordance with the express terms of a concession agreement, mining claim or license, or permit issued by the FDA. No person shall:

- Cut, remove, injure or destroy any trees;
- Hunt or trap wildlife or fish;
- Disturb the vegetation, soil, or mineral resources;
- Reside, erect or maintain any structure;
- Build, alter or destroy roads or dams;
- Dig in the soil or prospect for minerals, coal or oil;
- Set fire to vegetation or logging slash, or materials other than fuel as permitted by regulations;
- Deposit rubbish;
- Raise crops or permit cattle or other domestic animals to graze or in any way engage in agriculture;
- Alter, deface, or obliterate any property mark placed on a tree;
- Fell and leave trees or other obstructions across any trail, road, or waterway;

Subchapter D: Commercial Dealings. The FDA, in accordance with sound conservation principles and other provisions of this chapter, may contract for the sale of timber. The trees to be cut shall be designated either individually, by location, or by description of diameter and species. The contract will contain restrictions and obligations necessary to prevent permanent damage to the forest, including a provision for reforestation. The subchapter also includes provisions on the responsibilities of timber concessionaires and minimum girth requirements for the cutting of various species.

Subchapter G: Protection and Maintenance of Forests. Empowers the FDA to:

- Fell, cut, damage, tap, or destroy trees in Government Forests and clear or remove timber for the purpose of planting trees, improving the growth of trees, or for better forestry management;
- Initiate educational programs on approved methods of forest conserva-

- tion and the importance of forests as a valuable natural resource;
- Establish, operate and maintain nurseries for the production of trees to be used in reforestation;
  - Conduct silvicultural research and experimentation in forestry science on public lands.

In consultation with the concessionaires, the FDA has formulated a set of rules, promulgated as a regulation, to eliminate needless waste in logging operations. No information was available on how effective this rule has been.

Institutional Framework. The FDA is responsible for implementing the Forest Law, and for supervising and administering in accordance with sound conservation principles all lands constituting the Government Forest Reserves, Native Authority Forest Reserves, Communal Forests and national parks. The FDA became fully operational as a public corporation in 1977, assuming administrative responsibility for forestry and management of fish and wildlife resources, areas previously under the jurisdiction of the former Bureau of Forest Conservation, Ministry of Agriculture. In being responsible for all aspects of the management of Liberia's forest resources, the FDA has the right to promulgate, issue, amend, and rescind forestry rules and regulations. The FDA is organized into five major functioning divisions: Administration; Planning, Statistics and Research; Forest Management and Wildlife; Utilization; and Finance. Activities of the FDA in its first full year of operation included forest management, utilization, plantation development, and wildlife management and conservation, although its main focus and interest was commercial exploitation.

A Timber Marketing and Monetizing Center has been established within the FDA which concentrates on timber market analysis, price calculations for timber species, and the opening of new regional and international markets.

Exploitation Patterns and Practices. The exploitation of Liberia's timber resources is performed by the private sector. Commercial exploitation began less than twenty years ago, relatively late compared to other west African countries. Since then, timber concessions have become well dispersed over the country (see Fig. 8). Thirty-three concessions are listed in the annual report of the FDA for 1977/78, comprising a total area of 3,414,400 ha (see Table 3). This total is down from the 1976/77 total of 3,883,105 ha. The reduction in area is due to the cancellation of a number of contracts by the Government. 1/

Of the 90 potentially marketable timber species identified in Liberia, approximately 35 are currently marketed internationally. Concession agreements are supplemented by a "Forest Management Plan," which contains regulations on forest protection, the selective logging system, annual coupe, dues to be paid, etc. Natural forest management is mainly confined to the control of felling by diameter limit and area, prescriptions for which are contained in the management plan. The return period, diameter limits, etc. were derived from the 1960-67 inventory. 2/ A modified selective logging system is practiced with a felling

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1/ FDA, 1978.

2/ ATLANTA Industrie, 1977.



Table 3. Number and Size of Concessions, 1977/78

Size (ha)	Number	Total Area (ha)	%
Less than 40,000	7	150,500	4
40,000-80,000	9	574,600	17
80,000-120,000	6	659,900	19
120,000-160,000	6	855,200	25
160,000-200,000	3	562,400	17
Over 200,000	2	611,800	18
<b>Total</b>	<b>33</b>	<b>3,414,400</b>	<b>100</b>

cycle of 25 years in concession areas of 40,000 ha or more. Concessions of less than 40,000 ha are given special treatment. The Government has revised stumpage fees for valuable species (two species account for over one half of total cuttings) to protect these in future cuttings. Concessionaires are permitted to exploit 4% of their concession area annually. Under a set of "processing rules" introduced in 1973, compulsory processing rates have been increased and concessionaires are required to process 40% of logs cut in the country. The infrastructure for logging control (vehicles, offices) is slated for improvement, and research is to begin soon on natural forest management systems. 1/

Reforestation. At present, Liberia does not have a concrete national policy on reforestation. However, in 1971, the Government launched a National Reforestation Program within the former Bureau of Forest Conservation of the Ministry of Agriculture. Under the program, since taken over by the FDA, the concessions are required to replant one acre with new trees for every 30,000 board feet (135 cubic meters) cut, or to pay \$450 into a special fund for the reforestation program. As of 1978, over 5,000 ha had been reforested primarily with teak, tropical pines and eucalyptus. Reforestation activities are concentrated in selected areas of the country where development of transportation, industry, and urban areas is anticipated, so as to ensure future utilization of the planted species and to support the balanced development of the economy. The main reforestation sites are Bomi Hills, Yekepa-Nimba National Forest, Cavalla Forest, and Grebo National Forest. 2/

In determining potential reforestation sites, a system of diagnostic sampling of various intensities is undertaken to determine the stocking and quality of

1/ Ball and Sutter, 1980.

2/ Forestry Development Authority, 1978.

the forest cover. While detailed research is being carried out to determine the best application of this system, all areas with reasonable stocking of the known timber species are protected and areas of poor forest stocking are cleared for plantation (see below).

The FDA identified the following constraints to the reforestation program:

- Inadequate labor to carry out the program at the desired level;
- Lack of locally reliable seed stock, necessitating the import of seeds from foreign sources. The seeds tend to lose viability during transport, which adversely affects the reforestation effort;
- Inadequate social infrastructure to cater to migrant workers when local labor cannot be recruited in large numbers. <sup>1/</sup>

The World Bank is involved in one reforestation project in Liberia. This is a \$17.5 million project beginning in 1979 and scheduled to last five years. The main components of the project are:

- to strengthen the technical, administrative and physical capabilities of the FDA. This includes completion of the aerial photographic cover of Liberia, providing thematic maps for vegetational and land use studies and planning, as well as for forest management and control. Liberians will be trained to analyze and interpret all types of remote sensing.
- the establishment of a pilot industrial plantation of 1,600 ha in Grand Cape Mount County. This is the first stage in the development of a 64,000-72,000 ha pulpwood plantation, large enough to support a pulpmill in Liberia.

### Plantation Forests

The development of plantation forests is at a relatively low level because industrial roundwood is currently readily available from natural forests (and will continue to be in the immediate future). The FDA is presently emphasizing slow-growing species as a source of timber for furniture, face veneers, etc. Roughly 4,000 ha of forest plantations have been established. Most of the plantations are young and mainly intended for scientific trials. An active program of species selection and research into plantation establishment techniques is being undertaken so that the FDA is prepared for an expanded program when necessary. As of 1977, six concessions were operating 78,000 ha of hevea (rubber) plantations. Firestone, the leading concessionaire, has an extensive replanting program in which 2,000 ha have been cleared and replanted annually since 1960.

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<sup>1/</sup> Forestry Development Authority, 1978.

## Issues, Problems, Potentials

Deforestation. Though Liberia still has significant forest reserves, their exploitation is intensifying and they are being converted at an increasingly rapid rate. Although there is little reliable data, it can be reliably stated that large areas that were formerly forest have now been converted to rotational bush fallow and permanent scrubland. Under the combined pressures of shifting cultivation, demand for firewood, commercial logging, and the government land clearing program, Liberia's primary forests will likely be completely converted within ten years. 1/ In the longer term, the whole of Liberia's forests are threatened. 2/

According to the World Bank, in spite of some ongoing research efforts to test the suitability of various species for reforestation, little is known about the effects of present exploitation policies on the future potential of the forest. Research is needed to assess the long term effects of present cuttings on regrowth and future distribution of species in present cutting regimes, the possibilities to preserve valuable species through reforestation, and the effect of reforestation (with pulpwood) on soil fertility and regrowth in following growing cycles. There may, therefore, be an acute danger that present forestry exploitation policy is at the expense of future potential. 3/

The lack of staff, particularly at the technical level, is a serious constraint to forest management, whether of natural forest or plantations. To meet this problem, the training of technical staff at the rate of 15 to 20 officers yearly on a two year course was recently started at a new school.

## E. Wildlife

### Introduction

Terrestrial Wildlife. The terrestrial wildlife of Liberia is adapted and specialized to the lowland rainforest ecosystem and its range of habitats: brackish and freshwater swamps, rivers, high forests, and woodland savannas. Thus, the fauna is typical of the great African equatorial lowland rainforest, though Liberia does possess some unique species.

Although human encroachment along Liberia's coastal plain has led to the disappearance of most wildlife, the forests of the interior still support a wide variety of species. Most of this wildlife is restricted to high forest and inaccessible or undisturbed areas away from villages. In a somewhat dated study, over 100 species of mammals, 33 species of amphibians, 41 species of reptiles, and 280 species and subspecies of birds were identified in Liberia. 4/

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1/ Myers, 1980.

2/ Verschuren, 1979.

3/ World Bank, 1978.

4/ Strong, 1930.

In the waterways of Liberia are found the Nile hippopotamus, the pigmy hippopotamus (unique to Liberia) and three species of crocodile. There are 15 species of snakes, including water snakes, mambas, cobras, vipers and the python. Several types of monkeys live among the trees of the forest, including baboons, Colobus monkeys, white spotted nose monkeys, chimpanzees and a lemur called Bosman's potto. Other characteristic mammals are the elephant, buffalo, antelope, duiker, bushbuck, groundhog, mongoose, honey badger, bongo, tortoise and several members of the leopard group.

Liberia has a wide variety of birdlife. Waterfowl are abundant along the estuaries and tidal creeks where large flocks of white herons roost in the mangrove. Ibis, egrets and flamingoes are found in the mudflats and shallow waters. Game birds include guinea fowl, partridges, doves and pigeons. Other birds include hornbills, weaver birds, woodpeckers, kingfishers, curlews, phalaropes, parrots, plovers and many types of hawk and eagle.

Twenty-one species of useful meat-producing ungulates exist in Liberia. Potential meat-producing mammals in the forests of Liberia include: elephant, tree hyrax, buffalo (bush cow), hippopotamus, pigmy hippopotamus, bushbuck, black-dorsal striped duiker, Jentink's duiker, banded duiker, bongo, light-backed duiker, black-fronted duiker, bay duiker, Maxwell's duiker, pigmy antelope, bush pig, giant forest hog, ten species of primates, and several rodents. Many other mammals as well as birds, reptiles and invertebrates represent important protein resources. <sup>1/</sup>

Fisheries. Liberia has three sources of fish: freshwater bodies (lakes, rivers, and inland swamps); inland saltwater bodies (lagoons and estuaries); and the ocean. Among the varieties of freshwater fish are several kinds of catfish and perch, carp, and a large salmon-like hydrocyon. Marine life is more abundant in the estuaries where saltwater fish such as mullet come inland. A wide variety of fish are found off the coast, including many types of mackerel and snapper, barracuda, mullet, sole, tuna, and grouper. There is also an abundance of crustacea such as lobster, crab, and shrimp. No figures were available on the contribution of fish to protein supply. However, in view of the shortage of land-based animal protein, fishing has always been important in balancing the population's diet.

#### Status of Information on Wildlife and Fisheries

Responsibility for the management and conservation of fish and wildlife rests with the Wildlife Division of the FDA. Information on wildlife populations consists of two general surveys conducted by a representative of IUCN for the Liberian Government. These surveys are basically overviews of the wildlife situation in Liberia and offer little data. A National Fisheries Survey was conducted in 1975 by the former Bureau of Fisheries of the Ministry of Agriculture (this was not available).

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<sup>1/</sup> Curry-Lindahl, 1969.

The Nimba Range, which is contiguous to Liberia, Guinea, and the Ivory Coast, has been the subject of extensive scientific research due to its particular value for the study of ecology, evolution, and speciation. At least 200 species of animals are unique to the Mount Nimba area. Through the Institut Fondamental d'Afrique Noire (IFAN) in Guinea and the Ivory Coast, a series of geographical and biological monographs on Mount Nimba have been published. Since 1963, the Nimba Research Committee of the IUCN has organized botanical, zoological, and ecological investigations on Liberian Nimba. This research has been based at the Nimba Research Laboratory in Grassfield. 1/

#### Rare and Endangered Species

According to an IUCN survey on wildlife, national parks, and forestry conservation conducted in Liberia during 1977/78, the "situation of wildlife is absolutely desperate..." 2/ Tremendous hunting pressure and loss of habitat have combined to reduce the wildlife resource to a fraction of its former wealth and productivity. Wildlife has almost disappeared along the coastal plain and there are no longer any large herds of big game in the interior. Liberia has the highest number of guns per capita among west African countries and there is absolutely no banning of firearms.

The Annual Report of the Forestry Development Authority noted that the President has approved a list of fully and partially protected animals, but the origin and contents of the list were not identified. The Report also noted that the FDA has formulated a regulation for the protection of wildlife, but again no further information was available to the author.

Some Liberian mammals have a very restricted range and therefore deserve special attention. The most famous is the pygmy hippopotamus, which has perhaps always been rare (though it breeds well in captivity and so will probably never become extinct). Even rarer than the pygmy hippo is a forest antelope, Jentink's duiker (Cephalophus jentinki), known only from a few areas in Liberia and the Ivory Coast. The banded duiker (C. zebra) also has a very restricted range. 3/

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 that occur in Liberia:

#### Mammals

Common name: Olive colobus.

Scientific name: Colobus verus.

Status: Rare, but locally numerous.

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1/ Curry-Lindahl, 1969.

2/ Verschuren, 1979.

3/ Curry-Lindahl, 1969 and 1974.

Habitat: Arboreal; inhabits high forest, commonly occurs along river banks and in abandoned cultivation. Feeds and normally travels in the lower layers of the forest, generally below 9 m. The middle layer, 9-27 m, is used only for sleeping and escaping from enemies. Diet is strictly vegetarian, composed almost entirely of leaves. Only a very few of the species groups of monkey in Africa are both unispecific and monotypic, and this is the sole example from the forests west of the Cameroons. This is a species whose biology is apparently unique.

Common name: Chimpanzee.

Scientific name: Pan troglodytes.

Status: Vulnerable.

Habitat: No further information given.

Common name: Leopard.

Scientific name: Panthera pardus.

Status: Vulnerable; depleted throughout parts of the coastal states of West Africa.

Habitat: A wide variety of biomes. One important factor is cover, both for hunting and for lying-up to feed and rest. Human modification of savanna ecotypes tends to the removal of trees and bush, although the leopard has proved to be exceptionally resilient and tolerant of changes to its habitat.

Common name: West African manatee.

Scientific name: Trichechus senegalensis.

Status: Vulnerable; seriously depleted throughout most of its range in rivers and coastal areas of West Africa.

Habitat: Occurs both in coastal and riverine areas, where it feeds on aquatic plants and terrestrial plant material. There is no conclusive evidence of regular or extensive migration. The possible effects of modification of habitat on populations through pollution, water impoundment or increased human disturbance, have not been ascertained.

Common name: Pygmy hippopotamus.

Scientific name: Choeropsis liberiensis.

Status: Rare.

No further information given.

Common name: Jentink's duiker.

Scientific name: Cephalophus jentinki.

Status: Endangered; threatened with extinction. The population is unlikely to exceed a few hundred. There may also be a residual population along the Cavally River.

Habitat: Swamplands in the high forest, tropical rain forests, dense jungles, and savanna.

### Birds

Common name: White-necked rockfowl.

Scientific name: Picathartes gymnocephalus

Status: Very rare; threatened with extinction due to over-exploitation for the bird trade. Its estimated numbers are not known, and even an estimation

is made virtually impossible due to its widely scattered breeding colonies and the nature of its habitat.

Habitat: Dense forests, though they are restricted in their breeding to the comparatively few localities where rocky outcrops and cliffs occur in the dense cover.

Common name: Grey-necked rock-fowl.

Scientific name: Picathartes oreas.

Status: Very rare; declining in numbers due to over-exploitation for the bird trade. Its numbers are not known, and even an estimation is made virtually impossible due to its widely scattered breeding colonies and the nature of its habitat.

Habitat: Confined to the rain forest.

### Reptiles

Common name: African dwarf crocodile.

Scientific name: Osteolaemus tetraspis osborni.

Status: Endangered.

Common name: African slender-snouted crocodile.

Scientific name: Crocodylus cataphractus.

Status: Endangered.

Common name: Nile crocodile.

Scientific name: Crocodylus niloticus.

Status: Endangered.

### Amphibians

Common name: Mt. Nimba viviparous toad.

Scientific name: Nectophrynoides occidentalis.

Status: No further information given.

Common name: Cameroon toad.

Scientific name: Bufo superciliaris.

Status: No further information given.

## Exploitation and Management

Legal and Institutional Framework. Chapter 3 of the draft Natural Resources Law charges the FDA with responsibility for the management and conservation of fish and wildlife. There reportedly is a jurisdictional conflict between the FDA and the Ministry of Agriculture over responsibility for this area, which previously was under the jurisdiction of Agriculture. The outcome of this debate should determine the final form of the Fish and Wildlife Law. The following is a general outline of those sections pertaining to the management of wildlife.

Subchapter L: Management of Wildlife Resources.

§ 3.10 Restricted areas.

- § 3.11 Control of dangerous diseases.
- § 3.13 Destructive or menacing wildlife.
- § 3.14 Endangered species.
- § 3.15 Buying and selling unlawfully taken wildlife.
- § 3.16 Unprotected wildlife.
- § 3.17 Hatching and breeding stations.
- § 3.18 Wildlife research.
- § 3.19 National Zoological Park.
- § 3.20 Game animals in captivity.
- § 3.21 Exportation of live game animals.
- § 3.22 Taxidermy.

Other subchapters include Hunting and Trapping Licences, Hunting, Trapping, and Pesticides.

An FAO consultant prepared a report for Liberia on fisheries legislation after the drafting of the law. The report was favorably received and will most likely lead to some changes in the draft law. The following are significant sections of the draft law pertaining to the management of fisheries:

Subchapter B: Management of Fish Resources.

- § 3.10 Restricted areas.
- § 3.11 Control of dangerous diseases.
- § 3.12 Polluting streams prohibited.
- § 3.14 Endangered species.
- § 3.15 Buying and selling unlawfully taken fish.
- § 3.16 Unprotected fish.
- § 3.17 Hatching and breeding stations.
- § 3.18 Fish research.

Other subchapters cover regulations for fishing and pesticides.

International Conventions. Liberia is not a signatory to the Convention on International Trade in Endangered Species (CITES). However, as a signatory to the African Convention on Conservation of Nature and Natural Resources, Liberia has pledged responsibility for the protection of animal and plant species that are threatened with extinction, or which may become so, and for the habitat necessary for their survival. Appendix 5 provides a list of species occurring in Liberia that are covered by the Convention.

Terrestrial Wildlife. The FDA estimates that 70% of the rural population supplement their protein diet with bushmeat (or their income from the sale of it). <sup>1/</sup> The nutritional value of bushmeat makes it a very important source of protein. The meat content of a carcass of wild animal is higher than that of cattle. However, serious depletion of wildlife throughout Liberia limits its potential as a significant protein source. Because ecological conditions in Liberia are unfavorable for large scale production of livestock, wildlife becomes all the more important as a future source of protein.

With proper management, particularly with respect to land use, wildlife could become a major protein resource. The secondary forests of Liberia could sup-

port a rich wildlife - their initially dense undergrowth is an excellent food reservoir for browsing animals. The woodland savannas of Liberia used to be inhabited by large herds of a wide range of grazing and browsing wild ungulates. Quantitative studies of the wild African ungulates utilizing savannas and marginal lands in the Congo and east Africa have shown that these animals are capable of reaching on poor pastures a standing crop biomass and a productivity which is many times higher than those obtained by domestic cattle on good grazing lands, and without adversely affecting the vegetation and soil. The northern savannas of Liberia have comparable precipitation and almost similar vegetation as the highly productive areas in the Congo and east Africa. In addition, Guinean woodland savannas are generally on poor soils and are not particularly suitable for optimal agriculture or pastoralism, but in undisturbed status they produce continuously a high yield of wild animals. Thus, the basic conditions exist for an equally high protein production in Liberia, provided the fauna can be restored. The actual situation in several west African national parks and nature reserves, where the depleted animal populations have recovered rapidly in number as soon as they became protected, clearly indicates that Liberia still has the potential to restore its wildlife.

Fisheries. The vast bulk of fishing today is done by ocean-going trawlers; most of them owned by, or under contract to, the Mesurado Fishing Company. The company has built up a system of refrigerated trucks and storage facilities which, together with cold storage facilities at Monrovia's port, have brought Liberian seafish to the interior. Marine shrimp fisheries are being exploited on an increasing scale. No information was available on freshwater fishing in the interior of Liberia. The following table, based on FAO estimates from the Yearbook of Fishery Statistics, outlines Liberia's fish catch for the years 1971-75.

Table 4. Total Fish Catch and Major Species (metric tons)

Fish	1971	1972	1973	1974	1975
<u>Major Species</u>					
Snappers	200	400	900	1008	1008
Croakers, Drums	500	900	400	423	423
Sardinellas	3000	3000	3000	3000	3000
Clupeoids	2000	2000	2000	2000	2000
Tuna-like fishes	5500	5500	5500	5500	5500
<b>Total</b>	<b>15800</b>	<b>16500</b>	<b>16500</b>	<b>16600</b>	<b>16600</b>

No information was available on specific problems with fisheries beyond a general reference to overfishing in the interior. The pollution of rivers by mining operations must also be having some negative effect on inland fisheries.

1/ Forestry Development Authority, 1978.

### III. NON-RENEWABLE NATURAL RESOURCES - USE AND CONSERVATION

#### A. Minerals

##### Introduction

The mining industry is the most important sector in Liberia's economy, with iron ore the most important product. Iron ore exports account for 60-70% of total export earnings. After averaging 30% of GDP between 1964 and 1974, its contribution declined to about 20% of GDP in 1977, and this decline is expected to continue into 1978. All mining production, which includes diamonds and gold, is exported. In 1975 Liberia had an iron ore production capacity of 25 million tons, making it the eleventh largest producer in the world.

##### Status of Information on Mineral Resources

Liberia was mapped by geologic and geophysical methods during the period 1965 to 1972 as part of a program undertaken cooperatively by the Liberian Geological Survey and the U.S. Geological Survey, under the sponsorship of the Liberian Government and U.S. AID. The resulting geologic and geophysical maps are published in ten folios, each folio covering one quadrangle (see Fig. 9). Field data gathered by project geologists were supplemented by data provided by private companies from their mineral exploration surveys and geologic mapping programs. Aerial photography, airborne magnetic and radiometric surveys of the entire country, and limited gravity data were utilized extensively in defining map units, determining location of contacts, extrapolating field data, and determining structural attitudes.

##### Mineral Resources

Resource Supply. The following is a general account of the known mineral resources of Liberia, by quadrangle, based on the country-wide survey described above (see Fig. 9).

Area 1 - Voinjama Quadrangle. The iron ore deposit in the Wologizi Range constitutes the major known mineral resource in the region. Reserves of low-grade iron ore are estimated to exceed 40 million tons; however, development of this deposit will entail a major investment in mining, processing, and transportation facilities. Bauxite in the form of nodules in surface cappings exists in scattered areas but the total amount known is small. Diamonds have been found in some localities, but to date production has been small.

Area 2 - Bopolu Quadrangle. Iron ore is mined at the Mano River mine, located in the southwestern part of the quadrangle. Production is chiefly from enriched itabirite, but minor amounts of ore are extracted from canga (an iron rich conglomerate) and from enriched laterite and iron-silicate formations. Numerous occurrences of itabirite, the dominant iron-formation, and extensive

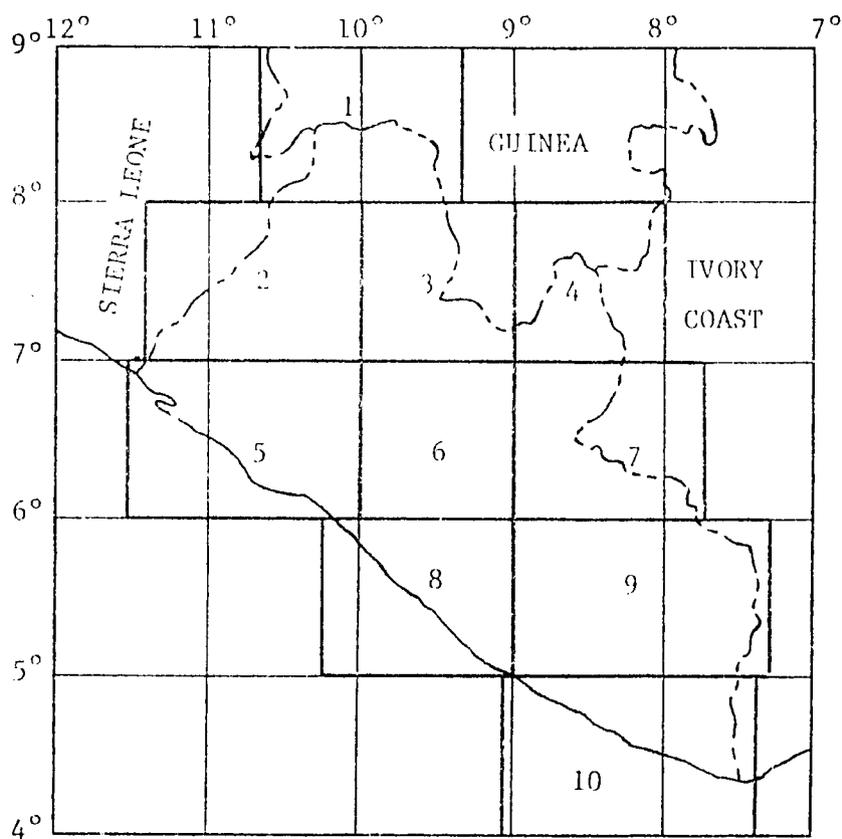


Figure 9. Geologic mapping of Liberia.

tracts of metamorphosed sedimentary and volcanic rocks with which iron-formation is commonly associated, are in the Bea and Tokani Mountains and throughout the Kpo Range. They represent potentially large iron ore reserves. Diamonds have been found in placer deposits along the Lofa and Mano Gbeya river systems, and in the Zoi-Kungbo area. Many of the placers contain minerals such as picroilmenite, pyrope-garnet, and chrome-diopside that are characteristic of kimberlite.

Area 3 - Zorzor Quadrangle. Gold has been mined from alluvial deposits along tributaries of Zaya and Mawi creeks in the Kiliwu-Zolowo area 10-20 km southwest of Zorzor. Production in the area has been on a small scale. Gold has been found in many other parts of the quad, but not in deposits that warrant extensive development. Diamonds have been mined on a small scale in the region near Zorzor. Itabirite and Iron-formation occur in the quad, but the quantity and grade are not sufficient for commercial exploitation.

Area 4 - Sanokole Quadrangle. At Mt. Nimba, hematite and goethite iron ores are being mined by LAMCO. Deposits at Mount Nimba are estimated at 250 million tons of 67% iron content, and 700 million tons at 40-45% iron content. Predom-

inantly magnetite ore at Mt. Tokade and goethite ore at Mt. Gbahrn are also being mined by LAMCO. Large iron resources are present at Mts. Yulitohn and Kitoma. Diamonds are being recovered from graphite schist and adjacent muscovite gneiss at Gbapa and from derived alluvial deposits, which occupy the present drainage basins of Yaa River and Ya, Boo, and Nzra Creeks.

Area 5 - Monrovia Quadrangle. High grade magnetite ore and itabirite are being mined at Bomi Hills by the Liberia Mining Company, and itabirite in the Bong Range by the Bong Mining Company. Reserves of high grade magnetite at Bomi Hills are expected to be exhausted in the near future. Iron-formation also occurs in the Goe-Fantro Ranges and their northwesterly extension. Deposits of kyanite have been found at Mt. Montro and barite veins have been described near Gibi Mountain. Possible commercial deposits of heavy minerals are found in beach sands near Robertsport, Monrovia, and Marshall. Diamonds are mined from placer deposits near Kakata and Bomi Hills and from gravels along the Lofa River.

Area 6 - Gbanka Quadrangle. No mining is known to have been conducted in the quadrangle. At Green Hill typical gneiss has been quarried for railroad-bed material. Cassiterite-bearing granular veins occur with pegmatites along shear zones and in the southern part of the St. John Range. Geochemical anomalies of tin have been shown in stream sediments near the northern part of the St. John Range.

Area 7 - Zwedru Quadrangle. Based on the wide distribution of itabirite and magnetic quartzite in Gbi Range, and the large associated magnetic anomaly, the iron-formation here is a possible resource. Quartzite containing much coarse-grained kyanite is apparently interlayered with iron-formation. The only current mining activity in the quadrangle is minor panning of diamonds from alluvium along Zina Creek near Leputa.

Area 8 - Buchanan Quadrangle. Diamonds are mined on a small scale in placers near Chom at Grand Buto Point. Heavy minerals in the beach sands between Bafu Bay and Greenville may be of commercial value.

Area 9 - Juazohn Quadrangle. Gold is common in placer deposits of gneiss and molybdenum is locally present in the gneiss unit. Itabirite occurrences are being explored in Jide Mountain by the German-Liberian Mining Company.

Area 10 - Harper Quadrangle. Mining has been limited to small amounts of placer gold from a few streams within the schist zones. Although manganese oxides are concentrated in the weathered zone of manganese-rich metasedimentary carbonate and siliceous rocks within the schist zones, none are known to be of commercial value. Bedrock quarry material for construction purposes is available in the vicinity of the larger villages and towns along the coast and can be obtained from some of the many inland ridges and hills. Siliceous laterite soil, a good unprocessed road surfacing material, is sparse within a coastal belt 15-25 km wide, but the soil is abundant in much of the interior region.

Demand on Mineral Resources.Table 5. Mineral Exploitation, 1974-76 1/

	1974	1975	1976
Iron ore ('000 metric tons) <u>1/</u>	14,920	13,770	14,010
Diamonds ('000 carats) <u>2/</u>	636	406	320
Gold (kg)	90	140	n.a.

1/ Metal content.2/ Exports only.Exploitation and Management

Legal and Institutional Framework. Chapter 6 of the draft Natural Resources Law covers the exploitation and management of mineral resources, which is the responsibility of the Ministry of Lands and Mines. All minerals, except non-metallic construction materials, are property of the state. Liberia has been without a formal mining code, which the World Bank believes may have minimized interest in Liberia's mineral resources (other than iron ore) on the part of international mining companies.

Concessions. The iron ore mining industry is composed of three massive mining operations, all of which are foreign owned and controlled. The largest is the Liberian American-Swedish Minerals Company (LAMCO) which exploits the rich Nimba mountain deposits on the Guinea border. In 1974, its output accounted for 52% of total production. Other mining concerns include the German-Liberian Mining Company (DELIMCO), which operates in the Salala District in the southwest part of Bong County and accounts for 26% of production, and the National Iron Ore Company (NIOC) which operates the Mano River mine in Grand Cape Mount County, 14% of production. Concession agreements for the development and exploitation of three other iron ore sites - the Wologisi range, the Putu range and Gbie Mountain - have been concluded or are in various stages of negotiation.

1/ Europa Publications, 1979.

#### IV. PARKS, RESERVES, AND EQUIVALENT PROTECTED AREAS

##### A. Introduction

Chapter 2 of the draft Natural Resources Law (subchapter B) empowers the Forestry Development Authority and the President of the Republic "to create and establish National Parks embracing any area of the country having such outstanding scenic, recreational, scientific or other pertinent values that it is deemed wise and expedient in the national interest to set aside as permanent parks to be retained insofar as is practicable in their existing condition." In addition, as a signatory to the African Convention on Conservation of Nature and Natural Resources, Liberia has agreed to certain conservation obligations and measures. Article 10 - "Conservation Areas" - of the Convention states: "The Contracting States shall maintain and extend where appropriate, within their territory and where applicable within their territorial waters, the Conservation areas existing at the time of entry into force of the present Convention and, preferably within the framework of land-use planning programmes assess the necessity of establishing additional conservation areas in order to:

- (i) protect those ecosystems which are most representative of and particularly those which are in any respect peculiar to their territory,
- (ii) ensure conservation of all species and more particularly of those listed or may be listed in the annex to this Convention."

In 1969 a representative of the International Union for Conservation of Nature and Natural Resources (IUCN) submitted a report to the Government of Liberia outlining a plan for the conservation, management, and utilization of wildlife. The plan included recommendations on the establishment of a system of national parks and nature reserves. <sup>1/</sup> The plan was approved by the Ministry of Agriculture in 1971 and by the President and his Cabinet the following year. Phases of this plan are being implemented, beginning in 1976 with the training of two Agriculture staff members at the College of Wildlife Management at Mweka, Tanzania. The former Bureau of Forest Conservation within the Ministry of Agriculture had already planned prior to 1969 three areas to be set aside as national parks, and these three areas were incorporated into the recommendations of the IUCN report. However, despite official acceptance of the plan's recommendations, none of these planned reserves has been created, nor has any type of protected area been established in Liberia.

##### B. Recommended Areas for National Parks and Nature Reserves

The following are the three areas already planned as national parks.

Mount Wituvi. Located in the Wologisi Range in northwestern Liberia, of which it is the highest massif and dominant feature, covered by high forest. The

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<sup>1/</sup> Curry-Lindahl, 1969.

area also includes the foothills down to the Lofa River. Elephants and other large mammals occur.

Bokoma. This area is located within the Kpo Range in western Liberia. It is a scenic area with a spectacular waterfall and is rich in birds.

Tiempo. This area is located in southeastern Liberia and is the largest of the planned national parks.

Several other areas have been singled out for their economic, social, recreational, educational, scientific or aesthetic value. These include:

Nimba Range. The Nimba Range is a biologically invaluable area containing virgin forest and a distinctive animal life. At least 200 species of animals are endemic to this area, as well as several plant species. Contiguous parts of the Nimba Range in Guinea and the Ivory Coast have long been designated as a strict nature reserve, a category which, as far as protection goes, ranks higher than national parks. Scientists and international organizations such as Unesco, UNEP, and IUCN have been very active in this area because of its special value for the study of ecology, evolution, and speciation. Through the Institut Fondamental d'Afrique Noire (IFAN) in Guinea and the Ivory Coast, a series of geographical and biological monographs on Mount Nimba have been published. Botanical, zoological and ecological research conducted by the Nimba Research Committee of the IUCN at the Nimba Research Laboratory in Grassfield has made the Nimba Range, as far as the flora and fauna are concerned, the best explored area of Liberia.

The protection of the Liberian side of Nimba is thus the most urgent conservation measure facing the Government, particularly in view of the threats posed by mining and logging concessions in the area. The Iti Valley, with surrounding slopes and ridges of the Nimba Range, was singled out as an especially important site for protection.

Cape Mount. This hilly area on the coast of Liberia is situated close to settlements and relatively easy reach of Monrovia. The area has been recommended as a reserve for future tourist development.

Forests, mountains, hills, and lowlands around the Lofa River. This area, in northwestern Liberia, could be combined with the Mount Wutivi National Park and include the Wologisi Range.

Putu Range. The Putu Range and surrounding forests in eastern Liberia westwards beyond the Cestos River represents one of the largest remaining forest blocks of West Africa. The Putu Range is likely to be exploited and at least partly destroyed by mining.

Region between lat. 6.5 and 5.5 degrees north along the Cavalla River. This is a high forest area with elephants, hippopotamus, buffalo, many species of antelope, leopards, and many other animals. Due to the low human population density in this area, it probably has the richest and best preserved animal life in Liberia.

Representative swamp and delta areas.

## V. ENVIRONMENTAL PROBLEMS AND IMPACTS

### A. Introduction

Legal and Institutional Framework. Liberia does not have a centralized government agency responsible for the monitoring and control of pollution. In 1977, a new Public Health Law was enacted as Title 33 of the Revised Code. Chapter 24 covers water pollution control, with "water" construed to include:

"...lakes, bays, sounds, ponds, impounding reservoirs, springs, wells, rivers, streams, creeks, estuaries, marshes, inlets, canals, the Atlantic Ocean within the territorial limits of the Republic and all other bodies of surface or underground water, natural or artificial, inland or coastal, fresh or salt, public or private."

The Ministry of Health is charged with enforcing the provisions of this law, which include:

- a prohibition against the discharge of sewage, industrial or agricultural waste or other wastes into any of the waters of the Republic, unless granted permission by the Minister of Health;
- procedures for obtaining such permission;
- a strict prohibition, without reservations, against the pollution of drinking water supplies.

Chapter 3 (fish and wildlife) of the draft Natural Resources Law contains a section prohibiting the pollution of public or private waters from any industrial or agricultural waste or other harmful substance in quantities injurious to fish life, protected wildlife or waterfowl in those waters.

Chapter 21, "Nuisances," contains two general provisions that can be applied to pollution of the air. Under these two provisions, "local authorities" are responsible for regulating and controlling:

- any vehicle which is in such a state of condition as to be prejudicial, injurious or dangerous to health;
- any factory or trade premises causing or giving rise to smells or effluvia which are prejudicial, injurious or dangerous to health.

The Ministry of Health is the government's public health administration. Headed by a Minister with cabinet rank, the Service has three main bureaus: the Bureau of Curative Services, which includes hospitals and dental services; the Bureau of Preventive Services; and the Bureau of Planning and Development. Below the national level the Ministry lacks an infrastructure, with local bodies responsible for the immediate administration of hospitals and clinics. As of 1976, the Ministry of Health had a Division of Environmental Health responsible for environmental problems associated with urban and rural water supply and human settlements.

## B. Sanitation and Water Supply

Poor sanitation is the main environmental factor affecting the level of public health in both rural and urban areas. The most serious problems include lack of sanitary piped water, lack of waste water and sewage treatment plants, poor sanitation and sewage systems, and improper disposal of human waste. Piped water is only available in four county capitals. Water supply is usually limited to open sources such as streams, swamps and shallow, uncovered wells. Water borne insect vectors of disease thrive in such conditions and are a leading cause of debilitating disease. The problem is particularly severe during the rainy season when the rivers overflow their banks and create stagnant pools which are breeding grounds for many vectors of disease such as sleeping sickness, malaria, and schistosomiasis. As with surface waters, groundwater supplies can be a source of environmental health problems. Wells dug for domestic use frequently become contaminated because of location, misuse, waterborne parasites, etc.

Sanitation in the cities and towns is wholly inadequate. Monrovia is the only city in Liberia with a sewage treatment system. Yet, a recent World Bank study noted that 5,000 gallons of liquid human waste and twenty tons of solid human waste are improperly disposed in public areas of Monrovia daily. The poor state of sanitation stems from a chronic lack of funds to support adequate programs such as the building of safe water supplies, sewerage systems, and the drainage of swamps.

## C. Water Pollution

Villages and industries have developed along the rivers and lakes, which has led to other pollution problems. The Mano and St. John Rivers are becoming increasingly polluted by iron ore dust and other residues of the iron ore production process. The dumping of iron ore tailings into these rivers creates a stony red or yellow iron precipitate. Investigation of LAMCO's mining area in Nimba revealed three sources of contamination: a wash-off of tailings into the rivers by heavy rains; yellow clay precipitate from ore of lateritic origin in water washing down the mountainside; and run-off from hematite ore.

The coastal waters of Liberia, and of the Gulf of Guinea in general, are becoming increasingly polluted. Oil is the most serious pollutant and is the result of residue from large oil tankers, oil cargo handling and off-shore drilling of petroleum. Increased development along the coast and the subsequent increased dumping of untreated sewage and waste water are also contributing to the pollution problem. In response to the growing pollution of the Gulf, nineteen West African countries have joined together with the World Health Organization and other U.N. agencies to set up a program to tackle the problem. Under this joint effort, a coastal water quality program is planned involving four stages: assessment of the degree of pollution; determination of water quality; establishment of criteria for defining "acceptable risk"; and the development of control strategies and appropriate legislation.

#### D. Air Pollution

There are two prime sources of air pollution in Liberia - smoke from slash and burn agriculture, and dust from lateritic roads. Slash and burn agriculture produces low to moderate levels of air pollution as a result of smoke created during the burning process. The burning takes place during the dry season when there is little wind and, as a result, smoke mixed with natural haze occurs from approximately 152 to 610 meters (500 to 2,000 feet) above ground. Harmful effects to the human population are kept to a minimum because of (1) the relatively short period of about one month when the smoke is prevalent, (2) the wide dispersal of the small farms on which the burning takes place, and (3) the distances between the upland farms and the centers of population.

A minor amount of dust is created during land clearing and cultivation. The prime source of dust is the movement of traffic and machinery on existing roads. Most roads are made of laterite and produce clouds of red dust during dry periods. A thick coating of this dust can be seen on vegetation and buildings paralleling the roads.

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Appendix 1 - Demographic Data 1/

Total population, mid-1979 estimate: 1,776,000

Average annual growth rate, 1968-1978: 3.1%

1978: 3.3%

Crude birth rate/1000 population, 1977: 49.7

Crude death rate/1000 population, 1975: 20.0

Population by age and sex, 1975: 2/

	Female	Male	Total
Less than 1 year .....	29,000	30,000	59,000
1 to 4 years .....	103,000	103,000	206,000
5 to 14 years .....	194,000	188,000	382,000
15 to 64 years .....	425,000	409,000	834,000
Over 64 years .....	27,000	25,000	52,000
Total .....	778,000	755,000	1,533,000

Population density per sq km, 1979: 18.5

Population density per sq km of agricultural land, 1979: 343

Urban population as % of total, 1974: 29% 3/

Urban population growth rate, 1974: 7.9% 3/

Projected population in year 2000: 3,265,000 2/

Projected urban population as % of total in year 2000: 42% 2/

The World Bank estimates that Liberia will achieve a net reproduction rate of 1 in 2040.

1/ Unless otherwise noted, figures are from "Selected AID Official Data," in Agency for International Development, 1979a.

2/ Tsui, 1979.

3/ 1974 Census.

Population and Regional Distribution (1962-1974)  
(County and Major Urban Areas)

County (Urban Area)	Area Sq Km	Population		Annual Growth Rate 1962-74 %	Share of Population 1974 %
		1962	1974		
Bong (Gbarnga)	9,453	131,528 3,962	194,191 8,474	3.3 6.5	12.9
Grand Bassa (Buchanan)	13,144	131,840 11,909	150,926 24,375	1.1 6.2	10.0
Grand Cape Mount (Porkpa Dist.)	5,827	32,190 6,915	56,604 20,395	4.8 9.4	3.8
Grand Gedeh	17,029	59,275	71,825	1.7	4.8
Lofa	19,360	123,165	180,737	3.2	12.0
Maryland (Harper)	4,338	62,786 6,095	91,619 11,715	3.2 5.6	6.1
Montserrado (Monrovia)	6,604	258,821 80,992	439,997 204,213	4.5 8.0	29.3
Nimba (Yarmien clan)	12,043	160,743 11,637	249,702 31,938	3.8 8.8	16.6
Sinoe (Greenville)	11,266	56,095 3,962	67,599 8,474	1.6 6.6	4.5

Appendix 2 - Social and Economic Data 1/Social DataAverage life expectancy, 1973: 43.5Female life expectancy, 1973: 45.1Male life expectancy, 1973: 41.9Infant deaths during first year of life/1000 infants, 1972: 148Population per physician, 1974: 10,697Population per nursing person, 1970: 4,140 2/Population per hospital bed, 1970: 530 3/Population with reasonable access to safe water supply, 1975: 20%Population with access to excreta disposal, 1970: 19% 3/Rural population with access to excreta disposal, 1970: 9% 3/Per capita calorie supply as a % of requirements, 1973: 86%Average daily per capita protein intake in grams, 1970: 36Literacy rate, 1972: 24%Total school enrollment as a % of population in age group:Primary (ages 5-14), 1975: 41.3% Male: 53.3% Female: 29.4%Secondary (ages 15-19), 1975: 22.3% Male: 33.5% Female: 11.1%Post secondary (ages 20-24): 1.8% Male: 2.8% Female: 0.7%Economic Data 4/Per capita GNP (US\$, 1974-76 base period), 1977: 420Average annual per capita real GNP growth rate, 1960-77: 1.8%Dependency ratio, 1970: 1.0 2/

1/ Unless otherwise noted, figures are from "Selected AID Official Data," in Agency for International Development, 1979a.

2/ "IBRD Social Data," in Agency for International Development, 1979a.

3/ "World Bank Economic and Social Data," in Agency for International Development, 1979a.

4/ For more detailed economic data, see Ibid.

Economic Data, cont'd.Proportion of labor force in agriculture, 1977: 73%Agricultural production as % of GDP, 1976: 30%Avg annual per capita agricultural production growth rate, 1970-78: 1.2%Energy production as % of consumption, 1976: 6%Gross Domestic Product(GDP) and Employment By Sector

Sector	GDP (\$ million - current prices)		Employment
	1975 %	1976* %	1974 %
<u>Monetary Economy</u>			
Agriculture, Forestry & Fishing	9.1	9.9	17.2
- Rubber	5.5	5.3	
- Forestry	1.7	2.4	
- Other	2.0	2.2	
Mining & Quarrying	26.0	24.2	4.0
- Iron Ore	24.6	23.1	
- Other	1.4	1.1	
Manufacturing	4.5	4.4	1.6
Construction	4.5	4.5	.8
Government Services	6.6	6.7	5.2
Other	<u>34.0</u>	<u>34.8</u>	<u>11.2</u>
Total Monetary Economy	84.7	84.6	40.0
Traditional Economy	<u>15.3</u>	<u>15.4</u>	<u>60.0</u>
Total GDP	100.0	100.0	100.0

\*Preliminary  
World Bank Mission figures.

Agricultural Production, 1970-78 ('000 metric tons)

Commodity	1970	1972	1974	1976	1978
Rice .....	138	152	249	245	275
Corn .....	11	11	11	11	11
Cassava .....	235	244	258	275	295
Sweet potatoes ....	9	10	10	10	10
Yams .....	8	8	8	8	8
Cocoyams .....	9	9	9	9	10
Groundnuts .....	2	2	2	2	2
Bananas .....	60	64	65	69	73
Plantains .....	24	26	28	30	32
Pineapples .....	7	7	7	7	7
Coffee .....	5	5	4	5	4
Cocoa beans .....	2	2	3	3	3
Rubber .....	83	83	86	82	105
Palm oil .....	14	17	14	20	22
Palm kernels .....	15	15	18	15	15
Meats .....	3	4	4	4	4

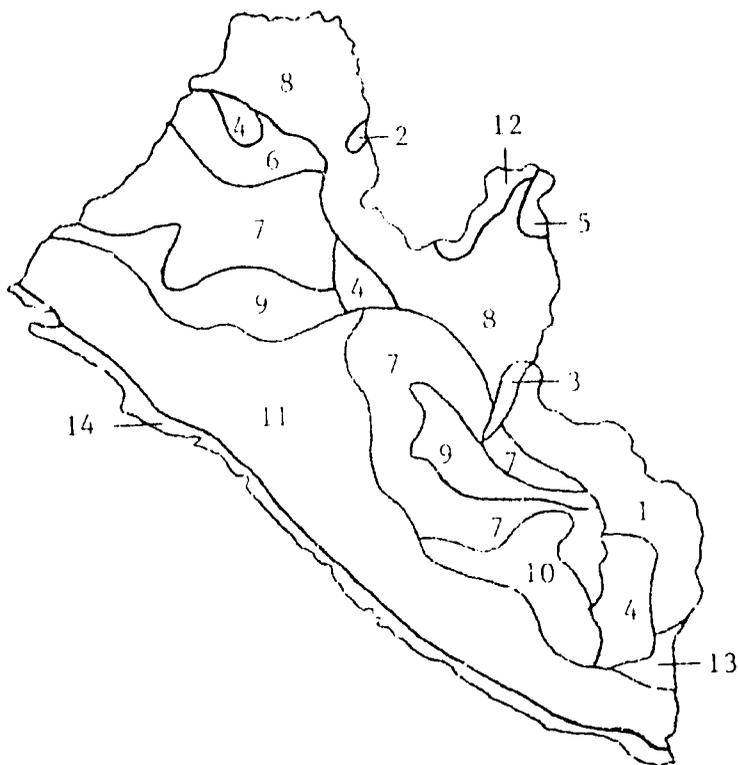
Livestock Population

Type of livestock	Number in the Country	% of holdings Raising
Cattle .....	25,000	2
Pigs .....	38,000]	
Sheep .....	48,000]	10
Goats .....	133,000]	
Chicken .....	2,000,000	10

Ministry of Planning, External Trade of Liberia, 1976.

Appendix 3 - Soils

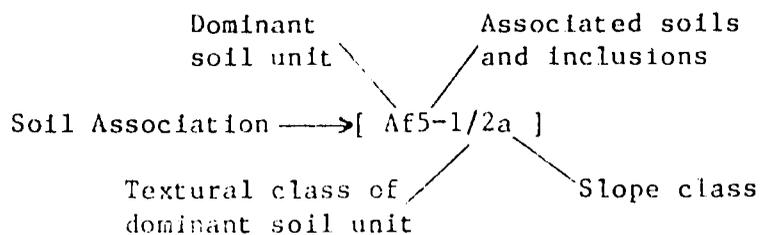
Shown below is a general soil map of Liberia, from the FAO Soil Map of Africa, illustrating the distribution of the major soil associations throughout the country.



Soil map of Liberia.

Key to Soil Map

Example:



Associated soils: Subdominant soils with an extension of more than 20% of the mapping unit.

Inclusions: Inclusions of important soils occupying less than 20% of the mapping unit.

6

Slope class: Topography in which a soil association occurs; 'a' denotes a slope of 0-8% (level to undulating), 'b' a slope of 8-30% (rolling to hilly), and 'c' a slope of more than 30% (steeply dissected to mountainous).

Phase: A subdivision of a soil series having characteristics that affect the use and management of the soil but which do not vary sufficiently to differentiate it as a separate series.

Petric phase: Shows the presence of indurated layers (concretionary horizons) within 100 cm of the surface.

Saline phase: Shows that certain soils of the association (not necessarily the dominant) are affected by salt to the extent that they have a conductivity greater than 4 mmhos/cm in some parts of the soil within 125 cm of the surface for some part of the year. The phase is intended to mark present or potential salinization.

1. Af5-1/2a

Dominant soil: Ferric Acrisols, coarse to medium textured.

Associated soils: Orthic Acrisols and Dystric Nitosols; level to undulating.

Phase: Petric.

Extension: 836,000 ha.

Vegetation: Tropical lowland rain forest.

2. Bf2-3a

Dominant soil: Ferralic Cambisols, fine textured.

Associated soils: Rhodic Ferralsols; level to undulating.

Extension: 21,000 ha.

Vegetation: Tropical semi-deciduous rain forest and moist savanna.

3. Bf3

Dominant soil: Ferralic Cambisols, fine textured; with Lithosols.

Associated soils: None listed.

Extension: 35,000 ha.

Vegetation: Tropical lowland rain forest.

4. Bf3-2b

Dominant soil: Ferralic Cambisols, medium textured, with Lithosols; rolling to hilly.

Associated soils: None listed.

Extension: 77,000 ha.

Vegetation: Tropical lowland rain forest.

5. Bf7-2b

Dominant soil: Ferralic Cambisols, medium textured.

Associated soils: Humic Cambisols and Humic Ferralsols, with Lithosols; rolling to hilly.

Extension: 35,000 ha.

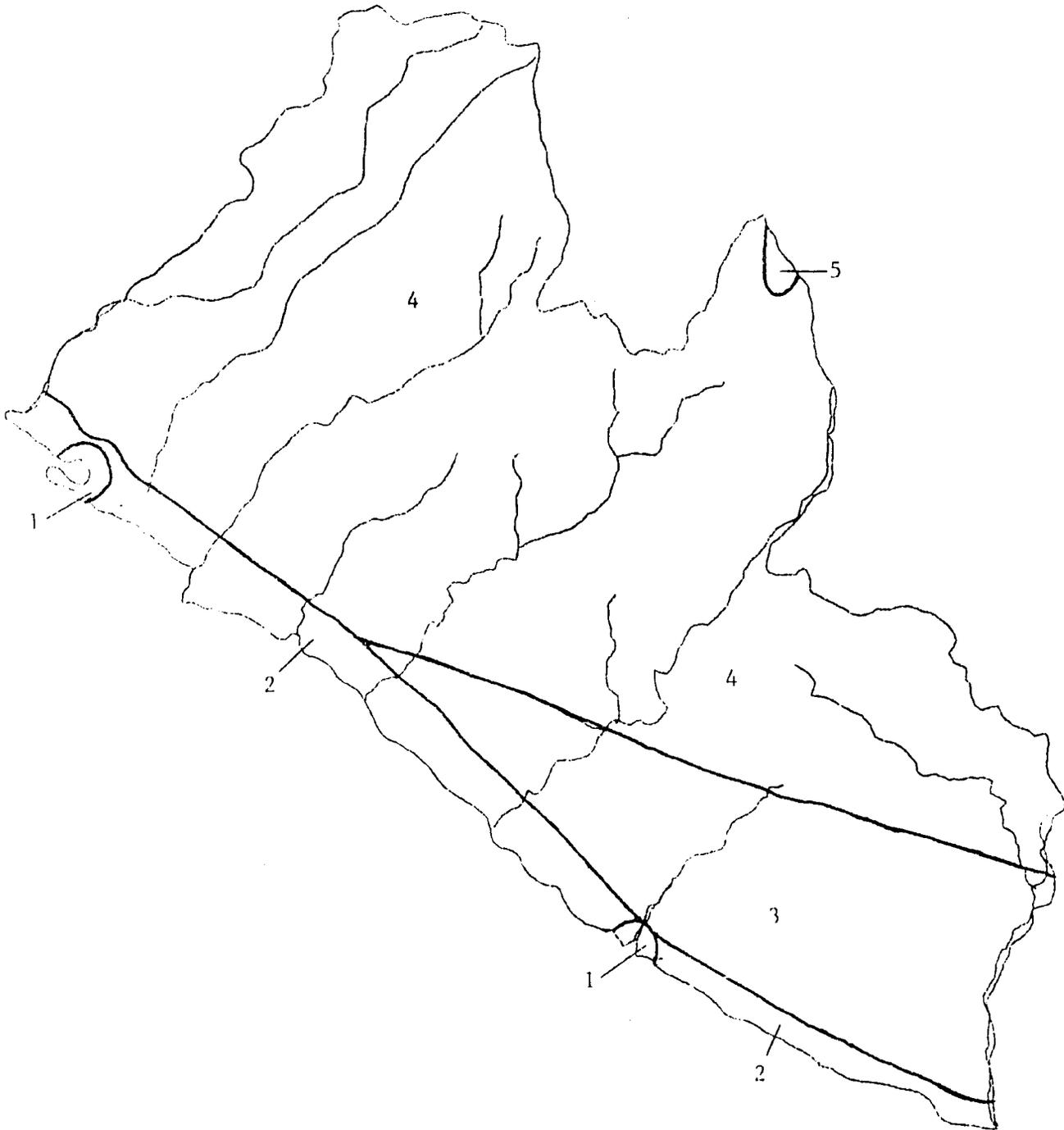
Vegetation: Tropical lowland rain forest.

6. Fh7-3b  
Dominant soil: Humic Ferralsols, fine textured.  
Associated soils: Xanthic Ferralsols and Humic Gleysols; rolling to hilly.  
Phase: Petric.  
Extension: 327,000 ha.  
Vegetation: Tropical lowland rain forest.
7. Fo45-2b  
Dominant soil: Orthic Ferralsols, medium textured.  
Associated soils: Xanthic Ferralsols and Humic Gleysols, with Lithosols; rolling to hilly.  
Phase: Petric.  
Extension: 2,292,000 ha.  
Vegetation: Tropical lowland rain forest.
8. Fo46-3bc  
Dominant soil: Orthic Ferralsols, fine textured.  
Associated soils: Rhodic Ferralsols and Humic Gleysols, with Eutric Cambisols, Eutric Fluvisols and Dystric Nitosols; rolling to hilly and steeply dissected to mountainous.  
Phase: Petric.  
Extension: 1,759,000 ha.  
Vegetation: Tropical lowland rain forest.
9. Fp6-2b  
Dominant soil: Plinthic Ferralsols, medium textured.  
Associated soils: Xanthic Ferralsols, with Dystric Gleysols, Lithosols, and Dystric Nitosols; rolling to hilly.  
Phase: Petric.  
Extension: 913,000 ha.  
Vegetation: Tropical lowland rain forest.
10. Fx7-3b  
Dominant soil: Xanthic Ferralsols, fine textured.  
Associated soils: Orthic Acrisols and Orthic Ferralsols, with Plinthic Acrisols; rolling to hilly.  
Phase: Petric.  
Extension: 505,000 ha.  
Vegetation: Tropical lowland rainforest.
11. Fx12-2ab  
Dominant soil: Xanthic Ferralsols, medium textured.  
Associated soils: Orthic Acrisols, Plinthic Ferralsols, and Humic Gleysols, with Dystric Gleysols and Lithosols; level to undulating and rolling to hilly.  
Phase: Petric.  
Extension: 3,348,000 ha.  
Vegetation: Tropical semi-deciduous rain forest.

12. I-Fo-2bc  
Dominant soil: Lithosols, medium textured and Orthic Ferralsols; rolling to hilly and steeply dissected to mountainous.  
Associated soils: None listed.  
Extension: 70,000 ha.  
Vegetation: Tropical semi-deciduous rain forest.
13. I-Fx-1ab  
Dominant soil: Lithosols, coarse textured, and Xanthic Ferralsols; level to undulating and rolling to hilly.  
Extension: 523,000 ha.  
Vegetation: Tropical lowland rain forest.
14. Rd17-1a  
Dominant soil: Dystric Regosols, coarse textured.  
Associated soils: Ferralic Cambisols, with Lithosols; level to undulating.  
Phase: Saline.  
Extension: 362,000 ha.  
Vegetation: Tropical semi-deciduous rain forest and tussock steppe.

Appendix 4 - Biogeographical Map of Liberia

The map shown below and accompanying key illustrate the distribution of the major forest types in Liberia. 1/



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2/ From IUCN, 1979.

1 Mangrove

Forest vegetation confined to marine and fluvial intertidal areas, regularly flooded with salt or brackish water. Dominant tree species include: Rhizophora racemosa, R. harrisonii, R. mangle, and Avicennia nitida. No extensive areas of mangrove forest remain. Persson estimated the total remaining area to be 200,000 ha, including coastal forest.

2 Guineo-Congolian lowland rain forest/secondary grassland mosaic

The coastal region is dominated by secondary grassland derived from rain forest. The coastal areas are heavily settled and have been extensively cultivated. Due to the poor quality of the sandy soil, grass invaded the farmed-over areas that were left to revert to bush fallow to restore fertility. These grassy areas were burned over during the dry season which frequently killed off the less resistant forest species.

3 Wet evergreen lowland rain forest

Extending inland from the coastal region up to about 80 km is the belt of broadleaf evergreen rain forest. This forest type covers a narrow band along the Atlantic coast and is characterized by a very rich and distinct endemic flora. All the trees are broadleaved and are covered with foliage year-round, though their leaves are shed intermittently throughout the year. Undisturbed, the evergreen forest has a closed canopy, often in several layers, with the taller trees often reaching 60 m in height and allowing little undergrowth. Among the more common species are ironwood (Lophira procera), wismore (Parrietia utilis), African pine (Diacalotia spp.), Entandrophragma utile, Mimusops heckelii, Canarium Schweinfurthii, and Terminalia superba.

4 Mosaic of evergreen and semi-evergreen lowland rain forest

Beyond the wet evergreen forest is the belt of mixed tropical rain forest, separated by a narrow transitional forest zone consisting of both evergreen and deciduous species. Typical species in this zone include Terminalia ivorensis, Clorophora excelsa, Piptadenia africana, and several Azelia spp. Beyond this zone, deciduous species increase in number with the decreasing level of rainfall and generally high level of humidity. Most individuals of larger trees are deciduous, but often only for 1-2 weeks in the dry season. Individuals of the same species shed their leaves at different times so that the forest continues to show an evergreen nature, though the dominant species are different and the growth is not so dense. In addition to the species mentioned above, other species typical of this zone are Triplochiton scleroxylon, Sarcophalus Diderichii, Lovoa Klaineana, Khaya ivorensis, and K. anthotheca. This zone encompasses the bulk of Liberia's forests, and it is here that the country's most valuable commercial timber is found.

5 Montane forest/secondary grassland mosaic

In the northern highlands is a kind of transition zone between the fringe of the rain forest and the Guinean woodland savanna composed of mixed montane

forest and secondary grassland. The montane forest of the Nimba range is composed almost entirely of species that also occur in the lowland rain forest, though they may be of restricted occurrence there. The forest on the lower slopes is generally semi-deciduous, often degraded, with Triplochiton scleroxylon and Chrysophyllum perpulchrum. Over 900 m the forest is confined to ravines, with Parinari excelsa (sporadic in the lowland rain forest) and abundant Syzygium staudtii in the high altitude ravines. The crests are covered with sub-montane savanna with Acidanthera aequinoctialis, Gladiolus unquiculatus, Eupatorium africanum, Disa subaequalis, and Protea angolensis. The portion of the Nimba area extending across Guinea and the Ivory Coast was declared a strict nature reserve in 1944. This represents the only protected montane area in west Africa.

Appendix 5 - Liberian Species Listed in the African Convention on Conservation of Nature and Natural Resources

As a signatory to the African Convention on Conservation of Nature and Natural Resources, Liberia has assumed responsibility for the protection of animal and plant species that are threatened with extinction, or which may become so, and for the habitat necessary for their survival. These species are listed in Class A or B of the Annex to the Convention according to the degree of protection required:

Class A. Species in Class A are to be totally protected throughout the entire territory of the country. The hunting, killing, capture, or collection of specimens is to be permitted only by the highest competent authority and only if required in the national interest or for scientific purposes;

Class B. Species in Class B are to be totally protected, but may be hunted, killed, captured, or collected under special authorization granted by the competent authority.

The following Liberian species are listed in Class A:

Diana monkey (Cercopithecus diana)  
 Chimpanzee (Pan troglodytes)  
 African palm squirrels (Epixerus)  
 Water civet (Osbornictis piscivora)  
 African golden cat (Felis aurata)  
 West African manatee (Trichechus senegalensis)  
 Pygmy hippopotamus (Choeropsis liberiensis)  
 Jentink's duiker (Cephalophus jentinki)  
 All pelicans (Pelecanidae)  
 All storks, hammerkops, ibises, spoonbills, herons, egrets, and bitterns (Ciconiidae, Scopidae, and Ardeidae)  
 Secretary bird (Sagittarius serpentarius)  
 All vultures (Aegyptus, Gyps, Pseudogyps, and Torgos)  
 Crowned hawk-eagle (Stephanoetus coronatus)  
 All cranes (Gruidae)  
 Abyssinian ground hornbill (Bucorvus abyssinicus)  
 White-headed guineafowl (Agelastes meleagrides)  
 White-necked rockfowl (Picathartes oreas)  
 Gray-necked rockfowl (P. gymnocephalus)  
 All marine turtles (Cheloniidae and Dermodochelyidae)  
 Cameroon toad (Bufo superciliaris)  
 Viviparous toad (Nectophrynoides occidentalis)

The following species are listed in Class B:

All shrew otters (Potamogalidae)  
 All prosimians of the family Lorisidae  
 All monkeys except common baboons  
 Giant pangolin (Manis gigantea)

Tree pangolin (M. tricuspis)  
Long-tailed tree pangolin (M. longicaudata)  
All otters of the subfamily Lutrinae  
Serval (Felis serval)  
Leopard (Pantherus pardus)  
Aardvark (Orycteropus afer)  
Elephant (Loxodonta africana)  
Giant forest hog (Hylochoerus meinertzhageni)  
Hippopotamus (Hippopotamus amphibius)  
Water chevrotain (Hyemoschus aquaticus)  
Sitatunga (Tragelaphus spekei)  
Bongo (Boocercus eurycerus)  
Buffalo (Syncerus caffer)  
Banded duiker (Cephalophus zebra)  
Royal antelope (Neotragus pygmaeus)  
Dwarf antelope (N. batesi)  
All birds of prey and owls which are not in Class A  
All bustards  
All crocodiles