Environmental Profile of Paraguay

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Foreword

Development is synonymous with quality of life, which includes and indeed demands environmental quality. The Technical Planning Secretariat has, since its inception, drafted development plans with this perspective in mind. Thus the Secretariat has been interested in learning of Paraguay's natural resource potential as well as the various ways in which these resources are and can be used and conserved. Development plans have always favored avoiding environmental degradation through sound natural resource policy.

Conservation and preservation of our natural wealth guarantees future generations the possibility of producing goods in a comfortable, appropriate habitat.

Environmental protection is the responsibility of all Paraguayans, individually and collectively, and of all public and private institutions. Conservationist considerations should prevail over secondary activities of such institutions. Thus environmental protection implies the need to be aware of the importance of the environment and of its fundamental role in day-to-day life. Such awareness is key if environmental quality is to be safeguarded.

This document has been drafted to satisfy a deeply felt need: to have before us a comprehensive study of environmental aspects of Paraguay, so as to be able to come to important conclusions and set forth proposals and recommendations in order to achieve conservation and preservation of the Paraguayan environment.

Federico Mandelburger
Executive Secretary

In this day and age, almost all countries recognize that it is impossible to raise the standard of living without rational use of natural resources and the environment. The Government of the United States, through the Agency for International Development (AID), has developed the Environmental Profile to help countries design development plans based on sound natural resource use. This, in turn, will assure adequate living conditions for today's populations and future generations.

It is a great honor to note that during my tenure as Ambassador of the United States to Paraguay, the Environmental Profile of Paraguay was carried out. The study was done by the Technical Planning Secretariat, in cooperation with the International Institute for Environment and Development.

I have had many opportunities to become familiar with Paraguay's natural environment: the beautiful landscapes of the national parks, the forests, the pure air and the many rivers and streams. I have also noted the tremendous diversity of wildlife in this most beautiful country. Above all, out of a personal interest, I have been able to admire the abundance of splendid birds. Because of all these, I consider this Environmental Profile to have raised expectations of future achievements.

I hope that this document is not considered an end in itself, to be put on the shelves of a library and forgotten. Rather, it should be a beginning, a beginning that serves as a catalyst to further activities as part of the national effort to safeguard Paraguay's natural heritage.

Arthur H. Davis
Ambassador

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List of Acronyms

ACRONYM	MEANING
ACEPAR	Paraguayan Steelworks
AID	Agency for International Development
ANDE	National Electricity Administration
ANNP	National Navigation and Port Authority
APAL	Paraguay Alcohol Administration
BNF	National Development Bank
CAH	Agricultural Credit Service
CEUR	Center for Urban and Regional Studies
CIIU	Uniform International Industrial Classification
CITES	Convention on International Trade in Endangered Species
CORPOSANA	Corporation for Sanitary Works
CRAA	Center for Architectural and Environmental Resources
DGT	General Traffic Office
EA	Environmental Education
FAO	United Nations Food and Agriculture Organization
FEPAMA	Paraguayan Federation of Lumbermen
FG	Ranchers' Fund
FUNDLAY	Foundation for Protection and Development of the Lake Ypacaraí Basin
GDP	Gross Domestic Product
IBRD or WB	International Council for Bird Preservation
ICB	Basic Sciences Institute
ICBP	International Council for Bird Preservation
IDA	Environmental Development Institute
IDB	Inter-American Development Bank
IDM	Municipal Development Institute
IDA	Environmental Development Institute
IBRD or WB	International Reconstruction and Development Bank (World Bank)
IDM	Municipal Development Institute
IICA	Inter-American Institute for Agricultural Cooperation
IIED	International Institute for Environment and Development
INDI	Paraguayan Institute for Indigenous Affairs
INHS	Illinois Natural History Survey
INTN	National Institute of Technology and Standards
IUCN	International Union for Conservation of Nature and Natural Resources
IWRB	International Waterfowl Research Bureau
JICA	Japanese International Cooperation Agency

Acronyms (continued)

MAB	Man and the Biosphere
MAG	Ministry of Agriculture and Livestock
MDN	Ministry of Defense
MEC	Ministry of Education
MIC	Ministry of Industry and Commerce
MOPC	Ministry of Public Works and Transportation
MSPBS	Ministry of Public Health and Social Welfare
OAS	Organization of American States
PETROPAR	Paraguayan Oil Company
PRONATURA	Paraguayan Society for the Preservation of Nature
RARE	Rare Animal Relief Effort
SEAG	Agriculture and Livestock Extension Service
SENASA	National Environmental Sanitation Service
SENEPA	National Malaria Eradication Service
SFN	National Forest Service
SIDEPAR	Paraguayan Iron and Steel Works
STP	Technical Planning Secretariat
UN	United Nations
UNA	National University of Asunción
UNCNSA	Our Lady of The Assumption Catholic University
UNDP	United Nations Development Program
UNESCO	United Nations Educational, Scientific & Cultural Organization
UNFPA	United Nations Fund for Population Activities
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WEC	World Energy Conference

Preface

The Environmental Profile of Paraguay is part of a series of environmental profiles sponsored by the United States Agency for International Development. The general outline of the study was prepared in Paraguay by Mr. Dennis McCaffrey and Mrs. Diane W. Wood, both of the International Institute for Environment and Development (IIED), and Mr. Gary Hartshorn of the Tropical Science Center of San José, Costa Rica.

Analysis, synthesis, coordination of sector reports, and the final draft were the responsibility of Sr. Gregorio Raidán (STP) and Sr. Alberto Jiménez Ferrer (STP).

Stylistic editing was the work of Sr. Hugo Oddone (STP), while Sra. Carlota Rheineck de Méndez was in charge of all diagrams.

The Spanish document prepared in Paraquay was translated into English by Mr. Charles Roberts of Language Specialists and Translators, Inc., Washington, D.C.

Contractual arrangements for the profile were made by the International Institute for Environment and Development, a private non-profit organization, and the Technical Planning Secretariat (STP), of the Office of the President of the Republic of Paraguay. Both institutions worked together in preparing and publishing this document.

Other individuals and institutions contributed to this project. The Profile staff would like to express its thanks for the help and advice of Paul Fritz, Oscar Carballo, Aristóbulo Redes Cáceres and Corina de Cazenave, all of AID/Paraguay. Furthermore we wish to thank Abe Peña, Weston Emery, and Blair Cooper, formerly of AID/Paraguay, for their valuable contribution in the initial stages of work on the Profile. Mr. Donald Bogue of the Social Development Center of Chicago provided useful advice on demographic matters. Guillermo Sosa of the Technical Assistance Division of STP played an invaluable role throughout discussions relating to the Profile. Carlos A. Pusineri Scala, Director of the Museum of the Casa de la Independencia, contributed with his usual competence the many times he was consulted. Similarly, Luis Iturri, General Secretary of the same museum, deserves utmost recognition for his role. The Profile would not have been possible without the many contributions of time, information, and materials of all those interviewed by the staff. Their generous contribution is most appreciated.

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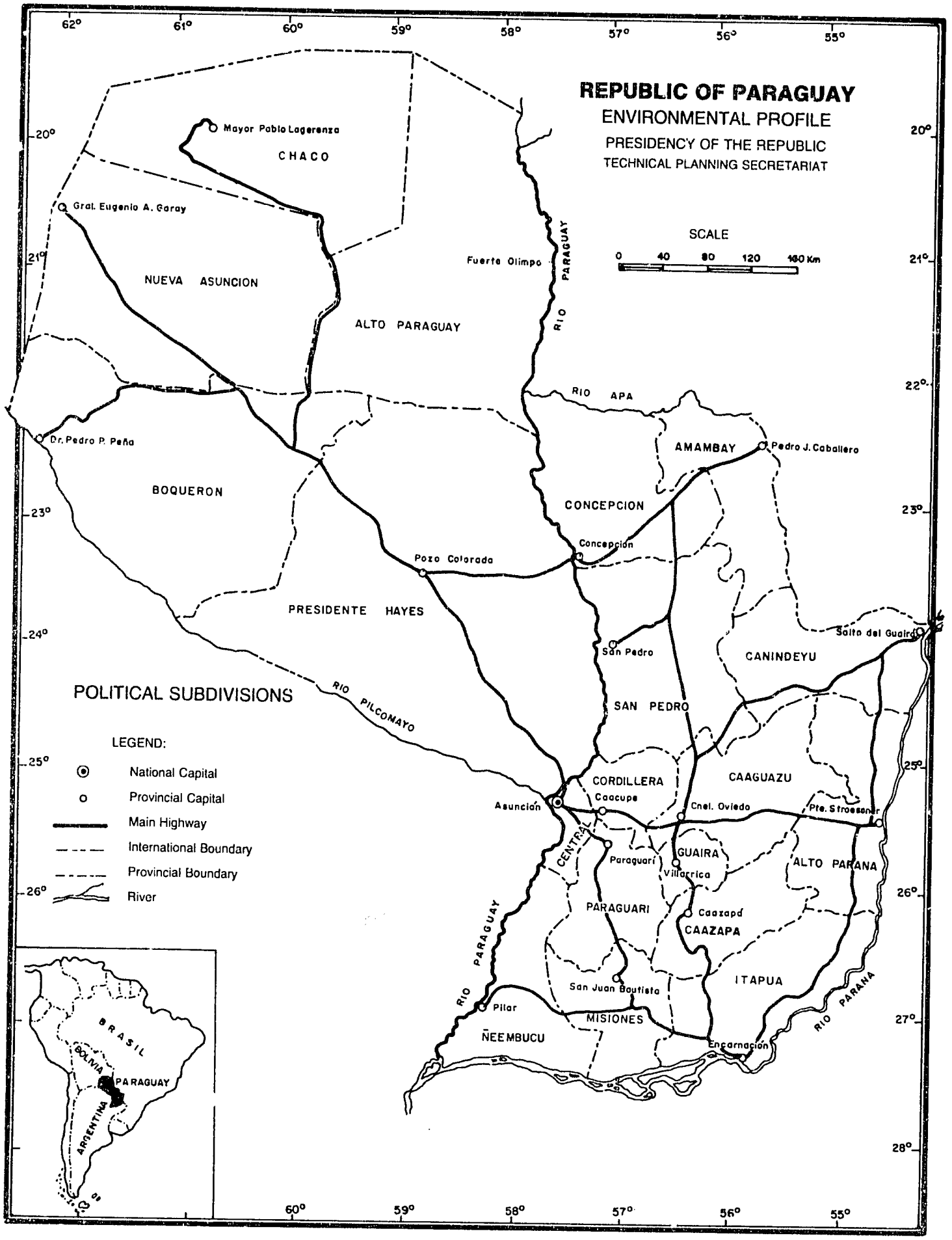
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Provincial Capital
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River
Mayor Pablo Lagerenza
CHACO
Gral. Eugenio A. Garay
NUEVA ASUNCION
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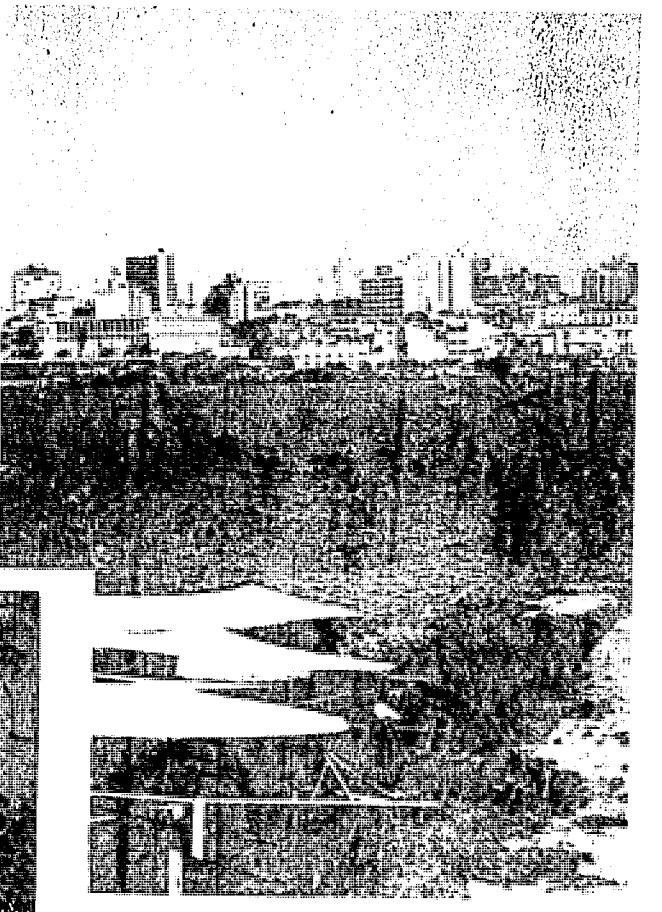
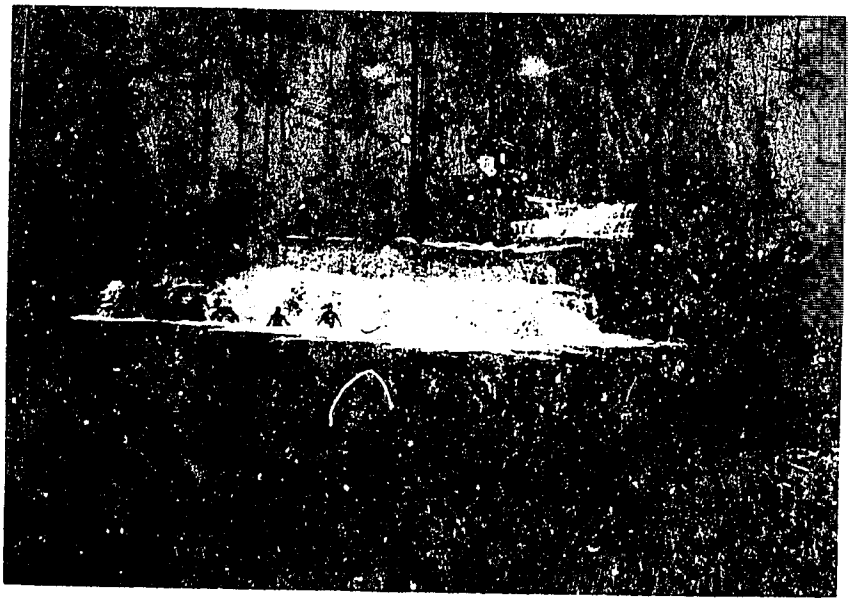
Introduction

Coconut Plantation typical of the Central area.



Asunción Bay.

Corrientes Falls, Ybycuí National Park.
Photo Courtesy National Forest Service



I

Introduction

Background

Given the need to understand better all aspects related to the gradually but persistently changing environment, Paraguay's Technical Planning Secretariat requested technical and economic assistance from the United States Agency for International Development (USAID). One of USAID's objectives is to aid countries interested in studying their environments.

As part of its commitment to promote development, USAID has carried out environmental profiles in Latin America and the Caribbean. These profiles vary in format, style, description of each country's conditions, and methodology. But each profile constitutes a document on a given country's environment, points out the main features and problems, and recommends specific actions.

Once the need for an environmental profile of Paraguay was agreed upon, the bases of such a study were set forth.

Objectives

The general objectives of this environmental profile of Paraguay are:

- Describe the social, cultural, physical, and economic dimensions of the environment.
- Describe the status of Paraguay's natural resource base. This description is intended to provide quantitative and qualitative data on natural resources and identify environmental issues related to the use of Paraguay's human and natural resource base.
- Analyze Paraguay's environmental problems: causes, effects, seriousness, interrelationships, and possible solutions.
- Evaluate the legal, institutional, and educational aspects of natural resource management and begin to study the role of government and educational institutions vis-a-vis the environment.
- Recommend a general course of action for opening up new opportunities and solving environmental problems.
- Promote specific projects that may arise in the course of this study.
- Involve Paraguayan professionals in drafting this profile, thereby giving them the opportunity to work in a coordinated fashion to solve Paraguay's environmental problems.

The following specific objectives have been set:

- Gather and analyze existing data on the environment.
- Provide an overview of the Paraguayan environment.
- Describe the current situation and trends as regards natural resource use.
- Stimulate debate, studies, and conclusions regarding the environment.
- Establish a sound basis for international financial institutions and technical assistance agencies to take appropriate action.
- Set forth guidelines for the actions of Paraguayan institutions.

Methodology

The Technical Planning Secretariat and the International Institute for Environment and Development jointly worked out the theoretical framework and methodology that have been used in developing this Environmental Profile. The method-

ology was developed by a team of Paraguayan and international experts, and covers all aspects of relevance to the environment.

The study, which lasted 54 weeks, was carried out nationwide, with an intersectoral approach.

Specialists who have been a part of the project were chosen by the office in charge of the Environmental Profile of Paraguay based on their knowledge, pragmatism, and team spirit. A total of 31 specialists were contracted, 21 of them Paraguayans, and 10 from abroad.

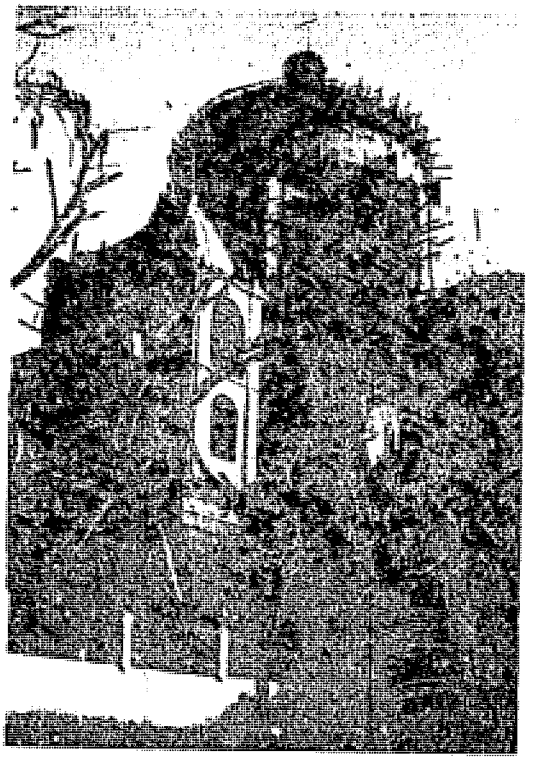
Paraguayan and non-Paraguayan consultants covered the 20 specific areas or sectors into which work of the Profile was organized. In 11 areas, Paraguayan and international specialists worked together.

Beginning by reviewing existing information, the specialists double-checked this information and carried out personal interviews. Where necessary, sectoral information was complemented with field trips.

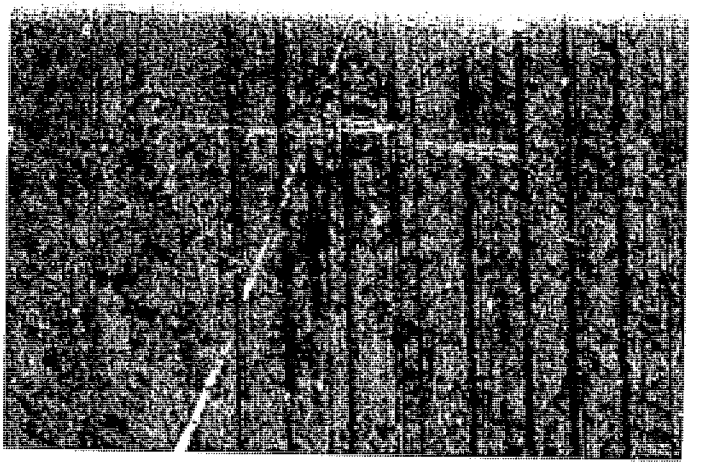
The sector reports prepared by the specialists were integrated, rendered mutually consistent, and summarized by the Profile's permanent technical staff, which was in charge of analyzing the documents. The technical staff also summarized the definitive conclusions relating to Paraguay's environmental outlook.

Finally, the permanent technical staff identified possible actions or ideas for projects that would be of interest to the entire nation (see Chapter III).

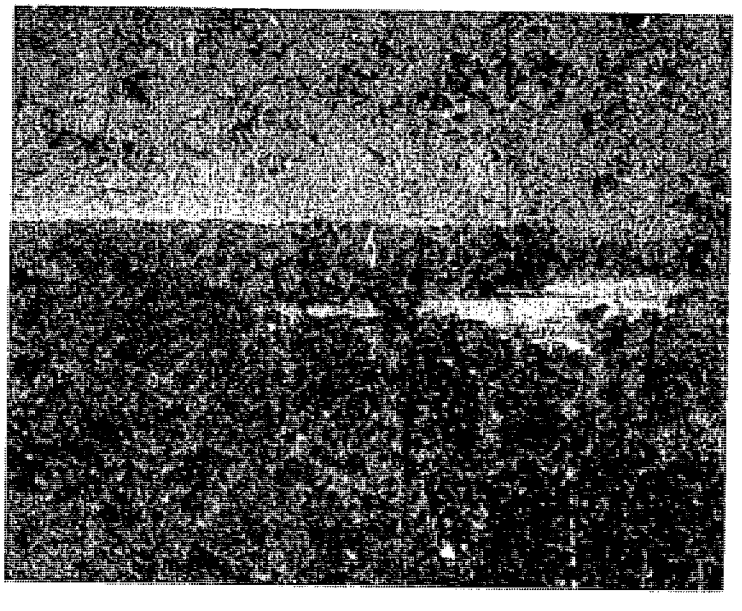
Environmental Perspectives



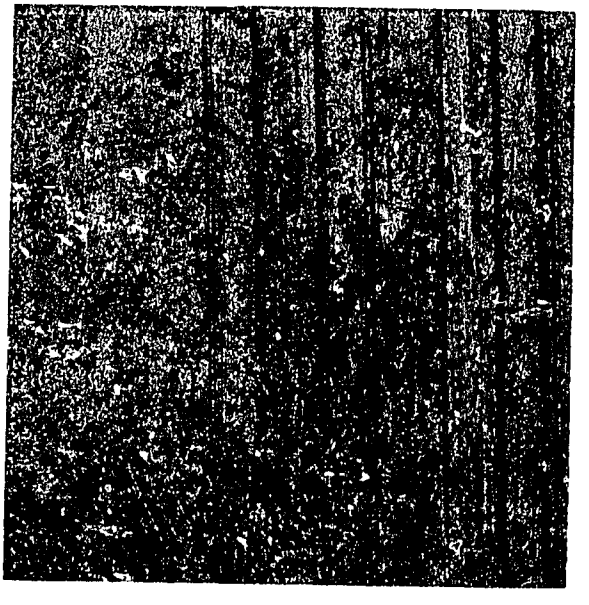
A modern basilica replaces an historic Church in Caacupé.



Road in the Chaco. Photo courtesy National Forest Service.



Lake Ypacaraí.



Jesuit ruins.

II

Environmental Perspectives

The Outlook for the Year 2011

How have society and the environment changed over the past generation? The year 2011 has been chosen as a point of reference for such an inquiry, for it will mark the bicentennial of Paraguayan independence, clearly a milestone in the social, political, and cultural development of Paraguay.

The limited use of natural resources, which until 20 or 30 years ago had been in abundant supply, had not given rise to fears that such resources would be degraded or depleted. The few regulations regarding the use and possession of resources were aimed not at protecting them, but rather at avoiding conflicts among resource users. However, economic growth, social mobility, modern communications technology, and rising expectations as regards the quality of life have led of late to a greater demand for and more widespread and intensive use of land and water resources and flora and fauna. The result has been a rapid decline in the availability and quality of such resources.

As problems have arisen, both preventive and corrective measures have been taken. The 1967 Paraguayan Constitution charged the government with conserving natural resources, and regulating their use. This includes assuring adherence to international agreements, enacting legislation, and taking other appropriate measures. Thus, there is a legal basis for protecting the environment. Nonetheless, studies regarding the application of environmental and natural resource policy reveal certain contradictions that must be corrected if such guidelines are to be more effective. Furthermore, the institutions in charge of this policy have certain weaknesses which undermine their ability to take effective action in those areas under their jurisdiction.

Paraguay's objectives as outlined in development plans—such as domestic peace, social welfare and greater territorial unification—are based on a strategy of increasing exports and fostering agro-industrial development and import substitution. Agriculture and forestry are defined as the bases of development. Indeed, development depends on the use of natural resources, and implies an increase in total cultivated lands at the expense of forests, as well as the expanded use of water resources, grasslands, and other resources.

Development objectives and strategies depend on several factors, including the potential of productive resources, and have provided for their conservation, preservation, and even reclamation in the case of some degraded resources. The actions and projects necessary for the success of this strategy and achievement of its objectives are based on a solid juridical foundation with corresponding legal measures.

In the future, the quality of the environment will depend on the same factors as today; the only difference will be in the magnitude of these factors. On the one hand, no doubt, the natural resource base will diminish considerably; some resources may even be totally depleted. Also, population may double in the next generation. Such population growth, along with economic and social development, will no doubt lead to:

- a considerable increase in the urban population, and a decrease in rural population as a percentage of total population;
- rapid industrialization; and,
- a greater demand for services.

Paraguayan development as it now stands, the natural resource potential, and prevailing socio-economic policy all suggest that significant environmental changes will occur. The increasing exploitation of nature by man will lead to imbalances in the ecosystem and the environment, imbalances which are not yet of alarming proportions, but which will have irreversible consequences if current trends continue.

The economy will continue to be based on the primary sector, complemented by agro-industry. The abundance of hydroelectric energy may lead to significant innovations, such

as electric-powered public transportation, electric railways, and perhaps the development of electricity-intensive industries.

Studies indicate that if today's trends continue apace, Paraguay's population in the year 2011 will be approximately 6.7 million, with more than 3.0 million in towns and cities.

With such an increase in population, total cultivated lands may come to 8 to 10 million ha; there would be more than 13 million head of cattle. Timbering might continue at current levels, but the product would be of inferior quality as compared to today. The forests are already on the verge of depletion; the potential for production of some top quality species is reaching its limits.

If the historic pace of deforestation and depredation continues, the forests will not be able to fulfill their other functions—such as providing protection and serving as habitat for wildlife, maintaining a natural reserve, and providing for recreation—as effectively as in the past.

Current tendencies will probably not continue for another twenty or thirty years. Unless a number of limitations are overcome, it will not be possible to combine higher production levels with socio-economic development and sound environmental management.

The issues of future development, natural resource use, and environmental quality give rise to certain questions:

1. Will the urban/rural population distribution be as outlined above, or will urbanization occur at a faster rate? The reach of the communications media, farmers' difficult access to means of production, and the random fluctuations in agricultural prices and markets, as well as the natural attraction to the cities all suggest that urbanization will be much greater in the future.

2. Will structural problems in the countryside persist, especially as regards land and natural resource use, or will they be overcome so as to give rural dwellers better opportunities, simultaneously avoiding depredation and pressures presently affecting natural resources?

3. Will thorough knowledge of the natural resource base be attained in the medium term, so as to facilitate land management and sustained development?

4. Finally, will economic development lead to income levels that would provide for the quality of life to which the population aspires, without such development leading to serious environmental degradation?

Development that would bring about an improvement in the quality of life and of the environment will only be solidly grounded if it calls for the measured use of natural resources, minimizing environmental damage. This principle arises from the fact that natural resources are finite and are the patrimony of the society as a whole. The right of future generations to make use of natural resources must be respected.

Natural Features of the Environment

Paraguay is situated between 54°19′ and 62°38′ west longitude and between 19°18′ and 27°30′ south latitude. Its total area is 406,752 km². It shares borders with Brazil, Argentina, and Bolivia.

Paraguay's most noteworthy physical features are that it is a land-locked country, and it has no mountains exceeding 800 m in elevation. Outlets to the sea are either by way of the Paraguay, Paraná, and La Plata rivers (1,600 km); or overland, through Brazil (1,200 km to the port of Paranaguá).

The orographic system is made up of the Los Altos, Caaguazú, Amambay, and Mbaracayú ranges. The Caaguazú separates the Paraguay and Paraná river basins in the Eastern region.

The Paraguay River separates two markedly different environmental regions. The Western region (246,925 km²), also known as the Chaco, is an alluvial plain with level topography throughout almost all of the region. This region experiences seasonal fluctuations, ranging from extreme humidity to extreme aridity; its impermeable subsoil renders a large area along the Paraguay and Pilcomayo rivers susceptible to flooding.

The Chaco's population is 57,000—1.7% of Paraguay's total—with a population density of 0.2 inhabitants per km². Extensive cattle raising is the main economic activity, though mixed farming has also been developed in the Mennonite colonies in the central part of the region.

The Eastern region is made up of part of the Paraguay and Paraná river basins. Its area is 159,827 km², 39% of Paraguay's total area. It has rolling topography. Ninety-eight percent of all Paraguayans live in this region, the population density of which is 18.6 inhabitants per km². Most of the country's economic activity is based in the Eastern region, the main activities being agriculture and lumbering.

Paraguay's climate has been defined as subtropical continental. But there is disagreement as to whether the climate is tropical or subtropical. Average yearly precipitation varies from 400 mm in the far northwestern part of the Chaco to 1,800 mm in the southeastern part of the Eastern region.

Average annual temperatures drop gradually as one moves from north to south, from 25°C in Bahía Negra to 21°C in Pilar and Encarnación. Temperatures may rise above 38°C in the Chaco and 35°C in the Eastern region; and they may fall below 0°C anywhere, except in the far north. Thus, almost all of the country is susceptible to frost.

Climatic conditions allow for production of more than 45 vegetable species. However, weather conditions are sometimes severe, resulting in drought, flooding, frosts, and other phenomena which affect not only production, but the environment as well.

Heavy rainfall, which may total 80 to 120 mm in just a few hours, causes significant soil erosion, particularly in areas of accidented topography.

Paraguay lies entirely within the La Plata river basin, and includes two major sub-basins. The Paraguay river basin covers all of the Chaco and the western half of the Eastern region, while the Paraná river basin covers the eastern part of the Eastern region.

The Chaco's hydrographic network is made up of waterways whose flow is highly variable throughout the year. Such variation is due to topography, impermeable subsoil, melting from

the Andes, and precipitation. These characteristics, as well as the xerophytic vegetation, vast marshlands, and very low human population account for the numerous and varied animal species to be found in the Western region.

In the Eastern region the Paraguay River has seven tributaries, which vary in length from 50 to 500 km. Their basins range in area from 1,000 to 31,000 km². The Paraná River has 11 tributaries along its western banks in Paraguayan territory.

The hydrographic network also includes two lakes, Ypacaraí and Ypoá, whose basins make up two natural ecosystems, though Lake Ypacaraí's has been altered ever since it has been used as a recreational and sporting vacation spot. Lake Ypoá's ecosystem, however, still has an abundance of wild animals, and may become a biological reserve of great importance to science.

The Eastern region includes several sub-basins with lush vegetation, ranging from low grasslands to forests, including all strata of flora, and constituting distinct habitats and ecosystems. Due to characteristics such as the slope of their course, and their flow and water quality, the rivers of this region have great potential for a variety of uses. These characteristics, together with climatic conditions, flora, and fauna, constitute systems that should be conserved and preserved so as to prevent their complete destruction.

Nature has been generous with Paraguay, granting her high-quality resources such as the soils, vegetation, rivers, and fauna, which have constituted environments used by the inhabitants of Paraguay even before the Spaniards arrived. Thus, the original abundance and quality of the natural resource base, plus the low intensity of its use, had until a few years ago sustained an image of a lasting environment.

Nonetheless, the passage of time and the growing pace of economic activities have steadily chipped away at this image, to the point that nowadays one finds highly contrasting environmental milieu. These range from the relatively overpopulated areas (Central area) where the natural resource base has been depleted, to areas with no economic activity whatsoever. But there are no longer any areas or ecosystems where man's impact is not felt.

Nine National Parks have been established in order to preserve natural environments. They cover 11,200 km², i.e. 2.8% of the country's total area. By region, these parks cover 4.5% of the Chaco and only 0.13% of the Eastern region. (The names, locations, and areas of these parks can be found in Chapter VIII).

These natural reserves constitute particularly important ecosystems, and are representative of Paraguay's different natural milieu. There are also other such ecosystems which are not protected and should be preserved. The location of such habitats is illustrated in map VIII-5.

At least 10% of the total area of such ecosystems should be protected so as to preserve their natural characteristics. This figure is simply a general guideline, as decisions regarding areas to be covered by conservation programs will be based on several factors, which will vary from case to case.

Population growth and development demands have made more intensive use of natural resources necessary. Migration, highway construction, cultivation of new lands, construction of hydroelectric dams, and the development of new cities—all using modern technology—have brought about profound environmental changes. The most evident effects of this process have been deforestation, erosion, emigration, pollution of the waterways, destruction of habitats, and the extinction or reduction in population of animal species.

Population and Environment

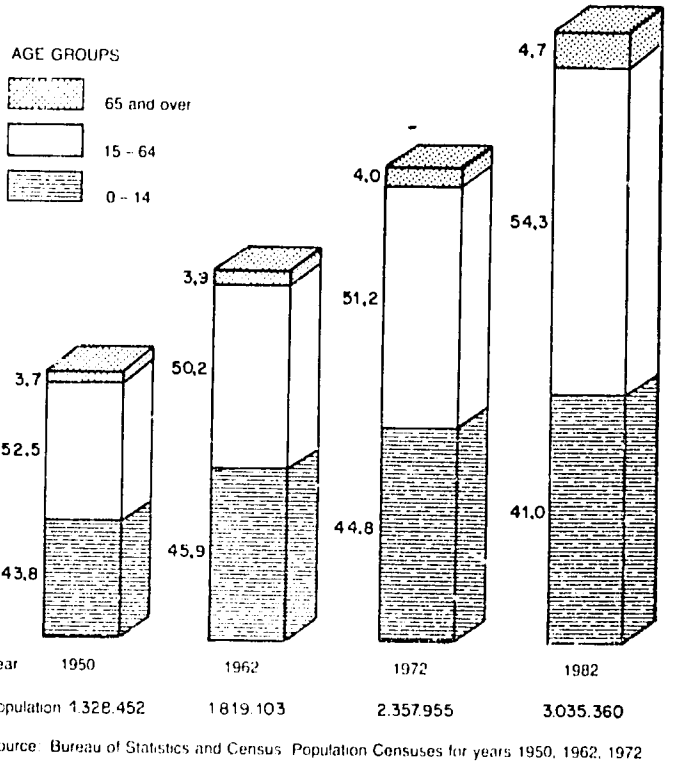
There are few countries where the close link between population and environment is as clear, and plays such a dynamic role in a process of rapid change, as in Paraguay.

Paraguay is still basically rural and agricultural. Most of the population interacts directly with the environment and the natural resources which provide the materials used to produce most goods.

The population is mostly rural (58%) and young (52% under 20)[1]. Fertility is high, while mortality is declining. The population is very unevenly distributed (18.6 inhabitants/km² in the Eastern region, 0.2 inhabitants/km² in the Western region); and urbanization has been slow (58% rural, 42% urban).[1]

Graph II – 1

Relative Distribution (Per Cent) of the Population in Three Major Age Groups – 1950, 1962, 1972, and 1982.



Source: Bureau of Statistics and Census. Population Censuses for years 1950, 1962, 1972 and 1982.

Some of the main factors affecting Paraguay's demographic features (e.g. size, economic activities, distribution, mobility) have been:

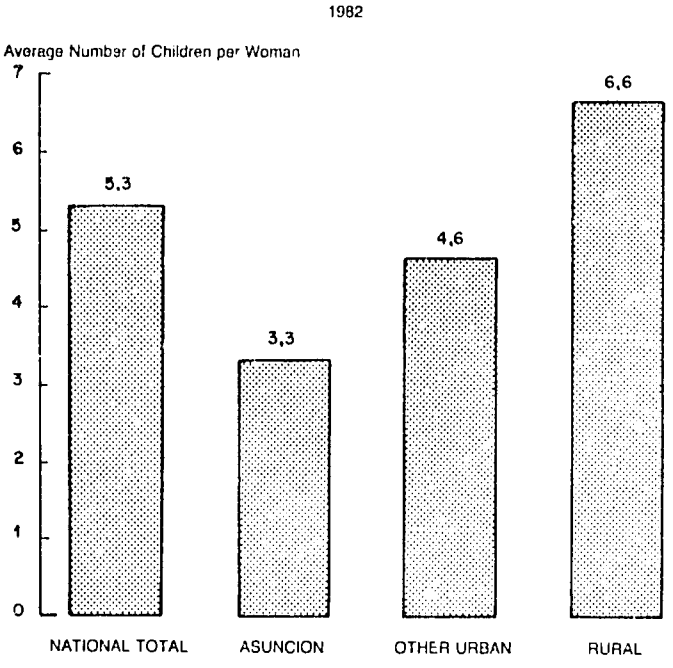
Paraguay's geographic position and natural features;

domestic and foreign migration;

1/ 1982 Population and Housing Census

Graph II – 2

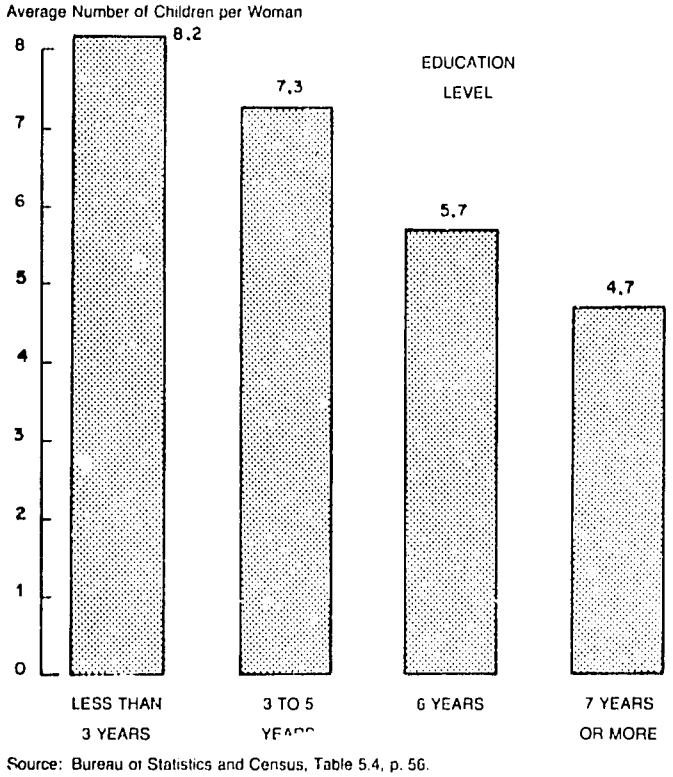
Global Fertility Rate of Women Between the Ages of 15 and 49, by Place of Residence



Source: Bureau of Statistics and Census. 1982 Census 10 percent sample

Graph II – 3

Global Fertility Rate for Women 20 to 49 Years Old in Permanent Union During Five Year Period 1947 – 1975, by Level of Education.



Source: Bureau of Statistics and Census, Table 5.4, p. 56.

- the two international wars Paraguay waged, from 1865 to 1870, and from 1932 to 1935; and,
- the implementation of land reform and settlement projects.

Until about 1950, the population was concentrated in an area of some 20,000 km² in the Central area, with a population density of 31 inhabitants/km² This contrasted with other areas, where population density ranged from 0.2/km² to 26/km².

Traditional agriculture in the Central area, based on small holdings and sharecropping or tenant farming has waned, in part because the environment was poorly used and soil productivity was declining, and in part because modernization in agriculture is doing away with submarginal farms, forcing those farmers without reasonably profitable operations to migrate to other areas.

Despite large-scale investment in highway construction, communications systems, and other public services, the Western region's population declined between 1972 and 1982. Modern technology has not yet been able to increase its attractiveness and profitability as compared to other regions.

Urbanization, oddly enough, has proceeded at a relatively slow pace as compared to other developing countries. The abundance of natural resources and access to them seem to have slowed migration to the cities, especially Asunción. Nonetheless, at present urban growth is picking up in the Asunción area and in some of the border areas as provincial capitals come into their own.

Concentration of population in the Central area has led to environmental conditions such as:

- excessive subdivision of farms and continuous use of lands with no conservation measures, resulting in their degradation;
- depletion of the area's natural resources;
- destruction of the natural habitat, with most of the animal wildlife becoming locally extinct;
- pollution of most of the waterways, through erosion and industrial effluents;
- emigration from the 1920s to the 1950s, primarily to Argentina;
- internal migration to settlement areas, beginning in the sixties.

Among the main factors leading to population growth are changes in fertility and mortality rates:

(a) *Fertility*. Fertility levels are very high in rural areas where family farming prevails. In 1972, the average family had 8 members or more. This approaches maximum human reproductive capacity. Although fertility has declined in the countryside as well as in the cities, in 1977 rural mothers had an average of 6.4 children each. Asunción's fertility rate is, in contrast, less than 3.2 children per mother, i.e. less than half the rate for rural areas. Fertility in other urban areas is between these two extremes.

(b) *Mortality*. Living conditions in rural and border areas pose serious health problems, especially in neonates and children under 5, although mortality figures for Paraguay as a whole are below average for Latin America. Infant mortality was 28 percent greater in rural areas than in Asunción for

Table II – 1

Spatial Distribution of the Population of Paraguay

Region	1962 Population	%	1982 Population	%
1. Eastern Region	1,744,974	95.9	2,980,880	98.2
– Central Area[1]	517,955	28.5	950,710	31.3
– Other areas	1,227,019	67.4	2,030,170	66.9
2. Western Region	74,129	4.1	54,480	1.8
– TOTAL (1 + 2)	1,819,103	100.0	3,035,360	100.0
1. Urban	651,819	35.8	1,298,880	42.8
2. Rural	1,167,284	64.2	1,736,480	57.2

Source: Population and Housing Census, 1962; 1982

[1]Asunción and Central Province.

1972. Since 1972 these rates have fallen, but such urban/rural differences are thought to persist, due to disparities in health services and environmental conditions and practices.

Table II-1 illustrates the disproportionate regional and urban/rural figures for population centers.

Migration

One of the main causes of migration is the difficulty in improving one's quality of life, which generally results from the degradation or scarcity of natural resources. Whenever a given population migrates, whatever its destiny and livelihood, another cycle in the process of environmental change is set in motion.

International Migration

Emigration to Argentina, where people saw a better chance to get ahead, has continued into the latter part of this century. Some estimates indicate that by 1961 500,000 people had emigrated. Furthermore, in 1970, the Argentine census counted 230,000 Paraguayan-born persons living in Argentina. Similarly, Brazilian data showed a total of 18,000 Paraguayan immigrants. Over the past few decades, emigration from Paraguay has served as an escape valve for surplus labor, i.e. labor which the domestic market could not absorb. Economic growth in the last 20 years together with the land reform have practically ended emigration.

Immigrants from neighboring countries, especially Brazil, have tended to settle in rural areas or new settlements. Thus, natural resource use has been more intensive. According to the 1982 census, there were 169,000 foreigners living in Paraguay, including 99,000 Brazilians and 44,000 Argentines. To date, emigration of Paraguayans abroad has outstripped immigration of foreigners.

The main migrations to Paraguay were:

1. Europeans, who settled in the province of Itapúa beginning in the 1920s.

2. Mennonites, who settled in the Chaco as well as in Caaguazú and San Pedro provinces in the Eastern region, beginning in 1926.

3. Japanese and other Asians, most of whom reside in Itapúa, Paraguarí, and Alto Paraná provinces.

4. Brazilians, who have settled in the eastern part of the Eastern region, in the provinces of Amambay, Canindeyú, Alto Paraná, and parts of Caaguazú and Itapúa.

According to census data, 351,400 foreigners immigrated to Paraguay between 1950 and 1982.

Migration within Paraguay

A rural-rural migratory flow has developed in Paraguay. Such flows are uncommon elsewhere. After 1950, and especially since the 1960s, internal migration began, reaching its peak in the 1970s. This migratory movement resulted from increasing difficulties in productive activities, especially agriculture; it was facilitated by the land reform and settlement programs, highway construction, infrastructure for social services, and other basic services.

The government has encouraged a large migratory flow to the Eastern region as part of its policy of promoting greater territorial unification. Many migrants are from old settlements located within a 200 km radius of Asunción where lands had been subject to intensive agriculture. In such settlements excessive exploitation of arable lands and small holdings has reduced agricultural employment. Furthermore, the Paraná river basin has attracted many people, as the harnessing of natural energy resources by hydroelectric facilities has given rise to new economic activities. This process should continue at least until the year 2000.

The land reform has provided lands for migrants to the settlement areas. Thus, the environment is rapidly changing. Migration from the countryside to the cities has been attenuated by migration to the agricultural settlement areas. Nonetheless, the suburbs of Asunción continue to grow rapidly, as people are still drawn to the capital city.

Demographic features and economic activities of the pop-

Homestead in a zone of new settlement.

ulation reflect the wide variety of environmental milieu. In other words, the environment helps to explain the particular demographic features of each area. Similarly, the relationship between the population, natural resource use, and the environment appears to be improving. For example, there is a tendency for depleted agricultural areas to be reclaimed, and underused resources are now being exploited more efficiently. Nonetheless, the problem of using natural resources, both for the settlements and for production, without destroying them, is far from being solved.

The Technical Planning Secretariat estimates that by the year 2000, Paraguay's population will rise to 5.4 million, i.e. it would almost double in 20 years. Incorporating this population increase into development while maintaining the standard of living to which people nowadays aspire will result in severe pressures on the social and economic system, and may lead to greater abuses and environmental degradation. This can be avoided by appropriate planning, taking into account the needs of both the population and its habitat.

Land Reform and Settlement

The land reform and settlement programs begun in the early 1960s were based on the following:

1. Social pressures in the Central area, as a result of population growth, soil depletion, and degradation and depletion of other natural resources.

2. The abundance of uncultivated, high quality lands in the Eastern region, many of which at the time were state-owned lands.

3. The need to boost production, most feasibly by increasing the total area of cultivated lands.

4. The urgent need to change the structure of land tenure and the size of farms.

These were the factors that led the government to opt for land reform and settlement projects, which have the following legal bases:

- Law No. 622 (August 19, 1960), on de facto Settlement and Urbanization;
- Law No. 662 (August 27, 1960), on Subdividing Large Landholdings;
- Law No. 852 (March 22, 1963), which established the Institute for Rural Welfare; and,
- Law No. 854 (March 29, 1963), which established the Agrarian Statute.

Paraguay's 1967 Constitution refers to the Land Reform in Chapter VI.

Article 128 states: "This Constitution establishes the Land Reform as one of the key factors for improving the standard of living in rural areas by effectively incorporating the rural population in the nation's economic and social development. To this end, fair systems of property, land distribution and land tenure shall be adopted, and credit and technical and social extension services shall be provided for; cooperatives and other similar organizations shall be encouraged; and increased production, industrialization of agricultural production, and rationalization of the market shall all be fostered, so as to allow the rural population to better its economic situation, thereby guaranteeing its freedom and dignity, and national wellbeing in general."

Article 129 states: "The law shall establish the maximum area of land that can be owned by a single individual or legal entity. The relationship between the country's total area and its population, the lands' natural qualities, and the needs and advisable measures with respect to agriculture, lumbering, and industry shall be taken into account in establishing said limits. Surplus lands shall be considered excess lands, and shall be sold under special terms and conditions to be set by law, in the case of uncultivated lands needed for agriculture, or for founding or extending stable settlements or towns. The excess lands shall be subject to progressive taxation, which shall contribute to their elimination."

The land reform's main goals have been of a social and economic nature, and can be summarized as follows:

- to change the agrarian structure;
- to cultivate better lands;
- to redirect migratory flows; and,
- to promote greater territorial unification.

The land reform and settlement programs have conferred a particular style of development on the eastern section of the Eastern region. Twenty-five years after this process was begun, many of its objectives have been achieved.

Nonetheless, the activities to which this process gave rise have brought about significant environmental changes. These include:

1. Settlement of more than 600,000 people in the new areas, which cover 8.7 million ha. These areas were uninhabited in earlier times. Between 1960 and 1984, 631 settlements were established, and more than 126,000 plots of land were granted to settlers.

2. Deforestation, estimated to have affected over one million ha in 25 to 30 years time.

3. The establishment of large, highly capitalized agricultural enterprises, which have deforested vast areas.

4. The establishment of 15 new districts, in which the population of the main town or city varies from 4,000 to 28,000.

Human Activities

Communities, both the subject and the object of the development process, grow within the physical-biological complex known as the environment.

The environment is constantly changing; it changes over time and as a result of economic activity. As a result, man must make an ever greater effort to achieve his goals. Environmental quality is directly related to the size, age distribution, spatial distribution, and lifestyle of the population. These factors, in turn, are a function of the nature and intensity of the population's activities, which define their degree of development. In this context, nature is both the habitat of all living beings and a fount of natural resources.

All human activity involves the use of some natural resources, whatever their form. Resource use brings about change, which is reflected in the quantity and quality of a given resource. The effect of any such change may become the cause of yet another alteration of the environment: cause and effect interact.

If man does not adopt appropriate measures, his activities will have a negative impact on some aspect of the environment. The resource being used becomes degraded.

Following are the most significant activities affecting the environment.

Roads and Highways

Roadways have a greater impact on the environment than any other means of transportation and communication. Other means of communication have indirect effects, and play an important role in disseminating information related to the environment.

Highways have a direct impact on nature, both in being built and by facilitating travel to previously isolated areas. Highway construction in uninhabited areas has increased during the last 30 years; many people have moved from old settlements to new agricultural zones.

The evolution of the road and highway system over the last 20 years is illustrated in Table II-2.

There are currently 51,000 km of roads and highways in Paraguay. Some 60% of all highways were built in the last 25 to 30 years, in the provinces of Caazapá, Caaguazú, Itapúa, Alto Paraná, Canindeyú, Concepción, San Pedro, and Amambay.

These provinces had, in large measure, been covered by forests; highway construction has made it possible to convert these lands to agriculture, establish population centers, and undertake a variety of economic and social activities that have changed Paraguayan geography.

Primary Activities

Primary activities are those most closely related to renewable natural resources. Indeed, they largely depend on the quality of such resources. Paraguay, which has been an agricultural country since pre-Columbian times, had not experienced changes nor significant degradation of the environment until recent decades except in certain areas. The past 30 years have witnessed intensification of agriculture and lumbering and, thus, gradual transformation and pollution of the environment.

Agriculture, lumbering, and hunting and fishing have taken distinct forms at different points in history:

Pre-Columbian Period

The indigenous economy was based on extraction and gathering, as well as hunting and fishing. Subsistence agriculture with rudimentary tools, also practiced, had a negligible impact on environmental change and depredation of natural resources.

Colonial Period

Subsistence agriculture continued to prevail, while production of some export products gradually increased. The Span-

Table II – 2

Periodic Growth of the Highway Network by Category

(In Km)

Year	Graded	Graveled	Paved	% Paved	Total
1963	2,358.2	795.6	347.3	10.0	3,501.1
1968	4,756.9	724.1	687.3	11.1	6,168.3
1973	5,243.4	554.9	870.9	13.1	6,669.2
1978	7,817.5	510.8	1,323.4	13.7	9,651.7
1983	9,159.1	474.2	1,982.6	17.0	11,651.9
aa.%	7.0	−2.6	9.1		6.2

Source: Ministry of Public Works and Communications. Highway Department.

Opening new roadways incorporates new lands into agricultural production. Photo courtesy Diane Wood.

iards introduced some metal tools, previously unknown, for agriculture. These included the hoe and plows. They also introduced the use of draft animals, such as horses and oxen.

Independence

After independence from Spain, there were no significant changes in primary production, except under the rule of President Francia and President Carlos Antonio López. Francia's rule was characterized by a closed economy, with no foreign trade. Production was geared to domestic demand, the main products being foodstuffs, fibers, and tobacco.

Under the government of Carlos Antonio López the borders were opened, and Paraguay began a period of intense trade, exporting agricultural and forest products. Thus primary production picked up. This trend continued under the government of Francisco Solano López until the war against the Triple Alliance (1865–1870).

After the war, which wiped out much of the population, primary production fell sharply. The survivors once again took up subsistence agriculture, with few resources and only rudimentary tools. This stage was overcome some time later, and as the population grew, production picked up again. The first post-war governments took measures regarding sale of lands, as a large part of Paraguay's territory was state-owned. The extensive denationalization of lands had a marked impact on the structure of land tenure and the nature of agriculture in Paraguay today.

At the beginning of the 20th century, subsistence agriculture, hunting and fishing continued to prevail, with a slow but steady turn to commercial agriculture, which accelerated with the arrival of European immigrants.

Gradually, in response to the growing population and the ever more depleted soils, more lands were turned over to agriculture. Soil depletion resulted from continuous use, erosion, and excessive subdivision of farms, which were no longer efficient. Sugar cane was introduced as a cash crop, with the intention of producing molasses and sugar. Mixed farming was begun, combining cultivation of crops with cattle-raising on family farms.

Lumbering expanded, and as the forests were gradually felled, secondary and isolated (island) forests began to appear as sources of firewood.

With the arrival of the first European settlers and later the Mennonites, Japanese, and others, the natural features of the settlement areas changed. Also, during this period Paraguayans began to emigrate to Argentina due to the lack of opportunity in the Central area. This emigration continued until the mid-20th century.

The activities described above were mainly based in the Central area (Cordillera, Guairá, and Central Provinces, and part of Paraguarí Province), the Province of Itapúa, and around some towns and cities far from Asunción.

Around 1950, traditional farms were gradually turned over to fruit, vegetable, and milk production, especially in the outskirts of Asunción. Gradually traditional crops such as maize, manioc, beans, and others were replaced by fruits, vegetables, sugar cane, and pasture for milk cows. This period also witnessed the growth of towns and cities; establishment of vacation areas; establishment of several industries; a rise in the price of land, due to inflation and the increased demand for land; highway construction; and installation of basic infrastructure and social services (electrification, schools, health centers, etc.).

The most noteworthy primary sector activities since the 19th century, and which have had a profound impact on the environment and natural resource base, are:

Tannin Production

Quebracho was used beginning in the late 19th century to produce tannin; in the mid-20th century, production dropped off. Towns grew up around the processing industry, but declined as falling production led to migration.

Tannin production covered a 35,000 km² area in the eastern Chaco, with the main production centers at Puerto Sastre, Puerto Pinasco, and Puerto Casado, all along the Paraguay River. These areas experienced profound environmental changes, as the quebracho was depleted, and the original ecosystem destroyed. Some animal species became locally extinct, while others experienced a sharp decline in their populations.

When tannin production came to an end, the population migrated: some abroad, others to the cities, and others to work in agriculture in the settlement areas.

Gathering and Production of Yerba Maté

Use of yerba maté (Ilex paraguariensis) dates back to the indigenous economy of the pre-Columbian era. During the colonial period production increased and it became one of Paraguay's main exports. Originally, as the plant naturally occurred in abundance in the Paraná river basin, yerba maté was simply gathered. Later, when it became a cash crop, it was grown in large quantities.

Yerba maté production did not degrade nor otherwise have a marked impact on the environment, for it simply involved harvesting the plants; vegetation did not have to be cleared.

Lumbering

Lumbering began in colonial times. Originally based in the Central area, it was later concentrated in the east. This extractive industry involved just a few particularly valuable species.

As lumbering continued apace and the natural resource base of the forests diminished, production areas extended to include all of Paraguay's forests. The selective and extractive nature of such exploitation has reduced potential for production to the point that many forests have lost some or all of their commercial value. The situation has only grown worse with the extension of the agricultural frontier, highway construction, and the spread of other forms of communication that now cover all Paraguay. Lumbering has altered the quality of the forests, waterways, soils, and fauna.

Initially rustic methods were used in lumbering: the ax and machete were used to cut down the trees, animals were used for hauling with flatbed trailers and rafts, manual saws known as "tronzadoras" were used to cut the logs. Later, modern methods were incorporated: chainsaws were used for felling, tractors and trucks were used in transport, and power-driven saw mills were operated by steam engine, gasoline engine, or hydroelectric power. Modernization, while increasing productivity, has also led lumbering and deforestation to continue at a much faster pace.

Deforestation

The clearing of forests, mostly in the eastern part of the Eastern region and to a lesser extent in the Chaco, has taken place as a result mostly of primary sector production, and to a lesser degree as a result of other activities.

The consequences of the extensive clearing of forests are: destruction of the natural habitat, erosion, change in the river basins and climatic change, and other as yet unevaluated effects.

Economic development in general, and in particular agricultural development, required the use of still more forest lands for agriculture. Between 1945 and 1976, the total forest area in the Eastern region was reduced from 68,364 km^2 to 41,774 km^2[1], i.e. from 34% to 26% of the region's total area.

Other studies indicate that from 1975 to 1979, 43,900 ha were deforested in the area under observation. This figure yields an annual deforestation rate of 1.3%.[2] There has also been deforestation in the Chaco, but it has not been studied. (See Chapter VIII.)

Settlement programs have brought about rapid population growth and a striking increase in production, especially in agriculture and lumbering. Settlement peaked in the 1970s, with highway construction and other large scale projects such as the international bridge over the Paraná River, in Pte. Stroessner city, and the hydroelectric dams at Acaray and Itaipú.

Use of deforested lands generally involves:

- clearing and preparation with heavy machinery and burning of plant overgrowth;
- cultivation with no basic soil conservation measures, such as contour plowing and terraces. Many areas have slopes greater than 5%, the limit above which measures must be taken against hydric erosion;
- cultivation of the same species year after year;
- working the land with heavy machinery; and,
- use of chemical products, especially pesticides.

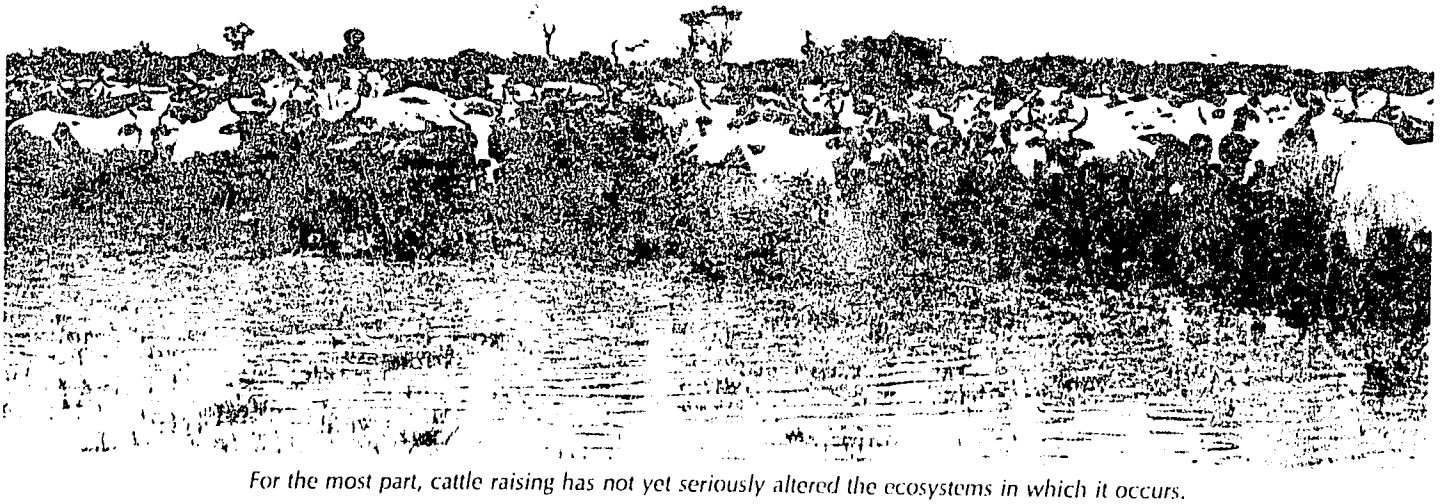
Existing data are partial, and much of them are contradictory or unreliable. Thus it is impossible to come to precise conclusions regarding the pace, location, and consequences of deforestation.

As agriculture displaces forests over a large area, the biome, in which thousands of plant species interact, is destroyed in order to make way for cultivation of just a few species. Thus the physical-biological process which involves interaction of the soil-water-plant-animal complex with the climate is interrupted. When this break, or change, takes place, most resources tend to become degraded, as does the environment as a whole.

Cattle Raising

Though the Spanish word "ganadería" covers animal husbandry in general, it is commonly understood to refer primarily to cattle raising. This reflects the key economic, social, cultural, and historic role cattle raising has and, according to all indications, will continue to have,in Paraguay. The Spanish first introduced cattle early in the colonial era. As the environment was particularly apt, cattle raising developed quickly.

1/ Technical Report of the FAO Project: PY/PAR/72/001
2/ S.F.H./JICA—1983



For the most part, cattle raising has not yet seriously altered the ecosystems in which it occurs.

Indeed, the herds were able to complete their life cycle and reproduce without man intervening.

Cattle raising began around Asunción, and later spread to other parts of the country. As cattle are herbivores, the herds reproduced and expanded in the natural grasslands, which until then had been used for hunting.

The introduction of bovines in the 16th century led to the widespread use of a technique which had until then not been used on a large scale, i.e. burning to clear grasslands and fields. Fire, which had previously been used in the grasslands in hunting, came to play a key role in the grassland flora: climax grasslands disappeared in many parts of the country.

With the introduction of barbed wire in the 19th century, cattle could no longer roam as they pleased, but were limited to a given ecosystem and area. As a result, selective feeding and overgrazing led to changes in the vegetation which, together with the burning, contributed in some areas to the "dirty fields" where weeds and brushwood grow.

Except for the tapir and the marsh deer, barbed wire has not contributed significantly to the decline of animal wildlife, though some of the higher forms, such as upland deer, have not benefitted, and indeed may be harmed.

This century, and particularly during the 1970s, there has been a large scale expansion of the total area used for cattle raising at the expense of forest areas. Due to high beef prices, pastures sown with colonial grass have been developed on slashed and burned lands. These lands are highly productive, for the soils are fertile. The ranches, which benefit from loans, are commercial. While colonial grass was cultivated in the Eastern region, other improved pasture lands were developed in the Western region. Herbicides are now used in both regions, not on an experimental basis but commercially.

Cattle raising currently covers 21.4 million ha, with a total of 6.3 million head of cattle. There is an average of 3.4 ha per head of cattle, indicative of extensive cattle raising with low productivity, as reflected in the following figures:

Branding rate	: 45%
Weight at weaning	: 120 kg.
Death rate	: 3–10% (depending on age)
Culling	: 13%
Finishing time	: 3–4 years
Productivity of milk cows	: 2 liters/day

As cattle raising is mostly extensive, and thus is not highly capitalized but rather depends largely on the availabilty of land, ranches have not been able to develop infrastructures or methods that would have a significant impact on the ecosystems in which the activity unfolds.

Agriculture

Agriculture is the most important activity from a socio-economic standpoint: it is closely tied to the population, natural resources, and the environment. During the last 25 to 30 years it has been one of the most dynamic sectors, as production has increased at a fast pace. It has also left its mark on the rural milieu.

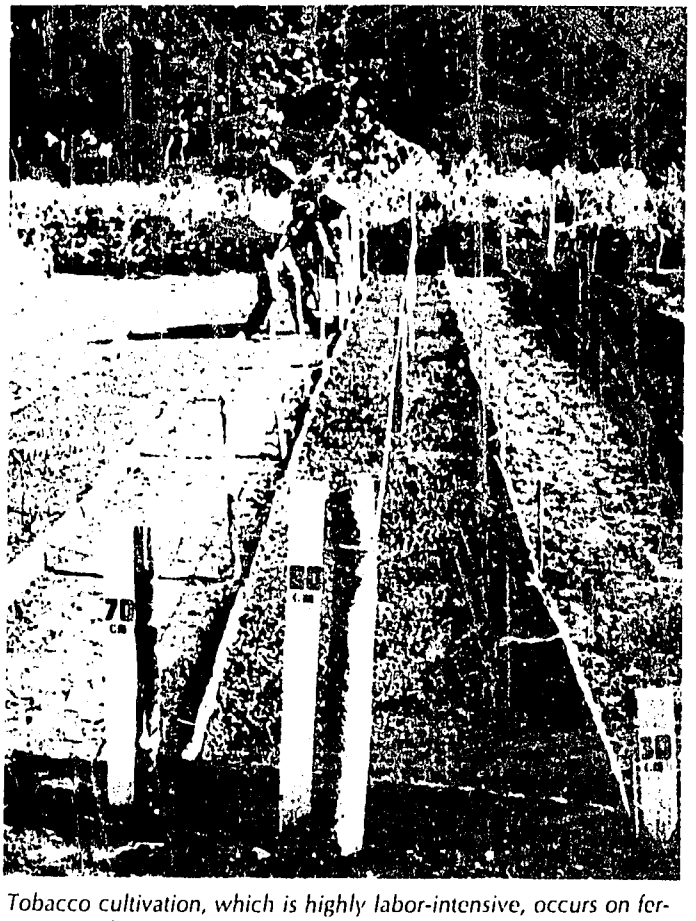
Agriculture generates 20% of the gross domestic product, involves 48% of the economically active population, and supports a total of 1.3 million people. Furthermore, it supplies most of Paraguay's food products, raw materials, and over 65% of her exports. Agriculture currently covers some 5.0 million ha, of which 2.2 million are cultivated.

Most agriculture is based in the Eastern region. The main areas are the Central region, Itapúa, and settlement areas in the north and east. Agriculture in the Western region is based primarily in the Mennonite colonies and, to a lesser extent, the Benjamín Aceval area, both in the Central area.

Agriculture, by its very nature, has infringed upon the environment; specific natural resources have been particularly affected. Originally such changes were gradual, and limited to specific areas. Later, with population growth, domestic migration, highway construction, the settlement projects, and services provided to producers, the environmental impact has been more widespread and profound. All of these factors have played a role in extending agriculture, thereby provoking rapid degradation and depletion of natural resources, especially forest resources.

Socio-economic and environmental changes in the countryside have resulted from the combination of spread out family farms, with some clusters, and the rise of mechanized agriculture, all compounded by the rapid growth of agriculture in recent years.

Agriculture has expanded rapidly and changed its structure over the past 25 to 30 years. Family farms, concentrated in



Tobacco cultivation, which is highly labor-intensive, occurs on fertile soils. Photo Courtesy National Forest Service.

certain areas, today cover the entire Eastern region. Machinery has led to new forms of production, depending on the size of the farm: family farms have a high labor/land ratio; large farms are often totally mechanized; and there are intermediate cases as well. Mechanized agriculture prevails on an estimated 40 to 50% of total cultivated lands, and involves primarily soy and wheat production.

The use of chemical fertilizers and pesticides is another innovation in Paraguayan agriculture. It is estimated that an average of 4 kg/ha of such chemical products are now used. Though this figure is still low, it is on the rise and may have a more harmful effect on the environment. The situation will grow still worse if the boll weevil (Anthonomus grandis Boh), which has already affected Brazil's crops, comes to Paraguay, as combatting this pest would require intensive use of chemical products.

Erosion

Erosion is one of the main causes of loss of soil fertility; together with other factors, such as inappropriate cultivation methods, it has led to the degradation of soil. The texture and slopes of the soils, and the frequency and intensity of rains all contribute to erosion.

Ninety percent of cultivated lands are subject to erosion, especially hydric erosion; thus, measures should be taken to avoid further loss of soil fertility. There is little data as to land use and the impact of different use systems, ranging from slash and burn to management of crops and pastures.

In several studies, erosion varied from 30 to 80%; 1,442,600 ha of a total 2,463,500 ha studied had been affected by erosion.

There have been few studies on the causes of loss of soil fertility, which include erosion. Nonetheless, the qualitative impact of erosion is clear. The most direct effect is to lower crop yield. Indeed, available data indicates that most crops show a tendency for productivity to fall off or, in the best of cases, to remain constant despite the use of fertilizers, improvements in cultivation methods, and the incorporation of more productive lands.

The clearest case of the impact of erosion is in the Central area where, together with other factors, erosion has led to migration of much of the population, and to changes in soil use. Nonetheless, measures must be taken to avoid further losses in the soil's natural quality. Such measures should range from establishing regulations for soil use, to transfer of technology, and even watershed management, in order to reclaim affected areas.

Erosion is a link in the process of soil degradation. It is caused by deforestation, inadequate soil management, and intense and frequent rains. Erosion, in turn, causes loss of soil fertility, and affects the sources and stream flow of waterways. This can be observed in the Central area, where erosion has caused pollution of streams.

Urbanization

Urbanization necessarily brings about environmental change, and when certain norms are not followed in the urbanization process, it leads to pollution on a scale directly related to population size, degree of industrialization, and effectiveness of preventive and corrective measures.

Paraguay's urban population has grown steadily, as indicated in the following data:

Year	*Urban Population*	%
1950	407,000	30.6
1962	652,000	35.8
1972	883,000	37.4
1982	1,281,000	42.3

These figures indicate a 3.8% annual increase in the urban population. Due to Paraguay's small population, slow urbanization process, and the absence of large, polluting industrial facilities, urban environments have not been seriously harmed. Furthermore, lack of damage to urban settings results in part from the lack of huge urban centers, as the population of most cities is under 5,000.

Asunción is the only city with over 400,000 inhabitants. Of the other 135 urban centers, 117 (87%) have less than 5,000 inhabitants, 10 have a population of 5,000 to 10,000, and only 8 cities have over 10,000 inhabitants.

Nonetheless, city life has led to some pollution problems, the main ones being:

Air pollution

Which is a problem primarily in Asunción, though it has not reached a critical point. The problem is worse at certain times of day and in certain areas as the city has grown.

Exhaust fumes and disturbing noises and odors are the principal effects of busy traffic. Though there is no quantitative data, it is estimated that at peak traffic hours in downtown Asunción pollution reaches 6,000 micrograms per hour per cubic foot of air of particles, and 2,000 micrograms per hour per cubic foot of air of sulphuric oxide. These levels far surpass the generally accepted limit from the standpoint of health and aesthetic considerations.

Municipal ordinances and other provisions regulate exhaust emissions, requiring, for example, proper adjustment of diesel motors, especially those with deficient injection systems. But such regulations should be enforced more effectively. Noise pollution from traffic has also become a nuisance during peak traffic hours in downtown Asunción.

Unpleasant odors are found in parts of Asuncion and other cities. In Asunción they generally come from tanneries, as none of the tanneries has effluent treatment systems. Such odors also come from waste and dumps in marginal urban areas. The Asunción garbage collection system, which serves 65% of the population, is estimated to dump some 360 tons of garbage and 48 cubic meters of market wastes into Salamanca creek every day. The dump in Asunción's Barrio Obrero constitutes an unsanitary menace affecting some 30,000 people.

This situation is reproduced, albeit on a smaller scale due to the smaller populations, in some of the larger cities with garbage collection systems, such as Villarrica, Encarnación, Caacupé, Pte. Stroessner, and others.

Garbage that is not collected is usually left in waste lands or empty lots, burned, or dumped in streams or torrents that form on rainy days, giving rise to odors and smoke, and thus a pollution problem.

Waterways

Other polluted resources include Asunción's waterways, such as Muricaó, Ferreira, and Jaen creeks, among others. These streams had constituted small watersheds and ecosystems that have been destroyed by garbage, sewage, and effluents from the tanneries, all of which are dumped into them.

The sewage system serves 56% of Asunción's population, and carries domestic and industrial wastes to the Paraguay River in a part of the city where the river is polluted. This is a problem, as beaches are nearby. Nonetheless, aside from such areas, the river is not seriously polluted, due to its enormous volume.

At present, five other cities have sewage facilities that serve a total of 45,000 people. CORPOSANA, the institution in charge of this service, plans to provide facilities for 175,000 persons by the year 2004. In most cases, such plans do not include treatment of the effluents, which will be disposed of in the Paraguay and Paraná rivers and other waterways.

Furthermore, there are plans to install treatment facilities known as settling ponds so that the effluents would be in a more acceptable state when dumped in waterways. These projects will serve the sewage systems of San Bernardino, Villarrica, Coronel Oviedo, San Juan Bautista, San Ignacio, and Luque.

Caballero Park.

Green Areas

The cities' green areas are plazas and parks, which in general are smaller than 10,000 m^2 (one square block). Asunción has 153 plazas, with a total area of 124 ha, the average area being 8,100 m^2.

The parks vary in area from 1,000 m^2 to a maximum of 60,000 m^2. Eighty percent of the parks are smaller than 10,000 m^2, accounting for 45% of the total area.

The Caballero Park (17 ha) and the Botanical Garden/Zoo complex (450 ha) are the most important green areas, given their expanse and purposes. The Botanical Garden/Zoo complex has of late been neglected, especially its scientific and educational aspects, as areas of historic, educational, and scientific interest have increasingly been turned over to sports and recreation uses. There are several other green areas which, given their size and vegetation, have a positive impact on the urban microclimate. The main ones are:

- the School of Physical Education (Km 4 1/2), the Racetrack, and the Higher Education Institute, all three contiguous, thus forming a significant open space;
- the Carlos Antonio López park;
- clubs with sports facilities; and,
- the Lambaré hill and its environs, which have been made into a park.

The other parks and plazas no doubt play a very important social role. However, due to their small size, their contribution to the urban environment is negligible.

Urban centers have been modernizing rapidly, with installation of running water, waste and storm sewers, paved streets, etc., all of which affect the environment and the quality of natural resources. An estimated 3.0 million people will be living in urban centers by the year 2000. This increase, together with projected services and industrialization, will have a significant impact on the environment; but the negative effects can be neutralized with proper planning, adopting corrective measures for today's problems and preventive ones for the future.

In recent years most of the municipalities have extended their respective urban radii, creating new neighborhoods and dividing them into lots. These measures have led to changes in economic activity, and have had a socio-economic and environmental impact. New urbanized areas on the periphery of cities have rendered the lands more valuable; but such areas lack adequate water and light services, paved roads, and other services.

Urbanization means not only extending the area of a city, but also, especially in and around Asunción, new types of contruction, which have gradually led to the destruction of a variety of architectural styles that reflect historical periods of great importance in the Paraguayan environmental and sociocultural context.

Archeology, Monuments, and Historical Sites

None of the indigenous groups that populated Paraguayan territory left significant architectural ruins. Nonetheless, there are many archeological and ethnographic materials and samples in a variety of collections, of which the most important is clearly that of the Dr. Andrés Barbero Ethnographic Mu-

Some rich pieces from the Franciscan Period constitute an important artistic patrimony.

seum. The museums's collection includes ceramic and lithic remains, and a range of ethno-historic and more recent materials from most of the ethnic groups that live or have lived in Paraguay.

In recent years archeological research has gained importance and has attracted the attention of several archeologists and institutions. This research has uncovered natural caves with remains from primitive cultures and cave inscriptions in the heights of Ybyturuzú and Amambay, sites which should be protected. To this end, they should be made into national parks.

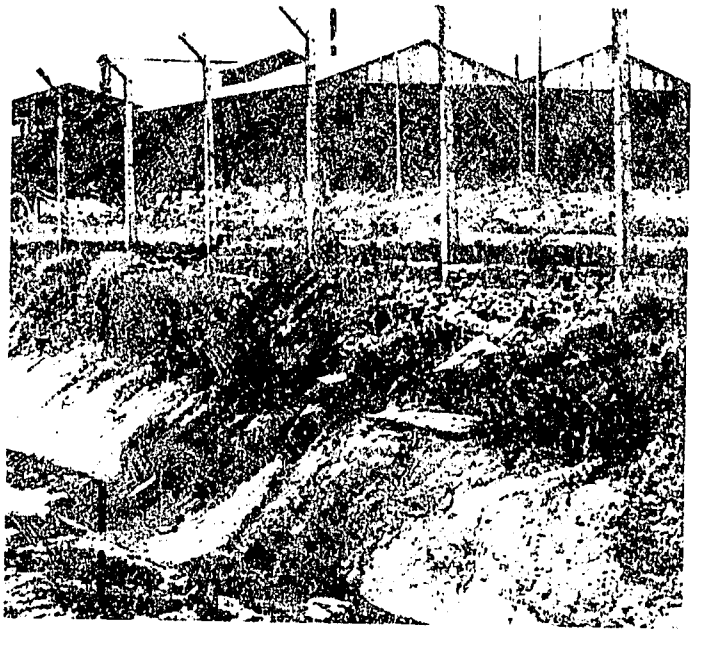
Efforts have been made to conserve and improve the most significant historical monuments and educationally and scientifically important points of interest. These include:

- the Jesuit ruins at Jesús and Trinidad, which date back to 1634 and 1712, located some 400 km from Asunción, in the Province of Itapúa;
- the Borbón fortress, which dates from 1792 and is known today as the Olimpo fortress, in the Province of Alto Paraguay;
- the San Carlos castle or fortress, built between 1803 and 1806 on the banks of the Apa river in the Province of Concepción;
- Vapor-cué, in the Caraguatay district some 100 km from Asunción, with remains of boats used in the war against the Triple Alliance;
- the ruins of Humaitá, south of Pilar, Province of Ñeembucú, 460 km from Asunción: a church built in 1861, then used as a fortress by the Paraguayan army in the war against the Triple Alliance;
- the church of Yaguarón, 50 km from Asunción, which dates from the latter part of the 18th century (1750 to 1780);
- the Cathedral of Asunción, built between 1842 and 1849;
- the Government Palace of Carlos Antonio López, generally known as the Cabildo, built between 1847 and 1854;
- the Church of the Incarnation, Asunción, built in 1893;
- the Church of the Trinity, built in 1856;
- Independence Hall and the Historic Way (1772);
- the Government Palace (1861–1867);
- the main railway station, inaugurated September 21, 1861;
- the Pantheon of Heroes and Oratory of the Virgin of the Assumption, built between 1863 and 1865, which was left unfinished at the time, and was finished in 1936;
- the home of Gen. Bernardino Caballero (from the mid-19th century);
- La Rosada foundry (1848–1869), located in the Ybycuí district, 200 km from Asunción; and,
- Corá hill, historical site where Marshal Francisco Solano López was killed.

There are several sites of social and environmental interest in and around Asunción in addition to those listed above, for the most part historic buildings or sites of interest because of past uses: residences of important persons, public institutions, churches, plazas, etc. Approximately 15 such monuments and historic sites are believed to have been demolished or fallen into ruin in Asunción.

Industry

Industry accounts for 20 to 22% of Paraguay's total gross domestic product; annual industrial growth has been on the order of 7.0% in recent years. Despite this growth, the share of industry in GDP has remained constant, due to the tremendous dynamism of the primary sector, especially agriculture.



Effluents from an industrial plant.

Most industries, by their nature, pollute the environment considerably. Nonetheless, due to their limited scale in Paraguay, the effects of such pollution did not become manifest until a few years ago. Nowadays, the effects of several industries are clearly quite serious in several parts of the country.

The food industry, the country's largest, accounts for 35% of industrial GDP. Textiles, the second industry, accounts for 13%. Other branches of industry account for 3 to 5% each. These industries have not had a serious impact on the environment because some of them, perhaps the most important ones, are located on the banks of voluminous rivers into which the pollutant by-products are dumped. The small size of most industrial facilities is another factor that has helped keep pollution down. And finally, many such facilities are located in sparsely populated areas; this does not include those of the Central area, and some sugar mills.

The industries that pollute most include meat-packing, vegetable oil, and liquor and alcohol plants. (See Chapter VI). At present industry is working at 20 to 60% of capacity, which means that the estimated maximum pollution level would be 1,884,450 population equivalents/day.[1] Industrial pollutants per plant vary from 15,200 to 400,000 population equivalents/day.

There are many family scale agro-industries which, as they are based in sparsely populated rural areas, do not pose a serious threat to the environment.

Energy

In 1982 Paraguay used a total of 1.7 million tons oil equivalent (TOE), per capita consumption coming to 560 kilograms oil equivalent (KgOE). The world average is 1,500 KgOE, and the Latin American average 1,000 KgOE. Energy sources are: biomass, 66%; oil derivatives, 21%; and electricity, 13%.

Energy consumption affects the environment and the natural ecosystem. The extent of this impact depends on the energy source, and the amount of energy produced. Following is a description of Paraguay's main sources of energy, and their relationship to the environment and the ecosystem.

Biomass

Biomass is the main source of energy. Sixty three percent is used in its primary form, and 3% in secondary form. Firewood is the main primary resource, accounting for 58%; charcoal and alcohol are the main secondary resources, accounting for 2.5% and 0.5%, respectively, of total energy supply.

Firewood and charcoal produce only low levels of pollution, given that they are used in the home, primarily in rural areas. Nonetheless, intensive use by industry, as for example in the ACEPAR blast furnaces, may be harmful, though in this particular case treatment of exhausts and gasses is planned, so as to avoid air pollution in the Asunción area where the plant is located.

Kilns, whether powered by firewood or steam, are not a source of pollution.

While organic fuels are not yet a pollution problem, the process whereby they are produced does affect the environment. In and of itself, this process is not a serious problem. However, taking into account the clearing of forests for other purposes, it does contribute to the destruction of the ecosystem, destroying the habitat of wild animals and altering local and regional climate and vegetation.

Such energy resources depend on forest resources; if the forests are not replenished by man, serious environmental problems will arise. Scarcity of such energy will drive its price upwards. Some users will have priority access, and domestic imbalances may arise once the Paraguayan national iron and steel works (ACEPAR), which will use charcoal, begins operations. Its demand for this resource will rise above current total supply levels.

Alcohol production deserves special attention. It is a significant source of pollution, as the mash from alcohol production consumes dissolved oxygen when dumped in streams, thereby giving rise to unpleasant odors for a distance of several square kilometers below the processing plant.

The distillation of each cubic meter produces 12 to 14 cubic meters of mash; a single cubic meter of mash can render 3,000 cubic meters of water anoxic. In other terms, 12 to 14 liters of mash from a distillation plant has the same biological oxygen demand as the daily urban wastes of 6 people.

Current alcohol production levels and the 1.2 million liters of waste waters currently produced have the potential to pollute 50.4×10^7 cubic meters of water. At present, alcohol production, especially at Paraguay's main distillery, located at Mauricio J. Troche, Guairá Province, involves dumping of wastes in the Tebicuary-mí river, making it impossible for nearby cities such as Villarrica and Coronel Oviedo to be supplied with potable water. Pollution takes place on a smaller scale in the Caacupe waterways and Lake Ypacaraí, caused by effluents from sugar cane processing plants that produce hard liquor.

Given current trends, it is estimated that demand for alcohol fuel for 1985 will come to 147,000 cubic meters. This would mean 2.0 million cubic meters of waste waters, with a potential to pollute 6.0×10^9 cubic meters of water. The effects would be particularly serious for fish life and the affected population; there may also be other unforeseeable consequences.

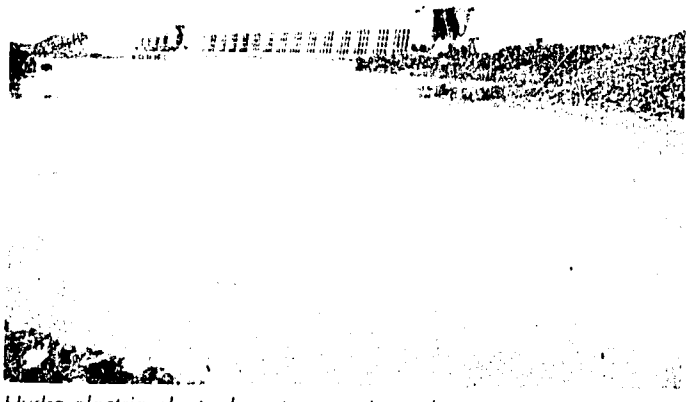
Oil Derivatives

Oil derivatives covered 11% of the total demand for energy in 1982. There is as yet no oil produced in Paraguay, but processing of oil derivatives has brought about environmental changes on a small scale. The maximum capacity, 7,500 barrels a day, is far below that of other refineries that do cause serious damage. The refinery, located along the Paraguay river just 10 km from the center of Villa Elisa, Central Province, receives oil shipments. Oil and other residues that spill into the river when the tankers are cleaned damage and pollute downstream river banks. This can be observed with the naked eye.

Use of tetraethyl lead to improve the octane rating of gasoline, prohibited in countries with strict environmental regulations, is the most noteworthy pollution problem connected to oil use. Indeed, tetraethyl lead pollutes the environment wherever used, the lead components posing a particular health hazard.

1/ One population equivalent = 54 grams BOD/day (BOD:Biological Oxygen Demand).

Hydroelectric energy production involves less pollution than other forms of energy production.



Hydro electric plants do not contaminate the environment but dam construction causes significant physical and biological changes in the environment.

Hydroelectric Energy

In 1982 hydroelectric energy supplied 13% of Paraguay's energy needs. Production of hydroelectric energy has increased at an annual average of 17.4% over the last 10 years, a much higher growth rate than other energy sources.

Due to its natural features, Paraguay's Eastern region has a tremendous hydroelectric capacity, ranging from small plants, with less than 10 KW/h capacity, to very large ones with capacities ranging from 8 to 13 million KW/h.

With the Acaray power plant and Itaipú's 12.6 million KW/h capacity projected for 1990, as well as the Yacyretá and Corpus projects, Paraguay may develop an abundance of per capita energy reserves.

Hydroelectric energy production involves less pollution than other forms of energy production. However, dam construction causes significant physical and biological changes in the environment. Installation of hydroelectric facilities also has significant socio-economic consequences.

Approximately 200,000 ha have been directly affected by the Itaipú, Yguazú, and Acaray dams. The effects have been as follows:

a. *Social*: Emigration of much of the local population.

b. *Economic*: Lumbering, agriculture, cattle raising, and other rural activities have come to a halt.

c. *Biological*: Installation of dams along the Paraná, Acaray, and Ygauzú rivers has brought about the destruction of natural vegetation, primarily top quality forests. The change in precipitation patterns is directly related to the disappearance of forests and the significant increase in surface evaporation from air-water contact in the reservoir. As yet no studies have evaluated these changes; nonetheless, experiences elsewhere indicate qualitative effects in this regard.

This disequilibrium may be accompanied by parallel effects such as the proliferation of some animal species which serve as disease vectors, as well as the appearance of some plant species that become weeds. Such plant species, however, have to date not been observed in Paraguay.

The flooding caused by the dams also drives away many animal species, while others become locally extinct.

The most dramatic aquatic effects of the dams are:

- change in the speed of stream flow;
- accumulation of sediment; and,
- change in the water's degree of turbidity.

The above phenomena will become more pronounced once the Yacyretá and Corpus dams are completed. Together with Itaipú, they will constitute three large reservoirs that total 500 km in length, destroying the present aquatic ecosystem and giving rise to new ones. Their impact on fish life will be manifested in:

1. A halt in biological migratory movements of fish.

2. The dammed rivers and their tributaries and lagoons will no longer serve as spawning grounds for several species.

3. Construction of dams may favor the proliferation of more voracious, aggressive, and trash carnivorous fish species, to the detriment of species that are more valuable economically and for sport.

Finally, the construction of electric power lines also affects the environment. In recent years over 1,000 km have been installed in a variety of areas, including forests, natural grasslands, and cultivated zones. Furthermore, this system of distribution and supply causes radiofrequency radiation, low frequency electromagnetic radiation, electric induction, and other effects on the environment. Its effects, however, have not been studied, and no minimum or maximum limits have been set.

Although the environmental impact of electricity lines is not well-known and the negative effects go unnoticed, together with other phenomena, distribution of electricity contributes in a gradual fashion to the process of environmental change.

Areas of significant change

1. Central area.
   Agriculture and mixed farming.
   Area: 20,000 km².

2. Itapúa area.
   Agriculture and Forestry. Settlement by European and Oriental settlers beginning about 1920.
   Area: 10,000 km².

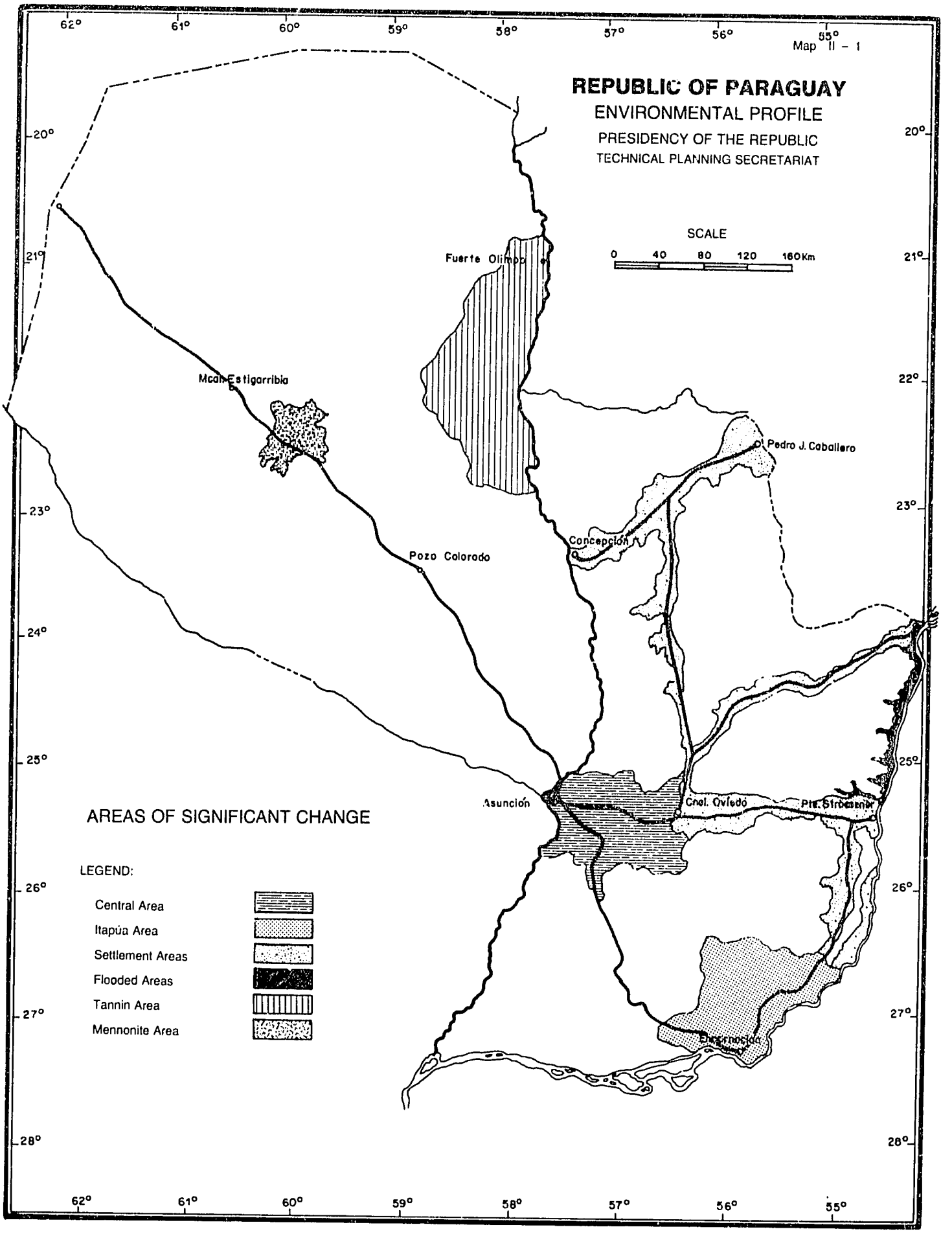
3. Settlement areas.
   Settled by Paraguayan and Brazilian settlers, beginning in 1960 with the agrarian reform.
   Area: 87,000 km².

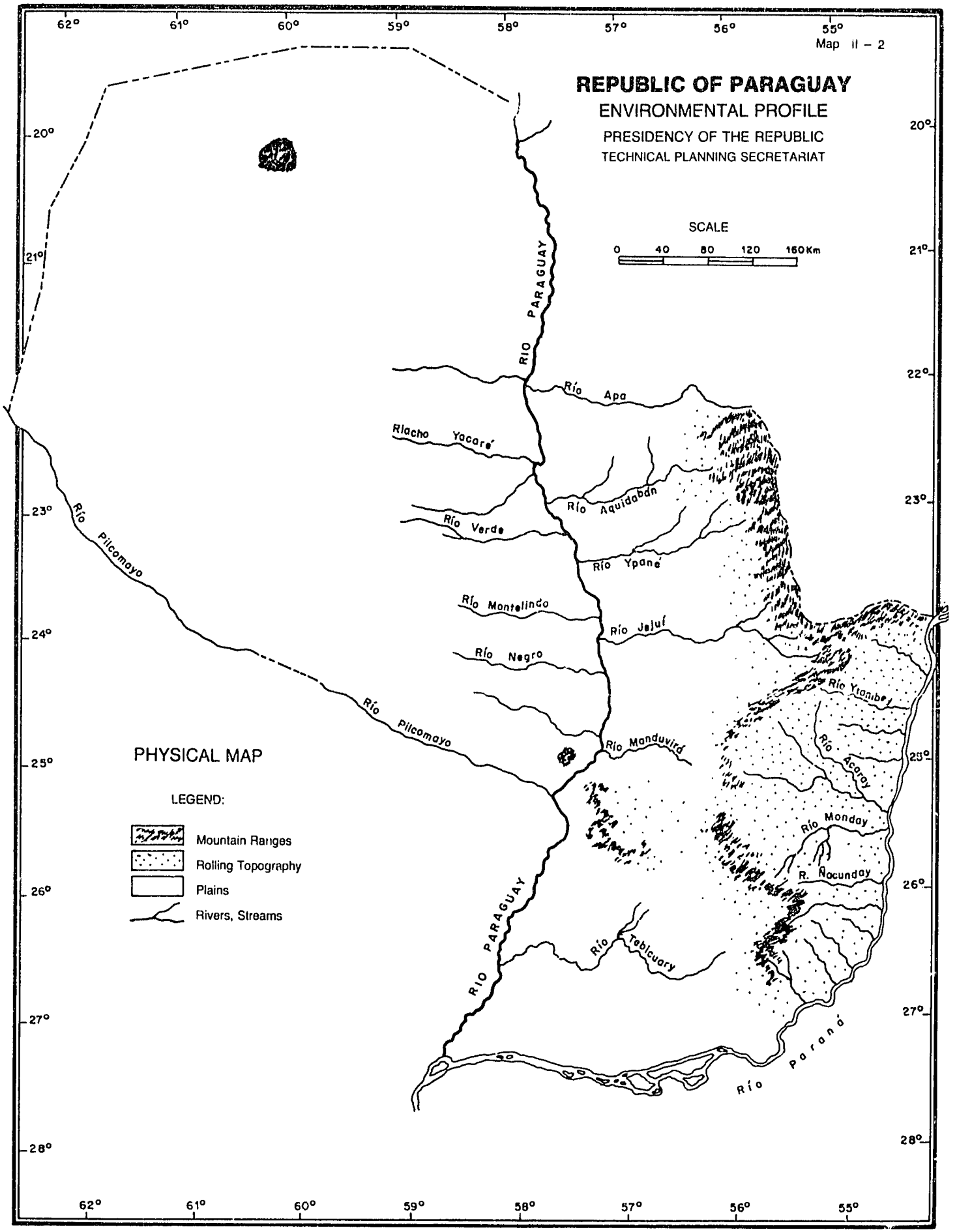
4. Flooded areas.
   Created by the Itaipú, Acaray and Yquazú dams.
   Area: 200,000 ha.

5. Tannin area.
   Begun toward the end of the last century and continuing into the 1950s.
   Area: 30,000 km².

6. Mennonite area.
   Settlement begun in 1926 – mixed farming and agroindustries.
   Area: 9,000 km².

Note:
Areas are estimated.


Map II - 1
REPUBLIC OF PARAGUAY
ENVIRONMENTAL PROFILE
PRESIDENCY OF THE REPUBLIC
TECHNICAL PLANNING SECRETARIAT
SCALE
0 40 80 120 160Km
62° 61° 60° 59° 58° 57° 56° 55°
20° 21° 22° 23° 24° 25° 26° 27° 28°
Fuerte Olimpo
Mcal. Estigarribia
Pedro J. Caballero
Concepción
Pozo Colorado
Asunción
Cnel. Oviedo
Pte. Stroessner
Encarnación
AREAS OF SIGNIFICANT CHANGE
LEGEND:
Central Area
Itapúa Area
Settlement Areas
Flooded Areas
Tannin Area
Mennonite Area


Map II – 2
REPUBLIC OF PARAGUAY
ENVIRONMENTAL PROFILE
PRESIDENCY OF THE REPUBLIC
TECHNICAL PLANNING SECRETARIAT
SCALE
0 40 80 120 160Km
PHYSICAL MAP
LEGEND:
Mountain Ranges
Rolling Topography
Plains
Rivers, Streams
RIO PARAGUAY
Río Apa
Riacho Yacaré
Río Aquidabán
Río Verde
Río Ypané
Río Montelindo
Río Jejuí
Río Negro
Río Pilcomayo
Río Manduvirá
Río Ytanibey
Río Acaray
Río Monday
R. Ñacunday
Río Tebicuary
Río Paraná
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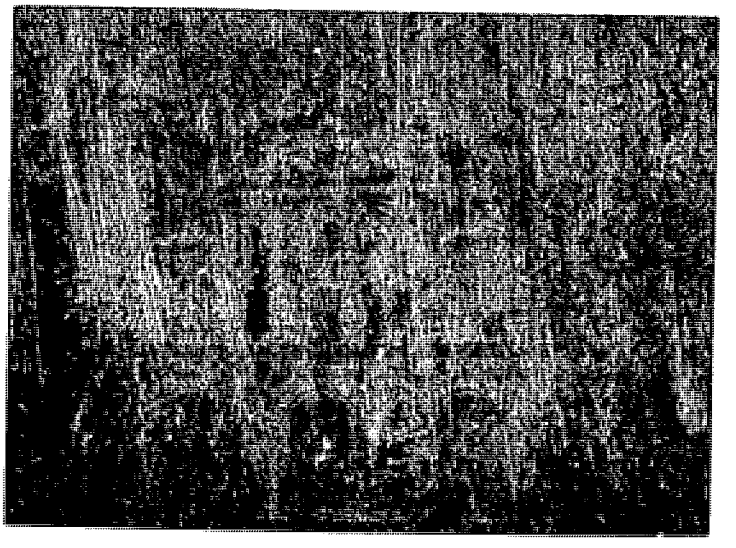
Toward an Environmental Conservation and Preservation Policy



Asunción Cathedral.

Guairá Falls, which have disappeared under the reservoir behind Itaipú dam.

III

Toward an Environmental Conservation and Preservation Policy

The actions proposed in this chapter are of a general nature, and reflect concerns that arose in the course of investigating the current status of the environment. Implementation of these ideas will require more in-depth study, and application of such research in the form of profiles or projects. The appropriate institutions should make decisions in accordance with the guidelines for each case, and guarantee the implementation of such decisions.

Medium-Term Actions

Research into the status of natural resources and the environment indicates the need for a cohesive policy regarding natural resource use, conservation, and preservation. Given the complex nature of the environment issue, which affects several sectors, environmental policy should be:

- broad, so as to cover the whole range of issues entailed;
- flexible, so as to be consistent with the interests of both development and conservation;
- far-sighted, taking into account the time needed to implement policy and achieve the stated objectives;
- normative, setting a framework for all activities related to use, reclamation, conservation, and preservation of natural resources and the environment; and,
- institutional, with the appropriate hierarchical organization and sufficient resources.

The following are required for defining and implementing this policy:

Revision of Legislation

Some contradictions and outdated provisions have been found in the laws on natural resource use and the environment. A study of current legislation is recommended so as to overcome these problems. The legislation should be updated and corrected; inconsistencies should be eliminated so as to avoid legal conflicts. The most important documents in need of updating are the Civil Code,[1] the Rural Code, the Agrarian Statute, and others (laws, decrees, etc.).

Strengthening Institutions

Modern administrative techniques are necessary for achieving the objectives of natural resource and environmental policy.

The present administrative apparatus needs to be improved and strengthened along the following lines:

- defining the respective institutional functions and attributes of all bodies whose work is related to natural resource use and the environment;
- defining the structure and nature of the institution in charge of natural resources and environmental planning and management (e.g., an Institute for Natural Resources);
- assuring that all levels and specialties are staffed by competent personnel; and,
- allocating sufficent resources for all functions.

Land Management

Land management is needed to determine how different lands will be used, in accordance with the natural resource base, so as to avoid environmental degradation and achieve more balanced development from one area or region to the next.

It is particularly important to define urban areas, or areas to be urbanized, rural spaces, areas to be protected, and areas set aside for industry and basic services. These divisions will be set forth in more detail in each region and zone.

1/ Currently being studied in Congress for updating.

The objectives of land management are:

- use natural resources rationally and preserve environmental quality;
- improve knowledge about problems related to the environment;
- help set priorities in dealing with difficulties;
- quantify financial needs in more precise terms; and,
- reconcile development interests and conservation interests.

Implementation of the above requires the proper legal framework.

Immediate Measures

Ideally, measures should be implemented in a defined context. But in the absence of such a context, and while legal tools are being drafted and the respective institutions are being set up, the following projects and measures can be undertaken:

Data Center and Office for Evaluation of the Environment

This office should gather information from different sources regarding all aspects of the environment. Such data should be processed and analyzed so as to determine related points and reach conclusions regarding the environment.

Its main functions will be:

- systematically evaluate the environment in the country as a whole, and by region, zone, or specific topic;
- propose, where appropriate, environmental policy alternatives and decision-making methods;
- promote plans, projects, and measures to solve environmental problems;
- guide and coordinate the actions of public, private, and international institutions;
- disseminate information gathered and conclusions reached in environmental studies; and,
- establish a data bank.

Institution: Technical Planning Secretariat. (The specific office is to be set up.)

Soil Classification

Most soil studies to date have been general and exploratory, and have used different classification systems. Soil maps, at a scale of 1:50,000, cover only 28,300 km^2, or 7.0 percent of the country. Most of these studies were carried out by consultants for specific projects.

In light of the above, the following measures are recommended:

- creation of a government office in charge of soil studies;
- gathering and revision of existing data regarding soil classification, climate, vegetation, and other indicators for the taxonomic study of these resources;
- design of a uniform system for classifying soils according to their uses;
- passing legislation to adopt a national classification system;
- drafting maps indicating soil use capacities for all Paraguay;
- establishing norms for soil use according to potential, so as to avoid soil degradation, and for reclamation of soils that are already degraded; and,
- establishing a national soil conservation program.

Institution: Ministry of Agriculture and Livestock. (A specialized office should be created to cover this area.)

Management of Wildlife and Natural Areas

A total of 1,120,500 ha have been set aside as protected areas. Of these lands, 98.2% are found in the Western region, and 1.8% in the Eastern region. There are also other natural areas which, given their ecological features, must be protected so as to avoid their destruction or alteration. Appropriate management of wildlife and natural areas requires measures to complement those taken to date. The main ones are:

- reinforcing the office in charge of administering parks, reserves, and wildlife, through appropriate organization with a hierarchical structure and allocation of sufficient funds;
- designing and implementing a system of national parks and reserve areas;
- updating legislation regarding wildlife management so as to avoid legal conflicts and establish specific norms for each area;
- establishing and implementing regulations for hunting, fishing, trapping, and marketing of products and by-products of these activities;
- systematically undertaking public education campaigns on the importance of conserving Paraguay's biological resources; and,
- promoting tourism and scientific and recreational activities so as to make better use of national parks.

Institution: National Forest Service.

National Biological Inventory and Museum of Natural History

This program has gotten off the ground, but has come up against serious limitations, and is thus unable to operate as it should. Compiling the inventory and building the museum are both extremely important for learning about Paraguay's biological resources. They are key in terms of gathering the basic information for any effort to conserve plant and animal species.

The following measures should be taken to assure proper development of this program:

- strengthen the office in charge of the program, defining its place within the institutional structure and its specific functions;
- appropriate more resources to the program, and streamline allocation of funds to cover expenditures; and,

- redefine the program so as to set the objectives, timelines, and expenditures needed to cover the entire country.

All of these measures will allow for continuous follow-up and evaluation while the program is underway. They will also facilitate refinancing.

Institution: National Forest Service.

Paraguayan Natural History Museum

As there is no such national institution, the following measures are recommended:

- Establish a natural history museum, as, to date, Paraguay has not had one.
- This museum, which would be of high scientific and educational quality, would serve as a depository for geological, botanical, and zoological collections of interest to the university community and the public in general. It would serve the needs of research, teaching, tourism, recreation, etc.
- The museum would relate to the zoo and botanical garden, possibly as a dependency.
- The museum would include specimens, insofar as possible, representative of all Paraguay. In the future, or if regional or local museums are established, the national museum would serve as a central or reference museum.

Institution: National University of Asunción.

Forestry

Forests constitute one of Paraguay's most important resources. Given current threats to the forests, several protective measures are proposed to assure they can continue to fulfill their various functions.

The most important measures to be taken are:

- designing and implementing a national forest system;
- carrying out and periodically publishing a national forest resources inventory;
- developing a forest management plan;
- developing a reforestation plan with several purposes, including soil reclamation, supplying ACEPAR with charcoal, and others;
- developing programs for transfer of forestry technology;
- strengthening the institution in charge of forest resources, assuring it has adequate personnel and funding; and,
- revising legislation regarding harvesting and marketing of forest products, legislating needed changes in accordance with present and future needs.

Institution: National Forest Service.

Rational Use of Toxic Substances

To foster greater public awareness regarding the dangers toxic substances pose to the environment and public health, measures already being taken should be stepped up and complemented with others so as to carry out this task more effectively. The priority measures to be taken are:

- setting up a campaign to inform the public about the presence of toxic substances in the environment, and their possible consequences;
- ensuring enforcement of existing regulations regarding use of chemical products, as well as those regarding importation, storage, and marketing of toxic substances;
- revising and complementing existing norms on importation, storage, and marketing of toxic substances;
- setting up an educational campaign with outreach to farmers, agricultural workers, and food processors regarding appropriate use of toxic substances, techniques to avoid health hazards, and measures to protect those who buy and sell agricultural products;
- establishing and implementing regulations regarding advertising of products that contain toxic substances; and,
- strengthening the capacity of the appropriate institutions to carry out the proposed measures.

Institutions:
- Ministry of Public Health and Social Welfare.
- Ministry of Agriculture and Livestock.
- Ministry of Industry and Commerce.

Management of the Lake Ypacaraí Basin

The natural resources in and around Lake Ypacaraí, such as the water, soil, and flora and fauna, have been significantly degraded in recent years. This drop in quality is due to stepped up use of the lake for recreational purposes, an increase in industry and agriculture in the lake's vicinity, and more means of transportation in the lake's watershed.

Given the ecological and social importance of the lake and its watershed, measures must be taken to avoid further and irreversible damage.

Due to the relationship among the resources affected, and to be as effective as possible, any plan must deal with both the lake and its watershed. Such a plan should include:

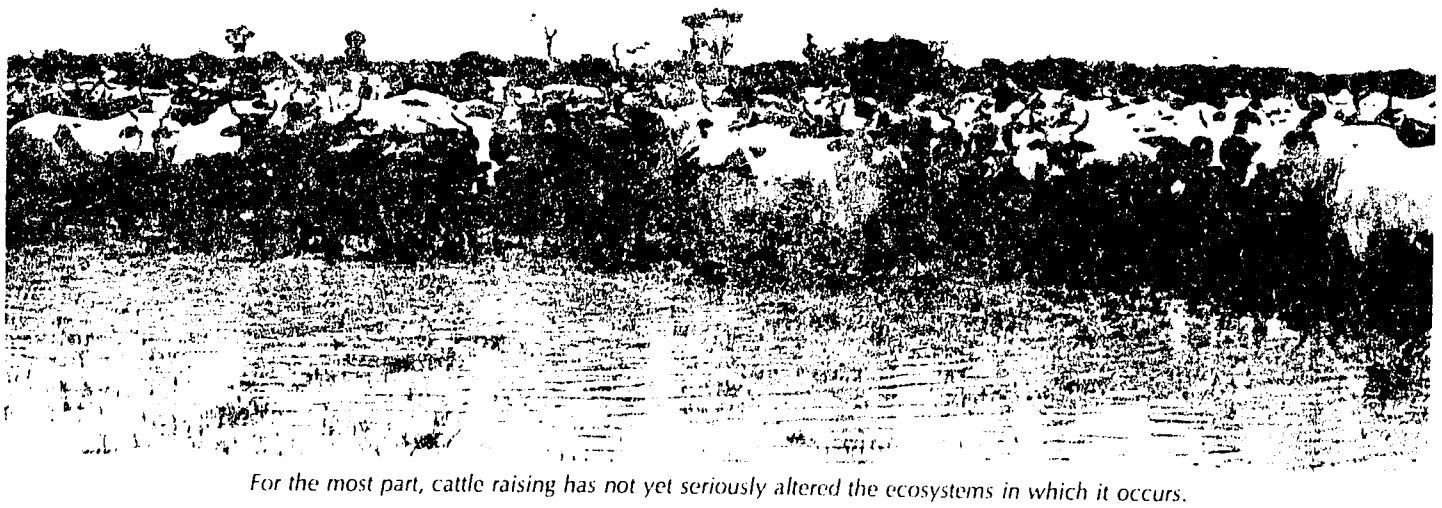
- regulations for establishment and operation of industry;
- land management of the watershed to establish areas for urban development projects, recreation areas, and agriculture; and to define those areas that should always have natural vegetative cover and those that require forestation or reforestation, etc.;
- regulations regarding garbage and waste disposal in general; and,
- regulations regarding disposal of industrial effluents.

Institution: The institution(s) in charge, costs, and financing for the plan for management of the lake and watershed need to be identified in order to implement the plan.

Strengthening and Developing Private Entities

Private non-profit organizations working in conservation and natural resource management, such as PRONATURA, FUNDLAY, and MAB, will be able to play an important role once they have the appropriate organizational capacity. To this end they should be supported.

The thrust of these organizations' work is research, education, and publicity related to the environment. These groups could complement government-sponsored programs as part of Paraguay's conservation policy.



For the most part, cattle raising has not yet seriously altered the ecosystems in which it occurs.

Private entities in charge of monitoring and guaranteeing environmental quality in their respective communities should be encouraged on a regional basis.

Urban Solid Waste Recycling Project

Making use of domestic and industrial solid wastes in the Asunción area is the goal of one environmental project that is likely to be put into effect.

Presently, more than 400 tons of garbage and other solid wastes are collected daily in Asunción. The current disposal system, whereby garbage is dumped in layers into a natural depression, known as a sanitary land fill, has significant shortcomings in both operations and approach.

A recycling plant that at first would operate with simple reclamation processes, employing environmental protection techniques such as solid waste management, would combine the goals of physical removal and sanitary disposal. Other basic reclamation methods, such as recycling bottles and similar economic stimuli at the neighborhood level, should be studied and implemented by the municipal governments.

Institution: Municipalities, especially Asunción.

Urban Land Management

Cities, which constitute a man-made milieu, have not yet grown to alarming proportions. Asunción (population 400,000) is the only Paraguayan city with population over 100,000.

Despite the fact that environmental degradation in Asunción as regards noises, vibrations, wastes, odors, pollution, microclimatic discomfort, etc., has yet to reach worrisome levels, regulations and methods for protecting the urban environment should be adopted.

Urban land management, barely begun in the Asunción area, should move beyond enforcing ordinances and other regulations: land management in both the cities and countryside should be dealt with by a national land management law. Yet, as there have been few experiences in this regard, regional measures are recommended in the first stages.

Towns and cities other than Asunción, despite their smaller populations, can and should also ensure their growth is consistent with environmental protection and especially with the quality of life.

The proposed project would use available environmental protection techniques, studying their impact and economic and legal implications.

Institution: Institute for Urban Development.

Archeological Studies Center

The establishment of an archeological studies center should proceed immediately. Such an institution, which would be part of a larger, comprehensive scientific and educational undertaking, would contribute to the conservation and preservation of the environment and natural resources.

Thus, archeological studies should be taught in the context of a well-rounded anthropology program, covering physical, social, and cultural anthropology, as well as archeological and pre-historic studies, and ethno-historic museum studies.

The objective of the proposed studies center would be to train social scientists in the broad field of "human sciences," i.e. interdisciplinary studies in the above-mentioned branches of anthropology; it would also pursue the practical matters of research, recovery, collection, and classification of relics of past cultures and the ethnographic manifestations of present-day indigenous communities in Paraguay. These artifacts would be organized in permanent or traveling exhibits.

This center would also play a key role in educating all Paraguayans to respect the need to recover, conserve, and preserve relics of cultural history and of Paraguayan society of all epochs.

Given this project's scientific and academic character, it should be channelled through the National University. Indeed, this program may be set up within the University's School of Philosophy and Letters. Nonetheless, the Ministry of Education may organize its own Department of Study, Conservation, Preservation and Education of the Paraguayan historic and cultural environment. This might mean splitting functions, for such an entity within the Ministry of Education could take charge of museums and repositories while the University could train specialists in the human sciences related to these proposed measures.

In any event, the National University is not only capable, but is clearly structured to play both roles simultaneously. This recommendation is intended to centralize rather than fragment actions to be taken.

Institution: National University of Asunción.

National Environmental Education Program

A nationwide educational program should be set up with the following objectives:

- disseminate information as to the current status of the environment and the natural resource base;
- publicize the important role of natural resources;
- disseminate information on the causes, effects, and interrelated aspects of environmental change; and,
- develop regular educational programs at all levels.

In the program, the word "education" should be broadly understood as involving both formal and non-formal education: all possible communication media, including the mass media, should be used, and the program should be geared to the broadest possible audience, so that the community can increase its awareness of society's need for a clean environment.

The program will also provide incentives to institutions related to the environment.

Institution: Ministry of Education and Culture.

Preservation of Indigenous Cultures

While establishment of a program to recover and conserve historic cultural relics by setting up an archeology studies center is certainly important, ensuring the social and cultural cohesion of the indigenous peoples surviving in Paraguay today is an even more pressing and fitting task.

Fortunately, there is already a national law in this regard, the Statute on Indigenous Communities. Article I sets forth as an objective of the law "the social and cultural preservation of the indigenous communities, protection of their heritage

and traditions, and improvement of their economic conditions." Nonetheless, the specific measures and policies for achieving such wide-ranging and just aspirations have yet to be defined.

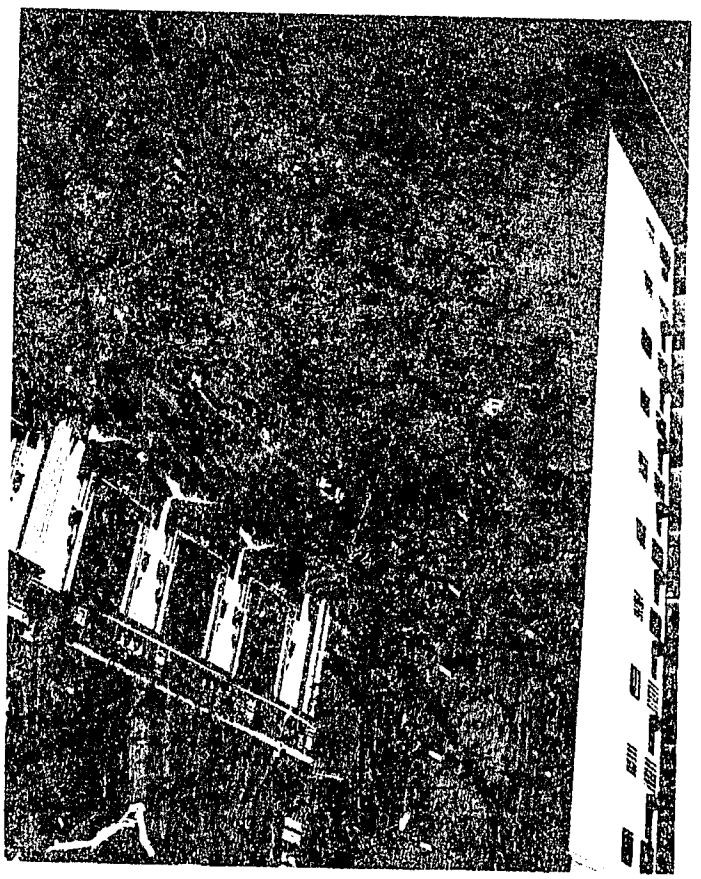
Several parties, acting individually or as part of an institution, are active in conservation and preservation of indigenous cultures. These parties' diverse theoretical and practical approaches to the issue of inter-ethnic contacts sometimes overlap and sometimes conflict.

However, as immediate measures to guarantee a comprehensive, cohesive policy for conservation and preservation of the natural and socio-cultural environments are the issue at hand, such measures should be the responsibility of the Paraguayan Institute for Indigenous Affairs (INDI), as it was set up for this purpose by the above-mentioned law (904/1981, Statute on the Indigenous Communities).

Indeed, INDI is the autonomous government entity set up to implement the law. Among its functions is the "coordination, monitoring, and evaluation of activities for the benefit of indigenous peoples in the public and private sectors," as well as "providing scientific, technical, legal, administrative, and economic assistance to the indigenous communities, alone or in coordination with other institutions."

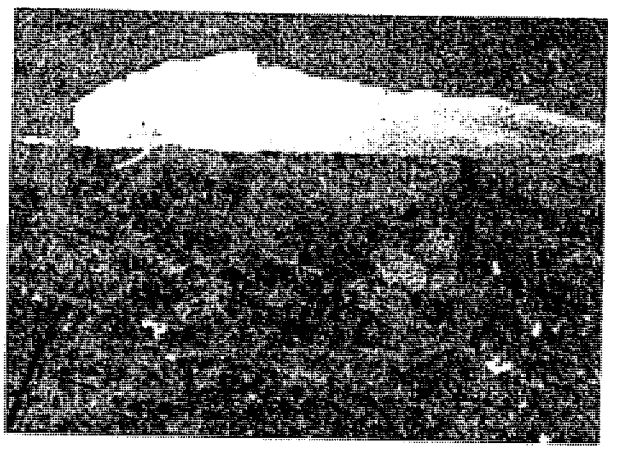
INDI, it should be pointed out, not only has the legal authority to develop its own policies in this field, under the aegis of a specific law; it also has the option of coordinating all related activities.

Institution: Paraguayan Institute for Indigenous Affairs (INDI).



Two architectural styles.

Social Aspects



Cué mines, Ybycuí National Park. Photo courtesy National Forest Service.

Indigenous census takers compiling data on distinct ethnic groups.

IV

Social Aspects

Ethno-Historic and Anthropological Background of the Paraguayan Environment

Pre-Hispanic Paraguay

Socio-spatial Aspects

In the early 16th century, present-day Paraguayan territory constituted two distinct ecological, social, and environmental milieu. The Paraguay River, running north to south, clearly defined the borders for two socio-spatial and cultural regions, which, moreover, were marked by sharp geographic and climatic contrasts. This is what the Spaniards encountered when, in the course of their expansionist conquest and settlement drive, they came to what is today Paraguay. They first settled at the site that became Asunción, later moving into Paraguay's Eastern region.

The Western region or Chaco includes a vast plain, perhaps once a sea bed, which is semi-arid and is criss-crossed by forests. The area is characterized by its hot climate, scarcity of water resources, low levels of precipitation—especially as one advances further to the northwest—and its periodic rises of rivers and streams, causing flooding and extensive spill-overs, which drain with difficulty due to the heavy clay soils.

Nature has been generous with low vegetation, grasslands, forests, and palms. Native fauna are found in great abundance, turning the Chaco into an immense hunting ground for nomadic peoples with a gathering, hunting and fishing economy. The earliest written accounts testify to the presence in the Chaco of "very barbaric . . . , very bellicose nations that do not cultivate the land nor gather any seed fruits, for their survival, but who live from hunting and fishing." This description is by Ruy Díaz de Guzmán in his "Historia del Descubrimiento, Conquista y Colonización del Río de la Plata," 1612.

Across the Paraguay River, to the east, one finds humid, subtropical forests, fertile soils, and a more benign climate with abundant rainfall and generous water resources, especially as one approaches the Paraná river basin.

The spatial and cultural dichotomy was thus marked in pre-conquest times, and was decisive in determining the location of the Spanish colonial settlements. In the Chaco were to be found several bellicose, rebellious, and hostile tribal groups, with a hunting, fishing and gathering economy and, worst of all, a habitat unsuited for the Spanish agricultural, urban, and artisan traditions.

The prototypical form of social organization in the Paraguayan Chaco was that of nomadic tribal paleolithic clans that hunted, fished, and gathered. There were a few exceptional cases of rudimentary agriculture; this, however, was carried out under subjugation to the aggressive, paleolithic hunters.

In the Eastern region, and particularly in the area of Asunción bay, the Spaniards did find neolithic cultivators with highly productive agriculture. Historian Ulrico Schmidl reports that "among the above-mentioned Carios or Guaraníes we find 'Turkish wheat' or maize and mandiotín, yam, poropí manioc, pepirá manioc, peanuts, bocaja, and other foods, as well as fish and meat, deer, wild boar, ostrich, 'Indian sheep,' rabbits, hens, and geese, and other wild animals, not all of which can be described at this time. There is also divine abundance of honey, with which wine is made; they also have a great deal of cotton" (Schmidl, 1567).

Thus the Paraguay River, since the pre-colonial period, and since the times of conquest and settlement, has marked the striking and rigorous spatial, social, cultural, and environmental boundary between the two great milieu which make up Paraguay. This situation has determined the ethno-historic processes of population distribution, conquest, and colonization, as well as the configuration of Paraguay's towns and cities and the social organization of production and exploitation of natural resources.

Productive Activities

In pre-Columbian times, there were two productive modes: agricultural and extractive. The extractive mode was characterized by a completely utilitarian approach to the environment, with no production processes to speak of. Gathering, hunting, and fishing are typical extractive activities. While such activities required a wide range of procedures which, in some instances, were quite complex, there was no production in the sense of creating products. There was only extraction of natural products, and direct consumption or consumption with minimal processing.

Extraction was the basis of most pre-Hispanic economies in the Chaco. Virtually all of the pre-Hispanic groups hunted, fished, and gathered, but without carrying out actions that would lead to depredation of nature; they practiced a rotation system in their natural resource use, allowing for a more or less balanced renewal of these resources. Some indigenous peoples drove agricultural communities into serfdom, the agricultural goods produced complementing the basic extraction-based diet.

The pre-Hispanic agricultural cycle of most interest in analyzing Paraguay's production processes is Guaraní agriculture, especially that of the Carios from the area that was to become Asunción. Their subsistence agriculture drew on the natural fertility of the soil and used the slash-and-burn method, sowing on the cleared lands. This form of soil use is seen as a cause of the semi-nomadic nature of these groups, who often moved so as to continue the resource use cycle. This allowed for at least partial renewal of resources.

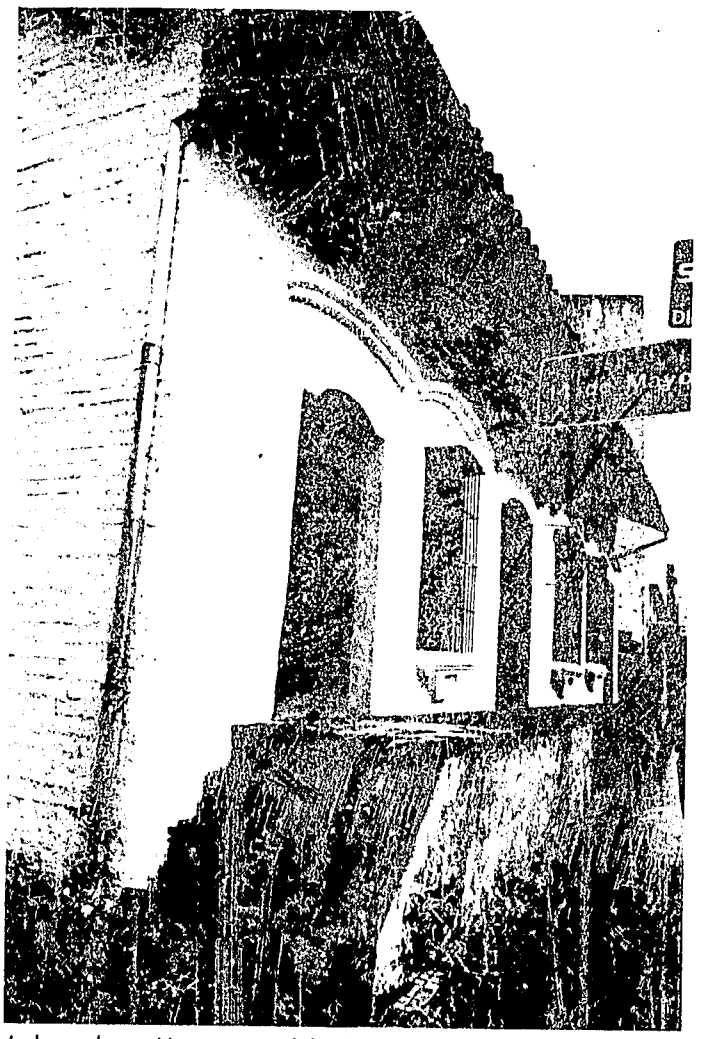
The Colonial Period

The New Socio-Spatial Arrangement

The arrival of the conquistadors in the region described above in the early 16th century—especially in the area where Asunción was established—signalled the beginning of colonization in Paraguay, the influx of a new population, and the starting point of a new model of resource use and environmental management.

Soon the demography shifted to a prevalence of mestizos of mixed Spanish and Guaraní background. Nonetheless, the Carios of the Asunción area fought against contact with the Europeans. The Spaniards, however, understood the importance of overcoming the opposition, ruling over these groups, and setting up stable settlements. Indeed, the conquistadors' advance from the mouth of the La Plata River had grown difficult due to the inhospitable climate and the bellicosity and aggressivity of most of the indigenous groups with which, up till then, they had come into contact. Initial Guaraní resistance was overcome after violent and bloody confrontations.

Two key aspects should be stressed. First, that the Carioguaranís resisted Spanish colonization from the beginning; miscegenation between the Spaniards and the Guaranís did not grow out of spontaneous friendship pacts. Rather, it was imposed by the Spaniards on the Guaranís. This relationship of the Spaniards and the indigenous peoples as oppressors and oppressed respectively, has from the outset determined the course of conquest and colonization, involving new forms of production and environmental use.



Independence House, one of the few extant testimonials to colonial architecture.

And secondly, the Spaniards stressed the importance of the Asunción area "with its land and people." There were lands already cultivated by small farmers, agricultural goods which could be consumed, and a work force subjugated by the "political relative" system of Guaraní social relations, which placed tremendous importance on the in-law relationship. This was seen as a means of broadening the extended family, with the consequent advantages of defending the clan and increasing productivity of the land through more male laborers.

As miscegenation began, with marriages of conquerers and Guaraní women, the first colonial settlements arose in Paraguay, with Asunción as the administrative and population center. The need for production led to new forms of organizing physical space, exploitation of natural resources, development and adaptation of new technologies and, finally, a cultural response to the gamut of social needs.

Productive Activities

The rapid and stable settlement of the Spaniards in Asunción, miscegenation with the Guaranis, and establishment of the colony's other early settlements gave rise to a gradual change in production.

The Guaranís' rudimentary tools were replaced by the Spaniards' modern tools: metal artifacts, axes, hoes, and later plows,

oxen, and other draft animals that were incorporated into what was clearly a more modern, productive, and diversified agriculture in colonial Paraguay. New crops such as garden vegetables and fruits were introduced, and subsistence agriculture slowly gave way to surplus production with storage and commerce. Cattle were raised for the first time, and their meat came to complement the indigenous diet.

At first production for subsistence and to supply one's own needs continued to prevail. But soon bread and beef were produced, cattle having been brought in during the 16th century. Wine, wheat flour, starch and native cotton were also produced. The cotton was spun and woven in the colony itself; it was used in the production of Paraguay's first textiles. Molasses and, soon, hard liquor and sugar were all produced from sugar cane. Hides from both cattle and wild animals were tanned and used in local production. Lumbering was begun, and carved woods, beams, braces, and planks were produced and used to manufacture axles and other parts for carts, coaches, furniture, sugar mills, and looms.

In due time the Spanish learned of the infusive properties of yerba maté, and it was first planted for commercial purposes. This involved a transition from natural plantations which had provided leaves used in ceremonies by the indigenous peoples to production for a large market.

Throughout almost the entire colonial period the economy was not based on money, but rather on barter and attributing exchange values to consumer products, such as "wedges," cloth, and yerba maté. Nonetheless a growing surplus was produced, and several goods were increasingly produced for export: Yerba maté, woods, hides, tobacco, ceramic receptacles, and blankets were all among the goods carried to Santa Fé or Buenos Aires in Argentina and reshipped to other South American ports subordinated to the crown (e.g. Tucumán, Lima, Portobelo), or to Spain itself, all depending on the decisions of the Spanish colonial administration.

Types of Settlements

Among the key factors determining the nature of settlements and population centers, and the society-environment relationship, were: the growing needs of production; the gradual emergence of a stratified society; problems related to geo-political boundaries within the larger Spanish-American colonial context; and other factors particular to the Paraguayan situation, such as defense, navigation and communication needs, and evangelization.

What were the main types of settlements that arose from the above factors?

Valleys and Rural Districts: The rural districts that were prevalent in the area of Asunción (the present-day Provinces of Paraguarí and Cordillera) were based on Guaraní agriculture, which was adapted to the mestizo, or creole, Spanish-Paraguayan models. The valleys and towns of Valenzuela, Piribebuy, Barrero Grande, Arroyos y Esteros, Pirayú, and Quiindy, with their small farms devoted primarily to raising crops, and secondarily to mixed farming, all evolved through this process.

This model expanded, covering the above-mentioned provinces as well as Guairá, Central, and much of Caazapá, all of which make up what is today referred to as the "area of old settlements." This area constitutes the traditional smallholding region of Paraguay. The age-old use of its soils, dating back to the pre-Hispanic era, use of the slash-and-burn method, plows with handles, and hoes, the failure to rotate crops, and other factors all led to soil depletion and fragmentation of landholdings.

Parishes or Chaplaincies: Most of the types of settlement analyzed here were actually closely linked to other types as they unfolded. This was the case with parishes and chaplaincies, which generally related closely to the valleys and districts described above. The parishes and chaplaincies grew out of the evangelizing mission that was practically omnipresent in Spanish colonization. Each settlement or town, whatever its nature, was usually dedicated to a patron saint or under the care of a priest. Whether the townspeople were Spaniards, Indians, or mestizos, whether there was a priest or not, the construction of a small chapel or parish church would always play a key role in the town's social and cultural life.

Religious Missions: The situation was different in areas where settlement was clearly organized around religion and the evangelical mission of the Catholic Church. Such was the case south of the Tebicuary River, and north of the Paraná River, which came to be called the "Spanish mission area," in contrast to the Spanish colonial area. There, the Jesuit-run "missionary" towns flourished.

The Estancias or Landed Estates: Settlements based on livestock, established by the Spaniards early on in the colonial period, gave way to rural clusters and settlements organized around these estates, which were known as estancias. At the estancias were found poor rural workers, generally mestizos or Indians, who rapidly assimilated the various forms of production and cultural patterns associated with ranching, in contrast to the small farmers who only produced crops.

Ranching expanded around Asunción, in San Lorenzo del Campo Grande—where the Jesuit missionaries owned vast tracts of lands for cattle grazing—and in the Yarigua-á valley, later known as Paraguarí.

The estancia was the first production model to make extensive use of the land, as the cattle spread across the grazing areas. Conflicts arose continually, the farming population protesting over the excessive damage the roaming animals wrought on their plots. Indeed, cattle-raising tended to expand alongside or at the expense of cultivation of crops.

Indian Towns: The rigid social structure, involving the Spaniards, creoles, mestizos, Indians, and, later, blacks and mulattos, implied the need for spatial organization of the population by social strata. Thus arose the Indian towns in which the Spaniards, creoles, and mestizos were at least in theory forbidden to set foot, with the exception of priests and civil authorities.

Many of these towns were originally founded in the northern part of the Eastern region, in the present-day Province of Concepción, in the area of the Guarambaré people. However, ravaging invasions by indigenous peoples from the Chaco obliged them to relocate to their present-day locations around Asunción (Ñemby, Guarambaré, Ypané, Tobatí, Atyrá, and Altos). Others were founded later in more remote areas, such as Itapé, Belén, Yuty, and Caazapá.

Fortresses and Garrisons: Throughout the colonial period, the Mbayá-guaycurúes, the Payaguáes, and other indigenous groups from the Paraguayan Chaco invaded the Eastern region,

even occupying much of the present-day Provinces of Concepción and San Pedro, and causing continual instability and unease in nearby settlements.

Frequent and equally destructive incursions in the north were carried out by the Portuguese-led explorer and mestizo forces.

Asunción was also raided by Chaco Indians. Among the fortresses, garrisons, or "castles" as they were also called, built to protect Asunción were those at Tapuá and San Idelfonso, approximately 10 and 30 km, respectively, to the north of Asunción, and those at Tacumbú and Lambaré, both less than 30 km to the south.

Towards 1700, fortresses and garrisons were built under the policy of "defend by populating." Towns such as Villeta, 30 km south of Asunción, and San Agustín of Arecutacuá, 40 km to the north, were founded in this way. In Alto Paraguay, in the northernmost part of Paraguay, Fort Borbón (today Fort Olimpo) was founded; on the banks of the Apa river in the Province of Concepción, the San Carlos Castle was built; and to the northeast, the defensive outpost of Curuguaty was built to stop the Portuguese explorers' advances.

Sawmill-Yerba Maté Centers: Curuguaty was a combination of several types of settlement. Not only was it a typical Spanish town; it was also a defensive military outpost, and a center of yerba maté production. Indeed, a few settlements in eastern Paraguay, such as Curuguaty and Ygatimí, served both as defensive outposts and centers of yerba maté production and lumbering. During the colonial period both lumbering and yerba maté production began in the westernmost parts of the Paraná basin. Other such settlements were Caaguazú, San Estanislao, San Joaquín, Yhú, and Ajos (today Coronel Oviedo).

Black-Mulatto Towns: Like the indigenous settlements, the black-mulatto towns played a role in the spatial organization of the social structure. While colonial Paraguay did not directly import slave labor of African origin, many such slaves were brought to Paraguay via the La Plata River. The colonial authorities and the Francia Administration after independence had a policy of maintaining separate towns and settlements for the black and mulatto population, apart from day-to-day contact involved in domestic servitude and slave labor. Thus Areguá, Tabapy, and Emboscada, during the colonial period, and Tebegó, in the province of Concepción in the north under the Francia government, were black and mulatto towns. In Emboscada, the black population also fulfilled the defensive duties assigned to everyone in the vicinity, which was linked to the Castle of San Agustín de Arecutacuá. Later a group of blacks came to Paraguay with José Gervasio Artigas, exiled from his native Uruguay, and settled in the Laurelty area, near San Lorenzo del Campo Grande.

Moros-ayoreos tribespeople from Port Maria Auxiliadora (Chaco).

Members of the Chulupi and Lengua tribes attending a course on organization of cooperatives in Yalve Sanga (Chaco). Photo courtesy G. Raidan.

Spanish Towns: Finally, among the models of the social-environmental nexus were the Spanish towns, which later became creole and mestizo towns. These were the original foci of the conquest and colonization of Paraguay, though they grew and declined with the ebb and flow of incursions by Portuguese expeditions and invasions of hostile Indians.

The first Spanish town in Paraguay was Asunción. Asunción was the base for other ventures of conquest and colonization to the north, south, and east, which met with varying degrees of success. These ranged from the remote settlements in the former region of Guairá in the northeast, today the state of Paraná in Brazil (Ontiveros, Ciudad Real, and Villarrica), to Jérez de la Frontera in the far north, beyond Apa; and, to the south, Corrientes, Bermejo, Santa Fé and Buenos Aires. Except for those cities that later fell under the jurisdiction of Buenos Aires and which still exist today, the above settlements, all

founded in the 16th century, faded into history as a result of the Paraguayan colony's geo-political situation vis-a-vis Portuguese pressures.

Survival of Indigenous Peoples and Current Situation

How have the various indigenous groups from Paraguay survived, and what is their social and political role in Paraguay today?

Of the indigenous groups that originally inhabited or otherwise interacted with the environment of what is today Paraguay, 18 ethnic groups that belong to 5 linguistic families survive and live in the country. These groups play different roles in Paraguayan society.

Map IV-1 describes the surviving indigenous groups with respect to linguistic and ethnic groups, which correspond to variations in social-spatial configurations, and to attitudes and ties that mediate between the indigenous groups and Paraguayan society. As regards attitudes, one study [1] yielded the following results: a) those groups who have turned inward, in a hostile and defensive posture toward Paraguayan society; c) those who seek contact; and, e) those who peacefully avoid all contact. Categories b) and d) are intermediate between a) and c), and c) and e), respectively. (See Map IV-1.)

Main Archeological Remains in Paraguay

None of the indigenous peoples of Paraguay has left archeological monuments. The peoples of the Chaco, nomadic paleolithic peoples using stone or perishable materials such as bone and wood, and the neolithic peoples from the Eastern region, with rudimentary agriculture, without large villages nor lasting structures, have only left behind artifacts that should be located and systematically excavated. Unfortunately, Paraguay has no tradition of scientific archeological research; most of the scarce findings are from isolated or foreign research, and end up in museums abroad.

Significantly, however, the last 10 or 15 years have witnessed advances in important aspects of archeological research. Also, most of the research that documents Paraguay's ethnic history is ethnographic and ethnological. Breakthroughs have been made by Paraguayans and foreigners whose research, complemented by historic documentation, has allowed for a faithful reconstruction of the pre-Hispanic era, including a clear classif cation of Paraguayan indigenous groups today, during the colonial period, and during the pre-Hispanic era.

Two major lines of archeological research have been developed recently. On the one hand, there has been research into the natural caves or shelters that have been found in different highland areas, in which artifacts of primitive human cultures and cave inscriptions have been found. The main findings have been in the highlands of Amambay and Yvytyruzú, at the Cerro Guazú and Tororo sites (Amambay and Guairá Provinces respectively). Such research is generally private, lacking support from official scientific and cultural bodies. The Cerro Guazú caves are an exceptional case, in which the Paraguayan Institute for Indigenous Affairs (INDI) and the private Paraguayan Society for the Protection of Nature (PRONATURA) sponsored the research, with UNESCO support.

The second line of research has been pursued specifically in the area where the Itaipú hydroelectric dam is being built, in the province of Alto Paraná. From 1975 to 1981 archeological excavations and findings, financed by the binational (Paraguayan-Brazilian) Itaipu project, recovered more than 40,000 pre-historic stone and ceramic pieces, which are still being classified and catalogued, so as to later be placed in the Archeological and Ethnological Museum of the Paraguayan area of Itaipú, to be set up soon in Itaipú.

Important vestiges of the colonial period have remained, some conserved in varying conditions, others beyond repair and lost. Among those beyond restoration are several significant colonial buildings and historic spaces that have been demolished or altered by additions or changes in the spatial context. These actions, which alter the environment, are significant losses chalked up as a costly tribute to Paraguay's progress in public works. Furthermore, they testify to the urgent need for legislation to conserve and preserve the social-spatial environment in a balanced and harmonious fashion.

The most noteworthy remaining vestiges of the colonial period are the ruins of the Jesuit missionary settlements, which date back to the 17th and 18th centuries. Those at Trinidad and Jesús are the most interesting from an architectural standpoint. They are currently being restored after centuries of neglect. This effort is supported by several official and private bodies from Paraguay and elsewhere.

In other missionary towns, such as San Ignacio and Santa Rosa, are found significant carved wooden pieces, noteworthy churches, and other buildings of interest. Both towns have small museums. Most of the missionary towns have witnessed significant environmental change.

In Asunción the Catholic Church's Monsignor Juan Sinforiano Bogarin Museum keeps valuable treasures of Jesuit and Franciscan missionary art, cultural manifestations of colonial religious life. Asunción also houses some old buildings in which Paraguay's social and political history unfolded, though none date back to before the late 18th century. The Casa de la Independenci.. (Independence House) is perhaps the oldest which continues to serve in an official capacity today as a museum of relics from the early independence period.

Asunción abounds with pieces from the two wars Paraguay has waged as an independent nation: the war with the Triple Alliance, and the Chaco war. These relics, however, are not sufficiently well organized nor permanently displayed; rather, they are dispersed among several repositories.

In general, Paraguay's landscape, both rural and urban, still has interesting vestiges that survive from the past. In the far north are found relics, many of them restored, from the old San Carlos garrison, mentioned above. Toward the extreme south the ruins of the old church of Humaitá rise up alongside the banks of the Paraguay River. The ruins stand as a symbol of the bold defense of the plaza against the invasion of the Triple Alliance. Relics of a site known as Vapor-cué, near Caraguatay in the Province of Cordillera, have been collected. And not far from there, in the Province of Paraguarí, the ruins of an old iron foundry dating back to the governments of Carlos and Francisco López Solano have been restored. This site was also significant in the war with the Triple Alliance.

1/ Based on an anthropological study by Chase Sardi, M. (1971)

Jesuit ruins.

Efforts to redesign the environment, generally registering more costs than benefits, have given rise to paradoxes and useless sacrifices. Thus, the majestic Yaguarón church, an old Franciscan missionary building, still stands, constituting a wealth of architecture, woodwork, and depiction of sacred images; while in Caacupé, a traditional religious town that worships an old image of the Inmaculate Conception, a pretentious basilica totally unrelated to the landscape nor the town's history has replaced the old colonial church, which was felled in the face of the relentless forces of demolition.

Churches, buildings, monuments, and other historic forms of social interaction with the environment can be found across Paraguay: in colonial Spanish villages once immersed in Paraguayan history, such as Concepción, San Pedro, Luque, Villarrica, and Pilar; in former indigneous towns, such as Altos, Atyrá, Ypané, Guarambaré, Ñemby, Yuty, and Caazapá; in former black towns, such as Emboscada, Areguá, and Tavapy; and in Asunción itself, which as Paraguay's capital is committed to respect for the historic and environmental legacy. All of these require greater awareness of the need for preservation in the face of a pragmatic, utilitarian outlook that, envisaging apparent material progress, has relentlessly sacrificed vestiges of past progress and Paraguay's historic, cultural, and environmental heritage. These should henceforth be preserved as one of Paraguay's most valuable resources.

Overview of Paraguayan Society

Demographic Features

Population

Paraguay has a small population, totalling 3,026,165, the growth rate having fallen off slightly during the 1972–1982 census period. (See Table IV-1). Nonetheless, population growth is one of the highest among the Southern Cone countries. For 1970–1982, annual population growth was 1.7% for Chile, 1.4% for Argentina, and 2.6% for Brazil.[1]

Table IV – 1

Total Population and Average Annual Growth, According to the 1950, 1962, 1972, and 1982 Censuses

Year	Total Population	Period Covered	Average Annual Growth %
1950	1,328,452	- - -	- - -
1962	1,819,103	1952-62	2.6
1972	2,357,955	1962-72	2.7
1982	3,026,165*	1972-82	2.5

* The 1981 Indigenous Census reported Paraguay's indigenous population at 38,703; this total is not included in the 1982 census. The previous censuses tended to exclude the indigenous people of Paraguay.

Source: Provisional figures from the 1982 Paraguayan Census. Bureau of Statistics and Census, Ministry of Finance.

Regional Population Distribution

Population distribution is very uneven. On the one hand, 97% of all Paraguayans live in the Eastern region, covering 40% of the country (population density 19 persons/km^2). On the other hand, only 3% of the population lives in the Chaco, which covers 60% of the country, for a population density of 0.2 persons/km^2.

In the most populous area, Asunción and environs, population density is 3,908/km^2 and 629/km^2 respectively. The highest population density is in Central, Cordillera, Paraguarí, and Guairá Provinces.

Throughout history the population has tended to concentrate in the Central area of the Eastern region, especially within a 100 kilometer radius of Asunción. Indeed, almost 60% of the total population is found in this area. There has been a wave of migration from the old settlement areas to the Asunción area since the 1940s.

Two kinds of population movements caused demographic expansion in the eastern zone. The first consisted of internal migration from the south-central region, which reached its peak in the 1970s. This migration came especially from the Central area, where many families in the smallholding areas were drawn east by the expanding agricultural frontier, highway 7 (between Coronel Oviedo and Pte. Stroessner), and construction of the international bridge to Brazil and the Itaipú dam.

The second is immigration from abroad, especially from Brazil. Immigrants from Brazil have been attracted by the availability, fertility, and low cost of land. That is, the fertile lands

1/ World Bank, "World Development Report 1984," Washington, D.C., May 1984.

of the Paraná basin and the construction of the Itaipú dam have already had a considerable impact on demographic trends in Paraguay, especially as regards population distribution. The rapid growth of the "new settlement" area—which reached 7.5% annually between 1972 and 1982, thereby increasing its share of total population from 21% to 27%—is in part a reflection of the arrival of Brazilian settlers, especially along the banks of the Paraná.

Urban[1] and Rural Population; Urban Structure

From an ecologic and demographic standpoint, the urbanization process represents a transformation in the settlement pattern, with greater concentration and a relative increase in the urban population. As a process of social change, urbanization represents a change in individual and social behavior, as new forms of organization emerge.

Paraguay has one of the slowest rates of urbanization in Latin America. Urban population came to 34.6%, 37.4%, and 42.3% of the total in 1950, 1972, and 1982 respectively, while for Latin America as a whole 64% of the population was urban by 1980. Thus, Paraguay's population is basically rural.

In contrast to the high degree of dispersion of the rural population across Paraguay, the urban population is concentrated in the Asunción area,[2] which in 1982 accounted for 26.2% of total population, and 62% of Paraguay's urban population, as compared to 24.6% and 65.6% respectively for 1972. Asunción alone includes 15.1% of all Paraguayans, which remains nearly unchanged from the figure for 1972 (16.5%).

Analysis of the urban structure reveals significant concentration of urban population around a single metropolitan area, and the relatively small size of all other cities. Since 1950 Asunción has been the only city with population over 100,000. There are only four cities with population over 50,000, all of them in the metropolitan area. There are few intermediate sized cities. Those with population from 20,000 to 50,000 have grown rapidly, in contrast to those with 10,000 to 20,000 persons, which have not been so dynamic.

Distribution by Sex[3]

There are slightly more men than women (the ratio of men to women is 101:100). In urban areas there are more women (94 men for every 100 women). In rural areas there are 107 men for every 100 women. That is, the situation has reversed as compared to earlier decades. There are several factors that may explain why there are more men in rural areas, including the increase in employment among women in the cities. Studies indicate that women have had a growing tendency to migrate to medium-sized urban centers, and then to larger cities, in search of jobs. This phenomenon is the main cause of the greater number of men in the countryside.

1/ The Paraguayan censuses define the urban population as those who live in towns and cities, provincial capitals and municipal seats, regardless of size.

2/ The Asunción metropolitan area includes the municpalities of Asunción, San Lorenzo, Fernando de la Mora, San Antonio, Limpio, Lambaré, Luque, Villa Hayes, Villa Elisa, and Ñemby.

3/ According to provisional 1982 figures.

Immigration from 1950 to 1982

The foreign population residing in Paraguay increased 65% from 1962 to 1972. Trends from 1950 to 1982 are illustrated in Table IV - 2.

In the Eastern region, immigrants preferred the northeast from 1950 to 1972, particularly the Provinces of Amambay, Caaguazú, and Alto Paraná. Thus, this region's population rose from 8 to 15% of Paraguay's total between 1950 and 1972.

Brazilians form the largest single contingent of immigrants today. In 1950 they represented only 11%, in 1972, 43%, and in 1982, 58.3% of total immigrants. The vast majority work in agriculture.

In 1950 European immigrants constituted approximately 45% of the total foreign population resident in Paraguay. Some 42% of them, in turn, were Mennonites. In 1982 Europeans represented only 4.5% of all resident foreigners.

In 1972, 30% of the immigrant population of European origin resided in the province of Itaipú, where they founded settlements that are flourishing today. Japanese and other immigrants are more spread out.

Migration from Brazil and Argentina has been the most numerous due to proximity. In 1972 Brazilians and Argentines represented 43% and 35%, respectively, of total resident foreigners, and in 1982 58.3% and 26.0%, respectively.

Documents from the Bureau of Statistics and Census indicate that immigration between 1972 and 1982 came to over 5% of the June 1982 population. In absolute terms, the foreign population was 150,000 in 1982, up from 81,000 in 1972, the 1972 figure representing only 3.4% of total population. Today about 80% of all newly arriving foreigners are from Brazil.

Emigration

Until the mid-20th century the main causes of emigration were the weak economy, landlessness, political instability, the

Table IV – 2

Foreigners Living in Paraguay, according to the 1950, 1962, 1972 and 1982 Census Reports

Year	Foreigners No. of	Population Total	Foreigners as % of Population Total
1950	52,074	1,328,452	4.0
1962	49,075	1,819,103	2.7
1972	81,100	2,357,955	3.4
1982	169,140	3,026,165*	5.6

* The 1981 Indigenous Census reported Paraguay's indigenous population at 38,703; this total is not included in the 1982 census. The previous censuses tended to exclude Paraguay's indigenous population.

Source: National Population and Housing Censuses – 1950, 1962, 1972 and 1982, Bureau of Statistics and Census, Ministry of Finance.

search for better wages, cyclical economic crises, frequent stagnation of productive activities, and the fact that industry was only incipient. By 1961 some 500,000 persons had emigrated.

In the face of this striking demographic situation, one must recognize that the population is always any country's most important form of capital. The population factor, with a significant exodus in the last 30 years, is behind almost all problems affecting Paraguay on a nationwide scale.

Any population program must place a high value on the life of man, in this case "Paraguayan man," so that he can design and carry forth his own development and support a free nation. A study from several years back held that the Paraguayan is characterized more by his endurance than by his enterprising spirit. This was said to result from a variety of factors, ranging from the climate to the austere, conformist, and almost fatalistic concept of life, due perhaps to the fact that the bellicose situations Paraguayans have had to confront have not stimulated creative activity.

Today this concept is being overcome: the younger generations manifest a desire and capacity to improve their situation both as individuals and collectively. Paraguayans are today designing and carrying forth their own development, with the support and stimulus of various government agencies, through a variety of programs the objective of which is to develop the ties between man and his land, and reduce emigration.

Settlement

A thoroughgoing process of settlement and immi[illegible]ion has converted what had been virgin forests into agri[illegible] lands in part of the Eastern region. Furthermore, co[illegible] of the Itaipú dam 14 km upstream from the city of Pte. Stroessner has led to significant settlement along the right bank of the Paraná River. Economic opportunity has broadened the region's economic base, leading to greater economic integration with the rest of Paraguay as well as with Brazil. As the lack of a transportation and communications infrastructure had constituted a formidable obstacle to settlement in the past, the highway network that has steadily expanded since 1950 has played an important role in settlement along the Paraná River.

Rural-urban migration has not been as significant as rural-rural migration in Paraguay, thanks to government action, through the Institute for Rural Welfare's programs to resettle smallholders on lands suited for agriculture, as well as in areas with sufficient infrastructure to attract the rural workforce. Most internal migration has been channelled to 630 agricultural settlements across the country; more than 8.0 million ha have been distributed. In 1980 alone the Institute for Rural Welfare incorporated another 500,000 ha as settlement lands. By 1980, 100,000 land titles had been distributed through the land reform program.

However, as land prices have risen, small farmers have increasingly been uprooted from their traditional livelihood and habitat. Amidst rising land prices, Paraguayan settlers, many of whom have no titles, have been selling the rights of possession to their plots.

As settlement has continued, a modern communications infrastructure, rural electrification, and water supply have all penetrated the Paraguayan countryside. The National Environmental Sanitation Service is currently installing potable water services for dispersed settlements and villages with up to 150 inhabitants. Rural housing has improved, as have large-scale programs to install latrines and [illegible]ised stoves, which have had a direct positive impact on food hygiene, and an indirect impact on nutrition and health. Of the slightly more than 630 settlements established, about 60 have become districts, with their respective urban centers; others breathed new life into declining communities, in an effort to incorporate them into Paraguay's development process.

The indigenous peoples have also benefitted from the land reform. The government has formed the Paraguayan Institute for Indigenous Affairs; 40 indigenous settlements covering 157,605 ha have been set up through the Institute for Rural Welfare.

The Urban Milieu in the Greater Asunción Area

Urban Growth

Almost all of Paraguay's urban development has taken place in the municipality of Asunción.

Table IV-3 provides an overview of population trends in the metropolitan area, which as of a 1980 con[illegible]sus agreement has included 11 municipalities. Thus, the administrative structure of the Asunción area has shifted so as to conform with Paraguay's development needs.

The metropolitan area's population has skyrocketed. Between 1972 and 1982, population grew by 105.3% in Lambaré, 102% in San Lorenzo, 94.1% in Mariano Roque Alonso, and 152% in Villa Elisa. If current trends continue, population growth in the Asunción area over the next decade will be considerable.

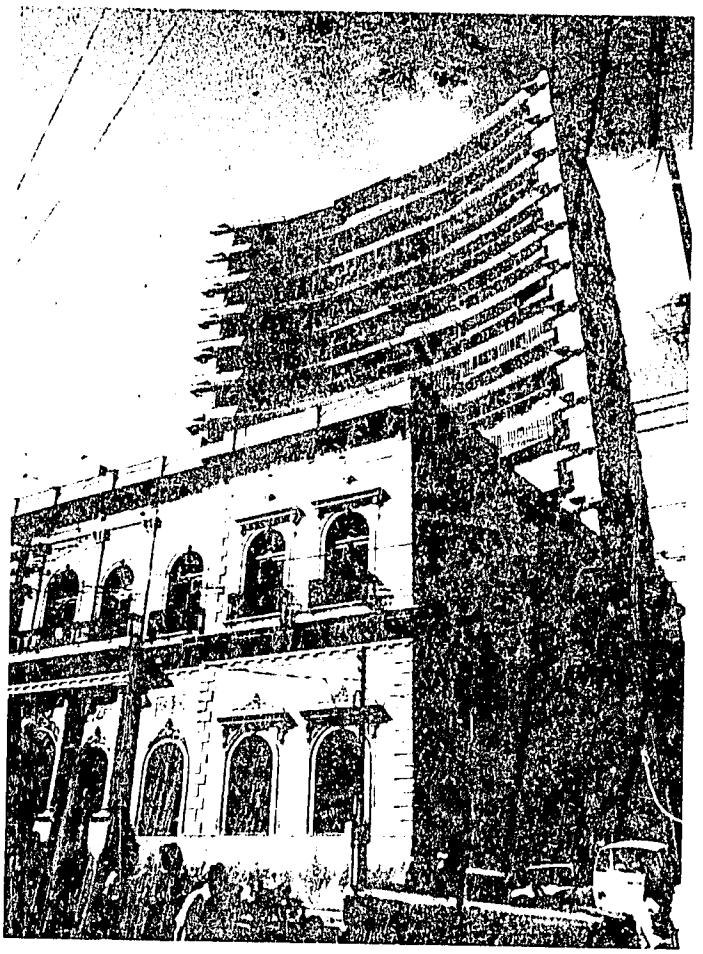
Asunción is the only urban center with over 400,000 inhabitants. Indeed, 45% of Paraguay's urban population and most services are concentrated in the capital city (table IV-4). The area's physical geography manifests progressive dispersion, with discontinuous nuclei of semiagricultural and semiurban pockets found in the various municipalities around Asunción.

According to table IV-4, Asunción and San Lorenzo are the only cities that enjoy all services. Electricity is satisfactory, except in Villa Elisa. The same cannot be said, however, of water supply, as some centers are barely covered. These include Villa Elisa (2.2%), San Antonio (15%), Villa Hayes, where water services are currently being installed, and San Lorenzo, with only 23%.

The deficit is greater still when it comes to public plazas and parks. In Asunción 70% of all plazas are either used for a variety of services or not properly equipped. Only 30% are outfitted for public use.

Adequate mechanisms for supervising settlements in the metropolitan area have yet to be found, despite the laws, decrees, and ordinances that are currently in effect. These measures have not prevented land speculation in the Asunción area from becoming a big business.

Construction of public buildings in areas that were formerly suburban and are currently residential as provided for by Municipal Ordinance 6339 is another consequence of the disorganized manner in which urban development has proceeded. Examples include the Central Bank, the Palace of Justice, and



Two distinct stylistic concepts in Asunción.

the Investigation Department of the Asunción Police: all of these have been built in areas that were set aside as residential neighborhoods in the above-mentioned ordinance.

The presence of these public buildings in residential areas has been most disturbing to residents given the sharp increase in traffic, passers-by, street vendors, and informal commerce, all of which bring on significant environmental degradation. Decentralization of services should not sacrifice already-established residential neighborhoods; rather, such services should be set up in vacant spaces that, like other areas, should be structured in an organic and functional fashion.

Public services cover urban sectors without any rational criteria. Indeed, the gradual extension of such services has not proceeded within a framework of comprehensive and harmonized programs. As a result, streets are often cut off and even destroyed to make way for services such as running water and sewage systems, while much peripheral housing lacks basic services, to the detriment of the environment. Furthermore, the high cost of water, electricity, and sewage systems in the so-called "urban developments" is still an obstacle to planned extension of such services.

Open Spaces

Urban growth has had a particularly strong impact on public plazas. The construction of increasingly taller buildings in the Asunción area has led to changes that had not been contemplated in the original design of the plazas.

There is no shortage of plazas in Asunción nor in the metropolitan area as a whole. But they should be able to fulfill their specific social function; to this end the plazas should be refurbished or, in some cases, provided with totally new equipment.(1)

The Asunción city government has taken upon itself the task of conserving the city's green areas. This effort implies great sacrifice and expenditures that are not at all profitable. Nonetheless, the city is trying to at least guarantee the cleanliness, beauty, and plant life of these plazas.

The current outlook for parks is optimal. Asunción has three main parks: Caballero, Carlos Antonio López, and the Botanical Garden. The Botanical Garden has the greatest potential for recreation and environmental conservation of any park within the city limits.

Work is currently underway on the Ñu Guazú National Park, along the highway to the International Airport. It will have a variety of activities, and will be appropriately equipped. A park may also be established in the fields formerly occupied by civil aviation, along the Mcal. Estigarribia road. If the project is implemented, the site will become significant as regards recreation and conservation of green spaces for a large area, as the above-mentioned parks only serve three zones in greater Asunción. In the Lambaré area, parklands have been set aside on Lambaré Hill.

Deterioration of the Cultural Heritage

Cultural, historical, and architectural sites abound in the Asunción area, legacies of the colonial period, the early independence period, and the time of the war of the Triple Alliance.

Asunción, Luque, and San Lorenzo conserve only a few historically valuable relics; most of their historically significant spaces have been altered. The stepped up pace of public works has led to the dilemma not only of demolishing old structures, but of erecting new buildings and redefining spaces with no foresight whatsoever, as urban development is not well-planned. Historically significant spaces and buildings have been abruptly destroyed.

Many historic sites and monuments have been destroyed or replaced by modern buildings of no cultural value whatsoever. Such has been the case of the "House of Don Carlos A. López," today the Fire Department; the "House of Vicente Barrios," which once served as the Municipal Atheneum and is now a high-rise under construction; the "Casa de Imprenta" (printing house), which housed the country's first newspaper, *Paraguay Independiente*, is today an apartment building; the home of President Francia, in Ybyray (Trinidad), which has been torn down; and several of Luque's colonial arcades, which have also been demolished.

Both Luque and San Lorenzo have suffered as a consequence of Asunción's growth, having lost their character as intermediate cities that served as stepping stones from the capital to the countryside, gradually losing their cultural identity as they

(1) According to the list of 163 plazas, 36% have no equipment whatsoever, 34% are taken up by housing, clubs, or other private uses; 10% have run down equipment; and ony 20% are fully equipped.

have become ever more dependent on Asunción. As Asunción constantly expands, architectural and urban planning models detrimental to the environment are adopted, destroying the landscape and grafting new buildings onto urban settings that, over time, had remained consistent with the process of historic and cultural change.

The priority given to Highway II, a paved road that cuts right through these historic sites, has been a major problem. The extension of Mcal. López Ave. in San Lorenzo through the historic center of the city has given rise to residential areas along the roadside, giving way in turn to a great many persons involved in tertiary activities, which do not blend in with the area's historic spirit.

There is a similar problem in Luque, where a road runs right through the historic center, leading to an ever more artificial atmosphere. The city has acquired an increasingly impersonal feel. Despite the fact that there is still a typical urban grid and several vestiges of the colonial period, a tendency to degradation has clearly set in.

In spite of the Law for the Protection of Cultural Heritage, which clearly provides for preservation and restoration, Paraguay's cultural heritage continues to be destroyed. This law defines as "cultural heritage, covered by this law, all those objects and natural features of historical value from our country's different historical periods." The law even prohibits the demolition and destruction of historic remains, the authorities being empowered to intervene in and suspend such actions.

Public Health

Main Health Problems

Available data indicate that despite significant advances in recent years, Paraguay's main health problems are still infant mortality, maternal mortality, and mortality of children under five.

Similarly, communicable and nutritional diseases, especially those which arise from poor sanitary conditions, are also significant causes of morbidity and mortality, especially among children. Poor conditions include: insufficient potable water supply, sub-standard human and solid waste disposal facilities, poor food hygiene, and number and quality of housing units, especially in rural areas. Also significant are respiratory diseases, diseases that can be prevented by vaccination, lack of measures to reduce nutritional diseases and, to a certain extent, zoonotic diseases.

Mortality: The overall mortality rate has been falling. For 1952–1956, the mortality rate stood at 18 per 1,000 persons, falling to 12.1 per 1,000 for 1960–1965, 10.6 per 1,000 for 1965–1970, and 7.0 per 1,000 for 1970–1980. In 1980 it reached 6.3.

Life expectancy at birth has risen considerably: 54.4 years for 1950–1956, climbing to 57.4 for 1960–1965, 59.4 for 1965–1970, and 63 for 1970–1980.

Given the high natural population growth rate and the drop in both infant and overall mortality, total population has increased markedly in recent decades.

Improving mothers' education was important in reducing infant mortality from 84.2 per 1,000 live births in 1973 to 63.2 per 1,000 in 1980. This process has been facilitated by expansion of the mass media, through programs to provide information and advice in matters pertaining to public health, hygiene, nutrition, and, above all, by preventive medicine in rural areas, working in conjunction with several institutions to achieve common goals.

Morbidity: A great many pathologies arise from environmental conditions. Indeed, the four main categories of disease are: a)acute respiratory diseases; b) diarrhea; c) parasitosis; and, d) influenza. Principal factors behind a) and d) include crowded, unsanitary, and unsafe housing. The lack of potable water and inadequate sewage disposal are among the factors leading to b) and c).

Public Services Related to Environmental Sanitation

The Corporation for Sanitary Works (CORPOSANA) is responsible for Paraguay's policy regarding potable water supply and sewage and rainwater drainage facilities in the main cities.

The National Environmental Sanitation Service is responsible for such services in rural areas and towns with less than 4,000 inhabitants.

In order to achieve its objectives, CORPOSANA has divided its activities as follows:

Immediate Plan: To further extend coverage to the steadily increasing demand for water services. To this end, equipment has been built and purchased for production, piping, pumping, and distribution of water in the Asunción area.

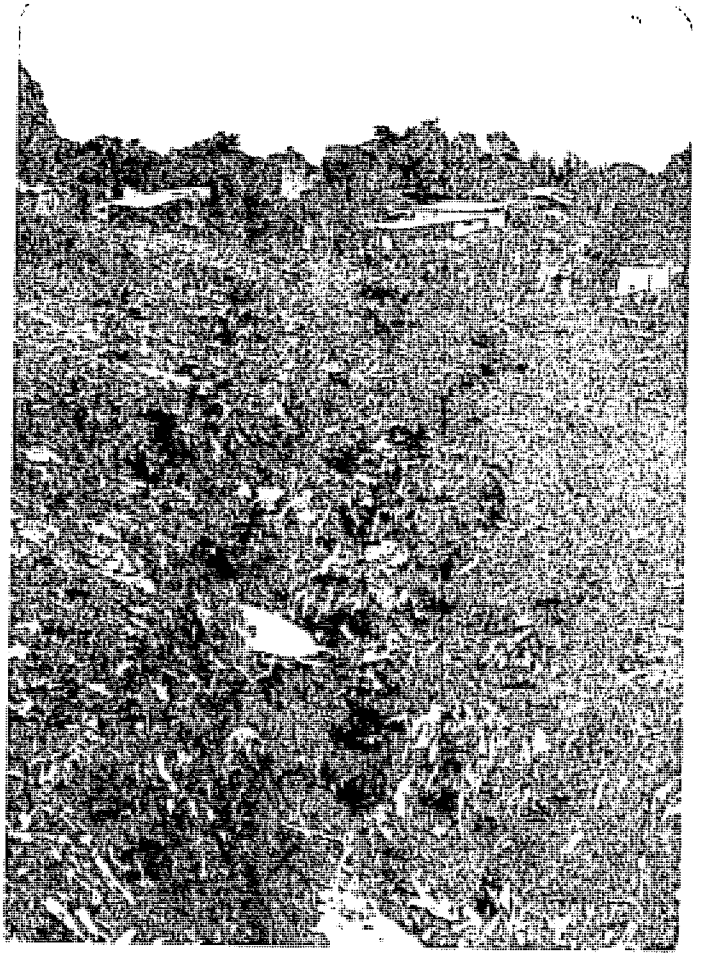
Direct Plan: Its main objective is to considerably increase production and distribution of treated water by 1985, with the goal of producing 520,000 cubic meters a day by the year 2008. At present, average daily consumption is approximately 240,000 cubic meters.

Expansion of CORPOSANA's services to cities in the interior: Potable water supply services are operating in Alberdi, San Lorenzo, San Bernardino, Mariano Roque Alonso, Encarnación, Pilar, San Juan Bautista Misiones, Fernando de la Mora, Luque, Concepción, Pedro Juan Caballero, Pte. Stroessner, and Caacupé. A modern potable water supply system will soon be installed along the Tebicuary-mí River, to serve the cities of Villarrica and Coronel Oviedo. The water systems for the cities of Paraguarí and Villa Hayes are 70% and 80% completed, respectively.

Other Efforts: CORPOSANA is currently finishing construction of a storm sewer project in Asunción. Available data indicate that 75.5% of Asunción's population is served by CORPOSANA; this is up from 63% in 1976. Furthermore, CORPOSANA's technical office is currently developing projects for building potable water systems in the context of what has been called the "13 Cities Plan," which is to benefit the following 13 cities: Bahía Negra, Caaguazú, Coronel Bogado, Eusebio Ayala, Hernandarias, Horqueta, Itá, San Antonio, San Ignacio, Santa Rosa, San Estanislao, Ypacaraí, and Presidente Franco.

Other Programs Affecting the Environment

Actions geared toward environmental protection have been primarily aimed at improvement and extension of potable water services, sanitary control of human and solid wastes, prevention and control of bacterial and parasitic diseases, improvement and greater coverage of food protection services, pollution



Garbage dumped in marginal settlements.

control as regards both solid and chemical wastes, and vector control.

A high priority has been placed on extending potable water services and improving human and solid waste disposal, both of which complement efforts to control diarrheal diseases, which are widespread among children.

The Environmental Sanitation Program covers the entire country, with priority on rural areas and towns with less than 4,000 inhabitants.

The National Environmental Sanitation Service (SENASA), mentioned earlier, was set up to implement environmental sanitation policy, programs, and plans. Its goal is to improve environmental conditions such as:

- potable water supplies;
- disposal of human and solid wastes, and wastewaters;
- food protection;
- sanitary control at the workplace and the home;
- control of physical and chemical pollution; and,
- prevention of adverse effects of economic development projects on health and human ecology.

SENASA has divided its target population into two sectors:

- *Towns or villages with 500 to 4,000 people*: This includes some 190 towns and villages, totalling about 200,000 people. The current program for this sector includes the 1986–1987 period.
- *Sparsely populated rural areas*: This includes some 1,200,000 people. As this sector is larger and has the fewest services, it has been given top priority.

SENASA's main actions include:

Provision of potable water services: Fifty communities are to benefit; the infrastructure has already been installed and services are operational in nine communities, directly benefitting 79,000 people, and providing access to another 15,000, which represents an increase of 1,170.5% with respect to 1978, when only 6,749 people benefitted from this service.

Disposal of human and solid wastes: A total of 19,205 toilets and latrines have been installed, benefitting 99,866 persons. This represents an increase of 235.2% with respect to 1978, when only 6 human waste disposal units were installed, serving 42,463 people.

Garbage disposal services have been provided for 24,418 homes with total population of 132,174, an increase of 243.7% and 253.7% respectively when compared to the 1978 figures of 10,019 homes and 52,099 persons served.

Food protection: SENASA's work as regards food hygiene involves inspection and, in some cases, reinspection, of companies that process and transport food, provision of equipment to assure proper hygiene, training for workers who handle foods, sanitary education for the public, and drawing up guidelines to improve quality.

Environmental Education

General Aspects

Various environmental education programs have been carried out in Paraguay, manifesting the growing concern on the part of those in charge of education.

Thus, one can find people, groups, committees, institutions and parts of institutions that have experience in environmental education. In general, however, great strides have not been made as regards a comprehensive environmental education program. Currently there are isolated nuclei that should be reorganized, taking into account common objectives, so as to avoid duplication of efforts; interdisciplinary actions should be implemented.

Levels of Education

Environmental education programs have been classified according to the various levels of Paraguay's educational system.

Pre-School: The pre-school program is a new addition to the educational system. Indeed, the pedagogic and administrative guidelines are still under review. Paraguay's experience in this field is difficult to evaluate because:

- it was only recently incorporated into the official educational system;
- it covers only a very small part of the official educational system; and,
- specialized teacher training for this level began only recently (1984).

The program is not yet strong enough to be able to integrate guidelines that arise from the needs of a complex structure such as that required for a comprehensive environmental education program. On the other hand, however, the gradual, supervised integration of environmental education may be of great benefit to the pre-school program.

Primary Schools: One specific environmental education program is the National Environmental Education Program of the Ministry of Education and the [U.S.] Peace Corps, carried out in 1984. This project hopes to raise public awareness regarding the importance of Paraguay's natural resources. The main objective is "to foster national consciousness effectively as to the importance of environmental preservation, so as to guarantee conservation of natural resources."

The challenge is to foster awareness of the problems brought about by massive destruction of natural resources so that the idea of conservation of natural resources will be meaningful. To this end, the project pursues the following goals:

- contribute to developing a viable, effective environmental education program;
- develop the program as part and parcel of the curricula at the various levels of education; and,
- provide teacher training in instruction and methodology of environmental education.

The National Environmental Education Program aims to cover gradually the areas that are most significant from the ecological point of view, so as to have the greatest possible impact. A commission has been formed with officials from both the Ministry of Education and the Peace Corps to implement the program, coordinating the actions of the various institutions involved, and promoting participation of those international organizations that wish to cooperate in achieving the goals.

The Project is being implemented in Asunción as well as in the interior. Already-existing curricula are being used, so that the teachers will assimilate the program to the greatest possible extent. The Project focuses on environmental protection, considering the environment as the nation's natural heritage.

The coordinating team can choose the schools where the Project is to be implemented. It is currently operating in three areas: Pedro Juan Caballero, Ybycuí, and Ayolas.

The teacher's manual for environmental education in primary schools, now in its second edition, has been a particularly important aspect of the Project's work. It is divided into five units, which were included in the 4th grade natural sciences curriculum. The fourth grade was chosen as the point at which to include environmental matters in the curriculum. Each unit, and each book, involves several subjects and projects, which in turn are made up of several activities:

Book One has five projects and 79 activities, emphasizing the variety of wildlife and relations among different forms of life.

Book Two has four projects and is 60 pages long. It presents the classification of living beings.

Book Three, Man and the Changing World, focuses on population, weather, and environmental changes.

Book Four, Man and the Balance of Nature, focuses on environmental problems, proposing some solutions. It involves conservation projects that the students can carry out themselves.

Book Five, Man and Space, covers some basic ideas of the universe, relating them to conservation.

At the end is found a 25 page Reference Manual, which serves as a teacher's guide, entitled "Community-Based Environmental Education." This book includes a significant classification of relevant aspects of environmental education found in official texts, with a page-by-page description.

The Project has also published more complete and up-to-date materials, with a description and guide for each year from 1st to 3rd grades, covering nature, health, and work; and for 4th and 5th grades in natural sciences.

Secondary Schooling and Teacher Training:

Background. In 1979 an agreement was signed between the Ministry of Education of Paraguay (through the Curriculum Development Department) and the United Nations, through UNESCO and the UNFPA (United Nations Fund for Population Activities). The first significant project in this joint endeavor was the First National Family Education Seminar, the main objectives of which were:

- disseminate information regarding the implementation of the Family Education Project in Paraguay;
- disseminate the conceptual framework of family education for the 1982 academic year;
- apply the Frame of Reference on Population Education in Latin America to family education in Paraguay;
- analyze the relationships between population growth, socio-economic development, and conservation, and the impact of these phenomena on the quality of life of the Paraguayan family; and,
- suggest sectoral and multisectoral strategies to support dissemination and extension of the family education program to all Paraguay.

Courses have been held to train teachers to in turn train family education promoters in a multiplier program. There are two main aspects to this program.

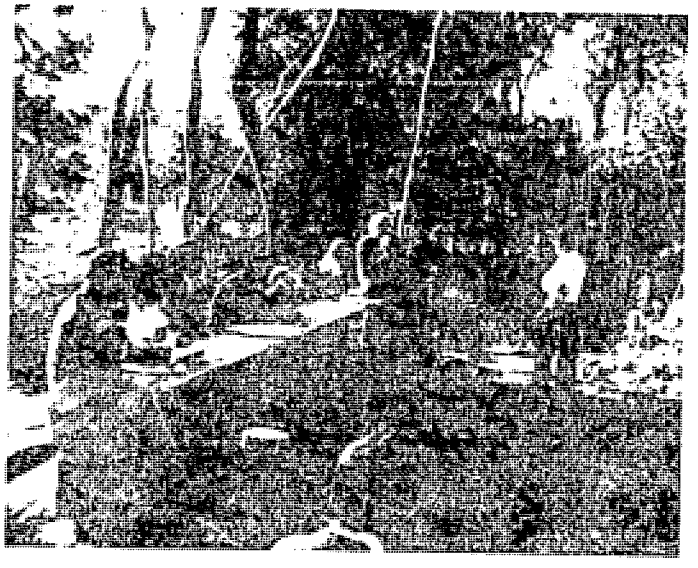
Training I: Teachers already on the job are trained primarily to train multiplier agents, with an introduction to the frame of reference and the different parts of the project: family and population, family and environment, and family and sexuality (relations within the family).

These courses encourage a value-oriented pedagogy, promoting a Western and Christian outlook on life.

The courses are organized with the following basic objectives:

- apply the foundations and different aspects of family education in Paraguay;
- develop training programs in family education for parents and teachers; and,
- make a commitment to implementing the family education curriculum in Paraguay.

The theoretical framework for training is drawn from the First Manual of Family Education, which has been drafted in



Environmental education is an urgent necessity. Workshop in Ybycuí National Park. Photo courtesy National Forest Service

simple, accessible language. These courses involve education regarding values, with 1) analysis of the goals and objectives of education in Paraguay; and, 2) analysis of the component parts of family education (population, environment, and sexuality).

Originally the family and environmental aspects were dealt with from a purely ecological perspective; later, they were broadened so as to emphasize their relationship to other related aspects. Indeed, the effort had involved simply summing up variables, rather than examining them in an integrated fashion. Evaluation of the various courses, and above all the interest that the multiplier agents-to-be expressed led to preparations for the following stage.

Those aspects of the family education project that dovetailed with environmental education were reflected in teacher-training on the environment (in the framework of dissemination of environment-related information); only in a few cases was it geared to metholodogical aspects that would allow for inclusion of environmental situations or tasks in the teaching-learning process.

Training II: Second-level training courses were organized with the following objectives:

- apply the foundations and theoretical framework of family education in Paraguay;
- analyze the contents of family education and its incorporation into existing curricula; and,
- develop *interdisciplinary* educational responses to situations that may arise, considering relationships among family, environment, population, and sexuality.

This synthetic approach constitutes a first step toward a systematic, interdisciplinary approach. Some 1,200 teachers have passed through this second level training program. Training II, like Training I, has spread to all parts of the country. A total of ten second level courses have been carried out. The terms of reference for the Training II courses were drawn up at each stage by Paraguayan consultants from the main institutions involved.

University

The National University of Asunción (UNA) and the Catholic University have programs related to the environment. These include:

Basic Sciences Insitute: (ICB), of UNA, especially in the Natural Sciences Department (biology and geology sections). In 1973 a special field of study in natural resources was proposed. It did not unfold as planned.

The training of professionals in this field, who receive a *licenciatura*, i.e. the approximate equivalent of a B.A., is sufficient for later research into environmental problems.

Ecology is a key subject in the course of study of geologists and, above all, biologists. Training in ecology is later reinforced through field work and research.

This institution's contribution to environmental education is reflected in advice on the part of technicians and professors to teachers at all levels, and particularly help for high school students and teachers in training.

Some of ICB's environmental programs geared to conservation include:

- The joint project with the Asunción city government to study noise pollution along the main streets and highways of the capital. The results are used in the teaching-learning process of the various secondary school courses.
- The project to study and analyze Lake Ypacaraí.
- The research program on water pollution, water biology, and ecology, including study of San Lorenzo creek. There are also sporadic programs on energy and other resources.
- Technical and scientific consulting for individuals and public and private institutions as regards environmental problems.
- The most specific project relating to an environmental problem was the Environmental School Project in Areguá. This environmental school, named the Moisés Bertoni School, was advised by ICB professionals; it was attended by school-aged children, who carried out specific tasks involving contact with nature on a rotating basis. Conservation practices and awareness were also fostered. Administrative factors and lack of resources made it impossible for the program to continue.

School of Chemical Sciences: This institute, primarily technical and scientific, carries out scientific studies of the environment, both in the context of teaching, and for research purposes. All of the five courses of study include exposure to environmental issues at some point. This institution is key, as it has a great deal of information and direct experience in conservation. The school often holds conferences, courses, and seminars, such as one on water ecology held in July 1984, for professionals from the school as well as for high school teachers in the area.

Schools of Agronomy and Veterinary Sciences: These institutions carry out technical studies and research that approach the issue of environment in a more thorough and comprehensive fashion, taking into account the interdependence of the factors that come into play. These two schools have a great deal of responsibility for the environment given their concrete approach to fundamental problems that Paraguay faces.

School of Science and Technology, Catholic University: This institution, founded a few years ago, includes a Natural resources Center, in charge of work related to natural resources. Its main contribution to environmental education was the First Symposium on Natural Resources in Paraguay, held April 19-24, 1982.

Non-Educational Institutions

Other institutions' functions and activities relate directly to environmental matters, with training programs related to ecology and the environment. There are both state and private institutions, the main ones being:

State:
The National Forest Service is part of the Ministry of Agriculture and Livestock. Since 1980 it has promoted a project with aid from the Rare Animal Relief Effort. Some of the objectives relevant to environmental education include:

- awaken interest in conservation;
- disseminate information on the project;
- provide information on national parks;
- provide audio-visual resources to interested groups and institutions; and,
- set up, in the short term, an information center.

Due to lack of funding and staff, this project is unable to carry out more systematic environmental programs, or extend its present activities. Nonetheless, the organizational structure, given its particular features, has a good future in store for it as regards comprehensive environmental education.

The *National Environmental Sanitation Service,* part of the Ministry of Public Health and Social Welfare, is in charge of water treatment and environmental sanitation in urban and rural areas. Its participatory structure should be taken into account for possible future environmental education strategies.

Private:

PRONATURA, the Paraguayan Society for the Protection of Nature, was founded June 5, 1976. It is a scientific, civic organization with the motto, "To protect nature is to defend the nation." It seeks to foster environmental awareness consistent with a conservationist outlook. Its activities are primarily focused on wilderness, involving direct contact with nature. Its main activities are:

- summer camping with pre-school children;
- publication of its magazine PRONATURA, with FAO financing; and,
- formation of the Recreation Committee.

Given its focus on consciousness-raising, *PRONATURA* is an effective organization through which to pursue environmental education.

FUNDLAY, the Foundation for the Protection and Development of the Lake Ypacaraí Basin, was set up April 13, 1984. It is made up of several people and institutions, including the municipal governments of San Bernardino, Areguá, Ypacaraí, Itauguá, Pirayú, San Lorenzo, and Capiatá, SENASA (MSPBS), INTN (MIC), DGT, MOPC, MDN, and private institutions including PRONATURA. Its basic aim is to preserve, conserve, and improve the lake and its basin.

FUNDLAY receives direct aid from international organizations and donations. The main objective is for those involved to agree on how to end lake pollution, with the focus on cleaning up the lake.

Mass Media

Mass media includes all radio stations, TV stations, and print media. Though radio and TV programs are not geared to education or training, they are effective means for increasing public concern for environmental quality.

The diverse forms of media all have a similar general approach to the environment. Environmental matters are taken up directly or indirectly whenever environmental problems are considered newsworthy, and are seen as an opportunity to arouse the interest of the public. Thus news coverage is not at all systematic. An environment-related event must first occur; then it is described in the media.

Nonetheless, the media—and especially journalists—are not only aware of the need to educate the public, but also have ideas for medium and large-scale public relations campaigns. The media are waiting for some institution or group to take initiative; then, if there is sufficient coordination, they will contribute their experience, infrastructure, and capacity to reach the public.

To summarize, the media have the potential to support environmental education to a significant degree. Media involvement would cover much of the non-formal educational system, and constitute an invaluable aid to formal education.

Conclusions

Given the need to implement an environmental education program based on the above-mentioned criteria, and in light of this review of the current status of environmental education in Paraguay, the following main difficulties should be noted:

1) lack of a basic philosophical and pedagogical framework;

2) lack of coordination needed for promoting an interdisciplinary, comprehensive environmental education program in both the formal and non-formal educational systems;

3) limited reach and lack of continuity of programs to date;

4) lack of teaching personnel trained in environmental education;

5) lack of material and financial resources for initiating, maintaining, and evaluating environmental education projects; and,

6) need for a proposal for a national environmental education strategy containing an authentic commitment to environmental education.

Pollution

Degradation of Surface Waters

The first worrisome signs of water pollution began to appear in Paraguay in the seventies, when traditional spa areas near Asunción (in the Yukyry creek basin) were seriously affected.

Pollution in Different Regions

Asuncion: Asunción's various creeks have been polluted to varying degrees. The most seriously affected are the Sala-

manca, where the municipal dumping site had been located; the Jaén, into which sewage and industrial wastes have been dumped; and the San Antonio and the Mburicaó, which have been affected by pollutants from textile plants and tanneries, and solid industrial wastes. The Ytay and Ferreira creeks, while not as severely polluted, have been subjected to growing levels of garbage and sewage.

Asunción Bay, formed by the waters of the Paraguay River, is used for water sports, and serves as Paraguay's main port. Pollution of the bay is caused mainly by runoff from storm sewers, industrial wastes from San Antonio creek, and sewage wastes from the Ricardo Brugada neighborhood.

A 1984 SENASA report presented data indicative of the poor quality of the bay's waters. Its coliform count is above recommended levels for sports involving direct contact with the water; biological oxygen demand is about 7 mg/l.

Central, Cordillera, and Paraguarí Provinces: These three provinces, which cover 10% of Paraguay's Eastern Region, are home to 30% of the country's people (not including Asunción); they account for 60% of industrial production.

Crisscrossed by several creeks that flow year-round, this region has been studied by SENASA as part of its Surface Water Classification Program. The study indicated that the most important surface waters can be grouped in three categories according to the extent to which the waters retain their natural quality or have been altered. The three categories in the region are: 1) waters with high natural quality; 2) waters with intermediate natural quality; and, 3) polluted waters.

1) Waters with High Natural Quality

These waters, found primarily in the Los Altos range, are characterized by their naturally low turbidity, high levels of oxygen saturation, low levels of organic pollutants, clarity, and color. Examples of such waters include the Y-Acaroysa, Paso Irala, Ytú, Pirbebuy, Yhaguy-mi, Yhaguy-guasú, and Chololó creeks in the Los Altos range, and the Peña, Ypane, and Ytororó creeks in the central area.

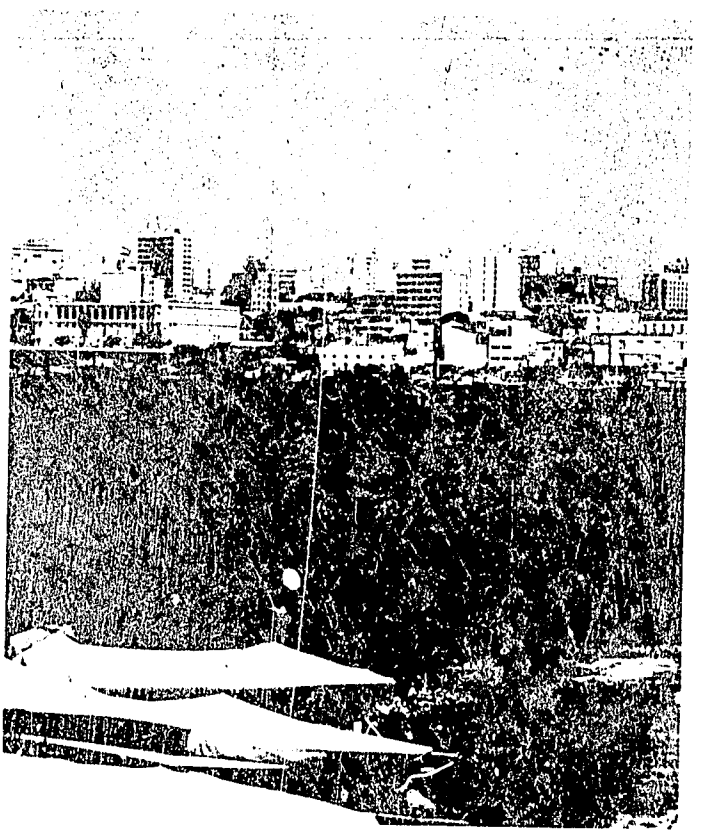
Due to their flow over rocky river beds, which allows for a high level of aeration and lack of pollution, the watercourses of the Province of Cordillera can be classified in group I, and can be used for all priority purposes, including recreation with bodily contact, drinking water once treated, protection of fauna and flora, and irrigation.

Most of these waters are used for recreation during the summer months. The main risks derive from deforestation, which is proceeding apace to provide for lots, and building of new roads in urban developments, which often proceeds without taking into account slopes, giving rise to soil runoff and rendering the waters more turbid. These waters are also threatened by "clandestine" dumping of sewage waters from homes located near the creeks and, in the Piraretá area, by fuel alcohol distilleries which have little or no pollution control infrastructure to process liquid wastes.

2) Waters with Intermediate Natural Quality

2.1) Lake Ypacaraí and the Pirayú Basin

Lake Ypacaraí, 30 km from Asunción, is the largest natural body of water near the capital. The beaches at Areguá, San Bernardino, and Ypacaraí are all very popular. With a surface area of 53 km^2, Lake Ypacaraí's waters originate in a basin that is still natural for the most part, or only slightly degraded. Pirayú creek is the largest one feeding the lake. The lake still has extensive natural areas, such as the marshlands by the delta of the Pirayú and Ypucú, in the Ypacaraí district, and the extensive lowlands by the Yukyry creek delta.



Asunción Bay, used for contact recreation and site of Paraguay's principal port.

The lake's particular features are: its strong coloring, due to natural humic compounds, and the low level of clarity (10 cm Sechi disk) due to colloidal particles and organic suspended solids. The shallow average depth of the lake allows for resuspension of mud particles from the turbulence of the waves.

The large amount of mud accumulated at the bottom is the result of vegetable detritus from the extensive basin, which is high in macrophytes and reeds. Studies carried out by SENASA and the Basic Sciences Institute point out high nutrient levels: 50–100 micrograms/liter of dissolved inorganic phosphorus, and 100–300 micrograms/liter of dissolved inorganic nitrogen, levels which by far exceed the limits for growth of phytoplankton and algae. These phenomena promote eutrophication. As there is no lack of nutrients, the naturally high level of turbidity must be the obstacle to further growth of algae. There is little data on the bacteriological quality of Lake Ypacaraí. There are no indications that microbiological pollution has surpassed acceptable levels at the most frequented public beaches.

2.2) Lake Ypacaraí and the Yukyry Basin

Yukyry Creek contributes to the hydrologic balance of Lake Ypacaraí to an as yet unquantified degree. It enters the Lake through a vast marsh, located at the far northwestern end of

Rivers flowing over rocky beds contain high quality waters. (Paraguarí).

the lake near the source of the Salado River, which is the lake's natural outlet.

Preliminary data obtained by FUNDLAY indicate the significant extent to which the waters of the Yukyry Creek, laden with organic matter and nutrients, are purified by the Yukyry marsh. These results show a very significant decline in bacteria content. The natural purification process is believed to result from the mechanical, physical, and biological action of the aquatic plant life, which is in contact with the water throughout the marsh.

Sources of Pollution: The most significant pollutants affecting Lake Ypacaraí come from two tanneries, two rural slaughterhouses, one vegetable oil factory, food industries, and the runoff of soils with animal wastes from the extensive cattle-raising in the basin. Due to the periodic nature of the discharges, it has not been possible to evaluate the pollutants and their impact. The greatest impact is believed to be at the Ypacaraí beach, which may be affected by microbiological pollutants from slaughterhouse wastes. Given their high level of nutrients, the effluents of the alcohol factory favor the growth of algae and have a high biological oxygen demand. The effluents of the tanneries include toxic metals, while those of the vegetable oil factory include oils and alkalis. All have a significant impact on aquatic life.

Potential Dangers to Lake Ypacaraí: The greatest potential dangers to water quality in the next few years will be:

- The installation of sewage drainage systems in the main cities (San Bernardino and Ypacaraí), and urban development projects without appropriate sewage treatment facilities.
- Soil erosion due to the destruction of plant cover, construction of new roads, and other factors.
- Channelling of the Yukyry Creek's waters to reclaim marsh areas for profitable uses. The direct flow of the Yukyry to the lake would impede the elimination of nutrients and bacteria, giving rise to serious pollution of the lake.
- Increase of total pollutants in the Yukyry basin, beyond the creek's self-purifying capacity.

3) Polluted Surface Waters

Table IV-5 lists waters in Central Province classified as degraded by the SENASA water classification program:

In general, food industries, sewage drainage systems, and the leather and alcohol industries are the main sources of pollution of the Central Province streams. Their effluents exercise a very high biological oxygen demand, give off unpleasant odors, and alter the normal aquatic fauna.

Bacteriological pollution levels are very high. Thus these waters should not be used to provide drinking water, nor should they be used for irrigation, fishing, or bathing, as they would seriously endanger public health. As high levels of pesticides are used in the orchards of the Central area, considerable amounts probably enter the waters during the rainy season.

Other significant creeks in the Central area, such as the Ytay, the Villa Elisa, and the Lambaré, are polluted to varying degrees, affecting a large population, as these creeks are near Luque and Villa Elisa. There are no data describing the degree to which these creeks are degraded.

Guairá Province: The largest river of Guairá Province is the Tebicuary-mí, in terms of both its volume and the abundance of recreation and fishing sites along its shores.

Some small-scale starch industries and anhydrous alcohol factories run by APAL are found along the upper course of the river. The alcohol factories, despite having reservoirs to store wastewaters since 1980 when they began operations, have polluted the waters to such an extent that a CORPOSANA potable water treatment plant which was to have supplied Coronel Oviedo and Villarrica by late 1983 could not be used.

At the treatment plant CORPOSANA has found too many pollutants to treat the water with conventional methods. Future potable water supply is threatened by the probable presence of trihalomethanes, which arise from the excessive organic matter in the water. Trihalomethanes are reported to be carcinogenic.

In order to remedy this situation, the Ministry of Public Health and Social Welfare demanded that APAL rigorously treat its

Lake Ypacaraí, with waters of intermediate natural quality, is a natural attraction and recreation site.

The leather industry causes pollution in the streams of the Central Province.

effluents, adopting measures to eliminate organic matter and ammonia, and monitoring pH fluctuations and water quality both upstream and downstream from the area where the effluents are dumped into the river. The treatment plant is now expected to be operational by late 1986.

The main pollution problem in the middle course of the Tebicuary-mí are two sugar mills, which discharge by-products from sugar manufacture, keeping the distillation wastewaters in reservoirs. No permanent damage to the fish life has been reported; indeed, downstream from the respective sugar mills, fishing has been a traditional occupation of much of the population of Itapé, Iturbe, and other towns along the river.

There have been cases of massive fish mortality due to abrupt discharges of liquids high in alkalis and acids used at the end of the sugar harvest to wash machinery. Sugar and alcohol production is the main activity affecting the upper and middle courses of the Tebicuary-mí River, diminishing its recreational value and seriously endangering the water treatment facility.

The lower course, which has an enormous self-purifying capacity, is in excellent condition by the time it reaches Villa Florida.

Alto Paraná and Itapúa Provinces: According to the most recent studies of the part of the Paraná River to be affected by a dam to be built at Corpus (between kilometers 1,592 and 1,927), the river's stream flow is usually a formidable 9,000 m^3/sec, indicative of an extraordinary capacity for self-purification. Almost without exception, in 1983 the river had near-saturation levels of dissolved oxygen, and very low levels of biological oxygen demand, typical of waters in group I.

One month after the waters were dammed by Itaipú, very high transparency (to a depth of 0.7 m) and low turbidity could be observed.

In December 1983, high fish mortality was observed downstream from Itaipú, in and near the Iguazú River. At the same time, maximum phenol amounts were observed, which were associated with the degradation of lignin from vegetation flooded by Itaipú, or to the degradation of herbicides that were originally present in fields that were later flooded. Fish mortality may eventually be attributed to a synergetic toxic effect of high phenol and ammonia levels.

As regards toxic substances, maximum mercury levels have been reported at the Campichuelo station, on the Argentine bank. Significantly greater levels of mercury in suspended solids were reported for some tributaries of the Paraná. At the mouth of Pirapó Creek, on the Paraguayan side, maximum levels were found in sediments, suggesting the impact of man, i.e. use of pesticides with mercury, which correlates with the high levels of pesticides and the lack of benthic fauna in the Pirapó River.

Maximum levels of arsenic have been detected on the Argentine side at Campichuelo station. The levels reported exceed maximum acceptable levels for human consumption according to international standards.

High levels of pesticides have been detected in both the waters and the sediments of the tributaries on the right bank, i.e. the Paraguayan side, of the Paraná River. For example, maximum levels of a highly toxic chlorinate compound have been detected in sediments. Phosphate compounds have been detected as well. Maximum levels of insecticides were registered in the Ñacunday River in 1984.

Pirapó Creek, which has a highly agricultural watershed had the highest levels of heavy metals for all tributaries of the Paraná that were studied. In December 1982 the highest levels were reported for soluble lead, soluble chromium, and soluble

The Paraná River has such a large volume of water that it has an extraordinary capacity to purify itself of pollutants. Guairá Falls, now disappeared.

mercury. These increasingly toxic levels of pesticides and heavy metals in some tributaries of the Paraná should alert those in charge of agricultural development to the possibility of significant short and long term damage both to the benthic and fish life of the rivers and to public health, as people may get used to eating fish contaminated with these substances.

Inventory of Polluted Water Resources and Affected Areas

Table IV-6 lists polluted water resources, areas affected, and environmental and social impact.

Water Pollution

As Paraguay is an agricultural country par excellence, most industry involves processing agricultural and animal raw materials. The most significant of the agroindustries is food processing. Food industries account for the largest share of water pollution, followed by other processing industries, such as alcohol production and tanning cowhides.

Table IV-6 summarizes estimates for water pollution from Paraguay's main industries, based on international unit emission factors.

Food Industries:

1) Meatpacking: Almost all of the industrial meatpacking plants are found along the Paraguay River, into which they dump liquid wastes. The impact of these waste products on the river has yet to be studied. Some plants remove solids and fats, as well as blood. This primary treatment reduces the polluting effect of the effluents. A meatpacking plant in Asunción dumps into the Ytay Creek, severely polluting it during the sugar harvest. In recent years only 20% of the installed industrial capacity of Paraguayan meatpacking plants has been used. Rural slaughterhouses, of which there are over 200, pollute on an irregular basis, provoking significant degradation of the small watercourses into which effluents are dumped.

The rural slaughterhouses slaughter and dress, in the most unhygienic conditions, between 5 and 200 animals per week. The most important aspect of meatpacking and related activities is the highly concentrated nature of the liquid wastes, as little water is used per slaughtered animal, and the blood and intestinal wastes are not separated out.

At the point where the effluents are dumped into the streams, one can note changes in color, gasses, accumulation of sediments, and large numbers of flies and other insects.

2) Vegetable Oils: There are about a dozen vegetable oil factories, most of which are in the greater Asunción area. Refining the oils is the process causing most pollution. Usually these plants dump effluents without any treatment whatsoever, giving rise to serious water pollution problems in Capiatá, Nemby, Itauguá, Ypacaraí, Colonia Obligado, and other areas.

The largest oil complex, in Capiatá, was required by SENASA to set up a physical-chemical treatment system to separate oils, so as to recover 80% of the pollutants, considerably reducing the impact on the Capiatá Creek. However, due to an error of scale in the treatment plant, a considerable part of the pollutants still enter the creek. Similar companies are in the process of meeting regulations, their main difficulties being with the high cost of imported technology and chemicals.

3) Hard Liquor from Sugar Cane: There are some 60 factories that make liquor from molasses; most are in the Central, Cordillera, Paraguarí, and Guairá Provinces.

These plants are well known for the tremendous amount of pollution they cause. Indeed, a typical distillery, processing 1,500 liters of liquor per day, dumps liquid wastes with the same capacity to contaminate the water as that of 7,000 persons. These distilleries, mostly located by streams, have become a serious problem in rural areas.

SENASA required both the hard liquor distilleries and the distilleries associated with sugar mills to have reservoirs for holding effluents from 1981 on. The goal was not only to control pollution, but also to make use of the fertilizing properties of the wastes, which are rich in potassium and organic matter, and are capable of improving soil quality and crop yields. However, the distances from the plants to the fields are uneconomical in the case of plants located in populated areas. The unpleasant odor that would result from keeping wastes for a prolonged time is another negative factor.

4) Other Food Industries: Whereas industrial production of manioc starch is a significant cause of pollution, the industry involves a large number of small artisan-scale shops, spread throughout the provinces of Guairá, Caazapá, Itapúa, Caaguazú, and some parts of Paraguarí Province. As these small businesses are generally in thinly populated areas, and since they only dump wastes on a sporadic basis, their effects are not well-known. The sugar cane-related industries have had a significant impact, especially in Guarambaré, Carapeguá, Villa Hayes, and Villarica, where waters with little capacity for assimilation are polluted. They are a nuisance in populated areas.

The sugar mills do not treat their effluents, with the exception of the above-mentioned distilleries. Approximately two-thirds of pollutants from beer production are dumped directly into the Paraguay river, with no treatment whatsoever; only the solid wastes, which are sold, are recovered. The rest is dumped into the Guayruyguá Creek, in Caaguazú; there is no information as to the impact of this dumping.

Other Activities Causing Pollution

Tanneries: Mechanized tanneries produce 60% of all hides tanned in Paraguay; some process as many as 2,000 hides daily. None has effluent treatment systems. Some dump part of their effluents into the Mburicaó Creek of Asunción, and the rest into CORPOSANA's sanitary sewage system. Another pollution problem is the solid wastes left along the banks of Asunción's creeks.

Efforts by INTN to introduce techniques for recovering effluents in the large tanneries have not had sufficient support. The medium-sized tanneries, many located in the interior, are interested in developing such techniques, as they wish to save foreign exchange otherwise spent on chemical products, while simultaneously curbing pollution.

The artisan-scale tanneries, of which there are over 220, are found throughout the Eastern region, especially in Yaguarón, Tobatí, and Carapeguá, where they are found in clusters along the creeks.

Due to the sporadic and highly concentrated nature of waste products high in soluble proteins, tannic acids, and lime, the

Dead fish in Tobatí Creek caused by water pollution from sugar mill wastes.

tanneries have a very definite impact over a short timeframe, except in cases where controls have been introduced. Water pollution is also caused by the remains of the hides. Up to 50% of the initial weight of hides delivered to the tanneries may end up as waste because there are no machines for splitting the hides.

Efforts begun to reduce water pollution from tanneries have run up against various obstacles, including the lack of space for reservoirs, the only economical means of controlling pollution from this type of artisan work, and lack of electric energy for pumping liquids.

Alcohol Manufacture: The most serious environmental problem related to production of fuel alcohol—both anhydrous and hydrated—is the failure to make use of the waste products. The APAL alcohol distillery, in M.J. Troche, produces 2,000 tonnes/day of liquid effluents, with a daily polluting capacity equivalent to 400,000 persons. Alcohol production is the clearest example of planning without taking the environment into account.

APAL was required to build large reservoirs to avoid permanent degradation of the Tebicuary-mí River. Although APAL could be proud of its overall accomplishment in pollution control, some effluents continued to spill into the river.

The lack of facilities for handling the wastewaters and pulp from sugar cane made it necessary to build an anaerobic treatment plant with aerobic and final denitrification processes, at a cost that was high in comparison to the alcohol plant itself. It is scheduled to become operable by late 1986. If SENASA's standards for quality of effluents are met, the river's stream flow and the distance are such that the waters will be acceptable for processing at the CORPOSANA potable water treatment facility, 15 km downstream. Until APAL's effluent treatment system is operating on a reliable basis, the potable water needs of Coronel Oviedo and Villarrica cannot be provided for by CORPOSANA.

There are a dozen or so alcohol distillery construction projects, some of which are practically completed. The largest will produce some 45,000 liters of ethanol daily. The Ministry of Industry and Commerce and the Ministry of Public Health are coordinating closely so as to require new distilleries to install facilities for making use of distilling liquids in irrigation. In order for this to work out, cane should be grown near the distilleries, and they should be far from urban centers, where the odors would constitute a nuisance.

Other activities contributing to pollution, such as the textile industry, do not have a nationwide impact.

Air Pollution

Motor Vehicles:

1) Diesel-powered Vehicles: Air pollution from diesel-powered vehicles is a well-known fact of life in Asunción, though there is no data in this regard. Based on emission factors for diesel motors, 6,000 micrograms of particles per hour per m^3 and 2,000 micrograms of sulphuric oxides per hour per m^3 are estimated to pollute downtown Asunción during peak traffic hours. As the air tends to stagnate, these pollutants are estimated to be present at levels far above the maximum for health and aesthetic considerations.

The combination of sulphuric oxides (which vary with the quantity of sulphur in the fuel) and particles aggravates respiratory problems, especially for those who spend several hours a day downtown.

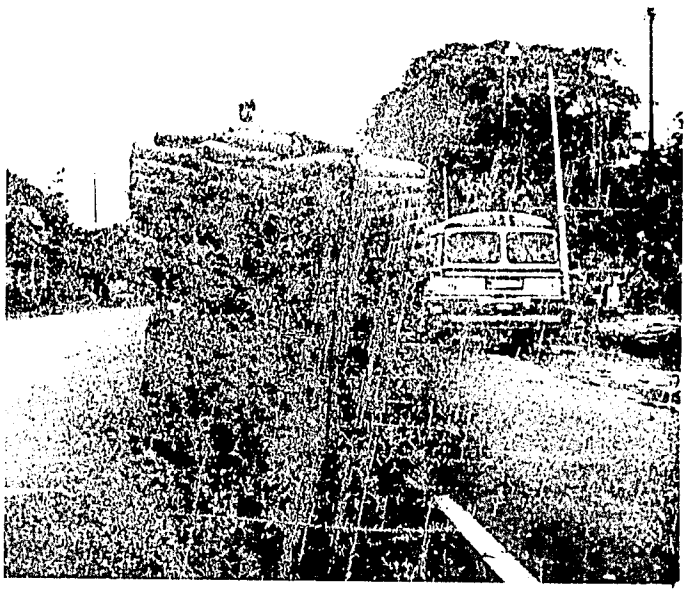
2) Alcohol-powered Vehicles: The increase in emissions from alcohol-powered vehicles may generate high levels of formaldehyde, a gas which irritates the nasal and ocular mucosa and the respiratory system.

Stationary Sources: There are few industries or services in Paraguay that produce significant air pollution. Based on 1982 Technical Planning Secretariat data for industrial production, and using pollution emission factors of the WHO, the following estimates have been made of industrial air pollution:

INDUSTRY	PARTICLE EMISSION	EMISSION OF SULPHUR OXIDES
	tonnes/year	tonnes/year
Sugar mills	1,620	—
Cotton gins	1,270	—
Portland Cement	3,800	—
Sulphuric Acid	—	90

Particle emissions far outstrip sulphur oxides. Particle pollution from sugar mills is particularly problematic in Villarrica, Tebicuary-mí, Iturbe, and Guarambaré. Despite residents' and municipal authorities' complaints, sugar mills have resisted improving bagasse combustion systems and installing particle removal facilities, citing prohibitive costs.

Agroindustries are the main cause of a social problem that has been hard to control, i.e. unpleasant odors. The reservoirs used to store the wastewaters and pulp by-products from alcohol and liquor production are well-known cases; most are located in the vicinity of the towns where the alcohol pro-



Air pollution in urban areas.

duction facilties and sugar mills with distilleries are based. It is hard to say whether the costs outweigh the benefits in this method of controlling water pollution, taking into account all social and economic factors.

Slaughterhouses and meatpacking plants, tanneries, coffee processing plants, bone meal plants, industrial tallow, garbage dumps, and stabilization basins are other sources of common odors that are a nuisance. About 60,000 people are exposed to unpleasant odors on an ongoing basis. This figure varies with climatic conditions, going up in the summer when wastes ferment more.

Food Contamination

Heavy Metals: Cadmium and Arsenic: INTN analyses indicate the presence of heavy metals in beef. Using spectrometric atomic absorption, traces of cadmium and arsenic have been detected in meat; however, as in the case of mercury detection in food products, the analysis was only qualitative. The minimum levels that could be detected with the instruments used were 10 parts per million of arsenic and 2 parts per million of cadmium.

These are both known to be highly toxic. Arsenic, a classic poison that has a negative impact on the hematopoietic and gastrointestinal system as well as the respiratory system, is known to cause cancer. Cadmium also has a negative effect on several body functions, including those mentioned above, and the liver, kidneys, endocrine system, and nervous system.

Reports indicate that in the Chaco there are grazing lands whose soils have high cadmium levels. The animals often take in soil while grazing. This may be the means by which the metal enters the animal, if indeed there are surface deposits. However, plants can selectively accumulate a variety of heavy metals, including cadmium and arsenic. The sources of meat contamination with these metals should be located, as both metals can accumulate and reach toxic levels in human beings.

Vegetable Contamination with Pesticides: With the exception of sporadic analyses of imported potatoes and vegetables, no efforts have been made to study Paraguayan-produced fruits and vegetables. Such a study, however, should be carried out.

Meat Contamination with Pesticides: INTN does not inspect meats for pesticide residues. The herbicide 2,4,5-T is used on grazing lands. While 2,4,5-T residues in meat do not necessarily pose a threat to human health, a derivative, 2,3,7,8 tetrachlorodibenzo-paradioxin (TCDD), more popularly known as dioxin, is found in commercial 2,4,5-T formulas. The most advanced technology is used to reduce its presence to a minimum.

Research should determine how long 2,4,5-T has been used in specific grazing lands, and whether significant concentrations of TCDD have been found in meats from areas with a longer history of 2,4,5-T use.

Fish Contamination from Pesticides: Available data indicate that most fish used for food comes from either of Paraguay's two main river systems. These rivers have a considerable capacity for dilution, due to both their large volume and their rate of flow. These features suggest that risks from soluble toxic substances carried by these rivers are minimal. However, recent studies mentioned above on water quality of the Paraná River reveal high concentrations of pesticides, which appear in the river during crop-dusting periods. Fish that feed along the river bed, such as the surubí, a kind of catfish, are more vulnerable than other forms of aquatic life to these risks.

Environmental Impact of Specific Projects

Steel Manufacture Using Charcoal: ACEPAR

The gasses released into the atmosphere from the ACEPAR plant do not contain sulphur dioxide because the ACEPAR process relies on charcoal and pure iron ores which do not contain harmful sulphur. The gasses from the basic oxygen process are burned and cooled in a water-cooled smokestack; particles are removed through gas treatment of emissions. Maximum particle concentrations in exhaust smoke will be 100 mg N/m^3.

Gasses from both the blast furnace and the basic oxygen process meet emission control standards of countries with the strictest regulations. ACEPAR does not foresee dumping liquid effluents into the Paraguay River, as the manufacturing process will have a negative hydric balance; it will have to be resupplied to make up for water lost through evaporation and water-based sludge. This sludge, which will include iron particles and calcium compounds, will be stored in a special area.

Visibility is expected to fall slightly around the steel plant, due to fine particles that will be emitted from the gas purification system, and from discharges from the charcoal, iron ore, and lime production processes. Air pollution is expected to be minimal, with no impact on air quality in the Asunción area.

Risk of polluting the Paraguay River is also minimal, assuming maximum possible recycling of water, as effluents will not be dumped. There could be cases of phenol pollution if liquids with organic matter escape from the decantation vessels to be located alongside the Paraguay River.

Substitution of oil derivatives

According to the goals of the National Alcohol Program, by 1990 and 1995 total fuel alcohol consumption will reach ap-

proximately 85,800 and 147,700 m^3, respectively. The latter figure represents five times current production.

If traditional fermentation and distillation technology is used, production of each cubic meter of alcohol will yield 12 m^3 of mash; this figure could be reduced by recycling the mash. One cubic meter of mash has enough biodegradable matter to render 3,000 m3 of water anoxic, that is contaminated, with attendant foul odors.

If conventional technology is used, total mash produced would pollute three billion cubic meters of water in 1990, and 5.3 billion in 1995; this would seriously degrade and render less useful all waters into which the mash would be dumped.

Using state-of-the-art technology, each cubic meter of alcohol produced would generate approximately one cubic meter of a concentrated liquid with high levels of mineral salts and organic matter, which would pollute to a significant degree. But due to its high concentration, it would be more suitable for animal feed, fertilizers, and so forth.

The high cost of state-of-the-art technology is such that it would only be economical in plants producing over 100,000 liters of alcohol daily.

The two most significant pollution problems for which measures should be taken are:

- effects on surface water quality, as surface waters may be exposed to intentional or unintentional spills of mash arising from improper terrain, slopes, and other problems; and,
- the nuisance created by mash deposits, which are located by populated areas.

Pollution from Solid and Household Wastes

Sewage Systems

The Asunción sewage system: CORPOSANA's sewage system serves 56% of Asunción's population. It eliminates raw industrial wastes as well as household wastes. The sewage system empties into the Paraguay River at several drainpipes; problems arise due to the proximity of the drainpipes to the beaches. The problem is particularly serious when the River is low.

Sewage systems in other cities: At present five other cities have sewage systems, serving a total population of 45,000. CORPOSANA plans to cover all cities that have or will have potable water systems provided by CORPOSANA.

Only San Lorenzo and Pedro Juan Caballero have settling ponds for treament of sewage before dumping into waterways. The location of San Lorenzo's stablization basins, in a populated area, at first gave rise to complaints about odors. Preliminary data gathered by SENASA on these stabilization basins indicate that the effluents from the second basin, which are dumped into the river, contain high levels of ammonia and very high concentrations of fecal and total coliforms.

By the year 2004 CORPOSANA plans to serve 175,000 people with sewage drainage systems, without sewage treatment, in the cities of Encarnación, Pte. Stroessner, Salto de Guairá, Concepción, and Pilar. The effluents will be dumped in the Paraguay and Paraná Rivers, and the Itaipú reservoir, without prior treatment. Luque's sewage system, which still lacks a stabilization basin, causes severe pollution of Ytay creek.

Other Systems for Disposing of Household Wastes

Latrines, used by most of the rural population, and wastes of those without sanitary facilities (1,074,000 persons using latrines, 174,000 without facilties), give rise to extensive bacteriological pollution of the subsoil in the vicinity of household wells, especially in areas with old settlements.

There are no systematic studies in this regard, but SENASA's experience in water quality indicates that a large part of household well water is contaminated with fecal coliforms at levels exceeding acceptable quality criteria for homes. The pollution problem is due to the permeability of the soil, the short distances between wells, lack of protection, and use of ropes and buckets to get water.

Solid Wastes

Asuncion: Garbage collection services cover 65% of the population of Asunción, yielding 360 tonnes of garbage and 48 cubic meters of market wastes daily.

That part of Asunción that is not covered disposes of its garbage by leaving it in heaps in empty lots, burning it, and dumping it in torrents that form on rainy days, giving rise to foci of pollution, odors, and smoke.

The present municipal waste disposal system involves dumping in a natural depression, in what was originally the bed of Salamanca Creek, which is now extremely polluted from so much contact with garbage. The garbage fill of the municipal dump is a focus of unsanitary conditions which, according to experts, affects 10,000 people, taking into account the insects and rodents that serve as vectors. The stench from this dump site affects 20,000 people under normal weather conditions.

Other cities: Handling of solid wastes has been particularly neglected. Some cities in the interior spend a considerable part of their budgets on garbage collection; nonetheless, services are often carried out without thorough consideration of sanitary, technical, and economic apsects, especially at the final stage of disposal, which has the greatest impact on public health and the environment.

Of the 11 cities and towns that make up Asunción's metropolitan area, only 4—Luque, Fernando de la Mora, Lambaré, and San Lorenzo—have garbage collection services. Only Encarnación of the interior cities has a garbage collection system in which final disposal is at a sanitary land fill. Other cities either use open-air dumps or have no services whatsoever.

Table IV – 3

Asuncion Metropolitan Area—Population According to the 1982, 1972, 1962, and 1950 Censuses; Growth Between Censuses, by District

District	Population				Growth Rate	
	1982	1972	1962	1950	1972/82	1962
Asuncion	455,517	388,958	288,882	206,634	17.1%	34.6%
San Lorenzo	74,359	36,811	18,573	13,100	102.0%	98.2%
Fdo. de la Mora	66,810	36,892	14,510	5,253	81.1%	154.1%
Lambaré	65,145	31,372	20,778	- - -	105.3%	52.7%
Luque	62,761	40,677	30,834	22,361	54.3%	31.9%
Limpio	15,461	12,767	10,126	8,473	21.1%	26.1%
M.R. Alonso	14,339	7,388	5,686	2,043	94.1%	99.9%
Ñemby	12,014	6,899	5,984	4,974	74.1%	15.3%
Villa Elisa	12,044	4,774	3,214	2,365	152.3%	48.5%
San Antonia	8,296	7,321	5,965	4,689	13.3%	22.7%
Villa Hayes*	7,420	4,195	4,712	—	54.7%	1.8%
Total for the Metropolitan Area	794,166	579,273	409,273	271,901	37.2%	41.5%

* Includes urban area.

Source: National Population and Housing Census, 1982—Provisional figures.

Table IV – 4

Services in the Asunción Metropolitan Area

City	Population	Basic Services					
		# of Electrical Connections		# of Water Connections		# of Sewage Connections	
		No.	Total Coverage %	No.	Total Coverage %	No.	Total Coverage %
Asunción	457,210	127,228	100	78,233[a]	76	67,965	66
San Lorenzo	79,775	13,271	83.19	3,558[a]	23	2,504	16
Fdo. de la Mora	70,898	[d]	[d]	6,808[a]	50	–	–
Lambaro		[d]	[d]	[d]	–	–	–
Luque	65,542	9,706	74	3,217[a]	26	–	–
Limpio	15,461	1,574	50	318[b]	52.4	–	–
M.R. Alonso	15,320	2,286	74.6	673[b]	23	–	–
Ñemby	12,014	1,290	53.6	2,019[b]	100	–	–
Villa Elisa	12,044	264[e]	10.95	55	2.2	–	–
San Antonio	8,296	1,155	69.6	250[a]	15	–	–
Villa Hayes	7,420	998	67.25	402[c]	27	–	–

[a]Served by Corporsana – [b]Served by Senasa – [c]Under construction – [d]Included in Asunción.
[e]Part is included in Asunción – Only Asunción and San Lorenzo have sanitary sewer facilities.
Sources: CORPOSANA, SENASA, ANDE, IDM, MUNICIPALIDADES.

Table IV – 5

Polluted Surface Waters – Central Province

Name (Creeks)	District or Muncipality	Traditional uses restricted by pollution	Population affected	IC	Source of Pollution
Abay	Guarambaré	Recreation	Rur.-Urb.	46	Sugar mills
Ñemby	Ñemby	Recreation	Urban	51	Sugar mills
San Lorenzo	Ibid	Drinking water	Urban	51	Hides, domestic meats, food industries
Tayuazapé	San Lorenzo	Recreation	Rur.-Urb.	71	Yeasts, tanneries
Yukyry	Luque	Recreation	Rural	65	Slaughterhouses
Capiatá	Capiatá	Drinking water	Rural	79	Sporadic discharges
Yukyry	Areguá	Recreation	Rural	63	Slaughterhouses
Capiatá	Capiatá	Drinking water	Rural	66	Oil factory
Ypucú	Ypacaraí	Drinking water – Fishing	Rur.-Urb.	72	Slaughterhouses, tanneries, alcohol factories

Table IV – 6

Polluted Water Resources, Sites, and Impact

Water Resource	Site	Activity	Types of Pollution	Traditional Uses Restricted by Pollution	Social Dimension of Impact
Tebicuary mí	Troche	Alcohol	Water, air (odors)	Recreation	Affects provision of drinking water for Cnel. Oviedo y Villarrica
Tebicuary mí	Tebicuary mí	Sugar	Water, air (odors)	Recreation	Relatively insignificant
Tebicuary mí	Iturbe	Sugar	Water, air (odors)	Recreation	Relatively insignificant
Tributary of the Tebicuary mí	Villarrica	Sugar	Water, air	Drinking water	Large population in area
Capiatá Creek	Capiatá		Water	Drinking water, recreation	Important
San Lorenzo Creek	San Lorenzo	Slaughterhouse	Water, odors	Drinking water, recreation	Important populated area
Tayasuapé Creek	San Lorenzo	Yeasts Tanneries	Water	Recreation	Cyclical
Yukyry Creek	Itaguá	Oil	Water	Drinking water	Recreation
Stream flowing into Lake Ypacaraí	Ypacaraí	Oil	Water	Drinking water	Not evaluated
Lake Ypacarí	San Bernardino	Coffee	Air (coloration)	Recreation	Important tourist area. Urban developments.
Ypucú Creek	Ypacaraí	Slaughterhouse		Drinking water	Flows into the lake
Ibid.	Ibid.	Tannery	Water	Drinking water	Flows into the lake
Ibid.	Ibid.	Liquor	Water, air (odors)	Drinking water	Flows into the lake, populated area
Ypucú Creek	Ypacaraí	Slaughterhouse	Water, air (odors)	Drinking water	Flows into the lake
Ytay Creek	Fdo. de la Mora	Meat-packing	Water, air (odors)		Populated area
Mburicaó Creek	Asunción	Tannery Cattle industries	Water, air (odors)		Important urban area
Ñemby Creek	Ñemby	Oil	Water	Recreation, drinking water	Important populated area
Abay Creek	Guarambaré	Sugar	Water, air	Recreation, drinking water	Populated; tourism in Villeta
Paraguay River	Limpio		Water, odors	Recreation	Populated area
Paraguay River	Zeballos-Cué		Water, odors	Recreation	Populated area
Paraguay River	Asunción	Brewery			Populated area
Paraguay River	Asunción	Sewer drainage	Odors	Recreation	Open sewage outlets above ground in marginal neighborhoods
Paraná River	Encarnación	Oil	Water	Recreation	Populated area
Pirapó Creek	Pirapó	Oil	Water	Recreation	Thinly populated area
Capiibary-mí Creek	Obligado	Oil	Water	Recreation	Thinly populated area
Paraguay River	Pilar	Textiles	Water	Recreation	Relatively insignificant
Groundwater	Filadelfia	Several industries	Water	Beverages, industry	Important production area
Groundwater	Loma Plata	Several industries	Water	Beverages	Important production area
Ortega Creek	Caacupé	Liquor	Water, air (odors)		Important production area

Table IV – 7

Main Activities Causing Pollution

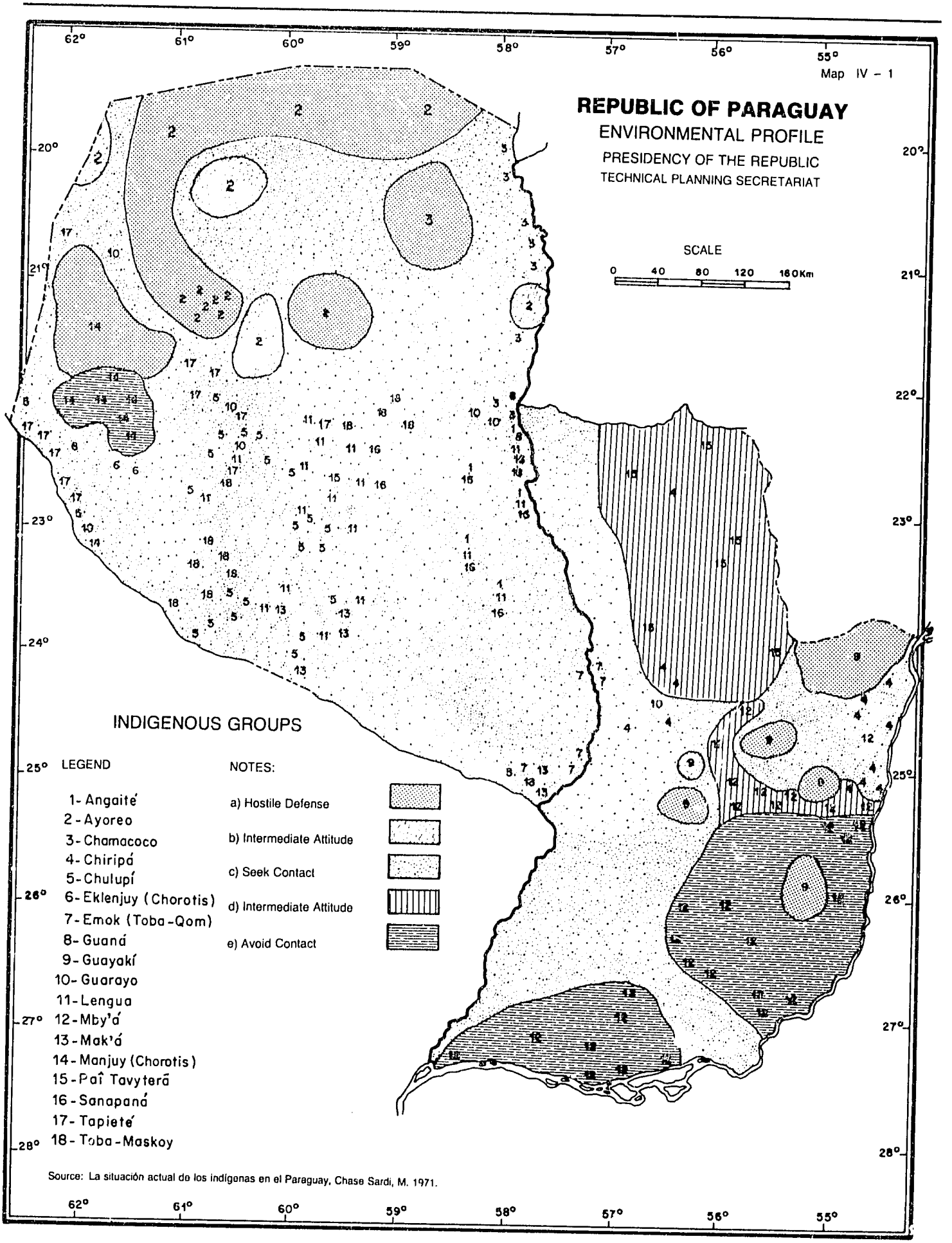
Industry	1982 Production[1]	1982 Installed Capacity	% Use of Capacity, 1982	Estimated Pollution[2] BOD Population Equivalent[3]
Cattle	68,700 Tn.	335,800 Tn.	20	100,000/day
Cheese	9.800 Tn.	20,200 Tn.	49	47,200/day
Vegetable Oils	72,600 Tn.	107,600 Tn.	68	47,800/day
Sugar	81,100 Tn.	119,100 Tn.	63	131,250/day (240 days/year)
Starch and Ground Manioc	73,800 Tn.	134,000 Tn.	55	121,000/day
Liquor and Alcohol	23,839 Kl.	83,963 Kl.	29	240,000/day (180 days/year) liquor 385,000/days (240 days/year) alcohol from molasses 400,000/day (90 days/year) mash
Wine	11,000 Kl.	22,737 Kl.	48	10,000/day
Beer	1,085,000 H1[4]	1,085,000 H1	100	341,000/day
Soft Drinks	171,076 Kl.	163,290 Kl.	105	26,000/day
Hides	4,152,000 ft^2	19,937,000 ft^2	21	20,000/day
Cotton Textiles	9,248 Km.	22,160 Km.	42	15,205/day

[1]Technical Planning Secretariat. Use of Industrial Capacity, 1980.

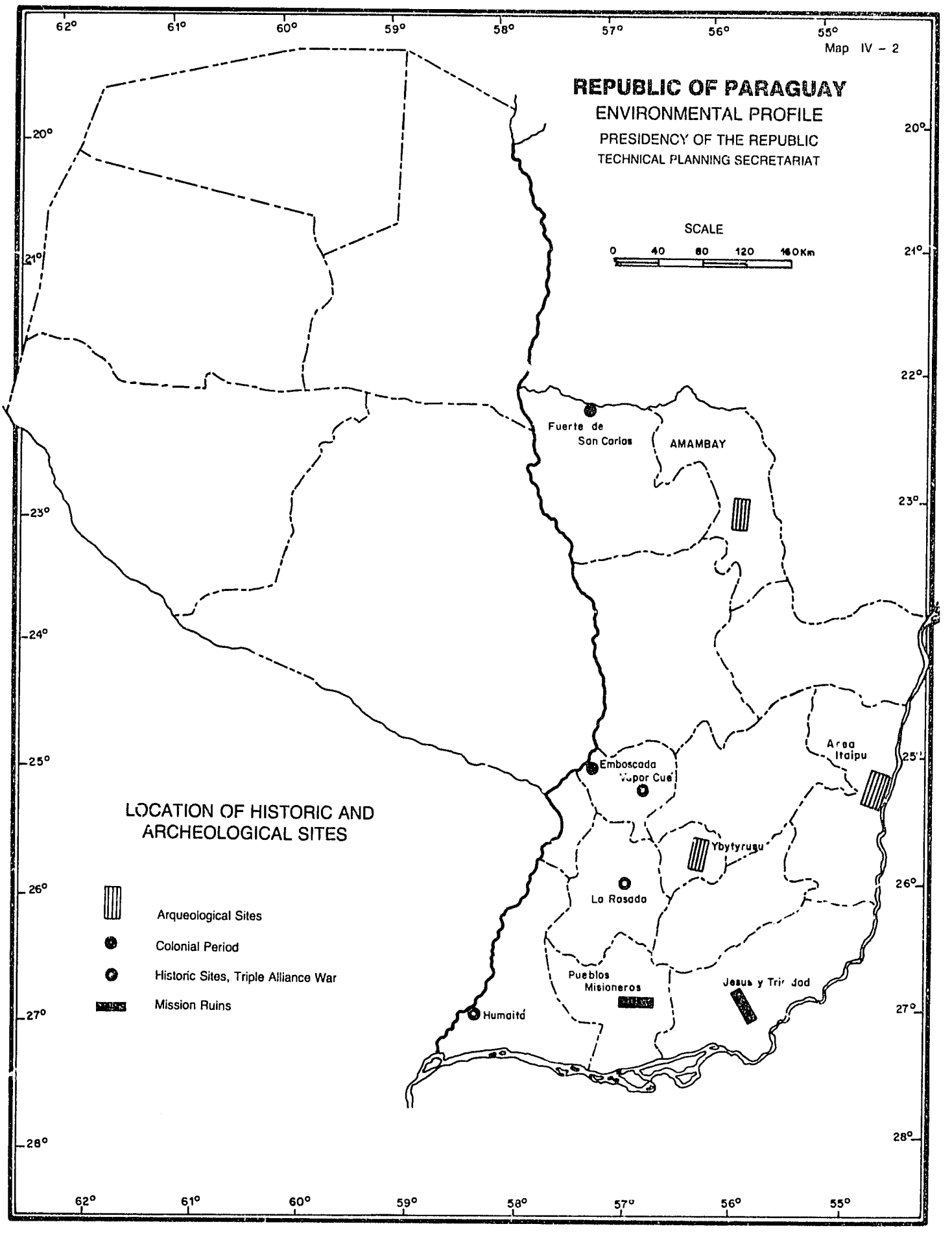
[2]WHO Publication No. 62. Assessment of Source of Air, Water, and Land pollution.

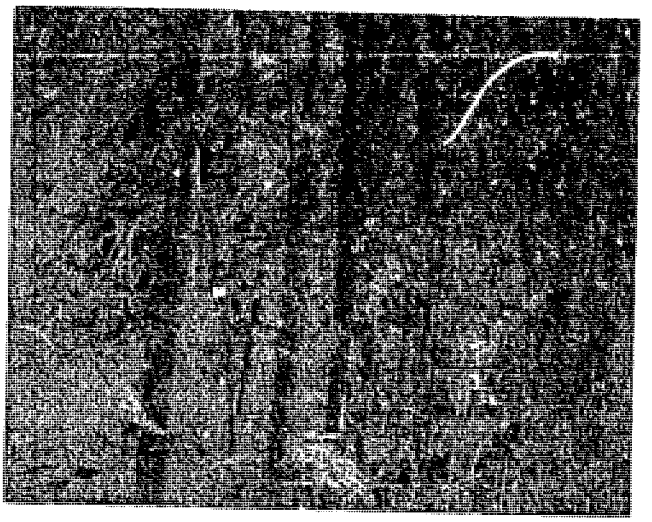
[3]1 population equivalent = 54 grams BOD daily, 365 days per year.

[4]Estimated in late 1984.



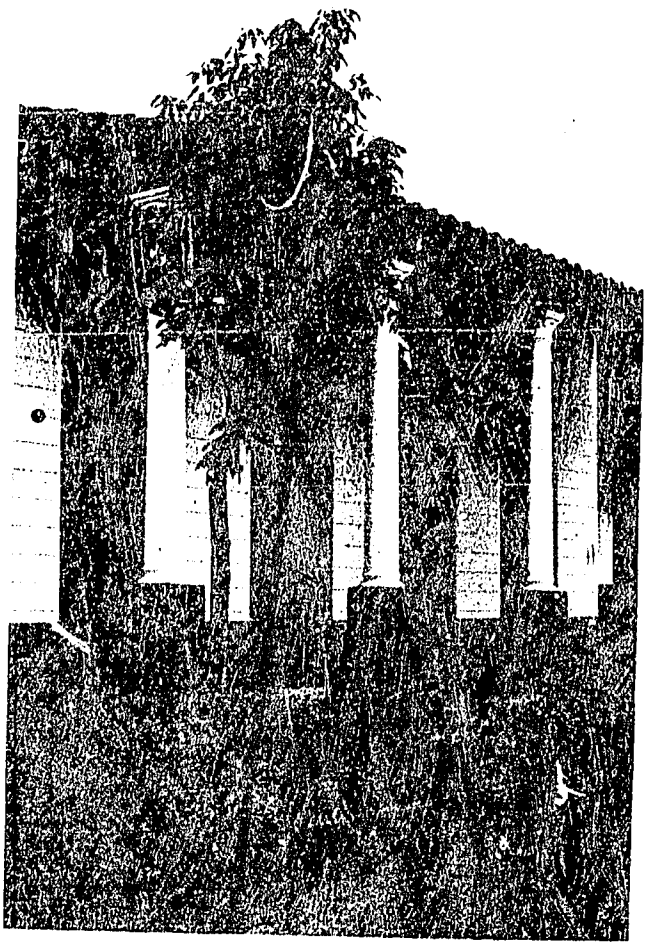
Source: La situación actual de los indígenas en el Paraguay, Chase Sardi, M. 1971.


Map IV - 2
REPUBLIC OF PARAGUAY
ENVIRONMENTAL PROFILE
PRESIDENCY OF THE REPUBLIC
TECHNICAL PLANNING SECRETARIAT
SCALE
0 40 80 120 160Km
62° 61° 60° 59° 58° 57° 56° 55°
20° 21° 22° 23° 24° 25° 26° 27° 28°
Fuerte de San Carlos
AMAMBAY
Area Itaipu
Emboscada
Vapor Cue
Ybytyruzu
La Rosada
Pueblos Misioneros
Jesus y Trinidad
Humaitá
LOCATION OF HISTORIC AND ARCHEOLOGICAL SITES
Arqueological Sites
Colonial Period
Historic Sites, Triple Alliance War
Mission Ruins

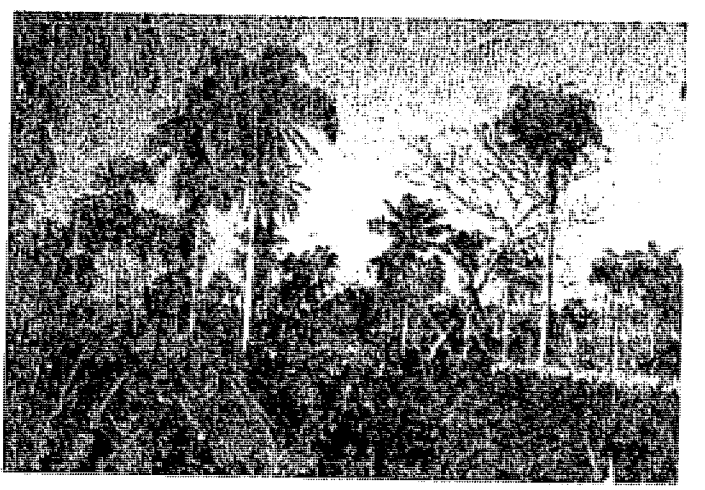


Southern screamer. Photo courtesy National Forest Service.

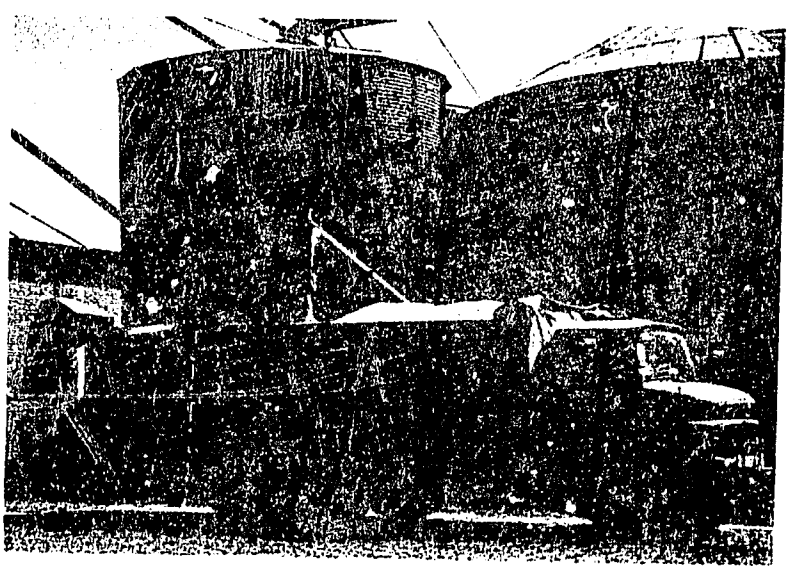
Legal and Institutional Aspects



Building from the colonial period.



Floriculture in the Central area.



Wheat storage.

V

Legal and Institutional Aspects

Legal Protection of the Environment

Introduction

This chapter will analyze legal protection for natural resources and the environment in Paraguay. This overview includes an analysis of the main regulations and of government agencies' attitudes regarding the vital need to conserve natural resources and protect the environment.

In Paraguay, environmental protection and conservation of natural resources, especially renewable resources, has only become a concern of late. Because of Paraguay's geographic, demographic, and physical features, Paraguayans had not become aware of the need to adopt strict measures to protect natural resources and the environment. These features include the huge expanses of fertile and forest lands in the Eastern region, ideal for agriculture and lumbering; the densely-forested plains in the Western region, which serve as a natural habitat for countless wild animal species; and the small human population, concentrated in Asunción and provincial capitals.

In evaluating natural resource and environmental protection policy, one must examine all relevant laws. It is often said, and rightly so, that while legislation is drafted by the legislators, it is a product of what a given community or nation thinks, feels, and needs at a given point in time. When a given way of thinking takes hold among the population as a whole, when the nation feels and believes it needs a legal solution to a common problem, it pressures the legislators until the sought-after legislation is passed into law.

And so it has happened in the case at hand. Paraguay did not perceive the need to protect its natural resource base or the environment, simply because until a short time ago its trees and forests were not felled indiscriminately; wild animals were found in great variety and abundance, to the point that hunting was practically unrestricted; fish abounded in the rivers, lakes, and creeks; water pollution from industrial effluents was practically unheard of; and there was no smog in the cities. Thus, it is easy to understand why there were so few environmental regulations.

Clearly, however, problems resulting from depredation of resources and pollution have begun to crop up, accompanied by a growing awareness of the need to adopt regulations to protect natural resources and the environment. Following is an analysis of relevant legislation.

Ranking of Regulations

As will be observed further on, there has been a profusion of disjointed legal regulations, each covering a particular aspect of natural resources and the environment. The lack of coordinated policy in this regard is reflected in contradictions among some regulations. Such problems suggest the need to determine which regulations have priority. An overview of precedence in Paraguayan law in general will help determine the ranking of laws related to natural resources and the environment.

The ranking and relative significance of the various provisions that make up the Paraguayan legal system are set forth in Article 8 of the Constitution of August 25, 1967; Article 9 of Law 879/82, which establishes the Code of Judicial Organization; and Article 63 of the Code of Civil and Commercial Procedure.

Article 8 of the Constitution makes the Constitution the supreme law of the land. Thus, all constitutional provisions have top ranking. All other laws and regulations are subordinate to this fundamental and unifying legal instrument. Indeed, Article 11 of the Constitution declares that none of the principles, guarantees, rights or obligations set forth in it can be altered by laws implementing its principles. Any law, decree, regulation or other legal measure that is counter to any constitutional provision shall be null and void.

The Constitution establishes as second in rank treaties, conventions, and other international agreements that have been duly ratified. In the third place are all laws.

There are also other significant guidelines as regards ranking of regulations. Thus, within the body of laws, codes take precedence. And each code should apply to its respective subject matter in preference to all other codes, except those supplemental to a given code. The Code of Civil and Commercial Procedure, for example, is supplemental to the Code of Criminal Procedure, for all cases not dealt with in the Code of Criminal Procedure. Yet they are analagous as regards civil procedure (Article 1049, Code of Criminal Procedure).

Once one has exhausted the above ranking system, regulations apply in the following order: First, legal principles from current legislation in the given area, and secondly, general principles of law. Thus, in Paraguayan law regulations are ranked as follows: a) the Constitution; b) treaties, conventions, and all other agreements with foreign governments, so long as they have been ratified; c) codes; d) laws, decrees, ordinances, etc.; e) analagous national laws; f) legal principles of current legislation in the given area; and, g) general principles of law.

Main Regulations Concerning The Environment

The Constitution

The Constitution was adopted August 25, 1967, after approval by the Constituent Assembly in which four political parties were represented. This is the first Constitution in Paraguay's history to set forth the government's responsibility to protect natural resources. Article 132 states: "The State shall preserve the country's forest resources, as well as all other renewable natural resources. To this end, it shall set forth regulations for conservation, renewal, and rational exploitation of resources."

This declaration is extremely important, as it has been set forth as part of Paraguay's fundamental body of law. It manifests the state's interest in caring for this matter, which is of such vital interest to all Paraguayans.

International Agreements

Paraguay has adhered to the Convention on International Trade in Endangered Species of Wild Flora and Fauna, concluded in Washington on March 3, 1973. It was approved and ratified by virtue of Law No. 583, of August 19, 1976; the Convention entered into effect February 13, 1977. The reasoning behind the Convention is set forth in the initial declaration of principles, which recognizes that animal and plant wildlife, in its several and varied forms, is an irreplaceable part of the earth's natural systems that should be protected for this generation and posterity. The declaration of principles also recognizes the vital role of international cooperation in protecting certain wild animal and plant species from excessive exploitation through international commerce.

One of the fundamental principles of the Convention is to promote strict regulations regarding endangered species, which are or could be endangered by commerce. Trade is authorized only under exceptional circumstances. Similarly, regulations are sought for all species which, while not currently in danger of extinction, could become endangered. Paraguayan adherence to the principles of this Convention is an express recognition of the importance of wild animal and plant life in maintaining ecological balance.

Trade of specimens of the above-mentioned categories of wildlife is also subject to regulations, by virtue of which exportation of any sample of such species requires special permission, and an export license that can only be granted once a scientific authority of the exporting state has verified that the specimen was not obtained in violation of national legislation protecting wildlife. Also, a national authority must verify that each live specimen will be handled in such a way as to reduce to a minimum the risk of injury, deterioration of health, or mistreatment. Finally, an import license must be obtained for the item to be exported.

Firm requirements have been set up so as to coordinate action to protect wild animal and plant life in each country that has acceded to the treaty. Unfortunately, however, such coordination is sometimes lacking. Often private interests prevail to the detriment of the general interest in maintaining ecological balance and preserving the environment through conservation of these species. States have adopted policies which, despite accession to the Convention, conflict with the Convention's sound purpose; Paraguay, however, adopted a strict measure that goes beyond the Convention's stipulations: hunting and sale of animal wildlife—either domestically or for export —is prohibited. This matter will be dealt with further below.

Civil Code

As mentioned above, in cases of two laws of the same rank, the more general one prevails over the more specific one, except when the specific one stipulates an exception. This consideration is important, as the Civil Code and the Rural Code have conflicting provisions regarding natural resources and environmental protection.

Gold, silver, and copper mines, precious stones, and fossils found in the earth are all officially state-owned, even though private persons or corporations may own the surface (Article 2342, paragraph 2, Civil Code). This provision is an exception to the iron rule of Roman law which, on declaring the right to property as the greatest of all of the rights of man, extended land rights infinitely upwards, and downwards to the core of the earth. Declaring such natural resources to belong to the state, despite their location beneath private property, is an important initiative in preservation of non-renewable natural resources.

The Civil Code (Article 2343) declares that fish life can be privately appropriated. Similarly, swarms of bees can be domesticated, so long as the owner does not claim the bees immediately; plants and grasses covering rivers and lakes can also be privately appropriated, in accordance with regulations regarding maritime and river fishing. Article 2527 stipulates that game, salt and fresh water fish, objects found on ocean and river beds—such as shells, coral, etc.—and other substances found in the sea or in rivers can all be appropriated so long as there are no signs of prior ownership by another party.

The Civil Code (Article 2549) has an important across-the-board exception: local regulations prevail in all cases regarding the right to appropriate game and fish. As a result, special measures can be taken as needed to protect species and thus

maintain the balance of nature.

Overall, the Civil Code says little about natural resources. This legal gap in terms of natural resources and the environment can be explained by the date of promulgation of the legal code (1877), and the state of affairs at that time.

Specific Regulations on Natural Resources and the Environment

The Rural Code

Paraguay's Rural Code was enacted September 30, 1931. Fifty years later, it is out of date in many respects, reflecting lack of foresight as regards natural resources and the rural environment. Some changes were made later, as part of an effort to bring it up to date. Such efforts, however, were not as successful as they might have been, as today the regulations need updating once again. This requires a well-defined rural policy to cover at least 20 years.

The Rural Code has only minimal coverage of natural resources, as needs at the time of its enactment were minimal. Title III, Chapter 1, "On Rural Matters," sets forth hunting regulations, establishing the hunting season (Article 34) as March 1 to August 31; hunting is prohibited at other times. Article 37 prohibits hunting and sale of small birds, as well as destruction of their nests. There is also a year-round prohibition on hunting of anteaters, some snakes, and birds which inhabitat Paraguay, such as thrushes, goldfinches, cardinals, calandra larks, tanagers, storks, ostriches, herons, crows, and others. Nonetheless, curiously, and without any apparent explanation, killing of mountain lions and all other felines, as well as of parrots, cockatoos, toucans, and in general all animals considered "harmful," is permitted year-round. Thus the Code considers mountain lions and other felines to be "harmful animals." This criterion, however should no longer be applied, as these species are threatened with extinction. This threat results from massive hunting, which in turn is due to the high prices feline skins bring on the international market, and to tourist outings with African-style "safaris," in which tourists are given the chance to kill these animals just for sport.

The Rural Code also legislates property rights over wild animals, stipulating that even if the animals are wild they are the property of the landowner on whose lands they happen to be found. This measure was justified by the absolutist concept of property that prevailed when the Code was enacted.

As regards penalties, there is a 100 peso fine (Article 44) for those who kill animals in violation of hunting prohibitions, with the animal being confiscated. This fine, which comes to 1,500 guaranís taking into account official adjustment to the present-day guaraní (Law 283), is but a pittance in relation to the animal's value. Furthermore, while the fine imposed is independent of civil or criminal sanctions against those who contract the hunter, such penalties often turn out to be minimal once the case is brought before the courts. Article 439 of the Criminal Code provides for a fine of from 10 to 50 pesos (i.e. from 13,190 to 7,950 guaranís), for anyone trespassing on private land for the purpose of hunting or fishing.

The government found it necessary to halt the increase in indiscriminate hunting of wild animals which, due to international prices of hides, has become a high-profit activity in recent years. Such hunting has endangered the most prized and ecologically important species. Thus on November 4, 1975, Decree 18,976 was issued, "By virtue of which state protection is declared over all wild animal species which, temporarily or continously, inhabit Paraguayan territory; conservation measures are declared; and hunting, marketing and export of such species is prohibited."

One of the justifications for this decree arises from the Paraguayan government's particular concern for conservation of these species, indicating that "studies and observations have demonstrated the steady decline in the concentration of several genetically distinct species, pushed to their last refuges by growing urbanization, roadways, technological advances, conversion of wilderness to croplands, and above all the ongoing, uncontrolled hunting by irresponsible hunters who sell domestically or on the international market." In response to this situation, Article 1 of the above-mentioned decree declares that the Paraguayan government shall protect all wild animal species that temporarily or continuously inhabit Paraguayan territory; and Article 2 prohibits hunting, marketing, import and export of all wild animal species, as well as of their parts or by-products.

Penalties for infractions of this decree were not set at fixed amounts, but rather took as a point of reference the current minimum wage for an unskilled worker, with the fine set at 30 days wages for each wild animal hunted, as well as confiscation of the animal products.

Implementation of this regulation began yielding results: within a short time wild animals began to repopulate the country's forests. Nonetheless, there are certain people and organizations bent on violating the prohibition, through illicit hunting, or by forging documents certifying that hunted animals came from other countries, thus making it possible to "legally" export them. Furthermore, the prohibition is hard to enforce given the expanse of Paraguay's wildlands and the sparse population of the Chaco.

The prohibition has been of utmost importance, as it reflects a firm commitment to protect endangered wild species.

The Rural Code also includes provisions which allow fishing in public-access rivers and creeks, in conformity with regulations established by the appropriate authorities (Article 49). Fishing using harmful substances, dynamite, or other explosive materials is forbidden, as is fishing with nets during breeding periods.

The most important aspect of these provisions is that the Code establishes administrative provisions to safeguard fish life, provisions which may even legally prohibit fishing altogether, if it were to prove necessary for the country's greater interest.

Forestry

A key aspect of the Rural Code deals with forestry. Article 399 defines "the administrative plan the objective of which is to conserve and increase the state's forest resources, preventing their destruction, using such resources through rational harvesting so as to keep the forests from being destroyed, and promoting planting of trees where there are none."

In general, the Rural Code's section on forestry summarizes a policy of protection of this natural resource, providing, for example, for possible expropriation of wilderness lands where it would contribute to protection of soils along streams and

water courses, and of such lands as may safeguard springs and waterways in general (Article 408, paragraphs 2 and 3). User permits to the same end are also provided for, though for excessively large areas (maximum area 10,000 hectares).

Title IV is noteworthy insofar as it refers to the "repopulation and tree-planting" policy, which would today be called reforestation and forestation. It charges technical offices with finding the best method for repopulating each kind of tree (Article 422), and it promotes establishment of nurseries to foster tree planting through contests with prizes (Articles 422 and 423), anticipating what would later become tax incentives for promoting reforestation.

The establishment of the National Forest Service within the Ministry of Agriculture (Law 422, November 22, 1973) set the stage for a new forestry policy. Law 422 updated the Rural Code with respect to forest resources. The creation of a special agency dedicated to the conservation of a particular natural resource leads, logically, to greater attention to that resource than would result if the agency's functions were more diverse. Thus a close look at the forestry law, its supplemental regulations, and its implementation, is called for.

Law 422 declares use and rational management of Paraguay's forests and forest lands to be in the public interest; the same applies to other renewable natural resources covered by the law (Article 1). Similarly, protection, conservation, and improvement and growth of forest resources is declared to be in the public interest and obligatory; restrictions on the use of rights to forests, forest lands, and renewable natural resources, whether public or private, are also established. Thus broad property rights—including the Roman "ius fruendi," i.e. unrestricted use of the civil and natural fruits resulting from private control of property whether real or personal—are circumscribed.

Objectives set forth in this law include protection, conservation, increase, renewal, and rational exploitation of Paraguay's forest resources; erosion control; protection for hydrographic watersheds and springs; promotion of forestation and reforestation; conservation and increase of game and river and lake resources; etc. (Article 2). The National Forest Service (SFN) is in charge of administering, promoting, and developing Paraguay's renewable natural resources, ensuring their protection, improvement, extension and rational distribution. To this end, it has been empowered to undertake activities including developing forestry policy (in coordination with government entities in charge of economic development), monitoring use, managing the forests and renewable natural resources, protecting wild animal life and regulating hunting and fishing nationwide, and promotion of forestry settlements, cooperatives, and communal forests (Article 12). So broad is its mandate that the National Forest Service could have jurisdictional conflicts with other state agencies.

The National Forest Service is headed by a Director responsible for policy and adminstration, accompanied by an Advisory Board made up of representatives from the Ministry of Agriculture, the Central Bank, the Institute for Rural Welfare, the Rural Association of Paraguay, the National Society of Agriculture, and two representatives of the association that represents Paraguayan lumbering concerns (one from the sawmills, and one from the loggers). This Board advises the Director on technical, administrative, and financial matters.

Generally speaking, the Forestry law has filled the legislative void which, understandably, had existed in the Rural Code; its regulations are appropriate for present-day needs in forest conservation and conservation of other renewable natural resources. Carefully analyzing its context, one can conclude that the National Forest Service has a breadth of functions that, in principle, is very difficult to cover fully. In practice, it deals only with forestry.

Other renewable resources do not receive sufficient attention; this is only to be expected, considering the dimensions of forest-related problems that need to be addressed. Perhaps the National Forest Service should be limited to its specific areas, leaving matters related to other resources to other Ministry of Agriculture offices, such as the Division of Hunting and Fishing, and the Division of Public Waters.

Sanctions for forest-related infractions include fines, confiscation, revocation of use permits, and disqualification for such permits.

Any law can be criticized when the sanctions it establishes are not sufficient to ensure compliance. Such is the case with the Forestry Law. For example, fines range from 1,000 to 1,500 guaranís. As currency values fluctuate, over time this becomes a mere slap-on-the-wrist. This is currently the case, as the market price of wood is high enough to encourage violation of the law.

The section of the Forestry Law dealing with forest development and tax exemptions is particularly noteworthy. It establishes several measures whose purpose is to provide incentives through deductions and exemptions for forestation and reforestation. Article 43, for example, declares forest plantations on forest lands that meet specifications exempt from real estate tax. The specifications are set forth in Article 57 of Decree 11,681, enacted January 6, 1975, which states that in order to avail oneself of the exemption, one must carry out reforestation projects in areas so designated by the National Forest Service. The plantation area must be at least 2 hectares, planted with species authorized by the Forest Service and otherwise meeting the law's requirements.

Article 44 of the Forestry law provides for another incentive: part or all of one's income tax need not be paid to the government if it is invested in plantation forestry. Article 58 of Decree 11,681 requires that the reforestation projects be carried out in special areas set aside by the National forest Service. Furthermore, if the total area of a plantation exceeds 50 hectares, the work plan for it should be overseen by an agronomist or other qualified professional. Additionally, on such plantations at least 80% of the seedlings must survive and be under silvicultural management 24 months after planting.

Article 45 of the Forestry Law frees all companies or persons involved in forestry from taxes and currency exchange fees for imports of equipment, tools, chemicals, seeds, stakes, forest plants, and all other items needed in forestation and reforestation.

These legal measures are an important stimulus for forestation and reforestation, for if a business can choose between paying its income taxes or investing in forestation and reforestation—which may prove profitable and will benefit the country—it may well choose the latter. Unfortunately, the purpose behind the law has not been clearly understood by

either the potential beneficiaries nor by the government tax offices. Few businesses and individuals have availed themselves of these tax incentives; some businesses and individuals, on the other hand, have managed to qualify for the tax incentives through cunning maneuvers without however, implementing reforestation plans.

As a result, the natural resistance of offices in charge of tax collection to granting tax exemptions was compounded by the discovery of fraudulent situations which have raised questions as to the sincerity of those who state their intention to undertake forestation or reforestation projects. Thus a law exists which provides for tax exemptions and other benefits to encourage forestry and reforestation, but it has been hard to implement for the reasons noted.

Environmental Regulations

Health Code

Legal protection of the environment is more wideranging, or at least more up to date, than regulations on natural resource use. The Health Code was enacted recently (Law 836, December 15, 1980). Title II, Chapter I deals with environmental sanitation, pollution, and degradation of the environment. This measure prohibits all actions that bring on degradation of the natural environment by diminishing its extent or rendering it a health hazard (Article 66). The Ministry of Public Health is to set limits for emissions or discharges of pollutants in the atmosphere, waters, and soil, and is to establish regulations for labor, industry, commerce and transportation so as to preserve the environment.

Article 68 assigns the task of promoting pollution prevention and control programs to the Ministry of Health, which is also to take measures to promote environmental preservation.

The section of the Code on water for human consumption and recreation emphasizes direct Ministry of Health supervision over all aspects of water supply, conservation, and treatment. Article 82 prohibits discharge of industrial wastes which cause or may cause soil, air, and water pollution affecting the atmosphere, canals, and surface and underground waterways without treatment. Such treatment should render such pollutants benign to public health, or otherwise reduce their harmful effects.

Protection of national parks is an important measure (Article 111) aimed at assuring ecological balance by keeping biotic communities and wild species threatened with extinction in a natural state. The destruction of natural forests by either agriculture or lumbering deprives many areas of important "lungs" that purify the environment. One effective measure has been to set up national parks.

Noises, sounds, and vibrations that can constitute health hazards are also regulated in the Health Code. According to Article 129, the Ministry of Health should dictate measures to prevent, diminish, or eliminate public nuisances caused by noises, sounds, or vibrations that are harmful to health, and define tolerable levels of personal exposure to such risks.

Sanctions set forth in the Health Code run the gamut of typical penalities, and should assure adherence to the regulations. These sanctions include warnings, fines, confiscation, and suspension and cancellation of property titles. The fine is not defined in guaranís, but in workdays for unskilled labor in Asunción. The maximum fine is 100 work days. This is problematic, as a serious infraction such as dumping industrial wastes in waterways, for example, should be more heavily penalized.

Nonetheless, from the legal standpoint, the Health Code has ample provisions aimed at environmental protection. The Code has filled a void, and its implementation will allow for effective environmental protection. However, it is not always implemented.

Municipal Regulations

There is a profusion of municipal ordinances relating to urban environmental protection. Ordinances are the main legal instrument used to regulate municipal activities in the Municipality of Asunción. Ordinances rank below decrees, and even further below laws and codes, in order of precedence of legal regulations.

Particularly important in Asunción is ordinance 9928 of November 1976 which prohibits bothersome, unnecessary and excessive noises in public or private places, when due to the time, place, or intensity they may disturb the peace or harm the environment. This measure defines tolerable decibel levels. Ordinance 2662 of January 27, 1979 refers to pollution control. It regulates domestic incinerators and municipal dumps, i.e. the sanitary landfills where garbage is deposited.

One should bear in mind that legislative conflicts over jurisdictional matters may arise. For example, a higher-ranking regulation, the Health Code, places the Ministry of Health in charge of taking pertinent environmental protection measures regarding wastes (Chapter I) and hazardous noises, sounds, and vibrations. Yet the municipality has also been accorded the same responsibility, and has passed relevant legislation. Coordination, of course, is thus necessary. The nature of the Ministry of Health is such that it should protect the health of all Paraguayans, which includes residents of Asunción. The municipal government is concerned with community welfare; but it, and particularly its municipal board, does not always include specialists in environmental protection; who can be found, in contrast, in a specialized ministry.

Legal Status of the Indigenous Communities

The Constitution says practically nothing about Paraguay's indigenous peoples. The silence of the 1967 Constitution is significant insofar as it establishes that all those born in Paraguay are treated as equals before the law. Article 24 states that all those born in Paraguayan territory are Paraguayan nationals; Article 31 stipulates that Paraguayan nationals 18 years of age and older are Paraguayan citizens. Article 54 establishes equality among all Paraguayans: "All inhabitants of the Republic are equal before the law, with no discrimination whatsoever; no privileges are allowed due to racial background or birth; in Paraguay there are no legal personal privileges nor titles of nobility."

This proclaimed equality, however, has not always been applied to the Indian communities. The survival of the indigenous peoples, heirs of a rich tradition they will pass on, has been an ongoing concern. Forgotten by "civilized man," the indigenous groups have turned to the land for subsistence. But the inexorable advance of civilization, and the continued exploitation of forests for agriculture and lumbering have pushed

the Indian communities to areas where it is impossible for them to continue their traditional ways. Thus, by virtue of Executive Decree 1341 of November 8, 1958, the Department of Indigenous Affairs was set up within the Ministry of Defense, so as to centralize activities related to the indigenous peoples, and unify criteria for legislation providing for the protection and development of Paraguay's native peoples.

Executive Decree 18,365 established the Paraguayan Institute for Indigenous Affairs, as a dependency of the Ministry of Defense, with objectives and functions specifically defined. The Statute on the Indigenous Peoples was passed by the Congress on December 10, 1981, and enacted by the executive branch on December 18, 1981, as Law 904.

Article I of this statute stipulates that the "objective of this law is the social and cultural preservation of the indigenous communities, protection of their heritage and traditions, improvement of their economic conditions, effective participation in national development, and legal provisions that guarantee equal property rights to land and other productive resources." The goal of social and cultural preservation presupposes that the indigenous groups are an important part of the environment, and constitute demographic communities at least as important as all other sectors of Paraguayan society. Thus Article 3 provides for respect for their traditional forms of organization, without this constituting an obstacle to Indian communities choosing other forms of organization established by law that would allow for their incorporation into Paraguayan society, in exercise of their right to self-determination.

The philosophy of social and cultural preservation of the indigenous communities, as well as their access to private and communal property in land, are key points of the statute. It also recognizes the indigenous authorities and traditional law, though if there is a violation of Paraguayan law, members of indigenous groups will be judged like any other citizen. This would be the case, for example, in a crime for which sanctions are defined in the Criminal Code. Equality in rights implies equality in responsibilities.

The statute also provides for specialized technical teams to develop educational programs about and for the indigenous peoples. These include training in farming, livestock-production, forestry, and handicrafts; training of indigenous teachers; assimilation of modern science and health practices into the indigenous cultural framework, in such a way that the indigenous peoples themselves can deal with and solve their health problems, and develop their organizational and administrative skills so as to assume leadership in their own communities.

The Paraguayan Institute for Indigenous Affairs has been established to implement this law and set and oversee policy with regard to the indigenous communities. It has its own resources and legal status. The Institute is made up of an Administrative Council with a Chairman, who has recourse to an Advisory Board. These bodies have played an important role in strengthening the indigneous communities. The Institute is supported by several agencies, including the Institute for Rural Welfare, which has granted lands for the indigenous peoples to settle on. The Ministry of Defense has also worked effectively in all aspects of protecting and extending assistance to the indigenous peoples.

In sum, the Statute on the Indigenous Peoples includes provisions which, through their implementation, could provide adequate protection to those communities that keep alive their native traditions.

Conclusions

1. Legal regulations in Paraguay are, at least in the abstract, appropriate for basic protection of natural resources and the environment.

2. Given the uncertain future of preservation and conservation, and present needs, the body of laws relating to natural resources and the environment should be restructured.

3. Badly-needed coordination should be a goal of the restructuring of environment-related laws, so as to avoid contradictions that can render such laws inoperative.

4. Bodies should be established that have exclusive jurisdiction to ensure that regulations aimed at protecting the environment are respected. Dispersion of responsibility minimizes the potential success of such an endeavor.

5. Paraguayans should become aware of the importance of preservation and conservation of natural resources for their own survival. Thus, all Paraguayans should scrupulously obey laws aimed at protecting the environment even though these laws, over time, may turn out to be insufficient.

Institutional Analysis

Introduction

For pragmatic purposes, this analysis is limited to a description and evaluation of the activities and work areas of the main national and international, state, quasi-state, and private institutions that play a role in promotion, administration, management, protection and improvement of physical and biological resources, regarded as key aspects of the environment.

Table V-1 will be used to analyze the activities and topics set forth by the charters and special provisions of the different entities, in the national budget, and in international programs and institutions.

Research for this chapter has led to the following conclusions:

- Paraguay's economy is based on the primary sector; institutions in charge of economic development place a priority on strengthening administrative entities and programs geared to exploiting natural resources. In this way they draw potential financial and human resources away from the few and weak domestic agencies that work to preserve and develop natural resources.
- There are few institutions specialized in environmental protection and development, and they have practically no funds to work with.
- Environment-related activities are among the functions of some institutions, but such activities are not provided for in the national budget.
- Financial institutions geared to agricultural development do not have any specific credit facilities for environmental preservation, reclamation, and development.

- Interinstitutional coordination is needed for certain activities in areas of mutual concern.
- The budgets of the few specialized institutions that are geared to the environment do not cover all of the activities assigned to them by law.
- Private institutions geared to conservation are all voluntary, and do not have sufficient funds; thus their efforts are limited to good intentions.
- There is a consensus that environmental degradation has not yet reached its *critical point*; the Central area may be an exception to this general observation.
- There is no conclusive evaluation as to the degree of environmental degradation (soils, water resources, forests, fauna, etc.).
- Research on the environment has been sporadic and fragmented; national priorities have not been defined.
- The functions of some institutions working on the environment overlap, though in practice this has not led to duplication of efforts in the same geographic area.
- Several centralized institutions lack statutes or charters; the responsibilities of others are not clearly defined.
- Some aspects of the environment are not dealt with at all by government institutions.
- It is difficult for the national budget to break down financing for specific activities; it is feasible, however, to do so by areas as laid out in table V-1.

It is impossible to gauge the precise sum of financial resources allocated for environmental projects, as such projects are generally lumped together with others in broader categories in the various institutions and ministries involved in environmental activities

Financing

Most financing of the institutions analyzed here is from ordinary funds, complemented by special funds and international loans.

Main Institutions Related to Natural Resources and the Environment

The Technical Planning Secretariat is the national body in charge of planning, coordination, evaluation, and advising in economic and social policy, physical resource management, environmental sanitation, and matters pertaining to organization of settlements.

Each institution draws up its respective program through its planning office. Following is a list of public sector institutions whose work is related to the environment, together with areas of responsibility:

- **Planning and Evaluation**
  - Technical Planning Secretariat
  - Planning offices of relevant institutions
- **Budget and Finance**
  - Office of Budget & Financial Supervision—Ministry of Treasury.
  - Executive offices of operative institutions.
- **Public Administration Sector**
  - Ministry of Agriculture and Livestock
  - Institute for Social Welfare
  - National Development Bank
  - Agricultural Credit Service
  - Ministry of Industry and Commerce
  - National Institute of Technology and Standards
  - Ministry of Public Health and Social Welfare
  - Corporation for Sanitary Works
  - Ministry of Public Works and Communications
  - National Ports and Navigation Administration
  - National Electricity Administration
  - Ministry of Defense
  - Asunción Municipal Government
  - National University of Asunción
- **Binational Sector**
  - Itaipú
  - Yacyretá
- **Mixed Enterprises**
  - PETROPAR
  - SIDEPAR

In addition to the public sector institutions, other development and environmental organizations exist, both in the private sector and as part of international organizations. These include:

- **Private Sector**
  - Catholic University
  - Lake Ypacaraí Basin Foundation
  - Man and the Biosphere
  - Paraguayan Society for the Protection of Nature
- **International Agencies**
  - United Nations Development Program (UNDP)
  - Inter-American Development Bank (IDB)
  - Food & Agriculture Organization (FAO)
  - Organization of American States (OAS)
  - Inter-American Institute of Agricultural Sciences (IICA)
  - World Bank (IBRD)
  - US Agency for International Development (USAID)
  - Japanese International Cooperation Agency (JICA)
  - United Nations Educational, Scientific and Cultural Organization (UNESCO)

Activities and Areas Covered by Institutions Involved in Natural Resources

The systemic concept of public administration involves three basic kinds of interrelated institutions. These are: forecasting/planning bodies, which aim to reconcile means and objectives, and resources and goals, generally represented in the planning office; operative bodies, i.e. the centralized and decentralized government agencies in charge of formulating regulations and producing goods and services all for the good of society; and finally, auxiliary input or funding bodies, represented by institutions that collect and allocate financial, hu-

man, and material resources so that the other institutions can do their work, this body being the Treasury.

a. Along these lines and consonant with the notion of public sector planning, the Technical Planning Secretariat is in charge of ensuring that appropriate institutions are established and formulating guidelines for development. To date, however, this institution has not undertaken specific projects for research, promotion, conservation, and evaluation of the environment. Nor has it defined the appropriate institution for such tasks. Its internal structure does not even include a special office to deal with environmental affairs.

b. The Ministry of Agriculture is the most important of the operative institutions, as it is responsible for the primary sector. In this capacity it defines and directs primary sector policy, and coordinates, evaluates, and advises the decentralized bodies related to the primary sector. Furthermore, through its internal divisions and semi-autonomous specialized services it is in a position to take the following actions relating to the environment: inspect agricultural products and enterprises; conduct research as to the causes of foci of disease and mortality of any animal species, including birds; monitor sanitary conditions in meatpacking plants, slaughterhouses, ranches and dairy farms; study pests and diseases affecting crops, and take measures to remedy them; disseminate information regarding conservation of natural grazing lands; develop programs for protection of soils, forests, and water resources through comprehensive rural development projects; and set standards regarding agronomic methods.

Through the National Forest Service, the Ministry can protect, conserve, increase, renew and make rational use of Paraguay's forest resources; control soil erosion; protect hydrographic basins and springs; conserve and increase game and lake and river fish life; research and disseminate information on forest products; and promote forestation and reforestation, crop protection, protection and beautification of roadways, public health facilities, and tourist areas.

Agriculture Ministry funding for natural resource programs is practically nil. The SFN's efforts are primarily directed to study and research, rather than implemention of projects to protect and improve forest resources, control soil erosion, and protect watersheds. Conservation and increase of game and lake and river fish resources has not even been incorporated into its structure. At present the Ministry has only one division with two staff members in Asunción, and none in the field, to protect fish life and game.

c. The Institute for Rural Welfare (IBR) is another institution whose work relates to the environment. Among its functions are: setting up agricultural settlements and building roads, bridges, and culverts in unsettled areas; promoting construction and improvement of rural housing; promoting redistribution of population in accordance with Paraguay's economic and social needs; and setting aside lands which, for geographic or historic reasons, tourism, or preservation of fauna and flora, are needed for national parklands.

d. None of the financial institutions geared to development, such as the National Development Bank, Agricultural Credit Service, and the Ranchers Fund, have any office nor finance programs and activities for protection, conservation, or improvement of natural resources.

e. The Ministry of Industry and Commerce, in addition to its regular activities (formulation and implementation of industrial policy, coordination and evaluation of and advice for the decentralized entities related to industry and commerce, etc.) is involved in activities relating to the environment, such as setting guidelines for extension, modernization, and installation of new industrial plants. Nonetheless, it does not have any office in charge of preventing environmental degradation resulting from the location and nature of industrial activities.

f. The National Institute for Technology and Standards designs, directs, coordinates and monitors research and dissemination of technology, and technical assistance. To date it has not formulated environmental quality standards nor has it developed appropriate environmental technologies consonant with public health.

g. PETROPAR and SIDEPAR are both mixed enterprises with majority state ownership. PETROPAR has an oil refinery, and prospects for oil deposits in Paraguayan territory. SIDEPAR is in charge of developing iron and steel production. To this end it has been authorized to purchase forest lands to produce and sell charcoal and to promote and carry out reforestation so as to guarantee future and ongoing supply of charcoal to the ACEPAR steelworks, for use in the blast furnaces. Neither PETROPAR nor SIDEPAR has any conservation programs.

h. The Ministry of Public Works (MOPC) defines and oversees implementation of policy for public works, transportation, energy, communication, tourism, and mining; it also coordinates, supervises and advises the decentralized entities working in those areas.

As regards the environment, MOPC is in charge of carrying out the geological survey of Paraguay, prospecting for mineral deposits, and inspecting oil prospecting operations nationwide; studying and evaluating oil deposits and quarries; advising efforts related to prospecting for mineral deposits nationwide; administering quarries; administering, building, and maintaining all of Paraguay's airports; and building structures to house hotels.

i. The National Port and Navigation Authority (ANNP) and the National Electric Company (ANDE) are decentralized government entities. ANNP is responsible for planning and building new port facilities; planning and building facilities for making use of navigable rivers and canals; and carrying out topographic, geological, hydrological and hydrographic surveys and studies of Paraguay's rivers and streams. There is an office for hydrological studies, but the budget does not include funds for carrying out the necessary activities. ANDE is in charge of hydroelectric energy programs. It does not have any conservation program.

j. The Ministry of Defense's three dependencies have environment-related programs. The Military Geographic Institute has the following functions: mapping Paraguayan territory; carrying out aerial photogrammetric surveys or survey expeditions to draft preliminary maps throughout Paraguay; and training personnel in photogrammetry, topography, and cartography.

The National Commission for Comprehensive Development of the Chaco is in charge of planning, promoting and implementing economic and social development projects throughout the Chaco.

The National Weather Service maintains and improves the network of weather and hydrological stations, in accordance with national and international needs.

k. The Ministry of Public Health and Social Welfare (MSPBS), in addition to defining and implementing national health policy, operates and monitors hospitals, and inspects pharmacies and pharmaceutical companies. Through the National Environmental Sanitation Service, it implements and supervises environmental sanitation programs related to supply of potable water, and garbage and waste disposal. This institution is in charge of upgrading rural housing, controlling water, air, and soil pollution, promoting legislation on environmental issues, enforcing such laws, and inspecting foods, occupational health and safety conditions, and sewage drainage facilities in rural areas and towns with up to 4,000 inhabitants. Through the National Malaria Eradication Service (SENEPA), it protects the population against malaria by disinfecting houses; combats Chagas' disease; and researches the vector chain in transmission of schistosomiasis in the vicinity of hydroelectric dams and other areas where stagnant waters or weak currents are found.

l. The Corporation for Sanitary Works (CORPOSANA) is a semi-autonomous dependency of the MSPBS, set up in 1954. Its functions are: to develop potable water systems and sanitary and storm sewers in Asunción and elsewhere, and to operate and maintain such systems; this includes ensuring that domestic outlets are functioning properly. It serves towns and cities with population over 4,000.

m. The Ministry of Education, as it is in charge of primary and secondary education, should take upon itself the task of promoting national awareness as to the importance of environmental conservation and preservation.

n. The Asunción Municipal Government, an autonomous institution, is responsible for cultural, social, and material development, the welfare of the people of Asunción, civic awareness and solidarity among neighbors, obligatory cooperation with other municipalities and entities so as to assure successful implemention of projects of mutual concern, thereby promoting national progress, and public services not specifically provided for by other institutions.

o. The National University of Asunción, through its various schools, provides instruction on natural resources:

- The School of Chemical Sciences offers degrees in chemistry, biochemistry, pharmaceutics, food technology, and industrial analysis.
- The School of Agricultural Engineering offers a degree in agronomy.
- The School of Architecture trains architects, and has an Environmental Development Institute (IDA) the objectives of which include the following: promote ecological awareness; oversee and revise curricula so as to include an environmental perspective; engage in research under the "Man and the Biosphere" (MAB) program; report on Paraguay's ecological situation; carry out studies on the availability of open spaces in the Asunción metropolitan area; and, define ways of assessing the value of environmental preservation, and especially natural resources. This institute does not have sufficient funds.
- The Basic Sciences Institute (ICB) offers degrees in chemical, physical, and natural sciences, as well as other fields of science.

p. The Binational Yacyretá Project, a binational Paraguayan-Argentine institution set up in 1973, directs hydroelectric projects, carrying out studies and projections, operating public works, and harnessing hydroelectric energy. It is also concerned with improving navigability of the Paraná River up to Yacyretá Island. This institution also aims to control the devastating effects of floods provoked by unusually high waters.

q. The Binational Itaipú Project, a binational Paraguayan-Brazilian institution, was set up in 1973 to study, direct, and implement hydroelectric works, operating them and utilizing the energy produced. Its specific objective is to harness the hydroelectric potential of the Paraná River, which runs along the border between both countries, from and including Guairá Falls up to the mouth of the Yguazú River.

r. The Catholic University has participated in environmental affairs through its School of Science and Technology, set up in 1981 to protect and increase awareness as to the importance of both the biological and man-made environment. It has organized the Center for Architectural and Environmental Resources (CRAA), which carries out the following activities: scientific research, publications, services to design and implement projects for public and private sector institutions, and training.

CRAA is part of the MAB Committee and includes separate departments for architecture, urban and land management policy, and policy regarding historic and cultural heritage. CRAA has insufficient financing.

s. The Lake Ypacaraí Basin Foundation (FUNDLAY), founded in 1984, aims to preserve, protect, conserve and improve the ecology of Lake Ypacaraí and its watershed; study and extend technical assistance for the preservation, protection, conservation and improvement of the lake and watershed; promote legal measures to preserve, protect, conserve and improve the Lake Ypacaraí watershed; promote the physical joining of the watershed with the Paraguay River, and through the Paraguay River, to the la Plata River basin; promote comprehensive development of the Lake Ypacaraí basin; participate in agreements and contracts to finance studies and other projects to benefit the basin; and study, promote and implement measures to increase the population of the basin's natural life.

FUNDLAY is a voluntary organization, the first of its kind in terms of entailing a voluntary commitment to prevent further degradation of a part of the Paraguayan environment. FUNDLAY attempts to coordinate the action of several public and private institutions. Its objectives are clear, though wide-ranging, and it needs a realistic plan with specific projects. Such projects, however, should be modest given the need to set priorities among the problems to be addressed. FUNDLAY needs a well-defined organizational structure with clearly defined roles and responsibilities, which would allocate resources. Despite these limitations, inherent to any new experience, this initiative merits recognition and support from both the public and private sectors.

t. The Paraguayan Society for the Protection of Nature (PRONATURA) is a voluntary institution whose objective is to disseminate through all means of communication the impor-

tance of nature and the environment. Its main activities include lectures, painting exhibits on the environment, newspaper articles, school trips, and camping outtings. PRONATURA works with FUNDLAY and MAB. Its limitations are largely due to its lack of funds.

u. International organizations' support for research, conservation, and reclamation programs has been in the form of technical assistance and financial aid for institutions implementing specific development programs.

Technical Assistance

The United Nations Development Program (UNDP) works with INTN, MAG, STP, MAB, and FUNDLAY, offering assistance to programs such as soil conservation, forest inventory, and energy studies.

The Organization of American States (OAS) works with the National Commission for the Comprehensive Development of the Chaco in the integrated study project for the Paraguayan Chaco, together with the Settler Protection Project in Coronel Oviedo and the rural-urban development project in the Province of Paraguarí.

The Inter-American Institute for Agricultural Sciences (IICA) works with the Ministry of Agriculture and Livestock (MAG) in soil studies, forest inventory, vegetable and animal sanitation, education, research, and marketing of agricultural goods.

The Japanese International Cooperation Agency (JICA) works with MAG in soil studies, forestry education, and technical and economic aid. JICA has a plan for developing the National Soil Map. It has distinguished engineers working in the Agricultural Mechanization Center, the Forest Development Center, and the Regional Center for Agricultural Research.

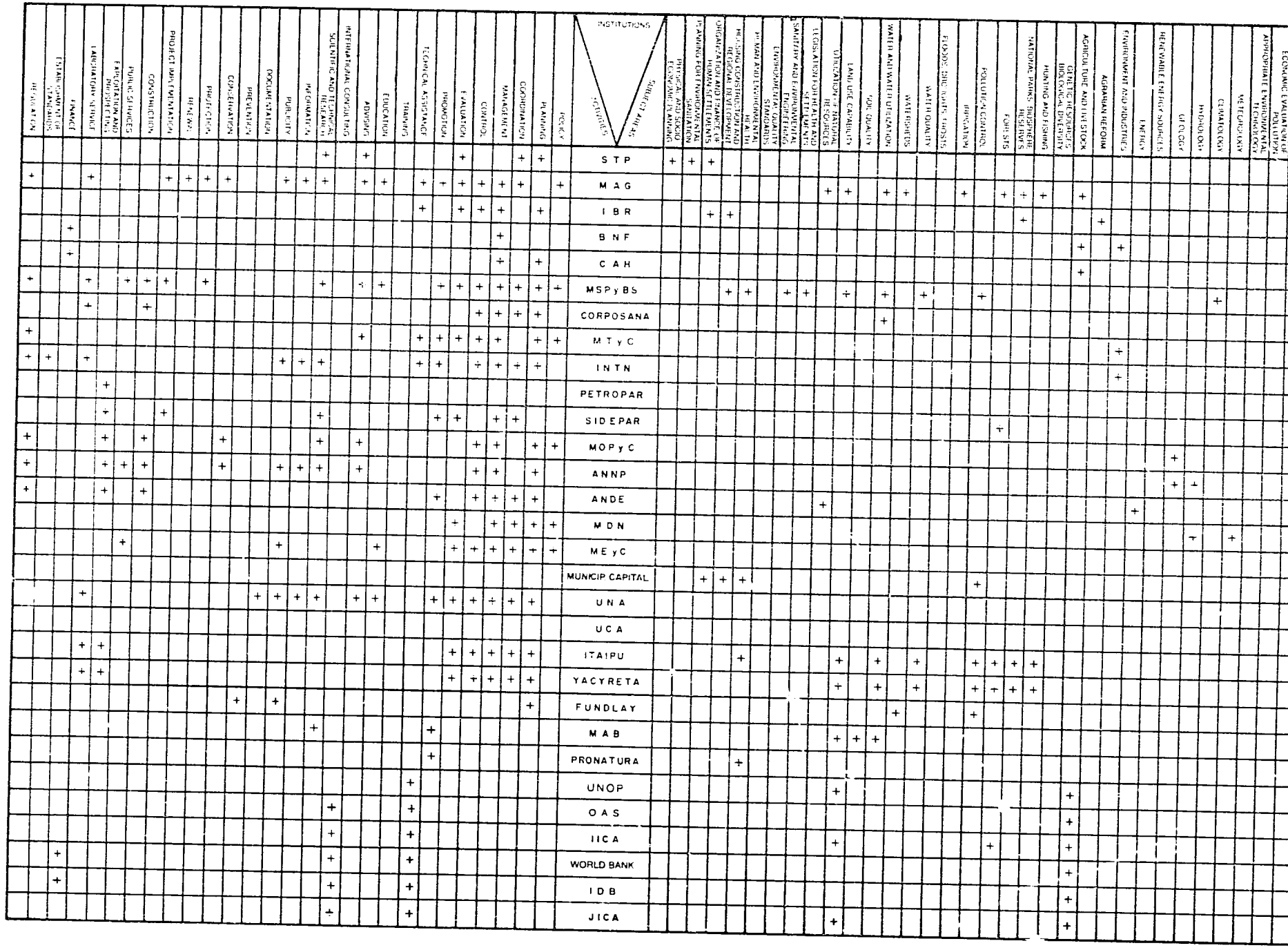
Financial Aid

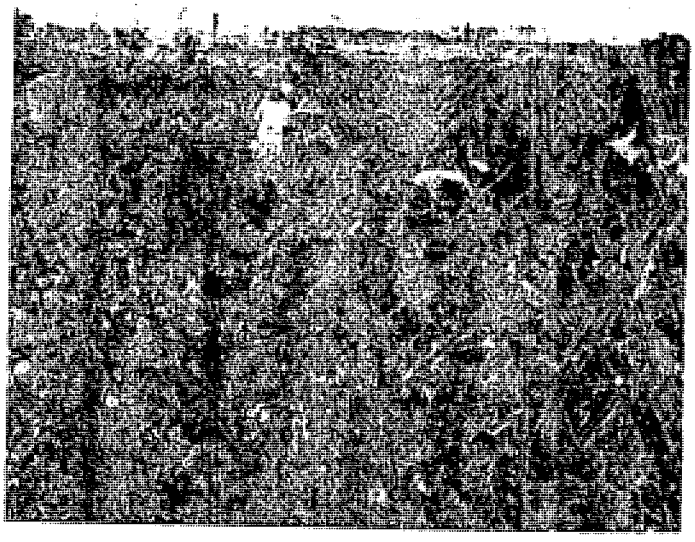
The World Bank is aiding MAG in financing comprehensive rural development projects such as Caazapá, Itapúa, and Caaguazú. It also works with SENASA on potable water supply projects in towns and settlements with under 2,000 inhabitants.

The Inter-American Development Bank aids, among others, MAG in financing comprehensive rural development projects such as the Eje Norte (North Axis), and projects in Alto Paraná, Canindeyú, and Paraguarí, as well as in studying potential multiple uses of the Paraguay river. Similarly, it aids a program to install remote sensors.

Table V-1

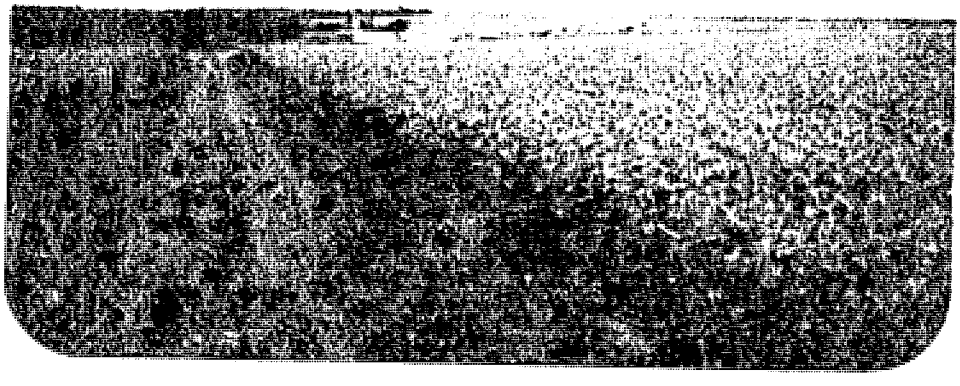
Institutional Activities and Subject Areas Related to the Environment



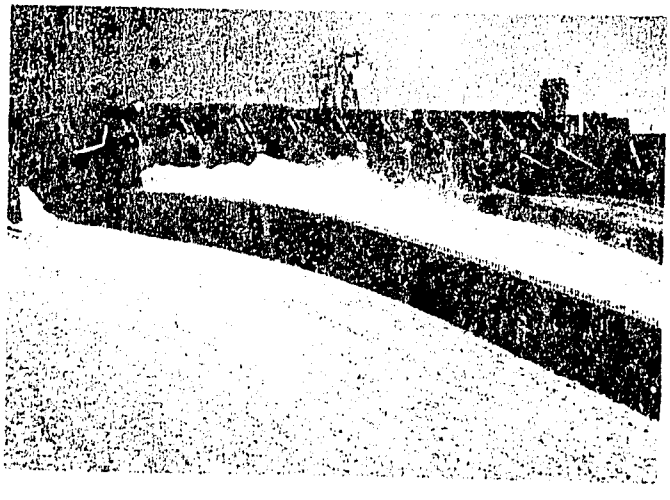


The Paraguayan Economy

Cotton Farming.



Mechanized cultivation of sunflowers, Alto Paraná. Photo courtesy Juan Buffa.



Cattle raising.

Itaipú hydroelectric plant. Photo courtesy Claude H. Bourgeois Photo Studio.

VI

The Paraguayan Economy

Economic Structure and Performance

In the 1960s the need to improve transportation and communications infrastructure became clear. The objective was to integrate the country geographically and economically. The sixties witnessed slight but steady growth which did not, in any event, bring about any structural change in the Paraguayan economy.

The primary sector is the basis of the economy, not only in terms of share of GDP, but also in terms of generating employment and foreign exchange. Industry also grew in the sixties, but not as much as had been hoped, considering the sizable investments made. Services nonetheless were quite dynamic, to the point of altering the structure of the gross domestic product, which made it possible to absorb a significant proportion of those who enter the labor force each year.

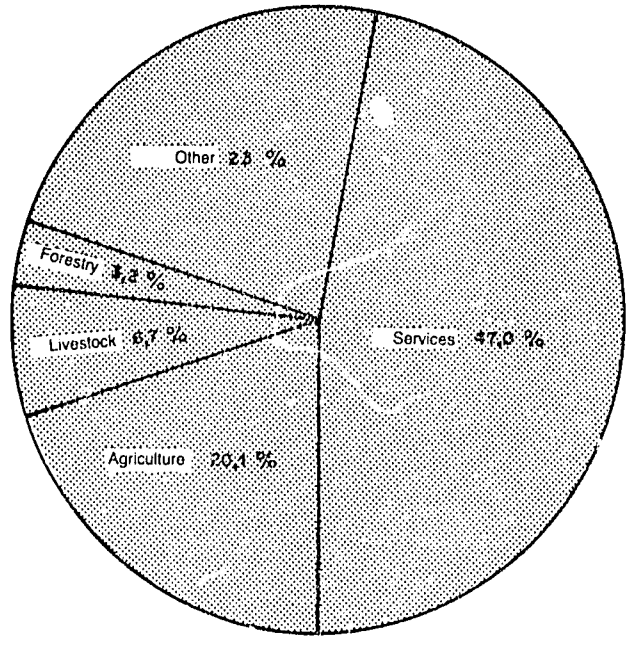
The public sector's share of the economy grew rapidly, this phenomenon being reflected in the steady growth of government spending, especially capital outlays. Indeed, government investment in the 1960s averaged 11.0%.

The balance of trade was negative, as fluctuating commodity prices kept export growth down, while capital goods imports, imposed by the development process, grew. The trade deficit was compensated for by net foreign indebtedness and, to a lesser degree, by direct foreign investment.

In effect, overall economic growth, taking 1977 GDP as the point of reference, gradually increased from 4.8% in 1970 to 12.8% in 1977. It stayed at about 11.0% for the rest of the seventies (table VI-1). The causes of this economic boom include, on the one hand, decisive government action to support infrastructure projects with a significant social and economic impact, and on the other hand, international demand for Paraguay's main agricultural exports.

Graph VI – 1

Structure of GDP by Sectors 1982



In the 1970s, production of goods continued to account for most of GDP, hovering around 54.0%. Agriculture and lumbering accounted for most of production, accounting for 30 to 35% of GDP. (Table VI-2). After the unprecedented growth of the seventies, the Paraguayan economy began to decline in late 1981, registering negative growth of GDP of −2.9% in 1982, and worsening to −3.7% in 1983.

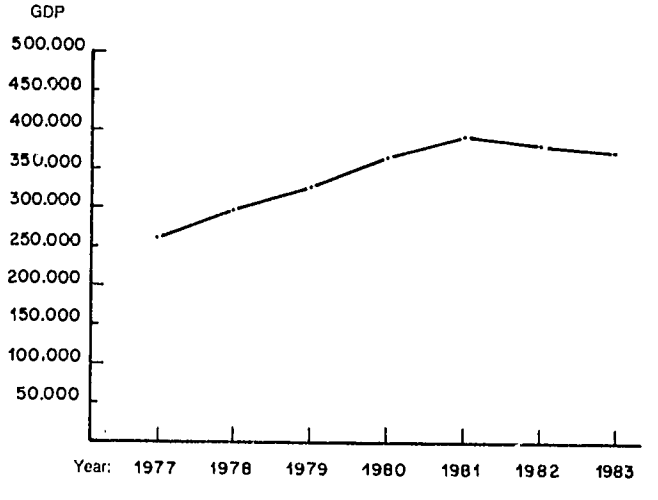
The hardest hit sectors were precisely those behind the dynamic growth of the seventies. Indeed, negative growth for 1982 and 1983 by sector was, respectively, as follows: agri-

culture, −4.4% and −6.4%; industry, −4.5% and −4.2%; construction, −6.0% and −5.4%; and commerce and finance, −2.2% and −4.9%. Basic services were the only sector to grow in those years.

Gross domestic capital formation had the greatest impact in spending, dropping from 29.8% to 20.5% between 1980 and 1983. Annual growth averaged −11.1%. This drop was the direct result of the decline of private sector activity. Employment suffered with the recession, with unemployment ascending to 11.0% in 1983. Inflation, meanwhile, dropped at first as a result of the decline in aggregate demand until, in 1983, the inflationary effects of exchange rate adjustments and the fall of the guaraní on the parallel market led to a 13.5% increase in prices.

Graph VI – 2

Gross Domestic Product (in millions of 1977 Guaranis)



This crisis resulted from both internal and external factors. Among the endogenous variables with a negative impact on economic development were:

1. Completion of significant projects, above all the Itaipú dam. This led to a considerable drop in demand for Paraguayan materials and labor, as well as a decline in direct capital revenues, increased unemployment and idle capacity in industry, and especially in construction.

2. The drop in primary sector production, which was caused on the one hand by falling prices to the producer for goods such as soybeans, cotton, beef, cooking oil, and tobacco and, on the other hand, by adverse natural factors such as extensive flooding in various parts of the country.

3. The steady overvaluation of the guaraní, which led to a drop in exports and greater imports.

The external factors contributing to the crisis included:

1. Deteriorating terms of trade, driven by the marked reduction in prices of export products as compared to the relatively stable prices of goods imported by Paraguay.

2. Continued, severe devaluations of the Argentine peso and later the Brazilian cruzeiro, provoking a precipitous decline in sales to both countries, and almost wiping out Argentine and Brazilian tourism to Paraguay.

3. The international recession, followed by protectionism and high interest rates in the industrialized countries.

Total exports for 1983, including sales to the binational entities, came to US$571.7 million, i.e. US$208.2 million less than 1982 exports. This contraction in exports of goods and services was due in large measure to the fact that the official exchange rate of the guaraní with respect to the dollar was very much below parity. This had a considerable impact on the competitiveness of agricultural and industrial goods on the international market, serving as a strong incentive to use irregular channels for foreign trade, especially smuggling across borders.

Imports, on the other hand, came to US$825.3 million in 1983, a decline of some 30% with respect to 1982. This decline was brought on in large measure by the drop in the demand for capital goods, as domestic economic activity contracted, and it became hard to obtain foreign exchange. As imports declined at a faster pace than exports in 1983, the balance of trade deficit, US$253.6 million, was 35.4% less than in 1982.

The increase in central government net capital revenues, over 100.0%, did not compensate for the drop in private capital revenues; thus the fiscal balance was once again unable to finance the balance of goods and services, forcing Paraguay to draw on $39.5 million in savings. As a result, by late 1983 net international monetary reserves had fallen to US$641.6 million, representing 9 months of imports.

At the same time, total foreign debt in 1983 increased by 22.1%, as compared to 26.9% for 1982; the debt rose from US$860.9 million in 1980 to US$1.4693 billion in 1983. Thus between 1980 and 1983 the debt grew at an annual average rate of 19.5%. In 1980 the ratio of debt to total GDP was 19.4%, and in 1983, 26.2%. This situation resulted primarily from the growing tendency on the part of the public sector to look abroad for loans, used mostly for financing capital expenditures.

Total supply and demand for 1983 fell to 428,477 million guaranís, slightly greater than 1979. Available goods and services and effective domestic demand dropped 0.4% between 1980 and 1983, from 368,626 million guaranís to 363,384 million guaranís. Per capita GDP and per capita income, in 1977 dollars, fell to US$843 and US$765 respectively in 1983. Behavior of all of the above variables clearly reflects the strong impact of the recent world recession on the Paraguayan economy.

Primary Sector

Agriculture, accounting for an average of 65.0% of primary sector production, and growing at an annual rate of more than 8.0%, has continued to be the most significant primary activity. Indeed, the Paraguayan economy continues to be predominantly agricultural.

Domestic factors behind sustained growth in agriculture included continued incorporation of better lands into agriculture; stepped up settlement in the context of the land reform program; planting of non-traditional crops with high interna-

tional demand, such as soybeans; and the increased production of agricultural goods for the domestic market, including corn, sugar cane, and garden vegetables. Internationally, greater demand and high prices for Paraguay's key exports contributed to sustained agricultural growth.

Livestock-raising grew rapidly between 1970 and 1975, reaching maximum growth rates (20.8%) and having a larger share than before in total production (9.5%). Circumstances changed markedly in the second half of the seventies as a result of losing the main consumer markets. Large meatpacking plants were shut down, contributing to unemployment.

Thus in recent years growth in livestock-raising has been largely due to domestic demand, bringing about a slight change in the make-up of gross value-added in livestock-raising. The main changes have been in poultry and hogs, and their by-products.

Forestry, despite its small but steady share of GDP (some 3.5%), grew with ups and downs; nonetheless, logging continued, reaching indiscriminate levels. This would seem to imply that log extraction is still not associated with significant industrial use of wood, and that uncontrolled marketing has continued. However, according to official figures, more than 60.0% of logging revenue is from activities geared to satisfy industrial demand, either in the form of logs or firewood.

Industry

Secondary sector production also played an important role in the 1970s economy, as it accounted for a steadily growing share of GDP, reaching 22% in 1979. Secondary sector growth reached a record 22% for 1976-1977. Cumulative annual growth in the sector for the 1970s was 10%.

Construction was the most dynamic activity in this sector. Growth in construction was based primarily on the rapid implementation of the Itaipú dam and, to a lesser extent, the Yacyretá project. Other construction in the public sector included highways, bridges, the international airport, rural electrification, and silos. These projects were in turn complemented by major private sector construction projects.

Industry's share of national product in the seventies averaged over 16%. Thus industry appears to have continued its upward trend begun in the sixties, which brought about a limited but significant change in Paraguay's economic structure. Mining, which contributes only 1.0% of the national product, also grew rapidly during the seventies, above all during the second half, achieving over 30.0% growth. Growth in mining was a response to growth in construction: almost all mining products are non-metallic materials used in construction.

Construction accounted for an average 17.2% of GNP for 1970-1976; this figure dropped to 16.5% for 1977-1983 in response to the decline in demand for products used at Itaipú, especially after 1980.

Manufacturing is made up of small and medium-sized businesses. Five areas of manufacture alone make up 70% of industrial production. Dynamism in manufacturing, which reached growth as high as 20.1%, was seriously dampened by the recent world economic crisis, and by the negative impact of foreign exchange policy. In 1982 manufacturing fell 4.5%, dropping off another 4.2% in 1983.

While manufacturing can play an important role in Paraguay's development, opportunities in industry are limited by the country's geographic situation, size of the domestic market, the small resource base, and the greater capacity of Paraguay's neighbors. Even electricity-intensive industries have an uncertain future as a result of the lack of mineral resources, the tremendous distances to international markets, and the need for advanced technology, huge investments, and skilled labor.

Thus, development of the manufacturing sector should, in the medium term, continue to be based on agroindustries and processing of raw materials, the final products of which could save Paraguay foreign exchange.

Services

Services accounted for more than 45.0% of total GDP, with 40% from non-basic services and the other five percent being electricity, water, and transportation services.

Electricity was more dynamic than the other basic services, reaching 26.0% growth. This is a significant indicator, for electricity plays a key role in economic growth. The dynamism in electricity is in part due to the various government electrification projects, which brought about a significant increase in per capita electricity consumption.

Trends in potable water and sewer services followed overall economic trends, increasing in function of government policy to provide such services to as many urban centers as possible so as to wipe out disease arising from poor environmental sanitation.

Transportation, communications, and storage had the greatest structural impact within basic services, making up over 3.5% of total GDP, and showing annual growth of 9.7%. This was largely due to the rapid increase in motor vehicle use, bridge and highway construction, and the increase in domestic and international telephone traffic.

Non-basic services also grew considerably, doubling in total value in the course of the decade and providing more employment. Non-basic services accounted for 30% of Paraguay's economically active population.

The most important sub-sector not only within services but for the economy as a whole, was commerce and finance, accounting for 25% of GDP.

Commerce and Finance

Commerce and finance carries the greatest relative weight in the Paraguayan economy, as its gross value added makes up about one quarter of GDP.

The dynamism of this sector during the 1970s was due to the significant increase in agricultural production, to which commerce and finance are closely tied; increased activity on the part of commercial banks and insurance companies; and the rise of finance companies and savings banks for housing. Financial activity linked to housing has been made possible by injections of capital from the hydroelectric works and export earnings.

With the world economic crisis, growth in commerce and finance was also negative. Growth for 1982 and 1983 was −2.2% and −4.9% respectively. The relative share of commerce and finance in the national economy, however, has held steady at just above 25%.

Primary Sector Production

The primary sector, agriculture and lumbering, was the single most important source of national income, exports, and employment. This sector accounted for 30 to 35% of GDP for 1972-1982. Primary sector exports accounted for 85.6% of all foreign exchange earned through exports, while 50% of employment is generated in agriculture and lumbering.

Crop production is the largest subsector, responsible for 66.8% of primary sector production.

Livestock production is the second largest subsector, accounting for 22.5% of total agricultural production in 1982. And lumbering contributed 11% of primary sector production the same year.

Crop Production

Of Paraguay's 51 crops, 26 are annual and 25 perennial. Crop production has expanded rapidly over the past 20 years, due above all to improvements in infrastructure, especially roadways. Settlement has also helped to expand the agricultural frontier rapidly.

Crop production has expanded at the expense of forest lands, especially in the eastern section of the Eastern region, and to a lesser extent in the northern part of the same region. To date few studies have been carried out to evaluate the extent of problems arising from lands being used for purposes other than those for which the land is best suited. There are some general studies, but none which quantifies the negative effects.

Main Crops

The most important crops are soybeans, cotton, tobacco, manioc, corn, sugar cane, rice, wheat, coffee, and beans. In 1982 these 10 crops accounted for 71% of crop production, almost 80% of cultivated lands, and 70% of export earnings.

Soybeans: Paraguay is a significant soybean producer in South America. In 1982 production totalled 750,000 metric tonnes. Soybeans generate more income than any other crop, and also take up more cultivated land. It is the second largest export earner. According to the 1981 agricultural census, some 30,000 workers were involved in soybean production.

Soybeans were first grown in Paraguay about 1921; but soybean production did not become widespread until the 1960s. Production has increased sharply since 1970 due to the boom in international demand and the accumulated experience of Paraguayan experts and producers. Soybean production, which grew 25% annually from 1975 to 1982, also benefitted from the Wheat Program, which facilitated mechanization of production.

Cotton: Cotton is a traditional cash crop, and has an important place in the Paraguayan economy. It is the country's leading export earner, second in crop production, and third in terms of cultivated surface area. Cotton is produced on small, family farms. According to the 1981 agricultural census, there are 137,938 cotton producers. Cotton is exported as fiber.

Cotton production increased considerably from 1975 to 1982. Whereas in the 1960s production varied between 30,000 and 40,000 tonnes, by 1981 production had skyrocketed to 317,000 tonnes.

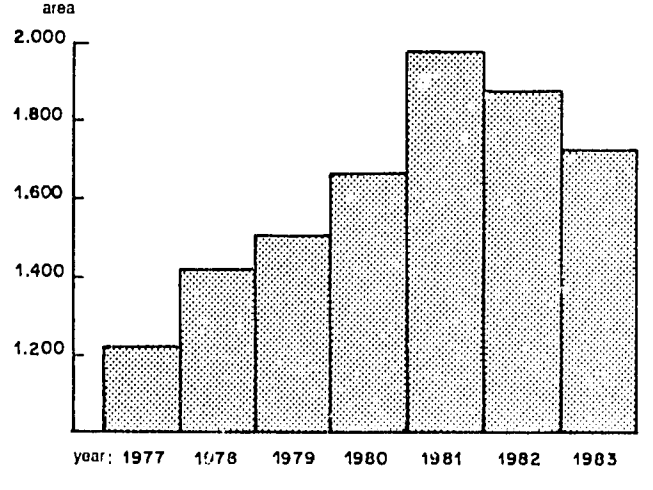
Cotton is processed by Paraguayan cotton gins, the by-products (lint, cottonseed cake, fibers) being sold on the international market. Most of the cottonseed is used to produce oil sold on the domestic market.

Tobacco: Tobacco is Paraguay's third largest export earner. It is 10th in total production, and 9th in terms of land under cultivation. There are some 12,533 tobacco producers. Almost all tasks involved in tobacco production, including preparation of the soil and weeding, are done with manual tools. As a result, the land has not been exposed to the degradation brought on by mechanization in other areas of production.

Tobacco production had its ups and downs between 1975 and 1982, dropping from 25,000 tonnes in 1975 to 18,000 tonnes in 1982. This decline was due to a change in international demand, with a greater preference for light tobacco instead of strong tobacco, light tobacco not being very common in Paraguay.

Graph VI – 3

Cultivated surface area (Thousands of ha)



Cotton: a crop that plays a major role in the national economy.

Manioc: Manioc is Paraguay's third crop measured by total production, and fourth in terms of land under cultivation. It is an important part of the rural diet. Manioc production rose slightly between 1975 and 1982, from 1,725,000 tonnes to 1,896,000 tonnes. Average annual growth was 1.3%.

Corn: Corn is the country's second most important crop in terms of land cultivated, and fourth in total production. Hardly any corn is exported, corn exports accounting for only 0.2% of export earnings in 1982. Like manioc, corn is a basic component of the rural diet. It is also used to feed smaller livestock and sometimes cattle. According to the 1981 agricultural census, there are 155,632 corn producers. Corn production increased an average of 6.3% annually for 1975-1982. Corn makes up more than 60% of total cereal grain supplies, which also include wheat and rice.

Sugar cane: Sugar cane was introduced in Paraguay in the 16th century; since then cane production has extended throughout the country. Currently it is a source of income in the vicinity of sugar mills and liquor distilleries. It is also a significant product around the alcohol distillery in Mauricio J. Troche, which has the capacity to produce 120,000 liters/day of fuel alcohol. Sugar cane is the fourth export crop, fifth in terms of total production, and seventh in terms of cultivated land. Sugar cane is produced mainly on small plots; according to the 1981 agricultural census, there are 39,262 cane producers.

Sugar cane is used to manufacture alcohol, sugar, molasses, liquor, and as forage. As production figures are for sugar cane as a whole, it is difficult to break down the figures by use. Sugar cane production increased from 1,200,000 tonnes in 1975 to 2,333,000 tonnes in 1982, for an average annual increase of 10%.

Rice: Rice production in Paraguay is primarily for domestic consumption, with only small amounts being exported in certain years. According to the 1981 agricultural census, almost 63% of rice production is on non-irrigated lands (upland rice); the rest is irrigated rice. Rice is the eighth largest crop from the standpoint of land under cultivation, and seventh in total production. In 1981 some 14,000 producers cultivated rice.

Sugar cane is used to manufacture alcohol, sugar and molasses. It is also used for forage.

Rice production increased from 50,000 tonnes in 1975 to 65,000 in 1982, for 4% annual average growth. This increase was primarily non-irrigated rice production in new settlement areas.

Wheat: Wheat is important for Paraguay, as it is the only agricultural product that Paraguay imports in large quantities. Besides it is a winter crop, and during the winter, crop production in general is significantly down. In 1982 domestic demand for wheat surpassed 100,000 tonnes. Sixty-five percent was met by domestic production; the rest was imported. Government policy is to gradually substitute Paraguayan-produced wheat for imported wheat. The National Wheat Program, set up in 1967, works to this end.

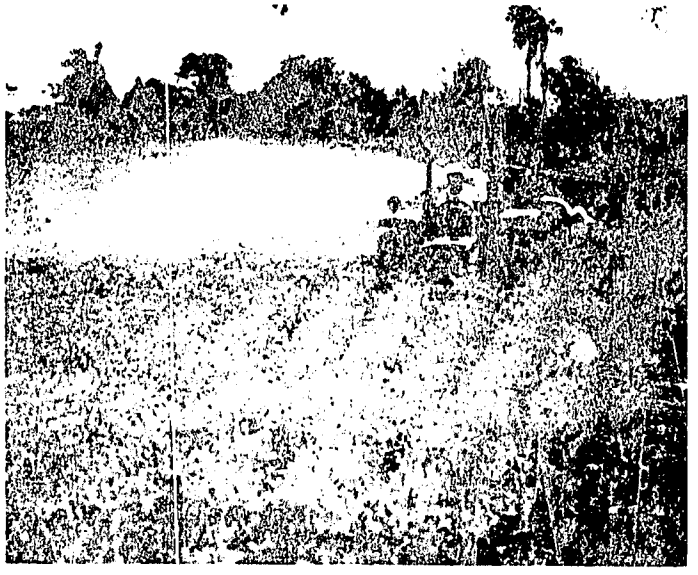
Wheat production jumped from 13,000 tonnes in 1975 to 70,000 in 1982, an average annual increase of 27.2%. Credit extended by the National Development Bank is a key factor behind extension of lands for wheat production.

Coffee: Coffee production was developed in Paraguay during the 1960s. Coffee exports have been on the decline, and made up only 0.1% of exports for 1982. Coffee is important as a source of employment, as there is a year-round demand for labor, which increases during the harvest months from May through October.

In contrast to most other crops, coffee production declined between 1975 and 1982, from 10,000 tonnes to 8,000 tonnes, after experiencing significant fluctuations. This performance appears to be associated with international price fluctuations.

Beans: Bean production in Paraguay is primarily for domestic consumption. Like corn and manoc, beans are a basic com-

The National Wheat Program has operated since 1967.



Treating soybeans with insecticide.

ponent of the diet of most Paraguayans. Beans are the fifth crop in land under cultivation, and sixth in terms of total production. The 1981 agricultural census showed 85,000 bean producers.

Bean production fluctuated markedly from one year to the next between 1975 and 1982. Nevertheless, in 1975 production was 60,000 tonnes, and in 1982, 61,000 tonnes. Growth for 1975-1982 was thus relatively insignificant, especially considering the dynamism of other crops.

Production Technology

Technology for crop production has changed slowly. The main innovations have been incorporation of modern machinery, fertilizers, and pesticides.

Machinery and Equipment

Crops such as wheat, soybeans, and rice are cultivated by mechanized agriculture. Most other crops are grown on small farms which could not economically justify greater mechanization. Tobacco is cultivated almost exclusively by hand, as it is usually grown on lands that have been cleared but from which tree stumps have not been removed. In 1956 there was one tractor for every 312 farms, whereas in 1981 there was one for every 41 farms.

Use of Inputs

Seed: Most improved seed use is in cotton, soybeans, wheat, tobacco, and garden vegetables. There is no reliable data on trends in use of improved seed, as a large quantity that enters Paraguay bypasses customs. The seeds used are generally not certified, with the exception of cotton seed. Other seeds are chosen by the producer himself, with the problems this implies.

Fertilizers and Pesticides: Despite their economic importance, use of fertilizers is extremely low. This is due in part to their high cost. Increased yield of most products has been due not to use of chemical products but to incorporation of better lands.

Fertilizer use remained steady between 1977 and 1981. In 1977 fertilizer use was 4.07 kg/ha; in 1981 13,000 tonnes were imported. At minimal recommended use levels for crops such as corn, rice, and soybeans, this would have covered 65,000 ha, i.e. approximately 3% of seasonal croplands.

It is felt that yields could be greatly improved by greater use of modern inputs; yet the high and constantly rising costs of fertilizers limit further use.

Other significant inputs, such as insecticides and fungicides, are used in different crops to varying degrees. The percentage of areas to which inputs are applied is as follows:

Crop	% of Area Treated
Cotton	100
Soybeans	100
Tomatoes	100
Wheat	100
Rice	25
Tobacco	40

The above estimates indicate widespread use of insecticides, even on small farms.

Livestock Production

Livestock raising is the second most important primary sector activity. Production could be rapidly increased and improved in the medium term if administration and technology is complemented by relative use of capital and an assured market for industrially-processed goods.

Between 1972 and 1982, livestock production increased at an average annual rate of 4.4%.

Production

Cattle: According to the 1981 agricultural census, there are 6,341,200 head of cattle in Paraguay, 62% of which are in the Eastern region, and 38% in the Western region. There were 167,546 cattle ranches, with an average of 38 head of cattle

In 1981, 62% of Paraguay's cattle were located in the Eastern region and 38% in the Western region.

per ranch. Most of the breeding and over-wintering cattle are found in the provinces of San Pedro, Concepción, and Paraguarí; 7% are in Ñeembucú, and 6% in Misiones. Overall, there were two head of cattle per person in Paraguay, and 16 head of cattle per km². Total 1972 production reached 9,158,800,000 guaranís, dropping off to 7,649,200,000 in 1976 and 7,197,100,000 in 1982. Cattle production accounted for 23.6% of total livestock production in 1982. The total value of cattle production dropped 2.3% between 1972 and 1982.

Most of the cattle is of the creole variety, a descendent of cattle introduced by the Spaniards and adapted to the milieu over time. Breeds of British origin (Hereford, Shorthorn, Aberdeen-Angus) have been introduced to upgrade the creole stock. Over time the product of the breeding process has proven to not be adaptable to the natural milieu; producivity, however, increases initially.

Current zootechnical improvements are based on incorporating the Zebu, whose genetic makeup has advantages over other crosses. It also has drawbacks, however, as there is a loss of fertility and aggressivity.

Holsteins are most widely used for improving milk herds, and can be adapted so long as they are properly handled. The Brown Swiss, more rustic and suitable for milk production, is expected to yield positive results.

Hogs: Hogs are second to cattle as a source of red meat. The 1981 Agricultural Census reported 984,902 hogs in Paraguay. This stock can be increased and used increasingly for meat; today hogs are used mainly for producing lard. Hog production came to 3,726,100,000 guaranís in 1972, rising slightly to 4,700,200,000 guaranís in 1976, and reaching 7,863,000,000 in 1982.

Hogs accounted for 25.1% of total livestock production in 1982; hog production grew at an average annual rate of 7.7% between 1972 and 1982.

Poultry: Poultry production has increased and improved considerably. In recent years egg and chicken consumption has been on the rise. The 1981 agricultural census reported 11,115,228 poultry.

The total value of poultry production rose from 537.8 million guaranís in 1972 to 667.4 milion in 1982. In 1982 poultry accounted for 3.3% of total livestock production, with an annual growth rate of 6.7% between 1972 and 1982.

Sheep: Some 358,900 sheep are raised on large and small farms. Total value of sheep production skyrocketed from 14.4 million guaranís in 1972 to 181.6 million in 1976, and 228.4 million in 1982, accounting for 0.7% of total livestock production in 1982. Average annual growth between 1972 and 1982 was 4.9%.

Goats: The 1981 census determined that there were 107,751 goats in Paraguay, with total value of goat production rising from 24.4 million guaranís in 1972 to 32.9 million in 1976 and soaring to 92.3 million in 1982. In 1982 goat production accounted for 0.3% of total livestock production. Average annual growth for 1972-1982 was 14.2%.

Equines: There were 310,593 equines according to the census, with average annual growth at -21.5% between 1972 and 1982. Total value of production of equines declined from 110.0 million guaranís in 1972 to 38.4 million in 1976 and 9.7 million in 1982.

Area Occupied by Livestock Raising

The 1979 agricultural survey indicated that 17.29 million hectares—i.e. 43% of Paraguay's total area--were used for pasturing. These figures have been slightly modified by the 1981 agricultural census. (See Grasslands, Chapter VIII).

Types of Farms and Ranches

The types of farms and ranches engaged in livestock production vary greatly from one area to the next. In general, however, the following types of farms prevail:

1) Mixed farming, which is the most common. All production is carried out on such a farm, including breeding, feeding, and winter pasturing. This form of production usually involves inadequate use of available resources, as it is geared mostly to winter pasturing, and neglects breeding, thereby affecting calves and replacement animals adversely.

2) Winter pasturing. This type of farming requires improved infrastructure, which allows for more weight gain per hectare. This leads to good finishing, so the animals can be marketed immediately.

Production Systems

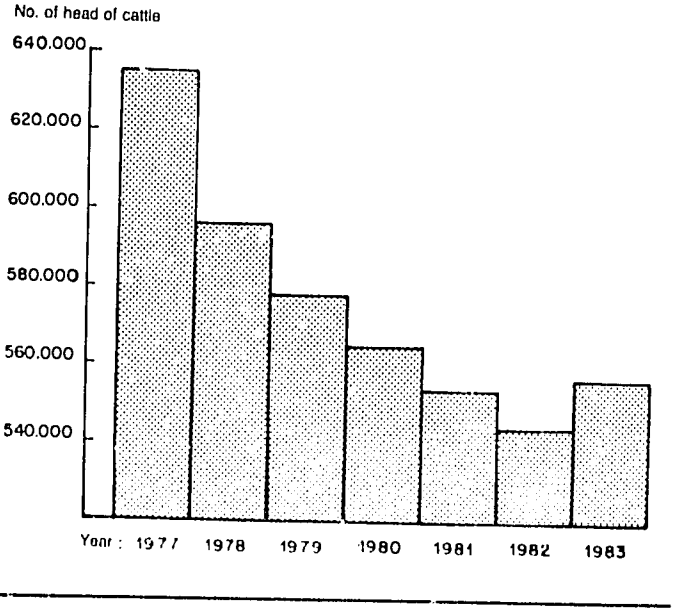
The basic systems of production for cattle are:

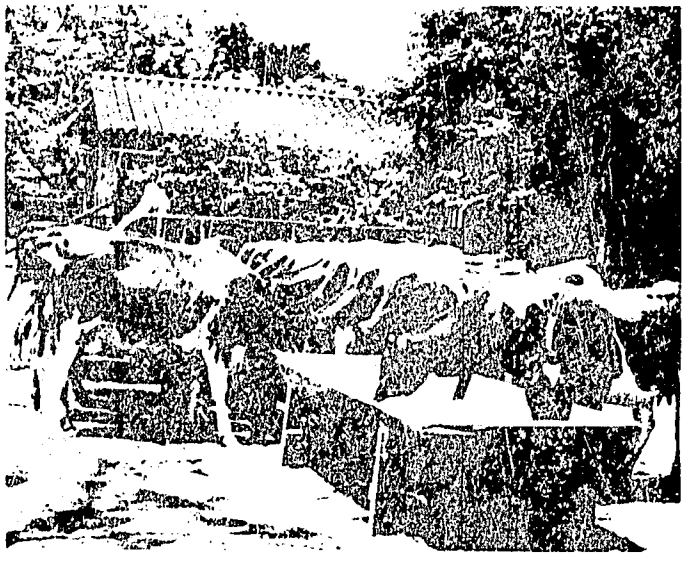
1) *Extensive*, characterized by extensive pastures using natural grasslands and watering places. Top-quality, large, natural pastures are hard to find. In such conditions effective management is impossible, and there is a negative impact on the efficiency and capitalization of such farms.

2) *Semi-intensive*: Preparation of grazing lands, distribution of watering holes, and cultivation of annual and perennial forages all make for better use of resources, and application of effective technologies. This is particularly common among ranchers involved in winter pasturing who have relatively large cultivated pastures, where land values are higher.

Graph VI – 4

Cattle Slaughtered Volume





Dairy operation

3) *Intensive*, which in turn breaks down into: a) over-wintering, on cultivated pastures, which is expanding with the dynamism characteristic of the entrepreneurial spirit; and b) finishing in the feed lot, with application of improved techniques and complementary feeding with cereal grains, industrial by-products, and other items. There are only a few cattle-raisers using this method.

Productivity of Livestock Production

Most of Paraguay's lands are used for grazing. Considerable improvement of current production levels could well lead to doubling of total quantity of livestock.

Given current conditions—particularly limitations regarding feeding, handling, health, selective breeding, infrastructure, credit, research, and technical assistance—efficiency of livestock production is still minimal. Over time, however, Paraguayan livestock production may undergo technological changes which would have an impact on productivity.

Beef Cattle: Branding rates are barely 45%, while weight at weaning is 120 kg. Mortality of calves (from birth to branding age) is between 6 and 10%. There are 5% orphans, while 3% of the stock are cows over 10 years old.

Finishing time is 44 months, i.e. 3 to 4 years. Finished steers weigh about 380 kg, and old cows weigh about 360 kg. Daily weight gains are 220 g per animal per day.

Grazing density is 3.5 head per ha, obtained by dividing total cattle stock by total area occupied by livestock raising, and culling is about 15%.

Dairy Cattle: The 1981 agricultural census figures indicated that only 62% of all dairy cows are milked; milking productivity was barely 2 liters per animal per day. The Census, however, was carried out in September, when little milk is produced.

Hogs: For 1962-1973, yields were 70.3% meat and lard from slaughtered hogs with average live weight of 82.5 kg, which was reached at 18 to 24 months.

In 1983 the technical cabinet of the Ministry of Agriculture and Livestock estimated that a live 110 kg hog would yield 68 kg of meat (62.7%), and 20 kg of lard (28.9%). The head, weighing 5 kg, accounted for 3.2% of total weight; the entrails 2.6%; and the rind, weighing 4 kg, 2.6%.

Poultry: Average yield was 60-70%, i.e. 1.25 kg of clean meat for each animal slaughtered, with total weight of 1.8 kg. Egg production has been estimated at a daily laying rate of 65%. Thus, an effectively exploited laying hen can produce 240 eggs per year. Nonetheless, actual productivity per hen in 1979 was estimated at 123 eggs, calculated from relating total egg production to the number of hens, based on the BCP's Department of Economic Studies.

Actual breeding was estimated to be 53%—in marked contrast to breeding animals managed under commercial standards which, following recommended techniques, approach 100% productivity. The slaughter rate, according to the 1981 census, was 26.8%.

According to this census, mortality was 23.8%. This figure, however, appears to be exaggerated, as commercial poultry operations place the figure around 10%, and even less for roasters.

Industrial Processing of Beef

Destination of slaughtered cattle: Beef cattle have two final destinations: domestic consumption, and export. Over time the quantity of cattle for domestic consumption has increased slightly, whereas the number of cattle processed by the meatpacking plants for export has plummetted, due primarily to the world recession affecting beef-importing countries. The percentage of beef cattle used for domestic consumption has risen from 77% in 1975 to 96% in 1982. Since 1975 the percentage of cattle slaughtered for processing and export has declined from 23% to 4%.

Meatpacking plants: In recent years Paraguay's meatpacking plants have introduced significant changes so as to come into line with the hygienic norms demanded by beef-consuming countries.

Seven plants that slaughter cattle are located in and around Asunción. The largest can slaughter 720 head of cattle daily; the smallest slaughters only 320 a day. Total daily slaughtering capacity is 3,400 head of cattle.

Total freezing and storage capacity is 4,000 tonnes for all the meatpacking plants together; thus larger stocks can be absorbed in the medium term, without posing any problems to the industry as it now stands.

Types of production: The usual slaughter period is from January to June, varying depending on the number of available animals and the assigned quota, which is currently about 200,000 head, with a significant potential to bring in valuable foreign exchange. The product is canned (corned beef, roast beef, chopped beef, tongue, meat extract, concentrated broth from bones, and cubed beef, among others). Frozen meats include frozen products and by-products, such as boned beef, frozen beef with the bone, and, as by-products, cattle entrails. All have been well-received in several European and American markets.

Export of Animal Products

Total 1975 exports of animal products came to US$34.7 million (FOB) in absolute terms; in 1982 this figure fell to

US$8.9 million (FOB). The share of animal products in total exports gradually fell from 19.6% in 1975 to 2.7% in 1982.

Forest Production

Primary Extraction

Primary extraction logging yields logs, railroad ties, posts, firewood, and palms, not including planks and other sawmill products. Following is a brief description of the main products, logs and firewood.

Logs: Logs of native woody species have been extracted continously and increasingly since the colonial period for industry, agriculture, and tannin. In 1983 the value of log production was slightly higher than that of firewood. Logs accounted for 47% of total timbering.

Most logs go to the sawmills first, and are then exported as beams, planks, boards, and other items. They are purchased on the international market for use in carpentry, furniture making, construction, and other trades.

In agriculture logs are used for rudimentary construction; usually they are not transported far from the forests in which they are cut. Quebracho logs, cut in the Chaco and used for tannin, are the only raw material for Paraguay's tannin industry. To date all logs have come from naturally occurring forests and are thus of native species.

The relative abundance of forests, covering 45% of all Paraguay, obscures the fact that they are not evenly distributed. It also obscures the high rate of deforestation. This has led to a distorted view of the capacity of forests to provide for socio-economic needs in the medium and long term. Also, no effective economic incentives for reforestation have been created.

What needs to be asked is: How long can Paraguay continue to use these products without having to recur to reforestation?

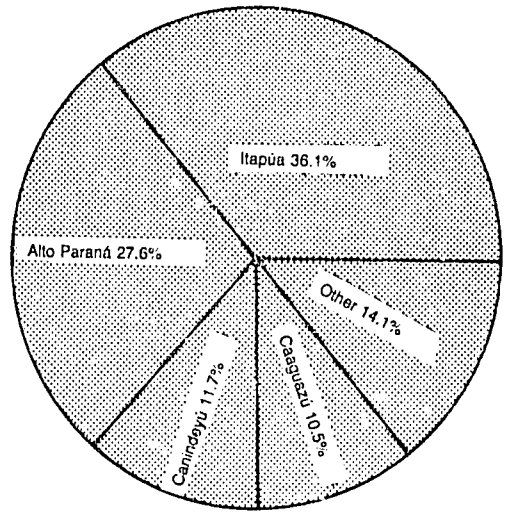
Firewood (Charcoal): Forests are distributed very unevenly in Paraguay. In some areas deforestation represents a growing problem. Regional imbalances reach alarming proportions, to the point that some consumers must transport firewood over ever increasing distances, with greater transportation costs, as most of the lands in their areas have been deforested. Deforestation continues unabated, above all because of the expansion of the agricultural frontier, threatening a reduction in supplies to the wood-processing industries, and threatening as well the supply of energy from firewood.

Per capita firewood consumption in Paraguay is very high, reaching approximately one ton annually. This is 2 to 3 times greater than for any other South American country. Industrial consumption is on the order of 500,000 TOE, which is second for Latin America. Some 52% of total demand is for industrial use, and 38% for domestic use. The 18% increase in domestic firewood consumption in the period at hand is disproportionate given the almost non-existent reforestation, and the very high rate of deforestation, which is reaching 150,000 to 200,000 ha per year.

Per capita consumption of charcoal in Paraguay is not at present a serious problem. It comes to 19 kg per person per year, well below that of any other South American country. Total demand comes to some 58,000 tonnes annually, equivalent to deforestation of roughly 2,300 ha of forest land.

Graph VI – 5

Area Deforested, 1975–1979



Province	ha
Itapúa	200,000
Alto Paraná	152,500
Canindeyú	65,000
Caaguazú	58,100
Other	77,800
TOTAL	533,400

Charcoal prices increased some 23% between 1980 and 1982. This increase is probably due to fuel price hikes, as transportation is the most significant component of the price. Charcoal has taken on extraordinary importance for the economy with the construction of ACEPAR (Aceros del Paraguay, S.A.), the steelworks that will produce some 150,000 tonnes annually of finished steel products; its blast furnaces will run on charcoal.

It is estimated that the plant will initially use 60,000 tonnes of charcoal yearly. This is equivalent to total current, national demand. When it reaches full capacity, it will consume 130,000 tonnes annually. These figures reflect the alarming impact that ACEPAR will have on the firewood and charcoal market in Paraguay. Deforestation due to firewood consumption is at present low, amounting to some 20,000 ha yearly. This situation will change radically once ACEPAR is set up, for in addition to the 20,000 ha that will continue to be in demand, another 12,000 ha yearly will have to be deforested to meet the 60,000 ton charcoal demand. ACEPAR is carrying out a study on alternative means of attaining charcoal.

Forest Industry

Lumbering has traditionaly been one of Paraguay's most important industries. A recent survey revealed that in the provinces of Alto Paraná and Itapúa alone there are 369 lumber plants, including sawmills, plywood plants, tongue-and-groove mills, wood floor tile manufacturers, and tool handle factories, with a range of capacities.

In Alto Paraná, 61% of the mills have an installed capacity of more than 6,000 bd.ft./day, a figure matched by only 33%

of the mills in Itapúa. The proportion of industrial GDP accounted for by lumbering has varied from 6.9% in 1974 to 6.4% in 1983. These figures come to 1.2% and 1.0% respectively of total GDP for 1974 and 1983. As these figures are relative, they are not indicative of stagnation. Indeed, as was mentioned above, the agriculture-livestock-forestry sector grew considerably during the 1970s, and lumbering must have evolved in a similar fashion in order to maintain its relative share in the economy.

The significant increase in the relative share of lumbering in 1979 and 1980 was due above all to the construction boom that resulted from foreign exchange revenues from Itaipú, and from the reactivation of trade with Argentina and Brazil. Annual average growth of wood derivatives (22%) is twice that for all sub-sectors (10.4%) for 1976-1981. Wood derivatives also have an important place in industry, with 13.4% in 1981. Lumbering projects that benefitted from Law 550/75 grew up to 1981, declining in 1982, and diminishing to practically nothing in 1983.

Employment

There is no data on the degree to which lumbering has absorbed labor. The 1972 census, however, indicated that 4,050 persons of the total economically active population were employed in lumbering.

Exports and Imports

Exports: Traditionally logs, and later lumber from the sawmills, have been exported. The enactment of Executive Decree 24,489 (1972) prohibited export of logs. Unfortunately, however, this law has only been partially enforced, as illicit export of logs continues, especially in the northeast.

Export of forest products has been quite irregular, with annual figures varying from a low of US$12.5 million (FOB) in 1976 to US$67.2 million in 1980. Relative participation of forest exports in total exports and agricultural exports is practically identical, as agricultural and forest products account for 96% of total exports. During 1981-1983 forest exports as a percentage of total exports fell off sharply. This was due above all to the strong growth of certain agricultural exports, especially soybeans and cotton. Nonetheless, these products, while registering greater relative values, also fell off in absolute terms during the same period.

Export of wild animal skins is prohibited; but, as is the case of logs, their export continues illicitly. There is a sharp difference between data on forest exports to Brazil as listed in the Paraguayan Central Bank's Statistical Bulletin and according to the import registry of the Brazilian Ministry of Treasury. The difference is on the order of 40% for 1979, 1980, and 1981, indicative of active illicit trade and the consequent loss of foreign exchange earnings for Paraguay.

Imports: Paraguay imports paper, cardboard and cardboard products, and on a smaller scale, wood and manufactured products. Imports of paper and cardboard products dropped off 90% in 1983 in relation to the previous year; this situation resulted primarily from unrecorded trade of such products, which benefitted from comparative advantages in foreign exchange.

Export markets: According to the 1975 industrial census, some 62% of processed woods were exported, and 38% sold on the domestic market. The partial industrial census of 1980 did not show any significant changes with respect to 1975: 54% of wood production was exported, and 46% marketed domestically.

Argentina, Brazil, and Uruguay purchase 90% of Paraguay's exports. Argentina alone accounts for about 80% of the market. This explains the decline in production and export of Paraguayan forest products in 1976, as Argentina suffered a deep recession that year.

Energy

Overview of Energy in Paraguay

Energy in all its forms has come to play a key role in the life of the Paraguayan nation, no less important than that of nutrition, housing, education, and health.

Energy has come to the fore in the wake of oil price hikes. Of particular importance in Paraguay have been the construction of the Itaipú hydroelectric dam, and the use of alcohol powered vehicles. Itaipú is expected to contribute significantly to improving Paraguay's balance of payments situation, while alcohol powered vehicles raise the possibility of substituting locally produced energy sources for oil.

Hydroelectricity will be able to meet a greater demand in the medium and long term insofar as capital costs fall, yields increase, and a national electrification plan takes off. Ethanol will continue to grow in importance if accompanied by a well-coordinated and timely sectoral development plan, and if crude oil and oil derivative prices, today in a long-term slump, turn upward once again.

Modern human comfort is closely linked to, and largely dependent on energy, whatever its source; economic and social activity can even be gauged by the degree of energy dependency.

Current Energy Supply

Biomass, oil derivatives, and electricity are the main forms of energy in Paraguay. These forms of energy are important owing to their availability and ease of transport (See tables VI-11 and VI-12.)

Primary sources of energy are the most important, coming to 1,323,200 TOE in 1982, accounting for 82.4% of domestic supply. Fuelwood far outstrips other energy sources, with 1,087,100 TOE and 67.7% of the total for Paraguay, followed by hydroelectricity, with 157,300 TOE and 9.8% of the total.

Energy Consumption

In 1982 Paraguay consumed 1.7 million TOE (see tables VI-13 and VI-14). Per capita consumption was 560 KgOE (kilograms of oil equivalent), as compared to the world average of 1,500 KgOE, and the Latin American average of 1,000 KgOE. Sixty-six percent of this demand was met with biomass, 21% with oil derivatives, and 13% with electricity.

Primary energy sources account for 63% of national consumption; fuelwood alone accounts for 58%. Secondary en-

ergy sources, though accounting for only 37%, are nonetheless much more dynamic, with elasticity rising from 0.6 for 1972-1977 to 1.9 for 1977-1982. Elasticity for primary sources fell from 1.2 to 0.6 for the same periods. Several factors contributed to this performance, including: a) the rapid growth of oil derivatives, first, followed by electricity, and finally, alcohol; and, b) the possible statistic value of calculation, used for fuelwood and charcoal, which should be revised or increased per sample in order to improve adjustments and obtain better data.

Table VI-15, energy consumption by sector, indicates that industry, with 47% of total demand, is the most significant sector, followed by residences, with 35%. Transportation is also noteworthy for its dynamism.

As is illustrated in table VI-15, transportation tripled its growth between the two periods studied, in contrast to the drop in growth rates of the other sectors. Transportation, however, relies most heavily on imported energy.

Principal National Resources

Paraguay abounds in hydroelectric potential and biomass. Fuelwood is currently the most important energy source in terms of both production and consumption. But possible future trends are indicated by prospects for exploiting hydric resources, in the medium term, and naturally occurring renewable resources, which pollute less than conventional commercial energy sources. Bagasse, sawdust, coconut shells and tung seeds, and other industrial by-products, will continue to be used to the extent allowed for by their opportunity costs, and to the extent sugar, alcohol, cooking oil, and other markets continue to generate demand.

No commercially exploitable oil reserves have been detected in Paraguay to date; but natural gas reserves, which according to recent data may be able to produce 5 million m^3/day, have been discovered.

Alcohol and charcoal, both from the agriculture and lumbering sector, are similar as concerns their potential development, but along different lines, and in connection with different projects.

Agricultural producers are familiar with traditional sugarcane production methods. But charcoal production depends on the country's forest resources, which have been poorly exploited, and are ever more scarce and costly, showing no signs of reforestation, despite the plans to use charcoal at the new steelworks.

In the medium term, once the binational entities Itaipú and Yacyretá begin commercial production, Paraguay will be able to dispose as it chooses, in accordance with the respective treaties, of 50 billion kilowatt hours of electricity annually. This is equivalent to 800,000 barrels of oil daily (1 Mwh = 0.290 OE; 1 Mwh = 1,000 Kwh; WEC adjustment factor = 2.6; density = 0.8 Kg/l; 1 barrel = 159 l). Then Paraguay will have more per capita electric energy reserves than most countries.

Current Situation

Paraguay's orographic, hydrographic, and climatic conditions, plus the fact that it is landlocked, are among the factors shaping supply and demand of various energy sources.

Fuelwood and Charcoal

The abundance of virgin forests, and stepped-up clearing of lands for agriculture, lumbering and related activities, all allow for energy to be tapped.

But stepped up clearing in areas distant from potential fuelwood consumers does not allow for use of timber for fuelwood; also, as it is costly to extract and transport, fuelwood is burned in situ, with consequent losses to the Paraguayan economy, which is always ready to consume any type of cheap energy. Some farmers produce charcoal from the timber they have cleared, but only to a minimal degree. There is not enough awareness and knowledge to rationally exploit this resource. Use of fuelwood and charcoal in traditional rural kitchens and ovens leads to significant heat loss.

When ACEPAR produces 150,000 tonnes of steel annually, it will consume 6,000 ha annually of natural forests. If these forests are not reforested with suitable species, the environment will suffer permanent and irreversible damage.

The possibility of selling charcoal to the ACEPAR plant has aroused the expectations of farmers and industrialists. The huge quantities ACEPAR is expected to consume, on the production side, will generate changes in lifestyle, employment, transportion and services connected to the plant, land and river communication, health, agricultural income, industrial development, education, migration, and training at all levels. With the increased importance of charcoal as an energy source, biomass resources will continue to play a central role; this is compatible with national development objectives and specific recommendations regarding energy substitution.

The charcoal production program, above all if the plant's needs can be met efficiently and on time, may be one of the programs with the greatest social impact in the short and medium term.

Underdevelopment in many sectors, such as lack of technology in business and the public sector, which have shown neither flexibility nor foresight to date, could bring about serious problems for ACEPAR. If it decides to import to meet some of its energy needs, it would set back the objectives and basic goals of the energy sector, spending foreign exchange for yet another item, and drawing away scarce national resources. The charcoal program deserves special attention immediately.

Oil Derivatives

Almost all energy from oil derivatives is imported. It is increasingly expensive for local consumers, partly because of high Paraguayan taxes, and absorbs more foreign exchange every year.

Local supply comes from refining of light crude (50%) and imports of oil derivatives (the other 50%). At present, it is more economical to import all the oil, given high production costs at the Villa Elisa refinery. High processing costs, obsolete technology and old machinery, as well as the small installed capacity (it can process 7,500 barrels daily), render the plant uneconomical. It continues to operate, however, due to strategic and social considerations.

The greatest demand is for gas oil, which is supplied at subsidized prices. This subsidy has led to rapidly increasing domestic demand. Today gas oil accounts for 14% of total

energy consumption. Gasoline represents 5% of total consumption, and kerosene and turbofuel 1.5%. Relative demand for kerosene and turbofuel, however, is on the decline. With the exception of turbofuel, consumption has been increasing about 10% per year, which makes oil derivatives first in growth, aside from alcohol, which is growing much faster than all other liquid fuels.

There is natural gas potential in the Western region, as was mentioned; oil prospecting, however, has continued for many years, with no results to date.

Hydroelectricity

Hydroelectricity has the fastest growth rate—17.4%—in the most recent period studied. This is due to harnessing of hydroelectric potential at Acaray and continued extension of networks and services to urban centers in the interior. Itaipú has begun operating, and is scheduled to have 12,600,000 Kw installed capacity by 1990. This will make it possible for Paraguay to plan more rational and suitable uses, and avoid national stresses and use of domestic resources, in meeting increased demand for electricity.

Steam-turbine plants operated by the national service have only been set up in areas with urgent needs, in areas far from the hydroelectric network, or areas not yet reached by the hydroelectric network.

Private generating stations generally use industrial by-products, such as bagasse from sugar cane, coconut shells and tung seeds, and sawdust. Though there are no reliable statistics on production, it is estimated that 10% of the national electricity demand is covered by the privately-owned power stations, mainly for supplying industry and nearby residential areas.

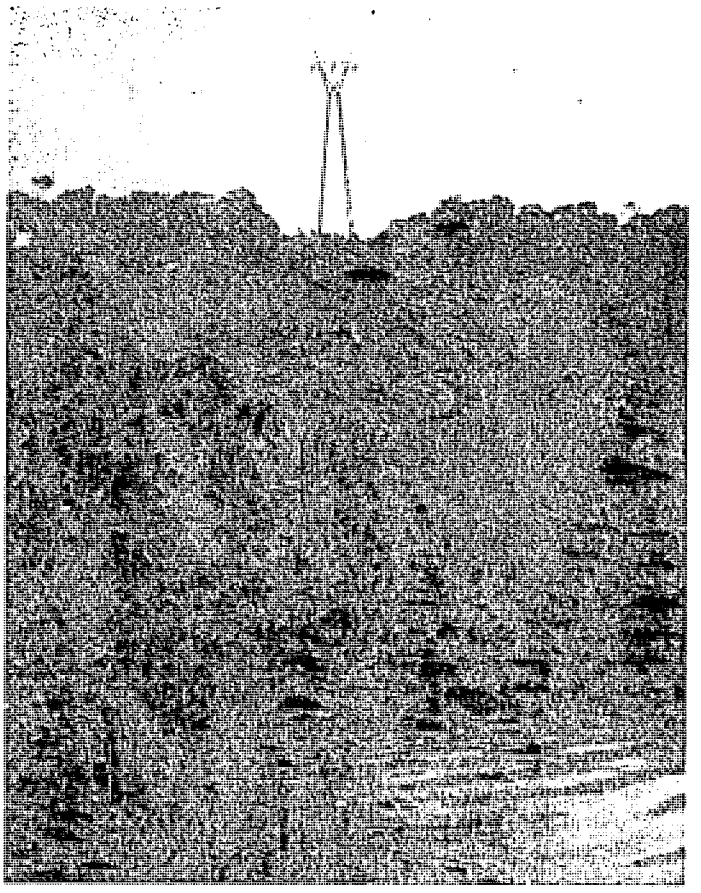
Operating costs to generate electricity at steam-turbine plants have risen steadily due to fuel price increases and because the uniform national rate to consumers does not compensate for costs; but the electricity produced serves the basic needs of rural users. National policy for electricity and extension of services is based on the rate paid by the consumer, which is uniform throughout the country. This rate subsidizes extension of services to users served by the hydroelectric plants, at the cost of consumers in Asunción. This policy has been economically and socially beneficial to Paraguay.

Alcohol

The national alcohol program has been in operation since 1981. It has begun to substitute a mixture of anhydrous alcohol and regular gasoline for oil derivatives in family and utility vehicles.

The plan to mix anhydrous alcohol was delayed due to the need to outfit the facilities of the Paraguayan Alcohol Administration for production of hydrated alcohol, as supply from the industrial private sector was not forthcoming. In 1984, anhydrous alcohol was taken out of the market so as to reduce it and sell it to the consumer in the form of fuel alcohol. Despite the need to meet a temporary shortage of this fuel, this practice is not in the best interests of APAL, which must de-refine a more expensive product and sell it at a lower cost. During 1984 and the inter-harvest period in 1985, 6 million liters were set aside to once again cover the demand, which the private sector has not yet been able to do.

Total investment in the anhydrous alcohol industrial plant—



In the midst of the forest, towers supporting high-tension cables carry electric energy.

some US$183 per liter of installed daily capacity—is much higher than the investment costs in hydrated alcohol distilling plants. As the prices of ethyl fuels are set by the expensive APAL plant, with its elevated production costs, in the short run production costs could be reduced, operating during a longer part of the year, and the private sector could set up several distilleries located in all parts of the country, thereby obtaining considerable marginal utilities.

As the earlier alcohol monopoly ceases to exist, the market mechanisms of supply and demand will take over allowing for long-term stability of the cost of fuel alcohol. This stability would depend, of course, on the purchasing power of the currency, which would be an incentive for even greater substitution for oil derivatives in motor vehicles. The free play of domestic supply and demand of alcohol will always move in function of price advantages and marketable volume of Paraguayan sugar on the international market. This depends on factors exogenous to the Paraguayan economy and is not always very elastic with growth, as it depends on the demand of certain buyer markets.

Alcohol production technology used in Paraguay pollutes a great deal, as each liter of alcohol produced yields 12 to 14 liters of mash. Each liter of alcohol produced causes pollution equivalent to the daily wastes of 6 inhabitants of Asunción.

The greatest problems are those of the largest distilleries; the APAL distillery's problems have not yet been resolved. A bid for a treatment plant has been accepted at a cost approximately equal to 30% of the total cost of the industrial production plant, but it will not come on line until the 1985 sugar harvest.

"Mini"-capacity distilleries (5,000 to 15,000 l/day) may resolve the problem by spreading the mash in the cane fields. This would re-fertilize the soil, and benefit both the producer and the country in the long run. It would also avoid soil depletion and imports of fertilizers to improve soils. Other solutions exceed Paraguay's possibilties due to high costs; use of such technologies would cut deeply into efforts to save foreign exchange given current market conditions.

Other Energy Resources

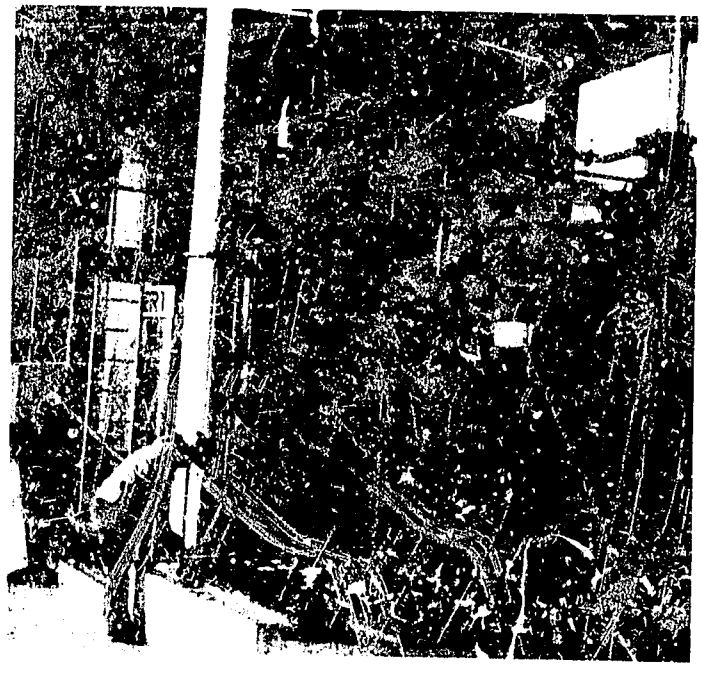
Biofuels, solar and wind energy, natural gas and its products, biogas, and small hydroelectric facilities, given their renewable nature, may come to be of interest to Paraguay at some future date, depending on technological progress and investment and production costs.

Methanol: Using current technologies the cost of methyl alcohol varies depending on the raw material. The cheapest is natural gas, the most expensive is wood. As wood is too expensive, the potential methanol biofuel program should be tabled until natural gas that can be extracted at relatively low cost is found. In any event, it should eventually be more economical than use of ethanol, which is currently booming.

Solar energy: The main institutions looking into solar energy for use in rural areas are the National Institute of Technology and Standards, and the Ranchers Fund. Solar radiation in Paraguay is suitable for thermic and photovoltaic applications. Such projects, however, are still in the experimental stage. Other solar technologies used around the world are very expensive with respect to alternatives available in Paraguay. Most common uses at present are solar water heaters in private homes as a substitute for electricity, and fuels such as gas, kerosene, fuelwood, and charcoal.

Wind energy: The Western region (Chaco) is the most suitable for harnessing wind energy. Traditionally windmills have been used for pumping water and charging DC batteries. Like solar energy, wind energy should be developed in areas far from the hyrdoelectric and transportation networks. Use of wind to generate electricity must await further study because costs of current technology are too high. Progress and research on wind generation may lead to a more profitable solution in the medium term.

Gasification of wood: Gasification of wood is an alternative use of this resource, which has traditionally more profitable uses, and which may grow more expensive over time. Wood may become more scarce and expensive as more lands are cleared for agriculture, as a result of the plan to produce charcoal for the steelworks at Villa Hayes (ACEPAR), and due to better prices for woods for wood turning and furniture. All of these uses contribute to the unbridled exploitation of Paraguay's commercial woods. Experiences in the Chaco with the



Combustible gasses produced by burning fuelwood, Loma Plata electric plant, Chaco.

Mennonite settlers is not yielding satisfactory results in gasification of wood. Given current indicators and production factors this form of energy will probably not be used to a significant degree, at least in the medium term.

Biogas: Due to socio-cultural and economic factors, it is highly unlikely that biogas production will grow significantly in the short and medium term. It would be appropriate in isolated regions where supply of other forms of energy is uncertain and discontinuous, taking into account that economically and practically, other forms of energy are almost always more appropriate. Biogas is being studied in laboratories of the Basic Sciences Institute, the National Institute of Technology and Standards, and the Ranchers Fund, mostly for use in family farms in rural areas.

Small hydroelectric facilities: Paraguay has some waterways whose energy could be harnessed by small and mini-size hydroelectric power plants. But such plants would only be appropriate in regions that are far from the reach of the national hydroelectric networks that transport energy from Itaipú and Acaray. Only private sources, with well-executed feasibility studies, could make use of these mini or micro plants, as the public sector already has a well-established development and investment plan for hydroelectric energy. Some small-scale hydroelectric plants do operate in the Eastern region.

Table VI – 1

Growth Rate of Gross Domestic Product

(Annual rates in percentage)

Year	1975	1976	1977	1978	1979	1980	1981	1982	1983[1]
Rate of Change (%)									
Total GDP at Market Prices	6.3	7.0	12.8	10.9	10.7	11.4	8.5	−2.0	−3.7

[1] Provisional figures.

Source: Central Bank of Paraguay, National Account, No. 19, July 1983.

Table VI – 2

Structure of Gross Domestic Product (GDP) by Sector

(%)

Percentage Composition	1975	1976	1977	1978	1979	1980	1981	1982	1983[1]
Crop production	22.4	20.0	22.5	21.6	20.7	20.6	20.5	20.1	19.5
Livestock-raising	9.5	9.2	8.2	7.7	7.3	6.8	6.5	6.7	6.9
Forestry	3.7	3.3	3.3	3.2	3.3	3.3	3.2	3.1	3.2
Hunting and fishing	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total agricultural production	35.7	34.6	34.1	34.6	31.4	30.8	30.3	30.0	29.7
Total industrial production	19.6	19.7	21.3	21.9	22.4	23.3	23.8	23.0	22.8
Total production of goods	55.3	54.3	55.4	54.5	53.8	54.1	54.1	53.0	52.5
Total production of basic services	5.5	5.8	5.7	5.8	5.9	6.0	5.8	6.5	6.5
Total production of other services	39.2	39.9	38.9	39.7	40.3	39.9	40.1	40.5	41.0
Total production of services	44.7	45.7	44.6	45.5	46.2	45.9	45.9	47.0	47.5
Total GDP at market prices	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[1] Provisional figures

Source: Central Bank of Paraguay, National Account, No. 19, July 1983.

Table VI – 3
Gross Domestic Product and Per Capita Income
(in 1977 dollars)

Year	GDP	National Income	Population	Per Capita GDP	Per Capita Income
1977	263,612	238,824	2,873,346	728	660
1978	292,235	266,045	2,970,153	781	711
1979	323,504	295,574	3,068,481	837	764
1980	360,383	330,869	3,167,985	903	829
1981	390,837	362,244	3,268,489	949	879
1982	382,851	353,317	3,369,966	902	832
1983	368,686	334,710	3,472,509	843	765
Average annual growth, 1977–83	5.7	5.8	3.2	2.5	2.5

Source: Office of Statistics and National Accounts, Technical Planning Secretariat

Table VI – 4
Available Goods and Services and Effective Domestic Demand
(In millions of 1977 guaranís)

	Available Goods and Services				Effective Domestic Demand	
Year	GDP	Imports	Exports	Total	Ct	Ib
1977	263,612	56,890	−48,975	271,527	214,729	56,798
1978	292,235	67,102	−56,084	303,253	232,691	70,562
1979	323,504	74,065	−71,592	325,977	248,848	77,129
1980	360,383	81,964	−73,721	368,626	261,021	107,605
1981	390,837	86,198	−80,461	396,574	292,070	104,504
1982	382,851	81,770	−84,534	380,087	297,354	82,733
1983	368,686	59,791	−64,793	363,684	288,053	75,631

Source: Office of Statistics and National Accounts, Technical Planning Secretariat

Table VI – 5
Structure of Livestock Production
(1977 market prices)

	Gross Value of Production (In millions of guaraníes)		
	1972	**1976**	**1982**
Cattle	9,158.8	7,649.2	7,197.7
Equines	110.0	38.4	9.7
Hogs	3,726.1	4,700.2	7,863.0
Sheep	140.4	181.6	228.4
Goats	24.4	32.9	92.3
Poultry	537.8	667.4	1,033.2
Other	4,943.5	6,677.9	9,387.4
Inventory Variation	1,567.6	4,274.9	5,500.0
Total:	20,208.6	24,222.5	31,311.7

Source: Based on National Accounts Nos. 16 and 19, Dept. of Economic Studies, Central Bank of Paraguay

Table VI – 6
Growth of Livestock Production
(1977 market prices)

		Average Annual growth rates (%)		
	% of total livestock production (1982)	**1972-76**	**1976-82**	**1972-82**
Cattle	23.0	– 4.4	– 1.0	– 2.3
Equines	0.1	– 23.1	– 20.4	– 21.5
Hogs	25.1	5.9	8.9	7.7
Sheep	0.7	6.6	3.8	4.9
Goats	0.3	7.7	18.7	14.2
Poultry	3.3	5.5	7.5	6.7
Others	29.9	7.8	5.8	6.6
Inventory variation	17.6	28.5	4.2	13.3
Total:	100.0			

Source: Based on National Accounts Nos. 16 and 19, Dept. of Economic Studies, Central Bank of Paraguay

Table VI – 7
Value of Exports of Livestock Products
(in thousands of US$ FOB)

	Year							
	1975	1976	1977	1978	1979	1980	1981	1982
Meat products	31,659	20,440	21,383	23,382	5,178	1,022	3	1,963
Total livestock products	34,672	24,551	27,930	32,293	11,836	4,423	6,788	8,968
Total exports	176,711	181,834	278,891	256,984	305,176	310,230	295,541	329,784
Livestock products/Total Exports	19.6%	13.5%	10.0%	12.6%	3.9%	1.4%	2.3%	2.7%

Source: Based on data from the Monthly Statistical Bulletin, Central Bank of Paraguay.

Table VI – 8
Share of Forestry, Hunting and Fishing in Rural Sector GDP
(Millions of 1977 guaraníes)

Year	1975	1976	1977	1978	1979	1980	1981	1982	1983
Forestry, hunting and fishing	8,216	8,094	8,840	9,616	11,023	12,356	12,945	12,338	12,106
Rural sector GDP	78,033	80,914	89,924	95,197	101,602	110,986	118,440	114,887	109,320
% share	10.7	10.0	9.8	10.1	10.8	11.1	10.9	10.7	11.0

Source: Based on data from the Central Bank of Paraguay, National Accounts 1975-1982, No. 19, July 1983.

Table VI – 9
% Share of Forest Products, Hunting and Fishing in Total Paraguay Exports
(In millions of US$ FOB)

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Forest, hunting, & fishing products	25.1	28.9	12.5	20.8	21.9	43.3	67.2	37.4	44.6	21.0
Total exports	169.8	176.8	181.8	278.9	257.0	305.2	310.2	295.5	329.8	269.2
% share	15.0	16.5	6.8	7.5	8.5	13.7	21.7	12.7	13.5	7.8
Total agricultural exports	165.9	175.1	178.2	275.9	254.1	302.6	308.6	292.9	328.7	269.2
% share	15.4	16.5	7.0	7.5	8.6	14.2	21.7	[illegible]	13.6	7.8

Source: Based on data from the Central Bank of Paraguay, Statistical Bulletin No. 31, March, April, May, 1984.

Table VI – 10

Exports of Hunting and Fishing Products[1]

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Tonnes	199	156	71	69	95	42	74	47	21	7
US$ (thousands)										
FOB	793	1063	382	923	1573	846	786	406	435	137

[1] Includes hides and skins of wild animals.

Source: Central Bank of Paraguay, Statistical Bulletins No. 278, July 1981, and No. 310, March, April/May, 1984.

Table VI – 11

Paraguay – Energy Supply

(1000s of TOE)

Year	1972	1977	1982
1. Primary	752.7	1,107.8	1,323.2
1.1 Fuelwood	631.4	937.5	1,087.1
1.2 Bagasse	37.5	44.3	46.5
1.3 Other	24.7	26.2	32.3
1.4 Hydroelectric	59.1	99.8	157.3
2. Secondary	290.6	283.0	282.6
2.1 Charcoal	29.7	34.5	40.0
2.2 Liquified natural gas	5.9	3.1	2.7
2.3 Gasoline	60.7	51.6	44.3
2.4 Kerosene and turbofuel	24.1	24.8	21.2
2.5 Gas oil	87.1	197.0	84.0
2.6 Fuel oil	31.5	28.9	24.8
2.7 Alcohol	- - -	- - -	9.0
2.8 Electricity	51.6	43.1	56.6
Total:	1,043.3	1,390.8	1,605.8

Source: Based on data from sectoral report of the Technical Planning Secretariat and other sources.

Table VI – 12

Paraguay – Energy Supply

(%)

Year	1972	1977	1982
1. Primary	72.1	79.7	82.4
1.1 Fuelwood	60.5	67.4	67.7
1.2 Bagasse	3.6	3.2	2.9
1.3 Other	2.4	1.9	2.0
1.4 Hydroelectric	5.7	7.2	9.8
2. Secondary	27.9	20.3	17.6
2.1 Charcoal	2.8	2.5	2.5
2.2 Liquified natural gas	0.6	0.2	0.2
2.3 Kerosene and turbofuel	2.3	1.8	1.3
2.4 Gasoline	5.8	3.7	2.8
2.5 Gas oil	8.3	6.9	5.2
2.6 Fuel oil	3.1	2.1	1.5
2.7 Alcohol	- - -	- - -	0.6
2.8 Electricity	5.0	3.1	3.5
Total:	100%	100%	100%

Source: Based on same data as Table VI – 11.

Table VI – 13

Paraguay – Energy Consumption

(1000s an TOE)

Year	1972	1977	1982	Average annual growth 1972/77	1977/82
1. Primary	625.2	908.0	1,049.9	7.7	2.9
1.1 Fuelwood	563.0	837.5	971.1	8.3	3.0
1.2 Bagasse	37.5	44.5	46.5	3.4	1.0
1.3 Other vegetable fuels	24.7	26.2	32.3	1.2	4.3
1.4 Coal	.03	- - -	0.03	- - -	- - -
2. Secondary	327.4	392.2	622.2	3.7	9.7
2.1 Charcoal	29.7	34.5	40.0	3.0	3.0
2.2 Liquified natural gas	6.4	3.0	8.0	- - -	2.3
2.3 Gasoline	74.9	70.9	77.5	1.1	9.3
2.4 Kerosene and turbofuel	25.3	24.3	25.3	- - -	- - -
2.5 Gas oil	90.5	143.2	228.7	9.6	9.8
2.6 Fuel oil	27.4	18.8	16.2	−7.8	−3.0
2.7 Alcohol	- - -	- - -	9.0	- - -	114.0
2.8 Electricity	73.2	97.5	217.5	5.9	17.4
Total:	952.6	1,300.2	1,672.1	6.4%	5.2%

Source: Ibid.

Table VI – 14

Paraguay – Energy Consumption

(%)

Year	1972	1977	1982
1. Primary	65.6	69.8	62.8
1.1 Fuelwood	59.1	64.4	58.1
1.2 Bagasse	3.9	3.4	2.8
1.3 Other vegetable fuels	2.6	2.0	1.9
1.4 Coal	- - -	- - -	- - -
2. Secondary	34.4	30.2	37.2
2.1 Charcoal	3.1	2.7	2.4
2.2 Liquified natural gas	0.7	0.2	0.5
2.3 Gasoline	7.9	5.5	4.6
2.4 Kerosene and turbofuel	2.7	1.9	1.5
2.5 Gas oil	9.5	11.0	13.7
2.6 Fuel oil	2.9	1.4	1.0
2.7 Alcohol	---	---	0.5
2.8 Electricity	7.7	7.5	13.0
Total:	100%	100%	100%

Source: Ibid.

Note: The apparent lack of continuity in electricity was due to the fact that in the table the figures used were from a year in which hydroelectric energy was down because of a lack of water in the reservoirs feeding into the dams.

Table VI – 15

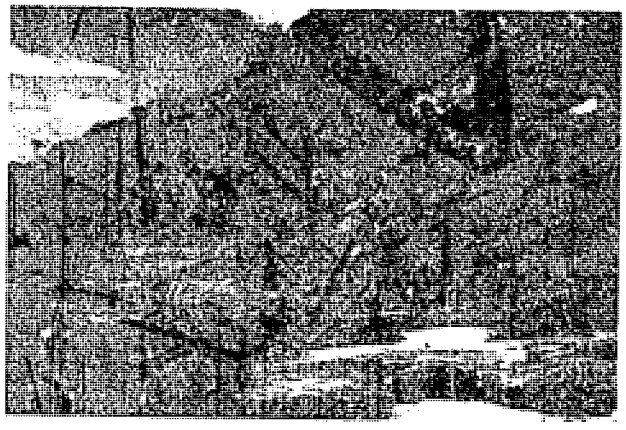
Paraguay – Energy Consumption

(By use)

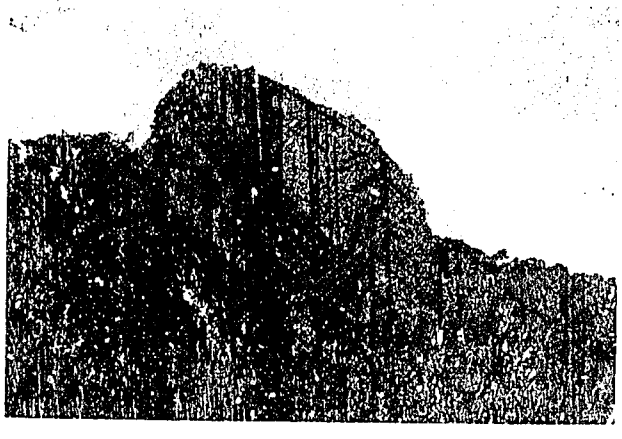
							Average annual growth	
Year	**1972**	**%**	**1977**	**%**	**1982**	**%**	**1972/77**	**1977/82**
1. Industrial	391.0	41	587.7	45	779.9	47	8.5	5.8
2. Residential	251.7	26	396.1	30	579.9	35	9.5	7.9
3. Transportation	137.6	14	153.7	12	218.9	13	2.2	7.3
4. Other	172.3	19	162.7	13	93.4	5	-1.2	-11.7
Total (1000s TOE)	952.6		1,300.2		1,672.1		6.4	5.2

Source: Based on data from the Energy Balance by the World Bank – UNDP technical cooperation team and the Technical Planning Secretariat, modified with recommendations from the World Energy Conference (WEC) Nov. 1984.

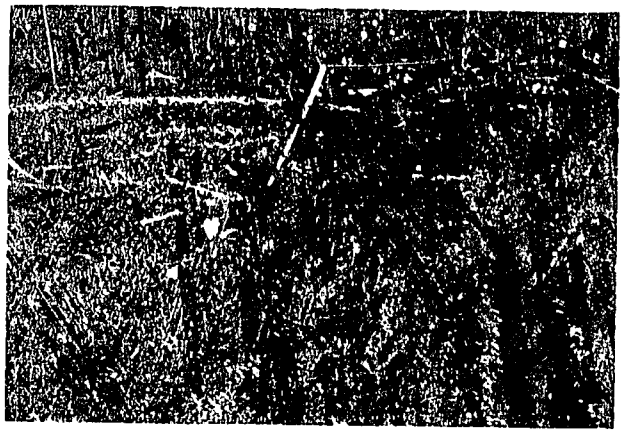
Physical Resources



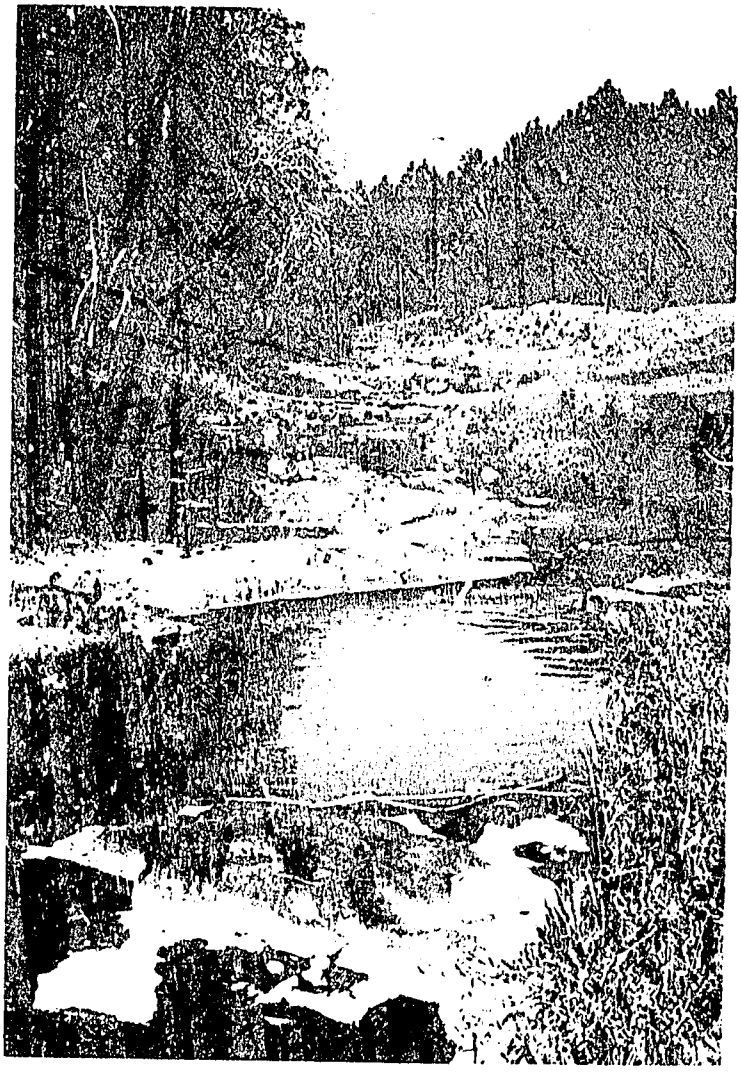
Corrientes Creek, Ybycuí. Photo courtesy National Forest Service.



Tuyá Mountain, Cerro Corá National Park. Photo courtesy National Forest Service.



Planting after clearing and burning. Photo courtesy National Forest Service.



Recreation area, Caaguazú.

VII

Physical Resources

Climate

Paraguay's climate varies from tropical to subtropical, with average annual temperature ranging from 20 to 25°C, and moderate to heavy precipitation, especially during the summer months. Nonetheless, there is great variation in climate: in the northwest Chaco, the climate is semiarid; in the Chaco part of the Paraguay river basin and the northeastern part of the Eastern region, it becomes submoist and megathermal with savanna vegetation; and in the rest of the Eastern region it is mesothermal moist, with the greatest moisture registered in the provinces of Alto Paraná, Itapúa, and Canindeyú.

Winds

Paraguay is influenced by the subtropical anticyclone of the Atlantic Ocean. This basic system, whose center varies seasonally between 20° and 30° South, brings hot and humid air masses from lower latitudes to Paraguay, as a result of circulation of dominant northeasterly and northerly winds.

This situation changes during the winter months, as cold fronts bring dry, cold air by way of southerly winds. Southeasterly and easterly winds represent the transition between the two main climatic systems affecting Paraguay. Other important systems are of a medium scale, such as the squall lines and isolated storms that give rise to variable, high-speed winds.

Temperature

Despite its small size and relatively homogenous topography, Paraguay experiences significant variations in temperature in both time and space. This is because it lies at the center of the continental land mass. Average annual temperatures range from 21°C in the southeastern part of the Eastern region, to more than 25°C in the central and northern Chaco. The northern and central Chaco has the highest mean maximum temperatures (over 31°C), while the southeastern part of the Eastern region has the lowest mean minimum temperatures (about 15°C). During those months when the sun is highest, daily highs occasionally rise above 40°C, especially in the Chaco; when the sun is low, significant frosts sometimes affect a large part of the country (see map VII-1).

Precipitation

Most precipitation in Paraguay is convective, brought on by isolated storms or by squall lines which occur frequently from spring to fall. Average annual precipitation varies greatly from one part of the country to another. The isohyets are southwardly oriented and vary from a minimum of 400 mm in the northwestern Chaco to more than 1,700 mm in the eastern part of the Eastern region. The Paraná river basin is the most humid part of Paraguay, with average annual precipitation over 1,800 mm, whereas in the Paraguay river basin this figure reaches as high as 1,600 mm in the Eastern region, and as low as 400 mm in Alto Pilcomayo, by the border with Argentina and Bolivia. Precipitation also varies greatly depending on the season. It is lowest in July and August. The driest month generally accounts for no more than 5% of annual precipitation. Precipitation is greatest from October to March, and usually comes in the form of storms or cloudbursts which arise from atmospheric instability associated with the significant rise in temperature of the lower layers of the atmosphere (see map VII-2).

Evapotranspiration

Potential evapotranspiration is greatest in the Chaco, due to the high temperatures; minimal precipitation translates into a constant deficit of soil moisture. Thus any agricultural development project should consider irrigation systems with good water economy, for during the growing season demand for water is high.

In the Eastern region potential evapotranspiration is less, and precipitation largely meets atmospheric demand for water during a good part of the year. This generates a significant surplus,

leading to yearly surface runoff. Nonetheless, due to poor seasonal distribution of precipitation—it rains 80 to 90 days a year in the Eastern region—irrigation should be considered during certain stages of the crop cycle (see map VII-3).

Geology and Mineral Resources

Geological Structure

Paraguay is located between the Brazilian shield and the Andean orogen and forms part of the South American continent's network of intracratonic basins (the Paraná basin) and pericratonic basins (the basins of the Chaco).

One of Paraguay's most noteworthy features is the contrast between the Eastern region and the Western region. In effect, when the Andes arose during the Middle Tertiary period, this part of the earth's crust broke, causing the depression of the Western region, which has since been refilled by very thick modern sediments.

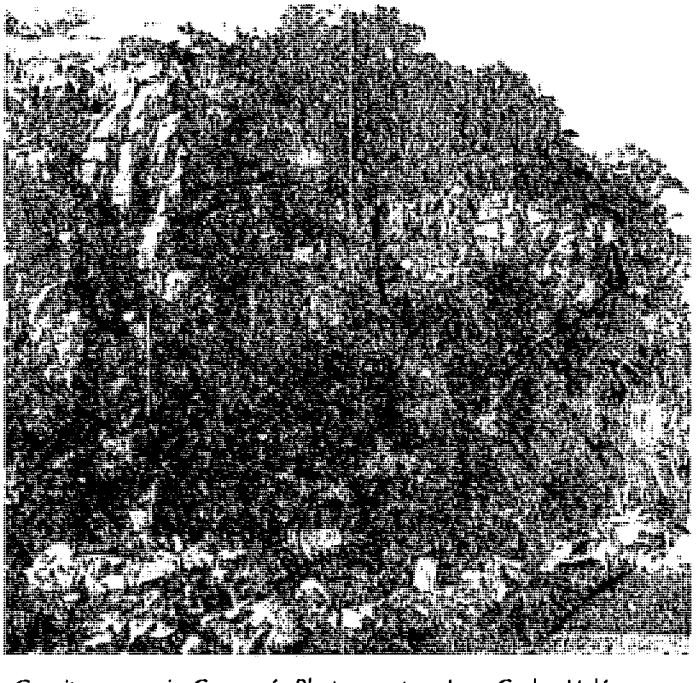
The Paraguay River separates the two main watersheds, corresponding to the Paraná River and the Chaco region. The Paraná watershed, bounded by Precambrian rocks that constitute arcs, has since been refilled by very thick phanerozoic sediments (from the Paleozoic).

These sediments, in turn, have been covered over by a semiarid continental sedimentary sequence, associated with great flows of tholeitic basaltic lavas (Jurassic-Cretaceous).

The Chaco watersheds have been refilled mainly by sediments from the Andean and sub-Andean basins, and material deposited from the Asunción arc, as a result of fluvial and, to some extent, aeolic sedimentation.

Mineral Resources

Paraguay, which has no mining tradition, has since the 19th century undertaken geological investigations so as to reveal the country's mineralogical potential. Focused studies have indicated the presence of some metallic minerals, and suggested the presence of others.



Granite quarry in Caapucú. Photo courtesy Juan Carlos Velázquez.

Paraguay's supply of non-metallic minerals and rocks is used in public works, roadways, ornamental rock, and as raw material in manufacture of glass and pigment for paint, as well as being used in other products.

Since the 1940s, oil prospecting has continued in both the Eastern and Western regions. Paraguay's need to find other minerals for energy supply aroused the interest of foreign companies, many of which came to prospect for minerals, such as uranium, in recent years. Following is an overview of the current situation as regards both metallic and non-metallic minerals. The following metals are known to be present in Paraguay: iron (known of since 1847), copper, manganese, niobium, and bauxite. It is thought that the following metals also occur: beryllium, tantalum, tin, copper, lead, zinc, silver, cobalt, vanadium, fluorite, barite, rare earth metals, and radioactive minerals.

Commercially exploited non-metallic minerals and industrial rocks include: marble, limestones, granites, talc, gypsum, clays, kaolins, and sandstones. Of particular importance are sand (for glass), mica, quartz, feldspar, and pyrophyllite.

Prospecting for energy minerals such as uranium and oil has been particularly significant. Some researchers have confirmed the presence of uranium; 39 wells have been drilled in search of oil. Results to date have been encouraging.

Soils

Since the beginning of the 20th century, several soil studies have been carried out. Yet these studies do not cover the entire country, and have been mapped at different scales, ranging from 1:1,000,000 to 1:50,000.

Those studies not performed at the 1:50,000 scale were based more on geomorphological features than on information derived with laboratory support, which is essential for proper soil classification. This lack of analytical data in soil studies over time limits the value of such studies, rendering them of a merely exploratory nature.

The general character of mapping limits the cartographic precision needed for formulating pertinent recommendations for each soil group or use. Furthermore, to classify soil use, the studies only consider the categories of classes and subclasses, which do not suffice as parameters; for soil classification to be adequate the studies must include the soil category unit, as is the case in the more sophisticated studies, such as those carried out on a 1:50,000 scale. As observed in such studies, this scale allows for identification and delimitation of critical soil areas, and leads to suggestions as to the best form of using such soils, clearly indicating fertility and productivity problems in restricted areas.

Only those studies done on a 1:50,000 scale have been duly supported with up-to-date and representative soil analysis, both physical-chemically and mineralogically. The studies thus provide precise data for planning agricultural and forestry development projects, and make it possible to specify and apply

pertinent recommendations as to management, use, and conservation of each classified unit.

Most of the existing soil surveys are not as useful for general planning purposes as they might be. They do not employ layman's terminology, nor are they sufficiently specific to allow detailed planning for small areas.

Most land use studies indicate that actual land use does not coincide with land use potential. In many places actual land use exceeds the capacity and limitations of the land, thereby jeopardizing sustained agro-economic development.

Soil Classfication by Use Capability

The soil survey of use capability covers only the Eastern region, as it is the only part of the country with enough information to carry out such a study. Land use classification constitutes an interpretative grouping of soil requirements and limitations, danger of soil damage, and suggested management techniques. It is used primarily to distinguish between lands with agricultural or livestock raising potential and lands suitable for forestry.

Areas of Soil Use Capacities

The areas of different kinds of use capacities and their distribution are illustrated in the soil use capacity maps of the study, "Inventory of soil studies,"[1] and in table VII-1.

Classes II, III, and IV are best for crop production, and cover 62.7% of the Eastern region. Among their limitations are susceptibility to erosion, and to a lesser extent, low fertility.

Table VII – 1

Area of Classes of Soil Use Capabilities for the Eastern Region of Paraguay.[1]

Class of Use Capability	Area (ha)	Area (%)
I	1,875	0.01
II	4,410,250	27.50
III	1,884,730	11.78
IV	3,735,275	23.36
V	4,346,625	27.18
VI	961,375	6.01
VII	555,000	3.47
VIII	93,045	0.69
TOTAL	15,988,275	100

Source: Soil Use Capability Map of the Eastern region. National University of Asunción. School of Agronomy. San Lorenzo. Paraguay. 1983.

[1] Study on a scale of 1:50,000

Classes V, VI, and VII are considered more suitable for livestock-raising and forestry, and cover 37.4% of the region. Their main limitations are deficient drainage, low fertility, and stoniness.

Conclusions

The soil survey carried out by gathering together studies of different areas of the Eastern region covers approximately 15,988,275 ha. The survey indicates that:

1. Some 28.11% of the area studied is suitable for cultivation. Particularly noteworthy in this regard are lands classified as having only slight to moderate risk of erosion (Classes II and III), on which crop production may take place with minimal conservation measures.

2. Much of Paraguay's agricultural production, made up mostly of cash crops (soybeans, wheat, cotton, corn, and tobacco) is concentrated on Class II lands.

3. The current expansion of agriculture is mostly on Class III and IV lands, especially in forested areas.

Soil Erosion in Paraguay

Natural erosion is considered normal because the soil naturally regenerates as it is lost. Thus soil is a renewable resource.

Accelerated erosion occurs when natural protective vegetation is altered by man and the soil is removed at a faster pace than it regenerates; this phenomenon is associated with irrational soil use and management.

Accelerated hydric erosion is a challenge that producers, engineers, and government must confront if soil productivity is to be safeguarded, for 90% of the area under cultivation in Paraguay is subject to hydric erosion to varying degrees.

Estimates of Eroded Areas

Continuous exploitation of the soil over several decades in extensive areas of Paraguay, with often inadequate use and management, has led to serious erosion and its consequences, diminishing the natural productivity of large areas.

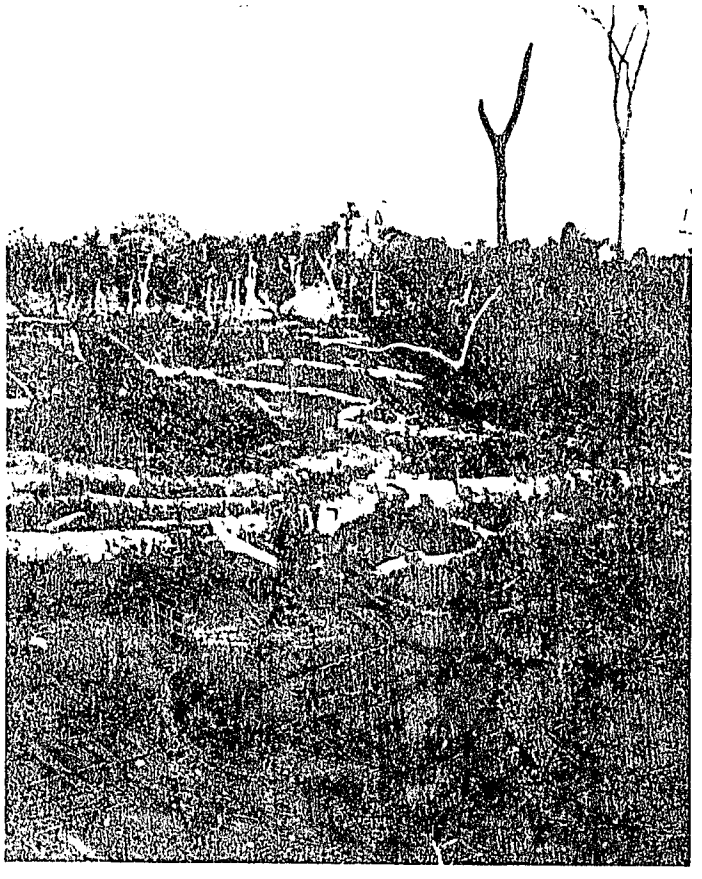
Hydric erosion not only affects agricultural productivity; silt-laden runoff also endangers the productive life of hydroelectric dams and makes navigation along rivers and canals providing access to ports more difficult.

Clearing of new areas for croplands and grazing lands without knowledge of the real use capacities of soils often brings on rapid erosion and physical degradation. Government authorities and private producers should study the feasibility of adapting lands to proposed uses before clearing takes place, and use conservation measures to manage such lands.

There is little available information on hydric erosion, and what there is is not very detailed. Critical areas of hydric erosion are illustrated in table VII-2 by extent, intensity, and degree of acceleration.

Despite the lack of information on soil degradation due to hydric erosion, it is certain that large tracts of land are affected, reducing productivity and yielding thousands of tonnes of silt.

1/ MAG, STP, 1983



Preparing new land for cultivation. Hand clearing and burning.

These losses are on the order of 10 t/ha/year; 38% of cultivated lands have a high risk of erosion, especially in highly mechanized, newly-settled farming areas.

Current Soil Use and Management

The Dynamic of Erosion in Paraguay

Migration from Central, Paraguarí, Cordillera, and Guairá Provinces to settlement areas, with settlement over the past two decades in Itapúa, on the one hand, and Caaguazú, Alto Paraná, Amambay, and Canindeyú, on the other, has had a considerable impact on erosion. Settlement in the Province of San Pedro has also been significant. Also of importance has been settlement over the last 10 years in the above-mentioned provinces by Brazilians, who have set up relatively modern productive units on lands considered to be the best for farming. These settlers have been determined to clear forests to make way for agriculture.

Of particular importance in the Eastern region is the torrential and intense rainfall, 1,200 to 1,800 mm annually, mostly between October and January. This rainfall has seriously furthered erosion, given current soil uses. During the period of heaviest rainfall, especially in October and November, the soil is freshly plowed and turned, and has just been planted or has small plants that do not constitute a protective cover. Cutting down the forest, which is the natural protection of the soils, triggers this phenomenon, which can be readily observed in newly-settled zones in the provinces of Itapúa, Alto Paraná, Canindeyú, San Pedro, and Amambay. From the ecological

Erosion. Gullies in San Antonio. Photo courtesy Juan Carlos Velazquez.

standpoint, these phenomena are considered to cause uncontrollable environmental changes, many of them irreversible.

Methods of Clearing Lands for Farming

In clearing lands, farmers slash and burn 70 to 80% of the useful wood and 90 to 95% of the biomass. Large agricultural enterprises remove the tree stumps from large expanses of land. Heavy machinery also has a negative impact, causing partial or total destruction of the organic stratum, hardening clays as a result of heating, and significantly diminishing potential fertility. Furthermore, the soil is compacted, reducing infiltration, and increasing surface runoff, which often leads to total removal of agronomically significant surface soils.

Small settler-farmers generally obtain 20 ha. Once the land is occupied, the above operations are carried out, though with little or no use of machinery. Often low-yield farming is carried out on soils not suitable for crop production, thereby diminishing soil productivity. This phenomenon is due to lack of technological development, and the economic and cultural situation: the small producers consolidated the traditional method, and continue using it in forested settlement areas. This method involves clearing through slash-and-burn of a small piece of land and cultivating it for four or five years, thereby taking advantage of its initial natural fertility, which later diminishes significantly.

In sum, settlement has led to an explosive, uncontrolled situation, with no planning for soil use in conformity with soil aptitudes. The entire situation needs to be addressed through planning, use of appropriate technologies, and an intensive educational campaign to convince farmers to use available resources properly.

Highway Construction

Highway and road construction are also closely related to current soil use and management. These roadways cut the terrain at different angles, diverting the natural runoff. Unless the shoulders are protected and kept in good condition, roads

cutting through the natural course of waters form deep ditches parallel to the shoulders; as a result, adjacent fields develop narrow erosive ditches.

The sediments from such ditches and shoulders are often deposited in lands considered optimal for agriculture; when care is not taken to protect and conserve the drainage system, running water forms ditches in the fields and alongside the roads.

Runoff from the roadways leads to degradation of croplands, and runoff from the croplands leads to destruction of roadways. The deep ditches alongside the roads frequently cause uncontrolled torrents on contiguous lands.

The government is in charge of road maintenance. Awareness of the harmful impact of erosion, and of the fact that construction of modern roads further aggravates the problem, has led planners to take erosion into account when designing roads in recent years.

Present Use of Lands

Paraguay's lands are used primarily for agriculture, livestock, and forestry. Only 18% of the total area is taken up by croplands. Livestock raising takes up 38%, and forestry 42%.

Lands have been occupied without sufficient investment in human capital and technology, and without planning for rational use of cleared areas and their natural resources. In the minifundia or smallholding area (Provinces of Central, Cordillera, Paraguarí, and Guairá), lands are used mostly for annual subsistence crops and some cash crops, such as cotton. Agriculture in this area is characterized by the prevalence of small holdings and use of traditional methods of cultivation, which lead to gradual soil depletion.

The recently settled area (Provinces of San Pedro, Caaguazú, Alto Paraná, Canindeyú, and Amambay) has fertile soils, generally apt for planting crops. Cash crops such as soybeans, wheat, corn, and tobacco are the most common. Subsistence crops are also grown. Land is also used for extensive ranching (Provinces of Ñeembucú, Misiones Concepción, and Amambay), and lumbering. Land distribution in Paraguay is illustrated in table VII-3.

Use of Chemical Products

Fertilizers and Pesticides

Crop yields need to be increased through use of fertilizers, for within a few decades, given the steady advance in clearing of lands, new agricultural areas will no longer be available.

Despite Paraguay's marked dependence on agriculture, use of fertilizers and pesticides is extremely lo[illegible]esults in part from high costs and in part from the [illegible]date, it has been possible to increase crop production by [illegible]ing new lands into production, rather than by using inputs to increase soil fertility.

The increase in total lands for just six of the main crops (soybeans, corn, cotton, wheat, rice, and sugar cane) from 1974 to 1980 made increased use of inputs a vital necessity. Despite the fact that all fertilizers and pesticides must be imported, it is impossible to determine total consumption, as fertilizer imports remained constant (annual average 9,600 t) from 1976/77 to 1982/83, skyrocketing to 38,000 t for the 1983/84 season, according to official figures. Consumption is believed to have been higher than the official import registry indicates for all of the above-mentioned years.

In the case of fertilizers, official figures probably represent only one-third to one-half of real imports. Even if this is the case, however, Paraguay would be consuming a mere 20,000 to 30,000 tonnes of fertilizer annually.

Furthermore, most of the soils in agricultural areas need fertilizer. The main additives needed are lime and phosphorus. Levels of complete additives are extremely low, due above all to high costs. Thus, this input is used only in areas where it is sure to produce positive results, and to an extent that yields an optimal cost-benefit relationship.

There is insufficient data as to whether fertilizers and pesticides are used in the most economical manner. Research on this matter is being carried out in only a few crops. Pesticides have become widespread with the extension of some particularly profitable crops, such as cotton, soybeans, tobacco, corn, wheat, rice, and garden vegetables.

Insecticides, fungicides, herbicides and other pesticides have become quite common: 950,550 liters of such products were used in the 1980/81 season, according to the official import registry. This figure does not include pesticides entering the country illegally.

Use of Chemicals in Agriculture and Erosion

Erosion carries particles of earth to waterways, thereby contributing to water pollution. The use of chemical products in agriculture contributes to such pollution, which results not only from the presence of solids, but also from the concentration of a variety of fertilizers and pesticides and their high toxic potential, even when total use is low.

Unless the necessary precautionary measures are taken, unleashing this harmful dynamic in waterways will, over time, endanger and even wipe out aquatic fauna and flora, leading to the extinction of species, and even posing a serious threat to public health.

Dissemination of Conservation Measures

At present there is little information and accumulated experience in Paraguay regarding soil conservation. Efforts are underway to test methodologies adapted to different regions and applicable by zone, watershed, or specific fields. Furthermore, ongoing education is needed to foster awareness among all sectors of the population as to the importance of conservation.

Paraguay has not been able to progress in this regard, for it does not have basic soil and soil use capacity maps on the appropriate scale, which are necessary for planning soil management and conservation programs.

The most important obstacles to adoption of conservation measures are:

a. Lack of conservation awareness.

b. Resistance on the part of producers to management changes concomitant to conservation practices, often due to narrow agricultural profit margins, making it impossible for producers to raise their production costs.

c. Lack of financial support for conservation production systems.

d. Very few specialists in conservation offering advice in the field.

e. Lack of national legislation on soil conservation. The entity in charge of developing and implementing such programs should be the Ministry of Agriculture and Livestock (MAG), through its Office of Research and Extension Services for Agriculture and Forestry, which is getting organized, seeking needed human resources by training professionals, and thus, seeking essential funds. Changes could come about in the short term if the project to train personnel for the National Soil Service is put into practice.

Mention should also be made of the National Program for Soil Management and Conservation, which is to be implemented in the near future. The MAG is in charge of this project, through its Agricultural and Livestock Extension Service, with UNDP/FAO support.

The MAG, aiming to improve soil management and conservation, plans to launch a systematic soil survey, placing top priority on the most important agricultural areas, such as Itapúa, Alto Paraná, San Pedro, Amambay, and Caazapá. These areas have been partially mapped: 1,457,000 ha have been mapped in an exploratory and semi-detailed fashion. The rest of the country has only schematic soil maps at scales ranging from 1:100,000 to 1:1,000,000; the information garnered from such maps hardly allows for analysis of erosive processes.

Several topics are to be dealt with by research offices and extension services. The following, related to erosion, are of particular importance:

a. factors leading to loss of soils and water;

b. precise quantification of erosive processes in different soil series;

c. effects on soil and water loss of residue and crop covers, and different systems of tillage (conventional, minimal, etc.);

d. evaluation of erosion control practices; and,

e. analysis of rains, types of storms, drought periods, etc., to be taken into account in estimating losses and designing control practices.

Extension efforts will be based on developing micro-watersheds for demonstration purposes. Comprehensive conservationist planning will be implemented at such sites. The project is aimed at promoting rational use and management of Paraguay's soils and water resources, by strengthening institutions directly linked to national resource conservation, and undertaking management and conservation actions with the participation, above all, of small and medium-scale farmers.

General Conclusions on Erosion

The present situation suggests the following:

1. According to available information, hydric erosion is very significant in Paraguay, reaching alarming proportions in some cases.

2. Soil erosion is gradually diminishing the productivity of cultivated soils.

3. Current or potential production of millions of tonnes of sediments poses a danger to the useful life of hydroelectric dams, and constitutes an obstacle to navigability of Paraguay's rivers.

4. Erosion affects long-standing agricultural areas as well as marginal or submarginal zones recently cleared for agriculture.

5. Accelerated soil erosion results from a lack of conservation measures in traditional agricultural areas, intensification of agriculture on newly-incorporated lands, and lack of knowledge as to whether lands are being used according to their real capabilities.

6. Low technical level where conservation measures have been applied.

7. Low degree of adoption of erosion control measures by small farmers, except in a few small, disperse-areas.

8. Lack of basic information needed to precisely quantify erosion, and determine its extent.

9. Little or no technical and service infrastructure, and lack of national legislation to set forth norms and guidelines for soil conservation in critical areas.

Water Resources

Watershed and Hydrographic Network

Paraguay lies entirely within the la Plata River basin, above the confluence of the Paraná and Paraguay rivers (see map VII-4). The Paraguay River divides Paraguay and Brazil in northeastern Paraguay, while the Paraná River divides the two countries in the southeast. Other countries in the la Plata River basin are: Bolivia, which borders Paraguay to the north and west; and Argentina, to the south. Uruguay is also part of the la Plata River basin, but does not border Paraguay; the hydrological connection between the two countries is marginal.

The total area of the la Plata River basin is approximately 3,100,000 km^2. Of this total, 1,415,000 km^2 is in Brazil, 920,000 km^2 in Argentina, 410,000 km^2 in Paraguay, 205,000 km^2 in Bolivia, and 105,000 km^2 in Uruguay. In percentage terms, each country's share of the total basin area is as follows: Brazil, 46%; Argentina, 30%; Paraguay, 13%; Bolivia, 7%; and Uruguay, 3%. Brazil has the largest share and, from Paraguay's standpoint, constitutes the most significant geographic area within the basin. The sources of the Paraguay and Paraná rivers are in Brazil; thus, Brazil's impact on the basin's hydrology will affect all countries downstream. From the standpoint of practical hydrology, Brazil is Paraguay's most important neighbor.

The Paraguay River is Paraguay's main drainage system; it receives surface waters from both Brazil and Bolivia, and in turn produces surface waters that flow to Argentina to the south. The Paraguay River is the natural boundary between the drier alluvial plains of the Chaco, in the Western region, and the more moist and geologically varied region to the river's southeast, in the Eastern region. There are marked differences between these two regions, which are hydrologically significant.

The Paraguay River is clearly the most important waterway from the standpoint of navigability, serving as Paraguay's link to international markets for export of its products. The Paraná River, though having greater volume than the Paraguay, is

navigable only for vessels with relatively small drafts, because of rapids.

The Paraguay River divides the country into two clearly distinct regions in terms of hydric balance, with a deficit in the Chaco (Western region), and excess water supply during most of the year in the Eastern region.

Paraguay's hydrographic network includes lakes, rivers, and streams, some of which are navigable by small vessels, that drain the two great waterways mentioned above; this network forms part of the la Plata River basin. With the filling of the Itaipu reservoir, a large lake has been created, with a total area of some 1,300 km^2; the entire upper course of the lake is navigable.

There are large-scale binational hydroelectric projects, some of which have begun to operate, while others continue under study. All are along the Paraná River. These projects have made it possible to set up hydrometeorological stations and gather information; in some cases, registers have been kept for 10 years.

Several institutions make use of water for specific purposes—such as generation of electricity, navigation, and irrigation—which do not constitute consumption of this resource.

Water Resources

Paraguay's water resources include the waters of the Paraguay, Paraná, and Pilcomayo rivers, and their permanent and intermittent tributaries; soil moisture; and groundwater. Of these three, surface water and soil moisture are at present the most important. Groundwater is not significant in determining Paraguay's supply and use of water, except, perhaps, locally in rural areas.

Surface Water

Surface waters originate primarily from the excess of precipitation with respect to evapotranspiration. In some areas where this situation persists year-round, or in areas where sufficient seasonal precipitation is deposited as groundwater and slowly released at the surface, rivers and streams flow throughout the year. Streams that flow only during the rainy season are intermittent. The Paraguay River flows throughout the year in southeastern Paraguay, and intermittently in most of the upper Chaco. The lower Chaco has some year-round streams (e.g. the Lower Pilcomayo river and the Confuso river), which presumably have their sources in groundwater.

Average total surface water of the la Plata River just south of the confluence of the Paraná and Paraguay rivers is estimated at 15,000 m^3/sec. Of this total volume, it is estimated that 12,000 m^3/sec are from the Paraná River, and 3,000 m^3/sec from the Paraguay River. The surface area of the Paraná watershed is about one-and-a-half times that of the Paraguay. Thus, the fact that the Paraná's stream flow is four times that of the Paraguay reflects the much more arid conditions of the Paraguay River basin.

In general, the annual rise and fall of surface water in much of the basin depends directly on seasonal distribution of rains. The Paraná's stream flow and that of most of its tributaries reaches its monthly maximum between February and April, which roughly coincides with the rainy season. Most streams reach minimum stream flow between August and October, which roughly coincides with the end of the dry season. The Paraguay River is an exception: from the *Pantanal* region in Brazil, near the river's source, and downstream to its confluence with the Paraná, the above-mentioned pattern of high and low stream flow is inverted. The Paraguay's stream flow is greatest during the dry winter months, from May to August, reaching its minimum levels during the rainy summer months.

This inversion of the typical pattern for rivers in the same basin is doubtless related to the inability of the Paraguay basin's drainage system to pass along immediately the large volumes of water it receives periodically in the form of precipitation. As precipitation falling within the Paraguay basin builds up within its flood plain at a greater velocity than that of its drainage system downstream, this apparently acts as a prolonged reservoir. The water is stored due to the drainage blockage until the waters from precipitation diminish below the basin's capacity to transmit the water hydraulically. It is only when this happens that annual flooding can begin to abate.

It can be assumed that the crest of the flood that comes down the river hydraulically from the *Pantanal* is accentuated by the dammed waters that result from the blocked drainage in the river's straight lower sections. Maximum flooding that comes down the river from the *Pantanal* can be expected to coincide with excessive precipitation along the lower straight sections.

The specific quantity of surface water per area (mm/m^2) is a useful indicator of the relative availability of water in a particular site. It also indicates energy available for erosion and transport of sediments for uniform topography and uniform types of rock. Specific values of surface water decrease as one moves from east to west across Paraguay, ranging from an annual maximum of 600 mm to less than 100 mm throughout most of the Chaco (map VII-5). Paraguay's maximum values are believed to occur around Encarnación and coincide with maximum annual precipitation and minimum annual evapotranspiration. The minimum values occur in the upper Chaco.

The concept of specific surface water is of great use hydrologically, as it allows for a direct comparison of elements that enter into the hydric balance, i.e. precipitation, evapotranspiration, and surface water, in comparable units of depth per unit area.

Soil Moisture

Continuing with the concept of specific surface water, Thornwaite's "hydrologic index" makes it possible to calculate the seasonal excess or deficit of precipitation with respect to evapotranspiration. It is used mainly to determine the availability of soil moisture.

Based on calculations of the seasonal tendency of the hydrologic index, virtually all of Paraguay's Western region, and a small part of the country just north of Concepción to the east of the river, has a soil moisture deficit during all or almost all of the year (map VII-6). Throughout the upper Chaco and along the upper Paraguay River soil humidity deficit occurs year round, with the exception of the banks adjacent to the river where seasonal flooding should maintain high humidity levels during at least part of the year. Only in southeastern Paraguay are moisture levels consistently positive throughout the year, thus avoiding the need for supplementary water resources for farming (graph VII-1).

To the west of the Paraguay River in the Chaco, unconsolidated and unseparated alluvial sediments, from the Quaternary period can be expected to produce small quantities of water of variable quality through wells or prospective drilling. A given well's capacity, for example in liters/day, will depend on the aquifers' capacity to transfer water while maintaining its density and lateral extension.

In alluvial sediments in general, transfer levels are normally high, but their density and extent are highly variable as a result of rapid changes of alluvial sediment deposits in the environment in general. The aquifers of the Chaco are probably not characterized by production of water in volumes exceeding the needs of low-intensity use (e.g. domestic use, maintenance of water reserves, small domestic gardens, etc.).

The extremely low gradients of the Chaco's aquifers (on the order of a few cm/km) are such that water naturally remains in these aquifers for a long time. In such conditions of quasi-stagnation, water quality, determined by total dissolved solids (TDS), can be expected to be poor. This will determine time available for the groundwater to reach a chemical balance with soluble salts (mainly calcium, magnesium, potassium, and sodium salts) found in the geological material that makes up the aquiferous stratum. Where conditions indicate shorter-than-average water staying times, water quality—though not available quantity—can be expected to be above average.

There is no available data on the biological quality of the waters of the region's aquifers. If human and natural wastes are dumped without treatment, one can reasonably assume that microorganisms—including pathogenic ones that might be affecting residents of the region—may be present in the groundwater.

To the east of the Paraguay River, rock formations from the pre-Cambrian period to the Cretaceous period can be expected to produce large quantities of water locally where breakage has increased the porosity and permeability of the consolidated rocks, or where unconsolidated alluvial deposits are present at the surface. The chemical quality of this region's groundwater should be superior to that of the Chaco, due both to the relatively lower solubility of the rocks and the lower staying time of water in the aquifers as a result of the higher levels of overburden and transmission.

As is generally the case with groundwater use, the exact conditions of availability and quality can only be determined through specific research at the site of both groundwater zones.

Groundwater

Groundwater represents one of the most important water resources in many parts of Paraguay, and is closely linked to the physical and chemical features of the geological substrata and the balance between supply and demand of surface waters, resulting from the interaction between atmospheric disturbances and the physical characteristics of the surface waters.

Groundwater reserves in the Paraguayan Chaco vary in quantity and quality. The potential for exploitation of an aquifer is determined by its physical dimensions and hydraulic characteristics. One would expect that in the Chaco, with highly transmissible alluvial sediments, the aquifers would have varying horizontal and verticle dimensions, indicating sufficient water storage to satisfy the water demand of human and animal communities, but not to develop agriculture. The low hydrostatic gradients in the aquifers of the Chaco plain are responsible for stagnation of waters, which in turn facilitates the waters' tendency to chemical balance with soluble salts found in the geological material of these aquifers.

At present a project is underway to draw up an official geological, hydrogeological, and metallogenic map for Paraguay. When complete, it will have more reliable data, for this project will bring together data currently dispersed among several institutions, including the Chaco Water Office of the Ministry of Defense, SENASA, CORPOSANA, and the Engineering Command and Geology Office of the Ministry of Public Works, which has data from deep wells drilled by foreign companies. This project will bring together in a single map the different wells that have been drilled, and the corresponding isopiestic lines (if they exist), as well as the quantity and quality (chemical analysis) of the water samples obtained in the different drillings, all of which will provide a comprehensive picture of water reserves in the Chaco.

In this way sites for settlement can be identified with a view to development of the Chaco, which is a national policy goal.

To date not all of the groundwater prospecting studies in the Chaco have yielded encouraging results as regards regional development. This is not because of the amount of water for human consumption, but because in many areas the water cannot even be consumed by plants and animals due to its chemical quality. Thus, the National Commission for Comprehensive Development of the Chaco is examining the possibility of channelling waters from the Paraguay River, which will require raising water elevation 60 meters, to the settlement area of central Chaco through open-air canals, which would also be navigable for barges. This project appears feasible, despite the cost ratio of aqueducts to wells, which is 50:1 according to UN studies. Representatives from several European countries that have carried out such projects in areas more arid than the Paraguayan Chaco (e.g. Saudi Arabia) have visited Paraguay to look into this matter.

Any economic effort intended to benefit this 61% of Paraguayan territory by bringing the water needed for launching comprehensive development of the region should be welcome, as the Paraguayan economy is based on agriculture and livestock-raising.

The Eastern region's groundwater resources differ from those of the Chaco. Eastern region groundwaters are generally of better quality and greater quantity due to the more favorable hydrologic parameters of the aquifers, which recharge from excess surface water.

Hydroelectric Projects and Their Possible Effects on Water Resources

The great hydroelectric and reservoir works planned for the Paraná River will have a significant lasting impact on both aquatic and land-based ecosystems.

Such undertakings may convert the Paraná River into a series of practically continuous lakes. This string of lakes would maintain many of the characteristics of the fauna and flora of bodies of water in the flood-plain, while substantially altering the present turbidity of the waters transporting sediments, as well as the regime of floods and local climate. A marked change

in water quality at the dams would result from stabilized river flow and retention of sediments.

Thick sediments that drag along the bottom will accumulate at the upper end of the reservoir, while suspended solids will tend to precipitate as stream flow decreases in the reservoir; thus water transparency will increase considerably. As a result, aquatic predators will have a greater advantage with respect to their respective prey. Due to the dams that block the river, fish that migrate for reproduction or feed on a steady supply of detritus or sediments may well suffer most from the environmental impact of the hydroelectric works. Predators that feed on the above fish will also suffer. The hydroelectric projects — like any project altering the natural course of a waterway — should include construction of fish ladders.

The increase in water surface area behind the dams will favor evaporation and thus greater humidity in the air. There will thus be more fog, which could affect transportation. A considerable increase in air humidity could increase pests and crop diseases. There may also be greater precipitation in the form of dew and significant changes in air temperature. The formation of expansive water surfaces opens the way to winds and thus more turbulent storms. The corresponding increase in breadth of waves may affect navigation and possibly cause erosion along the shores.

Causes of Floods and Possibilities for Controlling Them

Flooding of the Paraguay River and some of its tributaries has short and long-term economic and social impact. The short-term effects, which include human suffering and material losses, are generally the most obvious. Nonetheless, the long-term effects, such as limiting economic growth and development, are harder to quantify but just as real. Thus, all adverse aspects of flooding should be taken into account by the government when choosing an appropriate plan of action.

The level of the Paraguay River is regulated on an ongoing basis by the waters of the *Pantanal* in the upper basin (Brazil), by precipitation in the middle basin, and by the level of the Paraná River at the confluence.

Due to the extremely flat terrain and lack of suitable sites for the construction of containment dikes or reservoirs to control the enormous volume of the Paraguay River, such facilities are not a viable alternative for controlling floods on the Paraguay. It would be possible, however, to increase the river channel's capacity to transport such a large quantity of water adequately. Nonetheless, such an increase in channel capacity would have a negative impact on navigation during periods of low water. Given the importance of Paraguay River navigation for the entire country, transportation should be kept going at all times. Decreasing the volume of the river by infiltrating waters from precipitation into the soil would not be practical, as the floods occur when the soil is almost saturated. Construction of huge dikes in urban and some rural areas with high agricultural productivity is feasible from the standpoint of engineering. However, the cost of such works would be high, with operational and maintenance costs further increasing this amount. Such dikes would need an escape valve for runoff waters that would be entrapped. Such waters are generally emptied with huge pumps, which would have to work continuously for several months during large floods.

While this solution is feasible from the standpoint of engineering, economically such dikes are probably not feasible. In October 1979 Motor Columbus and Associates in its capacity as consultant to the Binational Yacyretá Project, researched measures for flood protection on the Paraguay River from Asunción to the confluence with the Paraná downstream from Itaipú. The consultants determined that dikes would be the only option for settlements along the Paraguay River. Motor Columbus's economic analysis indicated that all alternatives had a negative net value. That is, from a strictly economic standpoint, during the useful life of such works total costs would exceed tangible benefits. The cost of the dike was estimated at US$300 million (1977 dollars).

In 1983 a US team headed up by Miguel Lopez of the US Geological Survey analyzed risks of flooding of the Paraguay and Paraná rivers, coming to the same conclusions as Motor Columbus and Associates. Since the study (1977-79), construction costs have risen, but not the benefits.

A wide range of actions are feasible for reducing risk and susceptibility to damage caused by flooding. These actions generally involve little or no construction. Management of the flood plain can be implemented, considering it as part of the overall river system. This kind of management recognizes that the rivers will continue to overflow into the plain in the future just as they have done to date, whenever the volume rises above normal levels. Management of the flood plain promotes the practice of using lands in a manner compatible with flood risks.

Based on studies carried out to date, the following measures are recommended:

1. Determine the physical boundaries of the flood plain.
2. Inform all local authorities in provinces subject to flooding as to the extent of susceptible areas, so they know how many people will be affected if the river rises.
3. At critical times, maintain a hydrologic alert network, based in Asunción, to forecast floods and thus predict potential damage, proposing possible solutions to local authorities.
4. Create an official Civil Defense institution to make decisions in extreme cases.
5. Use lands in accordance with their potential to use floodwaters for irrigation.

Conclusions and Recommendations

The basic hydrological problem facing Paraguay today is related to the limited available data base for defining local conditions and specific sites. It is possible that many existing or potential problem areas are obscured by the relatively limited data base. In this regard efforts are underway to develop a system for gathering hydrometeorological data in Paraguay. The Weather Service of the Ministry of Defense, with the cooperation of international organizations such as USAID and the World Meteorological Organization, is in charge of this effort, which deserves optimum support.

As this data-gathering system is being set up, it is probable that new problems related to water resources will emerge. This, together with the inevitable increase in demand for water resources as a result of growing population and ongoing use of such resources, makes it imperative to incorporate the results

of hydrological data analysis into the decision-making process. This objective can be attained through an effort aimed at increasing Paraguayan hydrologists' knowledge of the complexity of the decision-making process. The relationship between environmental resources and processes, and collateral effects from exploitation of water resources should be impressed upon decision-makers. The best way to do this may be through an exchange with their counterparts in the United States, and by initiating interdisciplinary seminars and workshops to deal specifically with matters related to water use, exploitation of water resources in general, and needs of the decision-making process.

Based on the general data available for this study, all of Paraguay's characteristic hydrological phenomena can be deduced by understanding: 1) the decline in surface water exchange across the country from east to west; and, 2) the low hydrologic gradients that characterize the drainage system.

Seasonal flooding of the Paraguay River's flood plain and of the straight lower sections of some of its tributaries will continue to pose a problem. It is believed that there are no viable engineering solutions to this situation, unless the cost-benefit relation were to balance out to some extent. Such a model should be based on greater meteorological data than is currently available.

Measurements of precipitation, especially in the Eastern region between Concepción and the confluence of the Paraguay and Paraná Rivers should be linked to hydrometric stations, along the main tributaries of the Paraguay River in this section, so as to determine the inflow-outflow relation of water presumed to be at least in part responsible for the high crest of annual flooding. This should also include calculation of stream flow. Finally, measurements should be developed to register water levels and water inflow rates. Reliable maps covering the entire flood plain of the Paraguay River and reflecting anticipated levels of flooding in the *Pantanal* (Brazil) should be drafted.

There are no indications that Paraguay's main drainage system poses any water quality problem at present. Nonetheless, a limited number of water quality control stations should be set up at representative sites so as to provide basic data and serve as an advanced warning system concerning water quality problems as population and use of water resources increase.

The groundwater resources of the Chaco are probably insufficient for development of any water-intensive activity based on such resources.

At present the Paraguayan government's main objective should be assuring that existing groundwater quality not be degraded by toxic substances or toxic microorganisms. In straightforward terms this means designing sites for depositing wastes so as to minimize exchange of water from among the wastes and water in the aquifers. It also implies that use of chemical products in agriculture at the surface should be carefully monitored so as to prevent unacceptable levels of non-soluble chemicals from entering the aquiferous strata. Once aquifers with low hydrostatic gradients and low levels of overburden—like those found in most of the Chaco—are polluted, it becomes virtually impossible to eliminate the pollution. In extreme cases, potential potable water supplies from aquifers are rendered unfit for human consumption.

Table VII – 2

Degree of erosion for selected regions of Paraguay

Region	% Erosion			Area Total – Ha	% of Total Area Affected by Erosion
	Slight	Moderate	Severe		
Paraguarí	18	8	6	825,500	32
Caazapá	45	14	9	336,500	68
Curuguaty	50	18	2	249,000	70
Eje Norte	74	5	5	132,000	84
Yvy–Yeú	54	6	–	173,500	60
Alto Paraná	73	2	–	747,000	75

Source: Symposium on Erosion in the La Plata Basin. 1979.

Table VII – 3

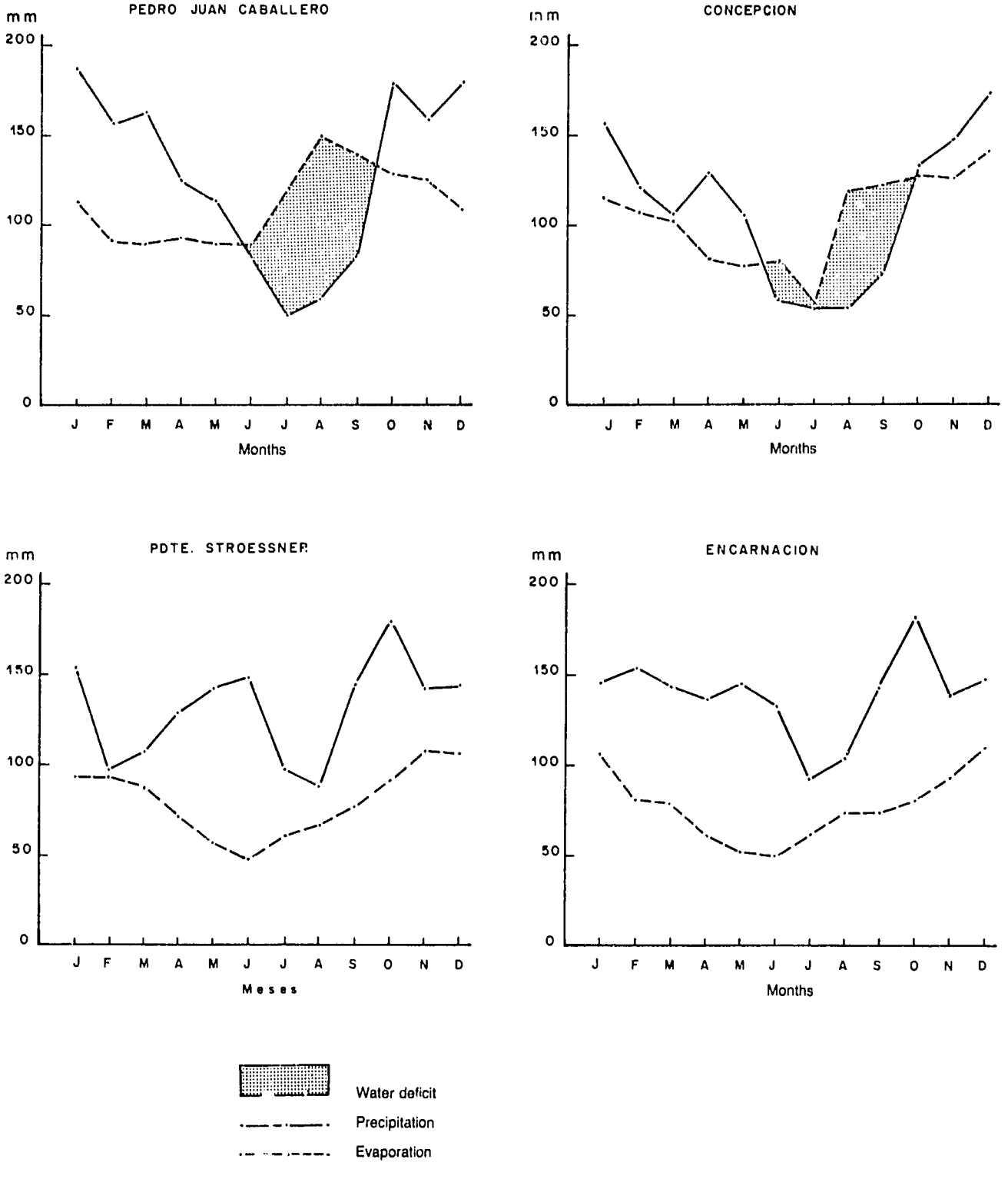
Estimated land use in Paraguay

Type of Use	Eastern Region		Western Region		All Paraguay	
	(Km²)	%	(Km²)	%	(Km²)	%
Crop Production	59,360	37	17,190	7	76,550	18
Livestock	57,623	36	100,000	40	157,623	38
Forests	36,100	23	112,900	46	150,000	42
Parks & Reserves	209	–	12,830	5	23,039	1
Other*	6,535	4	4,005	2	10,540	1
TOTAL	159,827	100	246,925	100	406,752	100

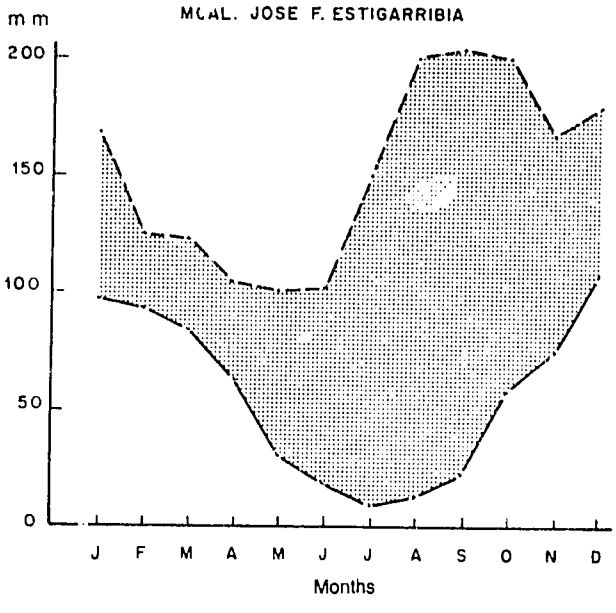
* Area covered by cities, towns, rivers, lakes, mountains, and roadways.

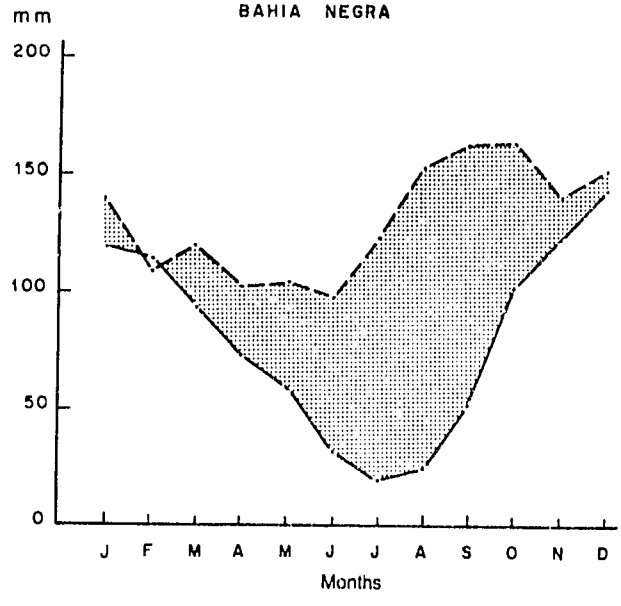
Source: Data gathered by Humberto Tosaido, UNDP/FAO Project BAR/76/005 – 1980.

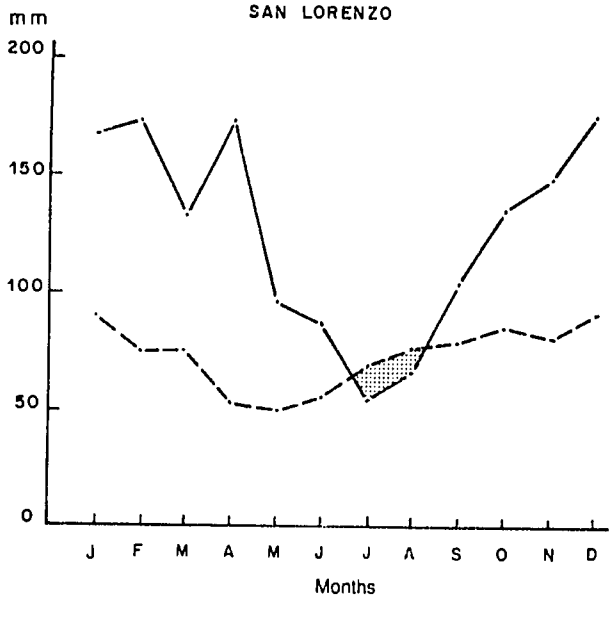
Graph VII – 1
Diagrams of Precipitation and Evaporation

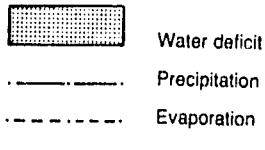


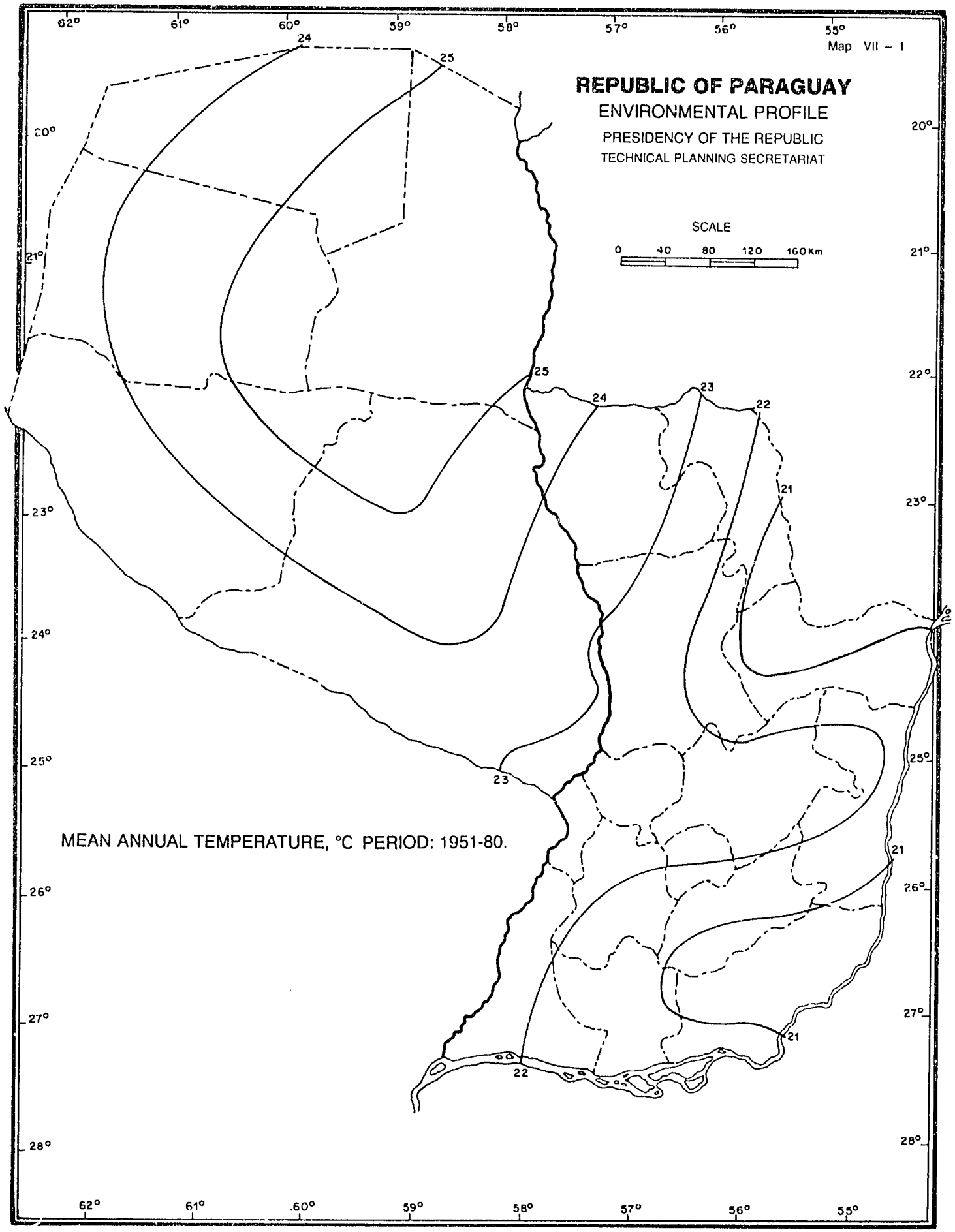
Graph VII – 1, cont.
Diagrams of Precipitation and Evaporation

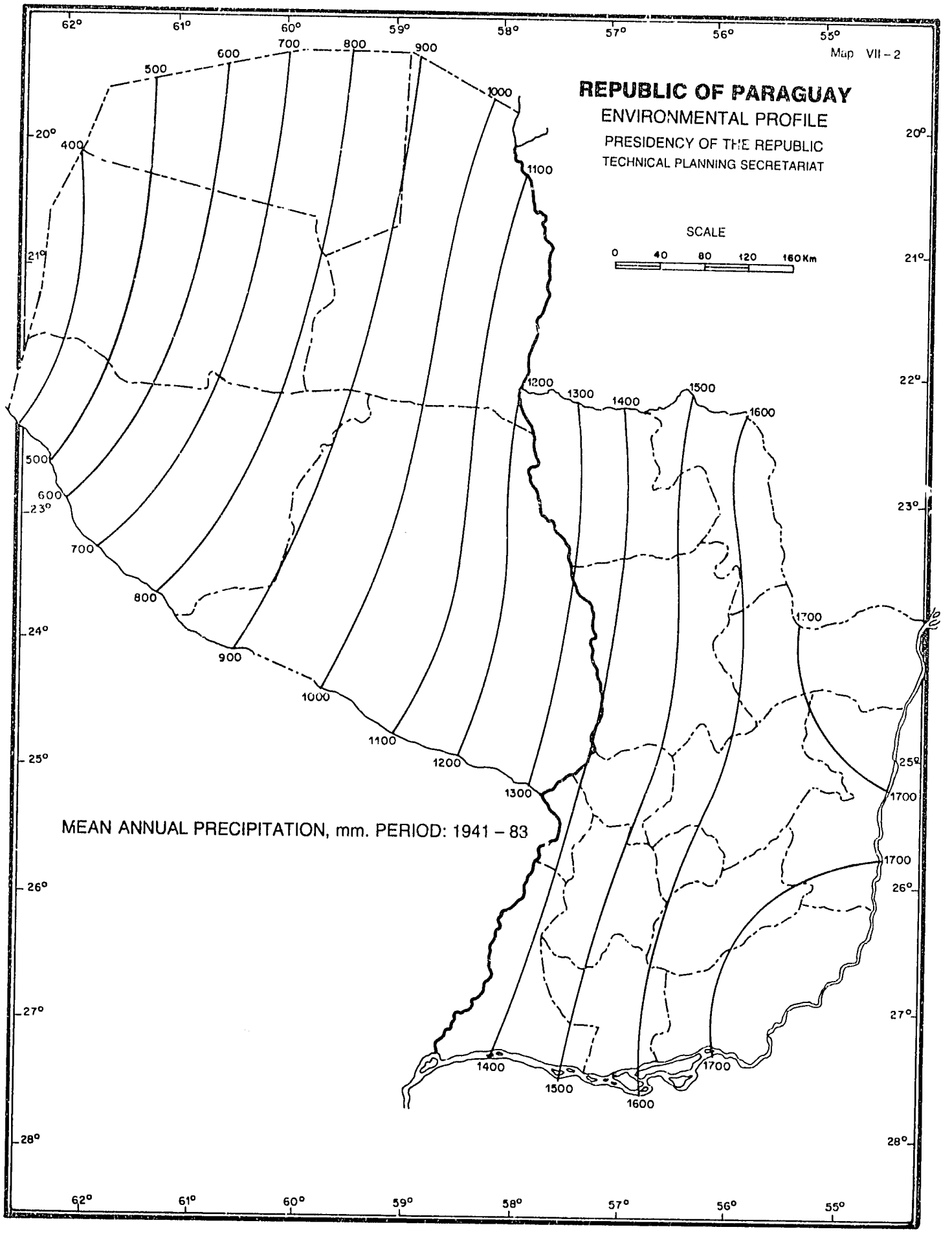


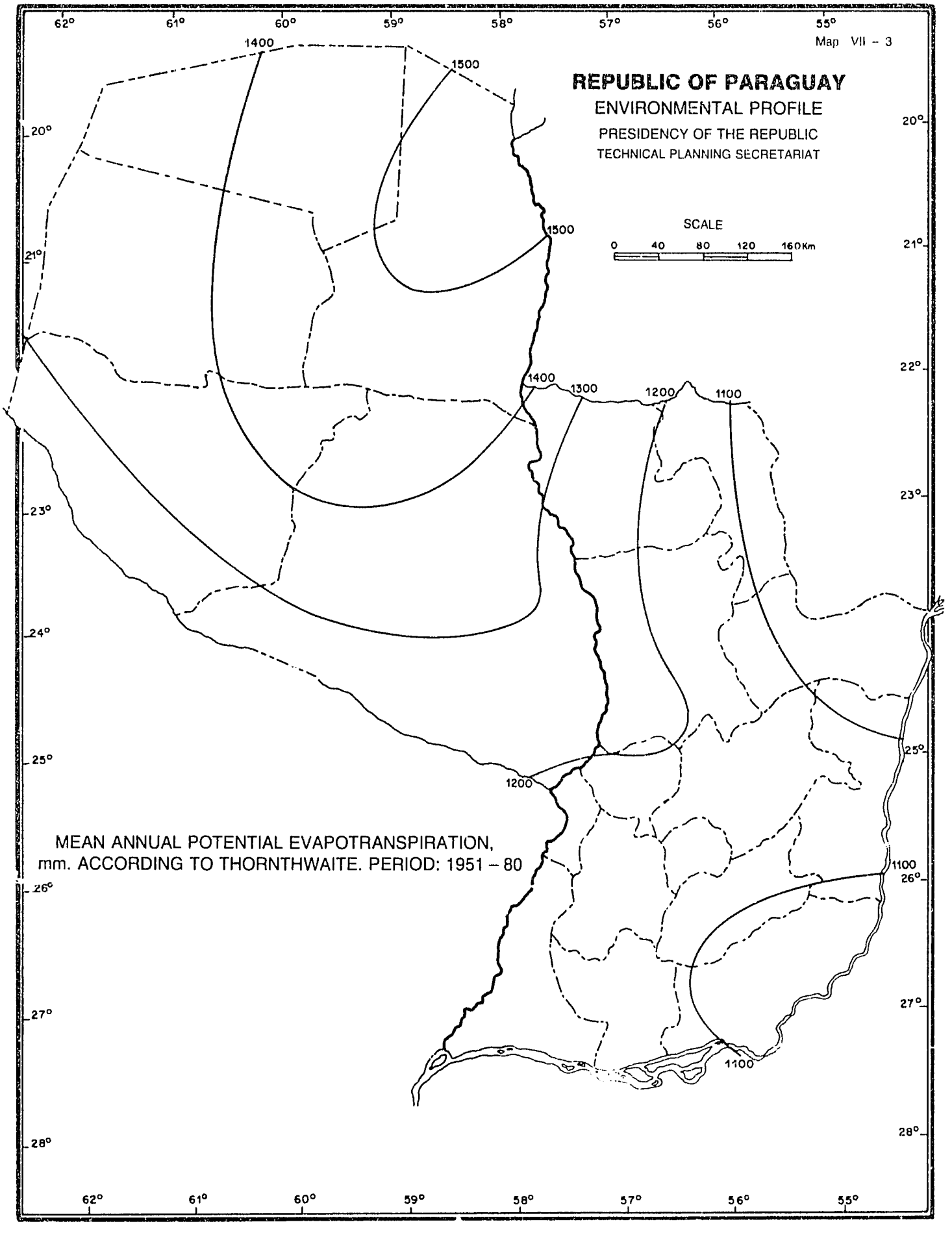




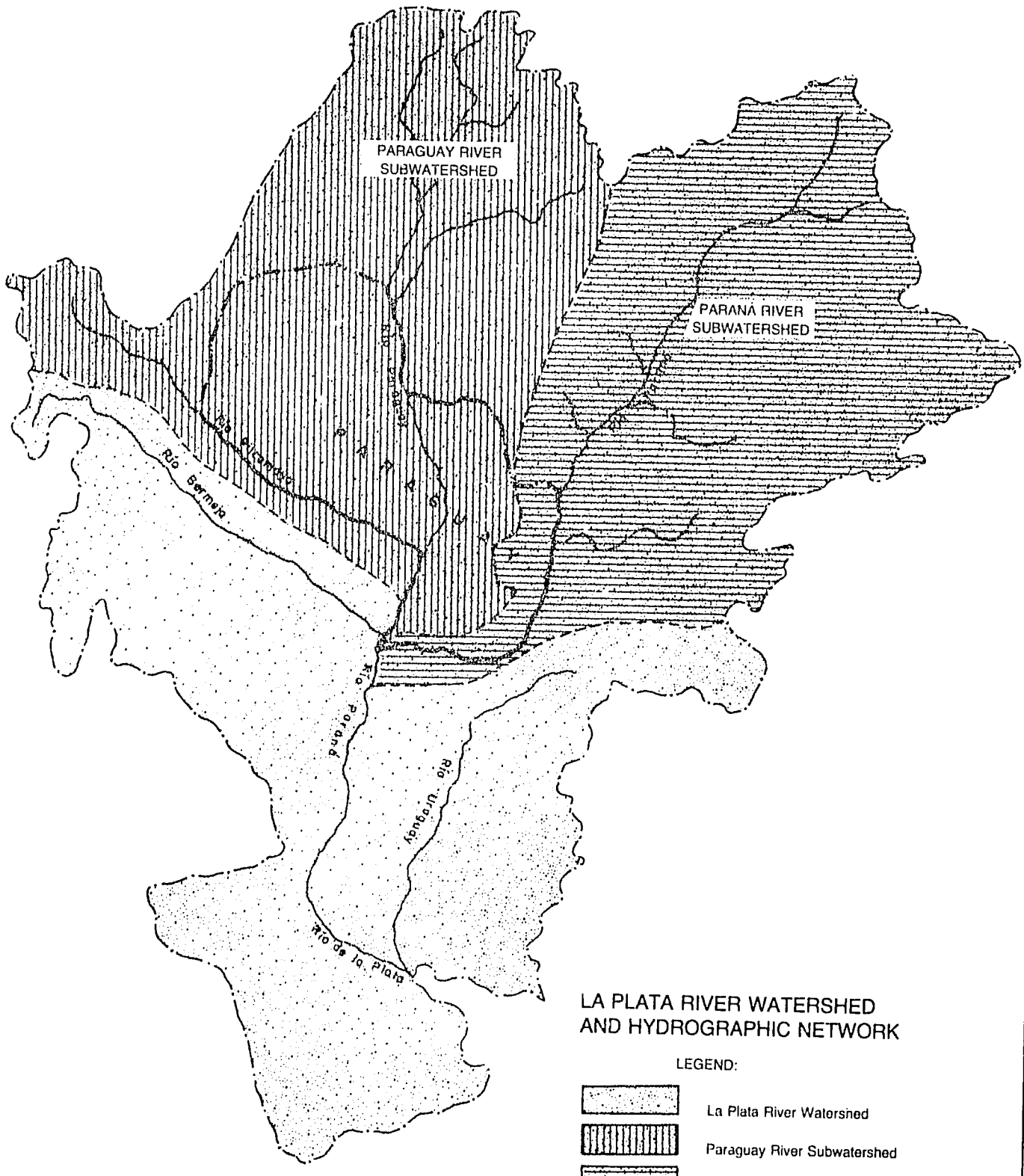


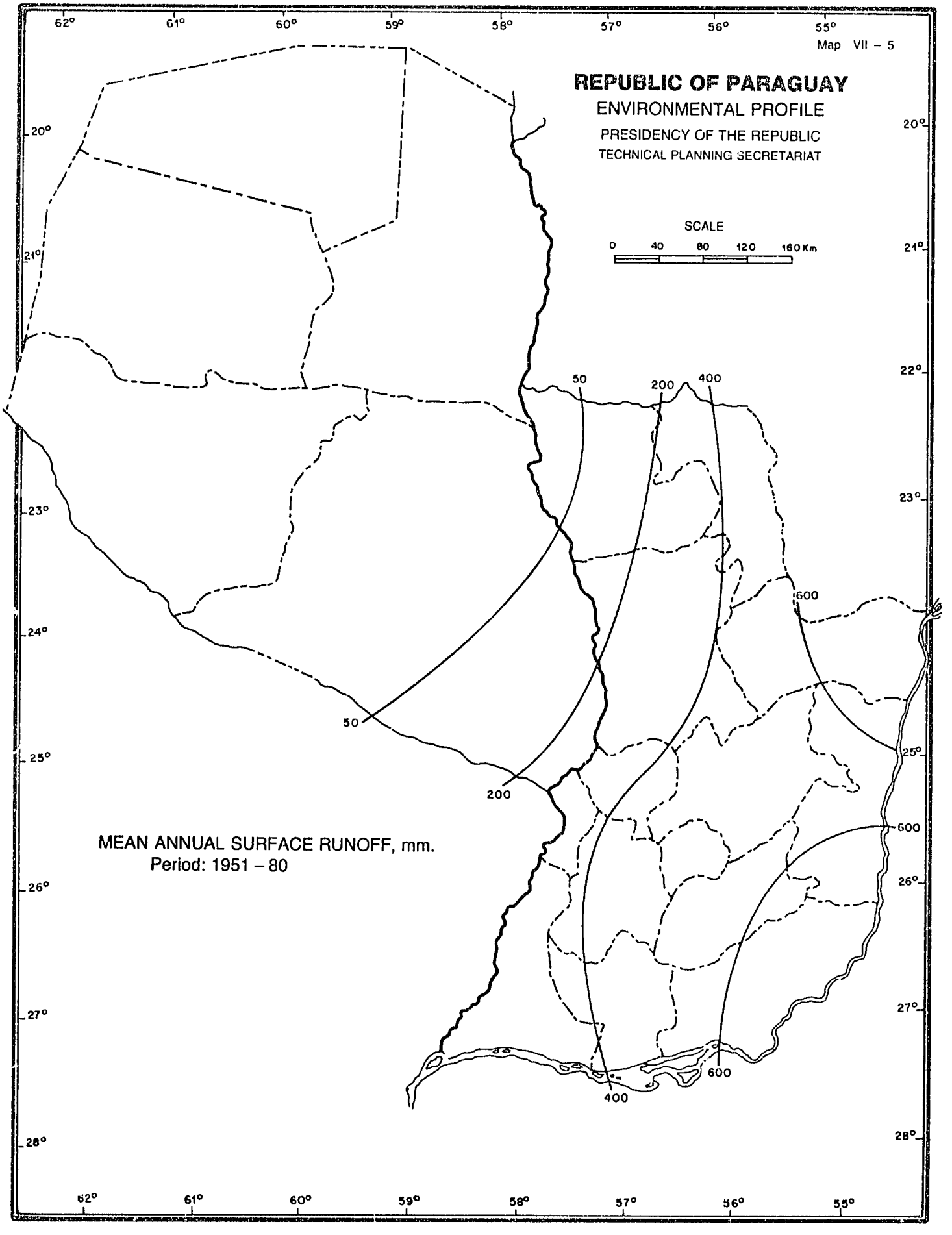

Map VII - 1
REPUBLIC OF PARAGUAY
ENVIRONMENTAL PROFILE
PRESIDENCY OF THE REPUBLIC
TECHNICAL PLANNING SECRETARIAT
SCALE
0 40 80 120 160 Km
MEAN ANNUAL TEMPERATURE, °C PERIOD: 1951-80.
62° 61° 60° 59° 58° 57° 56° 55°
20° 21° 22° 23° 24° 25° 26° 27° 28°
24 25 25 24 23 22 21 23 22 21 21

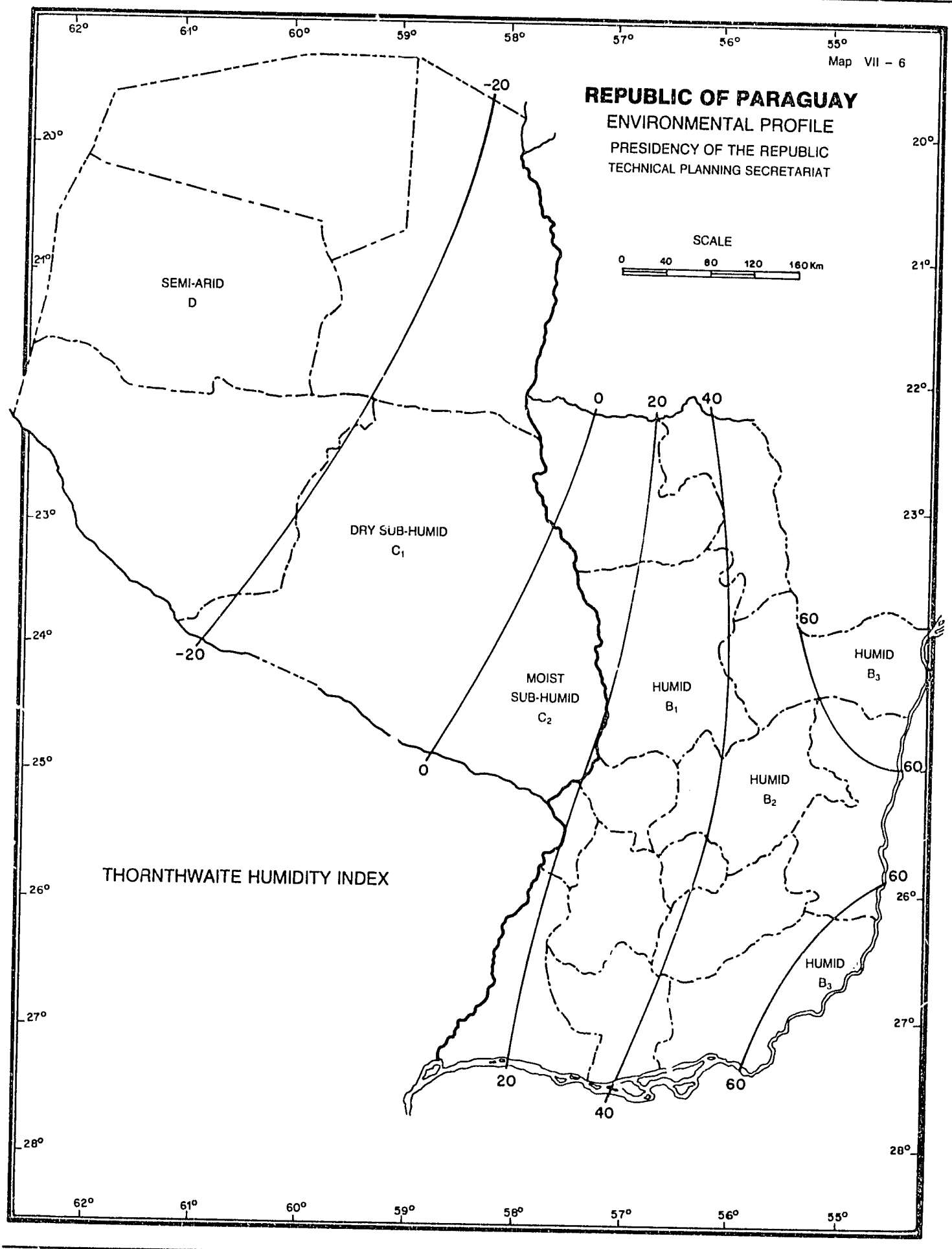

Map VII - 2
REPUBLIC OF PARAGUAY
ENVIRONMENTAL PROFILE
PRESIDENCY OF THE REPUBLIC
TECHNICAL PLANNING SECRETARIAT
SCALE
0 40 80 120 160 Km
MEAN ANNUAL PRECIPITATION, mm. PERIOD: 1941 – 83
62° 61° 60° 59° 58° 57° 56° 55°
20° 21° 22° 23° 24° 25° 26° 27° 28°
500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700

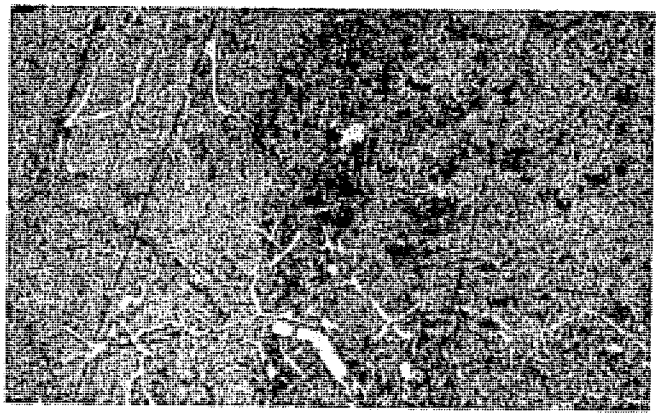

Map VII - 3
REPUBLIC OF PARAGUAY
ENVIRONMENTAL PROFILE
PRESIDENCY OF THE REPUBLIC
TECHNICAL PLANNING SECRETARIAT
SCALE
0 40 80 120 160Km
62° 61° 60° 59° 58° 57° 56° 55°
20° 21° 22° 23° 24° 25° 26° 27° 28°
1400
1500
1300
1200
1100
MEAN ANNUAL POTENTIAL EVAPOTRANSPIRATION,
mm. ACCORDING TO THORNTHWAITE. PERIOD: 1951 – 80

Map VII – 4


PARAGUAY RIVER
SUBWATERSHED
PARANÁ RIVER
SUBWATERSHED
Río Bermejo
Río Pilcomayo
Río Paraguay
Río Paraná
Río Uruguay
Río de la Plata
LA PLATA RIVER WATERSHED
AND HYDROGRAPHIC NETWORK
LEGEND:
La Plata River Watersned
Paraguay River Subwatershed
Paraná River Subwatershed

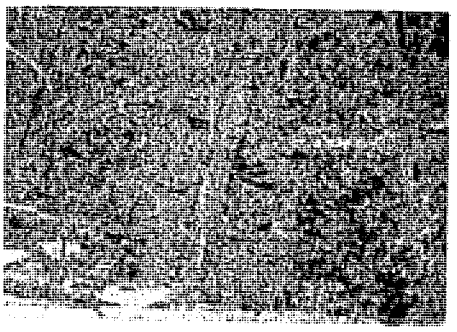

Map VII – 5
REPUBLIC OF PARAGUAY
ENVIRONMENTAL PROFILE
PRESIDENCY OF THE REPUBLIC
TECHNICAL PLANNING SECRETARIAT
SCALE
0 40 80 120 160 Km
MEAN ANNUAL SURFACE RUNOFF, mm.
Period: 1951 – 80
50
200
400
600
62°
61°
60°
59°
58°
57°
56°
55°
20°
21°
22°
23°
24°
25°
26°
27°
28°


Map VII - 6
REPUBLIC OF PARAGUAY
ENVIRONMENTAL PROFILE
PRESIDENCY OF THE REPUBLIC
TECHNICAL PLANNING SECRETARIAT
SCALE
0 40 80 120 160 Km
SEMI-ARID
D
DRY SUB-HUMID
C1
MOIST
SUB-HUMID
C2
HUMID
B1
HUMID
B2
HUMID
B3
HUMID
B3
THORNTHWAITE HUMIDITY INDEX
-20
0
20
40
60
62°
61°
60°
59°
58°
57°
56°
55°
20°
21°
22°
23°
24°
25°
26°
27°
28°

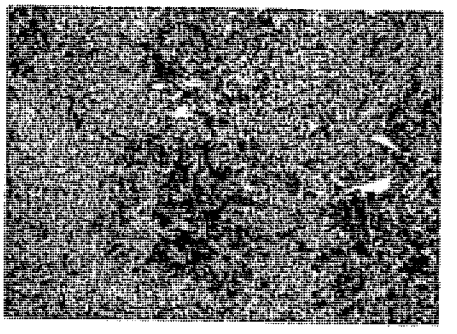


Crested Caracara

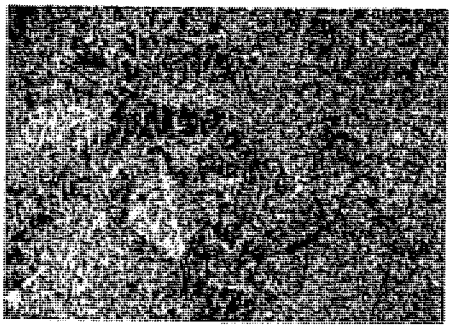
Biological Resources



South American "fox". Photo courtesy National Forest Service.



Common tegu. Photo courtesy National Forest Service.



Coral Snake. Photo courtesy National Forest Service.

Tembay Falls, Itapúa Province. Photo courtesy Gregorio Raidan.

VIII

Biological Resources

Vegetation

Forests

Vegetation, and above all natural forests, differ according to geographic location, with an especially marked contrast between the Eastern and Western regions (see map VIII-1).

The most important natural forests in the Eastern region are found in the region's broad eastern strip, corresponding to the basins of the Paraná River's tributaries, and having a climate Thornthwaite describes as "subtropical moist with hot and moist summers and relatively dry winters"; Holdridge's Life Zone system (map VIII-2) describes the same climate as "warm temperate moist forest life zone." Hueck's vegetation map for South America calls these same forests "subtropical hydrophytic forests." These forests, which Tortorelli calls "the jungle of the upper Paraná," have several species of broadleaved trees that reach heights of 30 m or more where there is good drainage.

The typical tall forest has several strata, with first, second, and third magnitude trees, bushes, grasses, epiphytic lianas, and parasites. The most representative species of this forest are: Spanish cedar (Cedrela sp.), guatambú (Balfourodendron riedelianum), Brazilian myrocarpus (Myrocarpus frondosus), piptadenia (Piptadenia sp.), cordia (Cordia trichotoma), and ybyraró (Pterogyne nitens). These form the dominant stratum of the forest, the codominant stratum being formed by several species of the Lauraceae family.

The conformation of low forest, which forms the subordinate stratum, is similar to that of the tall forest, but with vegetation generally not taller than 15 m. This kind of forest grows along running water and in soils subject to periodic flooding. The trees of this stratum often have deformed trunks; the most representative species are those of the Myrtaceae and Sapotaceae families.

The low forest formations are ecologically significant, for besides constituting the natural habitat of the fauna, they play a key role in the hydrologic cycle.

The undergrowth is the last stratum of the forest, and is made up of a large number of shrubs and annual and perennial plants from 2 to 5 meters tall. The most important families are the pepper familiy (Piperaceae) and the Urticaceae, and some grasses, such as the "Takuapí" and the "Takuarembó", which form thick creepers.

Other important forests in the Eastern region are those in the northeast and center, which Tortorelli called the Central Jungle and the Northern Forests. These include much of the provinces of Amambay, Canindeyú, Concepción, San Pedro, Caaguazú, and Caazapá, and correspond entirely to basins of Paraguay River tributaries.

These forests are made up of broadleaved trees, characterized by the large number of peroba (Aspidosperma australe) in the northeast. This is the main species in the tall forest there; in some areas it forms pure stands. Other commercially valuable species found in abundance in these forests include ybyrapytá (Peltophorum dubium), piptadenia, and guatambú(Balfourodendron riedelianum). The trebol (Amburana cearensis) is the country's most valuable commercial species. Today threatened, it is found in a rather small area in the north, between the Apa and Aquidabán rivers in the province of Concepción.

The forests of the Western region vary from mesophytic to xerophytic as one moves from the Paraguay River in the east, where annual precipitation reaches 1,300 mm, to the border with Bolivia in the west, where annual precipitation is but 500 mm. Golfari, using Thornthwaite's "hydric index," defines three kinds of climate for the Chaco. The first, where precipitation is greatest, is called "moist subhumid"; the intermediate are, "dry subhumid"; and the last, "semiarid" (see map VIII-3). According to Holdridge's system, there are two life zones in the region: the area near the Paraguay River, classified as

warm temperate moist; and the western part, beginning at Pozo Colorado, considered warm temperate dry (map VIII-2).

In the first zone, between isohyets 1,300 mm and 900 mm, extending approximately 150 km from the Paraguay River, the forest has heterogeneous flora, with vegetation rising to 15 to 20 m. The most representative species include: willow-leaf red quebracho (Schinopsis balansae), white quebracho (Apidosperma sp.), trumpet tree (Tabebuia sp.), star tree (Astronium balansae), Argentine calcophyllum (Calycopyllum multiflorum), seron (Phyllostylon rhamnoides), ybyrá ità (Diplokeleve floribunda), and floss-silktree (Chorisia speciosa). Further to the south (lower Chaco) one may also find Piptadenia rigida, ybyráa pytá(Peltophorum dubium), and ybyraró (Pterogyne nitens).

The intermediate climatic zone, lying between the 600 mm and 900 mm isohyets, has the same floristic composition in the forest, differing from the above zone only insofar as it is not as dense nor as tall (10 - 15 m). The most noteworthy difference is that there is less of the male red quebracho, and more of the female, or Schinopsis sarmientii.

In the westernmost zone, with annual rainfall less than 600 mm, the forest is open brushwood; it is not very dense, and the tallest trees are less than 10 meters. The most representative species are the crowntree, Schinopsis sp., white quebracho, palo santo (Bulnesia sarmientii), and several species of acacias and mesquite.

This description of the Chaco forests is similar to Tortorelli's distribution into Chaco Forest, Chaco Parkland, Chaco Forested Savanna, and Western Brushwood (map VIII-1).

Finally, there are the palm formations, made up of a very homogenous association of caranda palm (Copernicia alba), typically found in the Chaco countryside, especially in areas 3 and 4 of map VIII-3.

In 1969 Dr. L.R. Holdridge defined Paraguay's ecological life zones, tentatively concluding that there are only two life zones: the warm temperate dry forest, which covers most of the Chaco, and the warm temperate moist forest, which covers the rest of the country. (Holdridge, 1969; map VIII-2). Although Paraguay's flora is still very incomplete, an estimated 350-400 species are to be found throughout the country. Comparisons with other areas tend to confirm Holdridge's theory that Paraguay is clearly a temperate country. Tropical and subtropical countries have a greater diversity of species than that found in Paraguay.

Current Status of Forests

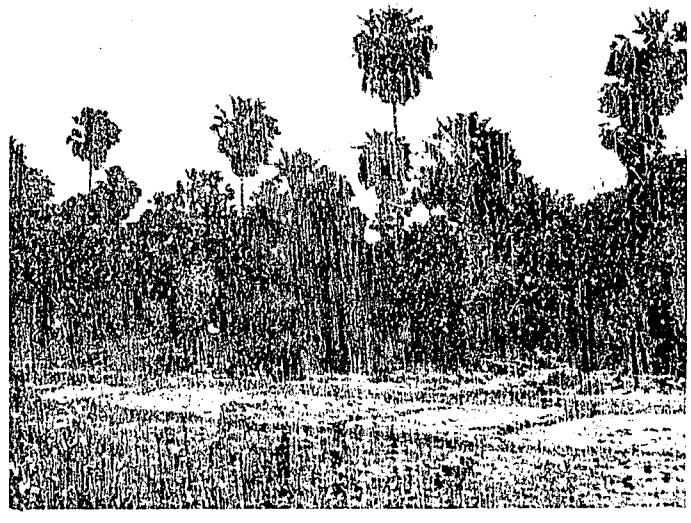
Forests of the Eastern region: Evaluation of the potential of the region's forests is based on analysis of the results of seven forest inventories (see locations on map VIII-4) in several parts of the Eastern region, carried out at different times and with a variety of objectives. These studies cover most of the area's forests.

The forest cover of the basins of the Paraná River's tributaries was much greater than that of the Paraguay's in the early 1970s. This can be explained by data from the inventory, which indicates that the forests of the Paraguay basin had more commercially valuable woods, i.e. the so-called Class A woods. Furthermore, the Paraguay basin had river transport through traditional lumbering ports such as Rosario and Antequera in past decades. With the opening of new roads and the advance of settlement to the east, these tendencies began to change irreversibly.

According to data from the inventories of the tall forests, exploitable volume per ha fluctuated from 20 to 38.1 m^3. Total area of the Eastern region forests was approximately 4.2 million ha in 1976. This figure is estimated to have dropped since then to below 3.5 million ha.

The results of all inventories carried out in the Eastern region coincide in indicating the degree of selectivity of exploitation of just a few commercially valuable species, determined above all by the demands of the international market. Nonetheless, it was also found that overexploitation of the forest, in relation to these species, is compensated for by good natural regeneration; thus rational management could preserve this natural resource in a sustained fashion.

Red quebracho in the Chaco, an important species for the tanning industry that has been heavily overcut. Photo courtesy Juan A. López.



Carandav palm, a useful species that is abundant in the Chaco. It invades pastures aggressively. Photo courtesy Juan A. López.

Forests of the Western region: Forest inventory data for the Western region covers only small areas, such as: 1) the 1982 natural resources study, in the area of Cerro León, covering the "Defensores del Chaco" National Park, with 700,000 ha; 2) the 1978 National Forest Service inventory, covering 30,000 ha in the province of Alto Paraguay; and, 3) the 1984 study on the potential for forest development in a 1.9 million ha area near Pedro P. Peña, carried out in the context of the Comprehensive Chaco Regional Development Project. Estimates of average forest productivity in the area studied came to 34.7 m^3/ha. In Alto Paraguay inventories show quebracho stocks on the order of 17.3 m^3/ha.

Unfortunately, there is still no forest inventory covering the Chaco's most important forests. Such an inventory could quantify their true potential for lumber production. Nonetheless there is no doubt as to the key ecological role of such forests.

Tapping Forest Resources

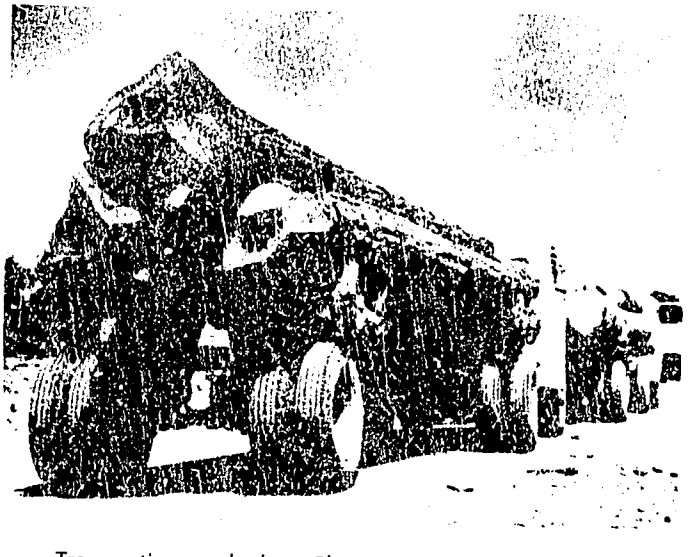
Lumber in Paraguay is produced exclusively from natural forests. Almost all such forests are privately owned in the Eastern region, as are most natural forests in the Western region. This form of ownership determines the form in which they are used, making it difficult to implement forest management plans.

The methods currently used to tap forest resources are:

a) Cutting and removing the branches, which involves felling, removing branches and treetops, and opening the "picadillas" or skid trails. The power saw is increasingly replacing the traditional ax.

b) Skidding and removal, which used to use flat trucks, is generally done with 75 to 120 HP farming tractors, which usually tow an attachment called a "pitogué" (manufactured locally) to skid the timber from the cutting site to roads suitable for trucks, generally 1 to 2 kilometers away. This method yields approximately 15 real m^3/day; larger-scale operations use articulated tractors, which can skid some 60 m^3/day.

c) Loading and unloading: loading is a slow operation and thus is very costly. It is done manually using a "catraca" or a farm tractor. Using an articulated tractor a 12-ton truck can be loaded in one hour; unloading at the loading dock of an industrial plant is generally done with farm tractors.



Transporting peroba logs. Photo courtesy Juan A. López.

d) Transport, which generally uses 8 to 12-ton trucks that tow a locally-built trailer called a "cachapé".

Logging in Paraguay is characterized by its selectivity. According to available data, 94% of total timber cut is Class A, whereas such woods make up only 25% of total commercial stocks. Furthermore, three species (trumpet tree, cedar, and peroba) of all those of Class A quality account for over 75% of all commercially exploited timber.

Not only is the timber felled selectively; the process also involves waste, beginning with the cutting process itself, and continuing through sawmill processing.

According to data gathered by the Paraguayan Federation of Lumbermen (FEPAMA), lumbering in the Eastern region yields one million m^3 of logs annually; the forest industries, with total processing capacity of about 1.5 million m^3 of logs per year, are presently consuming some 800,000 m^3/year, which translates into appromximately 400,000 m^3 of sawn woods, panels, etc. Of this production, according to FEPAMA, 280,000 m^3 are exported. Lumbering has fallen off sharply since 1980.

The only economically significant forest resources in the Chaco are quebracho, cut for its tannin; the palo santo, for essence; and palms, for posts.

Forest Reserves

Most forest reserves in Paraguay are legally-established national parks. Though they were set up for a variety of reasons—

"Kurity", a native conifer important for reforestation. Photo courtesy Juan A. López.

preservation of wildlife, historic sites, scenic landscapes, etc.—almost all of them have significant natural forest reserves. Some were declared national parks specifically to protect the forests. One such example is the Caaguazú National Park, in the province of Caazapá, which is significant insofar as it covers an extensive area of mountainous formations, along the watershed between the Paraguay and Paraná river basins. Unfortunately, the park's original boundaries have repeatedly been reduced. Other parks created to protect forests include the Kurí'y National Reserve, which covers 2,000 ha in Alto Paraná and conserves Araucania remnants, and the Jakui Protective Forest, extending over 1,000 ha in the provinces of Alto Paraná and Itapúa.

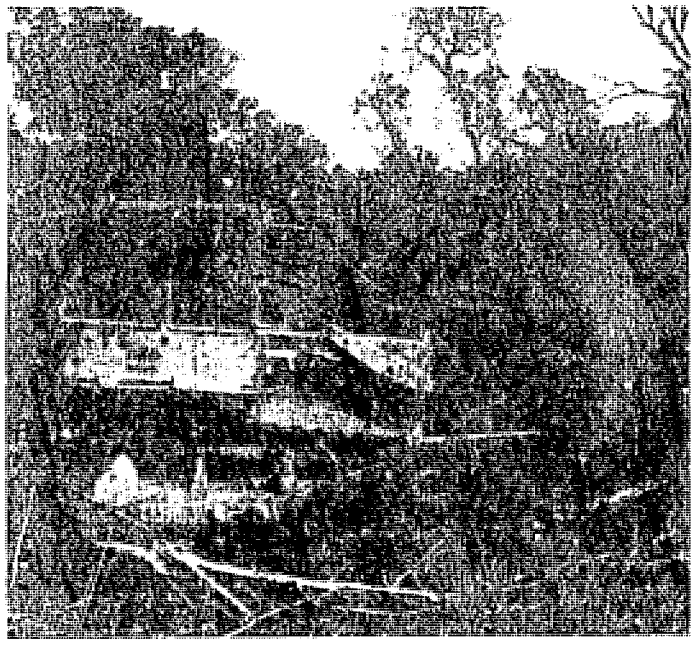
The Itaipú Binational Project has also set aside lands for three biological reserves in Itabó, Limoy, and Itambey, which preserve important forest species. The Binational Project manages these lands.

In general, there are not enough forest reserves, in terms of both the role such reserves should play, and their distribution and total area covered. There are many reasons why Paraguay does not have an adequate forest reserve system; but perhaps the most important is lack of awareness with which the situation is viewed at the various levels of decision-making, for the Forest law currently in effect does lay out the conditions justifying creation of forest reserves.

Deforestation

In the 1960s and particularly the 1970s, indiscriminate clearing came to pose the greatest danger to survival of forests, for in contrast to the more or less rational forms of exploitation, which may eventually prove to be reversible, deforestation is destroying the very basis of forest production.

According to Institute for Rural Welfare data, in the sixties and seventies over 5.6 million ha were cleared, usually at the expense of forests. Indiscriminate clearing in the Eastern region has already reached a critical point given its generally rolling



Mechanized land clearing transforms approximately 150,000 to 200,000 ha per year.

Land clearing near Paranambú, Alto Paraná. Photo courtesy Juan A. López.

topography and the fragility of the soils, all of which could lead to serious environmental and ecological damage.

It is estimated that total forest area in the Eastern region has dropped from 68,364 km^2 in 1945 to 41,770 km^2 in 1976, i.e. from 43% to 26% of the region's total area. According to the estimated rate of deforestation for 1976 to 1984, by 1984 forest lands in the region totalled less than 35,000 km^2, i.e. a drop of 20% as compared to 1976. And this is based on the most conservative of the many estimates one can find.

Plantation Forestry

The National Reforestation Program has progressed very slowly in terms of the overall goals set by the National Forest Service; indeed, for the past two years the program has practically stagnated. After almost a decade the program has yet to plant 10,000 ha, and thus can be considered a failure.

Economic factors behind this failure include the low profitability and long maturity period of the investments; lack of clarity in forestry policy in terms of gearing production to potential markets; the small size and uncertainty prevailing in the domestic market; and strong competition from other Southern Cone markets.

Perhaps the most important cause of the lack of entrepreneurial interest is the apparent conflict between taxation criteria and forest development in government incentives policy. There are encouraging prospects for a market based on forest products for energy (mainly eucalyptus), given the demand for charcoal once the ACEPAR plant begins operations.

In 1976 the government launched a 10-year reforestation plan that was to be financed through tax incentives, thereby placing major responsibility for the plan's success in the hands of the private sector. According to the plan, 77,000 ha were to be planted; nonetheless, to date only 7,000 ha have been planted, 3,820 ha without tax incentives, and 3,180 with incentives. The main species used in reforestation have been pines, eucalyptus, and to a lesser extent, native species.

Reforestation. Approximately 7,000 ha have been planted nationwide.

As the market for products from these plantations is uncertain, many of those involved in reforestation do not trust the market potential, especially when it comes to pines, which could provide raw material for a future pulp factory to manufacture cellulose and paper, and another factory for particle board. Another possible market, as was mentioned, is charcoal to meet the needs of the ACEPAR plant; this demand could be met with native species and eucalyptus.

The world market for kiri is unfavorable, as the main buyer is Japan, whose market is currently saturated. Brazil's plantations alone produce 60 times the Japanese demand.

There are several commercial nurseries in Paraguay, both private and state-owned. Most are permanent, with productive capacity ranging from 100,000 to 2.5 million seedlings annually. These could serve as an incentive to establish forest plantations. The work of the agroforestry nuclei is particularly important. These units are made up of one forest engineer from the National Forest Service and one extension worker from the Agricultural Extension Service, with support from the U.S. Peace Corps. These nuclei are aimed at promoting plantation forestry side-by-side with agricultural production.

Reforestation must take into account not only industrial raw material needs, but also the fundamental protective role of forests, both for soils and for quantity and quality of water resources. In the medium term, lumbering can be expected to come up against serious problems as regards supplying raw materials. Furthermore, total volume of stream flow has diminished in the hydrographic basins that supply the large hydroelectric projects.

The Expanding Agricultural Frontier and the Forests

The advance of the agricultural frontier at the expense of natural forests is one of the most worrisome problems of rural development throughout Paraguay, and is particularly serious in the Eastern region. One of the most critical elements of this problem is settlement of small farmers in agricultural settlements on forest lands without taking into account the use capacity of the soils.

Public and private sector settlement in the sixties and seventies affected 8.7 million ha. Data indicates that about 75% of the total area cleared for agricultural settlements was channelled through the Institute for Rural Welfare.

The problem of the agricultural frontier expanding at the expense of forests, in the framework of business-oriented agriculture, is no less worrisome than the clearing of settlement lots involving massive deforestation of thousands of hectares using heavy machinery, especially in the provinces of Itapua, Alto Paraná, and Canindeyú. This deforestation may proceed at a still faster pace once the paved road between Encarnación and Pte. Stroessner is completed.

Clearing of new areas for cultivated pastures also takes its toll of forest areas, as thousands of hectares of forests in both the Eastern region and the Chaco have been converted to grasslands. The Chaco will be particularly sensitive to the advance of the agricultural frontier given the particular features of its ecosystem. To date its natural environment has hardly been affected; but there is an incipient settlement process—aside from the old Mennonite colonies—based on large-scale capital investment, especially European capital, giving rise to cattle ranches with cultivated pastures, forage trees such as leucaena, and introduction of jojoba.

Forest Management and Conservation

Paraguay is in an excellent position to supply its own forest product needs on an ongoing basis (with sustained yields). Besides supplying its domestic needs, it could be in a position to export valuable products using wood as a raw material. Paraguay has abundant forest lands which are not particularly suited to agriculture, and which should be used for forest pro-

Eucalyptus in the Central area, a species recommended for reforestation because of its rapid growth. Photo courtesy Juan A. López.

duction. Set aside as forests and well-managed, these lands could yield not only the above-mentioned advantages, but could also protect the soils, water resources, and fauna of these forest areas. They would also protect agricultural areas from winds and other harmful phenomena.

Certain basic points should be mentioned:

1) The mixed forests of eastern Paraguay are one of the most valued on the world market. This resource is disppearing very quickly, due to the irrational and uncontrolled form in which it is being exploited, and above all due to expansion of the agricultural frontier.

The forest is disappearing on lands suited for agriculture, where clearing should be done rationally; on lands suited for forestry, where sustained harvesting should be practiced; and in areas where protective forests should remain untouched.

2) The Chaco has vast expanses of forest that are being levelled to make way for livestock and crop production, where the wood is usually burned and the wildlife disappears. In some areas Chaco soils are apt for continuous agriculture and livestock raising; but other soils are very fragile. Natural forests should be converted to other uses in a rational manner, or managed so as to have a perpetual yield of forest products, depending on what the area is best suited for.

3) Loans from both domestic and international sources are key for agricultural development. Agriculture is considered profitable because of its quick return. Often, however, the negative impact on the land is not taken into account. Investment in forestry does not have a rapid return; thus it is hard to secure financing.

4) Joint state-private sector cooperation is needed to turn Paraguay into a country with well-managed forests. As regards the public sector, scientific forest management is a relatively new activity in Paraguay, and there has been little progress in its various branches. Just ten years ago the National Forest Service was formed as an administrative unit within the Ministry of Agriculture and Livestock. The SFN is the appropriate agency for promoting forestry, but little has been done: a basic budget, well-trained human resources, and a strong commitment to resolve Paraguay's forestry problems are all needed.

Economic Potential of Forests

Paraguay's forests are extensive, varied, and could supply the country with most of its forest product needs, whether these be manufactured goods that use wood; fuelwood and charcoal; wildlife; protection of watersheds and soils; recreation; or forested grasslands with forage for livestock. With the exception of paper and pulp products, Paraguay's forests supply almost all domestically-consumed forest products.

Furthermore, Paraguay's forests could cover the country's needs in a sustained fashion for many years, if it were not for deforestation and irrational exploitation. The eastern forests—Paraguay's most valuable—were levelled at a rate of 1,000 km²/year from 1945 to 1976, leaving 68,364 km² at the end of that period. According to all indications, this rate has increased in recent years. Other reports indicate that 2.3% of the northeastern forests are lost each year, and that the annual rate of deforestation for the entire Eastern region is 3.4%. The Chaco's forests are not under so much pressure, but its soils are more fragile, and desertification could become another problem in the region.

These figures alone do not imply irrational deforestation; but most of the felling of trees is not geared to satisfying Paraguayan demand for forest products. Much of the forest is cut and burned so as to clear lands for agriculture. A large part is also cut to export wood.

Exporting forest and farm products without a minimum of processing is a luxury that many countries cannot afford. But there are two ways of doing this: the present system, without rational exploitation, which will bring excellent profits in the short term, simultaneously ruining both soil and forest resources; and a better system, which would involve converting some forests to agriculture, especially those with soils that are so suited.

Two factors could allay some of the pressures on the forests. First, more intensive management of agricultural lands so as to increase yield per hectare. And secondly, a more modern process of tree harvesting to avoid the loss of 50% or more of the wood from each tree.

Grasslands

Classification and Description of Natural Grasslands

In Paraguay there are great expanses covered with vegetation that, given their topography, climate, and soils, can be described as grasslands. Some 21.4 million ha, or 52% of the country's total area, is covered by different kinds of grasslands. The largest extensions of grasslands are along the Paraguay River, on alluvial soils with depressed topography that are generally subject to flooding. Grasslands are mostly located between the isohyets of 800 mm to the northwest (the Chaco) and 1,500 mm to the southeast (Misiones, in the Eastern region); and between isothermal lines of 25°C to 22°C. Table VIII-1 shows distribution of grasslands by provinces, area, total head of cattle, and density of grazing.

Table VIII-1 indicates that 21.4 million ha support 6,341,384 head of cattle. The provinces with the most extensive grasslands are Ñeembucú, Paraguarí, Misiones, Concepción, and San Pedro, in the Eastern region; and Presidente Hayes, Alto Paraguay, and Boquerón in the Western region.

The density of grazing can be used as a technical indicator of grassland productivity. This varies from high density in San Pedro province (.8 ha per head of cattle) to very low density in Chaco province (55.8 ha per head of cattle). Average density for the country as a whole is 3.4 ha/head of cattle; it is 2.5 for the Eastern region and 4.8 for the Chaco.

This description will treat the Western and Eastern regions separately. Shantz's system of classification will be followed, with some other names used to better differentiate among the different kinds of grassland.

Western Region

The Western region, or Chaco, covers 24,692,500 ha, accounting for 60.7% of Paraguay's total area. The region has some 11,438,799 ha classified as grasslands. Of course most of these grasslands are partially covered with woody vegetation, the most common kind of grassland being the savanna.

According to prevalent environmental features, the Chaco can be divided into sub-regions, each one, in turn, with several subdivisions.

Low Chaco and floodplain of the Pilcomayo River This area is located at the southern cone of the region, beginning at Pozo Colorado in the south, and including a strip of land parallel to the Paraguay River the breadth of which varies between 60 and 80 km from the river westward.

The grasslands found in this subregion are as follows:

1.1) Swamps

These are natural grasslands, occupying the most depressed places, and covered by water of considerable depth much of the time. Alluvial soils consist of humic gleys and shallow planosols that are dark, with silty clays, and impermeable hard clay subsoils. High in organic matter, calcium, phosphorus, and potassium, aeration is poor and surface drainage slow.

Herbaceous vegetation of the upper stratum is made up mostly of cypress grass (Cyperus gigateus) Ceripus validus, reeds, Thypa latifolia, Thalia geniculata and T. multiflora (Peguajhó). Herbaceous vegetation of the lower stratum is made up of good quality forage grasses such as clubhead cutgrass (Leersia hexandra) panic grass (Panicum elephantipes), Diplachne uninervia (rice grass), and Hyenachne amplexicaulis (pasto-y).

The swamps generally have savanna vegetation growing around the edges, with the caranda palm (Copernicia australis) particularly significant.

1.2) Marshlands

These are natural grasslands, occupying depressed areas where the water just covers the surface, and where dry and flooded periods alternate, flooded conditions prevailing most of the time. The soils are hydromorphic planosols, or humic gley. They have silty mud with impermeable hard clay subsoils, and slow surface drainage. Marshlands have a high capacity for ionic exchange, and are high in organic matter, phosphorus, calcium, and potassium. Aeration is poor.

The vegetation is made up of excellent quality forage grasses, the most noteworthy ones being Hemarthria altissima (carnation grass), Paspalum alcalinum, longtom paspalum (P. lividum), combs paspalum (P. almum), Louisiana cupgrass (Eriochloa punctata) clubhead cutgrass (Leersia hexandra), and Bermuda grass (Cynodon dactylon). Like the swamp vegetation, the marshlands have savanna type vegetation around the edges, in which the caranda palm and Acacia cavenia (aromita) prevail.

1.3) Palm savanna

This formation corresponds to savanna vegetation. It occurs in flat areas that represent a transition between the depression of the swamps and marshlands, and the heights of the esparto savannas or brushwood. They are subject to short-term flooding, alternating with dry periods, with high soil moisture. The palm savanna has grav hydromorphic soils (planosols), with silty muds and with impermeable hard clay subsoils. Surface drainage is slow, and permeabilitv poor, with shallow, poorly aerated soils. This savanna is low in organic matter and high in phosphorus, calcium, and potassium. The herbaceous vegetation is made up of upright shrub species such as Indiangrass (Sorghastrum agrostoides), Paspalum pauciliatum and brownseed paspalum (P. plicatulum). These species lose some or all of their forage quality rapidly as the shrubs develop, falling to minimum levels at flowering. There are also low grass species, good for forage, such as combs paspalum (Paspalum almum), Bermuda grass (Cynodon dactylon), and Paspalum alcalinum. Woody vegetation includes common mesquite (Prosopis campestris), black algarrobo (P. nigra), algarrobillo (P. algarrobilla), caranday palm, and Cathornion plyanthum (timbó).

1.4) High grass grasslands

These grasslands occur in areas where droughts and floods alternate. The grass species are tall and generally make for good forage. Among them are longtom paspalum (Paspalum lividum), Paspalum alcalinum, Louisiana cupgrass (Eriochloa punctata) and Porobulus argentinus. The botanical makeup of these grasslands is similar to marshland vegetation. During droughts, the vegetation is hardly productive, indeed it would seem that the vegetation were absent. With the floods, the presence of grasses is exuberant. These grasslands have varying degrees of brushwood such as viñal, aromita, algarrobillo, algarroba, and labon. These grasslands are quite common in the dry subhumid climatic region, and correspond to the transition from the low Chaco to the dry Chaco (Pozo Colorado, Pirahú, the General Díaz area, and Salazar).

2) Upland grasslands

Also found within the Chaco depression and Pilcomayo floodplain, and in the dry Chaco, are forms of vegetation covering relatively higher areas, which are not as moist nor as prone to flooding as those described above as low grasslands. Such vegetation can be broken down into esparto savanna and brushwood.

2.1) Esparto savanna

This corresponds to savanna vegetation, occupying higher areas less susceptible to flooding. The soils are hydromorphic, with loamy surface of variable depth (10 to 30 cm) above an impermeable hard clay subsoil. Surface drainage is good. Low in organic matter, this savanna is high in capacity for ionic exchange, phosphorus, potassium, and calcium.

Woody vegetation includes the caranda palm, espinillo, black algarroba, and algarrobillo. The prevalence of some of these species varies from zone to zone. In the Pilcomayo area, algarroba and algarrobillo prevail, whereas in the eastern Chaco depression palm and espinillo are most common.

Herbaceous vegetation is made up above all by balsamscale (Elyonorus latiflorus), brownseed paspalum (Paspalum plicatulum), cordgrass (Spartina argentinensis), fourflower trichloris (Trichloris pluriflora), manyspiked chloris (Chloris polydactila), and dropseed (Sporobulus pyramidatus).

3) Dry Chaco

The dry Chaco has two subregions: the central plain and the western plain. The predominant climate is dry subhumid, megathermal, with moisture deficit, varying between the 500 mm and 900 mm isohyets.

3.1) Semiarid savanna

In both subregions the prevalent vegetation corresponds to the savanna and dry forest, which means that woody vegetation prevails over herbaceous vegetation. The most common woody species are: red quebracho, white quebracho, bulnesia (Bulnesia sarmientoi), and Argentine calcophyllum. Herbaceous vegetation is very thin and is found along channels or drainage depressions, and in interstices in the forest. The most significant species are: balsamscale(Elyonorus adustus), six-

weeks threeawn (Aristida adscensionis), Heteropogon contortus, Trichloris crinita, and bristlegrass (Setaria leianta).

Eastern Region

In the Eastern region, as in the Chaco, grasslands are found in both high and low areas. There is a marked predominance of grasslands in low areas.

1) Low grasslands

1.1) Savanna with palm groves

On the east bank of the Paraguay River a strip of vegetation occurs, varying in width, characteristic of the eastern Chaco depression, i.e. palm savanna. This vegetation grows over hydromorphic soils—planosols and humic gleys—with limited permeability. The soils are deep, with poorly aerated clay subsoils. They have variable organic matter, and adequate levels of phosphorus, calcium, and potassium. The vegetation corresponds to the savanna formation in which the woody vegetation is represented by the caranda palm, espinillo, Mimosa millefoliata, and Mimosa asperata. The herbaceous vegetation is made up of upright shrub species, such as Indiangrass (Sorghastrum agrostoides), panic grass (Panicum prionitis), Paspalum pauciliatum, and bluestem grasses (Andropogen lateralis and A. condensatum); and low-lying species, such as tropical carpetgrass (Axonopus compressus), brownseed paspalum (Paspalum plicatulum), balsamscale (Elyonurus latiflorus), and Bermuda grass (Cynodon dactylon).

1.2) Flat grasslands with tall grasses

These areas are found in the Eastern region bordering on the palm savanna along the Paraguay River and often in the interior. These grasslands are typical, and generally lie in extensive plains subject to short-term flooding. These flat grasslands occur above hydromorphic soils—planosols with sandy, horizontal surface—and silty muds, which in turn cover an impermeable hard clay subsoil. Internal drainage is limited, while surface drainage is moderate. The soils are acidic with intermediate amounts of organic matter and are low in phosphorus, calcium, and potassium. Given their physical-chemical properties, flat topography, and capacity for surface drainage, these soils are ideal for conversion to croplands, especially for rice. The main upright species are Indiangrass (Sorghastrum agrostoides), bluestems (Andropogon condensatum and A. lateralis), panic grass (Panicum prionitis), and cypress grass (Cyperus sp.); the main creeping species are tropical carpetgrass (Axonopus compressus), A. affinis, Bahiagrass (Paspalum notatum), Paspalum guaraniticum, and cypress grasses (Cyperus spp.).

In conditions of undergrazing this vegetation becomes tall and shrub-like with little nutritive value. Such vegetation is burned frequently to make use of the land. When there is overgrazing, there are low grasses, such as Axonopus and Paspalum.

1.3) Low grasslands in depressed lands

These correspond to grassland vegetation. These grasslands develop in depressed areas that normally retain water at the surface or, more frequently, form natural drainage channels for extensive areas of highlands or plains near rivers and streams. The soils are hydromorphic, generally shallow, light in texture and rest on impermeable hard clay subsoils—planosols or acidic humic gleys—and are high in organic matter, low in calcium, phosphorus, and potassium, and poorly aerated. The vegetation is made up of tall grasses such as panic grass (Panicum pronitis), Indiangrass (Sorghastrum agrostoides), bluestem grass (Andropogon lateralis), satintail grass (Imperata brasiliensis), Paspalum Devincenzii, Cyperus giganteus, and witchgrass (Thypa latifolia); and low grasses such as clubhead cutgrass (Leersia hexandra) and Panicum elephantipes. These grasslands are characterized by their high productivity of forage, low nutritive value, and difficult access due to their swampy nature. In general, they could be best used as wildlife preserves.

1.4) Swamps

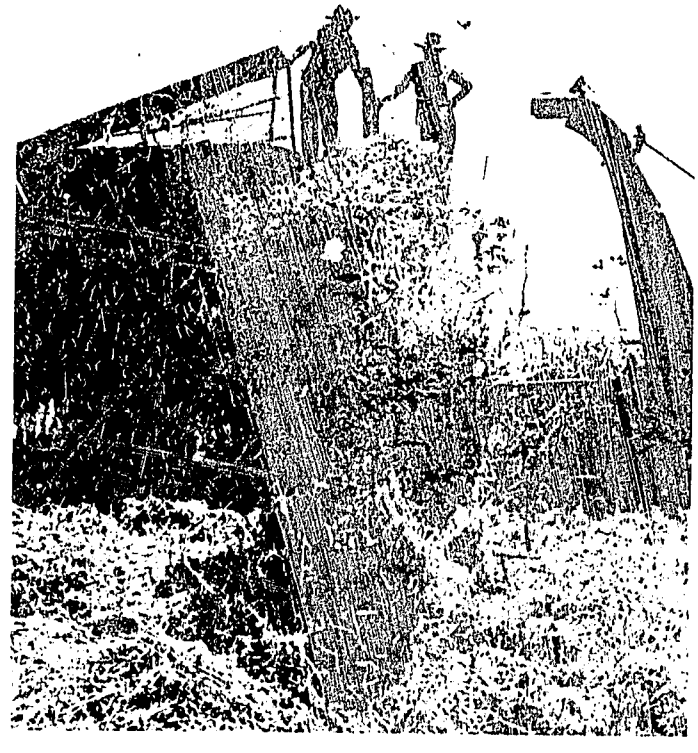
These correspond to grassland formations. They are similar to the low grasslands, but are deeper and hold water longer. There is little or no runoff of surface water. The vegetation is that of permanently moist environments: camalote, camalotillo, pirí, reeds, peguajó, and yahapé. Of limited forage value, these grasslands may be best used as wildlife preserves and for recreation. Lake Ypoá and environs and the drainage areas of Lake Ypacaraí constitute extensive areas covered by swamp vegetation.

2) Upland grasslands

2.1) Rolling grasslands

These correspond to grassland formations. They cover transition areas between low grasslands and upland grasslands and lie above transported or residual soils.

The soils are acidic, and poor in organic matter and minerals. Surface drainage is good, permeability is average. Forage is generally made up of mixtures of upright and creeping grasses. Among the upright grasses the most common are bluestem (Andropogon lateralis) and Indiangrass (Sorghastrum agrostoides); while the most common creeping grasses are Bahia-



In some areas the land produces excellent cut forage.

grass (Paspalum notatum) and tropical carpetgrass (Axonopus compressus). Paspalum predominates in the northern fields, and Axonopus in the south; both make excellent pastures.

2.2) Forested grasslands

These correspond to grassland formations. They occur at high physiographic sites, usually above residual soils derived from sandstone (in Concepción, San Pedro, Amambay, Misiones, and Caaguazú), granite (Paraguarí), and basalt (Itapúa, Alto Paraná). As they are found at higher altitudes these grasslands do not have excess soil moisture. Depending on soil depth and water retention capacity, these grasslands are generally affected by drought. The physical properties of the soils render them fit for conversion to croplands, especially in Misiones, Caaguazú, Itapúa, and Alto Paraná, even though the yields are limited by significant mineral deficiencies and high acidity. There are good foraging grasses, especially common carpetgrass (Axonopus affinis) Bahiagrass (Paspalum notatum), brownseed paspalum (P. plicatulum), and bluestem (Andropogon lateralis) in the grasslands of the northern area (Concepción, San Pedro, Amambay); and tropical carpetgrass (Axonopus compressus), brownseed paspalum (Paspalum plicatulum), bluestem (Andropogon lateralis), and Indiangrass (Sorghastrum agrostoides) in the forested grasslands of the south (Misiones, Caaguazú, Itapúa). The forested grasslands in the north have been penetrated by yataí (Butia yatay) and araza pé, while the southern grasslands have been penetrated by typychá moroty (Veronia chamaedrys).

Cultivated Grasslands

While livestock raising is generally carried out using forage from natural pastures, Paraguay has the proper conditions for developing improved cultivated pastures with greater productive potential both quantitatively and qualitatively.

In order to reduce the negative effects of feeding exclusively on natural pastures, and to increase livestock population on ranches, producers have been steadily incorporating cultivated pastures. Among the most widely used species are:

Spreading crabgrass, (Digitaria decumbens), in parts of the Eastern region and in the Chaco depression, generally on alluvial soils in plains that may be subject to short-term flooding.

Guineagrass, (Panicum maximum), in areas with residual soils, originally covered with forest vegetation, characterized by good drainage, depth, aeration, absence of floods, and average and high fertility. Extensive forest areas in the provinces of San Pedro, Concepción, Amambay, Alto Paraná, and Canindeyú were deforested and planted with guineagrass. At present these are among the most productive livestock-raising areas of the country.

Sandbur grass, (Cenchrus ciliaris), is found in parts of the dry Chaco (central plain and semiarid savanna), on lands characterized by deep sandy soils with good drainage and aeration, and water deficiency (semiarid-dry). Extensive areas of these regions have been planted with sandbur grass which are the basis of the high levels of beef and milk production attained by the Mennonites.

Star grass, (Cynodon plectostachyus), is the most suited of all cultivated grasses in Paraguay to a wide variety of environmental conditions. Extensive star grass plantations can be found in the southeastern part of the Eastern region (Itapúa and Alto Paraná), the northeastern part (Amambay, San Pedro, and Canindeyú), and in the Chaco depression and the dry Chaco. At present the Mennonite colonies are cultivating this species intensively.

Other species, such as signalgrasses (Bracchiara decumbens and B. humidicola), and bristlegrass (Setaria sphacelata, Kazungula variety), have only been used recently in Paraguay. The brachiarias and setarias have rapidly become popular among ranchers given their excellent adaptability and productivity in several parts of the country.

There are indications that 1 million ha of artificial grasslands have been planted in Paraguay.

Natural Grasslands and Forage Production

Receptivity of the grasslands. Making use of the tremendous quantity of forage produced by natural grasslands—converting it into animal products such as meat, milk, leather, and wool—depends on how the grasslands are managed. One of the main management techniques is planting pastures in accordance with their receptive capacity. The receptivity of grasslands is defined as "the total number of hectares of foraging area needed to satisfy the feed demand of one animal," (a 400 kg steer), or, in other words, the total number of animal units (AU) that can satisfy their food needs on one hectare of foraging area, expressed in AU/ha or ha/AU. The factors that determine grassland receptivity are: 1) foraging productivity, which depends on climate, physiography, soils, and botanic composition; and, 2) management practices, such as frequency and height of cutting, fertilization, pasture rotation, grazing system, weed control, supplementary feeding, and size of pastures.

Given the above definition, grasslands will show marked differences in their respective receptivities; even within a single pasture there will be differences in receptivity depending on how intensively or extensively the pasture is used. The first approximation of receptive capacity is based on the forage availability of growth of a complete cycle in the course of the year. Table VIII-2 presents annual availability of forage and receptivities for different kinds of natural grasslands.

Estimated receptivity is determined by several factors, including forage availability, potential use levels, accessibility, use periods, and weeds. Low grasslands and swamps have the same forage productivity, 7,000 kg/ha; nonetheless, receptivity of low grasslands is 2.8 ha/AU, while that of swamps is only 4.0 ha/AU. The lower receptivity of swamps is due to the fact that during certain parts of the year they cannot be used because of excess water, difficult access, and other factors.

Some grasslands have quite high receptivities, such as the palm savannas and marshlands of the Chaco, and the forested, rolling, and flat grasslands in the Eastern region. Low receptivity grasslands include the semiarid savanna in the Chaco, and the swamps of the Eastern region.

Burning grasslands. Burning is of one of the most common management techniques. The objective is to get rid of the hardened herbaceous mass, high in cellulose, hemicellulose, and lignin, which include above all the upright, shrublike species (Andropogon, Sorghastrum, Panicum), which form stalk annually, favoring the uniform resprouting of these plants. This practice is one way of rendering the grasslands plantlife youn-

Table VIII – 2
Kinds of natural grasslands, current forage availability. (Kg/Ha dry matter), and estimated receptivity

Kind	Forage Kg/Ha	Receptivity Ha/AU
WESTERN REGION		
Swamps	7,000	4.0
Marshlands	4,400	2.0
Palm savanna	4,000	1.8
Tall grass grasslands	2,700	3.5
Esparto savanna	3,000	3.0
Semiarid savanna	800	15.0
EASTERN REGION		
Palm savanna	4,000	1.8
Flat grasslands	4,500	1.5
Low grasslands	7,000	2.8
Swamps	7,000	4.0
Rolling grasslands	7,000	1.2
Forested grasslands	6,800	1.0
Average receptivity		2.1

ger, which leads to greater palatability, nutritional value, and digestibility of vegetation that had previously had little value as forage.

But burning also has a negative impact on the ecosystem. Negative effects include: 1) destruction of soil organic matter; 2) loss through runoff of minerals (calcium, phosphorus, potassium) that remain in the fields as ash after burning; 3) destruction or damage of the soil's microflora; 4) changes in the physical-chemical properties of the soil; 5) exposure of the soil to biological-climatic phenomena such as rains, trampling, winds, erosive agents, and weed infestation; and, 6) change of original vegetation, with increase in species that have greater tolerance for fire.

Burning is practiced on all of Paraguay's grasslands. The most common time of the year for burning is at the end of winter, after the frosts and before the spring rains. Usually the air is polluted by the smoke and dirt during August and September (smoggy skies) as a result of widespread burning of grasslands. The frequency of burning of a single pasture may be annual or spread over two or three years. There is little scientific information on techniques for burning.

Other management practices. Other management practices include: 1) grazing systems; 2) control of hardening of grasslands (cutting); 3) weed control in pastures; 4) supplementary feeding in critical periods; 5) fertilizing grasslands; and, 6) improving low flooded pastures.

Weed-infestation of grasslands. Most of Paraguay's grazing lands are weed-infested. In some cases, infestation is slight and even ephemeral; in other cases it can be so serious as to render the fields unfit for grazing.

This problem is less serious in the Eastern region, where the vast majority of weeds allow for the presence of forage species; this is not the case in the Chaco, where the weeds totally eliminate forage species.

The receptivity of grazing lands is substantially reduced as weeds become ever more present, jeopardizing the lands' productivity; thus it is necessary to develop effective and economical methods of weed control so as to eliminate or at least reduce the degree of infestation of pastures. Even more important is the task of developing management techniques to prevent infestation of pastures in the first place.

Functions of Grasslands in Environmental Conservation

Grasslands. Grasslands are plant communities that cover extensive areas of Paraguay. They cover areas normally affected by several climatic, topographic, and edaphic limitations. The plant species that make up grasslands are the first links in the chain of plant succession.

Succession of vegetation generally has the following order: swamps, marshlands, low grasslands, savannas, flat grasslands with tall grasses, upland grasslands, forested savannas, and forests.

The succession of plant life is particularly dynamic in the Chaco; this is manifested in very rapid changes in vegetation. Shrubs and woody vegetation invade and replace grassland vegetation rapidly. This change, or succession, is accelerated by inappropriate grassland management practices such as overgrazing and burning.

Grasslands as soil-improving agents. Grassland vegetation, with grasses, legumes, Cupressaceaes and other species, deposit significant amounts of organic matter in the soils each year through their roots, stems, and leaves. As these elements are recycled through the soil-plant-animal-soil process, they improve the soils.

Intensive studies are under way to determine species capable of fixing atmospheric nitrogen in acidic soils, and in tropical or subtropical climates. Studies in this regard have been undertaken in Paraguay.

Grasslands as a mechanism for soil recovery. The physical-chemical properties of the soil have been altered by agronomic practices in areas where crops are grown annually. Reduction of mineral content and clay as a result of crop production and the impact of climatic elements such as rains and wind accelerates erosion. There are indications that depleted soils recover their physical and chemical properties when crops are rotated and fallowed with grassland vegetation. The benefits can be increased if perennial grasses and legumes can grow side by side. There have been indications on a local level of soil recovery resulting from planting of bristlegrass, crabgrass, and Bermuda grass.

Grasslands as protection of soils against erosion. Sloping soil surfaces without vegetation, under intense rainfall, are prone to erosion on an alarming scale. Use of grassland species to cover areas susceptible to erosion is the best way of avoiding significant damage to the ecosystem. Railroad tracks, other banks, and highway embankments can be efficiently covered and protected from erosion using Bermuda grass.

In the northern part of the Eastern region, which has sloping topography, sandy soils, and intense rains, soils may erode easily and in an accelerated fashion. At present, large problem areas have been covered with Star grass, which serves the important function of reducing the effects of erosion.

Grasslands as protection for wildlife. Swampy grasslands,

marshlands, and swamps constitute particular ecosystems that are relatively unimportant in terms of material production (meat, milk, wool). Nonetheless, they constitute important environments from the ecological standpoint, fulfilling important functions insofar as they are home to wild fauna. If these areas were to disappear, this fauna would die off in large numbers.

Wild Animal Life

Biological Inventory

There is a great abundance and variety of animal species native to Paraguay throughout the country. But over time and with the advance of civilization the native animal wildlife has been diminishing to the point that several species are currently endangered as a result of destruction of habitat or indiscriminate hunting. With the advent of modern means of transportation there are but few areas where man has not had a considerable impact; his direct effects on wildlife are well known.

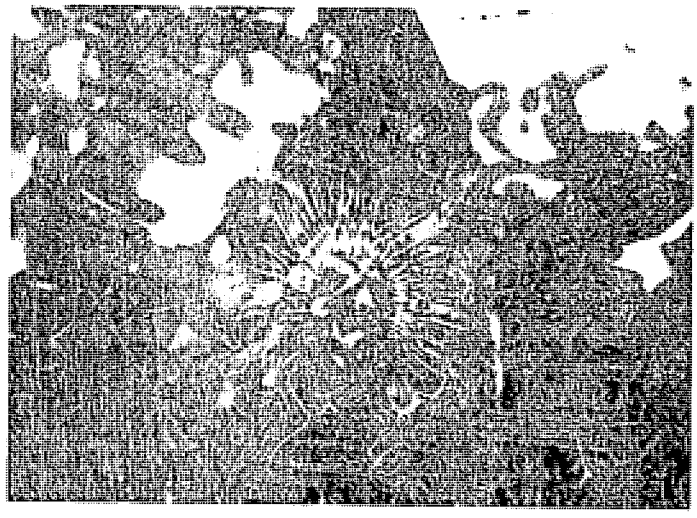
As a first step in conservation of fauna, two significant programs were undertaken by the Ministry of Agriculture and Livestock through the National Forest Service: the biological inventory and administration of wilderness areas.

The biological inventory is the main source of basic information regarding distribution, population, and current status of wildlife. One of the main goals is to provide basic data for conservation programs and scientific and educational projects.

The biological inventory was launched in 1980 and is supported by the U.S. Peace Corps. Though personnel is limited (4 biologists and one agronomist), the effort has yielded a taxonomic classification revealing, to date, 305 species of mammals, 650 species of birds, 120 species of reptiles, and 85 species of amphibians.

The biological inventory program also involves setting up and operating the Natural History Museum; this project is still at an incipient stage due to lack of resources. Once in full swing, it will study Paraguay's wildlife, setting norms, administering wilderness areas, and fostering conservation.

Low grasslands provide excellent habitat for birdlife. Photo courtesy National Forest Service.



The biological inventory should not ignore flora: Passiflora cincinnata, Defensores del Chaco National Park. Photo courtesy National Forest Service.

Critically Threatened Species

Endangered higher vertebrates in Paraguay have been grouped in four categories:

Endangered

This category includes all species that have declined at alarming rates and which are on their way to total extinction if immediate action is not taken.

Threatened

This refers to species whose populations have diminished considerably and which, if the pressures to which they are subject are not relieved, will be in danger of extinction.

At Risk

This applies to species with limited distribution that may pass to a more critical state if subjected to sudden pressures.

The giant anteater, a species threatened with extinction. Photo courtesy National Forest Service.

Undetermined

There is concern as to the status of such species, but available data is insufficient to determine whether they should be included in any of the above categories.

Table VIII-3 lists endangered species in the respective categories and causes of this status; it also notes if the species are listed by the International Union for the Conservation of Nature and Natural Resources as being endangered worldwide. None of the species are exclusive to Paraguay; nonetheless, this overview considers only their situation in Paraguay. Table VIII-3 clearly indicates the main factors affecting Paraguay's wildlife: destruction of habitat, commercial exploitation, and intensive hunting.

Destruction of habitat is the main reason why many species are endangered; this will clearly continue to grow in importance as a threat to wildlife, as Paraguay develops and the population expands to remaining natural areas. Clear signs of the impact of destruction of habitat are evident east of the Paraguay River, where the provinces of Caaguazú, Canindeyú, Alto Paraná, and Amambay, and areas along the new highways, are rapidly being cleared. It is only a matter of time, of which little is left taking into account the rate of deforestation, before the extensive forests of eastern Paraguay are reduced to small plots along the inaccessible foothills, and many wild species, which had depended on the complex ecology of the forests, become extinct in Paraguay.

Table VIII-3 indicates which species will be the first to disappear. The harpy eagle will certainly be among the first. This great hunter is larger than any other of its group, and it largely depends on the extensive primitive and virgin forests. Decomposition of its natural habitat has advanced to the point that only a few eagles are left.

Palmito, an endangered species, provides raw material for canning heart of palm. Photo courtesy Juan A. López.

The helmeted woodpecker is subjected to similar pressures. Like the harpy eagle, the helmeted woodpecker nests in tall trees to reproduce; its population has declined at such an alarming pace that none have been seen in Paraguay in recent years.

Birds that live in the large forests are endangered. The Brazilian merganser, a web-footed bird that inhabits the forest-covered banks of the rapid tributaries of the Paraná River, is virtually extinct in Paraguay.

Even though change and destruction of habitat invariably jeopardize forest species, careful planning taking into account factors affecting wildlife will help to considerably reduce losses of fauna and other resources, and will at the same time enhance the benefits of development in the long run.

Paraguay is relatively small as compared to its neighbors. Nonetheless it has an extraordinary variety of environments such as tall, low, and mixed forests, and palm-studded brushwood, as well as a variety of aquatic environments including rivers, lakes, lagoons, brooks, marshes, and swamps. All of these play a vital role as home to hundreds of species; they also take in migratory birds that spend a part of their life cycle in the Neotropics. These birds will also be affected, even by a minimal change in their areas of concentration, especially in the marshlands of the Chaco and southern Misiones.

The total number of species affected by destruction of habitat as shown in table VIII-3 is less than the sum of the subtotals. This is because in some cases a single species has been affected by the destruction of two or more kinds of habitat.

Wildlife Habitat

The broad array of habitats in Paraguay's natural environments is an important factor behind the diversity of fauna. Thus, conservation of parts of these environments will be necessary if the fauna is to survive. Even when some key habitats, such as the dry forests of central Chaco, are relatively protected insofar as they are at least part of national parks, other habitats have not been protected at all to date.

In many cases these unprotected habitats are even more spoiled due to the unfortunate fact that they are under intense pressure from development. This section will describe key areas that support important animal species in Paraguay. These sites are set forth in map VIII-5. Each of the 10 areas has components of the main biogeographic areas. These sites do not represent boundaries of potential refuges, but rather areas in which reserves can be set up.

However, each reserve should be large enough to sustain the biological diversity of the animal population for a long time. In effect, some of the areas indicated already have reserves; they have been included so as to suggest that such reserves be expanded. Of course, conservation of habitat for wildlife is compatible with other important objectives regarding land use.

Such compatibilities should be taken into account in regional land use planning. If immediate actions are not taken

Laughing falcon. Photo courtesy National Forest Service.

Savannah hawk. Photo courtesy National Forest Service.

to protect some of the critical areas, especially in rapidly-developing eastern Paraguay, some of the more important wildlife areas and their species will soon disappear.

The 10 sites indicated in map VIII-5 range from those critically threatened (the first five) to those that are at risk (the last five). The very areas threatened by deforestation overlap with the distribution range of several species listed in table VIII-3.

Critically threatened areas are those drastically affected by human activity. At risk are those areas where destruction of habitat is minimal but where illegal hunting and commercial exploitation is harming wild populations.

The areas indicated in map VIII-5 are presented in order of priority with respect to attention needed for conservation. Following is a brief description of each area:

Area 1: In this area are found Paraguay's densest palm forests, characterized by Euterpe edulis and Alsophila, a giant fern genus mixed with tall and moist woods. Some endangered and threatened species are found in this biogeographic zone. These habitats are not protected at present, and are being destroyed at an alarming pace. This area includes parts of the provinces of Canindeyú and Alto Paraná. Gradual settlement of Brazilians has had a serious impact on the original vegetation, as lumbering and agriculture have been intense. Immediate measures should be taken to avoid overexploitation of the last standing natural forests.

Area 2: This is a unique zone of vegetation that corresponds to tall subtropical forests, but with a different structure. The area is very moist and is drained by the many tributaries of the Paraná River. The forests are replete with yvyrapytá (Peltophorum dubium), which is covered with epiphytes and lianas. This area is in the eastern part of the province of Itapúa and the southern part of Alto Paraná. Little is known about the wildlife in most areas, and it is hard to point out more precisely where the species listed in table VIII-3 are found. It is more difficult to locate such species in large forests than in open areas such as the pantanal of lower Chaco.

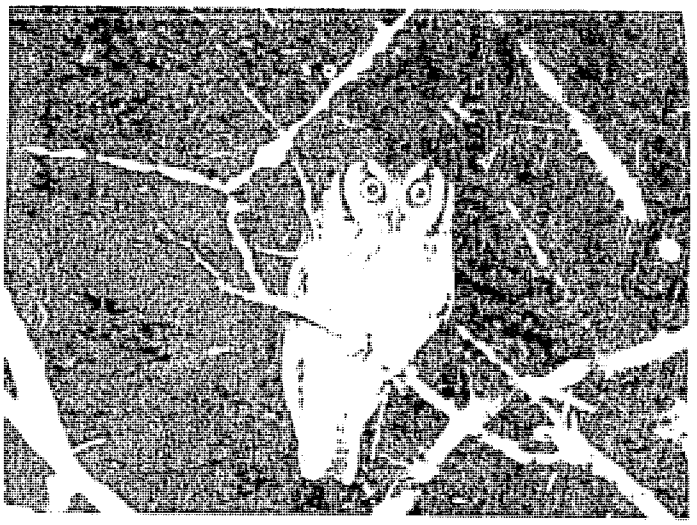
Area 3: A forested region with trees such as Balfourodendron riedelianum, Peltophorum dubium, and Cedrela sp.; endangered carnivores such as the jaguar live in this region, though in small numbers. This area includes the eastern parts of San Pedro and Canindeyú. It is the last important forested area in the province of San Pedro. Intensive reforestation projects are needed in all deforested areas; but in order to draw back the wild fauna, trees planted should be of native species, and not exotic species such as eucalyptus or pine. Non-native species do not yield fruits the animals can feed on, nor do they have adequate foliage or structure for parrots, woodpeckers, or birds such as the harpy eagle to nest. Neither do they offer appropriate conditions for mammals and reptiles such as the common tegu to rest.

Area 4: This area includes the thickest and tallest forests of the central area of Paraguay's Eastern region, including, for example, the forests along the banks of the Tebicuary River. Typical flora include Nectandra, Ocotea, and Microcarpus. This area is important for several wildlife species including the South American river otter (Lutra platensis), the Brazilian tapir, and the coatimundi. These forests of the province of Cazzapá are being felled rapidly.

Area 5: The significance of this area, circled by the Apa River, derives from its contiguity with the pantanal of Mato Grosso. The forests along the shores of the Apa, a tributary of the Paraguay River, also provide excellent conditions for wildlife and important bird species with limited ranges, such as the hyacinth macaw, mammals, including the Brazilian tapir, and reptiles such as alligators and iguanas.

Area 6: This area includes lowlands susceptible to flooding in the provinces of Neembucú and Misiones, including Lakes Ypoá and Verá, the country's largest. This habitat is similar to the lower Chaco, though the forests have been completely destroyed. The moist lands are still intact and free from pollution, though commercial exploitation has considerably reduced the alligator populations. This area continues to be important for some mammals such as the swamp deer. Drainage of this extensive aquatic area is a potential threat that should be dealt with immediately in the face of the advancing populations.

Area 7: The marshlands of the lower Chaco are highly susceptible to flooding, and have some palm (Copernicia alba) forests. The lower Chaco is important not only for some endangered species such as the alligator, black-necked swan, ibis, and Brazilian merganser, but also for most of the aquatic birds that gather there in great numbers to reproduce.



Tropical screech owl. Photo courtesy National Forest Service.

Though this habitat is not currently threatened by lumbering, as in the Eastern region, illegal hunting and commercial exploitation have brought about a precipitous decline in the populations of swamp deer and bush dog. No part of the lower Chaco or any other important aquatic habitat is presently protected as part of a reserve or otherwise. This is the most striking area as regards the variety of animal species, including reptiles and amphibians.

Area 8: This is the only part of the upper Chaco that has extensive mixed forests with palms and typical Chaco vegetation. The area floods periodically with rises of the Paraguay River, thus markedly altering the ecology. There has been a significant decline of certain wild animals that are hunted, such as alligators, iguanas, and large snakes, not to mention the complete elimination of storks.

Nonetheless, this habitat has not been significantly altered. Besides the alligator, the area is suitable for the maned wolf, and even for the Chaco peccary. Reptiles and birds that were only known from neighboring countries were recently spotted here by the inventory group.

Opossum. Photo courtesy National Forest Service.

Areas 9 and 10: These areas correspond to the dry Chaco forests, with well defined physiographic features and quite varied climatological conditions. They support endangered wild felines and canines, and have been subjected to the pressures of commercial exploitation. The peccary, a species of pig considered extinct, was found in 1977 in these expanses. In area 9, Andean guanacos have been sighted in a semidesert, sandy area, which is particularly noteworthy, as these mammals have not been sighted elsewhere in Paraguay.

In general the entire Chaco is vulnerable; there has been growing interest in countries bordering on the Chaco, such as Argentina, that it be properly managed, for given its size and complex makeup in terms of flora and fauna, it requires special attention. Thus any changes in the Chaco's vegetation should be implemented with great care; otherwise desertification may set in.

Species Introduced to Paraguay

Paraguay has been very lucky in terms of not suffering negative effects from introduction of exotic species. In several parts of the world where exotic species have been introduced, exotic forms set in and grew, having escaped or been deliberately set free. These species have had a negative impact on their new environments. There are several potential effects, ranging from changing the native habitat and introducing new animal diseases to spreading serious crop diseases.

Aside from typical domestic species, it appears that no exotic forms have been established in Paraguay; the country should ensure that no such species are introduced in the future.

Hunting and Trapping

In spite of Executive Decree No. 18,796/75, which prohibited hunting, wild animals are commonly hunted. There are three main motives: profit, sport, and subsistence.

Commercial Hunting

Hunting and trapping for hides, skins, feathers, or for live animals to be sold has been and continues to be a significant economic activity in Paraguay. Table VIII-4 lists data on exports of wild animal hides and skins registered from 1974 to June 1984.

As a result of overexploitation, 27 species are threatened or endangered (table VIII-3) These include two species of alligators and several species of iguana, 11 species of birds, especially parrots, and 14 species of mammals, including 5 feline species.

In order to avoid overexploitation and facilitate reproduction of wild animals, Decree 18,796/75 prohibits "marketing, import, and export of all species of wildlife, including their parts or by-products." Paraguay has also acceded to the Convention on International Trade in Endangered Species, as of 1977.

Nonetheless, neither the decree nor the fact that the country has signed the CITES seem to have significantly affected this activity. Several large tanneries operate openly in downtown Asunción. Nor has the decree had much impact on exports, according to table VIII-4.

It is not known exactly what percentage of the hides processed at the tanneries are of Paraguayan origin. It is known, however, that illegal hunting continues in the Chaco. Appar-

ently the fact that wild animal stocks in Paraguay are being finished off has led to intensive illegal hunting in Brazil which, like Paraguay's other neighbors, Argentina and Bolivia, has also prohibited hunting of wild animals.

As a result of excessive commercial hunting there has been an increase in the piranha population of the Paraguay River, especially at the northern end of Alto Paraguay province, where the largest reptiles, such as the large alligators, snakes, and common tegus have been hunted in excess. Clearly an imbalance results from the lack of natural predators, giving rise to the abundance of piranhas (Serrasalmus spp.). Aquatic birds are also among the major consumers of fresh water fish. The elimination of storks by hunting may have contributed to the increase in the piranha population.

In order to know which species are most fecund in Paraguay's main rivers, one must have basic data on their reproductive biology, which has yet to be established in Paraguay. No fisheries management strategy would be feasible in the long run without taking into account that international waterways such as the Paraguay River are always subject to possible damage as a result of pollution from Brazilian towns and settlements to the north.

Hunting for Sport

Regulated hunting for sport practiced efficiently does not bring serious damage or risk of extinction to any species. However, not only is this sport illegal, but it is so widespread that it causes depredation. This is because:

- It is practiced in all seasons, not even respecting reproductive cycles.
- All species are hunted, at the whim of the hunter.
- Hunting is not limited to reasonable quantites; rather, the quantity is in function of the hunter's capacity or means of hunting (type of weapons, availability of cartridges, capacity to conserve and transport hunted products, etc.) Usually the many animals hunted are not completely used, as they decompose before arriving at their destination.
- There is an abundance of hunters who are not aware of the significance of animal wildlife and who carry out indiscriminate slaughter while hunting.

Subsistence Hunting

This kind of hunting is practiced by Indians, and in some cases by newly-arrived settlers who hunt for food. Such hunting is not intensive and does not bring on significant depredation, for the hunters are generally poor and do not have modern gear.

Based on this overview of hunting, one can conclude that:

- All commercial hunting should be definitively banned.
- A legal framework should be drawn up to regulate hunting for sport and subsistence, so that those who depend on hunting for their survival are able to do so legally.
- The institution in charge of enforcing hunting regulations should be strengthened.
- High priority should be placed on developing an educational campaign as to the importance of wildlife. This should be a multifaceted effort, and should use a variety of methods and media so as to reach all ages groups and all sectors of society.

Sayacu tanager. Photo courtesy National Forest Service.

Protected Areas

Definition

The term natural (or wilderness) areas is used to designate those lands and waters found in their natural state and where, to date, the influence of modern man has been minimal or without lasting impact, the respective areas having returned to their natural state (Putney, 1976; Miller, 1980).

Objectives

The objectives of conservation of natural areas are as follows:

a. Maintain and conserve representative specimens of the main biotic units.

b. Maintain ecological diversity and regulate the environment.

c. Conserve genetic resources, especially of endangered flora and fauna.

Gray brocket deer. Photo courtesy National Forest Service.

d. Preserve relics, structures, and sites of cultural and historic interest.

e. Protect and promote scenic areas.

f. Facilitate and promote environmental education, research, and observation in natural milieu.

g. Facilitate and promote recreation and tourism.

h. Promote rational use of marginal lands and rural development.

i. Protect watersheds.

j. Protect special ecological resources.

k. Maintain areas for production of lumber and other items (multiple use areas).

Protected Natural Areas

Present Situation

Currently protected areas represent ecosystems in which some autochtonous animal or plant species persist or which have a physiography typical of a given region of Paraguay. Most of their natural features have not been altered, and man's impact has been minimal. Special criteria have been established so that these areas can fulfill their purposes when properly managed.

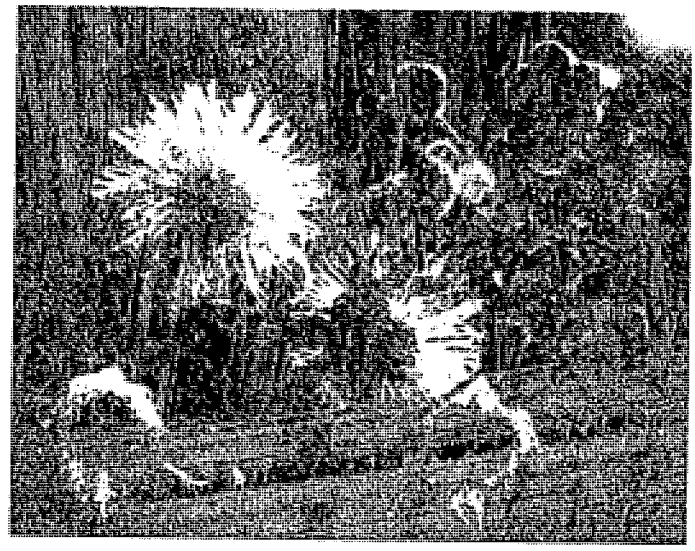
At present there are six national parks, two protective forests, and one national reserve, all part of the national conservation system. They are as follows:

Number, Category, Area and year of establishment of protected natural areas

Name	Area (ha)	Year estd.	Number of decree
1. Defensores del Chaco National Park	780,000	1975	16,806
2. Tinfunqué National Park	280,000	1966	18,205
3. Lt. Agripino Enciso N.P.	40,000	1980	15,936
4. Caaguazú N.P.	6,000	1976	20,933
5. Corá Hill N.P.	5,538	1976	20,698
6. Ybycuí N.P.	5,000	1973	32,772
7. Kuri'y National Reserve	2,000	1973	30,956
8. Ñacunday Protective Forest	1,000	1975	17,071
9. Jakui Protective Forest	1,000	1975	17,072

These nine conservation areas total 1,120,538 ha, or 2.75% of Paraguay. In the Chaco 4.45% of the land is protected, whereas only 0.13% of the Eastern region is covered (Clark, P., 1983).

All of the above areas were established by executive decree. The Ministry of Agriculture and Livestock, through the National Forest Service, is responsible for technical and administrative matters, and is aided in these tasks by the Ministry of Defense and Armed Forces, through the Technical Office and the Corps of Engineers respectively.



Yuquerí. Photo courtesy National Forest Service.

The "Defensores del Chaco", "Lieutenant Agripino Enciso", "Corá Hill", and "Ybycuí" National Parks all have their own respective administrations. Management plans for Corá Hill and Ybycuí have already been drawn up, while the plan for "Defensores del Chaco" is being worked on.

As set forth in Decree 11,681, the conservation areas are the responsibility of the SFN, through its Department of Forest Management, National Parks, and Wildlife. The national parks and other conservation areas are not part of a national system. Each unit, despite its adminstrative dependence on the SFN, enjoys complete autonomy, which may give rise to confusion, as can already be observed in the signposts. These anomalies will increase as each unit develops. Thus, a national conservation system would not only lend more organic cohesion to the state's efforts to preserve representative specimens of Paraguay's natural ecosystems; it will also allow for maintaining appropriate methods in their management and development in function of priorities set forth for all conservation units combined.

In order to give an idea of the relationship among protected areas, table VIII-5 relates Paraguay's floristic regions, accord-

Banana frog. Photo courtesy National Forest Service.

Entrance to Cerro Corá National Park, Amambay Province. Photo courtesy Diane Wood.

ing to Hueck (1978), with the level of protection in natural areas. The table clearly shows regions such as the inter-river parkland, the cleared fields, vegetation of the pantanal, and the hydric forest, which at this time are not protected by the protected areas system. These parks, however, have just been created in the last 10 years.

Despite government measures and the efforts of the National Forest Service to conserve fauna and the environment, there have been some problems in administration of protected natural areas that should be overcome if these areas are to fulfill their purpose. These problems include:

- lack of well-defined boundaries;
- the need to relocate those who live within the parks; and,
- the continuous incursions of local population, illicit hunters, and domestic animals in the parks.

Furthermore, the National Forest Service should take certain measures, including:

- provide better and larger roadways to the conservation programs;
- carry out the biological inventory of most of the parks;
- draw up regulations on resource use in the parks;
- adopt national conservation systems for protected natural areas;
- carry out specific studies; and,
- train personnel (especially forest rangers).

Strengthening of the National Forest Service will make it possible to solve the problems and implement the above-mentioned measures. This requires an adequate legal framework, proper organization, and a larger budget.

Legal Situation

Law 422, the Forest law, was adopted November 23, 1973. Among its 72 articles not a single one refers directly to conservation areas or national parks. Article 20, paragraph (a), only mentions "protection, conservation, increase, renewal, and rational use of the country's forest resources." This law does not provide for aspects key to developing conservation areas, such as expropriation, definition of infractions, and penalties. The conservation areas are mentioned only as national parks, in Articles 70 to 73 of Decree 11,681, which establishes regulations for Law 422. These articles read as follows:

Art. 70: "The National Forest Service shall propose to the Ministry of Agriculture and Livestock areas to be designated as National Parks."

Art. 71: "The National Parks cannot be altered in any way; all use of renewable natural resources is prohibited."

Art. 72: "Technical and administrative management of National Parks shall be the exclusive responsibility of the National Forest Service."

Art. 73: "Transgressions regarding use of renewable natural resources in National Park areas shall be sanctioned by the Judicial branch at the request of the Ministry of Agriculture and Livestock."

This decree does not define national parks, saying only that they cannot be altered in any way. Furthermore, as it deals only with national parks, it would appear to ignore any other category of management of natural areas, except for protective forests.

However, it is encouraging to note that these deficiencies in legislation are merely technical and not conceptual. This is apparent in the 1977-1981 National Economic and Social Development Plan, the objectives of which include "rationalize exploitation of natural resources and protect and improve the environment" and, more specifically, "preserve the national ecological heritage applying modern conservation methods and modern methods for managing national parks and similar areas." The problem is clearly understood by top-level officials of the relevant ministries and government agencies.

Nonetheless, in order to improve protection and functioning of protected natural areas, some items should be considered in the Forest Law, including:

1) A method of compensation administered by the SFN when protected areas are affected or destroyed by activities or programs whose objectives are not related to wildlife conservation.

2) Establishing fees for use of natural areas, and investment of such fees in management of the areas.

3) Defining the institutions in charge of protected natural areas so as to better achieve their objectives and assure that regulations on use are observed.

Need for New Areas

Among the natural areas that need to be better represented in the reserve system are:

- biogeographic provinces;
- geomorphological regions and noteworthy geological features;
- areas that can provide recreation sites for the main cities and towns;
- natural categories that to date are not represented;

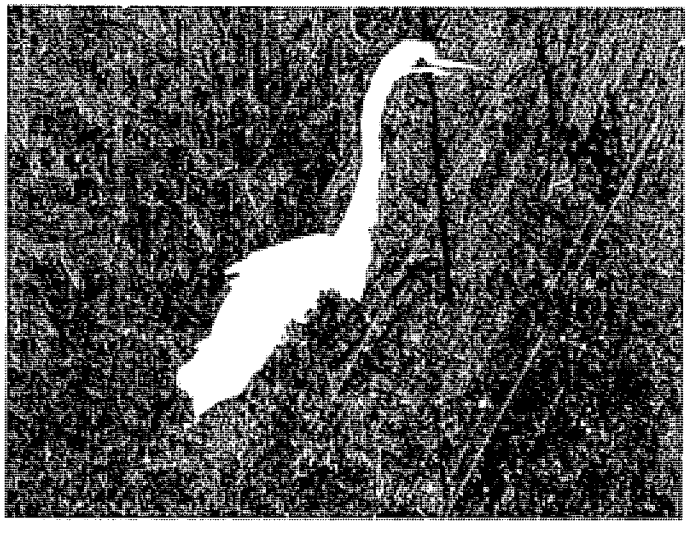
Wild pineapple. Photo courtesy National Forest Service.

- an area with sufficient habitat for each endangered species;
- natural formations (lakes, rivers, mountains, etc.); and,
- the upper watersheds of rivers and streams.

In accordance with these criteria, the following are recommended as new reserve areas:

The Capiibary Forest Reserve Project: This is a forest area that can provide for animals in danger of extinction.

Guazú Hill: Practically an archeological site given the remains of pre-Columbian cultures, this area also is typical of the physiography of the hilly zone where it is located.



Great egret. Photo courtesy National Forest Service.

Cream-backed woodpecker. Photo courtesy National Forest Service.

Yacyretá animal reserve: This area has been significantly altered and, due to population pressures or possibly other factors, the forests have disappeared. The Yacyretá dam has largely changed the area's ecology. The area can be used to relocate fauna whose natural habitat will be altered by the dam.

Corá Hill Protective Forest: This project would be an extension of the Corá Hill National Park. The area has been deforested to a significant degree. Nonetheless, the proposed area would protect the forest in the Aquidabán basin.

Nueva Asunción: This would correspond to the dry Chaco vegetative region, with low, thorny, forests. Cactaceaes, myrtaceaes, and bromeliaceaes abound. There are no economically useful species of trees. It is a dry area, with low annual precipitation where summer temperatures climb above 40°C. The area is windy, and has jaguars, maned wolves, collared anteaters, Brazilian tapirs, and peccaries, and is an important habitat for guanacos.

Tembey Falls: Located in Alto Paraná, with tributaries of the Tembey River, this area has tremendous potential for recreation and tourism. It is habitat for the Brazilian merganser and the helmeted woodpecker, and in general is rich in animal wildlife.

Acahay Hill: Located in the province of Paraguarí, there is no data on this area's animal wildlife. The forest is still conserved in natural form. It is surrounded by several towns and settlements.

Monday Falls: The vegetation is a continuation of that at Tembey Falls, as it is also in Alto Paraná. It also has the same plant and animal species. In general there are three strata of forest.

Mato Grosso Pantanal: This is the only part of upper Chaco with great expanses of forest—palm and other Chaco forests all occurring together. The area tends to flood from the Paraguay River. This is a critical zone for some species, including alligators, peccaries, and maned wolves; no other area has such a great variety of bird species.

Chaco-i. This part of the lower Chaco floods periodically and is important not only for endangered species and those of the

other categories, but also because most aquatic birds reproduce there, gathering in great numbers.

Lake Ypoá and Lake Verá: This area includes lowlands with extensive marshlands and areas susceptible to flooding.

Ka-í: This area has semimoist Chaco vegetation similar to that described for the Mato Grosso pantanal.

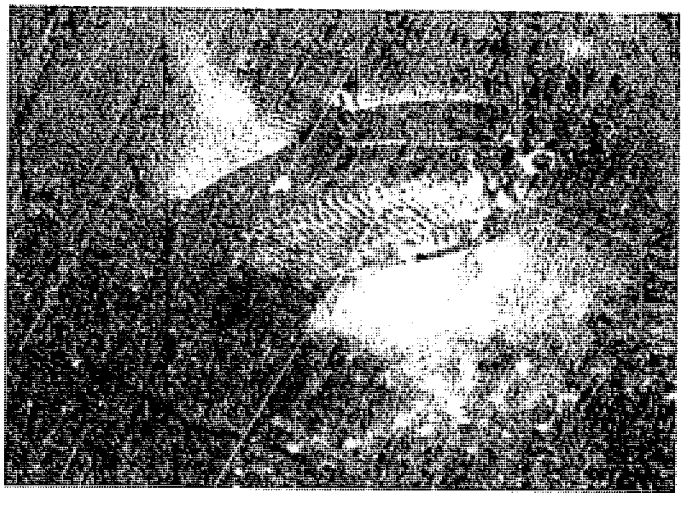
Fish Resources

The Aquatic Environment

The natural hydric environment is the dominant factor in the ecology of a riverine area subject to flooding, and in fishing as an economic activity. The rivers and their floodplains are considered here as a whole as they form an integral system as regards the production and reproduction of most fish species. "Floodplain" means a flat area adjacent to a river that is occasionally flooded for short periods. The floods are considered to be a negative factor. In voluminous rivers such as the Mississippi, the natural floodplain has largely been suppressed, resulting in problems controlling the water: solutions become ever more costly.

Most tropical rivers still have floodplains that flood slowly and gradually once a year. This allows biological processes to unfold in an expanded aquatic environment, thus giving rise to a habitat which is highly productive for large aquatic plants, invertebrates, and young fish (Boneyo et al, 1969; Junk, 1970; Bayley, 1980).

When the water level goes down, fish born during the high water period have grown large enough that mortality is reduced. When the water level is low, the fish move towards the main river and its tributaries, or remain in the residual waters left in the floodplain. As the waters leave the flood zone, aquatic vegetation left aground decomposes much more rapidly, in contrast to when water levels remain high, as in the case of an artificial reservoir. In the case of a reservoir, oxygen consumed by decomposition cannot be replaced at the same rate, and production is drastically reduced.



Specimen of Astyanax fasciatus, a non-commercial species of some interest for sport. Photo courtesy National Forest Service.

In natural floodplains, rapid formation of organic and nutritive matter allows for high productivity of fauna. A rich layer of fine detritus is formed in the bodies of water of the flooded plains as a result of partial decomposition of plants, especially large semiaquatic plants. This layer is a direct source of food for the most numerous fish in the system (in terms of biomass): the shad (Prochilodus spp.). The lentic habitat of floodplains in tropical regions have extraordinary biomass and productivity in terms of large plants (Junk, 1970), phytoplankton (Schmidt, 1973), invertebrates associated with large plantlife, (Junk 1973, 1976), and fish (Welcome, 1979; Bayley, 1973).

The Paraguay River and its extensive floodplain cover some 10,500 km^2 and are an excellent example of this kind of highly productive system. The waters flood this zone and then slowly recede because the huge pantanal region located upstream in Brazil controls its volume, and because the river's gradient is very low.

The section of the Paraná River that forms Paraguay's border to the southeast has a greater flow than the Paraguay but its floodplain is smaller. Furthermore, its "natural" hydrologic regime is less regular and floods occur more quickly. Nonetheless, the fish populations have adapted and there is considerable fishing potential given the size of the system and of the fish that migrate up from the extensive floodplains of the middle Paraná. Unfortunately, construction of the Yacyretá hydroelectric facility will have a negative impact on this environment and its potential use, reducing fish production and the number of species, and making it impossible to predict the yield and composition of species.

The smallest rivers of the system have fewer large migrant fish species, but are important as a habitat for the young fish, especially as a refuge when the water is low. Furthermore, many uncommon species currently being exploited at low levels as tropical pet fish live in their floodplains.

In sum, maintenance of the Paraguay River's floodplain and that of its tributaries as an economic source of production of proteins and as a flood control system (Lopez et al, 1983) is of vital importance for Paraguay's future. Fortunately there are no plans to make use of the water in such a way as would alter the present regime; pollution and excessive sedimentation have to date been limited to specific locations in certain tributaries.

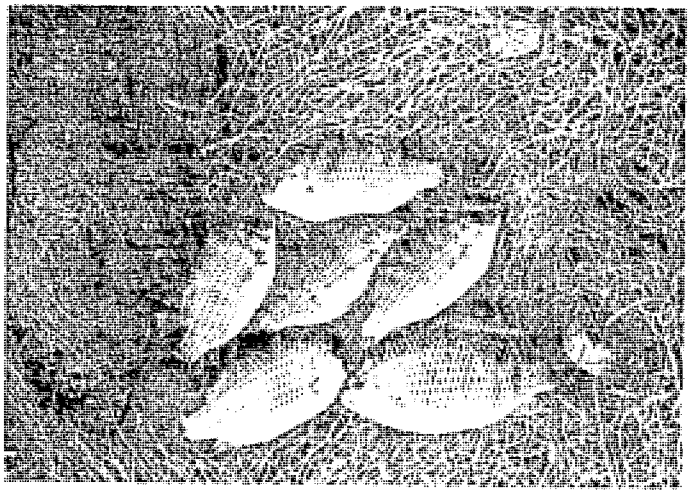
Fish Population and Main Species

Fish population of the main rivers is very rich and abundant, especially that of large fish with abundant meat. However, the fisheries inventory dates back to 1939, and should be updated so as to more precisely ascertain the potential of fish resources.

According to A. de W. Bertoni (1939), there are 298 fish species in Paraguay; to date there has been no revision of his list. Nonetheless, the following fish, which have been introduced, should be added to the list: Tilapia melanopeura, T. nilotica, T. hornorum, and Ciprinus carpio. It is possible that there are other new species that should be added once they are duly identified.

Perhaps the dominant species in both hydrographic basins is the Prochilodus scrofa (shad).

The most significant and relatively abundant species are as follows:



Fresh from the water and still in the net, these Tilapias can provide fresh fish to the daily diet of a family who owns a pond.

Scientific name	Common name
Rhapiodon	
Leporinus friderici	Boga
L. obtusidens	Boga
Salminus maxillosus	Dorado
Astianax bimaculatus	Mojarra-Piky
Colossoma mitrei	Pacú
Pseudoplastistoma corruscans ...	Surubí
Hemisorubim platyrhynchos	Patí
Pimelodus maculatus	Mandií
Pimelodus albicans	Mandi-í morotí
Plagic scion squemosissimus	Corvina, pescado blanco

The pacú (Colossoma mitrei) is an important commercial and domestic fish whose food source would be altered by disappearance of vegetation and plant species that grow along the banks such as the inga (Inga spp.) and the tala (Celtis tala), which are the pacú's favorite diet, and some fruits such as the ambay (Cecropia peltata).

Other fish species may also draw on vegetation growing along the banks for food. But the transformation of floodplains as a result of the dams on the Paraná River will doubtless cause changes in spawning, as these sites have been favored for fertilization and laying of eggs. Furthermore, given that such sites are important as a source of food, the above-mentioned changes will have a significant impact on the density of whole fish populations, above all in the first 10 years after the dams are filled.

The Pimelodus sp., or mandii, may suffer the same fate, as it needs sediments, detritus, and organic matter, which it takes in directly from the river bottom.

Due to the interrelation between water quality, bank vegetation, floodplain vegetation, plankton from lentic waters, and the potamoplankton from lotic waters, some species will suffer initially when the resrvoirs are filled, and a significant blockage in the food chain of many species may result, which would in turn have a tremendous impact on future biological events such as trophic and genetic migrations and, above all, on the development of the young populations of species such as the dorado and the surubí.

Retention of sediments in the reservoirs upstream and stabilization of their stream flow will contribute to the disappearance of some species' populations as the dams are first filled without this necessarily posing danger of extinction to such species. Survival of populations will be directly related to quick stabilization of the ecosystems' new conditions and of plans for regulating use of the dam.

If the main channel, with its corresponding flow, is regulated so as to not overflow into the lagoons, watercourses, marshlands, and other bodies of water in its valley, there will no longer be periodic flooding. Indeed, many of these bodies of water would dry up. This would cause problems for the river's flora and fauna, and to the flora and fauna of the valley as well. Most of the breeding grounds of the young fish will suffer profound changes which would make it impossible for them to take refuge in the different bodies of water that form on the islands, where they go during high waters and stay for one or more years before returning to the main channel. This will undoubtedly lead to reduction of fish populations such as the shad (Prochilodus spp.), for which such sites are the ideal habitat.

Characteristics of Fish Reproduction

Regulations prohibit fishing during breeding periods. This is advisable in the case of some species with limited fecundity whose mating area is subjected to intence fishing. Nonetheless, some fishing has always been based on taking advantage of the fact that large numbers of fish gather together for reproduction. This is the case, for example, with the cod banks at Lofoten, near Norway, which have been exploited in this manner since the 13th century.

Most edible fish species are highly fecund, and fishing in rivers and floodplains has not affected the high concentration of habitat for reproduction when fish are brought in during this period. Even more important is the fact that intensive fishing in voluminous rivers can reduce the number of fish as a result of "overfishing of adult fish" and not "overfishing of young fish"; thus stocks for reproduction are diminished to levels that affect production of young fish. Of the tens or hundreds of thousands of eggs of a single female, only two need to survive and reach reproductive size in order to keep a constant population.

Administrative measures should be taken to restrict total quantites to be fished; but whether adult fish are caught during the productive period is not significant for edible species that inhabit the rivers and floodplains.

Fish Hatcheries and Stocking Young Fish

It is often thought that other countries support more intensive fishing by forming stocks of young or newly-born fish. This only works in special cases, as for example when receptacles of unpopulated water are used, or when using young fish in small ponds where one must pay a fee to fish.

High natural mortality resulting from actions mentioned above renders this practice unfeasible in the Paraguayan context. Using adult fish to reduce mortality will cost many times more than the income yielded by catching the survivors.

Sport fishing occurs during open season.

Fishing and the Fishing Industry

Fishing for food is much more important in quantity and value than fishing for sport or trade in tropical pet fish. There is no known financially viable fish breeding activity.

Fishing yields about 26,000 t/year (whole, fresh caught fish) of fish for consumption in Paraguay. At least one-fourth is accounted for by large predator fish. Another 2,000 t/year of large species are sent to Brazil. In terms of the fishermen's income alone, fishing comes to some 2.7 billion guaranís (US$ 6.75 million) annually.

The floodplain of the Paraguay River, within Paraguayan territory, may yield at least 40,000 t per year on an ongoing basis if fishing regulations are relaxed so as to permit fishing of smaller species, and if the demand for the cheaper protein of new species increases, as has happened in other South American rivers. This is a conservative estimate, for it does not take into account the Paraná river or its tributaries; nor does it consider migration to Paraguay of fish not caught downstream.

An administrative strategy that would allow for increased fishing—an increase that is already occurring despite the fact that it is not encouraged by the present strategy—would cut back production of large species in areas far from population centers, but would not lead to the extinction of any species.

The alternative for this strategy is to try to regulate fishing of some larger species, an effort currently underway. Using nets for fishing is prohibited in all waterways except for the two main rivers, where it is only prohibited from September 15 until March 1 so as to protect fish during the reproductive cycle. Much ongoing fishing depends on catches of large numbers of fish concentrated for spawning. Furthermore, successful fishing in the Amazon floodplains and African floodplains is not subject to seasonal prohibitions. A prohibition during spawning does not make sense from the biological standpoint for highly fecund species that prevail in large rivers.

The present strategy is clearly inefficient and lowers the profitability of the fishing industry, which could provide cheaper fish to more Paraguayans. Besides, the cost of effectively implementing this strategy would outstrip the benefits that would derive from expensive fish that only a small minority could afford.

Thus, conservation of a given environment and its resource, the extensive use of which cannot be avoided—in contrast to the situation of national parks, for example—depends on using this resource in such a way that its protection can be economical. Greater exploitation of more fish species in the Paraguay River, combined with appropriate education for administrators and users, would be a good example of this principle.

Overfishing

There is great confusion as to the difference between an individual's catch and total catch. The first may mean the average catch per fisherman per day with a particular gear or tackle: this is what administrators and fishermen are usually referring to when they speak of catch. Any exploitation of an animal population causes a lower level of equilibrium of that population, which is frequently interpreted as overfishing. Nonetheless, at moderate levels of exploitation, total catch increases as individual catch decreases. Furthermore the average size of the fish diminishes; this is also erroneously interpreted as overfishing.

Biologically there is overfishing when increased fishing leads to a reduction in total catch. However, from the economic standpoint there is overfishing for the fisherman sooner, when profitability decreases as individual catch drops off. Even biological overfishing in a large system with many strains of the same species, as happens in the Paraguay River, may lead to a local depression of total stock before the species becomes extinct in the system as a whole.

Fishing of Varied Species

Most fishing enterprises that catch a variety of species cannot have an optimal catch of all of them, given the need to use gear that can catch more than one species. Increased levels of catch with greater diversity will increase total yield but may deplete stocks of some larger and more vulnerable species, such as the surubí. The marked increase in yield is due to middle-sized species that are less in demand as food, such as the shad, salmon (Brycon orbignyanus), and boga (Leporinus spp.).

This is normal in fishing in a river and its floodplain, where a variety of fish species develop near a large city, as happened in Manaus and Iquitos and is now happening in Asunción despite regulations. Meanwhile, the larger species that become scarce locally can be found further from the cities. Assuming that the fishing gear will not be more effective than those currently in use, and that the hydric and physical environments will be protected, experience has shown that in such cases fish do not become extinct in the large systems, in contrast to the fate of the highly vulnerable alligators and turtles.

Yield, Consumption, and Export of Fish

Methods

Though the dynamic theory concerning a population of varied fish species has yet to be successfully applied, the logical

way of evaluating fish production is by comparing it with other, ecologically similar environments that have maintained high yields. Welcome (1975, 1976) was a pioneer of this idea, having applied it comparing the rivers and floodplains of Africa, where most of the species have their ecological equivalent to those of the South American systems. Fishing trends in Africa are paralleled by projects underway in South America.

Difficulties in obtaining estimates of total fish yield for voluminous rivers are quite different from those faced when making estimates for lakes. Traditional approaches involve estimating individual and total catch and multiplying these two figures. The first method is extremely difficult given the enormous number of small outlets, and given that the amount of unsold fish consumed by the fisherman himself is never taken into account.

In order for the second method to be sufficiently precise, frequent samples must be taken on a regular, stratified basis, which is costly. Nonetheless, it is an important long-term investment, as it may reveal many other useful fishing indicators, such as changes in population structures, individual catch, and the relative importance of different gear or tackle.

The method of stratifying the catch within what can be estimated on the basis of per capita consumption and what is exported from the area (or distributed in some other form from well-defined sources) has been successfully applied in the Brazilian Amazon region (Bayley, 1981) and the Peruvian Amazon region (Hanek, 1982). The same approach is used in this study.

Paraguayan fish exports are sold to Brazil. In 1983, most fish was sold in Pilar or at the Asunción National Frozen Storage Facility (Frigorífico Nacional). The fish sold to the Frigorífico Nacional came mostly from small towns along the Paraná river (Ayolas, for example). One cooperative and four other businesses sold frozen fish to Brazil. It is believed that other towns and cities, especially Concepción, accounted for less than 20% of the volume of the two main centers.

Diet, Exports, and Yield

Paraguayans are traditionally consumers of beef. A 1965 national survey indicated that consumption of fresh fish was practically nil. Another survey, carried out by the Ministry of Health in 1978, indicated that average consumption came to 3.3 grams/person/day (equivalent to 5.5 grams of whole fresh fish). This study revealed that consumption has been practically constant in areas far from the main rivers, as a result of difficulties in distributing good quality fish, and unchanged dietary habits despite the steadily rising cost of beef.

Nonetheless fish consumption was considerably greater in communities along the two main rivers, even when no member of the family was a fisherman. Two short surveys were carried out in Paraguay river communities. Adults who purchase or catch fish for the whole family were asked how much fish the family normally consumes. In those cases in which the adult purchased the fish (or sold part of his own catch), those surveyed appeared to have a good idea of total weight procured each week. Estimates per family were adjusted so as to reflect average per capita consumption of a typical family with two adults and three children, the three children adding up to a single adult. Only one family was unable to provide the information. The results were as follows:

	Neighborhood		
	Villeta	Piquete cué	Combined data
# households	7	13	20
g/person/day	65.7	67.8	67.0
95% confidence level	45	21	19

As these two communities were not significantly different, their data were combined. The result reveals much higher consumption, but not as high as compared to the typical 150 - 200 grams in the Amazon river communities. Families continue to consume a significant amount of beef when they can afford it.

The estimate of 67 g was applied to all the communities along the Paraguay river and the Paraná river, including the 20% of the population of Asunción that includes the lowest income groups. The figure of 6 grams/person/day was applicable to the rest of the population for reasons outlined above. The following table gives the breakdown for the total yield of 18,000 tonnes, corresponding to the 12 months preceding the survey.

Source	Yield (tonnes/year)
Population living along the Paraguay River (6% of total population)	5,260
Population living along the Paraná River (4% of the total population)	3,500
Rest of Paraguay	7,060
Total yield for national consumption	15,820
Exports from Pilar	855
Exports from Asunción	960
Exports from small centers (approx.)	350
Total exports (to Brazil)	2,165
Total yield	18,000

Fishing Potential

Welcome (1975) estimated the typical fish yield of the African river systems at 4 to 6 tonnes per km^2 on average for the maximum flooded area. A conservative estimate for Paraguay's potential is based on just the 10,500 km^2 of floodplain associated with the Paraguay river. To the extent allowed for by the maps, marginal swamps were excluded from this estimate.

Thus, between 40,000 and 60,000 tonnes/year of fish could be exploited if appropriate methods for the catch, preservation, and distribution are developed so as to satisfy the growing demand for fish. Large species, which are the most frequently caught, would not be caught in such large numbers, but their prices would rise. Fishing would be dominated by medium-sized fish that are becoming more popular in some communities, as has already happened in other South American countries.

There will be a gradual tendency to greater total yield and greater diversity of species caught, whatever the official strategy. However, measures can be taken to control these tendencies by gearing both fishermen and consumers to a more rational exploitation of this resource. This should be taken up

with commercial fishing cooperatives, which have suffered unnecessarily as a result of existing guidelines and lack of investment. Large additional capital investments for export, such as that planned for Puerto Remanso, should not be encouraged. Although these investments are geared to local consumption, they invariably end up supplying fish at a price suitable to those consumers who are least in need of fish.

Possible Effects of Dams on Fish Life

Man has long built reservoirs for a variety of uses. But unfortunately, none of these efforts was accompanied solely by improved resource use.

Little is known in Paraguay about the impact of dams on the ecosystems.

The fish life of the la Plata River basin, which includes the Paraná River, is constantly on the move, whether to the north or to the south, in function of various stimuli, in order to gather for reproduction or feeding.

Most if not all of the fish species need to be able to move about in a huge area within the La Plata basin to carry out all vital functions previously mentioned as well as others that are part of a normal life. There are many situations that have not been studied and some must be particularly important in development of individual fish and fish populations.

The dynamic equilibrium of these natural systems is determined not only by physical space, but by physical, chemical, and biological conditions as a whole.

The dams will create a series of "ecophysiological sections," which will constitute veritable scars in the La Plata basin, the effects of which over time and space are hard to evaluate. There will be considerable change in stream flow in those parts of the river where the dams are located, and the response to this new situation will not be long in coming as regards the fish population of any of the levels, whether surface, intermediate, or at the riverbed. This situation may benefit only the benthic fauna, which may only suffer the impact of accumulation of sediments which abound in rivers such as the Paraná.

Forseeable Changes in the Fishing Industry

As a result of dam construction, the river will become a series of lakes. The waters will be transformed from lotic waters, or currents, laden with sediments, to lentic or semi-lentic waters, slower and more transparent. This situation will have a negative impact, above all for species that migrate for reproduction or that need detritus or sediments for food, as well as for predator species that depend on migrant species for their own sustenance.

Sedentary fish species found in lagoons, watercourses, or other bodies of water in the floodplain will probably find optimal or, at any rate, more propitious conditions in the new lakes.

One genus that is extremely important in the food chain of several icthyophagous species is the shad (Prochilodus sp.), whose main source of food is detritus and organisms found on the river bottom. This species may suffer the impact of the hydroelectric works, with its population density declining.

The most important icthyophagous or carnivorous species are, no doubt, the surubí (Pseudoplastistoma corrucans and P. fasciatum) and the dorado (Salminus maxillosus), as they are migratory fish of high commercial value which are also prized for sport. The shad is an important part of the diet of both of these fish. Their populations are likely to shrink considerably in the "new lakes".

Transparency

If suspended solids are reduced considerably, transparency will increase; and if greater transparency is not offset by turbidity owing to greater production of algae, the icthyophagous and carnivorous species will have an advantage over their prey, bringing about a considerable change in the eco-biological balance of the present system.

One must bear in mind in this regard the voracious piranhas, Serrasalmus spp., whose dense schools, which are very active, are capable of altering interspecific relations.

To summarize, the consequences of dam construction in the rivers will be:

1. Interruption of fish migrations as a direct result of the dams. These trophic and genetic displacements will alter populations significantly.

2. The ecobiological unit formed by the Paraná River will be transformed into a series of irreversible fractions; this process will destroy much of the fish life.

3. Adaptation to new physical, chemical, and biological conditions, as a result of dam construction, will take its biological toll, which in turn will bring about a change in feeding and interspecific relations.

4. The river spawning sites, small streams, branches of rivers, brooks, and flooding areas will experience significant changes that will profoundly affect the fish populations, which will have to change their spawning sites, running the risk of some species disappearing.

5. Interruptions of migrations due to dams will encourage the search for new ecosystems and perhaps habitat, together with appropriate spawning areas, among many species, so as to continue positive biological evolution.

6. There is no doubt that commercial fishing will vary in direct proportion to species' conditions of ecological adaptation. Fishing spots or areas will vary as a result of microclimatic and environmental changes.

7. Once the reservoirs form, proper conditions will exist for good fishing, so long as actions are taken to regulate proportional populations.

8. The most voracious, aggressive, and rustic species will prosper more quickly, and may rapidly reduce other economically important fish populations.

Recommendations

Information

An investment should be made in a continuous information system on fishing so as to provide estimates of annual yields and individual catches, taking into account the gear used and the species caught. This system should include a frequent sampling of fish caught by fishermen and estimates as to the total catch per gear or tackle and region. This system should be completely independent of authorities in charge of enforcing

regulations and collecting taxes. There are no resident experts who can design this kind of plan. Furthermore, annual surveys on household fish consumption should be carried out so as to obtain independent estimates of total yield. An adequate design should be properly stratified, taking into account geographic differences in diet. These surveys should be shared, financially and operationally, with the Ministry of Public Health, so that other aspects of diet can also be included.

Administration

There are a number of potential administrative strategies consonant with environmental protection. Though present provisions pursue this goal, they are unrealistic in terms of viable economic development of the fishing industry. The least that can be done would be to eliminate closed seasons in the Paraguay and Paraná rivers.

Development

The best defense against environmental abuse would be to encourage the population and economy to turn increasingly to fish as a source of protein. It is essential—indeed urgent, given the growing difficulty in obtaining beef—that methods of preservation and overland distribution be improved. Marketing cooperatives should receive greater support so that they in turn can provide greater stability for fishermen and facilitate quality control. Furthermore, international technical cooperation is needed.

Table VIII – 1

Areas Covered by Natural Grasslands, # Head of Cattle, and Grazing Density, by Province.

Province	Area ha	Head of Cattle	Grazing density ha/animal
EASTERN REGION	9,941,854	3,958,365	2.5
Concepción	1,681,821	467,055	3.6
San Pedro	416,417	515,933	0.8
Cordillera	297,400	203,328	1.5
Guairá	255,870	158,736	1.6
Caaguazú	662,414	305,423	2.2
Caazapá	486,975	266,841	1.8
Itapúa	993,323	262,721	3.8
Misiones	654,859	391,444	1.7
Paraguarí	612,547	446,563	1.8
Alto Paraná	636,943	80,777	7.8
Central	165,749	116,992	1.4
Ñeembucú	818,470	402,528	2.0
Arnambay	808,726	265,610	3.0
Canendiyú	516,335	74,414	6.9
WESTERN REGION	11,483,799	2,383,019	4.8
Pte. Hayes	5,949,958	1,896,668	3.1
Alto Paraguay	3,318,894	240,915	14.0
Chaco	531,650	9,520	55.8
Nueva Asunción	141,700	6,408	22.0
Boqueron	1,481,546	229,508	6.4
TOTAL – PARAGUAY	21,425,603	6,341,384	3.4

Source: Ministry of Agriculture and Livestock, 1981.

Table VIII – 3
Endangered Paraguayan Wildlife

MAMMALS		Status				Causes of Endangered Status							References
Scientific name	Common name	E	A	J	D	Destruction of habitat				Hunting	Commerce	Undetermined	
						BA	BB	W	P				
1. *Myrmecophaga tridactyla*	great anteater	+								+			IUCN (V)
2. *Priodontes giganteus*	giant armadillo	+								+			IUCN (V)
3. *Burmeisteria retusa*	Burmeister's armadillo	+								+			IUCN (D)
4. *Chrysocyon brachyurus*	maned wolf	+									+		IUCN (V)
5. *Spepotos venaticus*	bush dog	+								+			IUCN (V)
6. *Lutra platensis*	river otter	+									+		IUCN (V)
7. *Pteronura brasiliensis*	giant otter	+								+		+	IUCN (V)
8. *Felis paradalis*	ocelot	+				+	+			+	+		IUCN (V)
9. *F. tigrina*	little spotted cat	+				+	+				+		IUCN (V)
10. *F. yagouaroundi*	jaguarundi	+				+	+			+	+		IUCN (E)
11. *F. wiedii*	margay	+				+	+				+		IUCN (V)
12. *leo onca*	jaguar	+				+	+			+	+		IUCN (V)
13. *Catagonus wagneri*	Chaco peccary	+					+			+			IUCN (V)
14. *Blastocerus dichotomus*	swamp deer	+								+			IUCN (V)
15. *Tapirus terrestris*	Brazilian tapir		+				+			+			
16. *Ozotocerus bezoarticus*	Pampas deer		+							+			
17. *Dusicyon gymnocercus*	South American "fox"			+						+			
18. *Tamandua tetradactyla*	collared anteater				+					+			
19. *Nasua nasua*	coatimundi				+		+			+			
SUBTOTAL		14	2	1	2	5	8			15	7	1	

BIRDS		Status				Causes of Endangered Status							References
Scientific name	Common name	E	A	J	D	Destruction of habitat				Hunting	Commerce	Undetermined	
						BA	BB	W	P				
1. *Mergus octosetaceus*	Brazilian merganser	+				+							ICBP
2. *Morphnus guianensis*	guinea crested eagle	+				+							ICBP
3. *Harpia harpyja*	harpy eagle	+				+							ICBP
4. *Leucopternis polionota*	mantled hawk	+				+							ICBP
5. *Falco Peregrinus tundrius*	peregrine falcon	+						+					ICBP
6. *Aburria jacutinga*	black-fronted piping guan	+				+				+			ICBP
7. *Numenius borealis*	eskimo curlew	+						+	+	+			ICBP
8. *Claravis godefrida*	purple-barred ground dove	+				+	+					Months	ICBP
9. *Anodorrhynchus glaucus*	glaucous macaw	+				+				+			ICBP
10. *Ara caninde*	caninde macaw	+				+					+		ICBP
11. *Dyrocopus galeatus*	helmeted woodpecker	+				+				+			ICBP
12. *Coscoroba coscoroba*	coscoroba swan		+					+		+			IWRB (R)
13. *Cygnus melancoryphus*	black-necked swan		+					+					IWRB (R)
14. *Coturnicops notata*	Darwin's rail		+						+				IWRB (R)
15. *Laterallus xenopterus*	rufous-faced crake		+						+				IWRB (R)
16. *Neocrex erythrops*	paint-billed crake		+						+				IWRB (R)
17. *Gallinago undulata gigantea*	giant snipe		+						+				IWRB (R)
18. *Penelope oscura*	dusky-legged guan		+			+				+			
19. *Crax fasciolata*	bare-faced curassow		+			+				+			
20. *Odontophorus capueira*	spot-winged wood quail		+						+				
21. *Plegadis chihi*	white-faced ibis			+				+		+			
22. *Anodorrhynchus hyacinthinus*	hyacinth macaw			+						+	+		
23. *Ara ararauma*	blue and yellow macaw			+		+				+	+		
24. *A. chloroptera*	green-winged macaw			+						+		+	
25. *A. auricollis*	yellow-collared macaw			+		+					+		
26. *Ara maracana*	Illiger's macaw			+						+	+		

BIRDS		Status				Causes of Endangered Status							References
Scientific name	Common name	E	A	J	D	Destruction of habitat				Hunting	Commerce	Undetermined	
						BA	BB	W	P				
27. *Amazona vinacea*	vinaceous Amazon			+		+					+		
28. *Geranoaetus melanoleucus*	grey eagle-buzzard			+		+					+		
29. *Harpyhaliaetus coronatus*	crowned solitary eagle			+		+							
30. *Spizaetus ornatus*	ornate hawk eagle			+		+							
31. *S. tyrannus*	black hawk eagle			+		+							
32. *Procnias nudicollis*	bare-throated bellbird			+		+					+		
33. *Pluvialis dominica* (WR)	American golden plover			+								+	
34. *Limosa haemastica* (WR)	Hudsonian godwit				+							+	
35. *Bartramia longicauda* (WR)	upland sandpiper				+							+	
36. *Tringa melanoleuca* (Tr)	greater yellowlegs				+							+	
37. *T. flavipes* (Tr)	lesser yellowlegs				+							+	
38. *T. solitaria* (WR)	solitary sandpiper				+							+	
39. *Actitis macularia* (WR)	spotted sandpiper				+							+	
40. *Phalaropus tricolor* (WR)	Wilson's phalarope				+							+	
41. *Calidris alba* (WR)	sanderling				+							+	
42. *C. pusilla* (WR)	semipalmated sandpiper				+							+	
43. *C. fuscicollis* (Tr)	white-rumped sandpiper				+							+	
44. *C. bairdii* (WR)	Baird's sandpiper				+							+	
45. *C. melanotos* (WR)	pectoral sandpiper				+							+	
46. *Micropalama himantopus* (WR)	stilt sandpiper				+							+	
47. *Tryngites subruficollis* (Tr)	buff-breasted sandpiper				+							+	
48. *Penelope superciliaris*	rusty-margined guan				+					+			
49. *Pipile pipile*	common piping guan				+	+				+			
50. *Pulsatrix perspicillata*	spectacled owl				+	+							
51. *P. koeniswaldiana*	tawny-browed owl				+	+							
SUBTOTAL		11	9	12	19	23	1	6	6	14	9	16	

REPTILES		Status				Causes of Endangered Status							
Scientific name	Common name	E	A	J	D	Destruction of habitat				Hunting	Commerce	Undetermin-	References
						BA	BB	W	P				
1. *Caiman latirostris*	broad-nosed caiman	+						+		+	+		IUCN (V)
2. *C. crocodilus jacare*	Paraguay caiman	+						+		+	+		IUCN (V)
3. *Tupinambis teguixin*	common tegu		+			+					+		IUCN (V)
4. *Eunectes murinus*	anaconda (also: water boa)		+										
5. *E. noteus*	yellow anaconda		+								+		IUCN (V)
6. *Dracaena paraguayensis*				+			+	+			+		IUCN (V)
7. *Hydrodynastes gigas*				+			+	+		+		IUCN (V)	
8. *Mastigodryas bifosatus*				+			+	+		+			IUCL (V)
9. *Boa constrictor*	boa constrictor				+					+			IUCN (V)
10. *Phrynops nasuta*					+					+			
11. *Phrynops geoffroanus*					+					+			
12. *Hydromedusa tectifera*	South American snake-necked turtle				+					+			
SUBTOTAL		2	3	3	4	1	2	5		9	5		
AMPHIBIANS													
1. *Phyllomedusa sauvagei*					+		+					+	
2. *Ceratophrys ornata*					+			+					
3. *Phrynohyas venulosa*					+			+				+	
SUBTOTAL					3		1	2				2	
SUBTOTAL MAMMALS		14	2	1	2	5	8			15	7	1	
BIRDS		11	9	12	19	23	1	6	6	4	9	16	
REPTILES		2	3	3	4	1	2	5		9	5		
AMPHIBIANS					3		1	2				2	
TOTAL		27	14	16	28	29	12	13	6	38	21	19	

Table VIII – 4

Exports of Hides and Skins of Wild Animals

(In Millions of Guaranis)

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984 January to June
Hunting and fishing wild hides and skins	1285	69.4	45.9	33.5	42.7	66.7	42.3	53.3	–	0.2	
Others	1.2	1.7	8.2	0.3	0.4	1.0	1.9	–	–	–	

Foreign Exchange from Export of Wildlife Products. In Thousands of $US.

	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984 January to June
Hunting and fishing wild hides and skins	1.029	550	365	266	339	530	336	423	–	1	
Others	10	13	65	2	3	8	15	–	–	–	

Exports by Product and Sub-product, In Tonnes and Thousands of $US. FOB.

	1976		1977		1978		1979		1980		1981		1982		1983	
	Vol.	Value	Vol.	Value	Vol.	Value	Vol.	Value	Vol.	Value	Vol.	Value	Vol.	Value	Vol.	Value
Wild skins	71	382	69	923	95	1.573	42	846	74	786	47	406	21	435	7	137
Alligator	41	344	69	923	92	1.565	42	846	74	786	47	406	21	435	7	137
Jaquar	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
River otter	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Capybara	2	5	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pecarry	3	9	–	–	1	1	–	–	–	–	–	–	–	–	–	–
Nutria	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Iquana	1	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Deer	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Wildcat	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mountain lion	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Snakes	–	–	–	–	1	1	–	–	–	–	–	–	–	–	–	–
Toads	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Rhea	1	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Others	23	19	–	–	1	1	–	–	–	–	–	–	–	–	–	–

Source: Central Bank of Paraguay, Statistical Bulletin No. 311, June 1984.

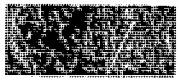
Table VIII – 5

Floristic Regions* in Relation to the System of Protected Natural Areas**

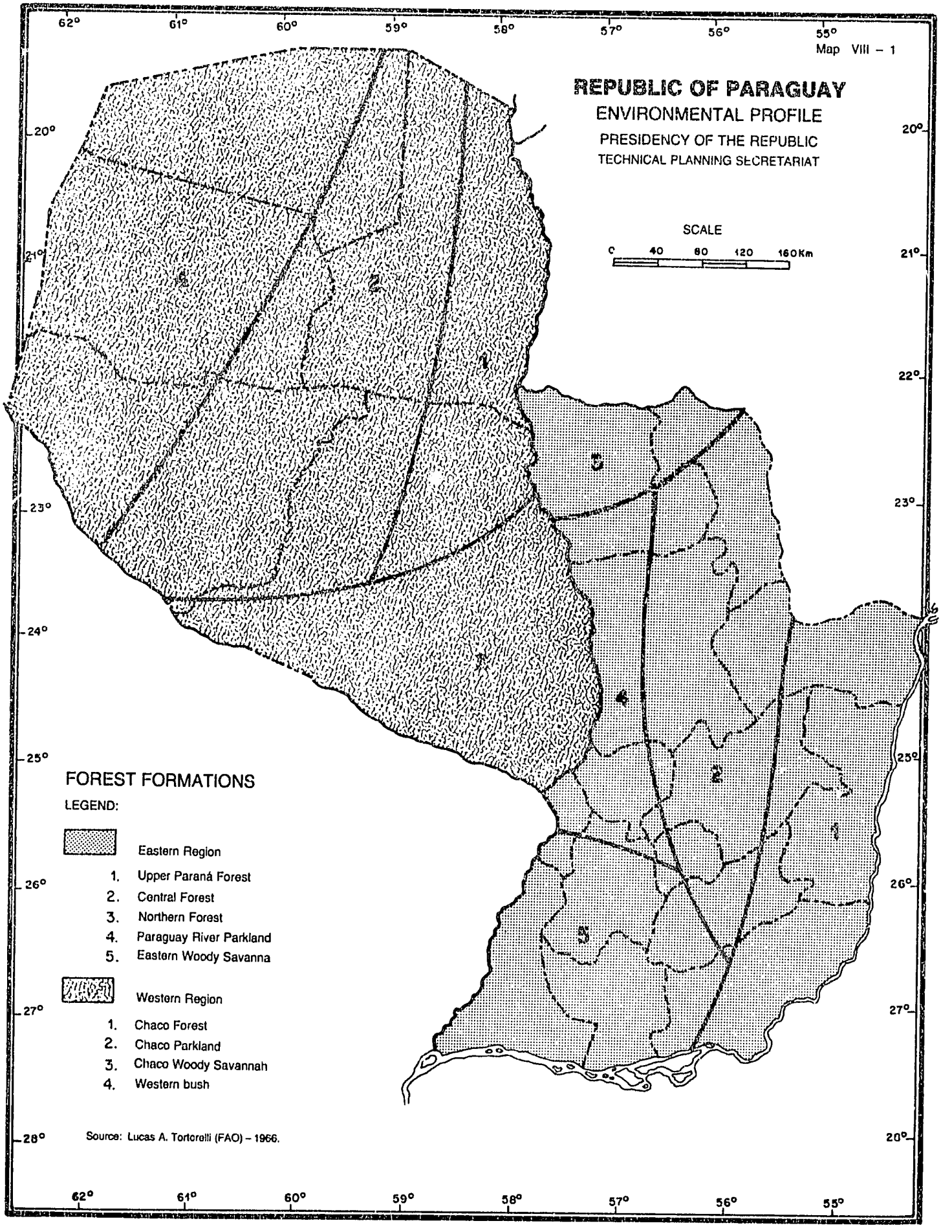
Floristic Regions / Conservation Unit	Def. del Chaco	Tte. A. Enciso	Tinfunqué	Ybycuí	Caaguazú	Cerro Corá
Subtropical Broadleaf Forest				X	X	X
Riverine Parkland						
Dense Savannah						X
Open Savannah						
Central Chaco Dry Forest	X	X	X			
Eastern Chaco Semi-dry Forest			X			
Pantanal						
Gallery Forest						

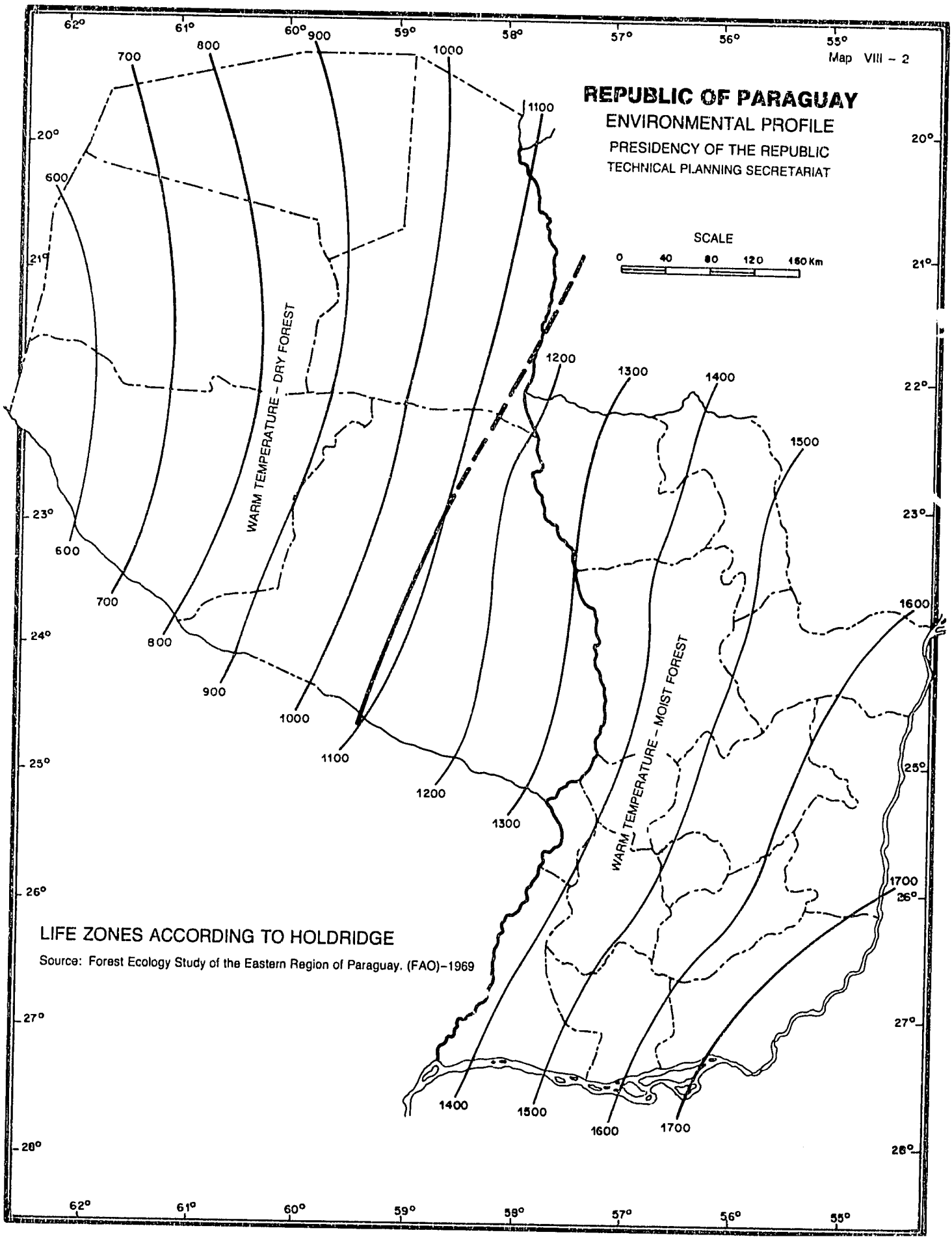
*After Hueck (1978).
**Adapted by P. Clark – 1983.

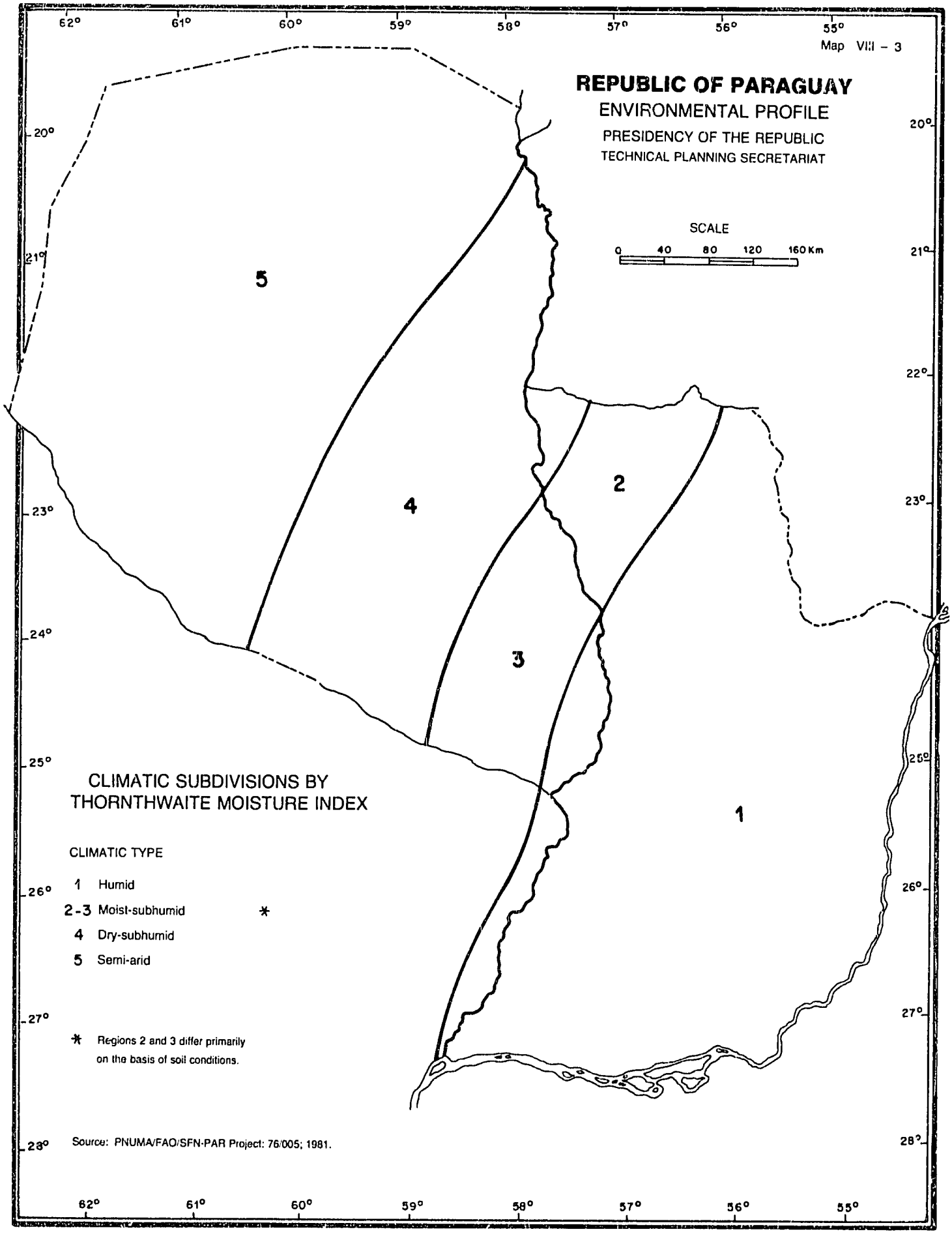
Major Vegetation Types

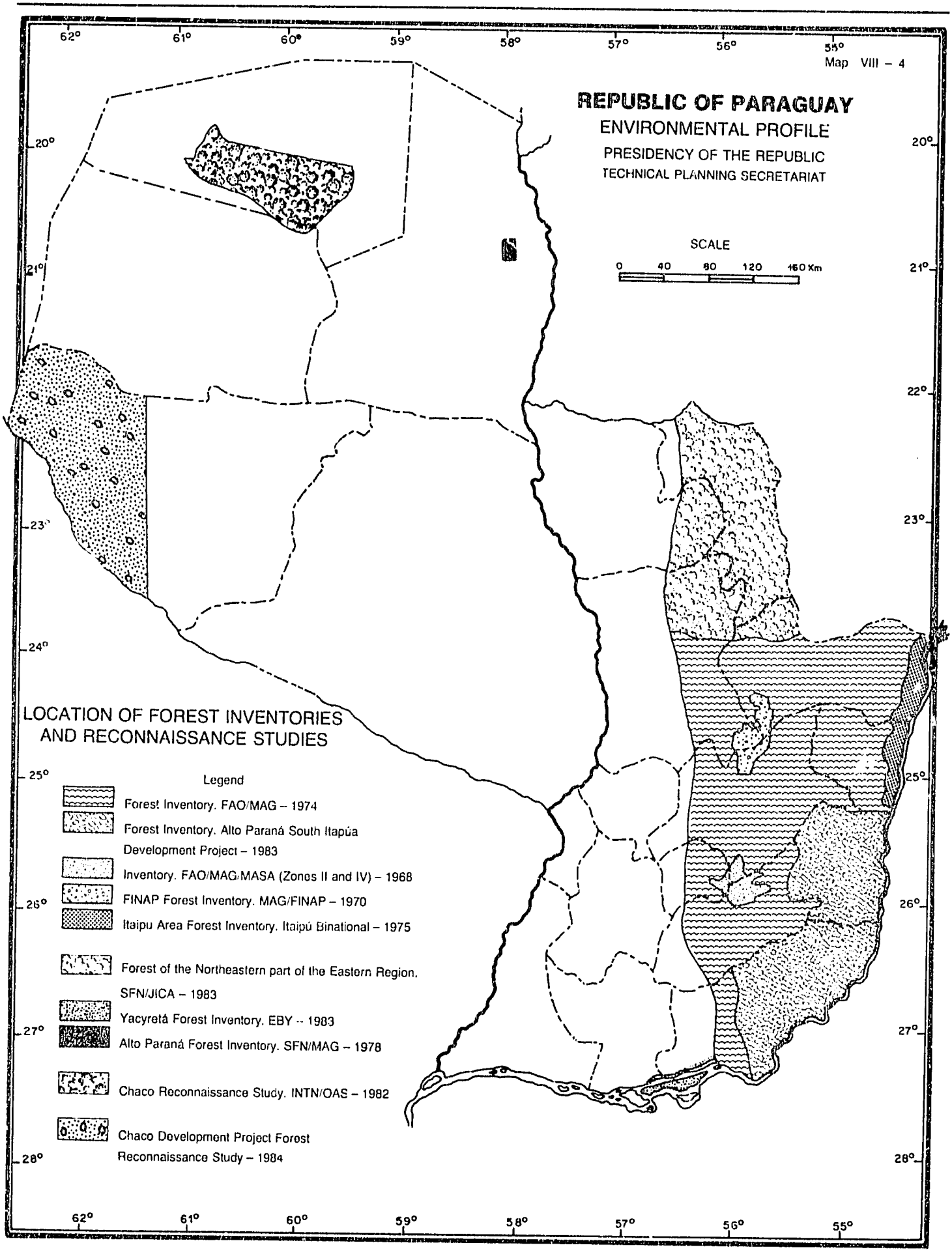
NOTES			AREA	
			Hectares	Percent
	Forest	Consists of all continuous plant formations in which trees predominate.	4,716,100	29.6
	Grassland	Consists of all continuous plant formations in which grasses predominate, even though small, discontinuous areas of forest are included.		
	Upland	Consists of formations on high ground above the maximum flood elevation, generally on residual soils including hills, slopes, and mountains.	3,968,970	24.9
	Plain	Consists of formations in valleys and flatlands affected to some degree by flooding, generally on alluvial soils.	2,257,180	14.2
	Lowland	Consists of formations on low ground and depressions, flooded or subject to flooding generally on alluvial soils, and including swamps and marshes.	1,848,860	11.6
	Cropland	Consists of vegetation on cultivated land including: annual crops, permanent crops, orchards, cultivated pastures, fallows, and land under preparation for planting.	3,140,140	19.7
			15,931,250	100.0

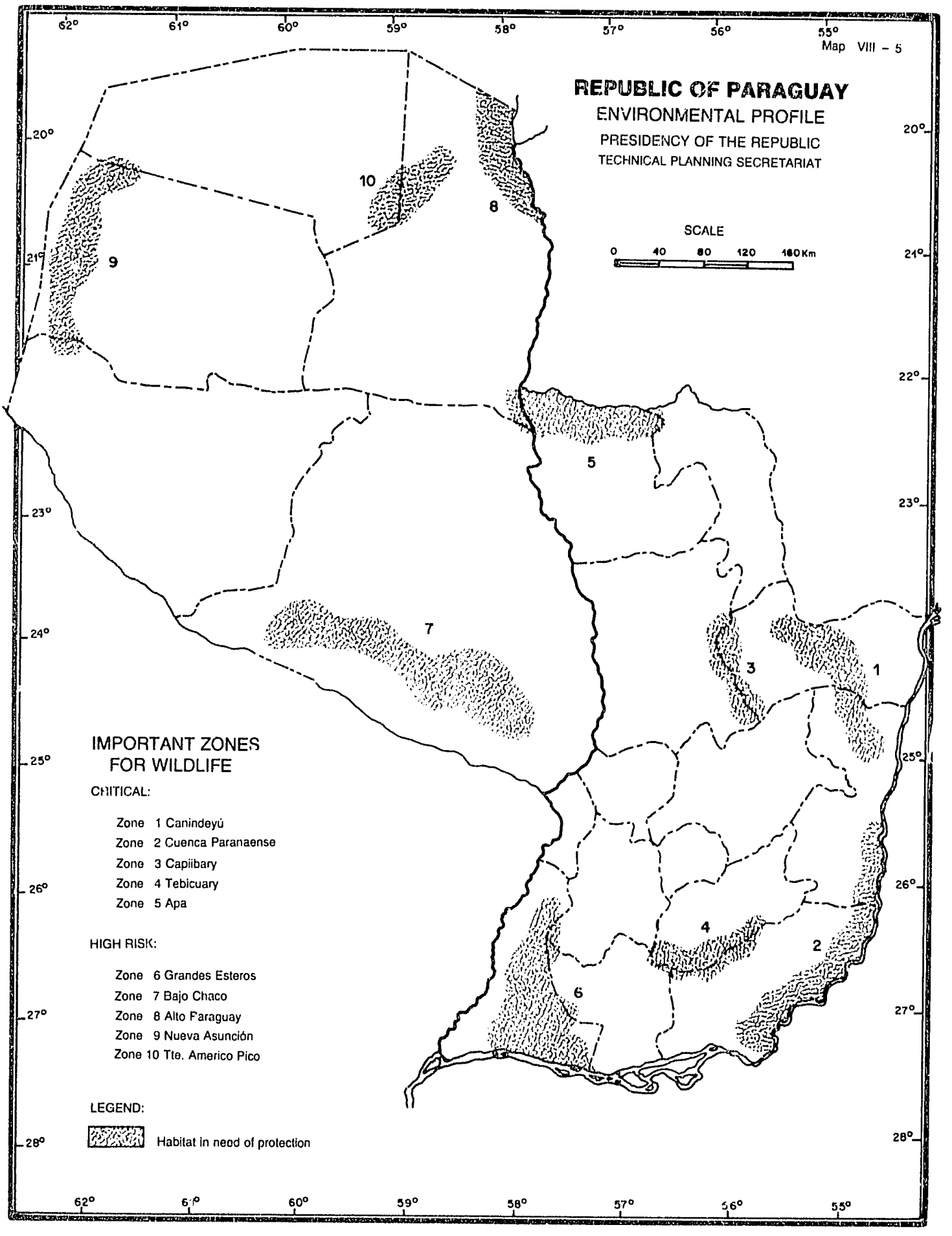
Source: F.I.A. – UNA and Contapar S.R.L.
(Courtesy Contapar S.R.L.)


62° 61° 60° 59° 58° 57° 56° 55°
Map VIII – 1
REPUBLIC OF PARAGUAY
ENVIRONMENTAL PROFILE
PRESIDENCY OF THE REPUBLIC
TECHNICAL PLANNING SECRETARIAT
SCALE
0 40 80 120 160 Km
20° 21° 22° 23° 24° 25° 26° 27° 28°
FOREST FORMATIONS
LEGEND:
Eastern Region
1. Upper Paraná Forest
2. Central Forest
3. Northern Forest
4. Paraguay River Parkland
5. Eastern Woody Savanna
Western Region
1. Chaco Forest
2. Chaco Parkland
3. Chaco Woody Savannah
4. Western bush
Source: Lucas A. Tortorelli (FAO) – 1966.


Map VIII - 2
REPUBLIC OF PARAGUAY
ENVIRONMENTAL PROFILE
PRESIDENCY OF THE REPUBLIC
TECHNICAL PLANNING SECRETARIAT
SCALE
0 40 80 120 160 Km
WARM TEMPERATURE - DRY FOREST
WARM TEMPERATURE - MOIST FOREST
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
62°
61°
60°
59°
58°
57°
56°
55°
20°
21°
22°
23°
24°
25°
26°
27°
28°
LIFE ZONES ACCORDING TO HOLDRIDGE
Source: Forest Ecology Study of the Eastern Region of Paraguay. (FAO)-1969


Map VIII - 3
REPUBLIC OF PARAGUAY
ENVIRONMENTAL PROFILE
PRESIDENCY OF THE REPUBLIC
TECHNICAL PLANNING SECRETARIAT
SCALE
0 40 80 120 160 Km
62° 61° 60° 59° 58° 57° 56° 55°
20° 21° 22° 23° 24° 25° 26° 27° 28°
1
2
3
4
5
CLIMATIC SUBDIVISIONS BY
THORNTHWAITE MOISTURE INDEX
CLIMATIC TYPE
1 Humid
2-3 Moist-subhumid *
4 Dry-subhumid
5 Semi-arid
* Regions 2 and 3 differ primarily on the basis of soil conditions.
Source: PNUMA/FAO/SFN-PAR Project: 76/005; 1981.


Map VIII – 4
REPUBLIC OF PARAGUAY
ENVIRONMENTAL PROFILE
PRESIDENCY OF THE REPUBLIC
TECHNICAL PLANNING SECRETARIAT
SCALE
0 40 80 120 160 Km
62° 61° 60° 59° 58° 57° 56° 55°
20° 21° 22° 23° 24° 25° 26° 27° 28°
LOCATION OF FOREST INVENTORIES AND RECONNAISSANCE STUDIES
Legend
Forest Inventory. FAO/MAG – 1974
Forest Inventory. Alto Paraná South Itapúa Development Project – 1983
Inventory. FAO/MAG/MASA (Zones II and IV) – 1968
FINAP Forest Inventory. MAG/FINAP – 1970
Itaipu Area Forest Inventory. Itaipú Binational – 1975
Forest of the Northeastern part of the Eastern Region. SFN/JICA – 1983
Yacyretá Forest Inventory. EBY – 1983
Alto Paraná Forest Inventory. SFN/MAG – 1978
Chaco Reconnaissance Study. INTN/OAS – 1982
Chaco Development Project Forest Reconnaissance Study – 1984


Map VIII - 5
REPUBLIC OF PARAGUAY
ENVIRONMENTAL PROFILE
PRESIDENCY OF THE REPUBLIC
TECHNICAL PLANNING SECRETARIAT
SCALE
0 40 80 120 160 Km
62° 61° 60° 59° 58° 57° 56° 55°
20° 21° 22° 23° 24° 25° 26° 27° 28°
IMPORTANT ZONES FOR WILDLIFE
CRITICAL:
Zone 1 Canindeyú
Zone 2 Cuenca Paranaense
Zone 3 Capiibary
Zone 4 Tebicuary
Zone 5 Apa
HIGH RISK:
Zone 6 Grandes Esteros
Zone 7 Bajo Chaco
Zone 8 Alto Paraguay
Zone 9 Nueva Asunción
Zone 10 Tte. Americo Pico
LEGEND:
Habitat in need of protection

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