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9. ABSTRACT

This report suggests a procedure for making an inventory of the natural resources that are significant to agriculture, and the relation of these to current production as well as to the apparent opportunities for feasible and substantial improvements in the production of crops, forages, and livestock. Toward these ends, a comprehensive estimate of the magnitude of a nation's natural resources endowment (climate, lands and soils, waters and vegetation), is presented here as a basis for prudent and effective plans for their utilization. For many nations, the inventory of its natural resources and their actual and potential values is very incomplete. As a result, development of the agricultural potential is not well planned by either the government or by individual groups or families. Thus a more comprehensive inventory should provide guidelines for this development and also should help to prevent the disappointment and failure of projects unsuited to prevailing conditions.

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Evaluation of the Natural Resources Available for Agricultural Production and Development in the Tropics and Sub-Tropics

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EVALUATION OF THE NATURAL RESOURCES AVAILABLE

for

AGRICULTURAL PRODUCTION AND DEVELOPMENT IN THE TROPICS AND SUB-TROPICS

Prepared by: Howard B. Sprague

Division of Soil and Water Management

July 1975

Office of Agriculture
Bureau for Technical Assistance
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PREFACE

Each developing country faces the urgent necessity of increasing agricultural production to keep pace with a growing population, and the long term need for sound agricultural development. An inventory of the natural resources endowment of the country provides a rational basis for planning to meet national goals. This bulletin suggests criteria and procedures that have been useful in representative countries for agricultural planning and programming.

It is recognized that each country is a unique entity, and the treatment of natural resources must be adjusted to the economic status, social objectives and political considerations that prevail. For specific use in a specific country, additional information may be required to supplement the natural resources data.

Additional copies of this bulletin may be requested from this office, or through the USAID Missions or Regional AID offices.

Leon F. Hesser

Leon F. Hesser
Acting Director
Office of Agriculture
Bureau for Technical Assistance
Agency for International Development
Washington, D.C. 20523

OUTLINE

I. Introduction
II. Inventory of Natural Resources of the Country
   A. Geography and Topography
   B. Climates
      1. Rainfall
      2. Duration of dry seasons
      3. Land Use and Rainfall
      4. Temperatures
      5. Evaporation
      6. Strong Winds and Violent Storms
      7. Recording Weather Data
   C. Natural Vegetation Zones
III. Land Potential Classification
   A. Land suited for tilled crops, Classes I - IV
      Class I
      Class II
      Class III
      Class IV
   B. Lands not suited for cultivation
      Class V
      Class VI
      Class VII
      Class VIII
   C. Soil Surveys
IV. Present Land Uses and Status of Agriculture
   A. Available maps on land uses
   B. Agricultural statistical profile
      Section 1. General Information
      Section 2. Crop Production
      Section 3. Livestock Production
      Section 4. Trade in Crop Commodities
      Section 5. Trade in Livestock and Products
V. Evaluating the Potential for Higher Production on Existing Agricultural Lands.
   A. Effective Production practices
      1. Selection of Adapted Crop Species
      2. Choice of Best Varieties of Each Crop
      3. Effective Soil Management
      4. Planting Practices
      5. Control of Plant Pests
      6. Timely Harvest to Avoid Losses
      7. Effective On-Farm Use of Water
      8. Combination of Practices
   B. Other Developmental Potentials
      1. Diversification
      2. Soil Conservation and Management
      3. Integration of Livestock and Cropping
      4. Rangeland Improvement and Livestock Production
VI. Identifying Favorable Potentials for Developing New Lands
   A. Extension of present road systems
   B. Clearing forests and woodlands
   C. Drainage of wetlands
   D. Opening lands by control of endemic diseases (malaria, river blindness, schistosomiasis, etc.)
   E. Development of tsetse fly infested lands of Africa
   F. Localized, small scale irrigation projects

Evaluation of the Natural Resources Available for Agricultural Production and Development in the Tropics and Sub-Tropics

I. Introduction

The increasing production of sufficient food of adequate nutritive quality to keep pace with growing populations is a major concern of most nations in the tropical and sub-tropical zones. In addition, there is a need to improve the efficiency of all agricultural activities to meet the growing desire for an improvement in quality of living. Beyond these goals is the necessity for more efficient production of agricultural commodities for export, to earn the foreign exchange required to purchase the wide range of goods and supplies imported from other countries.

Each of these national goals requires a comprehensive estimate of the magnitude of the nations's natural resources endowment, (climate, lands and soils, waters and vegetation), as a basis for prudent and effective plans for their utilization. For many nations, the inventory of its natural resources and their actual and potential values, is very incomplete. As a result, development of the agricultural potential is not well planned by either the government or by individual groups or families. A more comprehensive inventory of the agricultural resources should serve as a guide to the successive stages of national agricultural development, and also avoid the risks of disappointment and failure of types of projects unsuited to the conditions that prevail.

Increasing agricultural productivity of a nation is a highly important governmental matter. Each nation constitutes a unique entity. Even when adjoining nations have similar natural resource endowments, they differ in their economic stage of development, their social structure, and their political and governmental status. Each sovereign nation may benefit from observing successes in other countries, but there is no substitute for an intimate knowledge of its own resources. The enhancement of agricultural production and of development programs should be based on the conditions that exist in the individual countries. This report suggests a procedure for making an inventory of the natural resources that are significant to agriculture, and the relation of these to current production as well as to the apparent opportunities for feasible and substantial improvements in the production of crops, forages and livestock.

II. Inventory of Natural Resources of the Country

A. The geography and topography of the country provides a logical starting point. The latitudes, which indicate the country's position with respect to the equator, determines the extent to which the country is tropical or subtropical. Territory between latitude of $23\frac{1}{2}^{o}$ south of the equator, and that between the equator and $23\frac{1}{2}^{o}$ north latitude, is considered tropical. The subtropical zones are of variable width beyond $23\frac{1}{2}^{o}$ north and south latitudes. and to about 35° latitudes.

However, there are two important modifiers of the environment, -- altitude, and the presence of large bodies of water/ Land areas with altitudes above 5,000 feet (about 1,524 meters) are essentially typical of the temperate zone rather than the tropics (except for the absence of a true winter season). With increasing altitude above sea level, the temperatures generally decline steadily, both as to averages by season or month, and the highest temperatures experienced.

Altitude has a pronounced effect on adaptation of plant species, and on the environmental stresses to which livestock are subjected. Reductions in temperatures caused by increasing atltitude make livestock more tolerant of most diseases and parasites, as well as permitting better nutrition, growth and reproduction.

Large bodies of water over which winds flow have a great modifying effect on land temperatures and on air humidity. The mass of water has a cooling effect in the warmer seasons, and a warming effect in cooler seasons. A country having prevailing winds blowing from water onto land, will feel the moderating effect of the expanses of water to a considerable distance. Conversely, lands that are exposed to prevailing winds from continental land areas, experience greater changes in temperature than would otherwise occur. Further, air masses moving inland from large bodies of water are more likely to be moisture laden, and to contribute to seasonal rainfall. Winds blowing from land masses are generally dry and contribute less to rainfall.

Country Accessibility

An additional important factor is the accessibility of the principal land areas of the country. Landlocked areas are heavily dependent on rail lines and roads for transport and travel, and for trade with other countries. Island nations are dependent on water transport for trade with other areas. Thus geographic position is an important factor that each nation must recognize in its plans for development.

Topography has a pronounced effect on the suitability of land for various uses. The extent to which the land surface departs from a level surface (steeper slopes), influences rainfall runoff, erosion losses, and thereby affects the soil depth that is generated over the long era of soil formation. Land areas with smoother and nearly level topography are generally better suited for tilled crops. As the topography becomes more rugged, the best use of the land may be for pasture and grazing lands, or tree fruit crops. The most rugged topography usually limits land use to forestry.

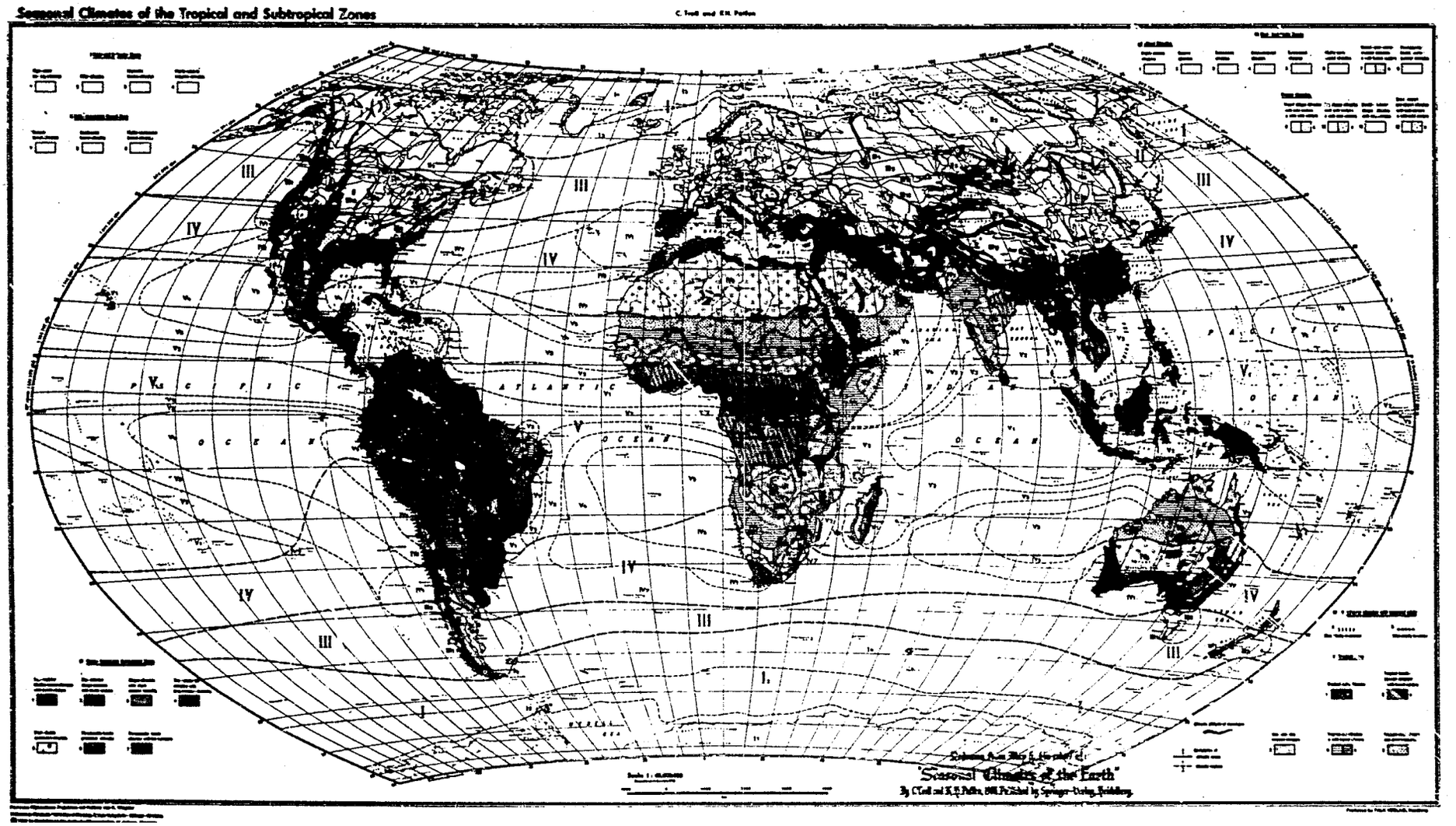


Figure 1. "Seasonal Climates of the Tropics and Sub-Tropics"

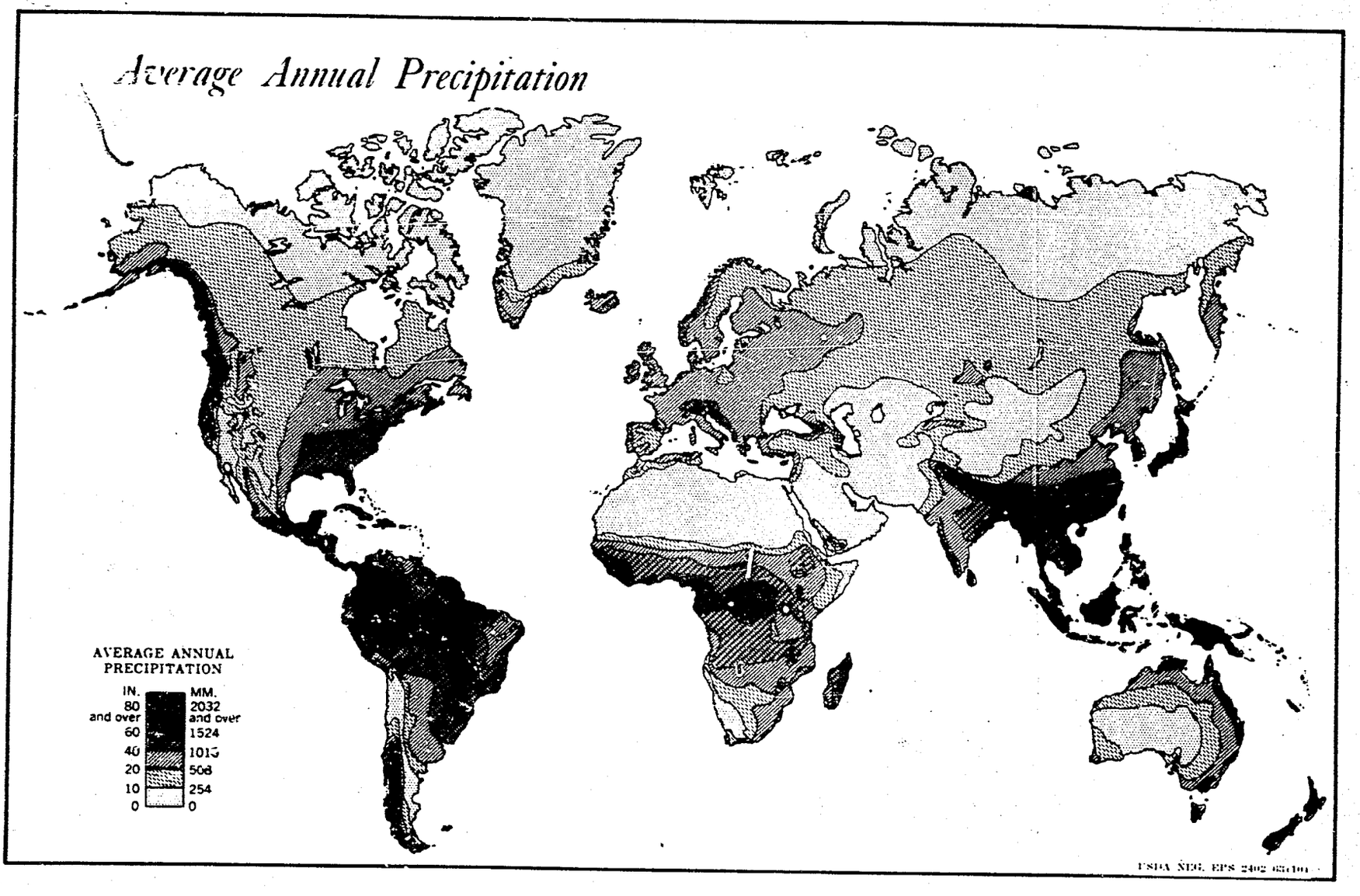
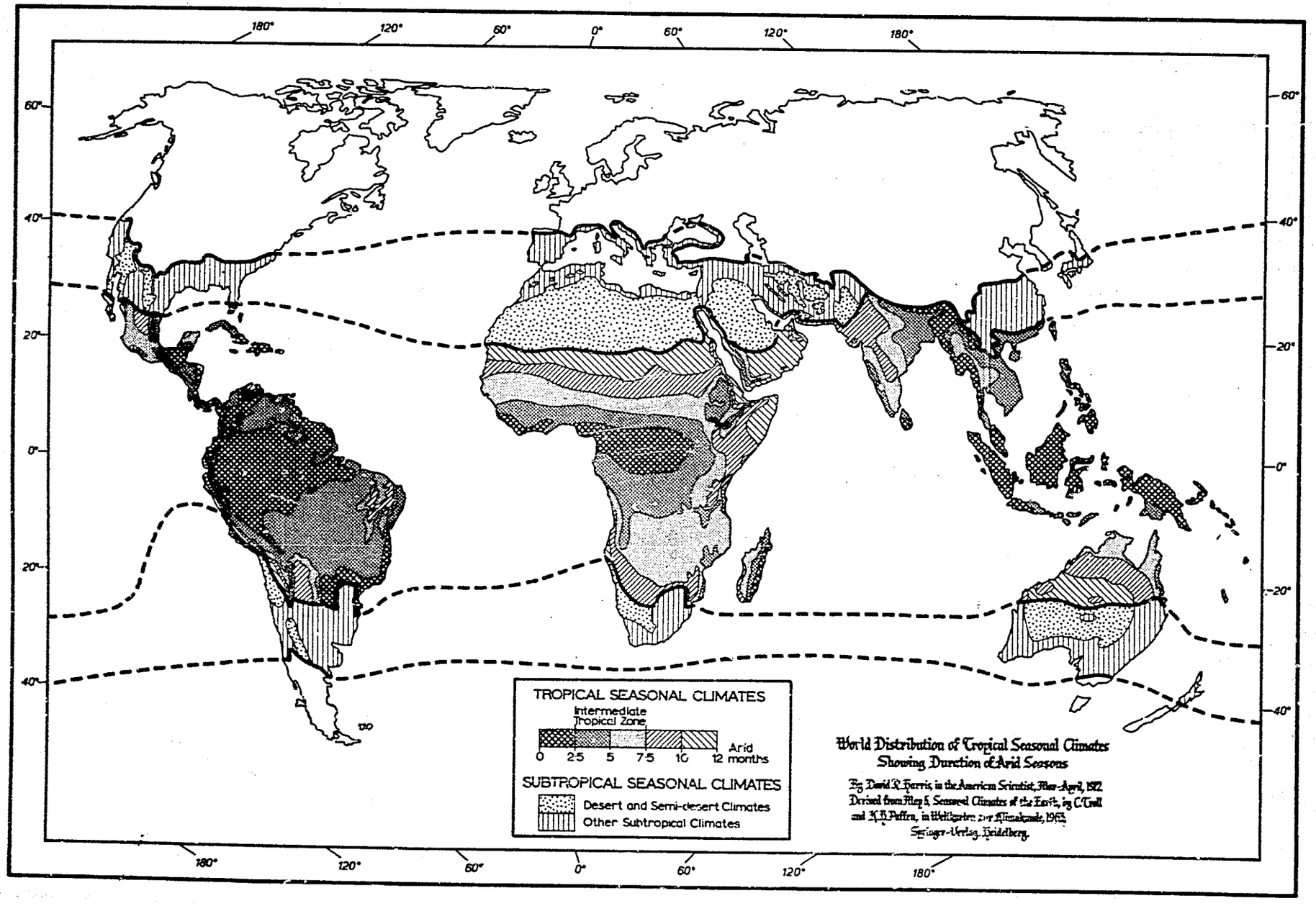


Figure 2. "Average Annual Precipitation"

Figure 3. "Duration of Arid Seasons"



B. Climates

The major factors of climate, which affect both plant growth and livestock performance, are rainfall, the temperatures, sunlight (particularly during seasons when rainfall permits plant growth), the occurrence and nature of prevailing winds, and the occurrence of violent storms (hurricanes, typhoons, tornados). Man has not learned to control climates; but progress has been made in improving general knowledge of the climatic conditions to expect in most land areas, so that agricultural practices may be adjusted to minimize damage from climatic extremes. The assessment of how to make best use of the prevailing climate is fully as important as knowing what climatic conditions to expect. (See Figure No. 1, "Seasonal Climates of the Tropics and Sub-Tropics.)

1. Rainfall

Rainfall occurrence, the amounts and seasonal distribution, and the character of rainfall all are important controlling factors that affect agricultural potentials of the areas concerned. Gentle rains are more likely to enter the soil and be stored, than sharp downpours that tend to be lost as runoff.

The rainfall zones may be classified as follows:

Table 1. Rainfall Types

Total yearly in millimeters*	Descriptive Terms
over - 2000	Continuously humid; tropical rain forest.
1500 - 2000	Humid; wet-dry tropics.
1000 - 1500	Moderately humid.
500 - 1000	Sub-humid; savanna, steppe.
250 - 500	Semi-arid; semi-desert.
-0- - 250	Arid; desert.

The abundance of average annual rainfall is shown in Figure No. 2.

(*100 millimeters = about 4 inches)

2. Duration of Dry Seasons

The duration of the season when rains occur, and the length of the dry season, have pronounced effects on cropping patterns, and on feed supplies for grazing livestock. The accompanying map (Figure 3.) shows that tropical zones may range from less than 2½ months of dry season in the high rainfall areas, to more than 10 months in the arid zones. The effects of rainless periods can be modified where the lands are occupied by deep permeable soils that may store substantial amounts of water during rainy periods

to sustain continued plant growth (crops or grasslands) for part of the dry season, until soil moisture is exhausted. This is most pronounced on alluvial soils in the flat lands of stream valleys, but may occur wherever permeable soils are present.

3. The general relations of land use to rainfall patterns are indicated as follows:

Table 2. Rainfall and Land Use

Average Annual Rainfall	Major Land Uses*
Over 2000 mm.	Rain forest regions. Adapted to wide range of tree crops, tilled crops, and forages where soil erosion is controlled, and soil fertility maintained.
1500 - 2000 mm.	Wet-dry tropics. Land use is limited mostly by dry seasons of 2½ to 5 months. Annual crops and forages, and some tree fruits are well suited.
1000 - 1500 mm.	Moderately humid. On deeper, well drained soils where erosion is controlled, rainfall will support wide range of food crops, certain tree fruits, and forages for grazing livestock.
500 - 1000 mm.	Savanna, steppe. Deeper soils may be cropped to short season grain crops, groundnuts, sesame and certain vegetables. All other lands are best suited to grazing and forage for livestock.
250 - 500 mm.	Semi-desert. Supports limited growth of browse and forage plants for migratory grazing. These lands require careful management. Local areas of deep soil may be cropped to millet and sorghum following sporadic rains.
0 - 250 mm.	Desert. Agricultural use is limited to extensive types of livestock grazing, with careful range management. Forage growth occurs only in the few weeks after local rains occur. Will not support sustained use.

*Exclusive of controlled irrigation, that may be practiced wherever irrigation water is available.

4. Temperatures

Air temperatures in the tropics are generally high enough to support plant growth at all seasons. Only at higher altitudes (above 1500 M.) are low temperatures in the cool season occasionally low enough to adversely affect plant growth. Maximum temperatures in savanna and semi-desert regions during the dry seasons may exceed 40° C. in tropical regions. No plant growth is possible during the periods when such extremes occur, except where irrigation is practiced.

Each type of crop or cultivated plant has specific requirements for growth, particularly temperature ranges and rainfall. In general, these requirements are fairly well known, and an inspection of weather data should be a useful guide as to whether a particular species of crop or plant is adapted to the local environment.

5. Evaporation rates of water from soil and plant leaves, and the relative humidity of the air are important factors in controlling plant growth. The rates of evaporation rise rapidly with higher temperatures so that considerably more rainfall is needed to meet plant needs than is required at moderate temperatures. Moisture deficits in plants are particularly important in periods when no rains occur. Growing plants must maintain a certain moisture content to permit growth and fruiting.

6. Strong Winds and Violent Storms

Prevailing winds at certain seasons are important factors in determining agricultural productivity. Very strong winds that persist for long periods may have adverse effects on most cultivated plants. Wind blown sand may severely injure tender plants; and hot dry winds may dessicate growing plants when soil moisture is limited. The use of planted windbreaks (annuals or perennials) may reduce wind erosion damage to susceptible crops, but these are less useful to control damage from hot drying winds.

Hurricanes (typhoons) which are violent, cyclonic tropical storms, are uncontrollable, but their probable occurrence has been recorded for most regions. They build up great force over bodies of water, but the storms diminish and disintegrate over bodies of land. Lesser islands and exposed shore areas of mainlands may be severely damaged. A great deal can be done to protect human life and property, and to minimize injury to livestock, but there is no real protection available for crops and plant life. The possible occurrence of such violent storms must be a factor for consideration in the development of agricultural lands.

7. Recording Weather Data

Many countries lack sufficient stations at which weather data are recorded daily, to provide reliable information at representative locations of the major agricultural and grazing regions of the country. These weather stations may be quite simple. Each station should include a maximum-minimum thermometer mounted under a sunshade (so as to measure air temperatures) at about a 2 meter height above ground, on a plot that is fenced to exclude animals, and is covered with low growing vegetation. Also, a simple but reliable rain gauge should be mounted vertically with the opening about 1 meter above ground, in a location somewhat removed from trees and buildings. Once-daily readings of temperature and rainfall will suffice at such auxiliary weather stations, but readings should be made at the same time every day, either early morning or late afternoon. Such recording of data takes but a few minutes, and should not interfere with other duties.

These auxiliary weather stations should supplement more completely instrumented principal weather stations within the country. The principal stations generally are located at airports, but without the auxiliary stations distributed through agricultural regions, the weather information is too limited to adequately serve needs in determining the effects of weather on crops, forages and livestock.

Sample form used in reporting monthly weather data.

MONTHLY SUMMARY OF WEATHER OBSERVATIONS

Name of Station:

Location of Station:

Altitude:

Temperatures, averages (in degrees Centigrade)
(average)

January, Daily maximum _____; Minimum _____.
February, Daily maximum _____; Minimum _____.
March, Daily maximum _____; Minimum _____.
April, Daily maximum _____; Minimum _____.
May, Daily maximum _____; Minimum _____.
June, Daily maximum _____; Minimum _____.
July, Daily maximum _____; Minimum _____.
August, Daily maximum _____; Minimum _____.
September, Daily maximum _____; Minimum _____.
October, Daily maximum _____; Minimum _____.
November, Daily maximum _____; Minimum _____.
December, Daily maximum _____; Minimum _____.

Yearly Temperature absolute extremes: Maximum _____; Minimum _____.

Rainfall: Total, in millimeters.

January _____
February _____
March _____
April _____
May _____
June _____
July _____
August _____
September _____
October _____
November _____
December _____

Yearly Total _____.

NOTE: The daily weather records in addition should show:
(a) Percent of cloudiness (or sunshine) in daylight hours.
(b) Occurrence of damaging winds, and their direction.
(c) Nature of rainstorms; heavy and sporadic; light and sustained, etc.
(d) Name of recorder, and hour(s) when weather instruments are read.

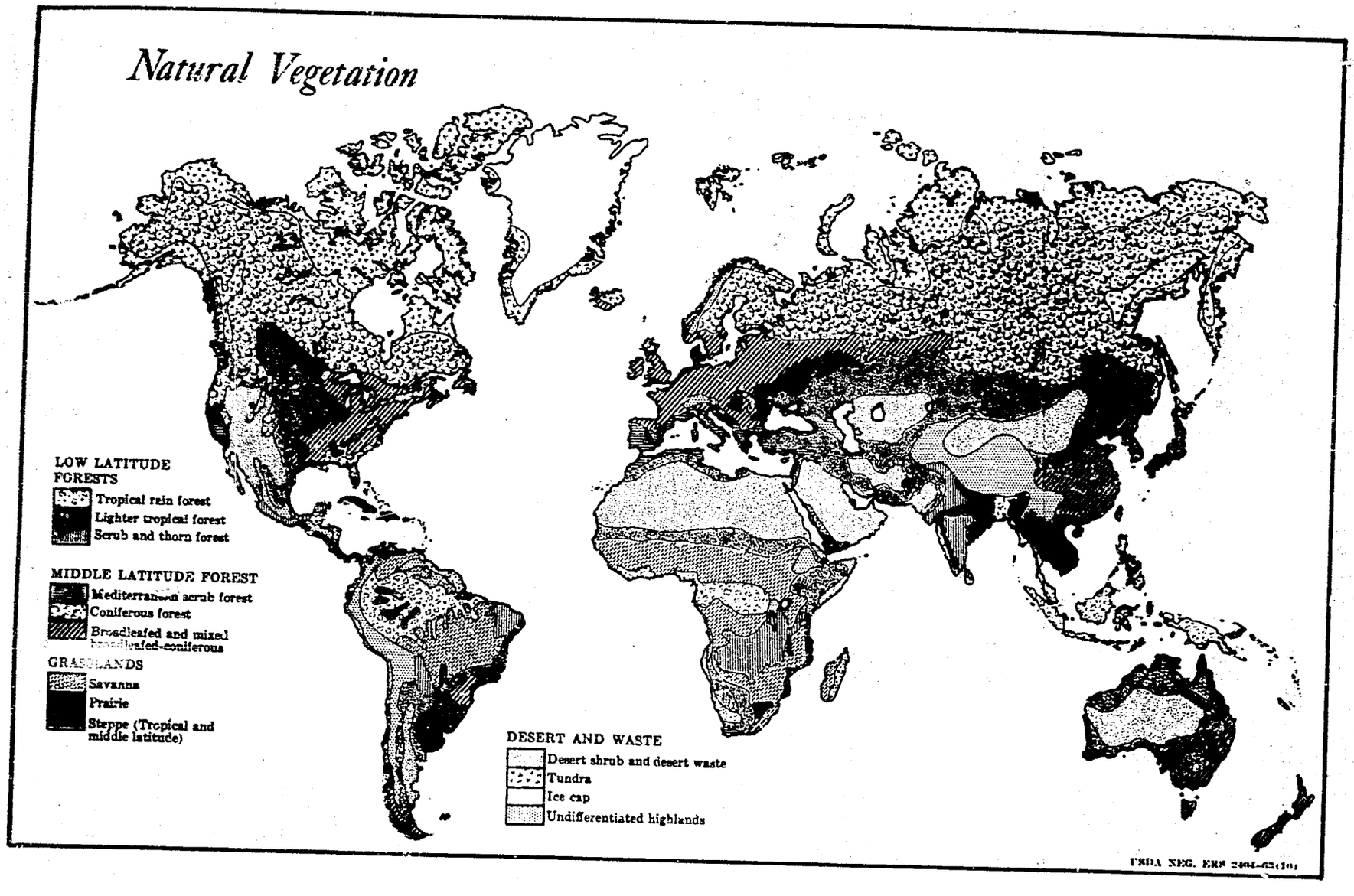


Figure 4. Natural Vegetation Zones

C. Natural Vegetation Zones

Natural vegetation zones are determined largely by yearly rainfall and its seasonal distribution (See Figure 4.) A comparison of Figures 2. and 3. with Natural Vegetation Zones, Figure 4., shows this relationship. The agricultural utilization of lands in the natural vegetation zones may be summarized as follows:

(see next page)

Table 3. Agricultural Potential of Natural Vegetation Zones in the Tropics and Sub-Tropics

Natural Vegetation	Average Annual Rainfall	Duration of Dry Season	Agricultural Potential: Arable Lands*	Agricultural Potential: Non-arable Lands
Desert shrubs (Sparse browse plants)	less than 250 mm.	Variable; often over 10 months.	No cropping except under irrigation.	Intermittent migratory grazing, very sparse growth.
Steppe (Semi-arid)	250- 500 mm.	7.5-10.0 months.	Cropping limited to irrigated areas.	Light, extensive type, migratory grazing.
Savanna (grass and shrub)	500-1000 mm.	5.5-7.5 months.	Cropping successful on deep soils not subject to erosion.	Primarily adapted to grazing. Under firm control as to stocking rates.
Scrub and Thorn (forest)	1000-1500 mm.	4.0 to 5.5 months	Cropping successful on permeable soils where erosion is controlled, and soil fertility maintained.	Non-arable lands well suited to grazing and to permanent pasture.
Light Tropical Forest	1500-2000 mm.	2.5-4.0 months	Cropping to plants with higher rainfall requirements, on soils where erosion is controlled and soil fertility maintained.	Non-arable cleared land well suited to year-round grazing, on seeded pastures.
Tropical Rain Forest	over 2000 mm.	below 2½ months	Suited to tree and tilled crops with highest moisture requirements; but soil erosion is a problem on sloping lands. Soil fertility must be maintained.	Non-arable cleared lands well suited to year-round grazing on seeded pastures.

*NOTE: Seeded pastures may also be included for two or more years in crop rotations wherever crops are grown, to maintain productivity of arable soils as well as to support livestock.

III. Land Potential Classification

Every nation should have a generalized map of land potential for agricultural purposes. If not already available, highly useful maps can be prepared rapidly and at comparatively low cost, by using aerial photography supplemented by limited ground surveys and the techniques of photo interpretation. See Appendix A for a series of maps that provide a useful basis for study of agricultural potentials and development.

Appendix A.

Maps contained in Atlas on "National Inventory on Physical Resources," for Nicaragua, as an example:

1. Elevations (Altitude)
2. Surface Configurations (Topography)
3. Natural Drainage
4. Surface Water Resources
5. Agricultural Soils
6. Natural Vegetation
7. Climatic Zones
8. Precipitation
9. State of Ground
10. Population
11. Land Use
12. Land Potential
13. Highways

Using a land potential map as a guide, the next step is construction of reconnaissance maps of important areas on which land capability classes are to be identified. This system was developed in the U.S.A., but has been effectively used in other regions.

Land Capability Classes: 1/

The capability classes indicate the general characteristics of soils from the standpoint of their support of plant growth, such as soil depth, texture, permeability to water, available moisture holding capacity, inherent fertility and other characteristics that affect the use and effective management of the land. These include surface slope, potential soil loss by erosion, any water overflow hazards, and wetness of the land.

There are two divisions of land capability classes: (a) lands suited and (b) lands not suited for tilled crops; each division containing four capability classes. The capability classes group all soils according to their usefulness, from Class I to Class VIII. Class I contains the lands that has the widest range in adaptations. They can be tilled easily. Class VIII are the lands with lowest value. The use of the land in Classes II through VII, is progressively more restricted because of permanent physical limitations.

A. Lands Suited for Tilled Crops, Classes I - IV.

Class I. Soils in Class I have no, or only slight use limitations, or risks of damage from erosion. They are very good. They can be cultivated safely without erosion losses under ordinary farming methods. The soils are deep, productive, easily worked and nearly level. They are not subject to overflow damage; although they are subject to fertility depletion and puddle erosion. However, Class I soils will need management practices to maintain soil fertility and soil structure.

1/ The following descriptions are derived in part from the book "Soil Conservation: by J. H. Stallings, published by Prentice-Hall, Inc. (Second Edition, 1970).

Class II. Class II consists of soils subject to moderate limitations in use, that have moderate risk to damage. They are good soils. They can be tilled with easily applied practices. These Class II lands differ from Class I lands mainly because they have gentle slopes, are subject to moderate erosion, have considerable depth, occasional overflows may occur, and may need some drainage; each of which requires special attention to prevent soil damage. Such practices as soil conserving rotations, water control devices or special tillage method may be required for continued cropping. A combination of cultural practices is commonly needed.

Class III. Class III soils are subject to severe limitations when used for crop production. They are subject to more severe risks or damage than Class II soils. They are moderately good soils. They can be used regularly for crops provided they are planted to good rotations and given effective land treatments. Soils in this Class have moderately steep slopes, are subject to more severe erosion, and are inherently lower in fertility.

These soils require cropping systems that produce adequate plant covers to protect the soil from erosion and help maintain favorable soil structure. Solid stands of pasture and hay plants should be grown in rotation with tilled crops; and the use of strip cropping, contour farming and terracing are important in achieving control of water and soil erosion.

Class IV. Soils in this Class have very severe permanent limitations if used for crops; more severe than Classes II and III. Class IV soils are fairly good, and may be cropped occasionally if handled with care. They are well suited for pastures, hay or non-tilled planting such as tree crops.

The unfavorable characteristics of Class IV soils; they are frequently on steep slopes and subject to severe water erosion. They are restricted in their suitability for tilled row crop use. They should be kept in solid plantings, such as pasture or hay, or in non-tilled permanent crops (fruits, plantain and bananas, etc.). However, a tilled crop usually may be planted once every four to six growing seasons. Being subjected to continuing erosion, these soils usually are shallow and low in fertility.

It should be noted that all soils in Classes I through IV, are well suited to perennial crops that are not tilled, such as perennial forages, fruit and nut trees, bananas and plaintain coconuts, oil palm, rubber, etc. wherever rainfall is adequate. The choice as to the most effective use of such lands, is based on economic returns. Perennial plantings that are not tilled, but have low growing plant cover that is controlled by grazing or cutting, may yield quite well; and the soil may be effectively protected against soil erosion and excessive rainfall runoff.

B. Lands Not Suited for Cultivation

Land capability Classes V, VI, VII and VIII should be kept in permanent vegetation and not used for tilled crops.

Class V. This Class of soils is not suited for cultivation because of wetness, stoniness, shallow soil, or other limitations such as limited or erratic rainfall. However, the land is nearly level, and is subject to only slight erosion by wind and water if kept in permanent vegetation. Yields of tilled crops are low on such soils, and the land is usually more productive when occupied by permanent grazing lands or by carefully selected, adapted tree crops or by forests. When grazed, the lands must not be over-stocked to avoid degradation of productivity.

Class VI. This Class of land includes areas that are steep and have shallow soils, or are located in zones with yearly rainfall below 1000 mm. Such land is best used for forages to support grazing livestock, or for woodland and forest. It is important that the grazing not be so intense as to destroy the cover of edible plant species. Should plant cover be seriously depleted, grazing must be restricted until cover is re-established. Class VI land is generally steeper or more subject to erosion than Class IV land.

Class VII. The soils of Class VII are subject to severe permanent limitations when used for grazing or forestry. They generally are semi-arid (below 500 mm. yearly rainfall), or they are steep, eroded, rough, shallow, or swampy. They are fair to poor for grazing or forestry, and must be handled with greater care than Class VI land to insure continued usefulness.

Class VIII. The soils in Class VIII are either on very rough land or in very dry locations (below 250 mm. annual rainfall). Either woodland or grazing is likely to yield very limited and uncertain income. These lands may well be reserved for wildlife and/or for watershed protection.

General Note: The terms "very good," "good," "moderately good," and "fairly good" as used in these soil capability class descriptions are qualitative in nature. They express the relative quality of land from the standpoint of both the properties of the soils and the climatic zones in which they occur. The soil properties include slope, erosion, depth, and workability of the soil, that contribute to the potential productivity of the land.

C. Soil Surveys

Eventually, it may be desirable to make detailed soil surveys of all agricultural lands of the nation. But initially, detailed soil surveys may be made only for those areas selected for intensive use; such as irrigation developments, for high value crops and for new settlement projects on land with soil capability Classes I, II, and III. Such soil surveys are relatively costly to make, and require extended field examinations and conversion of the information to maps showing precise boundaries of each soil type. Field soil surveys and maps should be utilized to supplement the more generalized soil capability classification described earlier.

Soil survey units used in mapping are the types of soil that may be distinguished on the basis of their specific physical characteristics. These characteristics include:

The soil profile, made up of horizons (layers) with different thicknesses, color, texture, structure, and chemical characterization.

Color. The topmost soil horizon is usually darker than the others, and the darkness of color denotes the amount of organic matter (humus) present.

Texture refers to the proportions of sand, silt and clay particles that constitute the soil mass. Soil texture may be expressed as sandy, loamy or clayey depending on the relative amounts of sand, silt and clay particles.

Structure refers to the state of aggregation of soil particles, the amount of pore space and aeration of the soil, the water holding capacity, and the friability or tendency of the soil to crumble or stick together. Permeability is an important factor in determinging root occupation of the soil, and crop productivity.

Drainage: Internal soil drainage may be good, slow, or waterlogged in periods of rains. A mottled soil color in the profile indicates impeded soil drainage, and usually is accompanied by heavy textured layers that are relatively impermeable.

Chemical characteristics that are used as important attributes of soil types are: the degree of acidity or alkalinity, the amounts of soluble aluminum and iron that are present in acid soils (they may be so great as to be toxic to plant roots), the presence of alkali (in dry regions) that adversely affects plants, and the "base exchange capacity" which refers to the content of calcium, magnesium, potassium and sodium of the soil colloids. These characteristics require laboratory testing of representative samples brought from the field.

The soil types which are the basic units shown on soil survey maps, are most useful in studies on inherent soil fertility and fertilizer requirements, and in determining crop adaptation, and responses of crops to various land management practices. Within each soil capability class there may be many distinguishable soil types by color, texture or structure. Total soil depth suitable for occupation by plant and roots is an important characteristic of soil types.

IV. Present Land Uses and Status of Agriculture

A. Available Maps on Land Use

There are available to individual developing countries useful generalized maps prepared by external agencies such as the one included in Appendix B. Also, there is much useful information to be gleaned from the FAO Production Yearbooks and the FAO Yearbooks on international trade. The FAO publications report data supplied directly by each country, but these yearbooks facilitate compilation of an agricultural statistical profile that may be used to characterize present status, and help to identify some problems and opportunities for agricultural development. Such an agricultural profile for a single country is offerred as an example of how the statistical record and the generalized maps may help to develop an agricultural perspective of the nation's current situation. From this record and other information of the type contained in the atlas maps included in Appendix A, selection may be made of possible opportunities for further agricultural development.

In the map (Appendix B) of the example used (Cameroon), the general topography, stream system, roads, and urban settlements are shown. Adjoining the main map of the country are supplemental maps showing distribution of population, natural vegetation zones, and the locations of specific economic activities. The areas that grow the five major export crops (coffee, cocoa, cotton, bananas and rubber) are shown. The production of food crops must be inferred from the distribution of population (for subsistence of rural peoples) and the proximity of urban centers (for domestic markets).

The vegetation zones (see map in Appendix B) are an index of suitability for increased production, but further pinpointing of potential areas of development should be sought in maps of land potential, such as those included in maps in Appendix A. With such information pointing toward specific land areas, it would then be useful to make field surveys of the land capability classes and show these on maps of selected areas.

B. Agricultural Statistical Profile

The following agricultural statistical profile of Cameroon is an example of useful planning information available in the FAO Agricultural Production and International Trade Yearbooks.

CAMEROON

Agricultural Profile - 1972

Section 1. General Information

(a) Land

Total Area	- 47.54	million	hectares
Land Area	- 46.94	"	"
Arable Land	- 6.72	"	"
Permanent Crops	- 0.58	"	"
Grasslands	- 8.30	"	"
Forests	- 30.00	"	"
Other Lands	- 1.94	"	"

(No irrigated lands reported.)

(b) Population

Total - 6.19 million
Agricultural - 5.06 "

Economically Active

Total - 3.01 Million
Agricultural - 2.47 "

Percent Agriculture - 81.8%

(c) Indices of Production

	1961-65	1973
Crops	100%	133%
Total Agriculture	100%	132%
Total Food	100%	130%
Per Capita Indices		
Per Capita Agriculture	100%	107%
Per Capita Food	100%	106%

(d) Population Increase - Index

1961-65 - 100 %
1973 - 123.2%

Average growth rate - 2.1%

CAMEROON

Section 2. Crop Production

Crops	1965		1972	
	(Thousands of Metric Tons)			
Rice	13	M.T.	15	M.T.
Maize	341	"	400	"
Millet	554	"	350	"
Potatoes	17	"	35	"
Sweet Potatoes	262	"	360	"
Cassava	741	"	1,000	"
Dry Beans	37	"	35	"
Other Pulses	3	"	8	"
Groundnuts	112	"	215	"
Sesame Seed	2.9	"	6.0	"
Seed Cotton	40	"	56	"
Cottonseed	25	"	34	"
Coconuts	3	"	4	"
Copra	0.5	"	0.5	"
Palm Kernel	37	"	57	"
Palm Oil	42	"	58	"
Sugarcane	56	"	150	"
Sugar, Raw Centrifugal	--	"	17	"
Bananas	147	"	130	"
Coffee	51	"	90	"
Cocoa Bean	81	"	102	"
Tea	0.3	"	1.3	"
Tobacco	2.5	"	6.0	"
Cotton (lint)	15.5	"	22.0	"

(Value in Constant Dollars)

Total Value All Crops	1965 - $255.1 million
	1973 - $301.1 million

CAMEROON

Agricultural Profile - 1972

Section 3. Livestock and Livestock Products

(a) Livestock Numbers

Horses	-	56,000
Asses	-	94,000
Cattle	-	1,950,000
Pigs	-	350,000
Sheep	-	1,470,000
Goats	-	2,000,000
Chickens	-	8,500,000

(b) Meats Produced

Beef and Buffalo	-	26,000	Metric	Tons
Mutton and Goat	-	9,000	"	"
Pig Meat	-	11,000	"	"
Poultry Meat	-	56,000	"	"
Edible Offal	-	6,371	"	"

(c) Dairy Products

Cows Milk - 42,000 Metric Tons

(d) Eggs - 6,000 Metric Tons

(e) Hides and Skins

Cattle Hides	-	5,016	Metric	Tons
Sheepskins	-	863	"	"
Goat Skins	-	1,000	"	"

(f) Total Value Livestock Products (in Constant Dollars)

1961-65	-	$16.7 Million
1972	-	$21.0 Million

CAMEROON

Section 4. Trade in Crop Products - 1972

(Thousands of dollars)

Crop	Imports	Exports
Wheat and Flour	$ 1,050	$ - - -
Rice	1,000	10
Maize	20	- - -
Other Cereals	500	- - -
Malt	1,900	10
Oranges, Tangerines	25	4
Lemons and Limes	10	- - -
Bananas	- - -	4,200
Apples	137	- - -
Grapes	18	- - -
Dates	3	- - -
Raisins	5	- - -
Potatoes	90	10
Beans, Peas, Lentils, Etc.	3	- - -
Tomatoes	3	1
Onions	110	12
Hops	100	- - -
Sugar	3,200	- - -
Honey	10	- - -
Coffee	38	6,000
Cocoa Bean	- - -	47,300
Tea	20	550
Pepper, Pimento	10	42
Bran, Mill by-products	- - -	235
Oilseed Cake, Meal	20	450
Margarine	280	2
Wine	3,300	- - -
Beer	1,750	650
Tobacco	1,200	1,170
Groundnuts	- - -	1,050
Copra	- - -	10
Palm Nut Kernels	- - -	1,400
Cottonseed	- - -	100
Sesame Seed	- - -	25
Rubber	- - -	4,000
Cotton, raw	- - -	7,500
Groundnut Oil	110	- - -
Olive Oil	30	- - -
Linseed Oil	40	- - -
Palm Oil	10	2,160
Palm Kernel Oil	- - -	580
Castor Oil	9	- - -
Totals	$15,001,000	$77,471,000

Net Trade Balance

Net Exports = $62,470,000

CAMEROON

Section 5. Trade in Livestock Products - 1972

(Thousands of Dollars)

Animals	Imports	Exports
Live Cattle	$ - - -	$ 800.
Livestock Products		
Meats; fresh, chilled frozen	179.	301.
(Poultry	52.	2.)
Meats; dried, salted, smoked	42	1.
(Bacon, Ham	40.	- - -)
Canned Meats	665.	14.
(Sausages	135.	1.)
(Meats; prepared, preserved	530.	13.)
Milk, condensed, dry, fresh	3,982.	- - -
Butter	205.	4.
Cheese and Curd	420.	2.
Animal oils, fats, grease	373.	- - -
TOTALS	$6,623.	$1,138.

Net Imports of livestock products = $5,485,000.

Section 6. Net Trade Balance

A. Net Exports of crop products = $62,470,000

B. Net Imports of livestock products 5,485,000

C. Net Exports All agricultural products = $56,985,000

Interpretation of the Statistical Profile

Section 1. - Land Use

About equal amounts of land are now in crops (arable lands and permanent crops), and in permanent grasslands. However, much of the grassland is now infested with tsetse fly that is the vector of the blood parasite that causes trypanosomiasis in livestock. Control of tsetse fly by spraying and by clearing bush and trees that serve as the habitat for the fly, would open up these lands to grazing and to cropping. The great areas of forest land (64% of the total land area) may be suited for clearing for crop production, or for seeded pastures to support livestock. This potential would need to be explored in relation to the land capability classes on well drained areas with fairly smooth terrain. It seems probable that much land now in forest and woodland could be added to the present agricultural resources of the nation.

Population. The nation is largely agricultural in nature, and with the land resources noted above, it seems appropriate to give agricultural production and development a high priority in allocation of governmental budgets and programs.

Indices of Production. The country has made creditable progress with agriculture in the decade 1963-1973, with average growth of 3% yearly. This is substantially greater than population growth of 2.1%, indicating a healthy trend. Such success with agricultural programs warrants continued effort in this direction. Not all countries have such a good record; many have declined seriously in per capita production in the recent decade.

Section 2. - Crop Production

The main export crops are cocoa beans, cotton, coffee, rubber, bananas, and palm oil. The more important food crops include maize, millet, root and tuber crops, groundnuts and sugarcane. It is in this group of food crops that important opportunities may be found for expansion. This is particularly promising because of the proximity of Cameroon to the Sahel zone across the African continent south of the Sahara that chronically suffers from droughts and food shortages. Food production on an economically profitable basis may be achieved by: (a) more efficient production on existing crop land, and (b) opening up new lands suited for development. The list of crops that may be grown successfully probably should be substantially enlarged to include more pulses, oil seed crops (particularly sesame), additional vegetables and fruits to more fully exploit the tropical soils and climatic conditions.

Section 3. Livestock and Livestock Products

Ruminants (cattle, sheep and goats) are supported largely on grazing lands. In terms of total liveweight, cattle make up about two-thirds of the total ruminant group, and sheep and goats about one-third. Meat production follows much the same pattern, although it is probable that much meat from small ruminants is consumed by rural families and does not get recorded in national statistics.

Since ruminants are supported largely by forages, mostly on grazing lands, any increase in production will necessitate more abundant forage supplies, of higher protein content and general nutritive value than is now commonly available. A limitation that is not evident in this data, but is well substantiated elsewhere, is the failure to provide feed for ruminant livestock during the seasons that are deficient in rainfall. Feed in the form of hay, grass silage, or reserved grazing lands must be provided for sustained growth and reproduction of livestock. It is probable that the tsetse fly constitutes the greatest obstacle to effective production of ruminant livestock, both directly through disease and indirectly by denying use of grazing lands.

Section 4. Trade in Crop Products

It is particularly important to examine the major crop imports to identify those that might well be produced within Cameroon as an alternative to importations. In this category are rice and other cereals, sugar, fruits, potatoes, onions, peppers, and vegetable oils, imported at a cost of about 5½ million dollars. There should be immediate urban markets for such crops produced within the country. Nationally grown crops would provide income to agriculture that is now paid to other countries and thus lost to Cameroon. These food crops are characteristically produced by small farmers, and substitution of locally grown foods for imports thus would have wide impact on the rural population.

It may be noted that oil seed cake, bran and mill products, and cotton seed valued at $785,000 were exported. These are high protein feeds that are most important for livestock, particularly pigs and poultry. The use of such feeds for local livestock might substantially reduce the imports of meats and milk, and thus strengthen the national economy.

Section 5.

The imports of livestock products amounted to $6.6 million in contrast to exports of $1.1 million. It is obvious that these imports of meats and dairy products have cost the nation a very large sum that might have been used to develop the livestock sector of the agricultural economy. The replacement of meat imports with locally produced meat may be more easily achieved than replacement of dairy products. However, there is clear evidence of national market demands for livestock products; and programs to capture these markets would probably be in the national interest.

Section 6.

The net trade balance in agricultural commodities is highly favorable, primarily because of the exports of six crops. An examination of the production of these major foreign exchange earners, to determine the methods by which small farmers may benefit, may be useful. Rural development must benefit the small operators who constitute the bulk of the nation's population.

V. Evaluating the Potential for Higher Production on Existing Agricultural Lands

There is good evidence that crop and forage yields may be greatly improved on lands now being used. The potential for increasing rice yields two to fourfold has been demonstrated by the International Rice Research Institute in the Philippines, and this productivity is now being widely exploited in other rice growing regions. Similarly, the production of wheat has been demonstrated by CIMMYT (the International Institute for research on wheat and maize in Mexico), and this great advance has been applied in many other wheat growing regions of the world. Further, comparable improvement in maize production has been achieved through research on this crop in Kenya. The application of the research is spreading over an ever-widening area of the tropics.

A. Effective Production Practices

These three illustrations may be duplicated with virtually all cultivated crops, and with rangelands and pastures. There are some basic principles that should be invoked. These include:

1. Selection of crop species that are adapted to the climate and soils of the region.

2. Determination of the best varieties of the crop from the standpoints of yields, resistance to pests, acceptable crop quality for the intended uses.

3. Effective land preparation and use of fertilizers to supplement soil fertility.

4. Choice of planting dates best suited to the climate, and providing plant populations that will not exceed the soil productivity.

5. Controlling plant pests by timely practices (weed control, insect pests, diseases).

6. Timely harvest to prevent losses.

7. For all irrigated lands, the effective use of water on the farm. (Probably 50% of water is now wasted by on-farm practices and conditions).

8. It is the benefits which flow from combining all of these good practices that results in higher yields and greater economic returns. The adoption of individual practices does some good, but they should be combined for truly outstanding benefits. If the country does not already have research stations to evaluate the technology on these matters, and to develop a superior "package" of improved cultural practices, they should be established as a major investment in agricultural development. There is good reason to believe that the progress achieved with cereal grains may also be accomplished for the various food grain legumes, oil seed crops, root and tuber crops, all manner of vegetables, tree fruits, sugarcane, as well as forage grasses and legumes for support of livestock. Although cereal grains constitute an important type of food that is easily stored for emergency uses, by far the greatest dependence on yearly food needs must be placed on other foodstuffs.

   A companion program that should serve every agricultural region or district, is the dissemination of information on improved practices and techniques to all producers on the land, particularly the smaller farmers and herdsmen. Since these smaller producers constitute the bulk of rural populations, and account for the majority of total national production, they must receive a high priority in government programs to increase food production, and stimulate long-term agricultural development. The actual adoption of improved practices is the only way that progress will be made. Research must be accompanied by effective programs to help small farmers and herdsmen increase their production and improve their economic status.

B. Other Developmental Potentials

The suggested components of improved production systems, listed above, do not cover all aspects of desirable agricultural development, but only the first stage. Other important aspects, which the government should explore through field research may include:

1. Diversification of cropping, to provide greater assurance of acceptable harvests, and to more easily adjust to changes in market outlets. Producing several commodities (crops and livestock products) will distribute family labor more evenly over the year, and also give the government opportunity to increase all of the essential foodstuffs that are adapted to the region. Single crop farming tends to aggravate risks of losses.

2. Soil conservation and management to develop continuously productive agricultural systems, will require government assistance. For all lands that are subject to water erosion, appropriate field management methods should be established such as contour farming, some form of terracing, and crop rotations that tend to stabilize the soil. Crop rotations that include adapted legumes to contribute soil nitrogen, and forage crops to restore soil structure and permeability are even more important than commercial fertilizers. A great need for all tropical regions (with the exception of irrigated rice) is to develop systems that will maintain soil productivity when land is continuously farmed.

3. Integration of livestock and cropping enterprises into farming systems. The local producers require milk and meat for family subsistence, but the livestock, particularly sheep and goats have no stable supply of feed. The inclusion of forages in cropping systems for grazing or harvested feed to meet needs of livestock during the dry seasons, may also have important soil improving benefits by controlling erosion, supplying nitrogen, and improving soils structure. Crop yields will be enhanced by such rotations, and there should be little need for "resting" such lands by allowing reversion to native vegetation.

4. Rangeland Improvement and Livestock Production

Livestock production on permanent grazing lands in subhumid and semi-arid lands has been gravely neglected in virtually all regions. There is good evidence that prudent management would greatly increase productivity, significantly reduce the harmful effects of recurring droughts, and alleviate the wide yearly fluctuations in off-take of marketable stock. The principles of good range management are established, but their

application has received little or no attention. Government assistance and guidance are indispensible since there is now no firm official attachment of herders to specific grazing lands. Rangelands are virtually "no man's lands," and these resources have been consistently degraded by lack of government attention. Corrective actions are not possible without strong government participation and direction to strengthen the herders effective use of these lands.

VI. Identifying Favorable Potentials for Developing New Lands

Development of new lands for agricultural use will take many forms, depending on the nature of the country. Such maps as those included in Appendix A, will usually assist in identifying potential opportunities. It is always important to determine that the areas selected contain lands that are likely to be productive. Field evaluations of soil capability classes that are present should precede any decisions on development.

Each country will contain opportunities for development. Some one or several of the following situations may be identified for further study:

A. Extension of the present road systems to provide all-weather access to potentially useful agricultural areas, that are not developed because of inaccessibility. The construction of serviceable roads would attract new settlers who may be encouraged to develop the lands. Government counsel and guidance would provide some assurance that settlers would proceed in a manner that would most likely assure prompt successful development.

B. Clearing Forests and Woodlands

Clearing trees and brush from lands in regions with over 1000 mm. annual rainfall, where there is considerable smooth land. A ground survey should be made to identify those areas occupied by soil capability Classes I, II, and III. Class III land may need some form of terracing to protect against water erosion when used for tilled crops. However, Class III land may be used for tree crops or for pastures without terracing.

Class I and II lands need no longer be farmed in the traditional pattern of a few years of cropping followed by a longer period when natural vegetation is allowed to take over. It is possible to develop farming systems on such lands that will make them continuously productive. The essential features for such systems involve effective use of mineral fertilizers, inclusion of legumes to maintain nitrogen supplies, and the inclusion of perennial forage grasses and legumes for about two years in a five year rotation, to maintain soil structure and organic matter content for the years when land is occupied by tilled crops. The forages

would provide the necessary feed for livestock enterprises to produce milk and meat for accessible markets. It would be prudent to conduct field research on such faraming systems in preparation for substantial land development programs.

C. Drainage of Wet Lands

Many countries have important areas that are not now used because of seasonal or chronic wet or swampy conditions. Each such area should be examined to determine the engineering feasibility of drainage, the quality of the land that can be reclaimed, and the best uses to which the land may be put. Where waters can be channeled to these areas, they may be well suited to rice production, or to sugarcane, and other irrigated crops. Wet lands that have permeable soils when drainage outlets are established, may be used for a wide variety of crops that are adapted to the amount and distribution of annual rainfall.

Most of the wet land areas will require government action to achieve development; in surveying the potential value of the areas, and in planning and financing the necessary development operations. Such projects appear to be ideal for developing superior producing areas and for placement of well qualified small producers, particularly young men, where they can become a substantial component of growing centers for application of modern agricultural technology.

D. Opening New Lands by Control of Endemic Diseases

Many countries have areas of potential agricultural value that have not been developed because of such human diseases as malaria, yellow fever, river blindness, cholera, trypanosomiasis, Chagas disease, schistosomiasis, helminth parasites, or other severely debilitating diseases. Control measures have now been developed for many of these diseases, but strong and continued action by the government is required to achieve effective control. Fortunately, there are important sources of external assistance that may be invoked by individual countries. These include the World Health Organization (WHO), the United Nations Development Program (UNDP), the World Bank (IBRD) and Regional Development Banks, Gorgas Memorial Institutes and Belem Virus Laboratory, U.S. Agency for International Development (AID) and other national bilateral assistance agencies. Such agencies are primarily concerned with protection of human health, but the collateral benefits of stimulating agricultural development would significantly contribute to the justification for providing external assistance for disease control programs.

When the endemic diseases are brought under control, these afflicted lands may then be developed to capitalize on the land and climatic conditions that will support agriculture. These new lands offer opportunities to apply modern technology for higher levels of productivity.

E. Development of Tsetse Fly Infested Lands in Africa

It is reported that some 4½ million square miles of Africa are infested with tsetse fly which is the carrier of trypanosomiasis in livestock and sleeping sickness in man. These lands are slowly being rid of tsetse fly by clearing trees and brush that serve as the necessary habitat for the pest, or by spraying to kill the fly, or a combination of these. A new technique by which the tsetse fly may be eradicated by releasing sterile (incapable of reproduction) males in abundance, shows promise.

For the most part, the tsetse fly infested lands have a sub-humid climate, and they may be developed for appropriate types of crop production on better soils, or for grazing lands. In either case the effective control of tsetse fly may open vast areas for effective development. The governments of these regions may well seize the opportunity to foster the types of development that will best serve the long-term needs of the nation and its rural people. The infestations that now constitute a heavy curse, may ultimately be transformed into a great blessing.

F. Small Scale Irrigation Projects

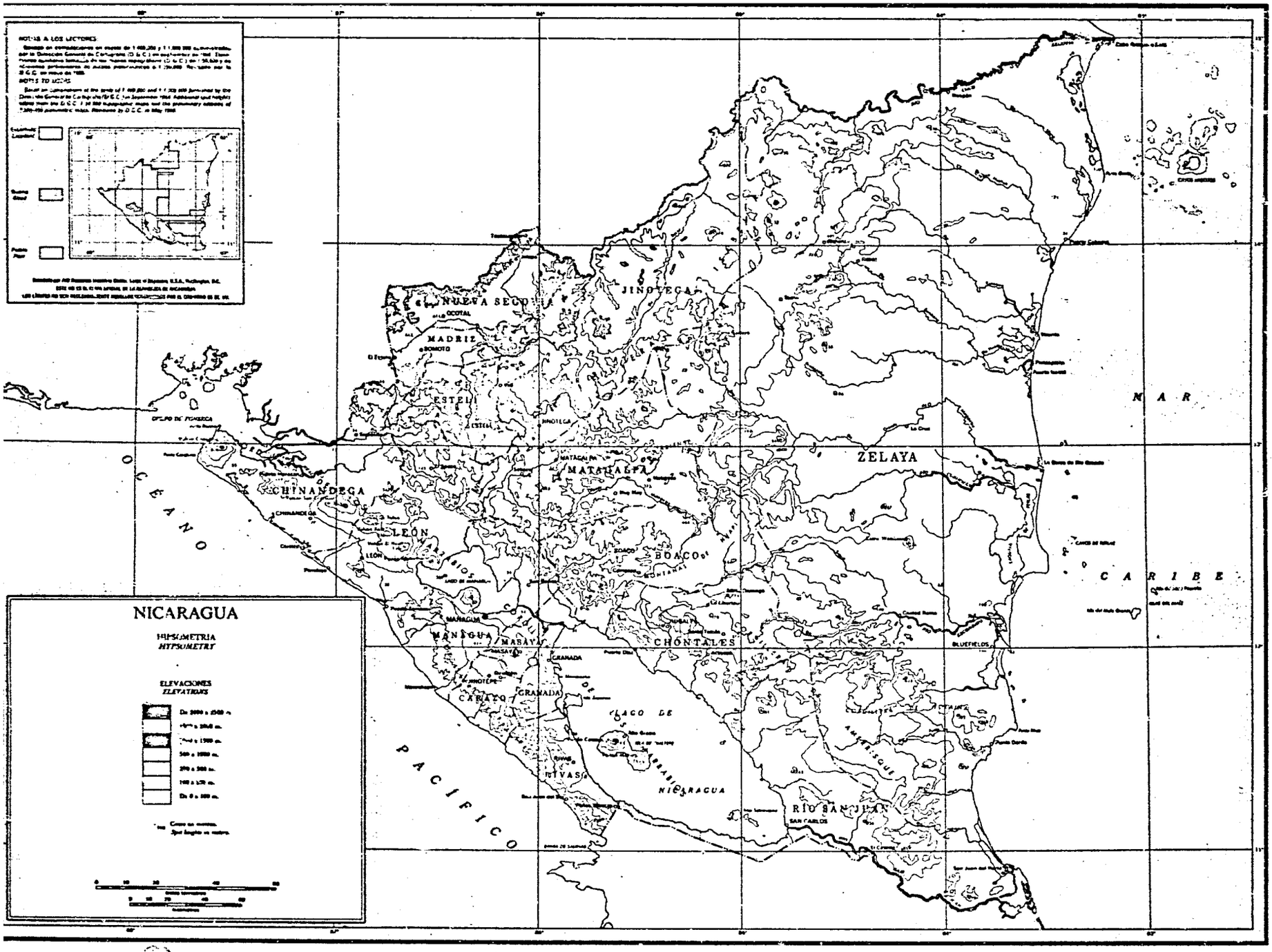
There are many regions of the tropics and subtropics, particularly in regions of limited rainfall, where shallow underground water resources may be exploited for local irrigation development. These areas are generally well mapped by geologists, but this knowledge often has not been called to the attention of governments, nor to the inhabitants of the fortunate regions. Exploitation of these local aquifers depends on their depth, and the quality of the land where they occur. In some areas, water may be drawn from dug wells in sufficient quantity for local irrigation of crops. With these sources, crops may be grown at all seasons. In other areas, tube wells and pumps are required to bring water to the land.

These small scale projects have the great advantages of requiring relatively small investments for development, and of producing crops and forages within a few months. They are at a scale and level of sophistication that is well within the capacity of the rural populations, where governments provide counsel and guidance in the most effective methods of utilizing these waters. Collectively, such irrigation projects may greatly enhance agricultural productivity of the nation.

APPENDIX A.

The following maps from the Atlas on "National Inventory of Physical Resources" for Nicaragua, are presented as an example of the types of information that may be assembled for most developing countries. Aerial photography and photo-interpretation, which are rapid and reasonable in cost, may be used to supplement existing maps and surveys, for creation of a comprehensive inventory of available resources for agricultural production and development. The following maps are included:

1. Elevation (Altitude)
2. Surface configurations (Topography)
3. Natural Drainage
4. Surface Water Resources
5. Agricultural Soils
6. Natural Vegetation
7. Climatic Zones
8. Precipitation
9. State of Ground
10. Population
11. Land Use
12. Land Potential
13. Highways



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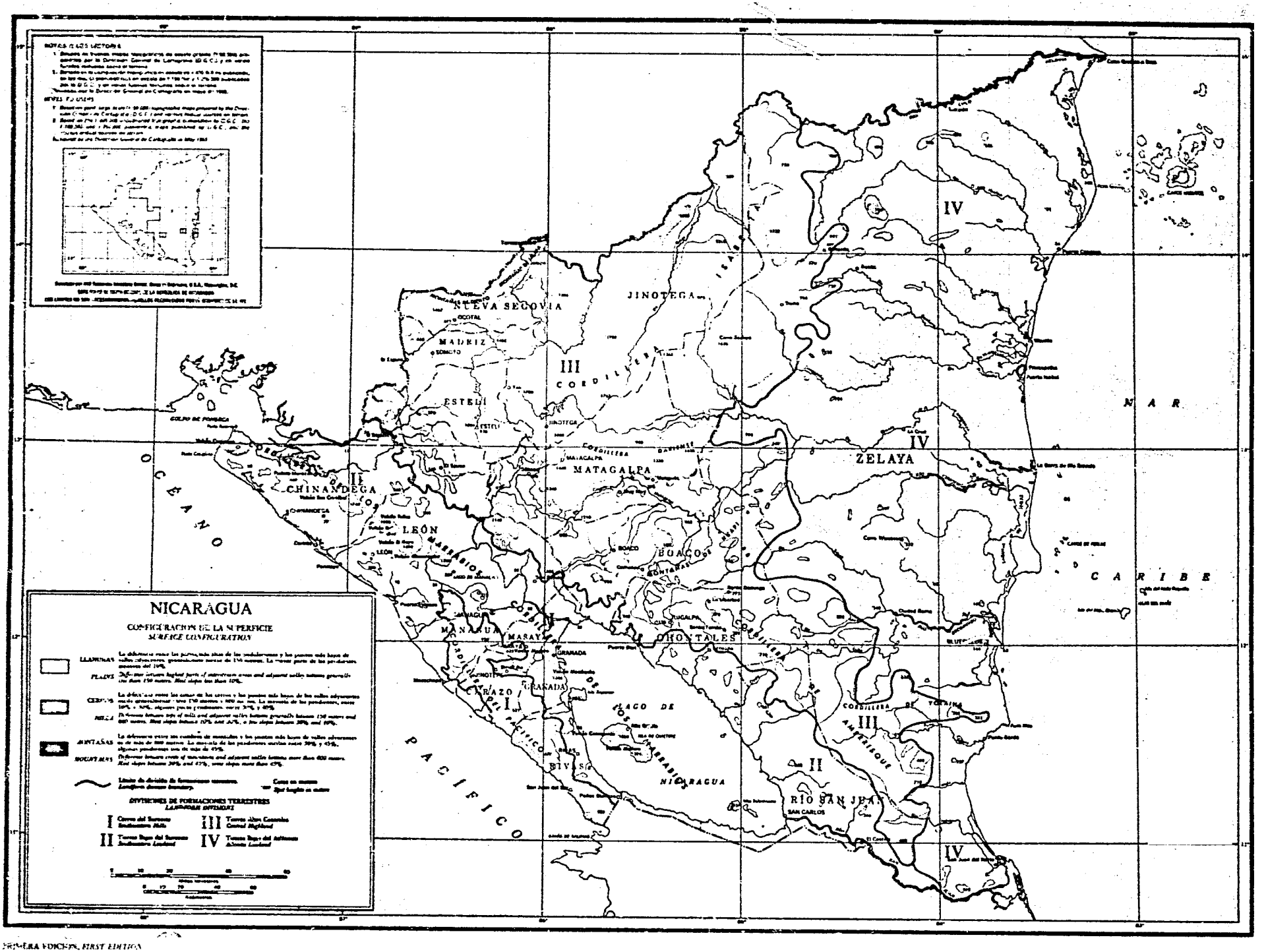

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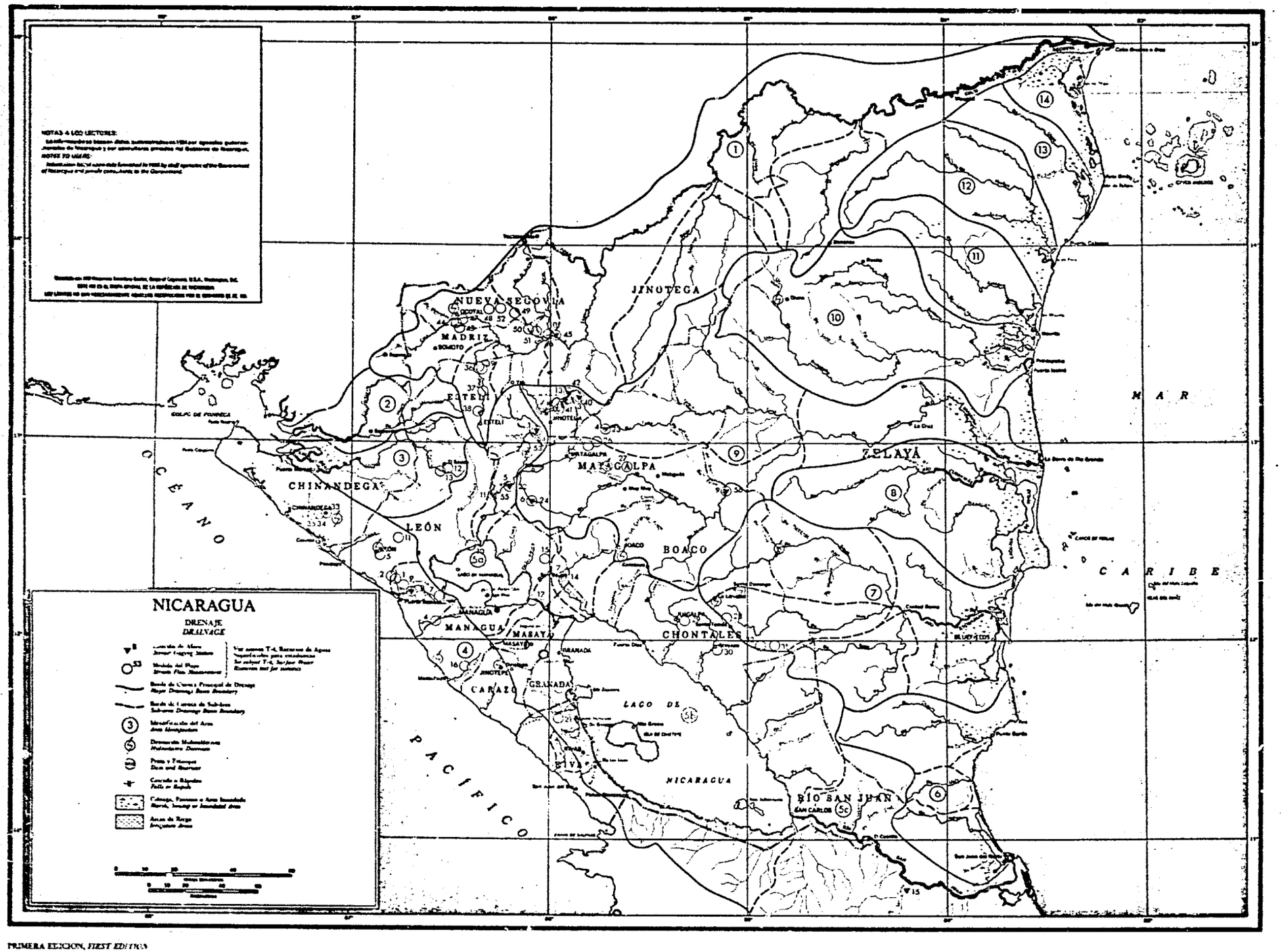

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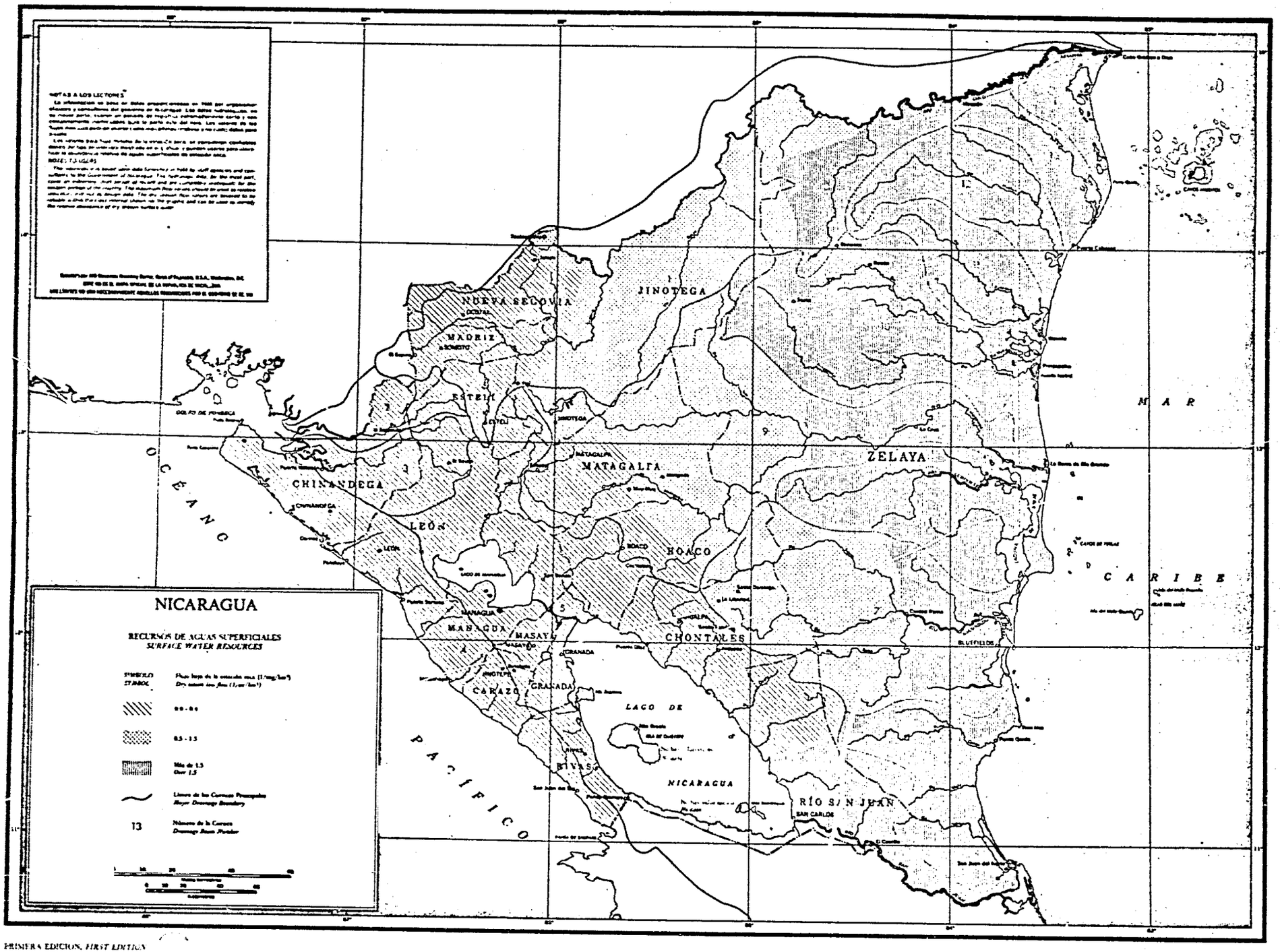

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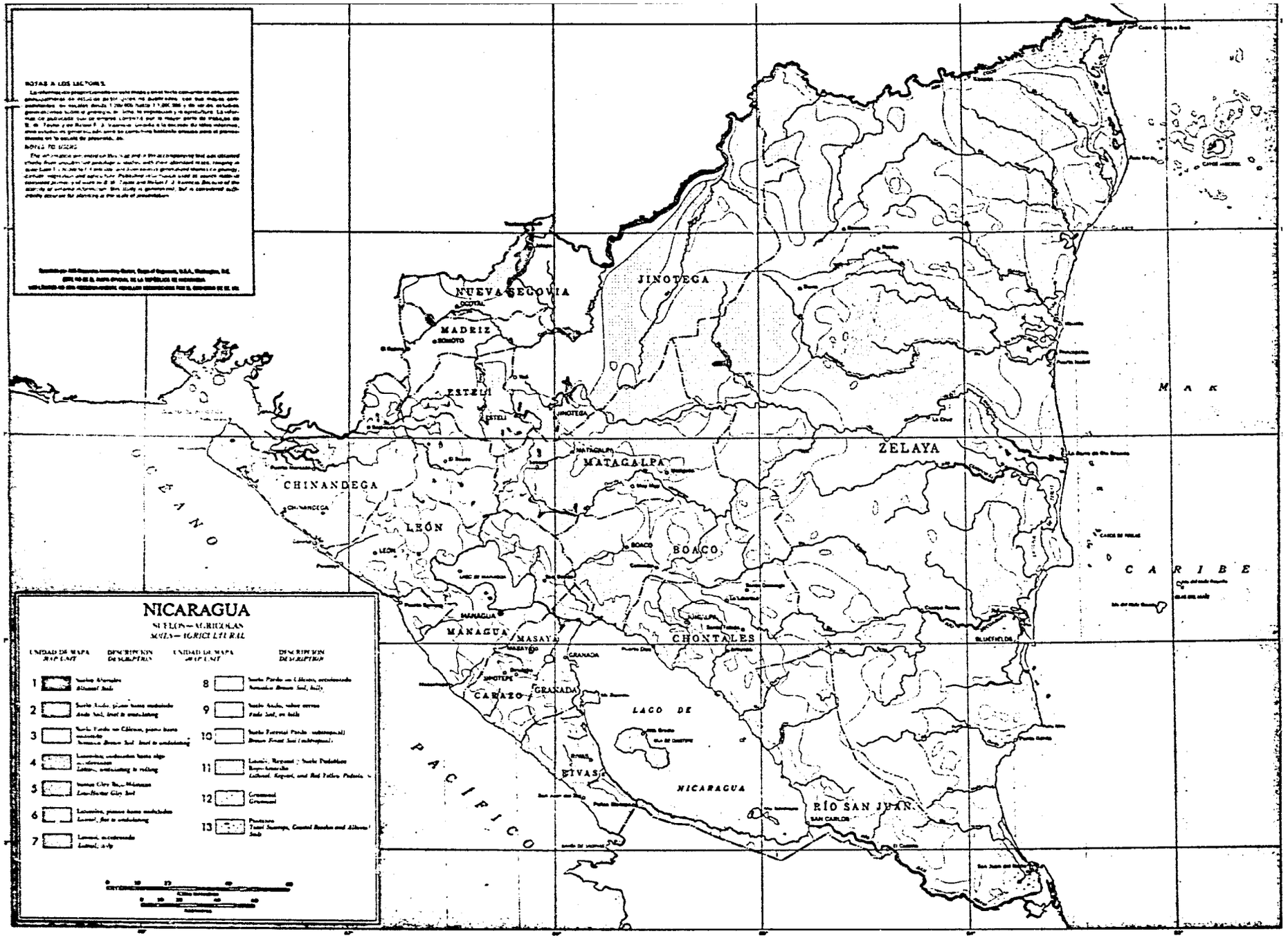
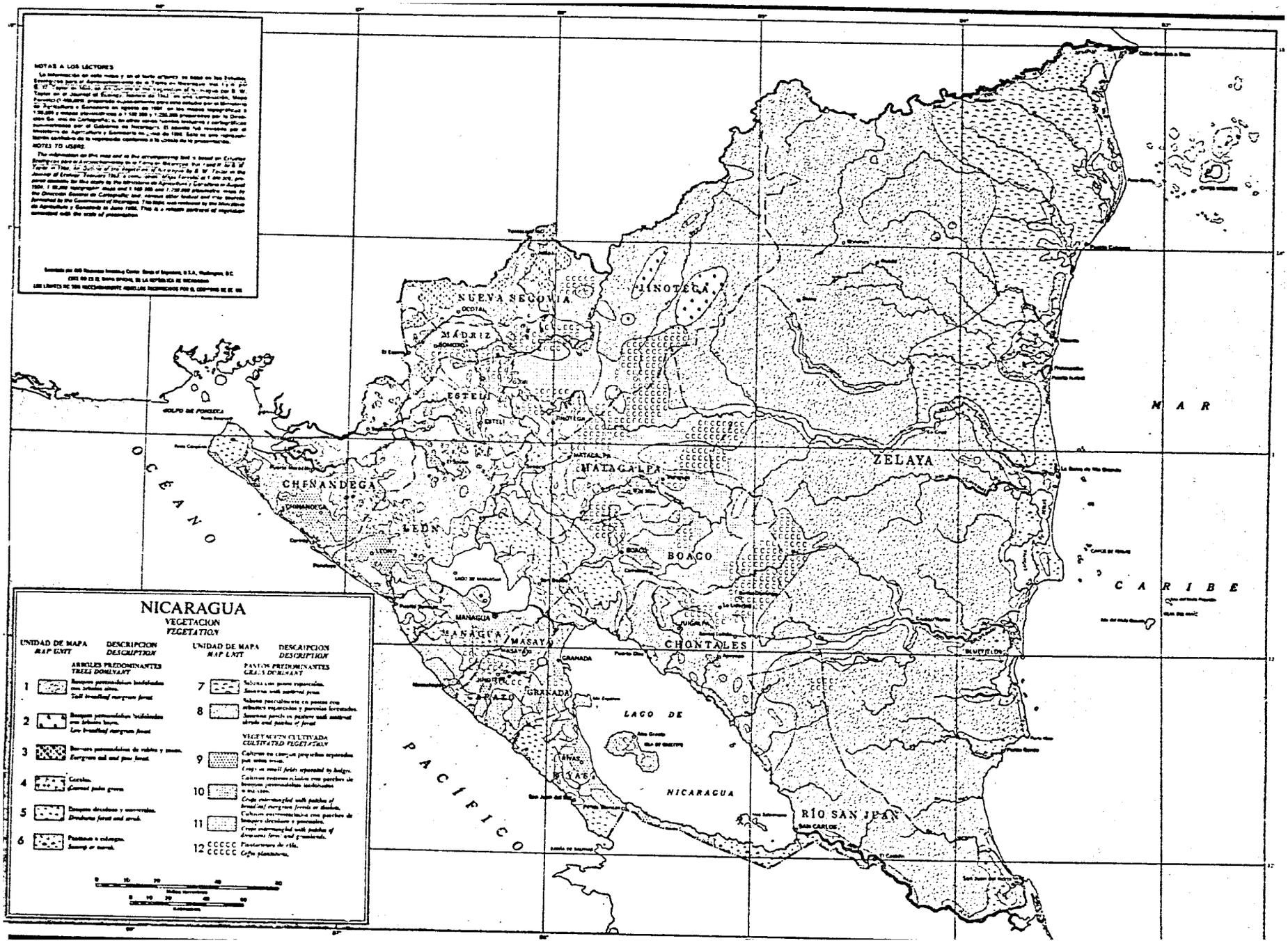

NICARAGUA
NUEVA SEGOVIA
JINOTEGA
MADRIZ
ESTELI
MATAGALPA
ZELAYA
CHINANDEGA
LEÓN
BOACO
CHONTALES
MANAGUA
MASAYA
GRANADA
CARAZO
RIVAS
RÍO SAN JUAN
LAGO DE NICARAGUA
OCÉANO PACÍFICO
MAR CARIBE



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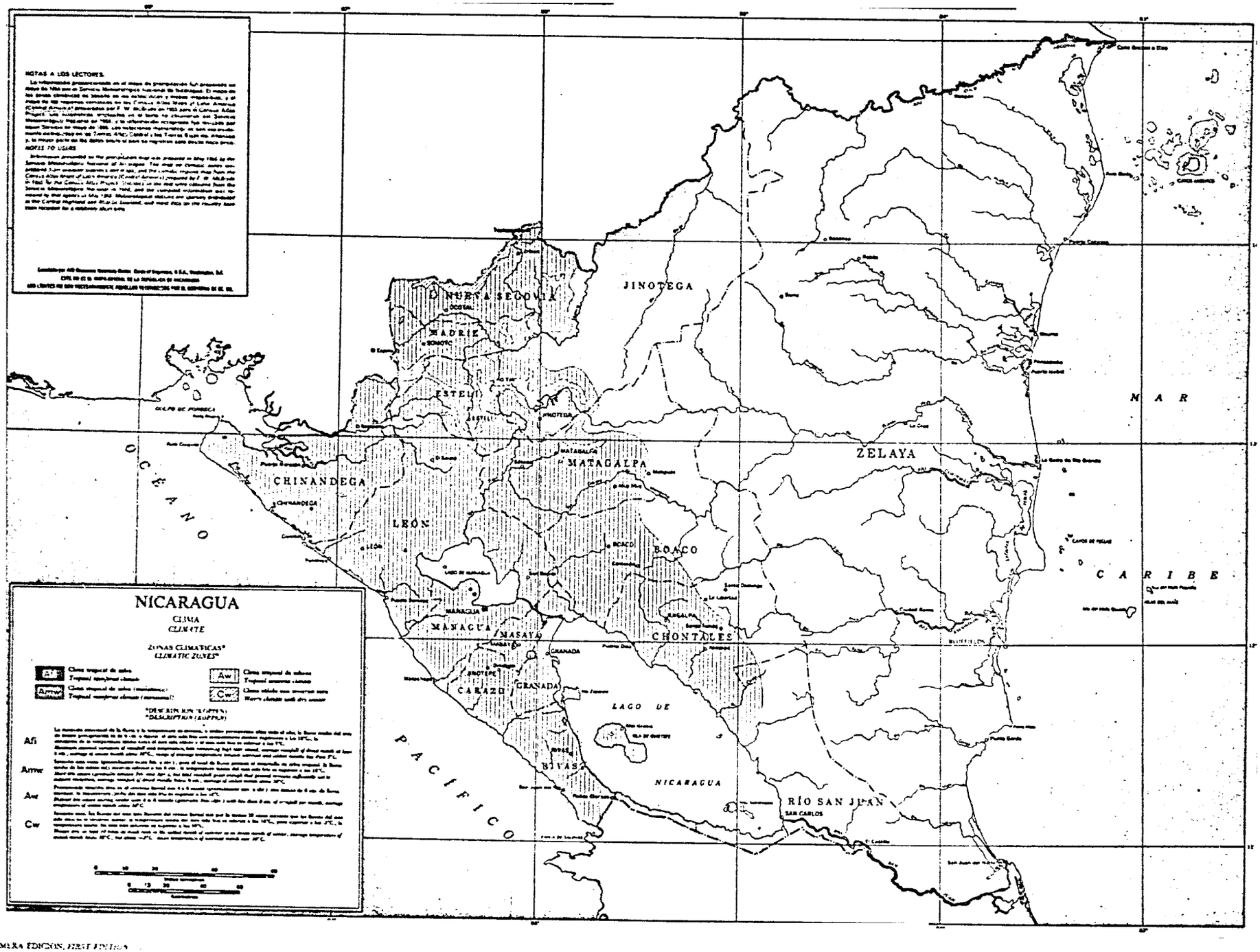

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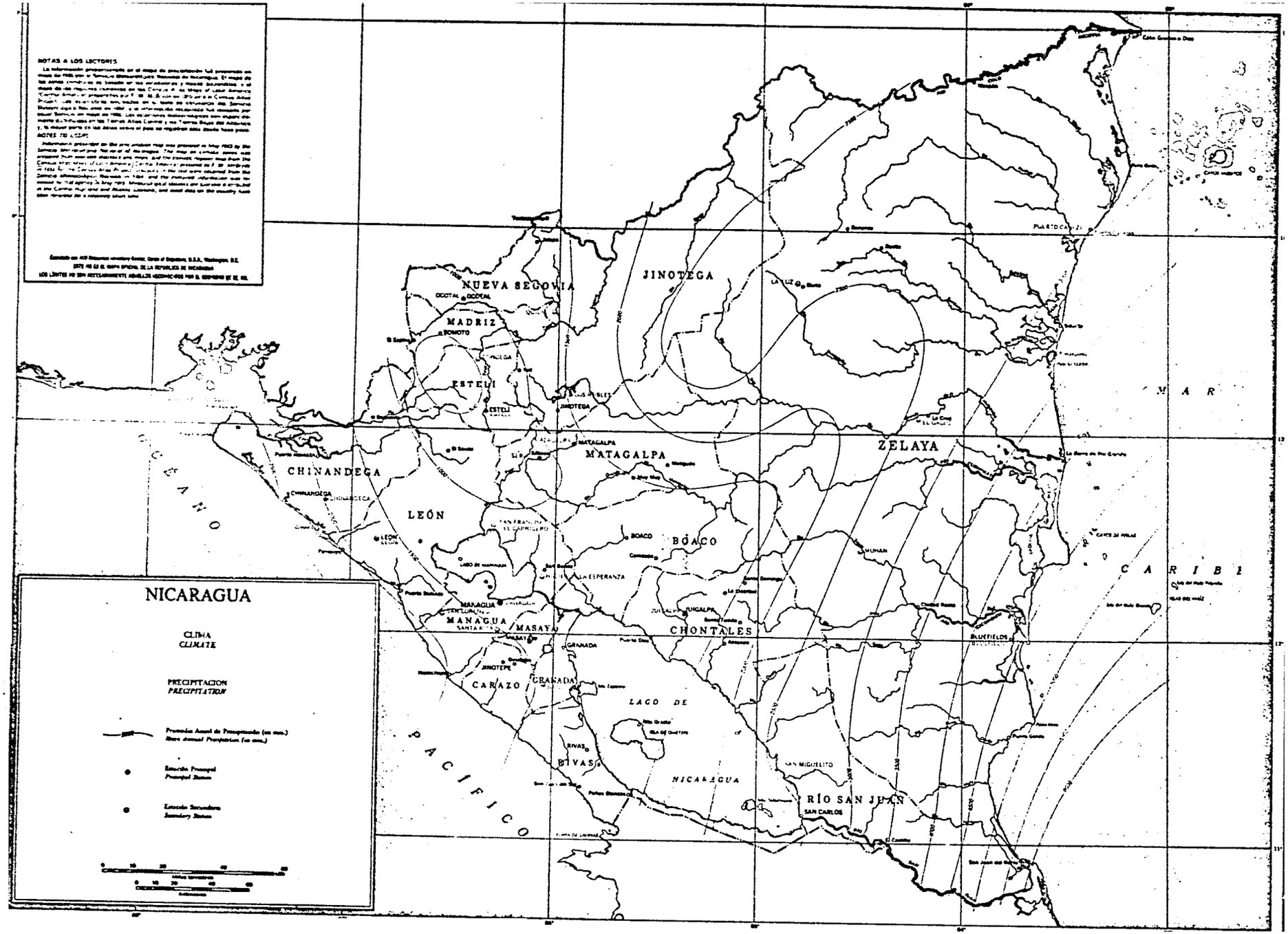

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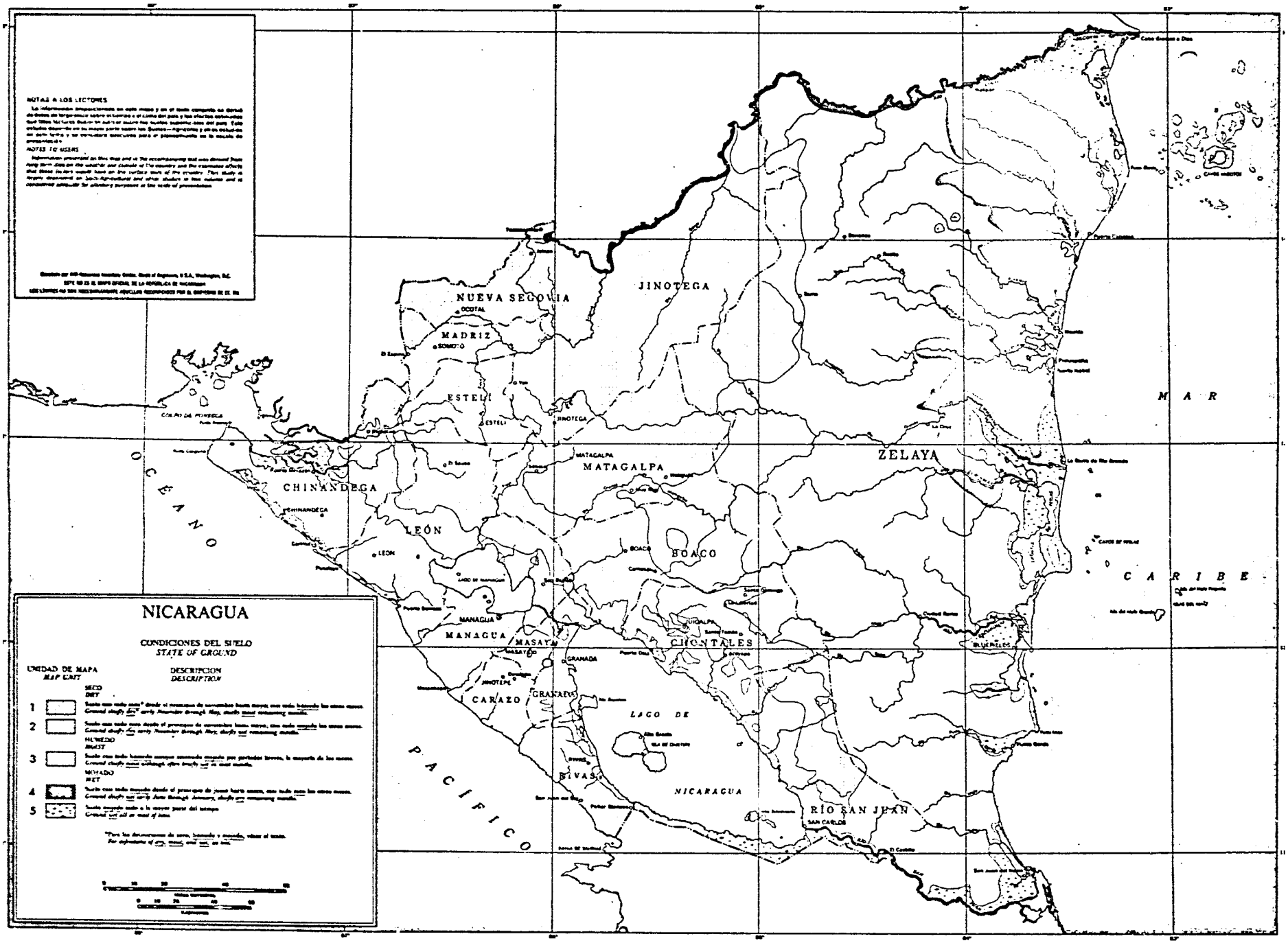

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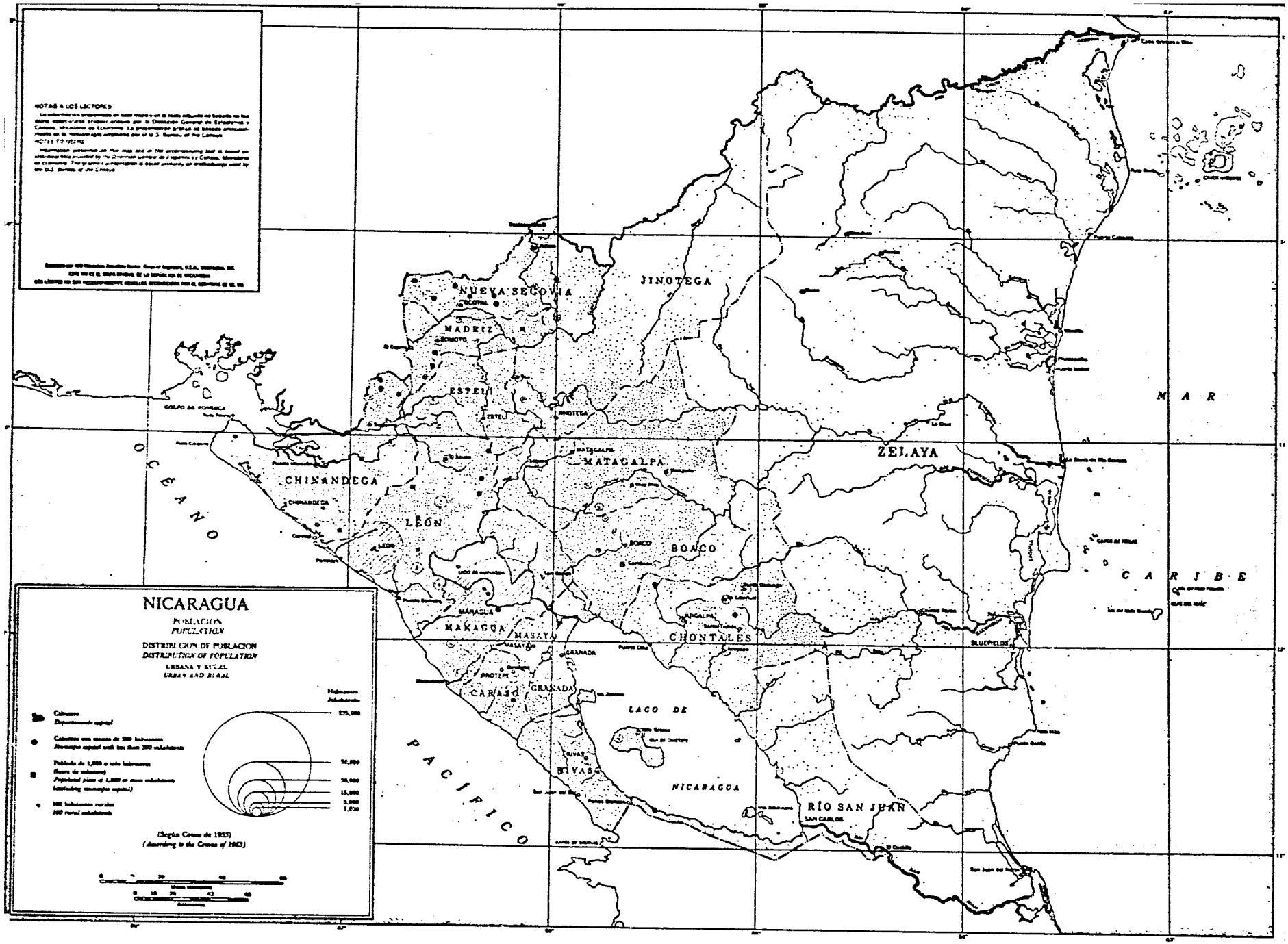
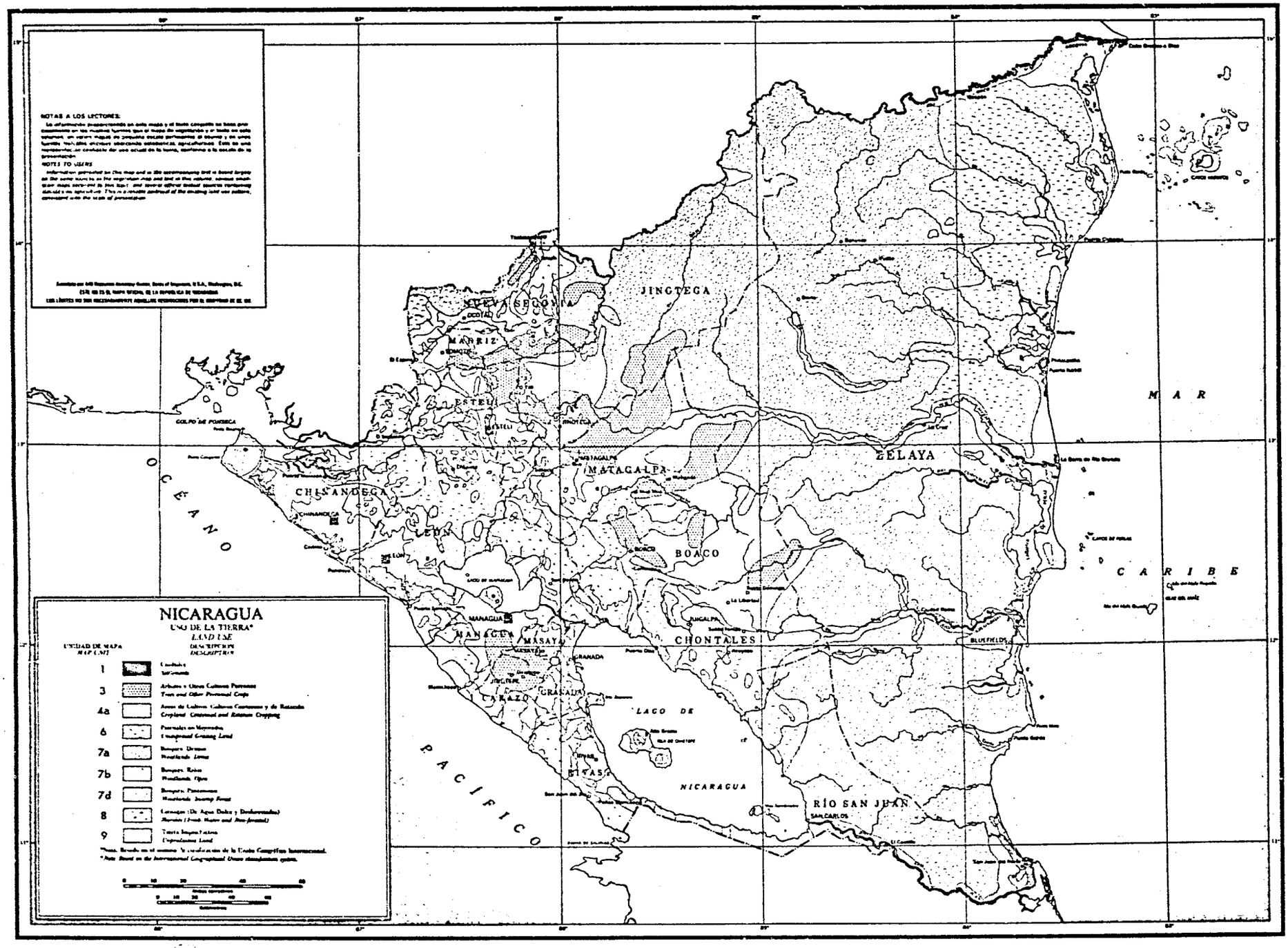
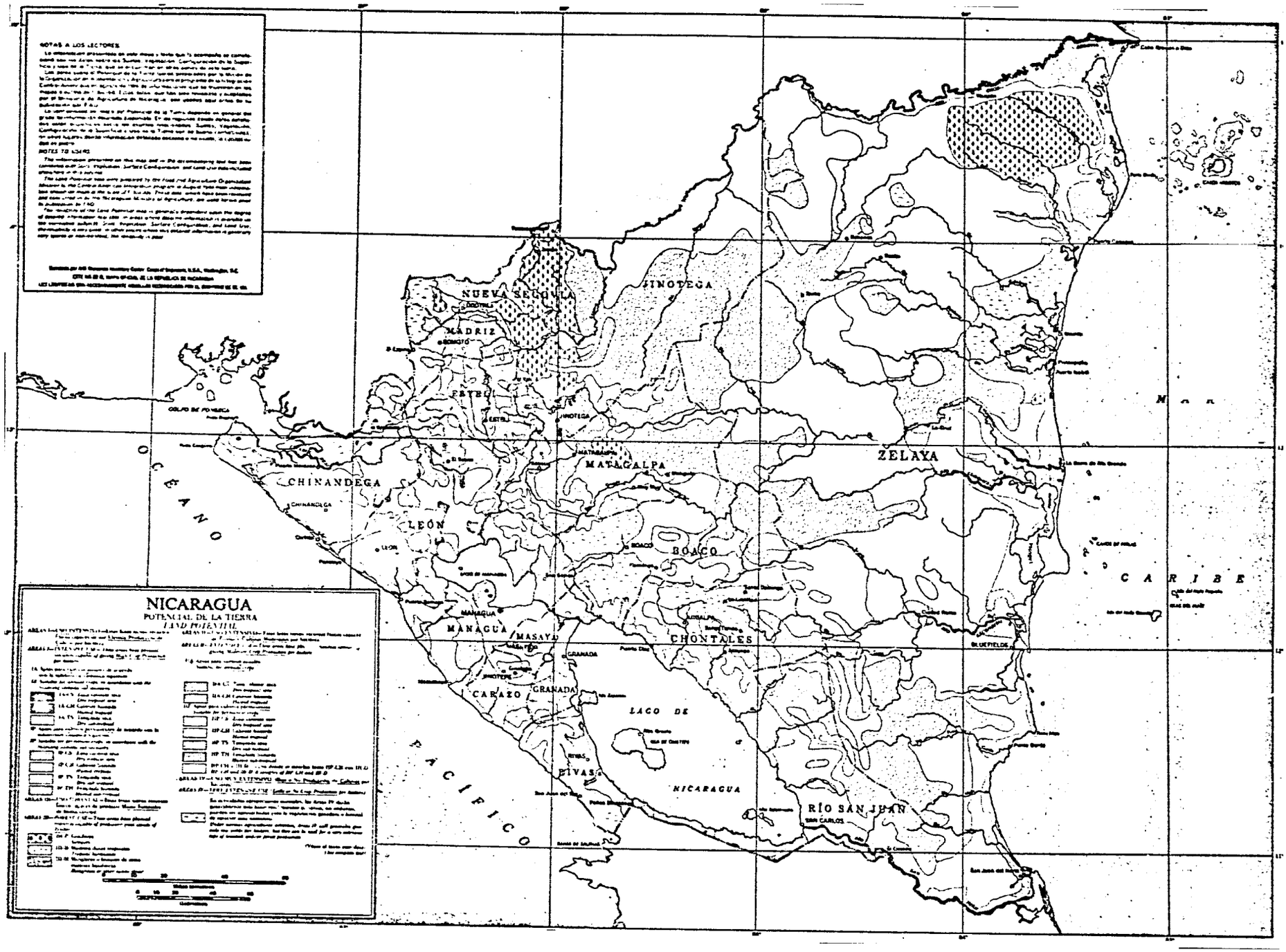
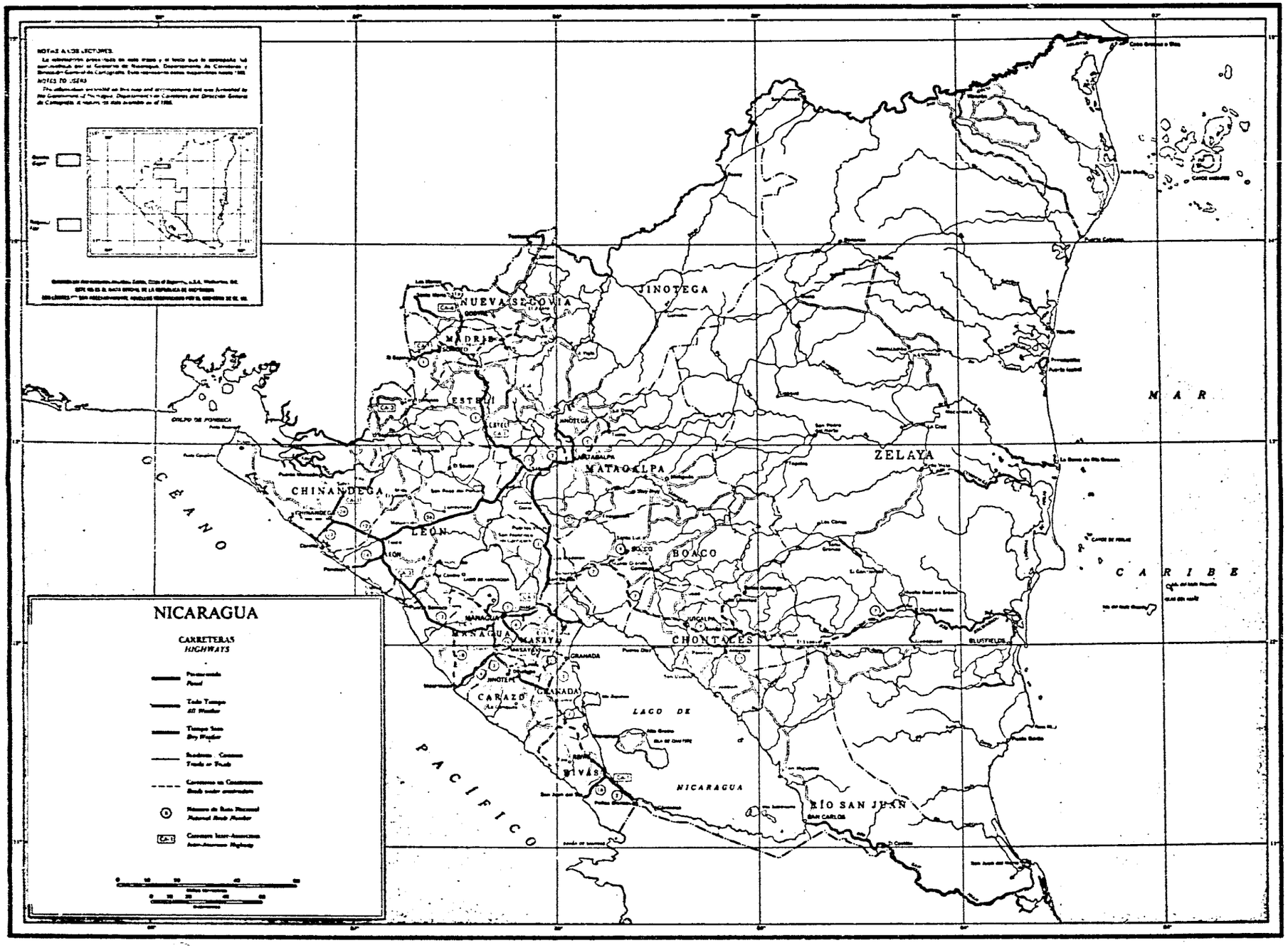

NICARAGUA
POBLACION
POPULATION
DISTRIBUCION DE POBLACION
DISTRIBUTION OF POPULATION
URBANA Y RURAL
URBAN AND RURAL
(Según Censo de 1963)
(According to the Census of 1963)
NUEVA SEGOVIA
JINOTEGA
MADRIZ
ESTELI
MATAGALPA
ZELAYA
CHINANDEGA
LEÓN
BOACO
MANAGUA
MASAYA
CHONTALES
GRANADA
CARAZO
RIVAS
LAGO DE
NICARAGUA
RÍO SAN JUAN
SAN CARLOS
BLUEFIELDS
OCÉANO
PACÍFICO
MAR
CARIBE
GOLFO DE FONSECA


NICARAGUA
USO DE LA TIERRA*
LAND USE
UNIDAD DE MAPA
MAP UNIT
DESCRIPCIÓN
DESCRIPTION
1
3
4a
6
7a
7b
7d
8
9
*Nota: Basado en el sistema de clasificación de la Unión Geográfica Internacional.
*Note: Based on the International Geographical Union classification system.
Millas terrestres
Kilómetros
NOTAS A LOS LECTORES:
NOTES TO USERS
JINOTEGA
NUEVA SEGOVIA
MADRIZ
ESTELI
MATAGALPA
ZELAYA
CHINANDEGA
LEON
BOACO
MANAGUA
MASAYA
CHONTALES
GRANADA
CARAZO
RIVAS
RIO SAN JUAN
SAN CARLOS
BLUEFIELDS
LAGO DE NICARAGUA
GOLFO DE FONSECA
OCEANO PACIFICO
MAR CARIBE


NICARAGUA
POTENCIAL DE LA TIERRA
LAND POTENTIAL
NOTAS A LOS LECTORES
NOTES TO READERS
NUEVA SEGOVIA
MADRIZ
ESTELI
JINOTEGA
MATAGALPA
ZELAYA
CHINANDEGA
LEÓN
BOACO
CHONTALES
MANAGUA
MASAYA
GRANADA
CARAZO
RIVAS
RÍO SAN JUAN
LAGO DE NICARAGUA
OCÉANO PACÍFICO
MAR CARIBE
GOLFO DE FONSECA
BLUEFIELDS



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