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WATER RESOURCES AND THEIR UTILIZATION IN LATIN AMERICA

Summary of results achieved by the Working Group

Note: The text of this study is provisional and is subject to revision both in form and in substance.

CONTENTS

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NOTE BY THE SECRETARIAT

Resolution 99 (VI), adopted at the Commission's sixth session, (Bogota, 1955), recommended that the Secretariat should, inter alia, "....carry out a preliminary examination of water resources in Latin America, and of their present and future utilization in so far as possible for multiple purposes, such as energy, irrigation and water supply, taking into account other factors, such as land reclamation, drainage and other benefits arising from the construction of such works and the use of water."

The resolution added that in carrying out its task the Secretariat should obtain the co-operation of the Technical Assistance Administration, the Department of Economic and Social Affairs, the other regional economic commissions of the United Nations and other agencies and institutions concerned.

In accordance with the above recommendations, a joint ECLA/TAA working group was set up to carry out the proposed preliminary examination. The World Meteorological Organization, too, is participating in the study. For the first two years the group included General Charles G. Hawes, a TAA expert in analysis of the development of water resources for multiple purposes, Mr. Guillermo J. Cano, a TAA expert in legal and administrative matters, and Dr. Rudolf Schroeder, a WMO expert in meteorology and hydrometeorology. For its first year of work the group also had the assistance of Mr. A. Pfaff, a hydroelectricity expert, whose services were kindly provided by the

/French Government

French Government. The Secretariat was responsible for the direction and co-ordination of the studies and for the economic analysis.

In carrying out its investigations the group also received assistance from other sources, particularly from TAA experts working in the countries studied. Furthermore, in agreement with FAO, special contacts were established with FAO representatives and with nationals of these countries who were experts on the subject. The United Nations inter-agency committee on water resources was kept informed of the progress made, with a view to maintaining the requisite co-ordination by the United Nations in that field. Lastly, the most valuable co-operation was obtained in the countries in which special inquiries were being made, namely, Chile, Ecuador and Argentina, and special thanks are due to the many officials in those countries who took part in the group's work or provided it with facilities. In addition several countries took the trouble to reply promptly to a questionnaire sent out by the secretariat, and this was of great assistance in obtaining a preliminary picture of the situation in Latin America.

The work began with an experimental study on Chile, followed by a regional study of the problems connected with the development of water resources in North Patagonia (Argentina) and, more recently, a study of the water resources of Ecuador. Although, in view of differences in the problems arising, the information available and the stage of development, each of the studies has its own distinctive features, they have the three following characteristics in common:

(a) The analysis of water resources and their utilization is made

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from the point of view of economic development. The physical magnitude of the resources and their economic significance are usually two very different matters. It is essential to have a picture of the process of economic development, with due attention to costs and profits, in order to guide and direct scientific and engineering research so as to obtain the best results. Consequently, in analysing the problems involved in the development of water resources, efforts were made to deal concurrently with the economic, technical and institutional aspects.

(b) The first requirement for an efficient utilization of water resources is an accurate measurement of those resources and their uses. It should be stressed here that the measurement of water resources takes many years of observation (some twenty to thirty) if trustworthy estimates are to be obtained. It is therefore important to begin the measurement far in advance of the construction of works. The studies that have been prepared point out the defects in existing measurement procedures and make practical suggestions for their elimination.

(c) As the necessity for a comprehensive programme for the development of water resources is increasingly recognized, the emphasis laid in the aforementioned resolution upon the multiple utilization of water resources has been kept steadily in view.

While these studies of one whole country or one specific

hydrographic basin were being made, more extensive research was undertaken in order to determine what features they all had in common and to find a basis for comparison with other regions of the world. With this in mind, research was undertaken along the following three lines:

(a) Efforts were made to compile a broad preliminary description of the water resources of the whole of Latin America and their possible utilization, as the basis for a possible broader approach to the country-by-country studies. A questionnaire was sent to all member countries in order to collect the relevant information. A provisional document has been prepared from the information already available to the secretariat and the first replies received from member Governments. The document will be completed and supplemented with further replies as they are received, and it is hoped that a closer relationship can be established between Latin America's water resources and its economic development.

(b) In view of the ever-increasing importance attached throughout the world to the integrated development of hydrographic basins, it was felt that it would be of interest to member Governments to study the organizations which, pending further studies of this important subject, are at present responsible for the development of hydrographic basins in Latin America and the rest of the world.

(c) While the research carried out so far has been undertaken at the request of specific countries, it should be pointed out that

out that the most significant water resources of Latin America are in the physical sense international, for the main rivers serve as frontiers between countries or else flow from one country into another. A provisional list of such rivers or lakes has been drawn up and a study has been made of what is now being done to develop them. (An additional purpose of this study was to provide basic information for the implementation of resolution 131 (VII), concerning international rivers.)

The following studies have been completed or are on the point of completion:

(1) Water resources and their utilization in Latin America. Summary of the work and results achieved by the Working Group (E/CN.12/501)

(2) Systems of administrative organization for the integrated development of river basins (E/CN.12/503)

(3) Preliminary review of questions relating to the development of international river basins in Latin America (E/CN.12/511)

(4) The water resources of Chile and their utilization (E/CN.12/501/Add 1). (Text of the study only; the technical annexes will be published in the final printed version.)

(5) The water resources of North Patagonia. Extensive summary.[1/] (The final report is in course of preparation.)

1/ It is hoped that this will be ready for presentation to the Commission at its eighth session.

(6) The water resources of Ecuador. Extensive summary.2/

(The final report is in course of preparation.)

The Government of Venezuela has asked for a study to be made of the water resources of Venezuela and a mission is being organized for that purpose. Other Governments, too, have indicated their interest in such studies, and these will be undertaken when they are officially requested.

2/ This will be distributed during the eighth session.

WATER RESOURCES AND THEIR UTILIZATION IN LATIN AMERICA

1. INTRODUCTION

Water is an essential factor in several branches of the present day economy, and consumption per head is constantly increasing. It has been estimated, for example, that in the United States in 1950 approximately 4 cubic metres of water per head of population were used daily in activities in which water was in some way physically consumed (drinking, industrial uses or irrigation), while the use of water not consumed in the process - e.g. to produce hydroelectricity and for navigation - was very extensive. Hence from the standpoint of economic development the first problem to be considered is whether or not the available water resources are sufficient to keep pace with increasing demand.

At the very outset mention must be made of another important aspect of water development: the fairly high cost of hydraulic works. To consider only the three main ways of using water, the cost of laying on a drinking water supply to dwellings is normally between $20 and $50 per occupant; that of building irrigation works (excluding reservoirs) to serve farms, between $100 and $300; and that of installing one kW of hydroelectric capacity, $250 to $500. Taken as a whole, investment in hydraulic works sometimes accounts for 20 per cent or more of a country's public expenditure. While, generally speaking, the advantages gained from such works are considerable, they require so much capital that a detailed analysis of the best method of utilizing them is called for.

For Latin America several demographic and economic indexes are available to illustrate the importance of water resources to the immediate development of the region. The population of Latin America, which is

/increasing rapidly,

increasing rapidly, is expected to rise from a total of 75 million in 1954-1956 to almost 300 million in 1975. So far as domestic uses are concerned, a gigantic effort will be needed to provide the new population with piped drinking-water and also to improve the existing supplies, which in many cases are inadequate. More food will also be needed. The value of farm products now consumed in Latin America is $6,200 million, some 13 per cent being imported. Assuming that the Latin American economies expand at a rate of slightly more than 5 per cent a year, the amount of food required will probably be doubled by 1975. In some Latin American countries one means of increasing agricultural output by the requisite amount will be to extend and improve irrigation. Furthermore, the first result of the trend toward industrialization of a country's economy is bound to be an increase in the water requirements of industry, especially in view of the types of industries likely to develop (chemical products, steel, etc.), although this need will show itself mainly through an increase in the demand for power. Total installed electric power capacity, now in the region of 14 million Kw, would have to be increased to almost 50 million Kw in 1975. The greatest increase will be needed in hydroelectricity. Lastly, if the Latin American countries increase trade through a common market, one of the consequences might be an increase in water-borne traffic in some hydrographic basins, especially that of the River Plate.

While the data so far to hand do not suffice to give an accurate picture of the available water resources and the different uses made of them, an attempt is made in this paper to give a general idea of the investigations which have been carried out regarding certain countries

/or certain

or certain hydrographic basins. The study comprises: (a) a survey of resources, with reference to arid zones in which water may be a limiting factor in economic development and then to the main hydrographic systems and the possibilities for their utilization; (b) a study of the administrative machinery governing the harnessing of water resources; and (c) a brief analysis of the main uses of water in Latin America.

II. SURVEY OF WATER RESOURCES

While, generally speaking, Latin America possesses, plentiful water resources and many areas in the region have sufficient rainfall to be termed humid, other areas of significant size and, in some cases, of great economic activity may be classed as extremely arid, arid or semi-arid. 1/

1/ The criterion of "aridity" used here is based solely upon mean annual rainfall. Owing to the uneven distribution of precipitation over the seasons, some localities are normally subject to major seasonal droughts, the effect of which, so far as agriculture is concerned, can be lessened by irrigation.

In the whole of Latin America this phenomenon of aridity is understood to affect, with varying degrees of intensity, over 3.5 million square kilometres. This figure represents 18 per cent of the total area of the region, but its significance is enhanced if we consider the population and the economic activities carried on in the different areas affected. Argentina and Mexico each have arid zones totalling 1 million square kilometres; Chile, Peru and Bolivia, 200,000 to 300,000 sq.km. each; Venezuela, 80,000 sq. km.; and Colombia and Ecuador, smaller areas.

/A first

A first section contains a description of these different zones, whose interest from the standpoint of water development lies in the fact that, as a rule, irrigation is a necessity for agriculture. Of particular importance in these zones is the problem of water rights over the scanty available resources. The use made of water in irrigation and other activities calls for careful study. Lastly, all methods of increasing the available water supply are of direct interest for these zones. Such methods include the utilization of ground water; regulation of the use of surface water and the conveyance of such water from more humid zones; the distillation of salt water (which, however, is still in the experimental stage); and the production of artificial rain.

A second section describes in general terms the principal surface water resources of Latin America, with reference to the use of such waters for navigation and for the production of hydroelectricity.

1. Arid and semi-arid zones

Such zones (see maps I-A and I-B) are found in the following localities:

High plain of Mexico and Chihuahua desert. This is the continuation of the vast arid region which stretches from the United States and which owes its origin to the general meteorological influence of the sub-tropical atmosphere. This zone branches out as far as the Gulf of Mexico, at the latitude of the mouth of the Rio Grande.

Peninsula of Lower California. The aridity of this zone is due to the influence of cold sea currents (California Current).

Southern arid belt. This extends over 50° of latitude and is a broad arid belt which owes its origin to the cold Humboldt Current and

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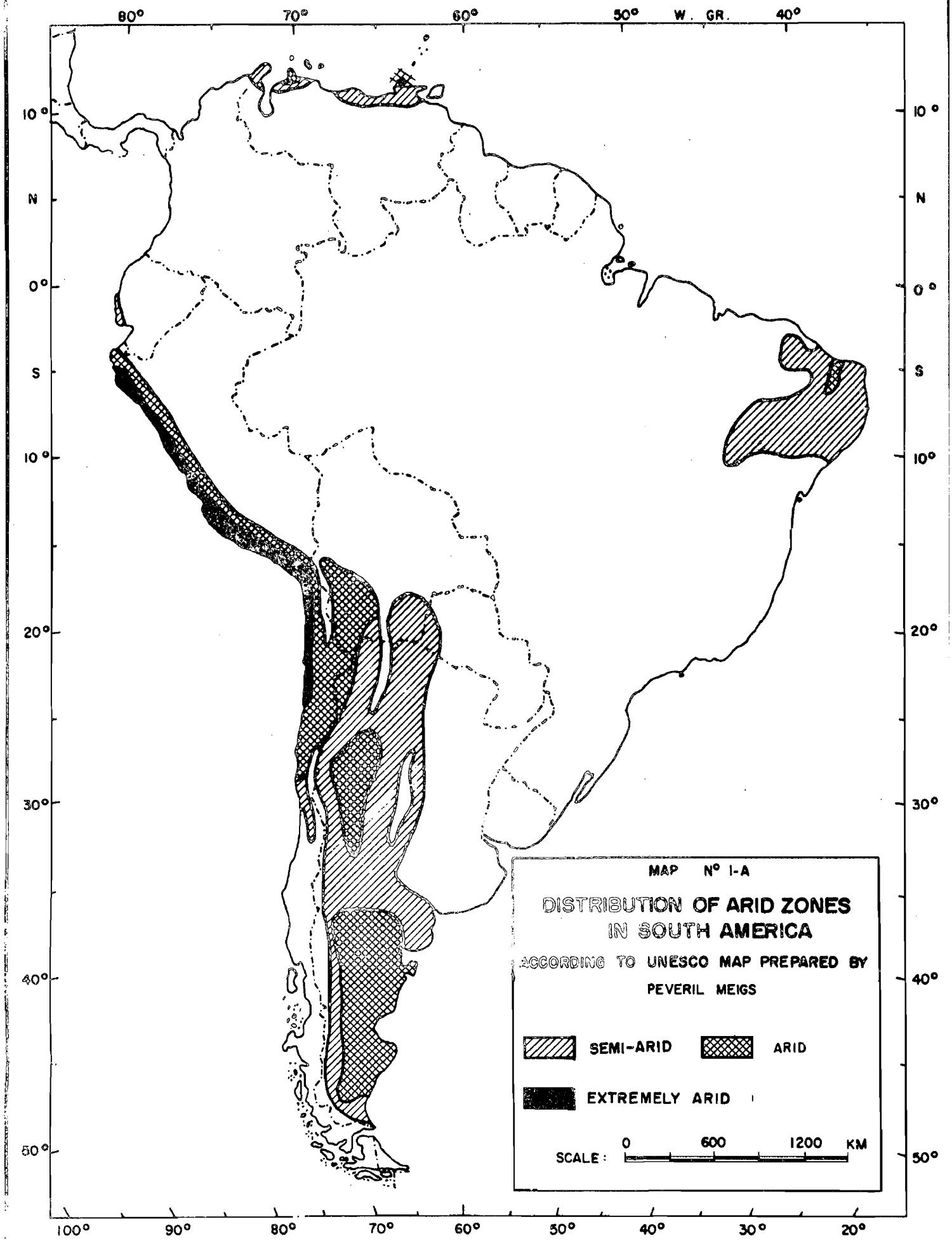
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MAP Nº I-A
DISTRIBUTION OF ARID ZONES IN SOUTH AMERICA
ACCORDING TO UNESCO MAP PREPARED BY PEVERIL MEIGS
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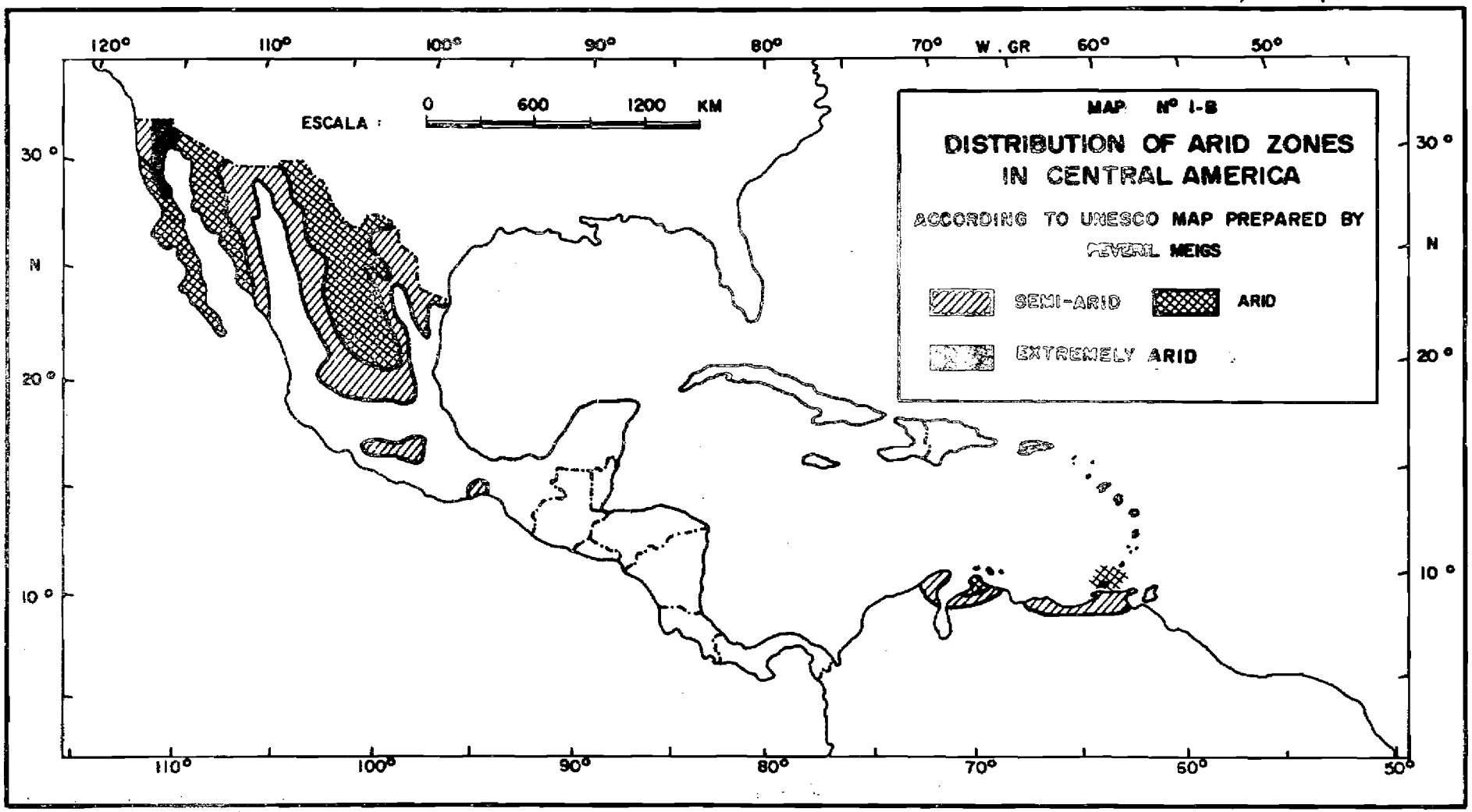
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MAP Nº I-B
DISTRIBUTION OF ARID ZONES
IN CENTRAL AMERICA
ACCORDING TO UNESCO MAP PREPARED BY
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SEMI-ARID
ARID
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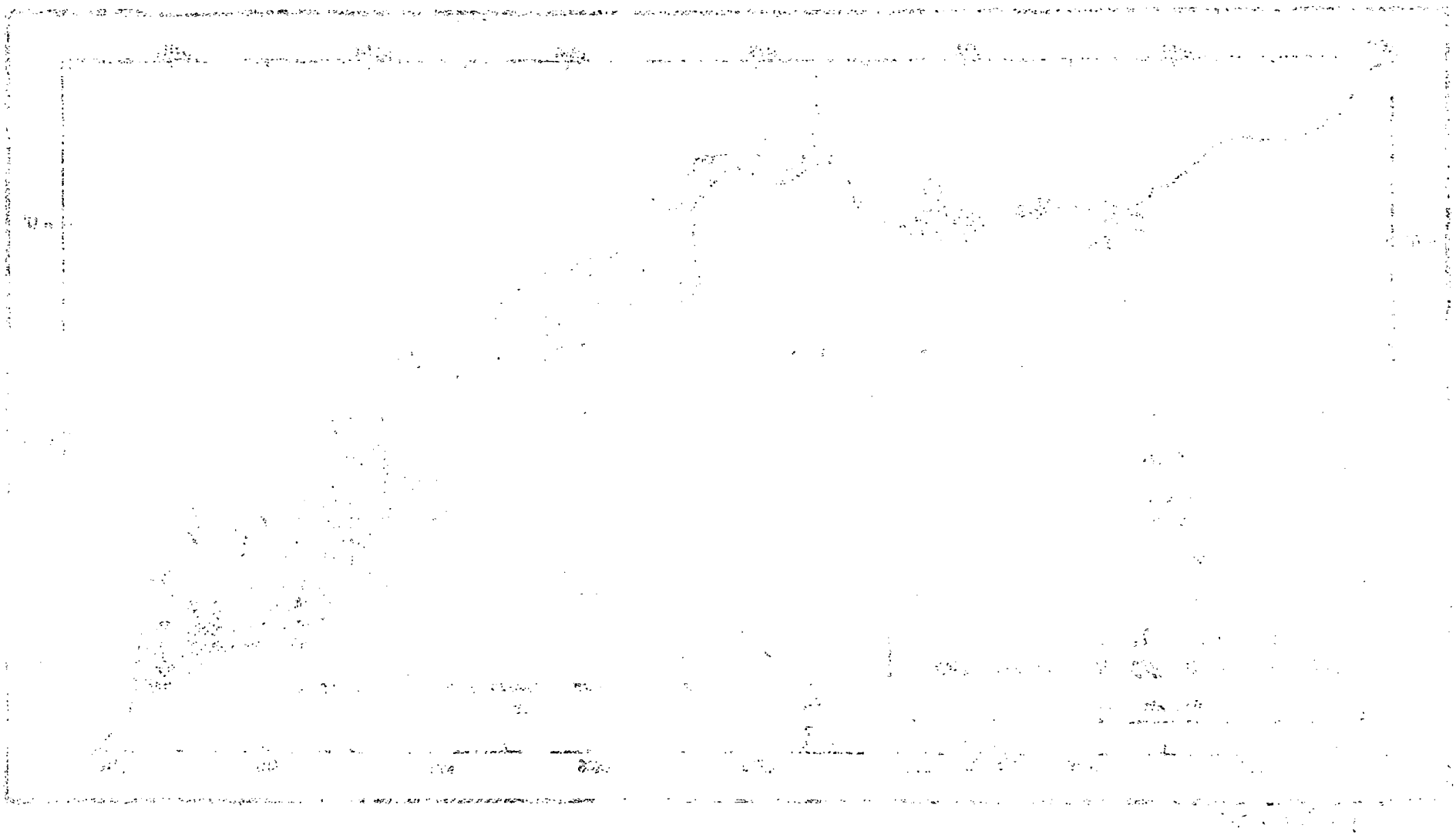

reaches the coasts of Ecuador, Peru and Chile. In the South the belt extends to Bolivia, large areas of Argentina and part of Paraguay (Gran Chaco). In Argentina, and especially in Patagonia, the aridity is determined by general meteorological conditions, and mainly by the location of the whole zone on the lee of the mountain chain.

"Drought polygon" in north-eastern Brazil. In this case the harmful factor is not the relatively low average rainfall but its great irregularity. In dry years the volume of rainfall is often as little as one third of the average, itself very low. There is disagreement among the various suggestions advanced to explain the existence of this arid zone and the irregularity with which extreme drought occurs in certain years.

There are other isolated and smaller areas on the southern shore of the Caribbean, in Venezuela, Puerto Rico and various parts of Mexico (the north-east coast of Yucatan, the state of Oaxaca in the isthmus of Tehuantepec and the middle reach of the river Baba-Mexcala). Other smaller dry areas, too small to be shown on the map, occur in some mountain valleys, especially in the inter-Andean part of Ecuador.

2. Main Basins in Latin America

A thorough and detailed account of the main Latin American basins would unquestionably do much to provide a useful frame of reference for the analysis of the region's hydroelectric potential. All that space would permit here, however, would be a review so succinct as to resemble a lesson in elementary hydrography. Bearing in mind that this subject must receive the full treatment it deserves in the final report on the water resources of Latin America, suffice it at this stage to give, reviewing the region from north to south, some particulars of the possibilities offered by its main rivers for hydroelectricity and navigation. A map of the main basins is also appended. 2/

In Mexico the main rivers - the Bravo or Grande del Norte, Panuco, Tecolutla, Papaloapan, Grijalva and Usumacinta - flow into the Atlantic and some, especially the last two, which enter the Gulf together, are navigable. However, the rivers which flow into the Pacific - the San Pedro, Colorado, Lerma, Santiago, Balsas and Suchiate - have the greater hydroelectric potential, despite their smaller flow.

2/ At the time of circulation of this report a special map of the main basins in Latin America is with the printer and will, it is hoped, be distributed during the Commission's eighth session.

The country's "technical potential"3/ for a water flow of 95 per cent duration is estimated at between 7 and 10 million kW. (See table 1).

In Central America the river basins are comparatively small; rivers entering the Atlantic carry the greater and more regular flow, while those which enter the Pacific are swift-flowing and short. Table 2 shows the main rivers of this area; among these, mention should be made of the navigable river Dulce in Guatemala, which rises in Lake Izabal. The rivers Suchiate, Michotoga and Paz, coupled with the natural reservoirs of Lakes Amatitlán and Atitlán, are a potential source of hydroelectric wealth.4/ The river Lempa in El Salvador, which is also navigable by small vessels, is endowed with power resources. The hydroelectric potential of Honduras, which is thought to be plentiful, has received little study so far. Along the frontier between Nicaragua and Costa Rica runs the river San Juan, which has been considered as the possible route of an inter-oceanic canal. The hydroelectric resources of Costa Rica have been estimated at 1.5 million kW.5/

3/ The fraction of the latent gross potential technically available for use at a given moment. An estimate of a basin's potential is by its very nature highly approximate. Flows of 95 per cent are used in almost all calculations. The development of water regulation works makes it possible to harness the flow of water more efficiently, and consequently to increase the potential. Furthermore, from the purely technical standpoint, a proportion of the resources in question is bound to be needed for irrigation, domestic uses, industrial uses, etc., with a possible reduction in potential.

4/ See Eugenio Salazar, El desarrollo eléctrico en Centroamérica, (Electricity development in Central America) (TAA/LAT/9), (Spanish only), 1957.

5/ Ibid.

/Table 1

Table 1

MEXICO: TECHNICAL POTENTIAL OF MAIN BASINS a/

Hydrographic Area	Energy in mW a/
North Pacific	3,360
San Pedro - Mezquital	580
Lerma-Santiago	1,600
River Balsas	200
North Gulf	
River Bravo, Mexico	160
River Pánuco	230
Gulf of Mexico	
North of Veracruz	1,500
Papaloapán, Tabasco and Campeche	1,500

Source: A. García Quintero, "Hydroelectric Potentiality of Mexico," AIEE Proceedings, Vol. 67, 1948.

a/ In the original the figures are given in h.p.; they were rounded off in converting to mW.

/Table 2

Table 2

CENTRAL AMERICA: PRINCIPAL RIVERS

Entering the Atlantic	Entering the Pacific
Motagua	Suchiate
Dulce	Nichatoya
Usumacinta	Paz
Ulúa (360 km)	Lempa (300 km)
Aguán	Grande de San Miguel
Patuca	Goascorán
Segovia (720 km)	Nacaome
Metagalpa (320 km)	Choluteca
San Juan (160 km)	Tempisque
Parismina	Guacimal
Coclé del Norte	Grande
Chagrés (150 km)	Negro
	Tuira (140 km)
	Chuchunaque
	Chiriquí

In Panama navigation through the Canal, which exceeds 30 million tons a year, provides the country with an important outlet for the sale of goods and services to passengers in transit and to United States personnel in the Zone.

In the Caribbean, the largely mountainous terrain and the tropical climate,

/with its

with its abundant rainfall, give rise to many rivers with small drainage basins. In Cuba the rivers Canto and Sagua la Grande, and in Haiti and the Dominican Republic the rivers Yaque del Norte and Yaque del Sur, are navigable by small vessels. The hydroelectric possibilities of the three countries are largely unexplored but appear, generally speaking, to be inferior to those of the continental Latin American countries.

In South America, considered as a whole, it is necessary first of all to draw a radical distinction between the rivers which flow westward and those flowing to the east and north. The Andes are so close to the Pacific Ocean that the westward-flowing rivers are relatively short and their basins small. In contrast, those which flow into the Caribbean and Atlantic are long and drain broad basins, have as a rule a very low average gradient and are generally suitable for navigation.

In the northern watershed mention should be made of two large basins: that of the Magdalena and that of the Orinoco. In the former, the river Magdalena is joined by the Cauca some 300 kilometres before the delta formed at the mouth, near Barranquilla. Even allowing for the interruption of the Honda Falls, the Magdalena and its tributaries offer over 1,000 kilometres of navigable waterways. Hydroelectric schemes under construction or consideration plus those already in operation will provide a total of approximately 2.62 million kW in the valley of the Cauca and 1.63 million kW in that of the Magdalena. 6/ A vast combined irrigation and power scheme has been launched in the upper part of the former.

6/ The figure given for the Cauca includes what is known as the Cauca Daque scheme, which is to yield 1 million kW and which involves diverting a certain volume of water from the Cauca Valley flow into the Daque, a river flowing into the Pacific. The figure given for the Magdalena Valley is an estimate base on the National Electrification Plan of Colombia, November 1954.

The terrain of the Orinoco basin is very uneven in its upper reaches and largely unexplored. It features the unique case of the Casiquiare, along which, at certain seasons, part of its water flows into the river Negro, a tributary of the Amazon. The river is navigable for some 1,600 kilometres of the lower part of its course. The same applies to its main tributaries, which include the Meta - which forms part of the frontier between Colombia and Venezuela - and can take fair-sized vessels. Little is known about the basin's hydroelectric potential. Systematic prospecting may yield figures higher than those estimated a few years ago. One indication of this may be the fact that the Caroni, one of the main tributaries, is thought to have in its lower reaches 7/ a gross potential of 8 million kW. Schemes under construction or consideration for the aforementioned National Electrification Plan represent a capacity of some 1.7 million kW in Colombian territory.

The eastern watershed includes many important basins. That of the Amazon, which covers an area almost half the size of Europe, drains into the Marañon-Solimoes-Amazon system, the greatest hydrographic basin in the world. The Marañon follows a course approximately 2,400 kilometres long in Peru before entering Brazilian territory, through which it flows for a total distance of 3,200 kilometres. The mean flow at the mouth is estimated at 100,000 cubic metres a second (200,000 cu.m/sec. at the peak), and it is calculated that the river carries down over 1,000 million cubic metres of sediment a year.

7/ See José Olalquiaga (Corporación Venezolana de Fomento), Algunos antecedentes para la programación del sector energía.

From Tabatinga, the first Brazilian port (on the frontier with Peru and Colombia), to the mouth, the average gradient barely exceeds 2 centimetres per kilometre. Into the mouth flows the Tocantins, 2,600 kilometres in length. The river is navigable by large vessels up to Manaus and by smaller vessels up to the Peruvian port of Iquitos (3,700 kilometres). Its tributaries are also navigable in Colombia and Bolivia.

The hydroelectric potential of the basin is not fully known and is for the most part a long way from the main centres of consumption. The Amazon-Tocantins system is estimated to offer a potential of approximately 4.6 million kW in Brazilian territory. In Colombia, taking both schemes under construction and schemes under consideration, the same system represents only 700,000 kW, for the plains are largely unexplored and the resources available for immediate use are far distant from the centres of consumption. In Ecuador, too, little is known about the hydroelectric potential of the Amazon basin, and most of it lies far from the main urban centres. It has been estimated, however, that three tributaries - the Napo, Pastaza and Santiago - have a firm potential of 280,000 kW which can be harnessed relatively easily. In Peru the Atlantic watershed is thought to have a hydroelectric potential of 4 million kW. 8/ In Bolivia, there has been

8/ The figures for Brazil have been calculated from a report by the Comissao Mista Brasil-Estados Unidos para Desenvolvimento Economico, entitled: Relatorio sobre energia elétrica do Brasil; those for Colombia have been estimated by ECLA from the National Electrification Plan already mentioned. Those for Ecuador were supplied by Mr. John Ritterhausen, an expert of the United Nations Technical Assistance Administration, while those for Peru are drawn from the Switzerland Peru Economic Advisory Council publication, L'industrie électrique au Pérou, November 1956.

/no systematic

no systematic study of this potential and the existing overall estimates indicate that a large proportion of the available resources stem from the Amazon basin.

The River Plate system, bounded by the Andes, the Matto Grosso plateau, the Brazilian plateau and the mountain ranges of the Atlantic Coast, is one of the most extensive in the world. It is formed mainly by the rivers Paraná, Paraguay and Uruguay, which rise in Brazil. The Paraná flows swiftly as far as Encarnación. Lower down it flows through level country and is navigable. It joins the river Paraguay near Corrientes. Below the confluence, the mean rate of flow is 16,000 cu.m/sec. In Argentine territory the river is navigable by vessels of 10,000 tons up to Paraná and Santa Fé (59 kilometres) and by smaller vessels up to Iguazú (1,900 kilometres).

The river Paraguay crosses Paraguay from north to south, over a course about 800 kilometres long, and is navigable above Concepción by small vessels. Before it joins the Paraná it attains a mean flow of approximately 4,000 cu.m/sec. Through this river and its tributaries, Bolivia too forms part of the River Plate system.

The river Uruguay, which partially divides Argentina from Brazil and Uruguay, is navigable as far as Concordia (530 kilometres), where navigation is interrupted by various falls, to be resumed at Monte Caseros. The mean flow in the lower reaches of the river is 5,000 cu.m/sec.

The estuary known as the River Plate is 270 kilometres long and covers an area of 35,000 sq.km, with an average width of 130 kilometres

/at the

at the mouth. The mean flow is calculated at 35,000 cu.m/sec. The water carries down a great deal of sediment.

The hydroelectric resources of this basin are thought to be of the order of 14 million kW, distributed as follows:

Brazil: in the basin of the river Paraguay, 0.07 million kW; in that of the river Parana, 7.1 million kW; and in that of the Uruguay, 0.69 million kW.

Argentina: in the basin of the river Parana, 2.85 million kW; and in that of the river Uruguay, 0.75 million kW.

Paraguay: in the basin of the rivers Paraguay and Parana, 2.1 million kW.

Uruguay: in the river Uruguay and its tributaries, 1 million kW.

Other important basins in the eastern watershed are:

The river Parmaiba in Brazil. Navigable stretches total over 600 kilometres. Despite the rapids, which make navigation difficult, its hydroelectric potential is small.

The river San Francisco, also in Brazil, with a mean flow of 3,000 cu.m/sec. at the mouth. It affords a long navigable waterway despite the Paulo Alfonso Falls. Its hydroelectric potential is calculated at 1.4 million kW. 9/

9/ ECLA's calculations respecting the Brazilian part of these rivers are based on the source cited in the previous note. The remainder were supplied directly by the Working Group on water resources, except those for Paraguay, which are drawn from "Developed and potential waterpower in the United States and other countries of the world", Geological Survey Circular 329, December 1952, of the United States Department of the Interior.

/The drainage

The drainage basin of Lakes Los Patos and Mirim, which are joined by the Sao Gonzalo canal. The main river is the Jacuí, which is navigable for 200 kilometres. Porto Alegre and Pelotas are active river ports. The prospects for hydroelectricity do not seem very favourable. Capacity installed and planned totals approximately 170,000 kw.10/ The river Negro (Argentina), formed by the Nequén and the Limay. The mean flow at the north is of the order of 1,000 cu.m/sec. Its hydroelectric potential is estimated at 3 million kw.

Owing to the proximity of the Andes to the Pacific Ocean, the rivers of western watershed possess, generally speaking, the characteristics already indicated: shortness, smallness of drainage basin and flow, and steep average gradients. Consequently they are ill-suited to navigation but rich in hydroelectric resources. Here follows a description, country by country, of those which are most important for either purpose.

Colombia is traversed by the Atrato, the San Juan, which is navigable for over 200 kilometres as far as Istmina, and the Patia, 450 kilometres long, one-third of which is navigable. The hydroelectric potential of the Colima is estimated at some 0.4 million kw.

In Ecuador we may mention the Mira, with a potential of 0.15 million kw; the Esmeralda, with 0.16 million kw and a navigable

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10/ Calculated from data of the: Plano Nacional de Electrificaçao e Centrais Elétricas Brasileiras, S.A. (1954).

/waterway of

waterway of 80 kilometres; the Guayas (estuary of the rivers Babahoye, Daule and Vinces), 600 kilometres of which are navigable and which has a potential of 0.12 million kw; and the river Jubones with 0.1 million kw.

In Peru the most important rivers are the Tumbes, Piura, Santa - with a hydroelectric potential of 1 million kw - the Rimac, Pisco and Rio Grande. The country's watershed as a whole is estimated to possess a potential of approximately 4 million kw. 11/

In Chile's case the characteristics of the principal rivers - the Loa, Elqui, Aconcagua, Maipe, Rapel, Maule, Itata, Bío-Bío, Palena, etc. - have been examined in detail elsewhere and it would seem pointless to dwell on the subject here. 12/

Lastly, mention should be made of the basin of Lake Titicaca, one of the highest lakes in the world (3,850 metres above sea level) and the largest in South America. It forms the navigable waterway between Peru and Bolivia and is fed from a drainage basin 57,000 square kilometres in area. It is linked to Lake Poopó by the river Desaguadero, and the basin feeding the system covers a total area of 110,000 square kilometres. Its geographical position affords Lake

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11/ For the sources of data for the different countries mentioned, see these listed in footnote 8. With reference to the figure given for the river Santa, Cf. Santiago Antúnez de Mayolo, Plan de Instalaciones hidroeléctricas de la Corporación Peruana del Santa, a paper presented to the First Pan American Engineering Congress, Rio de Janeiro, 1949.

12/ See Los recursos hidráulicos de Chile y su aprovechamiento (E/CN.12/501/Add.1).

Titicaca vast possibilities for irrigation and power. If its waters were led into the Pacific its potential, it is estimated, would be 2 million KW

To recapitulate the preceding summary description, table 3 lists the most important basins, i.e. those covering over 100,000 square kilometres. It should be noted that, quantitatively speaking, the waters of the international basins[13/] are far more significant than those of the purely national basins. To take only Argentina, it is calculated that they represent 76.5 per cent of the country's total water resources,[14/] though other estimates put this proportion at 87.1 per cent. There is no doubt that the Amazon, River Plate and Orinoco river systems, those of the rivers of Mexico and the United States, and Lakes Titicaca and Guija constitute Latin America's most important water resources.[15/]

13/ The expression "international waters" alludes to the physical fact that the river or lake in question is on the boundary between two or more countries, or else rises in one country, crosses the frontier and traverses another, leaving aside the legal implications.

14/ Carlos A. Volpi, Aprovechamientos hidroeléctricos internacionales, pp. 11 - 13.

15/ A list of international basins, showing the countries interested in each, appears in table 1 of the study prepared by Guillermo J. Cano, Preliminary Review of Questions Relating to the Development of International River Basins in Latin America (E/CN.12/511).

Table 3

Name	Length	Area of basin (Thousands or sq.km)	Mean flow (Cu.m/sec.)
Bravo or Grande del Norte a/	1,400	251	-
Lerma-Santiago	-	130	280
Balsas	-	110	280
Grijalva-Usumacinta	-	190	3,000
Magdalena	1,500	260	8,000
Orinoco	2,900	960	14,000
Amazon-Ucayali	6,000	5,000	100,000
Tocantins	2,600	980	-
Paranaiba	850	200	-
San Francisco	3,100	610	3,000
River Plate system	4,000	3,100	35,000
River Negro-Limay	1,050	125	1,000
Lake Los Patos-Mirim basin	-	200,000	-
Lake Titicaca-Poopó basin	-	110,000	-

Note: The Essequibo and Maroni river basins have not been included because they lie entirely in the territory of the Guianas: British, Dutch and French.

a/ Only the portion under Mexican jurisdiction.

III. LEGAL AND ADMINISTRATIVE ASPECTS OF THE DEVELOPMENT OF WATER RESOURCES.

1. SURVEY OF THE LEGAL POSITION

The legislation of the Indies was applied in almost all Latin American countries (the exception being Brazil) until the end of the eighteenth century. A transition period followed, after which many of those countries adopted their own civil codes in the second half of the nineteenth century. At that time the only economically important uses of water, apart from human consumption, were navigation and irrigation, and it was to these that the laws were at first confined. Problems relating to the utilization of rivers and lakes were at that time of a legal rather than a political character, particularly in the case of rivers which extended beyond the territory of a single country. Hence even the Constitution in force in some of those countries in the mid-nineteenth century made reference to them with a view to guaranteeing free navigation by vessels of all nations.

During that same period irrigation was practised in several countries but in almost all cases it was introduced by private initiative and effort. (Official action began to be taken only at the turn of the century.) Hence civil codes were concerned exclusively with the question of determining the ownership of waters, the way in which private persons could acquire the right to use them, and, more particularly, the establishment of the servitudes (aqueducts, etc.) required to enable private persons to use water on land belonging to others.

/The last

not conform to any fundamental principle or clearly defined policy but were improvised as the need arose. Hence Latin American water use legislation as a whole is often confusing and contradictory, particularly in those countries which have not codified their water laws.

The most important of the infinitely varied legal aspects of the development of water resources are: (a) systems of water rights, particularly in arid and semi-arid zones; (b) the problem of pollution, which is becoming increasingly serious in industrialized areas.

(a) Riparian rights

The system which recognizes the right of owners of property situated on the banks of rivers to use the waters of such rivers propio jure, without having to obtain a concession or authorization, originated in humid European countries. In such countries that right was subjected only to the provision that navigation and the supply of water to towns must not be interfered with.

In Latin America the right of riparian property owners was first recognized in Chile and in the countries which adopted the Chilean Civil Code either in its entirety (Ecuador) or in part (Colombia, Honduras, Nicaragua, Uruguay), as also in other preponderantly humid Latin American countries whose legislation was not based on that of Chile.

Argentina, Mexico, Paraguay, Peru and Chile (from 1951 onwards) entirely excluded from their legislation the system of riparian rights.

The situation may be summarized as follows:

(i) Navigable rivers: In the following countries their waters are public property and permission must be obtained for their use: Argentina, Chile, Brazil, Paraguay, Uruguay and Venezuela, as also

French Guiana and Surinam. In Colombia, Ecuador and Peru, riparian property owners may use such waters but the surplus not used by them may be assigned by the Government to others.

(ii) Non-navigable rivers: In Argentina, Chile, Mexico, Paraguay and Peru their waters are public property and permission must be obtained for their use. In Bolivia, Brazil, the Guianas, Uruguay and Venezuela, such waters belong to riparian property owners, who may use them without obtaining permission. In Colombia and Ecuador riparian property owners have the first option on their use and the surplus may be assigned by the Government to others.

This system gives rise to the following important consequences:

(i) Where no authorization is required, the right to use water is not registered anywhere nor is water consumption measured, with the result that the Government lacks the essential information needed to plan improved and more extensive use of water resources;

(ii) Plans for captation and conduction facilities likewise are not registered and require no prior official authorization; hence the Governments not only lack the requisite information but are also unable to enforce compliance with certain technical standards established for the purpose of improving water utilization.

In countries where the climate obviates the necessity for irrigation, riparian rights do not give rise to such serious problems, although increased industrial utilization of water may well provoke them in the future. In countries where irrigation is essential for agriculture, or simply beneficial to it, riparian rights are enormously prejudicial to the development of water resources.

/(b) Pollution

(b) Pollution

In Latin America the problem of water pollution has not yet assumed the proportions that it has in other countries of the same continent or of Europe. This very circumstance makes it urgent that Latin American legislation should take account of the problem. The enactment of regulations concerning pollution in the initial stages of industrial development will make it possible to prevent pollution at little or no cost or to keep it to a minimum. To try to combat it once it exists, on the other hand, is often so expensive as to be prohibitive. Few countries of the ECLA region have given the matter comprehensive or systematic consideration. Some have established by law the obligation of users to prevent pollution of the waters they use but many overlook the fact that non-users may also cause pollution (e. g., riparian industries). There are also special laws relating to pollution caused by the use of water for certain purposes (e. g., fish). There is, however, no legislation embracing the problem as a whole.

2. Survey of administrative machinery

In the past three decades studies have been made, and in some cases experiments conducted, to determine the desirability of co-ordinating the various uses of water resources and enacting legislation to prevent such uses from producing harmful effects. So far, however, there have been few cases in which such co-ordination has actually been practised.

(a) Co-ordination in harnessing different natural resources

Generally speaking, the Latin American countries have not

organized their public administration structures in such a way as to permit a co-ordinated utilization of all natural resources. An exception may be noted in the case of Honduras, which has a Ministry of Natural Resources divided into departments responsible for different aspects of the utilization of natural resources.

(b) Planning and co-ordinated management of the various uses of water resources

In many countries the administrative bodies concerned are almost entirely inactive and have no established method of operation.

Several countries (Brazil, Chile, Peru) have good programmes but they are limited to one particular use and make no systematic provision for other uses of water.

Mexico is a notable exception, for it has adopted a model system of organization for the utilization of its water resources. A Secretariat of State (Ministry) was established in 1947 for this sole purpose and it is in charge of practically all forms of water utilization and the problems to which they give rise. This unified and co-ordinated organization has made a satisfactory contribution to the development of the country's water resources.

(c) Water administration basin by basin

A greater number of experiments have been made in integrated development by river basins or by valley, since these are physical units in which the utilization of all the natural resources present can easily be coordinated. 16/

16/ See Integrated River Basin Development (E/3066).

/Because of

Because of the importance of this subject an informative document has been prepared giving the background of the main bodies established throughout the world for the development of river basins (including those set up in Latin America).[17] Those operating in Latin America are listed below, by country.[18]

ARGENTINA

** Comisión Nacional del Río Bermejo

** Comisión Interprovincial del Río Colorado

** Organización Interprovincial del Agua del Noroeste-Argentino (OIANA)

Comisión Interprovincial del Agua Catamarca-Santiago del Estero (CIACSE)

BRAZIL

Comissão do Vale de Sab Francisco

Departamento Nacional de Obras contra as Sécas (DNOCS)

Superintendencia de Plano de Valorização Economica de Amazonia (SPVEA)

COLOMBIA

Corporación Autónoma Regional del Valle del Cauca (CVC)

EL SALVADOR

Comisión Ejecutiva Hidroeléctrica del Lempa (CEL)

17/ Systems of Administrative Organization for the Integrated Development of River Basins (E/CN. 12/503).

18/ See document E/CN.12/503 for the laws establishing the bodies whose titles are underlined, the purposes of each and a reference to the way in which they are organized. Those marked with a double asterisk are engaged solely in study and programming rather than construction or administration.

/MEXICO

MEXICO

Comisión Ejecutiva del Papaloapan

Comisión Ejecutiva del Tepalcatepec

Comisión Ejecutiva del Río Fuerte

Comisión Ejecutiva del Grijalva

** Comisión de Estudios Hidrológicos del Valle de México

Comisión de Estudios del Sistema Lerma-Chapala-Santiago

PERU

Corporación Peruana del Santa

3. International waters 19/

Many treaties make reference to international waters but only for the purpose of designationg them as political boundaries or of establishing recognition by the Parties concerned of the reciprocal right of navigation in such waters. The only treaties or conventions which are relevant to the purposes of this document are those whose provisions are designed to promote the development of water resources.

So far there are only twenty-two such instruments, signed by only twelve countries and referring to eight basins. (See table 4.) This does not appear to be commensurate either with the quantitative importance of the international water resources of Latin America or with the potential economic value of their exploitation.

19/ For further details see document E/CN. 12/503.

/Table 4

Table 4

TREATIES AND OTHER AGREEMENTS CALLING FOR STUDIES OR WORK RELATED TO THE DEVELOPMENT OF INTERNATIONAL LATIN AMERICAN RIVER BASINS

Signatory countries	Date	General subject	Matters mentioned					
			Irrigation	Industrial electricity	Fishing	International organizations	Inundations	Specified work
Argentina-Bolivia-Paraguay	10. II.1941 [a/]	River Pilcomayo	x	x	x	x		
Argentina-Paraguay	1. II.1926	Apipé Rapids		x				
Paraguay	10. II.1941	Dredging of River Paraguay						x
Paraguay	1. VI.1946	Limits						x
Argentina-Uruguay	30.XII.1946	River Uruguay (Salto Grande)		x	x	x		x
Bolivia-Peru	17.VII.1935	Lake Titicaca			x			
Bolivia-Peru	30.VII.1955	Lake Titicaca				x		
Bolivia-Peru	19. II.1957	Lake Titicaca	x		x			
Brazil-Paraguay	14. VI.1941	Nav. on River Paraguay				x		x
Brazil-Paraguay	20. I.1956	Rivers Acaray and Monday						x
Brazil-Peru	29. XI.1957	Amazon Basin						x
Brazil-Uruguay	20.XII.1933	General régime of frontier rivers						x
Brazil-United Kingdom	27.III.1932	Limits and régime of rivers Mahú and Tacutú	x	x	x			
Chile-Peru	3. VI.1929	Partition of Tacna and Arica	x					
El Salvador-Guatemala	15. IV.1957	Lake Guija	x	x		x		
Mexico-U.S.A.	2. II.1848	Guadalupe-Hidalgo Treaty						
Mexico-U.S.A.	12. VI.1884	Limits of Rio Grande and River Colorado						
Mexico-U.S.A.	1.III.1889	Limits and creation of international trade					x	
Mexico-U.S.A.	20.III.1905	Removal of banks on Rio Grande						
Mexico-U.S.A.	21. V.1906	Irrig. through Rio Grande	x					
Mexico-U.S.A.	1. II.1933	Rectification of Rio Grande (Brair)	x				x	
Mexico-U.S.A.	14.XII.1944	Rivers Colorado and Tijuana and Rio						

IV. BRIEF ANALYSIS OF THE MAIN USES OF WATER [1]

1. Drinking water

With the exception of a few cases in the arid zones, there is generally no difficulty in obtaining the necessary volume of water for the needs of the population, for compared with the amounts required for other uses, these needs are relatively small. The principal restraining factor is usually lack of the necessary capital to cover the cost of catchment work and the treatment and distribution of the water.

As a result of this one obstacle, despite the considerable efforts made in Latin America, the problem has been barely half solved. It is estimated that only some 50 per cent of the urban inhabitants are supplied with drinking water and that this percentage is much lower in the rural zones. Probably some 120 million of the 173 million inhabitants of Latin America have no drinking water supply. Moreover, even if only the population which has such a service is considered, there is a vast difference between the larger towns, where water is used in abundance and even wastefully, and small communities where the installations are not such as to ensure a continuous supply, adequate pressure or a satisfactory quality. Even in some of the large cities the installations are so old and defective that they require renewal and extension, a process which is constantly being postponed for lack of funds.

[1] This analysis refers only to the independent uses of water, the supply of drinking water, irrigation, hydroelectricity and navigation. The original intention was to give a brief account of the multiple use of water in Latin America, as encountered, for example, in Brazil, Chile, Mexico, etc., but it was impossible to obtain sufficient data for a proper description of the most important aspects of this form of use.

/As a result,

As a result, the health situation in Latin America, so far as diseases connected with water are concerned, leaves much to be desired. In some countries, the deaths attributable to dysentery and typhoid fever are more than twice as high as in countries which possess good services and supplies.

The drinking water services are generally dependent on some Ministry, such as the Ministry of Health, or of Public Works (Chile), which often makes them slow or inefficient. Better results have been obtained by semi-autonomous bodies set up for that specific purpose, such as the Instituto Nacional de Obras Sanitarias (INOS) in Venezuela, or in order to deal with regional problems (Juntas de Reconstrucción) or with problems pertaining to river basins (River San Francisco in Brazil).

Finally, in many countries the services come under the municipalities, the results varying greatly according to the capacity and particular characteristics of each such authority.

The comparative figures, viewed in the proper international perspective, show that there is considerable room for improvement and a need for speeding the process of expansion and for raising the technical level. The Pan-American Sanitary Bureau, for one, has undertaken to begin a programme under which all the urban communities of the Western Hemisphere will have a supply of drinking water within the next ten years; it has accordingly started negotiations with the Governments of the countries concerned and with the Unites States International Co-operation Administration, which has also done commendable work in Latin America.

/The irrigation

2. Irrigation

The irrigated area in Latin America can be estimated at some 7 million hectares, which represents approximately 11 per cent of the total cultivated area. Irrigation has developed principally in the vast arid and semi-arid regions of Mexico, on the Peruvian coast, in the north and centre of Chile and in the north-east and south of Argentina, where it is indispensable for a stable and commercially profitable agriculture.

Table 5 shows in detail the irrigated areas in the different countries. It was prepared some years ago under the Joint ECLA/FAO Programme and has been brought up to date, so far as possible, in the light of recent information obtained by correspondence.

When the table was prepared, it was stated that the advisability and desirability of irrigation always had to be carefully weighed against other possibilities of agricultural improvement (such as popularization, fertilization, pest control, genetics, etc.), which require less capital and can therefore benefit greater areas already under cultivation. This consideration remains valid, since agricultural methods have not progressed much and can be considerably improved.

/Table 5

LATIN AMERICA: IRRIGATED AREA

	Thousands of hectares	Percentage of cultivated area a/
1. Mexico	2,510 a/	3.7
2. Guatemala	10	1.0
3. El Salvador	3	0.4
4. Honduras	20	5.3
5. Nicaragua	2	0.4
6. Costa Rica	13	3.0
7. Panama	8	4.6
8. Cuba	60	3.7
9. Haiti	40	9.5
10. Dominican Republic	85	19.8
11. Venezuela	116 b/	14.2
12. Colombia	250 b/	8.0 b/
13. Ecuador	110 b/	11.2
14. Bolivia	12	3.5
15. Peru	1,200	80.0
16. Chile	1,360 b/	
17. Brazil	126	...
18. Paraguay	12	3.6
19. Uruguay	70	4.7
20. Argentina	1,100 b/	4.1
	7,107	11.0

Source: The Needs of Agriculture in Latin America. United Nations Publication E/CN.12/83/Rev.1.

a/ Includes all land under annual or permanent cultivation, whether used for agriculture or grazing.

b/ These figures have been revised in the light of recent information. The others reflect the 1948 position. Guatemala, El Salvador, Honduras Nicaragua, Costa Rica, Panama and Cuba have no current projects and have probably not increased their irrigated areas since that time. Haiti, the Dominican Republic, Bolivia, Peru, Paraguay and Uruguay have begun or are due to begin projects affecting 232.000 hectares.

/nevertheless artifical

Nevertheless artificial irrigation is still perhaps the best agricultural expedient, when the necessary capital is available, for it increases the yield to a great extent - sometimes as much as ten-fold, as in the case of wheat in central Chile - or improves almost useless land so that it can be used for production of great local importance. The average production per irrigated hectare in the semi-arid zone of Argentina is fifteen to twenty times greater than in the pampas region, which is the best in the country. Outstanding results in irrigation have been obtained by Mexico - 2.5 million hectares, or a third of the cultivated area - where such work is constantly strengthening the basis of the country's economy.

Even considering only its most promising projects, Argentina will be able in the future to supply water to a further area as great as the one already irrigated if it continues its current methods. With better management of its water resources, the possibilities would be considerably greater. According to the preliminary estimates of the Ministry of Agriculture, Chile has some 3.5 million hectares of good irrigable soil, or almost 2 million more than the area already irrigated. Peru, too, possesses large water reserves in its mountains ranges, which could be used to irrigate more than 2 million arid hectares on the coast. Brazil is faced with serious problems of water shortage in its "drought polygon" in the north-east. The dry season in Venezuela brings agricultural activity virtually to a halt; with the help of irrigation, however, production during this period could make a useful addition to the harvest of the rainy season and the Government is accordingly pursuing its programme of dam construction. With proper irrigation, Colombia

/can not

can not only improve much of its tropical agriculture but also reclaim large areas, amounting to more than half a million hectares, through drainage. Finally, many of the somewhat humid tropical countries are finding new possibilities through the use of supplementary irrigation during the months of drought.

In some countries, the extension of irrigation is hindered by the difficulties inherent in the system of water rights referred to above.

3. Hydroelectricity

Practically all the Latin American countries have a great hydroelectric potential, but its accessibility and the ease with which it can be developed vary considerably from one country to another.

The knowledge of this potential is generally rudimentary. This is shown by the fact that an estimate prepared in 1954 set the total at a little over 62 million kW, while today, with more information available on certain countries and basins, the figure can be placed almost twice as high (see table 6).

This estimate refers to the permanent power which can be derived in the near future from technically accessible sources without any major regulation of the flow; it does not include all the latent potential of the great masses of water which flow only in periods of abundance or projects which would be excessively costly. Technical progress and a better knowledge of the possibilities of containing and regulating the flow may also affect these estimates of hydraulic potential.

This potential is found principally in the Andes range and in the mountain massif which forms its continuation northward through Central America and Mexico. There is also a substantial hydroelectric potential in the plateaux of Brazil where it could benefit the densely populated coastal zone. The plateaux of the

/Guianas afford

Guianas afford Venezuela a considerable potential, the evaluation of which has only recently begun. In the great plains of the Orinoco, the Amazon and the River Plate there are vast volumes of water which, with small changes of level could produce much energy; their utilization, however, is extemely difficult if not economically impossible.

The potential utilized hitherto is somewhat small, amounting to a more 5.3 per cent for Latin America as a whole. This figure shows the great wealth of the resources rather than a lack of interest in their development, since the work already done represents a considerable effort and 6,350,000 kW installed constitute almost half the total electric capacity. Brazil, Mexico and Uruguay have the highest rate of utilization of their hydraulic potential and a high percentage of hydroelectric power in their total installed capacity. The first-named of these countries had achieved the most outstanding results, having had to compensate for a lack of fuel. The same reason applied in Uruguay. Mexico has had plenty of oil but has simultaneously explited its water resources for multiple purposes.

Table 6

LATIN AMERICA: TOTAL HYDROELECTIC POTENTIAL AND PERCENTAGE UTILIZED

(To end of 1957)

Country	Total estimated potential	Installed hydro-electric capacity	Percentage utilized	Percentage of hydroelectric cpacity in total installed capacity
	(Thousands of kW)			
1. Argentina	11,000	440	4.0	1.7
2. Bolivia	7,000	96	1.4	72.2
3. Brazil	16,500	3,100	18.8	61.6
4. Colombia	40,000	350	0.9	52.5
5. Cuba	...	3	...	0.4
6. Chile	10,000	521	5.2	51.8
7. Ecuador	2,000	35	1.8	44.9
8. Haiti	...	—	—	—
9 Mexico	7,400	1,118	15.1	49.3
10. Paraguay	3,150	—	—	—
11. Peru	5,800	360	0.6	69.9
12. Dominican Republic	...	—	—	—
13. Uruguay	1,000	128	12.8	38.0
14. Venezuela	11,000	48	0.04	4.6
15. Central America	5,200	150	0.3	43.7
Total	120,000	6,350	5.3	46.6

Source: Official data adjusted by ECLA. Energy in Latin America, United Nations Publication E/CN.12/384/ Rev. 1 and more recent direct information.

A second group of countries has scarcely drawn on its potential resources, because of a relative abundance of power, but has nevertheless utilized them sufficiently for the percentage of hydroelectricity in the total electric energy to be fairly high. This group includes Bolivia, Colombia, Chile, Ecuador, Peru and Central America.

Finally there are the countries which have not made any major use of their hydroelectric potential: Argentina, Venezuela, Paraguay and others. The first of these has not done so because, among other reasons, the potential is far removed from the principal centres of consumption and the volume of demand has not stimulated long-distance transport, a problem which is now being faced with resolve. Venezuela, with its resources also relatively remote, has relied on its great oil wealth, but has nevertheless established the basis for the exploitation of its hydroelectric power, beginning with a 300,000 kW plant in the River Caroni in the south-east of the country.

As can be seen, although the work already completed and that under construction is considerable, there is still much room for development. This can very well be brought about by expanding on the foundations already established, provided that there is progress in the evaluation and assessment of the hydroelectric potential. Such preparation is an absolute prerequisite of the work, which requires considerable capital and must therefore be based upon most accurate technical specifications.

/The principal

4. Navigation

The principal river basins of Latin America are of importance in the transport of cargo and passengers either because of the volume involved or because they provide the sole access to forest areas in which there are no other means of transport.

As has already been said, the rivers flowing to the west of the Andes, being relatively short and rapid, are only suitable for transport near the mouth. One exception is the River Guayas, for although navigable over only a short stretch compared to the great rivers of the area, it is important to the country in that it serves its best agricultural export zone. The uneven terrain and narrow width of Central America and the Caribbean countries are also not conducive to river navigation. On the other hand, the great basins to the east of the Andes provide very important river routes such as the River Plate system, the Amazon and the Orinoco, and other waterways of considerable importance such as the Rivers Magdalena in Colombia and San Francisco in Brazil.

/On the river

On the River Plate system, which traverses one of its richest regions, Argentina maintains a river traffic (excluding strictly estuarine traffic) of some 6 million tons per year; this figure, which refers only to the country's internal trade, could in the next ten years be increased by 50 per cent, through greater utilization and an extension of the zone of influence towards the north and north-east of the country. 20/ This system also provides the sole outlet to the ocean for Paraguay, which in 1950 used it to transport approximately half a million tons. Uruguay and Brazil also use this route, to a lesser extent, and even Bolivia participates with a small tonnage.

The Amazon provides access to the difficult forest area extending as far as Peru and Bolivia. The traffic on the Orinoco is gaining in importance because of the mining and industrial possibilities of the river's lower stretch. The Magdalena carries 95 per cent of all Colombian river traffic, which in 1954 rose to some 2 million tons and served such important economic centres as Bogota, Medellin and Bucaramanga. Finally, the general development currently taking place in the valley of the River San Francisco is also designed to increase navigation.

Despite its importance and possibilities, there has been some stagnation in navigation over these routes; the port facilities are inadequate, the ships are scarce and old and the maintenance of navigability on the waterways has been neglected.

20/ See The Economic Development of Argentina (E/CN.12/429/Add.3).

/In certain

In certain cases, such as on the River Plate system and on the Magdalena, this is due to the competitive service offered by other means of transport. In other cases, such as on the Amazon, demand has fallen as a result of the insufficient development of the areas served.