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Economic Commission for Latin America and the Caribbean

LATIN AMERICA AND THE CARIBBEAN: THE MANAGEMENT
OF WATER SCARCITY */

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CONTENTS

	<u>Page</u>
1. Introduction	1
2. Water Scarce Areas in Latin America and the Caribbean	1
3. Water Scarcity and Integrated Water Management	3
4. The Continuing Challenge of Water Scarcity to Water Management	7
5. Conclusions	10
Annex 1	16

1. Introduction

Latin America and the Caribbean is basically humid although the region contains large arid areas. The average precipitation is estimated to be 1,500 mm, over 50% above the world average, and the average annual runoff - some 370,000 m³/second - is almost one-third of the world total. On the whole, the region possesses abundant water resources. The distribution of precipitation is, however, very uneven across the region and there are some very arid areas. The seasonal distribution and the annual variations in precipitation are also irregular in a large part of the region leading to the occurrence of secular and seasonal droughts.

2. Water Scarce Areas in Latin America and the Caribbean

In total, approximately one-quarter of Latin America and the Caribbean can be classified as arid or semi-arid (Table 1). The causes of the areas of extensive aridity are either the widespread and persistent atmospheric subsidence which results from the general circulation of the atmosphere or localized subsidence induced by mountain barriers. The former is the cause in the three major subtropical areas of permanent drought. The latter is the reason for the extension of the arid diagonal of South America into Patagonia.

The major areas of permanent aridity are,

(i) The northwest and north central regions of Mexico (Figure 1),

(ii) The Gaujira Peninsula in Colombia and the Paraguana Peninsula in Venezuela on either side of Lake Maracaibo in the extreme north of South America (Figure 2),

(iii) The great arid diagonal of South America which contains the driest area on earth - the Atacama desert. It runs from the southwest coast of Ecuador, along the coast of Peru, through northern Chile and the altiplano of Bolivia to central southern Argentina (Figure 2).

Persistent atmospheric subsidence is also the reason for the long periods of secular drought in the states of Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe and Bahia in the northeast of Brazil.

Minor arid areas are found in the islands of the Caribbean, particularly Curaçao, the Dominican Republic and Nueva Esparta, Venezuela.

There are also two important semi-arid areas, the Gran Chaco which covers parts of Argentina, Bolivia and Paraguay and Patagonia in southern Argentina and Chile in the extreme south of South America. These two semi-arid areas have characteristics somewhat different from the four arid sub-regions. The Gran Chaco has important periods of major flooding, particularly from the Pilcamayo River, while Patagonia has much lower temperatures, and therefore less evapotranspiration, than the rest of the region.

As well as the areas subject to permanent or secular water shortage, large parts of the region are subject to seasonal and

FIGURE 1: ARID AND SEMIARID ZONES IN MEXICO

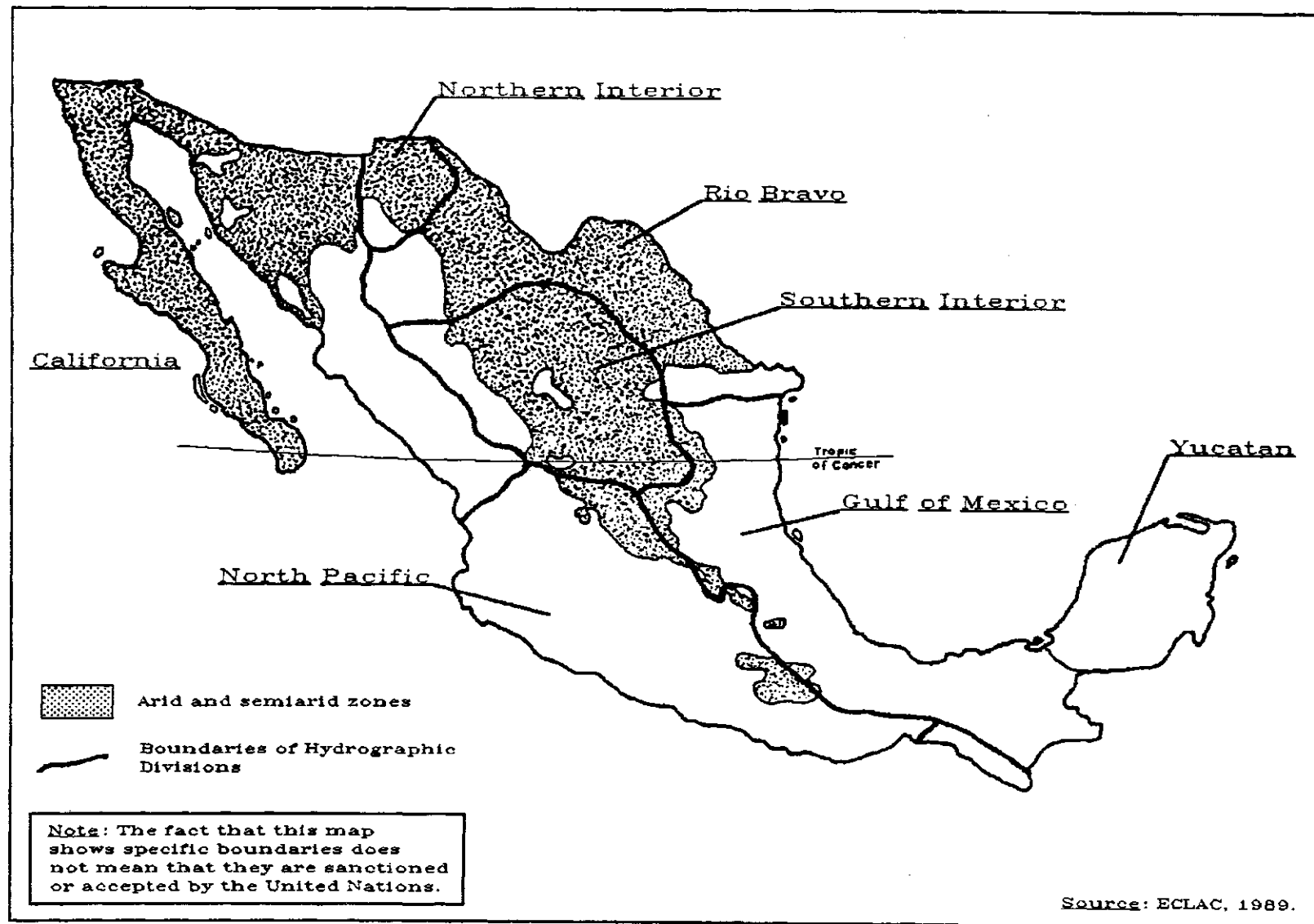
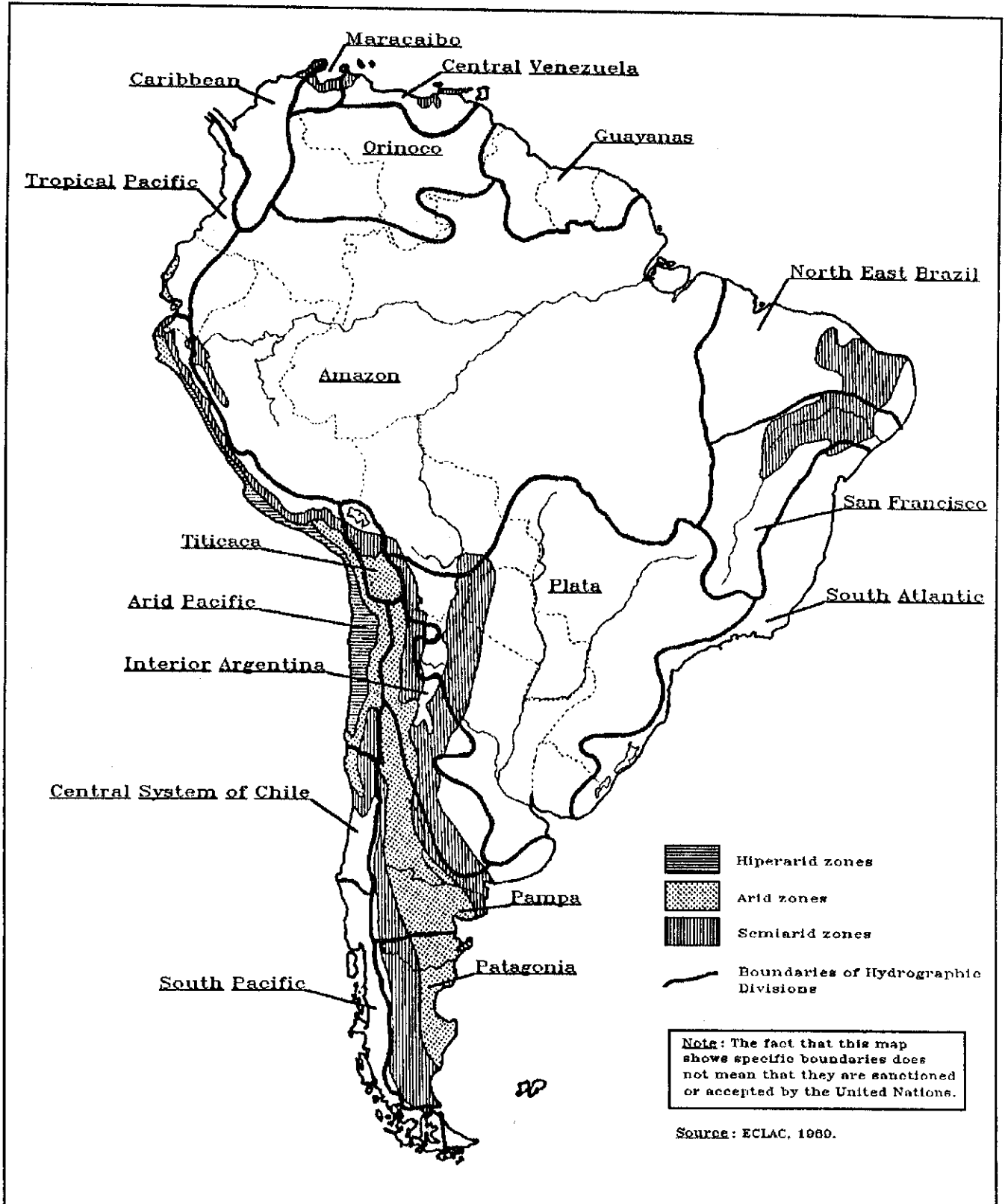


FIGURE 2: SOUTH AMERICA: ARID AND SEMIARID ZONES



contingent droughts. By definition, all areas subject to drought whether arid, semi-arid or suffering from seasonal or contingent drought are areas with negative water balances. Climatologically, this means that the evapotranspiration is superior to the precipitation. The resulting water deficits exhibit different degrees of water shortage which permit one type of water scarcity to be distinguished from another.

The more direct differences between the arid areas are related to whether the water deficit is permanent, secular, in which a sequence of drought years alternate with years of adequate rainfall, seasonal or contingent, an infrequent water shortage which may occur anywhere. In every case, water control and management is essential for economic and social development. Such management has permitted some 61 million of the regions population to inhabit within them and for significant development to have taken place in the water scarce areas of the region (Table 2). These areas are poorer, however, than the region as a whole with a per capita income approximately 80 percent of the regional average.

3. Water Scarcity and Integrated Water Management

There has long been an intimate relationship, in Latin America, between water scarcity and the creation of strong water management institutions. The foundations for the development of modern water management were laid in the nineteenth century with the constitutional establishment of the right of public intervention in the assignment of the right to use water, but this was not immediately followed by the formation of institutions specifically charged with responsibility for the management of the

water resource. Such institutions are, in general, of much more recent origin.

The earliest examples of institutional development in water-related fields are of interest to the understanding of the evolution of the social response to water scarcity in Latin America and the Caribbean.

In particular, two institutions founded as a response to water scarcity can be identified as marking early significant steps in the evolution of water management in the region. These institutions are the *Inspetoria de Obras Contra as Secas*, the forerunner of the *Departamento Nacional de Obras Contra as Secas (DNOCS)* of Brazil and the *Departamento General de Irrigacion (DGI)* of the province of Mendoza, Argentina. The founding of both institutions dates from the beginning of this century although the origin of the *DGI* lies in a process which began much earlier.

Neither institution was originally intended to be responsible for water management in the modern sense, but both were founded as institutions to manage water-related issues. In addition, both institutions were marked from the beginning by the application of scientific and technological knowledge in their work. The original objectives and functions of both institutions were designed to respond to conditions of water scarcity.

When established in 1909, the *Inspetoria* was charged with the development and application of policies and programmes to alleviate the drought that cyclically afflicted the Northeast of Brazil. In fulfilling this function the *Inspetoria* began by making a comprehensive evaluation of conditions in the northeast, including the physical resource base, the social situation of the population, and the economic conditions. It was only after the results of the survey had been studied that a plan was proposed for the execution of works.¹

The *Inspetoria* and its successor, DNOCS, were conceived to counteract water scarcity in a heavily populated and long developed region. In contrast, the founding, in 1916, of the *Departamento General de Irrigacion* was the culmination of the campaign of the Province of Mendoza to develop an irrigation based society in a water scarce region through planned immigration. The original basis of this early attempt at settlement through water management began with the promulgation of the *Ley de Aguas* of the province in 1884.²

The DGI is an institution characterized by an unusual mixture of public and private interests. Its titular head is appointed by the Governor of the Province, but the remainder of the board of directors is elected by the farmers with water right concessions. The income of the DGI is mainly drawn from direct charges for water use although a variable subsidy is received from provincial revenues.³ At its inception, as part of a policy to be continuously applied for the next half century, the DGI was charged with the expansion of water use. Unlike the *Inspetoria*, however, the DGI did not make diagnostic studies of the resource base, but it rigorously registered and controlled all concessions. As part of the policy of encouraging the use of water and ensuring the settlement of the province, concessions were withdrawn after five years if not utilized.⁴

The founding of these two institutions to manage water scarcity, if marking a new stage in the history of government intervention in the economy and of water management in Latin America, cannot be considered a harbinger of any region-wide response to the challenge posed by water scarcity. In most countries of Latin America, specific water resource institutions did not materialize until thirty years later when the influence of multilateral and international institutions began to be an important influence in the internal management of the countries of the region.

It is, however, worthy of note that when water management institutions were created it was almost always as a response to a problem of water scarcity. This was the case, for example, of the next major institutional innovation in the region the establishment of the first nation-wide water management institution in Mexico. The *Comisión Nacional de Irrigación*, founded in 1926, was charged with the construction of large scale irrigation works and the related large dams for water control in the water scarce north of the country.⁵ Only in 1937 was the *Comisión Federal de Electricidad* founded to undertake the construction of large generating plants and the necessary water control works. These two institutions have remained the dominant water institutions and laid the foundation for the emergence of a tradition of public water administration at the federal level of government in Mexico.

Even when the first specifically designated water management institution founded at the national level, the Mexican *Secretaría de Recursos Hidráulicos* (SRH) was established in 1948, it was based on the *Comisión Nacional de Irrigación* with an enlarged competence. The SRH had, from its initiation, responsibility for all water uses, excepting the generation of hydroelectricity, and was authorized to prepare plans for the future use of water, to operate of water resource control structures and irrigation systems and to concede water rights or licences for the whole of Mexico. The core remained, however, the management of water scarcity.

In recent years, other countries have created similar national water management institutions, but, from its base as an institution for the management of water scarcity, the SRH has remained the most powerful of all the water management institutions in the region. Its political pre-eminence has not been emulated in other countries, not even in those with the most centralized unitary governments.⁶

In most countries of the region, however, institutions charged with the management of particular regions continue to be the commonest institutional form for integrated water management. Some of these, following the model of the Tennessee Valley Authority, were established as river basin authorities. Early examples include the *Comision de Santiago Lerma-Chapala* in Mexico set up in 1950 and the *Superintendencia del Valle de Saõ Francisco* in Brazil founded in 1948 both, once again, in water scarce regions.

There is clearly, therefore, a more than coincidental relationship between the development of institutions charged with integrated water management and water scarcity. It is perhaps to be expected that where water is scarce the control of its use will become a social priority. This is reflected in many of the water laws of the region which permit the establishment of a strong central water authority in periods of drought.

4. The Continuing Challenge of Water Scarcity to Water Management

Water scarcity is a continuing challenge to water management in Latin America and the Caribbean. Even in areas of abundant rainfall droughts are frequent. In recent years significant droughts have been reported in Bolivia, Brazil, Chile, Costa Rica, Cuba, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Mexico, Nicaragua and Peru among other countries.

Drought produces severe impacts on both man and the environment. Its effect slowly accumulates and can persist for extended periods of time. The paramount environmental consequence of drought is the intensification or extension of desert conditions or desertification.⁷ The area affected by desertification in South America alone was estimated in 1977 to be more than 3

million square kilometers, almost 20 percent of the continental land mass (Table 3).

As important as desertification is as a threat to the continued existence of human society it is not the only significant consequence of water scarcity in Latin America. Other more immediate repercussions are also of importance. Among the more important continuing consequences of water scarcity are the following:

- (i) shortages of food and drinking water,
- (ii) increases in water-related diseases,
- (iii) crop failure and destruction of pasture,
- (iv) reduction in river flows to the detriment of hydro-electric power generation and water transport,
- (v) catastrophic degradation of vegetation cover and soil erosion.

An increasingly important phenomenon related to water scarcity is the increase in levels of contamination resulting from the lack of water for the dilution and transport of domestic and industrial wastes. This is particularly important in Latin America and the Caribbean because of the general absence of waste treatment⁸. In few countries, and those the smallest are more than 5 percent of urban waste flows given even primary sewage treatment and many industrial discharges also enter water bodies with little treatment.

The response to the challenge posed by water scarcity has been concentrated on attempts to increase supply through the construction of works to increase the availability of water, through the storage and transport of surface flows or through the tapping of

groundwater. The development of irrigation in water scarce and drought prone areas of Latin America and the Caribbean has been associated with all the dominant cultures in the region. In modern times, however, it has reached extensions which dwarf its historic importance. The area under irrigation in the region has increased from by more than 70 percent in the last 25 years from 8,245,000 hectares in 1961 to 15,231,000 hectares in 1987 (Annex 1). The irrigated area has grown more rapidly in Latin America than in any other region of the world. Additionally, the area under irrigation has increased most rapidly away from its traditional centres in Argentina, Chile, Mexico, and Peru. There is some irrigation in every major hydrographic division of the region (Annex 1). The use of irrigation as the main response to water scarcity is likely to continue in the future. For example, a five year irrigation programme for the Northeast was begun in Brazil in 1986. It is proposed under this programme to increase the area under irrigation by 1,000,000 hectares.

Not all irrigation schemes are large projects relying on conventional canal based systems for water collection, storage and distribution even if most are. Other methods of increasing water availability have been applied, most commonly the direct abstraction and application of groundwater. There are examples of the continuing or renewed use of more traditional small-scale techniques. Again in the Northeast of Brazil, for example, many small-scale systems of water capture are in use such as pot and capsule systems, underground sandtrap "salvation" dams, manually filled porous earthen pots etc.⁹ On the Pacific Coast in Ecuador, Peru and Chile experimental projects to condense water from the heavy coastal fogs seem to have potential for irrigation.¹⁰

The large irrigation schemes have not always realized their potential. There is considerable evidence of less than full use of the potential benefits and of the physical magnitude of the systems

exceeding managerial abilities.¹¹ Less attention has been paid to reducing demand by the more efficient utilization of water in irrigation or in other sectors than in the expansion of supply through the construction of new schemes. Some use of water saving irrigation techniques is accompanying the modernization of agriculture, but not as a means to reduce water demand. There are as well a few examples of waste water reuse. The only example on any scale is in Mexico City where the reuse of waste water supplies some 4% of current daily water use. This water is mainly used to replenish recreational lakes and for the irrigation of public parks.¹² Price is not used to any large degree as a device to ration water demand, perhaps because it is difficult to apply pricing systems to water, although a summer surcharge is applied to domestic water use in Santiago, Chile.

5. Conclusions

Water scarcity and drought are a significant water management problem and a restriction on development in Latin America and the Caribbean despite the overall abundant water supply of the region. The main response to the problem has been the construction of large-scale irrigation schemes. Other responses have only been applied on a limited scale in special situations.

It is possible that change may be coming in this situation and that the policy response to water scarcity and drought may be widened to consider more integrated approaches involving demand as well as supply management.¹³ There is evidence to suggest that management of water scarcity is beginning to consider approaches other than big public irrigation schemes and to respond to a broader range of options. There are signs that a more balanced, river basin oriented, perspective on water management is taking hold in the region. In water scarce areas, as generally in the region, the

demands being placed on the water resource are growing in both size and diversity. It can no longer be maintained that irrigation must be the only focus. The needs of water supply, hydro-electric power generation and even the transport of wastes are becoming equal partners for the use of the resource in water scarce areas. Water management institutions must respond to this new challenge and develop a resource rather than use focus for the management of water scarcity within a river basin approach.

NOTES

¹ For a brief history of the *Inspetoria* see, Brasil, Ministerio do Interior, Departamento Nacional de Obras Contra as Secas - DNOCS, Barragens no nordeste do Brasil, Fortaleza, 1982, pag.32-33.

² Joaquín Lopez, El Derecho y la Administración de Aguas en Iberoamerica, paper presented at the International Conference on Global Water Law Systems, Valencia, Spain, 1975, pag.27-29.

³ Greater detail is provided in the presentation of the case study "Irrigation in Mendoza: economic, social, institutional, legal and administrative factors in management", Annex 1.

⁴ See the discussion in Comisión Económica para América Latina - Consejo Federal de Investigaciones (Argentina), Los Recursos Hidráulicos de Argentina, VI Aspectos Institucionales y Jurídicos, Anexo B, pag. 548-560.

⁵ The Commission was to put into effect one of the major demands, access to land, of the Mexican Revolution, for a thorough discussion of the influence of the Commission and its sucesors on water management in Mexico, see, Miguel S. Wionczek, "La aportación de la política hidráulica entre 1925 y 1970 a la actual crisis agrícola mexicana", Comercio Exterior, Volume 32, No.4, April, 1982, pp.394-409.

⁶ The absence of similar institutions in other countries of the region serves to underline the special relationship of institutional developments in Mexico to water scarcity.

- ⁷ Desertification is a complex process resulting in reduced biological productivity and is the result of several factors in addition to drought, including salinization and general poor soil management.
- ⁸ In Chile only some 2 percent of wasteflows are subject to treatment prior to discharge,
- ⁹ Gwynne Power, "Land Reform Vital in NE Brazil", World Water, Vol.6, No.9, pp.37-42
- ¹⁰ Christian Gischler and Carlos Fernández-Jaúregui, "Técnicas económicas para la conservación y gestión del agua en América Latina", La Naturaleza y Sus Recursos, UNESCO, Vol.XX, No.3, July-September, 1984, pp.11-16
- ¹¹ For example see the disoussion in United Nations, CEPAL, La Gestión de los Recursos Hídricos en América Latina y el Caribe, Estudios e Informes de la CEPAL, No.71, Santiago, Chile, 1989, pp.217-237.
- ¹² Sandra Postel, "Conserving Water: the Untapped Alternative" Worldwatch Paper 67, September, 1985, p.32
- ¹³ For a discussion of this question see, Axel Dourojeanni and Terence R. Lee, "Irrigation Agriculture and Water Management Policy in Latin America and the Caribbean", Entwicklung+Ländlicher Raum, February, 1989, pp.17-19.

Table 1
 LATIN AMERICA AND THE CARIBBEAN: ARID AND SEMI-ARID
 AREAS, BY COUNTRY

Country	Total Area ('000 km ²)	Arid Area	% Country Area	% Regional Total
Argentina	2780	1706	61.4	34.4
Brazil	8512	1008	11.8	20.4
Bolivia	1098	140	12.8	2.8
Chile	757	374	49.4	7.6
Colombia	1139	35	3.1	0.7
Dominican Rep.	49	4	8.2	0.1
Ecuador ^{1/}	284	11	3.9	0.2
Mexico ^{2/}	1973	797	40.4	18.0
Paraguay	407	22	5.4	0.4
Peru	1285	290	22.6	5.9
Venezuela	912	43	4.7	0.9
Latin America	19,196	4,953	22.7	100.0

Sources: FAO, Report for the Regional Meeting on Desertification, Santiago, Chile, 23 to 26 February, 1977.

^{1/} Direct Information from the meeting.

^{2/} "Regiones Aridas y Semiáridas de la Republica Mexicana" in Simposio Internazionale sulla integrazione della ricerca per la valorizzazione delle risorse biologiche delle zone aride e semi-aride del America Latina, Istituto Italo-Latino Americano, Rome 1-5 October, 1979

Table 2
LATIN AMERICA AND THE CARIBBEAN: ECONOMIC IMPORTANCE OF
THE MOST WATER SCARCE AREAS

Region	Area in km ²	Population in 1980	Gross Domestic Product, 1980 ('000s US\$1980)
N. W. & N. C. Mexico	797,106	11,997,810	31,014
Northern S. America	76,427	3,608,403	11,745
N. E. Brazil	1,007,893	26,076,003	23,804
Southern S. America	2,407,715	19,944,613	35,334
Arid Latin America	4,289,141	61,626,829	101,897
Total Latin America	20,371,273	355,804,670	742,366

Source: ECLAC estimates

Table 3
DEGREE OF DESERTIFICATION HAZARD IN SOUTH AMERICA

Degree of desertification hazard	Affected Area	
	Km ²	% of total area
Moderate	1,602,383	9.0
High	1,261,235	7.1
Very High	414,195	2.3
Desert	200,492	1.1
Total South America	3,478,305	19.5

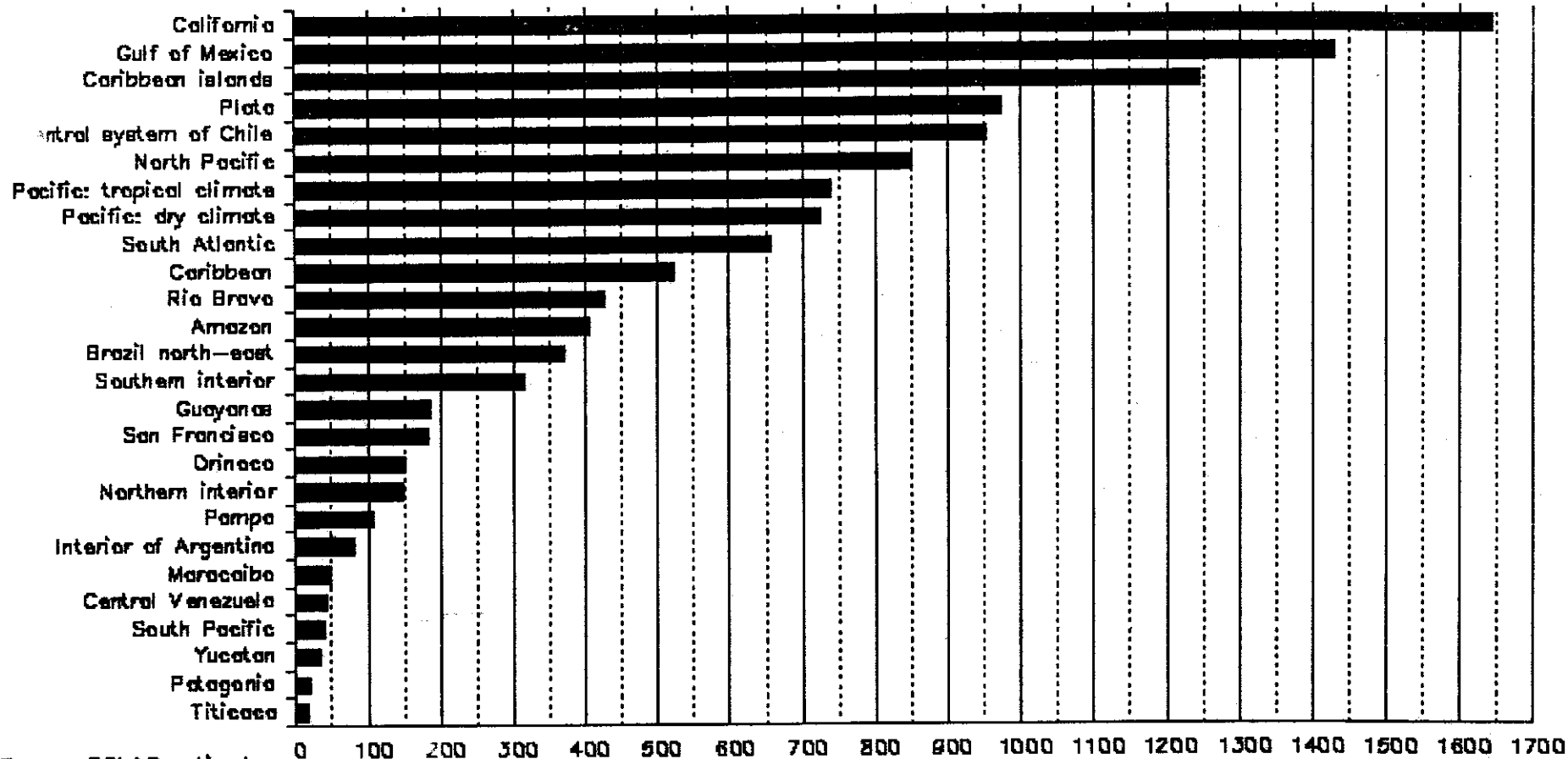
Source: United Nations Conference on Desertification, World Map on Desertification, Explanatory Note, A/CONF.74/2, p.9

ANNEX 1
IRRIGATED AREAS
LATIN AMERICA AND THE CARIBBEAN

Figure 1
LATIN AMERICA AND THE CARIBBEAN: MAIN HYDROGRAPHIC DIVISIONS



Figure 2
ESTIMATED AREA UNDER IRRIGATION, BY MAJOR RIVER BASINS (1 000 ha)



Source: ECLAC estimates.

Table 1

LATIN AMERICA AND THE CARIBBEAN: IRRIGATED LAND BY COUNTRIES, (1 000 ha)

Country	1961	1970	Increase 1961/70	1980	Increase 1970/80	1987	Increase 1980/87
Argentina	980	1 280	30.6 %	1 580	23.4 %	1 700	7.6 %
Belize	-	1	-	1	-	2	100.0 %
Bolivia	72	80	11.1 %	140	75.0 %	165	17.9 %
Brazil	490	796	62.4 %	1 800	126.1 %	2 500	38.9 %
Chile	1 075	1 180	9.8 %	1 255	6.4 %	1 300	3.6 %
Colombia	226	250	10.6 %	400	60.0 %	496	24.0 %
Costa Rica	26	26	-	61	134.6 %	118	93.4 %
Cuba	230	450	95.7 %	762	69.3 %	890	16.8 %
Dominican Republic	110	125	13.6 %	165	32.0 %	206	24.8 %
Ecuador	440	470	6.8 %	520	10.6 %	546	5.0 %
El Salvador	18	20	11.1 %	110	450.0 %	117	6.4 %
Guatemala	32	56	75.0 %	68	21.4 %	79	16.2 %
Guyana	90	115	27.8 %	125	8.7 %	128	2.4 %
Haiti	35	60	71.4 %	70	16.7 %	70	-
Honduras	50	70	40.0 %	82	17.1 %	88	7.3 %
Jamaica	22	24	9.1 %	33	37.5 %	34	3.0 %
Mexico	3 000	3 583	19.4 %	4 980	39.0 %	4 900	-1.6 %
Nicaragua	18	40	122.2 %	80	100.0 %	84	5.0 %
Panama	14	20	42.9 %	28	40.0 %	30	7.1 %
Paraguay	30	40	33.3 %	60	50.0 %	66	10.0 %
Peru	1 016	1 106	8.9 %	1 160	4.9 %	1 200	3.4 %
Saint Lucia	1	1	-	1	-	1	-
Saint Vincent and the Grenadinas	-	1	-	1	-	1	-
Suriname	14	28	100.0 %	42	50.0 %	60	42.9 %
Trinidad and Tobago	11	15	36.4 %	21	40.0 %	22	4.8 %
Uruguay	27	52	92.6 %	79	51.9 %	100	26.6 %
Venezuela	218	284	30.3 %	315	10.9 %	328	4.1 %
Total	8 245	10 173	23.4 %	13 939	37.0 %	15 231	9.3 %

Source: ECLAC, Statistical Yearbook for Latin America and the Caribbean, 1988 edition.