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THE WATER RESOURCES OF LATIN AMERICA AND THE CARIBBEAN: WATER POLLUTION

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INTRODUCTION

A hallmark of the second part of the twentieth century in the use of the water resources of Latin America and the Caribbean has been the emergence of pollution as a significant and alarming feature of many water bodies. There are very disparate factors which account for this increase in pollution. Among the more important are rapid population growth, particularly the urban population, improvement in the provision of drinking water supply and sewerage services, the expansion of industry and the technification of agriculture —all this unaccompanied by the development of waste treatment facilities and pollution control. Together, these factors have led to the emergence of the control of water pollution as a major challenge for water management in the region.

The growing seriousness of water pollution in the region can be seen in the decline in the quality of the waters of rivers with large volumes of flow, such as the Cauca and Magdalena in Colombia, the Mantaro in Peru and in the rivers of the La Plata system. The situation is far worse, however, in many smaller rivers, lakes and lagoons where the impact of pollution tends to be relatively greater.

There is a complex and specific set of relationships between human activity, the generation of waste flows, absorbing capacity and the resulting contamination of any water body.

It is known that one of the major causes of water pollution in Latin America and the Caribbean is the discharge of untreated or inadequately treated domestic and industrial waste water. Non-point source pollution from the percolation, precipitation and/or unregulated run-off of contaminated water can also be important. Water pollution can be caused by natural factors, but this is usually of lesser significance; however, Lake Managua in Nicaragua is seriously contaminated from volcanic sources.

There has been no systematic regional evaluation of the evolution of water pollution in Latin America and the Caribbean or of its impact on the welfare of the population and its economic consequences. At the same time, the overall magnitude of the pollution of the region's water resources is not known. This report provides a description based on existing reports and information of the state of water pollution in the region and of the efforts being made by governments to control it and to improve water quality management.

I. WATER POLLUTION CAUSED BY POINT-SOURCE WASTE DISCHARGES

A. OVERALL PATTERNS

In Latin America and the Caribbean, one of the main causes of water pollution is the direct discharge of domestic sewage and industrial effluent. Of these two contaminants, domestic sewage is usually the more important, particularly in large population centres. For example, it has been estimated that in Rio de Janeiro, Brazil, 70% of the pollutants in the recipient waters around the city are of human origin while only 30% are industrial and organic wastes. Storm-water run-off is a further source of pollution in major urban areas of the region.

There is a general absence in the region of waste water treatment plants for any but the most toxic industrial wastes. Virtually all municipal sewage and industrial effluent is discharged into the nearest rivers and streams without any treatment. In most major cities even the patterns of waste flows are only partially controlled through interceptor sewers and scientifically located outfalls.

The geographical pattern of water pollution from point-source waste discharges in Latin America and the Caribbean is dominated by the flows originating from large metropolitan areas, although water bodies in areas of non-metropolitan concentrations of mining and manufacturing industry also receive significant waste discharges.

A high proportion of industry and population is concentrated in relatively few regions, such as the Lower Parana-River Plate area of Argentina and Uruguay, the triangle of Rio de Janeiro/São Paulo/Belo Horizonte in Brazil, and the Mexico City metropolitan region in Mexico. Elsewhere, the largest cities usually account for a substantial part of both total population and total industrial production. For example in Peru, the Lima metropolitan area, which in 1980 comprised 27% of the total population, but accounted for 43% of GDP and more than 90% of capital goods production (table 1).

In the future, demands on the water resources adjacent to metropolitan regions for the disposal and transport of industrial and domestic wastes are likely to increase due to continued growth in population and industrial development. The limited financial resources and economic difficulties facing the countries of the region are likely to inhibit a parallel expansion of efficient water pollution control and the installation of the waste-treatment facilities required.

Table 1

LATIN AMERICA AND THE CARIBBEAN: MAJOR METROPOLITAN AREAS, POPULATION AND RECIPIENT WATER BODIES FOR WASTE FLOWS

Metropolitan area	Recipient water body	Year	Population	As a % of the population of the country
Mexico	River Tula & Lerma/Panuco	1980	13 368 315	20.0
São Paulo	River Tiete & Lake Billings	1980	12 183 634	10.2
Buenos Aires	River Plate & tributaries	1980	9 969 826	35.7
Rio de Janeiro	Guanabara Bay & Atlantic Ocean	1980	8 821 845	7.4
Lima	Pacific Ocean	1981	4 608 010	27.1
Bogotá	River Bogotá	1985	3 974 813	13.8
Santiago	River Mapocho	1982	3 902 356	34.4
Caracas	River Guaire & Tuy	1981	2 640 013	18.2
Belo Horizonte	River Das Velhas & others	1980	2 461 081	2.1
Guadalajara	River Santiago	1980	2 221 053	3.3
Porto Alegre	River Guiba	1980	2 178 079	1.8
Recife	Atlantic Ocean	1980	2 131 649	1.8
Medellín	River Medellín	1985	1 963 850	6.8
Havana	Gulf of Mexico	1981	1 929 432	19.8
Monterrey	River Santa Catarina	1980	1 913 075	2.9
Salvador	Atlantic Ocean	1980	1 696 318	1.4
Fortaleza	Atlantic Ocean	1980	1 501 469	1.3
Montevideo	Atlantic Ocean	1985	1 449 975	49.5
Santo Domingo	Atlantic Ocean	1981	1 313 172	23.3
Cali	River Cauca	1985	1 367 452	4.8
Curitiba	River Belem	1980	1 325 275	1.1
Guayaquil	River Guayas & Salado estuary	1982	1 175 973	14.6
Brasilia	River Paranua Sta. Maria	1980	1 139 480	1.0
Barranquilla	River Magdalena	1985	1 122 511	3.9
Guatemala	River Maria Linda	1981	1 098 476	18.1
Maracaibo	Lake Maracaibo	1981	1 013 939	7.0
Total			88 471 071	21.3

Source: Latin American Demographic Centre, America Latina en el año de los 5.000 millones, Santiago, Chile, 1987, p. 36.

B. MAIN POINT-SOURCE WASTE DISCHARGES

1. Domestic sewage

The average sewage production per capita usually ranges between 30 and 100 litres per day, although much higher figures can occur. For example, in Santiago, Chile, in 1984 the waste water discharge per capita per day was estimated to be 400 litres.1/ The main ingredient of domestic sewage --99% or more by volume-- is water. Dry organic matter, the most active portion of sewage, can constitute as much as 60%-70% of the total dry matter. The organic matter present in domestic sewage usually consists of carbohydrates, fats, proteins, oils, surfactants and agricultural trace compounds. Since some portion of the population carries various diseases, domestic sewage is infected by pathogenic organisms, the most significant of which are coliform bacteria, faecal streptococci, helminthic eggs, protozoa, salmonella typhosa and various viruses.2/ The bacteriological load of raw domestic sewage in Latin America usually varies between $10 * 10^6$ and $10 * 10^7$ coliform bacteria per 100 ml.3/ Domestic sewage in Latin America tends to have high biological oxygen demand (BOD), suspended and dissolved solids characteristics, while the fat content is generally low (table 2).

Domestic sewage is biodegradable. Its chemical composition permits relatively rapid decomposition by natural processes in water bodies or in engineered systems. However, owing to large population concentrations and a lack of sewage treatment facilities, the input of sewage into the environment in many locations in Latin America and the Caribbean exceeds the natural decomposition and dispersal capacity of the recipient water bodies. The result is a significant degradation of the quality of water. The percentage of domestic wastes currently treated is not known, but estimates suggest that less than 2% of total urban sewerage flows receive treatment.4/

Some idea of the current demand for the use of water bodies for domestic waste disposal and transport can be gained from the fact that in 1980 total domestic-municipal return water in South America has been estimated at some 127 m^3/sec, representing 4.2% of the world total whereas in 1950 these figures were 29 m^3/sec and 3.9% respectively. Waste flows can be very significant in the largest metropolitan areas and can be expected to increase as the population served by sewerage in the region grows. The served urban population increased by 18% between 1980 and 1985 and is expected to increase by a further 39% by 1990 (figure 1). Estimates of the outflow and parameters of domestic sewage for cities with 100 000 inhabitants or more in 1980 and the recipient water bodies of these discharges are given in annex 1.

A direct and sensitive measure of the overall state of pollution of water bodies by domestic sewage is obtained by counting indicator organisms such as faecal coliforms. Information on such counts is not available for the majority of the region's water bodies, but recent data on 24 major or regionally representative Central and South American rivers (figure 2) suggests that the situation in the region may be, on average, worse than in other parts of the world. For example, whereas 22% of the monitored rivers

Table 2

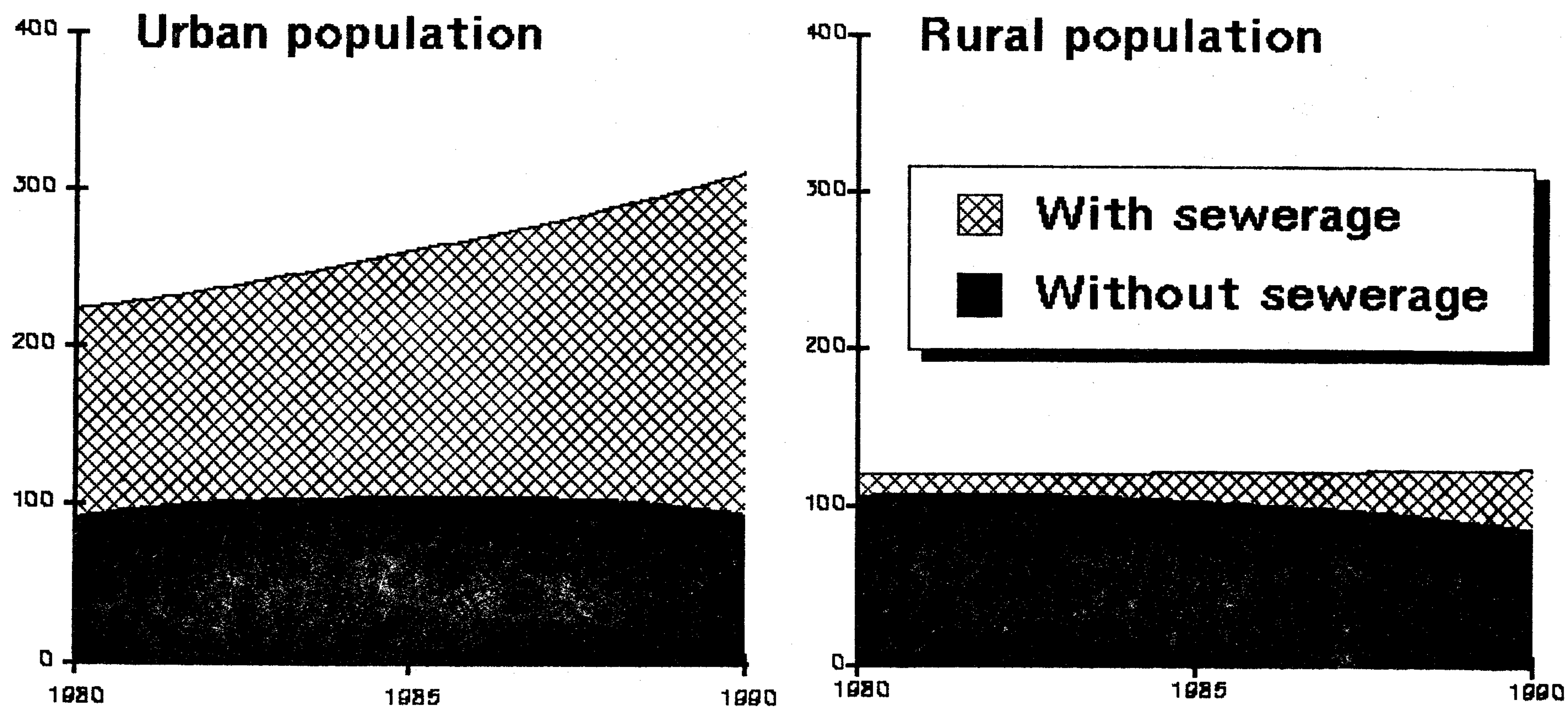
CHARACTERISTICS OF DOMESTIC WASTEWATER, SELECTED LATIN AMERICAN COUNTRIES

Characteristic	"Typical" composition (mg/l)	Uruguay (mg/l)	Mexico (mg/l)	Colombia[a] (mg/l)	Chile[b] (mg/l)
Biological oxygen demand	200	260[c]	299	241	109[d]
Chemical oxygen demand	500	n/a	719	n/a	n/a
Solids, total	700	n/a	n/a	n/a	1 059
Suspended solids, total	200	275	309	289	91
Suspended solids, non-settleable	150	193	n/a	n/a	n/a
Suspended solids, settleable	50	7	n/a	n/a	n/a
Dissolved solids, total	500	n/a	830	n/a	968
Nitrate (as N)	40	n/a	n/a	33.8	28
Nitrate, ammoniacal	25	n/a	28	n/a	n/a
Nitrate, organic	15	n/a	23	n/a	n/a
Phosphore (as P)	10	n/a	n/a	2.9	n/a
PPO_4, total	n/a	n/a	25	n/a	n/a
Oil and fat	100[e]	n/a	44	10.8	31[e]

Source: CEPAL/CPPS//PNU/UIFSM, Valparaiso, Chile, Descontaminacion de la Bahia, anexo 1; Walter A. Castagnino, "Polucion de Agua Modelos y Control", Serie Técnica 20, CEPIS, Environmental Health Division, Pan American Health Organization, p.5; H. Weitzenfeld and J. Barrios, "Water Pollution in Cartagena Bay, Colombia", Water Quality Bulletin, vol.9, No.4, October 1984, p. 216.

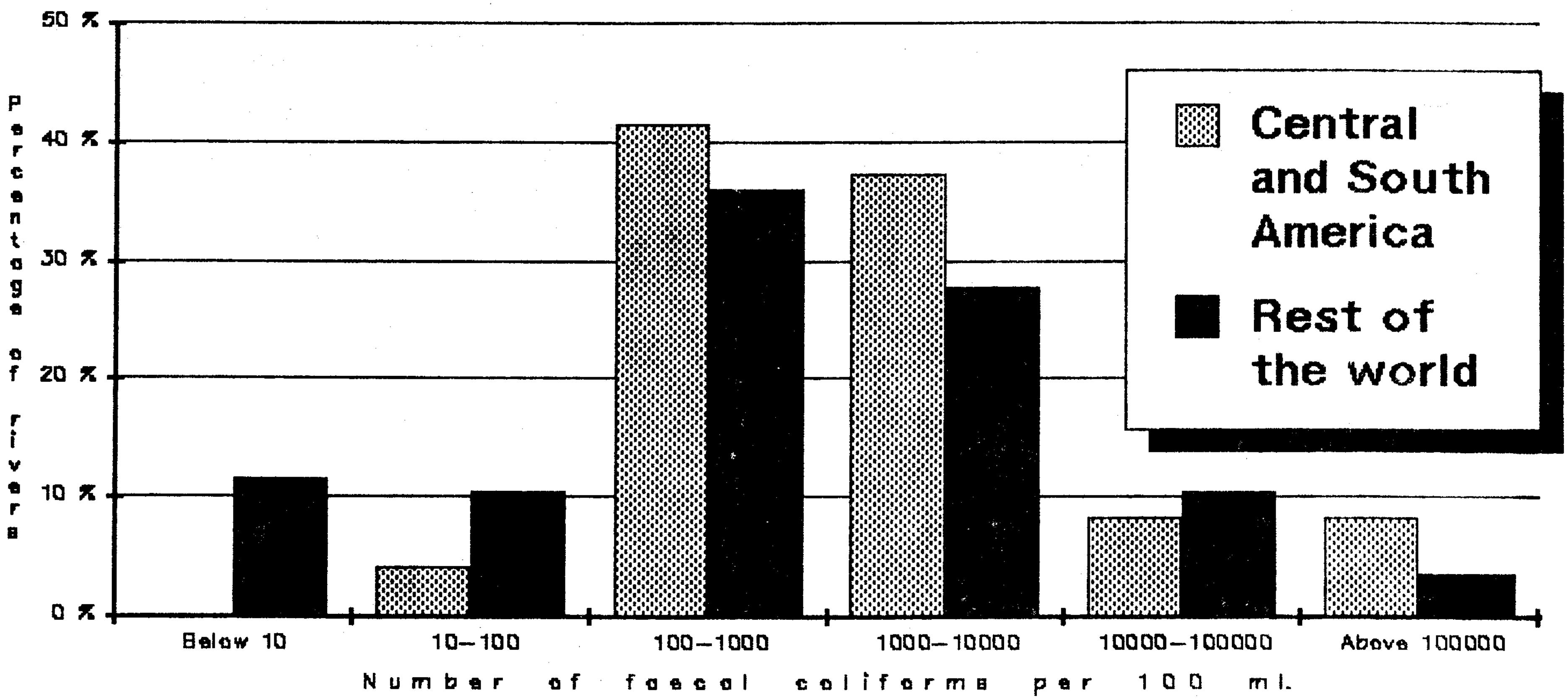
n/a = Not available.
a/ Cartagena Bay.
b/ Melipilla.
c/ $(DBO)_5$.
d/ $DBO_{5, 20}$.
e/ Fat.

Figure 1
POPULATION SERVED BY SEWERAGE IN 26 LATIN AMERICAN AND CARIBBEAN COUNTRIES (millions)



Source: PAHO.

Figure 2
FAECAL COLIFORMS IN RIVERS MONITORED BY THE GLOBAL ENVIRONMENT MONITORING SYSTEM



Source: Globd Environment Monitoring System (GEMS).

of other regions were characterized by faecal coliform counts of less than 100 per 100 ml and 58% of these by counts of less than 1 000 per 100 ml, in contrast, the corresponding indices in Central and South America are 4% and 46% respectively. Eight percent of the rivers monitored in Central and South America have faecal coliform counts of more than 100 000 per 100 ml; in the other regions only 4% of the rivers are polluted to such a degree.5/

Demands on water resources for the disposal and transport of domestic waste and the resulting potential for pollution can be expected to expand enormously in the region by the end of the century. For example, they will more than double in Sao Paulo, Brazil, although treatment is planned (table 3). Although the population of many of the major metropolitan areas is expected to more than double, population growth will be only one factor responsible for the rise in the demand on water resources. Equally significant will be the increased flows through sewerage systems as drinking-water-supply and sewerage connections are extended to a larger proportion of the population and individual water use increases. At present, in many metropolitan regions less than half of the population is served by sewerage systems, and water use per capita is substantially lower than in Europe and North America. Treatment facilities can, however, be expected to be built and in a number of major metropolitan areas, including, for example, Bogotá, Colombia, and Santiago, Chile, plans for the construction of primary treatment plants are well advanced.

Table 3

SAO PAULO, BRAZIL: CURRENT AND PROJECTED DEMAND FOR SEWERAGE TREATMENT

Estimated sewage/BOD	1975	1980	1985	2000
Sewage in m3/sec	21.0	26.0	42.0	94.0
Index	100	124	200	448
Estimated BOD (mg/l) in the river (without project)a/	80	120	150	250
Index	100	150	188	313

Source: L.V. Chang, "Wastewater pollution control in São Paulo, Brazil, Water Quality Bulletin, vol. 7, No.2, April 1982, p. 80.

a/ Estimated BOD_5 in water courses after dilution of total sewage with river flows.

2. Industrial effluents

The process of industrialization in Latin American and Caribbean countries has contributed to the increased occurrence of water pollution. In many countries practically all but the most toxic industrial effluent is discharged into the nearest water bodies without adequate treatment. For example, in Ecuador industrial effluent has been reported to be generally discharged into water bodies without treatment or the taking of precautions.6/ In other countries the situation is often similar. In Argentina retention of the waste load generated by industry does not exceed 10%;7/ while in the Maipo river basin in Chile, only 25.6% (18.0% if only manufacturing industry is taken into consideration) of industrial effluent receives treatment (figure 3), although for the region as a whole, this represents a relatively high degree of waste treatment. Even when treatment facilities do exist, they are not always well maintained or the technology employed is not always the most adequate.

There is no information from which to determine the overall impact of industrial waste flow on the region's water bodies. It has, however, been estimated that industrial effluents constitute 90% of overall water pollution in Mexico, the contribution from agriculture not having been taken into consideration; while in Colombia industry is estimated to be responsible for some 50% of water and air pollution.8/ The total return water flows from industry and power production in South America were estimated at some 254 m^3/sec in 1980. This is almost four times higher than the flows in 1950 but represents only 1.3% of the estimated world total.

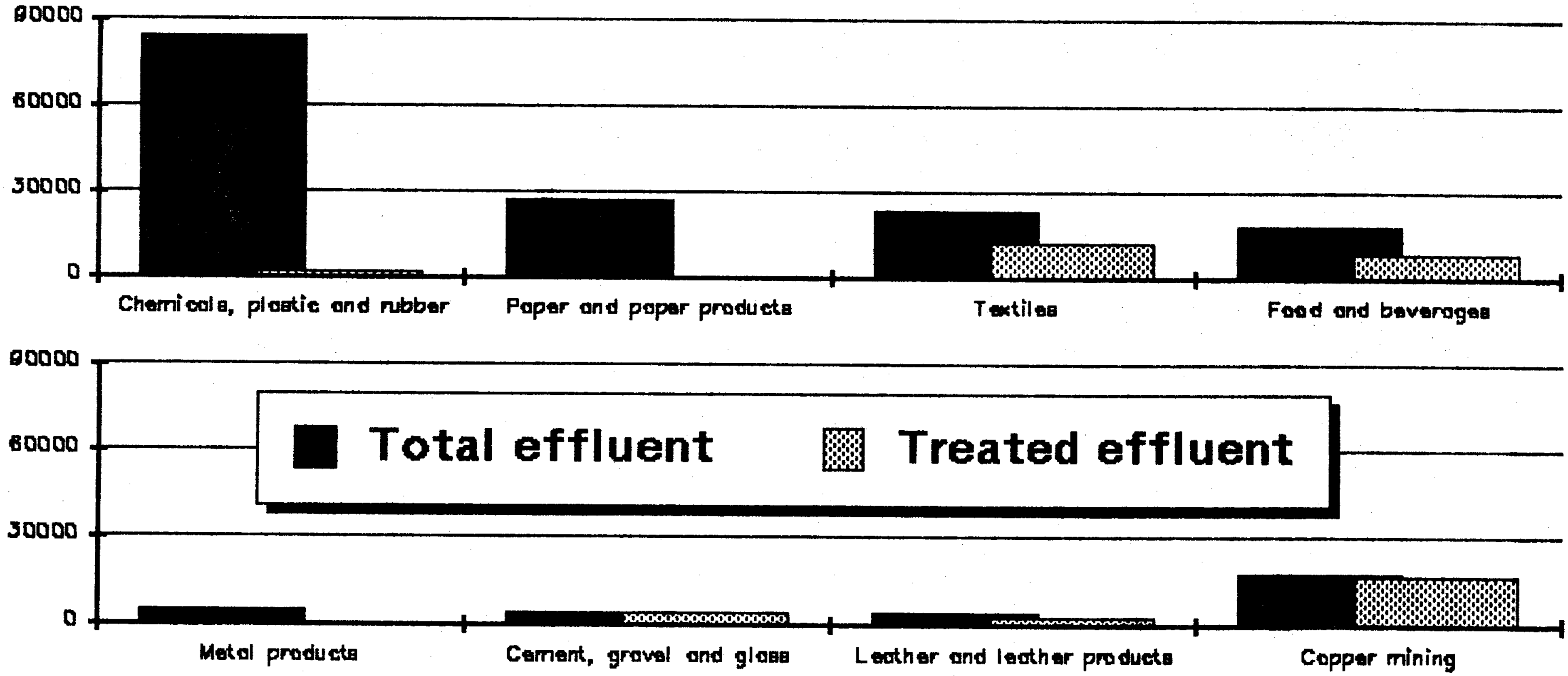
Demands on the water resources for the disposal and transport of industrial wastes and subsequent pollution problems can be expected to continue to increase. For example, both the pulp and paper and the iron and steel industries, which rank among the most important industrial sources of water pollution in the region, have been growing twice as fast as the economy of Latin American countries as a whole.9/

a) Effluent flows from manufacturing

In manufacturing, water is used in cooling, chemical treatment, transport, washing and other similar operations, many of which cause a deterioration of its quality. The characteristics of water use in selected industrial sectors are shown in figure 4. Of all the pollution caused by industry, chemical and biological pollution undoubtedly ranks foremost in the region owing both to the high toxicity and non-degradability of industrial pollutants and to the characteristics of the industrial structure.

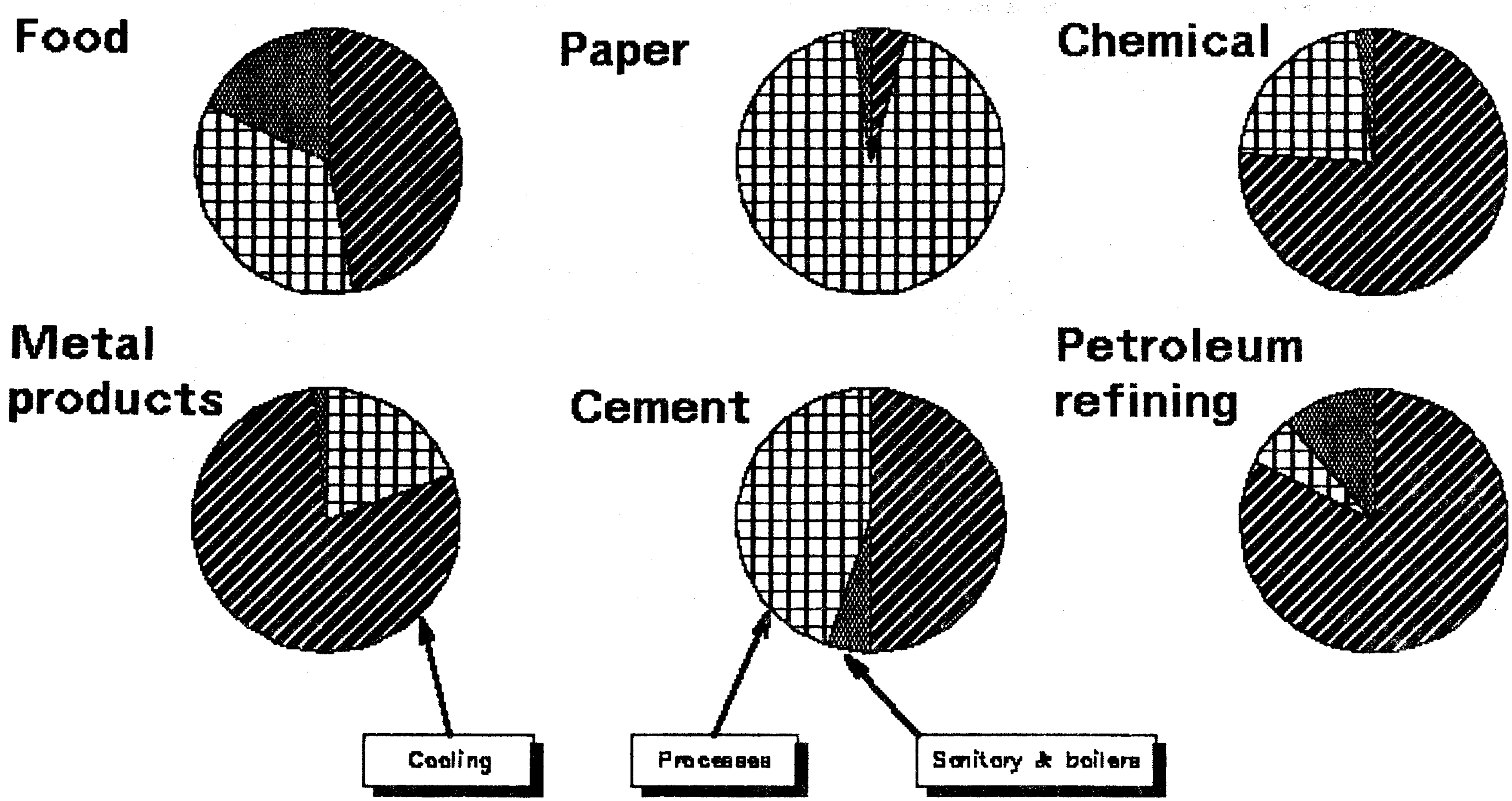
i) Chemical and biological pollution. The nature and quantity of pollutants vary in relation to products, processes and technology. Industrial waste waters may contain heavy metals, soluble organics causing depletion of dissolved oxygen, various toxic substances, acid-producing compounds, oil and fat, phenols, colloidal solids, dissolved trace refractory organics, colour and turbidity, suspended solids, nutrients (nitrogen and phosphorus compounds) and other organic and inorganic substances. Many of their components are resistant to biodegradation.

Figure 3
TREATMENT OF INDUSTRIAL EFFLUENT IN THE MAIPO RIVER BASIN, CHILE (cubic meters per day)



Source: Contaminacion marina en Chile, Ministerio de Salud, Santiago, 1979, p. 18.

Figure 4
WATER USE BY INDUSTRY



Source: Walter A. Castagnino, Polucion de agua, modelos y control, CEPIS, Organizacion Panamericana de la Salud, p. 12.

Industrial water use in the majority of the countries of Latin America and the Caribbean accounts for a relatively minor part of total water withdrawals. In those countries with a higher degree of industrial development, however, chemical and biological contamination from the effluents of manufacturing rivals domestic wastes as a source of water pollution. Locally it can be extreme. This phenomenon is due both to the nature of the predominant pollutants and to the fact that their toxicity tends to be very high. In metal-ore mining, for instance, the population equivalent of wastes per employee has been put at 40, while in the factories and refineries of the sugar industry which is also widely developed in the region, it is, on average 999.10/ Characteristic of the situation in the region as a whole is the fact that in El Salvador, the manufacturing labour force in 1980 comprised 247 621 persons, but the population equivalent of the industrial effluent was estimated to be equal to that of the population of the whole country —almost 5 million— a ratio of 1 : 19 (see table 4).11/

It appears that the region has a higher share of industries with potentially noxious effluents than the world as a whole. For example, while the share of Latin America in the world total value added in industry was 5.3% (1983), its share (1982) in petroleum refining was 17.7%; in the production of other chemicals, 14.7%; in the number of beverage industries, 11.4%; in food manufacturing, 8.7%; in iron and steel basic industries, 7.1%; in non-ferrous basic industries, 6.3%, and in paper products, 5.4%.12/

The major industrial waste loads in the region are generated by the pulp and paper, chemicals and petrochemicals and petroleum refining, metal-working (particularly iron and steel production and non-ferrous metal refining), food processing (particularly sugar in major producing countries), fish-meal, coffee-processing, thermal electricity generation and the textile industries. Some idea of the extent of the contribution from different industries can be gained from figure 5 showing the dynamic of waste water discharges by industrial sectors in Mexico. The location of these industries in relation to water bodies is shown in annex 2.

Insufficient data hampers any quantitative evaluation of the contribution of each industry to overall industrial water pollution; however, some idea of the extent of their potential contribution can be gained from process characteristics:

- Pulp and paper industry. Waste water discharges from the paper and pulp industry are among the greatest pollution hazards for the region's water bodies. Its pollution flows are mainly related to its bleaching, paper-coating, screening, washing and wood preparation and pulping processes. The typical effluent from a pulp and paper industry contains chlorinated organic compounds; colloidal solids; dyes; fat; colours; dissolved trade refractory organics; nutrients, such as nitrogen and phosphorus; oil; phenols and various other organic pollutants.13/

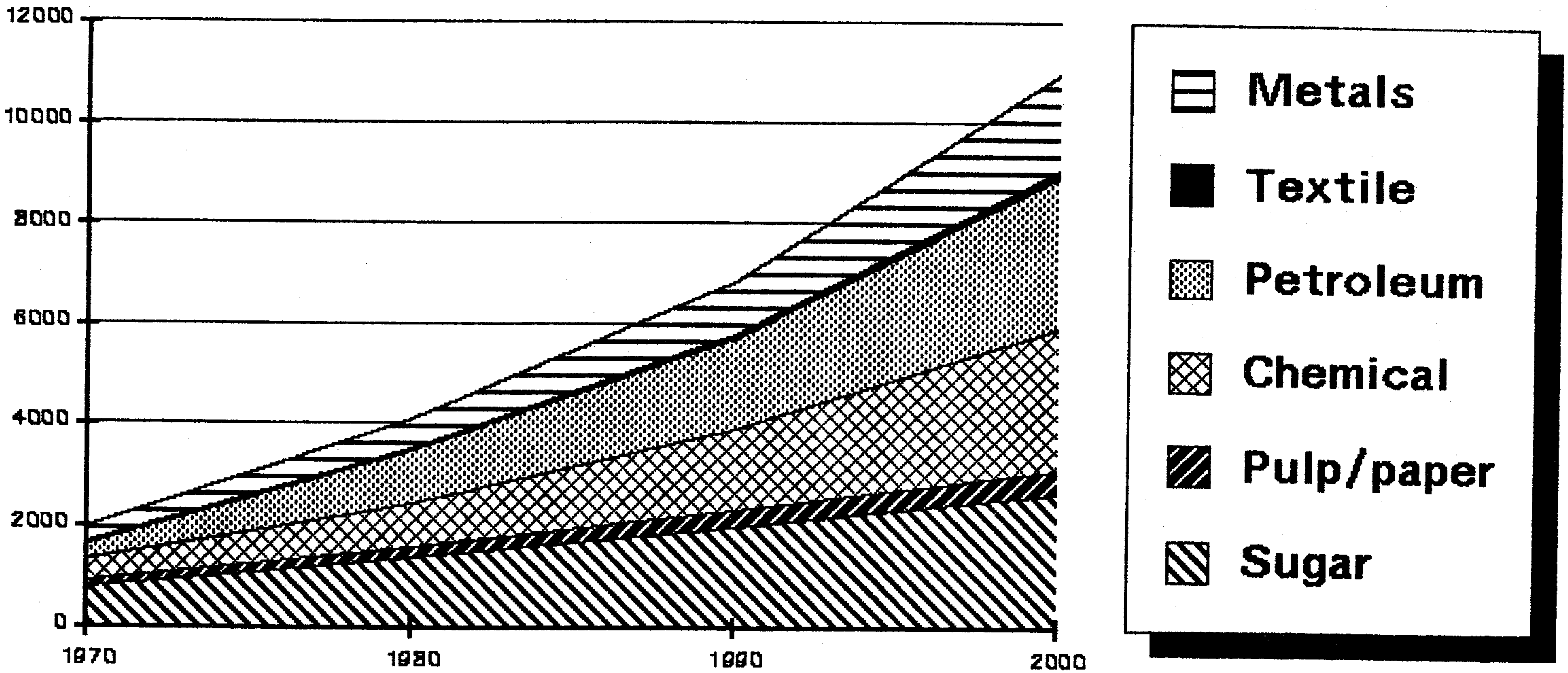
Table 4

POPULATION EQUIVALENT OF MANUFACTURING INDUSTRY EFFLUENTS IN EL SALVADOR

Industry	Number of plants	Population equivalent of the industry effluent
Coffee processing	211	2 123 357
Sugar	11	1 590 718
Processing of American agaves	4	694 535
Distilling	3	193 808
Tanning	14	85 872
Dairy	10	24 165
Textiles	19	23 604
Slaughterhouses	42	18 435
Paper	2	11 414
TOTAL	316	4 765 908

Source: Resumen general sobre recursos y demandas, Plan maestro de desarrollo y aprovechamiento de los recursos hídricos, El Salvador, Documento básico No. 14, PNUD/ELS/78/005, May 1982, Table No. 43.

Figure 5
ESTIMATED RESIDUAL WATER DISCHARGES BY INDUSTRIAL SECTORS IN MEXICO (million cubic meters per year)



Source: SARH.

Paper and pulp plants produce, on average, 200 m^3 of effluent per ton of cellulose pulp and 110 m^3 per ton of paper, although figures vary enormously from plant to plant.14/ The potential volume of effluent generated by the industry in the region is estimated at some 27 m3/sec.15/

- Petroleum refining. The products and production processes used in petroleum refining are varied, and the contaminants of the waste water discharges are similarly diverse. They range from phenols, other organic pollutants and suspended and dissolved solids to alkaline and caustic sludge, cyanides, heavy metals and sulphides.

Petroleum refining produces, on average, 380 litres of effluent per barrel of crude oil refined, although figures can vary depending upon the technology employed.16/ The potential volume of effluentt.17/

been estimated
that in the Caribbean refineries account for almost twice the volume of petroleum hydrocarbon residuals due to exploration and production activities. At the same time refined products may pose a more serious long-term threat than crude oil since they tend to be much more persistent and long-lived in the marine environment.17/

- Iron and steel production. Various processes in the production of iron and steel give rise to waste water discharges. These include the preparation of raw materials, sintering and coke-making processes, the operation of blast furnaces and hot rolling mills, pickling operations, the operation of cold mills and coke plants and the finishing of steel products. Depending upon the process in which water is used, effluent may contain ammonia, cyanides, oils, phenols, fluorides, ferrous chloride, emulsions, sulphuric acid, ferrous sulphate, hydrochloric acid and large amounts of suspended solids.

The iron and steel mills generate, on average, 25 m^3 of effluent per ton of production, although the amounts per individual mill vary substantially. The potential volume of effluent generated by the industry in the region is estimated at some 25 m^3/sec; and the annual potential pollution load from untreated effluent, at 1 762 700 tons of suspended solids, 910 tons of phenols, 400 tons of cyanide, 1 100 tons of nitrogen (ammonia), 38 500 tons of mineral oils and 1 100 tons of iron.

- Non-ferrous metal refining. The effluent from the non-ferrous metal refining industry is an important source of water pollution in several countries of the region. Depending upon the characteristics of the primary mineral being processed and of the other minerals in the ore, effluents may contain high concentrations of arsenic, lead, cadmium, copper, nickel, zinc and other harmful, non-degradable substances.

Non-ferrous metals refineries generate, on average, 20 m^3/sec of effluent per ton of production, although much higher and lower figures may also be recorded depending upon the technology and equipment employed. The potential volume of effluent generated by these plants in the region is estimated at 4 m^3/sec, of which copper smelting and refining probably account for more than half.

- Food processing and related industries. Food processing industries are important dischargers of suspended and colloidal solids and organic pollutants. For example, brewery wastes show a high BOD with an elevated carbonaceous soluble component. They also contain high concentrations of organic matter and suspended solids. Dairy wastes are also characterized by very high BOD. They contain organic compounds which, although initially neutral or alkaline, tend to acidify rapidly, posing treatment problems. Cannery waste may contain large amounts of oil and grease in addition to high BOD, solid materials, dissolved or colloidal compounds, soda and citric acid. Discharges from meat and poultry processing and packing show considerable concentrations of blood and excreta with elevated levels of the bacteria salmonella. The wastes contain high levels of organic compounds and suspended solids and also of nitrogen and grease.18/

The food manufacturing industry produces, on average, 2 050 m^3 of effluent per employee annually, although again figures can vary substantially from plant to plant depending upon the equipment and technology used.19/ Thus, the potential discharge of effluent by processors in 19 Latin American and Caribbean countries 20/ can be estimated at about 60 m^3/sec.21/ It should be noted that because of the seasonal nature of the production of some branches of the food processing industry, much of their effluent is likely to be discharged during a few months, which increases their potential for pollution, particularly if the period of discharge coincides with the period of low flow.

In many countries, it is known that these industries are important contributors to water pollution. For example, it has been estimated that in Argentina food, beverage and tobacco industries account for some 59% of the potential pollution generated by industry.22/ In the Maipo and Marga-Marga river basins in Chile, the food and beverage industry generates 11%-14% of industrial wastes (excluding those generated by copper mining).23/

- Sugar production. In recent years, Latin America and the Caribbean produced some 26 000 000 - 28 800 000 tons of centrifugal sugar. The sugar refining industry is developed in virtually all the countries of the region. Brazil and Cuba are the largest producers, accounting for nearly 60% of total production in 1984.24/

The sugar industry produces, on average, 3 m^3 of effluent per ton of production in the case of cane sugar and 40 m^3 in the case of beet sugar. The potential volume of effluent discharged can be roughly estimated at about 3 m^3/sec. However, due to the seasonal character of this industry, discharges tend to be concentrated during a relatively short period of time. In El Salvador, for example, the period of discharge lasts 5 months --from November to March.25/ During this period effluent is likely to be discharged at a rate of about 8 m^3/sec. This explains why the sugar industry and related industries put a considerable strain on the water resources of the main producer countries. In Brazil pollution by sugar industry effluent has been reported to be particularly high in the states of Sao Paulo and Pernambuco.26/ Relatively small and irregular run-off heightens the impact of sugar industry effluents in Caribbean countries.

The distilling and rum industries associated with the sugar industry produce a strong organic waste containing yeast. It is characterized by a BOD of 1 200 - 2 000 mg/l and a pH of 3.0 and has a strong aromatic odour.27/ Brazil produces a large volume of alcohol fuels from sugar cane. The production of such fuels grew by 35% annually between 1975/1976 and 1985/1986, reaching 11.1 billion liters in the latter season.28/ Problems associated with the water pollution caused by distilling and rum industry effluent exist in several countries of the region.29/

- Coffee-processing plants. In Latin America and the Caribbean, more than 17 500 000 tons of coffee berries are processed annually. The bean is known to comprise only 44% of the weight of the average coffee berry, the remainder being made up of pulp and mucilage. It is estimated that processors discard about 10 000 000 tons of waste every year, which is dumped in rivers and elsewhere, creating pollution and even constituting a health hazard. By comparison, Africa, Asia and Oceania together generate only about 6 900 000 tons of coffee waste.30/ As in the case of the food and sugar industry, the bulk of the coffee-processing effluent is discharged during a few months.

One of the most typical coffee-processing-related water pollution problems in the region is caused by the wet depulping process which is widely used in Central America, particularly in El Salvador and Guatemala, but is also used in some South American countries, such as Brazil and Colombia. This process requires high volumes of water. In Colombia 12 litres of water are used to produce one kilogram of washed coffee beans. Expensive treatment methods are not used because coffee farms are often very small, there are 3 000 plants in Guatemala, and the effluent from them is discharged directly into nearby streams. Moreover, one of the by-products of the wet depulping process is an organic residue which is left in mounds on river banks, the leachate augmenting the organic load and the BOD.31/

- The fishing industry. Effluent from the fishing industry is an important source of contamination of coastal waters near large fish-processing and fishmeal factories. Pollution tends to be a particularly acute problem when factories are located on the shores of bays characterized by weak currents.

The fishing industry is widespread in the region but is particularly highly developed in Chile and Peru. It has been reported that some 41 tons of fishing industry wastes are dumped into the coastal waters of the northern zone of Chile daily.32/ In Peru pollution caused by the fishing industry affects the coastal waters adjacent to several ports.33/

Apart from pollution caused by fish blood and absorbent water, fishmeal factories produce highly contaminated effluent characterized by an extremely high BOD (70 000 mg/l). In quantitative terms, effluent (other than absorbent water and fish blood) generated by fishmeal plants amounts to, on average, 23% of the tonnage produced. The estimated potential volume of effluent from the fishmeal industry in selected Latin American and Caribbean countries is given in table 5.34/

- Energy production. Water pollution caused by energy production is primarily physical pollution resulting from thermal discharges into bodies of water. Thermal discharges sometimes contain certain trace chemicals, but this is usually a minor problem. Hydroelectric projects can have a negative impact on the chemical and biological quality of water as a result of the flooding of forests. Experiences with the Curuá-Una Dam in Brazil and the Brokopondo Dam in Suriname show that decomposition of submerged forest can lead to the production of hydrogen sulphide and other harmful substances that pose serious public health risks and threaten a dam's machinery. Other adverse effects associated with reservoirs include massive fish kills and infestation by aquatic weeds.35/

Table 5

SELECTED LATIN AMERICAN AND CARIBBEAN COUNTRIES: ESTIMATED POTENTIAL VOLUME OF EFFLUENT FROM THE FISHMEAL INDUSTRY

Country	Estimated effluent (m^3/day)	Country	Estimated effluent (m^3/day)
Argentina	9	Mexico	41
Brazil	16	Panama	29
Chile	701	Peru	452
Cuba	11	Uruguay	7
Ecuador	192	Venezuela	4

Source: Information taken from Walter A. Castagnino, "Polución de agua modelos control", Serie técnica, 20, CEPIS, Environmental Health Division, Pan-American Health Organization, p. 14; FAO, 1985 Yearbook of fishery statistics fishery commodities, Vol.61, Rome 1987, p.98 and 234.

ii) Physical water pollution. Manufacturing affects water quality not only through effluents containing chemical substances and biological agents but also through physical contamination. In its most common form, such contamination is caused by thermal discharges into water bodies. The most apparent effects of thermal inputs are the rises they produce in water temperature. This can affect aquatic animals and plants, increase evaporation and reduce the availability of dissolved oxygen, which may have adverse consequences for water quality.

Cooling water accounts for between 60% and 70% of all the water use by industry and for as much as 90% of such water if thermal electric power production is taken into consideration.36/ Significant amounts of cooling water are discharged from iron and steel and pulp and paper mills, chemical and petrochemical plants, thermal electric power generating stations, etc. Thermal electric power generating stations are by far the largest contributors of thermal discharges into the aquatic environment. Thermal pollution is also caused by domestic sewage, but this is usually the least important source.

In contrast to other forms of industrial water pollution, thermal pollution does not at present, seem to represent any visible threat to the region's water bodies. The climates prevailing in the region, the relatively low level of use of thermal plants in energy production, the large amount of water resources available and other factors reduce the problem. It has, however, been reported that in Peru the discharge of refrigerating waters in the bay of Chimbote (0.4 m^3/sec) has negatively affected aquatic fauna.37/

b) Mining and the processing of minerals

Water, usually in very large quantities, is an essential element in every stage of the development of mineral resources —mining, concentration and processing. Water pollution is regarded the most hazardous environmental problem associated with the mining industry. The pollutants emitted by the mineral industry are, in order of importance, toxic metals, acid and solids in suspension.38/ The degree of water pollution caused by mining and the processing of minerals is determined both by the characteristics of the primary mineral being processed and/or of other minerals in the ore and by the technology used.

In order to evaluate the impact of the mineral industry on the water resources of Latin America and the Caribbean, the following important factors should be taken into consideration:

- The mineral industry plays a key role in the economy of many Latin American and some Caribbean countries and has been characterized by high growth rates (see annex 3).

- Usually the simplest means of mineral recovery (which are frequently used in the region) result in the greatest water pollution problems.

- Most chemical pollutants (toxic metals and acid) are known to result from oxidation of the minerals being mined and in particular from the oxidation of sulphide minerals. Many of the important metals produced in the region are mined as sulphides (including copper, zinc, lead, nickel, silver, mercury, cadmium and arsenic), and sulphides occur in many of the minerals not mined as sulphides.39/

- Many mines and mineral processing plants dump their wastes in small, isolated rivers and streams which bring pollution directly to the sea.

- The minerals industry also produces huge quantities of solid wastes and also have certain other potentially detrimental effects on the environment, which may in certain circumstances cause water pollution including physical water pollution, and/or aggravate water pollution problems which already exist. For example, in Peru it has been considered necessary to dredge Lake Junin, the source of the Mantaro river, to remove the mineral residues which have accumulated over several decades.40/

i) Mining. Pollution from mining affects many water bodies and some coastal areas in nearly all South American countries and poses a particularly acute problem in the Andean countries, especially Chile and Peru (table 6).41/ Chile produces coal, copper, gold, iron, lead, manganese, mercury, molybdenum, saltpeter, selenium, silver, sulphur and zinc. Peru produces antimony, arsenic, bismuth, coal, copper, gold, iron, lead, manganese, mercury, molybdenum, selenium, silver, tin, wolfram and zinc.

The basic reason for the significant contribution of mining to water pollution is the fact that, at best, only a minor part of its effluent receives treatment and this treatment is often only partial. As a result of inadequate treatment, many water bodies are polluted by mining industry wastes. One of the few exceptions to this rule is found in the Maipo river basin in the metropolitan region of Chile, where some 98% of the copper mining effluent was reported to receive some treatment (figure 3).42/

In the Mantaro River in Peru, the concentration of metals, including heavy metals was reported to substantially exceed the norms established by the Water Law. The concentration of iron was 260 times in excess of the norm, and that of manganese 55 times in excess.43/ The Rímac River is considered to rank among the most polluted rivers of the continent. The pollution of this river is a matter of particular concern because water for 60% of the population of Lima is supplied from it. Its water contains varying amounts of potentially harmful elements, such as arsenic, cyanide, lead, chrome and selenium. Concentrations were reported to be approaching the norms established by the Regulations Governing the Sanitary Classification of Bodies of Water. The water consumed by the population of Lima carries 0.14 mg/lt of lead whereas the norm is 0.10 mg/lt.44/

On the other hand, mining does not appear to represent a serious threat to the water resources of the countries of Central America and the Caribbean. For example, it has been estimated that in Mexico the share of the extractive industry in overall water pollution leaving pollution caused by agriculture aside, is only 0.5%.45/ There are exceptions however, in Jamaica, the effluent of the bauxite-alumina industry is a major pollutant.46/

Table 6

EFFLUENT FROM THE MINING INDUSTRY IN PERU

Location	Number of points of discharge	Treatment yes/no a/	Total volume of effluent m^3/min	% of total
Inland water bodies				
Locumba basin	2	No	73.7	36.8
Rímac basin	6	Yes	30.5	15.2
Moche basin	3	Yes	4.1	2.1
Majes basin	3	...	3.3	1.7
Pisco basin	2	...	2.5	1.2
Santa basin	5	Yes	2.5	1.2
Ocoña basin	2	...	0.5	0.3
Pativilca basin	1	Yes	0.4	0.2
Into the sea				
Marcona	1	Yes	81.6	40.7
Ilo	4	No	1.4	0.7
Total	29	——	200.4	100.0

Source: UNEP, Fuentes, niveles y efectos de la contaminación marina en el Pacífico Sudeste, Informes y Estudios del Programa de Mares Regionales, No. 21, 1983, p. 92.

a/ It is not known what degree of treatment is provided or to what extent the information available is complete.

In several bauxite-producing countries, wastes from the bauxite-alumina industry are dumped into coastal waters, endangering the marine environment, including fish life, and negatively affecting the use of the waters for recreational purposes.47/ The volume of waste produced in the Caribbean may seem insignificant in comparison with that produced by the mining industry of the South American countries, but on small islands, given their limited land and water resources, the negative impact of mining wastes may be much more pronounced.

ii) Petroleum production. Oil production is a further important source of water pollution in the region, both near points of extraction and in the case of transport by pipelines and ships. Historically, pollution related to petroleum production was significant only in a few Latin American and Caribbean countries, most notably Trinidad and Tobago and Venezuela, where Lake Maracaibo and several other water bodies have suffered from oil pollution for many years. It has been estimated that in the basin of Lake Maracaibo, 15 minor oil spills occur each month on average.48/ The ecological balance of the lake has recently been reported to be "in mortal danger" due to pollution from oil spills and illegal dumping by oil tankers.49/

The discovery of major petroleum deposits and the development of oil production in Argentina; southern Chile; the foothills of the Andes in Bolivia, Ecuador and Peru; the central Amazon basin; the South Atlantic and the Gulf of Mexico has considerably increased the number of water bodies exposed to such pollution (see annex 3). There are some specific cases of severe pollution. For example, according to a recent report, the Coatzacoalcos and Tonala Rivers in Mexico could be considered to have the most extreme levels of hydrocarbon pollution yet discovered in any of the world's coastal regions. In the Coatzacoalcos River, in particular, traces of fossil hydrocarbons were up to 10 times higher than the normal levels, -- an indication of the huge impact of the petroleum industry in the region.50/

Petroleum pollution puts at risk not only inland water bodies but also coastal waters, which are polluted as a result of oil exploitation, the drilling of oil-wells and deliberate discharges from ships that ballast their oil tanks with sea water and following accidents. It has been estimated that the total ocean and sea spills of hydrocarbons in the region amount to more than 500 000 tons annualy and that sea transport is responsible for some 28% of those spills.51/

II. NON-POINT SOURCE WATER POLLUTION

The percolation, precipitation and unregulated run-off of already contaminated water into water bodies are the constituents of non-point source water pollution. Run-off from agricultural land and storm-water flows from urban areas are the most important of such sources in Latin America and the Caribbean.

A. RUN-OFF FROM AGRICULTURAL LAND

Run-off carries various pollutants in dissolved or suspended form from contaminated surfaces into water bodies. In the majority of Latin American and Caribbean countries, agriculture is the prime source of contaminated run-off.

While the contamination of agricultural run-off caused by man-made substances is of relatively recent origin, contamination by suspended solids and salts has been common for a long time. The principal source of sediment is soil erosion, which, although it reaches its maximum in mountainous terrain, is also widespread in lowland areas. Increased amounts of sediment can result in substantial economic losses downstream. For example, in Honduras a rapid buildup of sediment has been reported to be reducing the capacity of the reservoir that supplies water to Tegucigalpa.52/ Increased sediment loads may also affect irrigation, navigation and other beneficial uses of water, but hydro-electricity generation suffers the most.

Irrigation drainage water can be a major source of pollution. While advanced methods of irrigation produce virtually no return flows thanks to their high water-application efficiency rates (up to 98%), they are not widely used in the region. In most countries of the region farmers still practise surface-gravity irrigation involving either the channelling of water through parallel furrows or the flooding of entire fields. The volume of return flow may be as much as one-third or more of the original flow. Irrigation drainage waters tend to be contaminated by varying amounts of suspended solids, dissolved salts or sodium, fertilizers, pesticides, insecticides, herbicides, pathogenic organisms (when organic fertilizers are used), and other substances.

On its way through the soil, irrigation water dissolves naturally-occurring salts and carries them to surface water bodies or groundwater aquifers, thereby increasing their salinity --or alkalinity, if sodium is dissolved. Salinity can render water unsuitable for other uses and adversely affect aquatic life. At the same time, the reuse of drainage water for irrigation is substantially accelerating the process of soil salinization or alkalinization which affects many areas in South America, Central America and Mexico. For example, on the coast of Peru about 34% the of land is estimated to suffer from salinization and drainage problems.53/

A large and growing part of agricultural water pollution is caused by the use of fertilizers, pesticides, herbicides, insecticides and other chemical substances. Although the utilization of such substances continues to be low in Latin America and the Caribbean, in many cases the situation is aggravated by significant local abuses in application owing to a lack of knowledge of soil management techniques.54/

1. Fertilizers

The consumption of fertilizers in Latin America and the Caribbean increased by approximately 97% between 1973 and 1985. In comparison with developed countries, however, Latin American and Caribbean countries still use a substantially smaller volume of fertilizer. In 1984 the consumption of fertilizers per hectare of farmland in Latin America amounted to only 7.9 kg (N, P_2O_5, K_2O) compared with 142.7 kg in Europe and 45.8 kg in the United States. In some countries of the region, however (e.g., Cuba, Dominica, El Salvador, Saint Lucia, Suriname, and Trinidad and Tobago), the consumption of fertilizers is similar to that of developed countries.55/

The increasing use of fertilizers poses the following problems for the region's water resources:

a) Both synthetic fertilizers and animal wastes are important sources of nutrients. The accumulation of nutrients in water bodies, especially lakes and reservoirs, can contribute to eutrophication.

b) The use of organic residues as fertilizers not only causes nitrate and phosphorus pollution, but can also be a source of pollution by pathogens, ammonia, etc., and increased BOD. In zones of intensive cattle breeding, animal wastes, even if they are not used as fertilizers, can still harm water resources.

c) The increasing use of nitrogenous and phosphate fertilizers is leading to high nitrate and phosphorus concentrations, which pose potential health hazards.

2. Pesticides, herbicides, insecticides and other chemical substances

These materials can be transported to water bodies either indirectly -- through percolation, precipitation, or run-off-- or directly when used to control aquatic organisms, pests and weeds.

Two characteristics of these materials make them a major hazard for water resources:

a) They are both toxic to aquatic life and humans; this is particularly true of organophosphates, which tend to penetrate more deeply into the soil than organochlorinated compounds, thus increasing the threat to deeper aquifers.56/

b) They are frequently non-degradable or only degrade very slowly; for example, the toxicity of organic chlorinated compounds decreases by only 50% over 10 years. As a result, they not only tend to accumulate but also are prone to food chain concentration (i.e., they become concentrated instead of dispersed with each link in the food chain).

In general, the Latin American and Caribbean countries use a substantially lower level of agrotoxic chemicals in their agriculture than do developed countries. Nevertheless, although the total volume of consumption is not known, pesticide imports increased by almost half between 1971-1973 and 1983-1985.57/

Furthermore, pesticide consumption substantially exceeds the regional average in some areas. For example, in certain areas of the Pacific coast in Central America, 80 kilograms of pesticides are applied per hectare of cotton, which is one of the highest figures in the world, while El Salvador was reported to have used at least 20% of the world's total parathion output in a recent year.58/ Even where the use of pesticides and other similar products is not so intensive their application can still pose problems locally for water resource management:

a) The Latin American and Caribbean countries place relatively few restrictions on the use of agricultural chemicals. For example, from the list of agricultural chemicals in the United Nations publication Consolidated list of products whose consumption and/or sale have been banned, withdrawn, severely restricted or not approved by governments, some 20%-25% are subject to any restrictions in Latin American and Caribbean countries, and the majority of these restrictions are of recent origin (see annex 4).59/

As a result, the countries of the region continue to employ chemical substances whose use is either restricted or no longer permitted in countries with more stringent environmental legislation (see table 7).60/ An example is afforded by the pesticide dibromochloropropane (DBCP), which has been banned in many counties and is classified by the World Health Organization (WHO) as extremely hazardous; nevertheless, this pesticide has been reported to be in use in Costa Rica, Ecuador, Honduras and possibly in Colombia and Panama.61/

Although organic chlorinated compounds such as DDT and aldrin --which have been in use for more than 30 years and are still being used today-- play a key role in water pollution in the region, they are giving way to others, such as phosphates and carbamates. In Peru, for example, 55% of all imported insecticides in 1979, were organic chlorinated compounds and, prior to 1977, DDT and mercury containing fungicides were used without restriction.62/ DDT use is still widespread in several countries of Central America.63/

b) The improper application and misuse of these potentially dangerous materials or non-observance of existing legal limitations on their use frequently result in a high number of pesticide poisonings; it has been reported that about 1 800 pesticides poisonings per 600 000 population occur

Table 7

LATIN AMERICA AND THE CARIBBEAN: PESTICIDES USED IN OR SOLD TO AGRICULTURE WHOSE CONSUMPTION AND/OR SALE HAVE BEEN BANNED, WITHDRAWN, SEVERELY RESTRICTED OR NOT APPROVED BY GOVERNMENTS a/

Product	Country	Year b/	100 kg
ALDRIN c/	Argentina	1984	5 832
	Ecuador	1984	689
	El Salvador	1979/81	432
	Guatemala	1979/81	1 470
	Guyana	1979/81	22
	Mexico	1985	1 000
	Suriname	1979/81	630
	Uruguay	1985	126
ARSENICALS	Uruguay	1979/81	26
BHC	Argentina	1984	60
	El Salvador	1979/81	12
	Mexico	1985	2 500
	Suriname	1979/81	961
DDT	Argentina	1979/81	6
	Ecuador	1984	4 000
	El Salvador	1979/81	1 269
	Guatemala	1979/81	12 570
	Mexico	1985	3 000
	Suriname	1979/81	33
LINDANE	Argentina	1984	1 725
	Guatemala	1979/81	11
	Honduras	1986	1 371
	Mexico	1985	150
	Uruguay	1985	5
PARATHION	Argentina	1984	9 234
	Ecuador	1984	584
	El Salvador	1979/81	12 144
	Guatemala	1979/81	905
	Honduras	1986	1 360
	Mexico	1985	46 000
	Uruguay	1985	140

Product	Country	Year b/	100 kg
TOXAPHENE	El Salvador	1979/81	5 252
	Mexico	1985	6 000
2,4-D	Argentina	1984	12 024
	Ecuador	1984	8 684
	Honduras	1985	28
	Mexico	1985	14 000
	Suriname	1979/81	525
	Uruguay	1985	1 424
2,4,5-T	Argentina	1979/81	117
	El Salvador	1979/81	168
	Guatemala	1979/81	124
	Mexico	1984	500
	Suriname	1979/81	200

Source: FAO, 1987 FAO Production Yearbook, Vol. 41, Rome, 1988, pp. 9-10 and 119-127; and United nations, Consolidated list of products whose consumption and/or sale have been banned, withdrawn, severely restricted or not approved by governments, ST/ESA/192, 1987, Second issue.

a/ Data refer generally to quantities of pesticides used in, or sold to agriculture. They are shown in terms of active ingredients, except for Ecuador and Guatemala, where data refer to formulation weight. Formulation weight usually includes active ingredients plus diluents and adjuvants.
b/ The latest year for which consumption data have been available.
c/ Consumption figures are for aldin and similar insecticides.

in Central America annually, in comparison with only 1 per 600 000 a year in the United States. In a recent five-year period approximately 17 000 pesticide poisonings were medically certified in Guatemala and El Salvador alone.64/ One of the contributing factors is that in some countries there is no centralized authority for the administration of the trade, use and application of pesticides.

3. The regional situation

Little information exists on the impact of chemicals used in agriculture on the water resources of the region. Brazil, however, with a consumption level of some 150 000 tons annually, ranks among the top five countries in the world in terms of pesticide use. Moreover, several of the products still in use in Brazil, including aldrin, eldrin, ethilic parathion, heptachlor and lindane, have been banned or restricted in a number of European countries and the United States.65/

Agriculture-related water pollution has been identified in several South American countries, including Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Peru and Venezuela, as well as in several water bodies in Central American and Caribbean countries.

Apart from the agriculture-related water pollution caused by fertilizers and agrotoxic chemicals, abstractions from rivers for irrigation and other purposes can alter the annual hydrograph and thereby indirectly affect water quality. Under certain circumstances, this may lead to saline water penetration into deltas or estuaries and the problem may be aggravated if abstractions are made during periods of low flow. Saline intrusion is particularly noticeable in the rivers of tropical countries where there is a large difference between maximum and minimum flows. This phenomenon has been observed in the River Guayas, Ecuador, where saltwater intrusion has precluded the river's use as a source of water supply for the city of Guayaquil during periods of low flow.66/

Abstractions of water reduce the amount of water available for the dilution of domestic and industrial effluents and thus give rise to a corresponding increase in the intensity of pollution.67/ This can be particularly significant in the case of industries characterized by a seasonal pattern of production, such as sugar or coffee processing, whose peak periods of activity coincide with major abstractions and low flows.

B. STORM-WATER RUN-OFF

In Latin America and the Caribbean the use of separate storm drainage systems is generally limited. In the majority of the urban areas, most storm-water run-off is channeled into the natural drainage system. A proportion, however, of storm-water enters the sanitary sewerage systems. As much of the region lies in tropical and sub-tropical zones characterized by heavy rainfall, the amount of storm-water run-off from urbanized areas can be significant (see table 8). The pollutant potential of urban storm-water run-off is related to its BOD strength, suspended solids content, organic and inorganic (particularly phosphorus, nitrogen and lead) pollutant load and bacterial contamination.68/ A comparison of the chemical characteristics of storm-water run-off and those of other urban effluents shows that they are, to a certain extent, comparable sources of water pollution. Given the possible volumes of storm-water run-off in major urban areas it can be an important source of pollution.

When collected in combined sewerage systems, storm-water run-off may also result in the hydraulic overloading of these systems and of sewage treatment plants. This may aggravate pre-existing pollution problems and cause the contamination of urban areas. Overloading of sewerage systems and treatment plants by storm-water run-off represents a particularly serious problem in the region because many Latin American cities lack storm sewer networks. For example, storm-water run-off has been reported to have caused

Table 8

ESTIMATED AVERAGE POTENTIAL STORM-WATER RUN-OFF FROM 1 SQUARE KILOMETRE, IN SELECTED LATIN AMERICAN CITIES

Country	City	Estimated average storm-water run-off $m^3/min/km^2$	
		Annual average	Rainiest month
1. Argentina	Buenos Aires	1.1	1.5
2. Bolivia	La Paz	0.6	1.6
3. Brazil	Rio de Janeiro	1.2	1.8
4. Chile	Santiago	0.4	1.1
5. Colombia	Bogotá	1.1	2.0
6. Costa Rica	San José	2.1	4.4
7. Ecuador	Guayaquil	1.1	3.4
8. El Salvador	San Salvador	2.0	4.4
9. Honduras	Tegucigalpa	1.0	2.6
10. Mexico	Mexico City	0.9	2.2
11. Nicaragua	Managua	1.4	3.9
12. Paraguay	Asunción	1.5	2.1
13. Peru	Lima	0.03	0.08
14. Suriname	Paramaribo	2.5	4.3
15. Uruguay	Montevideo	1.2	1.4
16. Venezuela	Caracas	0.9	1.5

Source: Estimated on the basis of information from FAO, Datos agroclimatológicos de América Latina y El Caribe, Rome, 1985; and on the assumption that storm-water run-off represents 60% of the original precipitation.

damage to water supply and sewerage systems in several cities of Honduras. This was accompanied by contamination problems.69/ In Santiago, Chile, rainwater periodically finds its way into the sewerage network and causes the collector chambers in some sectors of the city to overflow.70/

C. PERCOLATION OF POLLUTED WATER INTO GROUNDWATER

Seepage from waste dumps, septic tanks, sewerage systems, oil and chemical spills and the use of water for irrigation, watering, street-flushing, etc., can result in the slow percolation of polluted water into groundwater and its subsequent contamination. Eventually, such contaminated groundwater will find its way into rivers, lakes and reservoirs.

Groundwater pollution is a cause of particular concern in Latin America and the Caribbean because many cities, including several large metropolitan centres, such as Mexico City and Havana, as well as the extensive arid and semi-arid areas in much of the region and thousands of rural communities rely on springs and wells for drinking water and irrigation. Much of the rural dispersed population uses such for drinking water and latrines. The bad siting of latrines commonly leads to contamination of the well.

The percolation of water contaminated by fertilizers and toxic agrochemicals does not represent, however, such an acute problem in the majority of Latin American and Caribbean countries as in more developed regions. This is due both to the substantially lower utilization of these materials in the region's agriculture and to the predominant climatic and soil characteristics. According to recent assessments, in tropical climates certain soils have a lower risk of nitrate leaching than do similar areas under temperate conditions.71/

One particular aspect of the percolation problem is the intrusion of saltwater as a result of the growing use of groundwater from coastal aquifers for irrigation as well as for other purposes. This phenomenon can be seen in many coastal areas of the region, particularly in islands of the West Indies where intensive irrigated agriculture is based on groundwater utilization. In Caribbean countries groundwater is also frequently used for water supply. Other examples are to be found in Argentina, where saline water intrusion has been reported to threaten coastal areas near the city of Mar del Plata and to have caused the salinization of some aquifers in the area of Buenos Aires.72/ Saltwater intrusion has also been reported in El Salvador and Mexico.

The percolation of polluted water from septic tanks, sewerage systems and waste dumps is also a significant source of groundwater contamination in the region:

a) The percolation of water contaminated by human wastes from septic tanks, which are widely used in the region, and from sewerage systems, which are usually poorly maintained, is a major source of groundwater contamination, particularly by microorganisms and nitrates. In several cities as much as 50% of the water supply is lost through leakage (for example, distribution losses in Buenos Aires, Argentina, are reported to amount to 4.7 - 9.5 m^3/sec).73/ Although similar information is not available in regard to sewerage systems, there is no reason to believe that leakage does not occur.

Cases of groundwater pollution have been reported in many large metropolitan areas (e.g., in Buenos Aires,74/ Santiago,75/ and Mexico City). In Mexico City, in the neighbourhood of Xochimilco, it has been necessary to close several wells because of an excessive concentration of nitrates in the water, possibly due to pollution from the Chalco Channel, which transports urban sewage.76/ Also in Mexico, the dumping of waste water in the subsoil of the city of Mérida is reported to have resulted in the severe pollution of groundwater aquifers of the city, and some of its outlying areas.77/

b) The seepage of toxic chemicals from industrial liquid waste dumps and solid waste dumps containing household garbage is a further threat to the region's groundwater resources. It has been estimated that total urban solid waste production in Latin America and the Caribbean was 160 000 tons a day in 1984 and that the amount of such waste that is generated has been growing at the rate of 4% annually since 1980.78/ The total potential regional leachate from this volume of solid waste may reach 5 - 6 m^3/sec, with an expected increase to 9 - 10 m^3/sec by the year 2000.79/ Given that leachate from sanitary landfills usually contains high concentrations of both organic and ammoniacal nitrates, copper, zinc, nickel, phosphates, sulfates, chlorates, CO_2, SO_3, etc. and is characterized by high pH and extremely high BOD (in the range of 20 000-30 000 mg/l),80/ the risk to the region's groundwater resources is obvious. It should be noted that, in general, in Latin American countries industrial wastes are dumped together with domestic wastes. Of the countries for which information is available, only Brazil and Mexico have begun to use technologies for industrial waste disposal that take environmental protection needs into consideration.81/

An equally important and related problem in many countries of the region is the direct tipping of solid wastes into water bodies. For example, it has been estimated that in Colombia about 25% of solid wastes are disposed of by tipping them into bodies of water 82/ (some 184 000 tons are dumped every year in the basin of the Medellín River alone).83/ In Ecuador, the dumping of some 3 300 tons a year of solid wastes has been reported to have impaired the water quality of the Tomebamba and Machánagara rivers.84/ Direct tipping of solid wastes into bodies of water has also been reported in Haiti and the Netherlands Antilles.85/ In Guanabara Bay, Brazil, most of the solid wastes are dumped at the edge of the bay, with the city of Rio de Janeiro alone dumping over 3 000 tons daily.86/ Household solid wastes have also been reported to contribute to water pollution problems in the Caracas Metropolitan Region in Venezuela.87/

D. PRECIPITATION OF POLLUTED WATER

Precipitation tends to absorb certain air pollutants, gases, particles, pathogens, etc. and to carry them directly or indirectly, through run-off or percolation, into water bodies. For a long time this was presumed to be an insignificant source of water pollution in comparison with other non-point sources. In recent years, however, as a result of research on acid rain and toxic metals, the precipitation of polluted water and pollution loading from dry atmospheric deposition are receiving increasing attention.88/ Polluted precipitation may represent a particular problem in many Caribbean countries where rainwater is an important source of drinking water.

There is virtually no information on the relationship between air and water pollution in Latin America and the Caribbean. The characteristics of predominantly airborne pollutants found in the region are such as to suggest that many of them can be transferred to water bodies from the air by rain. One of the few areas of the region for which information on the chemical characteristics of precipitation is available is Cerro Verde in El Salvador (see table 9). A few cases of pollution through precipitation have been reported in the highly industrialized southeastern section of

Table 9

PRECIPITATION CHEMISTRY MONITORING, 1975-1982, IN EL SALVADOR (CERRO VERDE)

Characteristic	1975/1976	1977/1978	1979/1980
1. Average annual pH			
- El Salvador, Cerro Verde	4.7	5.5	5.1
- average for locations in the United States and Canada	5.3 a/	5.4 b/	5.5c/
2. Average annual concentration of sulfate (milligrams per litre)			
- El Salvador, Cerro Verde	n/a	0.54	0.70
- average for locations in the United States and Canada	1.20 a/	1.04 b/	1.04c/
3. Average annual concentration of nitrate (milligrams per litre)			
- El Salvador, Cerro Verde	n/a	0.03	0.36
- average for locations in the United States and Canada	0.38 d/	0.45 e/	0.44c/

Source: World Resources Institute and International Institute for Environment and Development, World Resources 1986, p. 324.

a/ Average for 17 locations.
b/ Average for 22 locations.
c/ Average for 23 locations.
d/ Average for 16 locations.
e/ Average for 21 locations.

n/a = Not available.

Brazil, where some soils have become acidic as a result of acid rains. Brazil is particularly vulnerable in this respect because in a number of areas (e.g., the Amazon basin) the soil is naturally acidic.89/ In Chile, acidic precipitations has been detected in the Santiago Metropolitan Region, as well as in the localities of Caletones, Catemu, Nos, Puchuncavi and Ventanas, and precipitation contaminated by heavy metals and industrial elements in regions V and VIII.90/ In addition to cases of acidic precipitation, at least one instance of seawater pollution by gases originating from fish processing plants has been reported in Peru.91/

III. THE IMPACT OF WATER POLLUTION ON HUMAN HEALTH AND WELFARE

Untreated human wastes are generally considered to be the most dangerous environmental threat to human health. In Latin America and the Caribbean despite the advance made in recent years diseases transmitted through water contaminated by human waste are still very common, although deaths from diarrroheic diseases have decreased dramatically in the last 20 years. Deaths from such diseases remain, however, the first or second principal cause of death in children under 1 year old and from 1 to 6 years old in those countries with the highest rates of infant mortality.92/

A. HUMAN WASTES AND HUMAN HEALTH

Water pollution by domestic wastes, organic matter and certain other substances plays a major role in the transmission of various diseases, including cholera, typhoid fever, dysentery, other intestinal infectious diseases, etc. The mechanisms of disease transmission vary. Initially, causative organisms find their way into water bodies either as part of domestic sewage and the effluent of certain industries (particularly meat packing and processing) or from other sources since they are present in the environment. Water polluted by organics provides a good breeding ground for microorganisms, which survive and/or reproduce there until they enter the human body. Direct transmission can occur through drinking water: in 1985, 14% of the urban population of the region and 55% of the rural population still lacked a protected source of drinking water. Even when a supply of drinking water is available, the water is not always of adequate quality. The sale of bottled water in urban areas reflects a general concern with the quality of the public water supply. Moreover, the contamination of water bodies used as a source of drinking water increases the cost of treatment.

In addition to the direct contamination of drinking water there are other routes of transmission. Certain diseases are transmitted by bathing in polluted water. Indirect transmission can occur through contaminated agricultural products and fish, the bite of an insect vector that breeds in polluted water, etc.

Undeniably, the pollution of surface waters by domestic sewage poses serious health problems for the population, particularly in urban areas. It is generally agreed that both the high rate of infant mortality and the incidence of various intestinal infectious diseases, which are markedly higher in the region than in developed countries (figure 6), can be, at least partially attributed to the biological pollution of water bodies by human wastes. For example, according to a study carried out by the School of Public Health of the University of Antioquia to determine the health benefits of controlling the pollution of the Medellín River (Colombia), 0.3% of all deaths in the city, 28.8% of deaths from enteritis and diarrhoea, and 71.4% of deaths from tuberculosis could be avoided. Considering the medical expenses involved, days off work, production losses, etc., the public health benefits were estimated to amount to US$ 3 600 000 (1982).93/ In Chile, although only 30% of the national population lives in Santiago, the city accounts for 60% of all cases of typhoid fever.94/ Both Medellín and Santiago are characterized by a high level of bacteriological contamination of adjacent water bodies due to a lack of sewage treatment. In Mexico, salmonella poisoning and other gastric problems have been reported to be above the national average among the 1 500 000 people living near the heavily-polluted Coatzacoalcos River.95/ The segment of the population which is most affected by such problems is usually composed of low-income groups that lacks safe water supply, sewerage facilities or medical services.

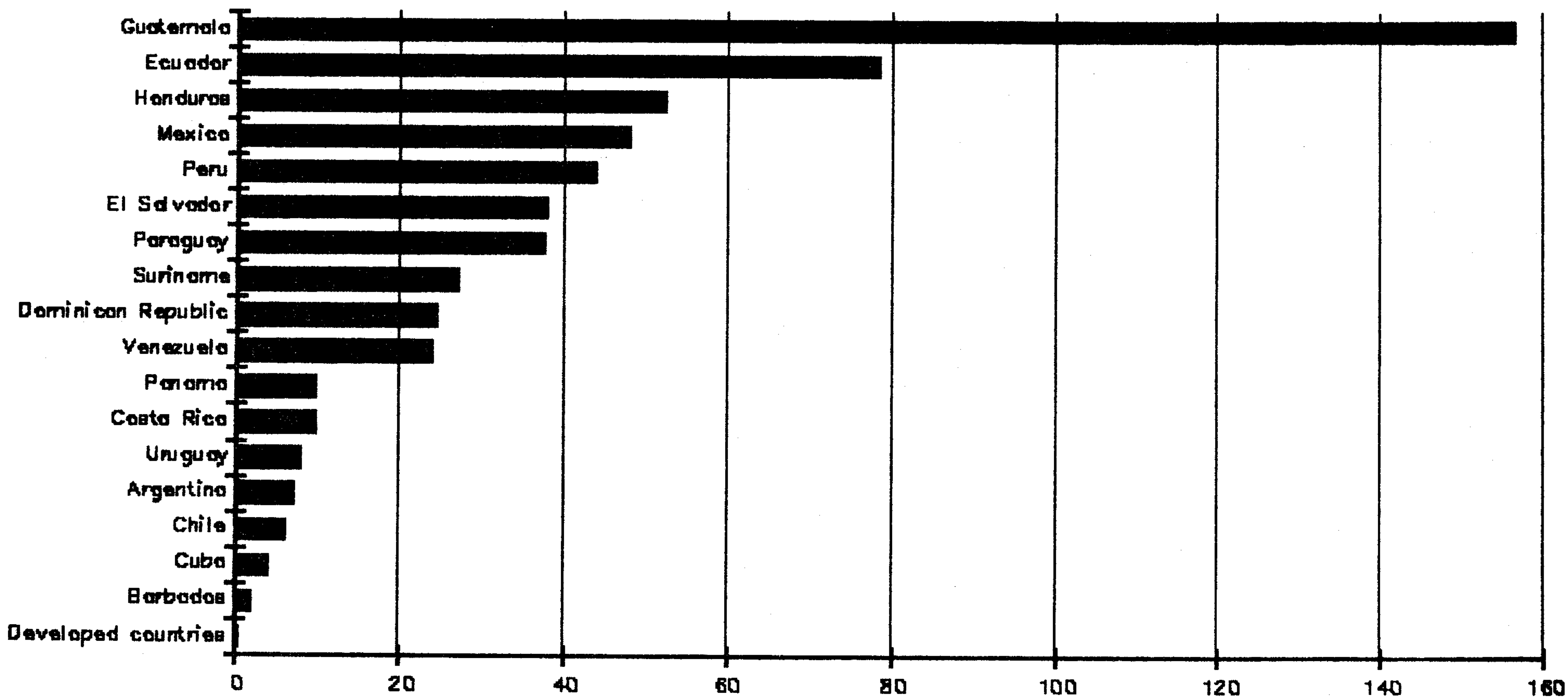
B. THE CONSEQUENCES OF THE USE OF POLLUTED WATER FOR IRRIGATION

A problem particular to point-source water pollution of urban origin is the use of already contaminated water for irrigation. This frequently occurs in areas where large urban centres are located in zones of irrigated agriculture and where untreated waste flows are returned to watercourses which are subsequently used for irrigation. One motivation for the use of waste water for irrigation is the fact that the nutrients in it may be regarded as cheap fertilizers capable of substantially improving crop yields.

The use of untreated waste water for irrigation —a practice which is widespread in the countries of the region— may give rise to serious sanitary problems, particularly if adequate sanitation and treatment standards are not maintained. Both pathogens and heavy metals, apart from having direct harmful effects on crops and soils, are able to enter the food chain along with other pollutants. For example, reports indicate that in Santiago, Chile, the risk involved in consuming raw vegetables originating from nearby areas may be as much as five times higher than that associated with vegetables grown in coastal areas.96/ In Mexico City, after little or no treatment, waste waters, including those contaminated by heavy metals and toxic organic compounds, have been used for irrigation. As a result, contaminants have been discovered in vegetables and other crops which give cause for concern about long-term health risks.97/ In Argentina, the

Figure 6

DEATHS FROM TYPHOID FEVER AND OTHER INTESTINAL INFECTIOUS DISEASES, RATES PER 100 000 POPULATION



Source: WHO, information for various recent years.

pollution of water used for irrigation has also been identified in the Grande and Primero Rivers.98/ In Cuba, water from the Almendares River and Arroyo Grande was reportedly being used for the irrigation of vegetables in spite of the level of microbacteriological contamination.99/

C. RECREATION AND HEALTH

Offensive smells, floating materials (particularly sewage solids) and certain other pollutants including high suspended sediments, dyes, etc., can create aesthetically repellent conditions for recreational uses of water and reduce its visual appeal. Even more importantly elevated levels of bacteriological contamination and, to a lesser extent, other types of pollution can render water bodies unsuitable for recreational use. This is of particular concern in those countries where tourism is an important source of foreign exchange and employment. Several tourist areas in the region are affected to various degrees by water pollution, including such popular resorts as Guanabara Bay in Brazil,100/ Viña del Mar in Chile and Cartagena in Colombia.101/

In general, recreation is a much neglected use of water in the region hardly considered in the process of water management. The available information suggests, however, that pollution in recreational areas is a serious problem. This is particularly the case as the recreational use of water is very popular and it is concentrated in those water bodies closest to the large metropolitan areas. Many of these are increasingly contaminated by domestic sewage and industrial effluents.

IV. WATER POLLUTION CONTROL

The increasing contamination of surface and groundwater has prompted the governments of many Latin American and Caribbean countries to adopt measures for combating water pollution. These include laws designed to control water pollution, water quality monitoring and more widespread treatment of waste water and incipient attempts to control some non-point pollution.

A. LAWS AIMED AT CONTROLLING WATER POLLUTION

Most countries have begun to develop a body of law providing for water pollution control. Many countries now have the necessary basic legislation to empower public agencies to take steps to control water pollution. In addition, several countries have incorporated provisions relating to environmental protection in their laws and, in a few, a guarantee of a clean environment is even contained in their national constitutions (for example, the Constitutions of Chile (article 19), Cuba, Guyana (articles 25-36), Panama (article 114) and Peru (article 123)).

Colombia, Mexico and Venezuela can be cited as having the most comprehensive legislation and the strongest institutions for environmental management.102/ In particular, Colombia possesses one of the most comprehensive bodies of environmental law, the National Renewable Natural Resources and Environmental Protection Code (decree 2811, dated December 18, 1974). This legislation, which has been referred to as the first "omni-comprehensive law in the world", deals with all elements of the environment in an integrated form.103/ Furthermore, water quality and pollution control in Colombia are also subject to the Sanitary Code, which was framed in 1945 and revised in 1979. In 1984 a section on water quality was added to the Code, and this was followed by pollution control regulations.104/ Other countries in the region have made fewer advances in institutionalizing the consideration of the environment in resource management.

In the majority of countries, regulations relating to water pollution control are incorporated not only in their environmental law, but also in the laws governing different spheres of water resource management and use. For example, in Antigua and Barbuda the public health laws prohibit the pollution of watercourses and drains, while in Jamaica the Mining Act contains some safeguards against pollution.105/ In many countries there are specific laws, sometimes dating back several decades, regulating pollution originating from major sources of contamination. One example is Venezuela, which adopted a law to control pollution from hydrocarbons as long ago as 1936.106/

In most cases the legislation specifically prohibits the discharge of untreated or inadequately treated effluent into bodies of water. For example, in Ecuador the Environmental Pollution Prevention and Control Act (decree 374, dated June 21, 1976) prohibits the discharge of untreated wastes into sewerage networks, lakes, rivers, etc., as well as the infiltration into the ground of waste water containing contaminants harmful to human health, fauna, flora or property.107/ In Cuba, Law Number 33, which deals with environmental protection and the rational use of natural resources (dated February 12, 1981), requires an adequate treatment of waste before its discharge into the environment.108/

Licensing the construction and operation of potentially contaminating industrial plants and processes is a relatively frequent means of controlling discharges. Such provisions are, for example, incorporated in the respective laws of Brazil, Colombia and Mexico.109/ In Brazil, the existing legislation delegates the authority to grant licenses to the state governments and in certain cases, to the municipalities. However, the granting of licenses for some activities, such as the operation of nuclear plants, is the exclusive prerrogative of the Federal Government.110/ In Cuba, all agencies that invest in the water resources sector must obtain the prior approval of the Water Economy Institute for each project in respect of the nature and disposal of effluents, the source of the water and the volume to be used.111/ In the Dominican Republic, a concession is required for the use of water in industry and mining. Such concessions remain in effect so long as the activity in question does not infringe the law by polluting the water with substances harmful to health, vegetation or to fish and fisheries.112/ The legislation of several countries (including Colombia, Cuba, Ecuador and Mexico) provides for the establishment of emissions standards governing the physical, chemical and biological composition of effluents.113/ In Ecuador, the Environmental Pollution Prevention and Control Act authorizes the Ministry of Health to establish the degree of treatment that effluents should receive.114/ Legislation in several countries —including Brazil, Colombia, Cuba and Mexico— provides for restrictive zoning. In some cases such laws refer to the protection of groundwater wells, upper watersheds, etc.115/ For example, in Montserrat a specific ban on activities likely to pollute surface water bodies is in effect within areas over which the Government has authority for water resource conservation and protection purposes.116/ In Cuba, the location of activities whose effluents, even when treated, pose potential risks of contamination is prohibited in the catchment areas of water supply sources for population and industry.117/

Pollution control legislation usually specifies the measures to be used to ensure compliance with the established norms. In Latin America and the Caribbean these provisions cover a wide spectrum, ranging from economic measures (such as direct effluent charges, fines and incentives for the development and construction of water treatment facilities) to administrative measures (such as the temporary or definite prohibition of pollution-causing activities or plants). In the case of pollution of, or in close proximity to, the sources of public water supplies, sanctions may even include imprisonment. As for economic measures, Brazil and Colombia, for example, have explicitly adopted the "polluter pays" principle in their legislation.118/ The legislation of Brazil, Colombia and Mexico provides for educational measures and the promotion of public awareness as a means of combating pollution.119/ Very strong penalties for offenders —including plant closures— have been recently introduced in Colombia.120/

Several countries of the region have adopted the requirement that all new projects be evaluated in terms of their impact on the environment, including possible water pollution. Although environmental impact evaluation provisions have not yet become widespread, they do figure in the legislation of Brazil, Colombia, Ecuador and Mexico, among other countries.121/ For example, in Colombia under the National Renewable Natural Resources and Environmental Protection Code, every person planning to undertake any activity likely to cause environmental degradation is required to submit a statement concerning the projected environmental risks involved. At the same time, an ecological and environmental study is necessary prior to any activity that may cause a serious degree of deterioration of renewable natural resources or the environment.122/

Few Latin American and Caribbean countries have comprehensive restrictions on the use of chemicals in agriculture. Of the countries for which information is available, Argentina, Colombia and Ecuador seem to have the most developed legislation (see annex 4).123/ In Mexico a new environmental law regulating the sale and use of toxic substances was to go into effect in 1988.124/ The legislation of several countries also contains provisions regulating the use of effluents for irrigation. For example, in Mexico, the Federal Environmental Protection Act provides that urban sewage may be used in industry and agriculture only if it is treated in accordance with the standards set by the Department of Urban Development and Ecology in co-ordination with the Department of Agriculture and Water Resources and the Department of Health and Welfare.125/

The apparent contradiction between the widespread occurrence of water pollution and the existence of sophisticated control legislation in many Latin American and Caribbean countries seems to arise from the fact that the implementation of such legislation is usually weak. In some cases regulations may not have been promulgated, while in others, even when appropriate norms do exist, their application is frequently hampered by the dispersion of legislative authority, the failure to set out the provisions of such regulations in sufficient detail, or both.

Positive steps have been taken, however, particularly in the more industrialized countries of the region, towards the serious control of polluting industries and the enforcement of requirements that effluent be treated. The same trend can be seen in regard to other sources of water pollution as well, particularly the treatment of municipal wastes. Evidence of this is provided by the adoption of policies on pollution abatement and control. Examples include the announcement in 1984 of a nationwide plan for the control of water pollution in Argentina,126/ the preparation of a number of studies on polluted water bodies, and the taking of specific measures to control emissions (e.g., a water pollution control programme for the city of Bogota, Colombia, has resulted in the installation of effluent treatment plants in dozens of factories).127/ Studies on the behaviour of water bodies for the purpose of planning pollution control measures have been undertaken in Havana Bay (Cuba), in Guanabara Bay (Brazil), off Montevideo (Uruguay) and Valparaíso (Chile), in the basin of the Yaracuy River (Venezuela), and elsewhere. As a result of sustained efforts in this connection, the decline in water quality in the State of Sao Paulo, Brazil, has been reported to be levelling off and, in some cases, even to be improving; some areas which had reached critical levels have been reduced to point problems and fish are re-entering certain rivers.

B. WATER QUALITY MONITORING

Even the best water pollution law is almost certain to fall short of its objectives if it is not supported by an adequate water quality monitoring network. Legislation in Colombia, Costa Rica and Cuba specifically provides for the collection, classification and dissemination of information related to the environment and its conservation. On-going monitoring of the environment and of its state of preservation is provided for by the laws of Brazil, Colombia, Cuba and Mexico.128/

An efficient water quality monitoring network should be able to measure the quality of potable water, of surface and groundwater in situ, and of effluent, as well as being capable of tracing specific pollutants to their sources. Of these three types of water quality monitoring, the control of drinking-water quality is the most highly developed in the region, and all the countries have laboratories for its analysis. In general, potable water control is best organized in the larger cities.129/ It should be noted, however, that some countries continue to experience problems in relation to the quality of their drinking water.

The measurement of surface and groundwater quality, particularly in the most densely populated, urbanized and industrialized river basins, has progressed considerably in the region, and especially in Argentina, Brazil, Chile and Mexico. In these countries systematic studies have been made of the pollution problems of many water bodies.

Most municipal and industrial effluents are discharged into water bodies without any prior treatment and consequently, the monitoring of waste water quality is limited. It is only practised only at the few existing effluent treatment facilities as a means of assessing the treatment process.

Thus, few countries have, as yet, adequate water quality monitoring networks. According to a United Nations survey, in 1983 the majority of Latin American and Caribbean countries considered their water quality observation networks to be insufficient, although reliable, and most of the countries had plans to expand existing networks.130/ Nonetheless, several countries do have relatively well developed national water quality monitoring networks. In Brazil, the National Water and Electrical Power Department (DNAEE) has been surveying water quality parameters since 1973 and, since 1978 the water quality network has been operating with Brazilian-made equipment.131/ This constitutes a notable achievement since many countries of the region must import monitoring equipment and have subsequently experienced difficulties related to servicing and spare parts. In Chile, the Bureau of Water Resources not only operates two networks used in the monitoring of water quality, but is also developing a modern computerized system for the storage and retrieval of hydro-meteorological information.132/ In Cuba, the National Network of Control Laboratories, comprising 37 Health and Epidemiology Laboratories and the National Institute of Health, Epidemiology and Microbiology (INHEM), monitors water quality, while INHEM regulates and supervises the Network's laboratories.133/ In Panama, the Institute of Water Resources and Electrification (IRHE) initiated a national water quality monitoring programme in 1975 and now maintains a network of some 200 water quality stations. Data validity is continuously checked by means of analytical quality control systems.134/ The use of remote-sensing technologies for water quality monitoring is being investigated in a number of countries.

Assistance has been provided in connection with much of the work being done in the field of water quality monitoring by the programmes of the Pan American Center for Sanitary Engineering and Environmental Science (CEPIS) of the Pan American Health Organization (PAHO) and by the United Nations Environment Programme (UNEP).

C. TECHNOLOGICAL ADVANCES IN WATER POLLUTION CONTROL

One of the main difficulties that Latin American and Caribbean countries face in improving water pollution control is the high cost of waste water treatment. Moreover, such local factors as the lack of qualified personnel, social and climatic particularities, the specific chemical composition of sewage and industrial effluent, etc., hinder the direct application of water treatment technologies developed in other regions. In several countries of the region, efforts are being made to develop relatively simple and low-cost waste treatment techniques, such as stabilization (facultative, maturation or anaerobic) ponds, and methods based on the use of locally available products.

Some countries (e.g., Brazil, Colombia, Costa Rica and Mexico) have even incorporated provisions into their legislation concerning the development of appropriate technologies as a means of environmental protection.135/

1. Waste treatment

Stabilization ponds are widely recognized as being a low-cost, highly efficient method of sewage treatment, particularly in tropical and subtropical regions. These two features make them very attractive in Latin America and the Caribbean, and stabilization pond research has been carried out in several countries. For example, research at the Federal University of Paraiba in Brazil has demonstrated that stabilization ponds substantially reduce BOD and suspended solids and are especially effective in removing excreted pathogens; in fact, the results of this techniques were found to be several thousands of percentage points better in this respect than conventional treatment systems.136/

Extensive research in the field of industrial and domestic sewage treatment is being carried out by CETESB in Brazil and has included the study of simple aeration systems, criteria for settling ponds, oxidation systems, etc. Waste water treatment-related research is also being conducted in other states of Brazil as well. For example, the Water and Sewerage Company of the State of Parana (Companhia de Agua e Esgotos do Parana - SANEPAR) has been actively studying anaerobic digestors for the conversion of biodegradable pollutants into methane gas and agricultural fertilizer, the utilization of methane gas obtained from sewage gas as an automotive fuel, the use of coagulants other than alum, and other subjects.137/

In several countries research has been accompanied by efforts to introduce simple and low-cost waste treatment techniques in smaller towns and villages. One example of such an initiative is the Proyecto de Desarrollo Tecnológico de Instituciones de Agua Potable y Alcantarillado in Peru, which has been undertaken with the assistance of CEPIS.

Another positive development is that some countries have begun to promote and encourage waste water reuse. This is particularly the case in areas characterized not only by water pollution problems but also by acute water shortages. Sewage reuse is of particular interest for the region's agriculture since it is known to be rich in nutrients, mainly nitrogen and phosphorus, and --after adequate treatment-- represents a valuable and low-cost agricultural input. Undoubtedly, the most notable example in the field of waste water reuse is to be found in the Federal District of Mexico, where recycled waste water accounts for some 4% (155 500 m^3/day) of current water use (mainly in recreational lakes and in the irrigation of public parks). According to existing plans, by the year 2000 about 17% of the District's waste water will be reused to supply some 12% of the projected water demand.138/ The Mexico scheme is also considered to represent the largest-scale use of raw sewage for irrigation in the world. Currently, approximately 82 000 ha are irrigated by raw sewage around the capital, and there are plans to convert a further 128 000 ha of land elsewhere in the country to sewage-fed irrigation. Before expanding the project, a detailed study on the health risks involved is to be carried out.139/ In Peru a research project has been undertaken at San Juan de Miraflores (near Lima) since 1961 to investigate the productive reuse of sewage waste water for irrigation; currently 500 ha are being irrigated by this means, and there are plans to use this method on another 1 300 ha in the future.140/

One important step forward has been the establishment, under the leadership of CEPIS, of a regional information system on the environmental health aspects of water management through the Pan American Network for Information and Documentation in Sanitary Engineering and Environmental Sciences (REPIDISCA).

A great deal of research is being done on the use of local products for waste treatment. For example, in Bolivia, with assistance from UNESCO, the utilization of Schocnoplectus tatora seeds and of aquatic weeds for water purification has been studied.141/ Other countries have investigated bacterial leaching. This technology, apart from permitting the extraction of metals from low-grade ores and concentrates, provides the possibility of using mine waste dumps productively while also curbing pollution, since the tailings undergo a chemical change as part of this process which renders them harmless. Industrial applications of this technology are in use at Cerro de Pasco in Peru and at Cananea in Mexico, and other projects are under consideration. In addition, research has been reported to be underway in Chile with a view to improving the bacterial action.142/ Another achievement has been the utilization of the large quantities of waste products generated by the coffee processing industry in Costa Rica for animal feed. At present, about one-third of the coffee-processing waste generated in Costa Rica is being used in the production of an energy-rich and nutritious animal food.143/

2. Biological control of agricultural pests

Research into means of reducing contamination by agrotoxic chemicals has led to the exploration of alternative methods of pest control, including biological techniques --although these are not yet in widespread use. An exception is Mexico, where in 1987 an estimated 765 000 ha of farmland (60% more than in 1986) were reported to be protected by biological means of pest control.144/ Biological control has also been successfully used in Costa Rica on banana plantations. Other applications, which have resulted in a substantial reduction of insecticide and pesticide use, have been undertaken in Brazil and Nicaragua. In Brazil, impressive advances have been made in the application of alternative methods of pest control in the production of soybeans; participating farmers have reportedly achieved a reduction of insecticide use of up to 80% - 90%.145/

3. Human resource development

One significant obstacle to better pollution control is the lack of appropriately qualified personnel. This lack tends to be aggravated by the low salaries prevailing in many national civil services and the consequent high staff turnover rates. There is in the region, however, much attention being given to the education and training of the required personnel.

Most countries have some form of training related to pollution control and waste disposal and there are institutions in some countries, as well as international organizations that offer training on a regionwide basis. For example, courses are offered at the Escuela Regional de Ingeniería Sanitaria (ERIS) at the University of San Carlos in Guatemala, at the Pan American Centre for Sanitary Engineering (CEPIS) of the Pan American Health Organization in Lima, Peru and at the Inter-American Centre for Integrated Land and Water Development (CIDIAT) in Merida, Venezuela. Some national courses are open to students from all Latin American and Caribbean countries. Equally important is the fact that several of these organizations are actively engaged in waste water treatment research.

D. THE WORK OF INTERNATIONAL ORGANIZATIONS

Various international and regional organizations are working in the field of water pollution control. Their activities focus on the preparation of studies (both at office level and field reports), training courses, the promotion of horizontal co-operation among competent national organizations and the preparation of manuals and dissemination of methods. PAHO and its sanitary engineering centre, CEPIS, are the most active organizations. Their recent water pollution control-related activities and projects have included: the monitoring and control of pollution in Cartagena Bay and tributary areas, in Colombia; the design of a manual concerning marine outfalls; advisory services concerning water pollution and the application of mathematical models of water quality in relation to the Bogotá River (Colombia), Chimbote (Peru) and the Asososca lagoon (Nicaragua); the transfer of water from the Mantaro River (Peru); a regional programme for the improvement of the quality of water for human consumption; a regional programme on appropriate technology for the collection, treatment and final disposal of waste water and excreta in medium-sized, small and dispersed rural communities in Peru; and a regional project on simplified methodologies for studies of eutrophication in tropical lakes.

The international and regional banks, particularly the Inter-American Development Bank (IDB), support investments in pollution control. In 1979 the IDB adopted a policy on environmental management with a view to preventing its projects from having adverse environmental impacts. In 1983, it established the Environmental Management Committee, which is responsible for ensuring the environmental review of all projects financed by the Bank and for promoting an understanding of environmental issues. Apart from helping its member countries with a variety of projects, such as those involving preventive measures to avoid the discharge of contaminating effluent into bodies of water, the IDB also stresses institution building, the training of personnel in environmental technology, and the identification and solution of environmental problems. An example of the IDB's special efforts in the field of water pollution control is afforded by two loans totalling US$ 46 400 000 which were approved in 1986 for a project to expand and improve the water and sewerage system of Tijuana, Mexico. This project involves extensive measures to treat and dispose of sewage effluents so that both the city and adjacent beaches will be protected from pollution.146/ In 1970, the World Bank, for its part, established the office which later became the Office of Environmental and Scientific Affairs. This office has the responsibility of examining all projects for their possible consequences for the environment and of incorporating suitable measures for the preservation or mitigation of seriously detrimental effects.147/ Recently the World Bank has created environmental units in its regional divisions, as well as a central environmental department,148/ and is taking other steps with the aim of increasing its ability to assist developing countries to manage their natural resources on a sound environmental basis. In addition to the pollution-control components in its projects, the World Bank, in co-operation with other organizations, has prepared and issued guidelines and manuals, conducted training activities, provided technical assistance, etc. One example of the Bank's activities in the field of water pollution control is the US$ 60 000 000 loan that it approved in fiscal year 1986 for the development of a water-supply and sewerage system in Santiago, Chile, which includes a pollution-abatement component.149/

V. CONCLUSIONS

During the past decade the countries of Latin America and the Caribbean have made some progress towards remedying the pollution problems resulting from their increasing use of water resources for waste disposal and transport. The region continues to face, however, a steady decline in water quality in many bodies of water, and efforts to arrest the decline are still no more than incipient.

The report provides clear evidence that the contamination of water resources continues to increase. Control measures are weak, the financial resources for investment in waste treatment are insufficient and, in general, the preservation of water quality remains a secondary consideration. There are too many water bodies in the region in which the decline in quality has reached critical proportions, although there is some evidence of a public reaction to this situation and the issue is beginning to figure more prominently on the political agendas of governments.

Despite the gains that have been made, far more remains to be done if even the most glaring instances of biological pollution are to be controlled, as indicated by the critical level of intestinal and other water-related diseases among children and adults. Moreover, if controls are not initiated, the problem will surely grow worse as the expansion of water-supply and sewerage coverage leads to a greater use of the water resources of the region for the transport of wastes.

Notes

1/ Denise Bure R., Francisco Pizarro A. and Nora Cabrera F., Diagnóstico de la contaminación marina en Chile Anexos, CORFO, AF 86/37, Annex No. 2, February 1986.

2/ On the basis of Wastewater Reuse and its Applications in Western Asia, E/ESCWA/NR/84/2/Rev.1, December 1985, pp. 9-10.

3/ Walter A. Castagnino, "Polución de agua, modelos y control", Serie técnica No. 20, CEPIS, Environmental Health Division, Pan American Health Organization, p. 7.

4/ Estimates are based on information taken from ECLAC, El Medio Ambiente en América Latina, Document 76-3-422-70, March 1976.

5/ On the basis of information provided in World Health Organization and United Nations Environment Programme, "Global Pollution and Health", Global Environment Monitoring System (GEMS), 1987, pp. 9-11.

6/ Luis Carrera de la Torre, Las Cuencas Hidrográficas del Ecuador y su Manejo Ambiental, document presented at the First Ecuadorian Environmental Conference, Quito, Ecuador, February 1987, pp. 127-128.

7/ República Argentina Plan de Acción de Mar del Plata Evaluación 1984. Report on the progress of and outlook for the application of the Mar del Plata Plan of Action submitted to the Water Committee, ECLAC, twentieth session, Lima, Peru, March 1984, p. 36.

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10/ Methodological approaches for the collection and assessment of data on pollutants flowing from industries located in the coastal area of ECE member countries, WATER/R.60/Add.1, 18 September 1978, annex IV, p. 1.

11/ Resumen general sobre recursos y demandas, Plan maestro de desarrollo y aprovechamiento de los recursos hídricos, El Salvador, Documento básico No. 14, UNDP/ELS/78/005, May 1982, Table No. 43; and ILO, Yearbook of Labour Statistics 1983, 43rd issue, 1983, p. 44.

12/ ECLAC, Desarrollo industrial: Generación y manejo de los residuos LC/R.602(Sem.41/6), 28 August 1987, pp. 9, 17 and 18.

13/ The chemical composition of industrial effluent in different sectors of the manufacturing industry is described on the basis of information provided in United Nations, Strategies, Technologies and Economics of Waste Water Management in ECE Countries, ECE/WATER/36, 1984, pp. 23-29.

14/ The coefficients for calculating the quantities of effluents generated in the course of industrial production in different sectors of manufacturing are taken from Walter A. Castagnino, "Polución de agua, Modelos y control", op.cit., pp. 10 and 14.

15/ Estimates of potential effluents in different sectors of manufacturing are based on conversion coefficients given in Walter A. Castagnino, "Polución de agua, modelos y control", op. cit.; Methodological approaches for the collection and assessment of data on pollutants flowing from ..., op. cit., annex III, p. 7 and annex IV, p. 1; and information in annex 2 of this document. These and other estimates given below are based on the corresponding coefficients and production and/or capacity figures and do not take into consideration possible differences in the technology actually used or the presence and/or absence of treatment facilities.

16/ Walter A. Castagnino, "Polución de agua, modelos y control", op. cit., p. 11.

17/ UNEP, "Development and environment in the Wider Caribbean Region: A synthesis", UNEP Regional Seas Reports and Studies, No. 14, 2 August 1982, p. 16.

18/ This description of the chemical composition of industrial effluent is based on information provided in United Nations, Strategies, Technologies and Economics of Waste Water Management in ECE Countries, ECE/WATER/36, 1984, pp. 20-23; and H. I. Awad,"Industrial discharges into municipal wastewater transportation and treatment systems for country towns of New South Wales, Australia", Water Resources Journal, ESCAP, September 1986, ST/ESCAP/SER.C/150, pp. 48-51.

19/ Methodological approaches for the collection and assessment of data on pollutants flowing from industries located in the coastal area of ECE member countries, WATER/R.60/Add.1, 18 September 1978, Annex I, p. 1.

20/ These estimates are for the following 19 Latin American and Caribbean countries: Argentina, Barbados, Bolivia, Chile, Colombia, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Mexico, Nicaragua, Panama, Peru, Suriname, Trinidad and Tobago, Uruguay and Venezuela.

21/ Estimates are based on employment figures for the corresponding industries which were taken from United Nations, Industrial Statistics Yearbook 1985, Volume 1 General Industrial Statistics, ST/ESA/STAT/SER.P/24(vol.I), New York, 1987. In cases where employment figures for the industries in question included employment in other industries as well, estimates, where possible, were used; in several countries estimates were made for the food, beverage and tobacco industry as a whole.

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23/ Ministerio de Salud, Contaminación Marina en Chile, Santiago, 1979, pp. 14-20.

24/ Sugar Yearbook 1984, International Sugar Organization, 1985, pp. 274-275.

25/ Resumen general sobre recursos y demandas, op. cit., Table No. 43.

26/ Aloisio Barboza de Araujo, O meio ambiente no Brasil: Aspectos económicos, Río de Janeiro, IPEA/INPES, 1979, p. 86.

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Annex 1

LATIN AMERICA AND THE CARIBBEAN: ESTIMATES OF DOMESTIC SEWAGE OUTFLOW AND COMPOSITION FOR CITIES WITH 100 000 INHABITANTS OR MORE IN 1980, BY MAJOR HYDROGRAPHIC BASINS AND COUNTRIES a/

a/ The presence or absence of waste water treatment facilities has not been taken into consideration.
These estimates are based on:

i) Population in 1980 (Latin American Center, Statistical Abstract of Latin America, University of California, Los Angeles, various recent years; and other sources).

ii) Sewerage service (house connections) coverage of the urban population for the country as a whole (1980); in the cases where this information has not been available, coverage by sewerage and excreta disposal services was used (WHO, The International Drinking Water Supply and Sanitation Decade - Review of National Baseline Data (as at December 1980), Offset Publication No. 85; PAHO/WHO, Environmental Health Program, International Drinking Water Supply and Sanitation Decade, Regional Progress Report, Environmental series No. 6, p. 18; and Osvaldo Montero Ojeda, Instituto de Hidroeconomía, El Programa cubano para el abastecimiento de agua y saneamiento para poblaciones de bajos ingresos, Seminario Regional sobre Agua Potable y Saneamiento para Grupos de Bajo Ingreso en Comunidades Rurales y Urbano-marginales, Recife, 1988, Documento No. 14, p. 3);

iii) The level of consumption is estimated to be 200 litres per capita per day;

iv) The following conversion factors are applied:
DBO_5 - 19.7 kg/inh./year,
phosphorus - 0.4 kg/inh./year,
nitrogen - 3.3 kg/inh./year,
suspended solids - 20.0 kg/inh./year
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Latin America and the Caribbean: Estimates of Domestic Sewage Outflow and Composition for Cities with 100 000 Inhabitants or more in 1980, by Major Hydrographic Basins and Countries

Cities by major hydrographic basins, countries, and recipient water bodies		DOMESTIC SEWAGE OUTFLOWS (m3/sec)	DBO (Ton/year)	PHOSPHORUS (Ton/year)	NITROGEN (Ton/year)	SUSPENDED SOLIDS (Ton/year)
BASIN: Amazon						
Bolivia						
Cochabamba	Rocha	0.14	1 180	24	198	1 197
La Paz	Choqueyapu	0.43	3 682	75	617	3 738
Santa Cruz	Pirai	0.18	1 534	31	257	1 558
	Subtotal	0.75	6 396	130	1 071	6 493
Brazil						
Belem	Marajo Bay	0.56	4 779	97	801	4 852
Campo Grande	Aripuana	0.21	1 783	36	299	1 810
Manaos	Amazon	0.45	3 865	78	647	3 924
	Subtotal	1.23	10 427	212	1 747	10 586
Peru						
Cuzco	Vilcanota	0.23	2 000	41	335	2 030
Huancayo	Negro	0.21	1 787	36	299	1 814
Iquitos	Amazon	0.23	1 937	39	324	1 966
	Subtotal	0.67	5 724	116	959	5 811
	TOTAL FOR BASIN	2.65	22 546	458	3 777	22 890
BASIN: Brazil, north-east						
Brazil						
Campina Grande	Paraiba	0.16	1 401	28	235	1 422
Caruaru	Ipojuca	0.10	868	18	145	881
Fortaleza	Atlantic Ocean	0.48	4 090	83	685	4 152
Joao Pessoa	Atlantic Ocean	0.22	1 831	37	307	1 859
Juazeiro do Norte	Salgado	0.09	790	16	132	802
Maceio	Atlantic Ocean	0.28	2 373	48	398	2 409
Natal	Atlantic Ocean	0.28	2 374	48	398	2 410
Olinda	Capibaribe	0.20	1 679	34	281	1 705
Recife	Atlantic Ocean	0.88	7 465	152	1 251	7 579
Sao Luis	San Marcos Bay	0.14	1 150	23	193	1 168
Teresina	Parnaiba	0.25	2 139	43	358	2 171
	Subtotal	3.07	26 160	531	4 382	26 558
	TOTAL FOR BASIN	3.07	26 160	531	4 382	26 558
BASIN: California						
Mexico						
Ciudad Obregon	Yaqui	0.21	1 754	36	294	1 781
Culiacan	Culiacan	0.37	3 130	64	524	3 178
Durango	Mezquital	0.26	2 208	45	370	2 241
Ensenada	Pacific Ocean	0.16	1 345	27	225	1 365
Hermosillo	Sonora	0.36	3 082	63	516	3 129
Mazatlan	Pacific Ocean	0.21	1 798	37	301	1 826
Mexicali	Colorado	0.40	3 364	68	564	3 416
Tijuana	Tijuana	0.64	5 467	111	916	5 550
	Subtotal	2.60	22 148	450	3 710	22 486
	TOTAL FOR BASIN	2.60	22 148	450	3 710	22 486

Cities by major hydrographic basins, countries, and recipient water bodies		DOMESTIC SEWAGE OUTFLOWS (m3/sec)	DBO (Ton/year)	PHOSPHORUS (Ton/year)	NITROGEN (Ton/year)	SUSPENDED SOLIDS (Ton/year)
BASIN: Caribbean						
<u>Colombia</u>						
Armenia	Cauca	0.25	2 166	44	363	2 199
Barrancabermeja	Magdalena	0.19	1 651	34	277	1 676
Barranquilla	Magdalena	1.27	10 775	219	1 805	10 939
Bogota	Bogota	5.61	47 765	970	8 001	48 493
Bucaramanga	Lebrija	0.48	4 104	83	687	4 166
Cali	Cauca	1.87	15 910	323	2 665	16 152
Cartagena	Caribbean Sea	0.69	5 905	120	989	5 995
Ibague	Combeina	0.38	3 239	66	542	3 288
Manizales	Chinchina	0.39	3 305	67	554	3 356
Medellin	Medellin	2.00	17 047	346	2 856	17 306
Monteria	Sinu	0.22	1 892	38	317	1 921
Neiva	Magdalena	0.25	2 141	43	359	2 173
Palmira	Cauca	0.25	2 105	43	353	2 137
Pereira	Otun	0.33	2 803	57	470	2 846
Santa Marta	Caribbean Sea	0.25	2 138	43	358	2 171
Valledupar	Guatapuri	0.20	1 716	35	287	1 742
	Subtotal	14.65	124 662	2 531	20 882	126 560
<u>Guatemala</u>						
Guatemala City	Las Vacas	0.69	5 900	120	988	5 990
	Subtotal	0.69	5 900	120	988	5 990
<u>Honduras</u>						
San Pedro Sula	Chamelecon	0.26	2 194	45	368	2 227
Tegucigalpa	Grande	0.42	3 607	73	604	3 662
	Subtotal	0.68	5 801	118	972	5 889
<u>Nicaragua</u>						
Managua	Lake Managua	0.69	5 881	119	985	5 971
	Subtotal	0.69	5 881	119	985	5 971
	TOTAL FOR BASIN	16.71	142 244	2 888	23 828	144 410
BASIN: Caribbean Islands						
<u>Cuba</u>						
Bayamo	Bayamo	0.09	726	15	122	737
Camaguey	San Pedro	0.21	1 770	36	297	1 797
Cienfuegos	Cienfuegos Bay	0.09	741	15	124	752
Guantanamo	Caribbean Sea	0.14	1 206	24	202	1 224
Holguin	Holguin	0.16	1 348	27	226	1 368
La Habana	Almendares	1.63	13 912	282	2 330	14 123
Matanzas	Yumuri/San Juan	0.09	727	15	122	738
Santa Clara	Sagua La Grande	0.15	1 250	25	209	1 269
Santiago de Cuba	Caribbean Sea	0.30	2 533	51	424	2 571
	Subtotal	2.85	24 212	492	4 056	24 581
<u>Dominican Republic</u>						
Santo Domingo	Ozama	0.68	5 765	117	966	5 852
Stgo.de Los Caballeros	Yaque del Norte	0.15	1 248	25	209	1 267
	Subtotal	0.82	7 012	142	1 175	7 119
<u>Haiti</u>						
Port-Au-Prince (1982)	Bois de Chene	0.68	5 792	118	970	5 880
	Subtotal	0.68	5 792	118	970	5 880

Cities by major hydrographic basins, countries, and recipient water bodies		DOMESTIC SEWAGE OUTFLOWS (m3/sec)	DBO (Ton/year)	PHOSPHORUS (Ton/year)	NITROGEN (Ton/year)	SUSPENDED SOLIDS (Ton/year)
BASIN: Caribbean Islands (cont.)						
Jamaica						
Kingston	Caribbean Sea	0.18	1 537	31	257	1 560
	Subtotal	0.18	1 537	31	257	1 560
Puerto Rico						
Bayamon	Cidra	n/a	n/a	n/a	n/a	n/a
Caguas	Loiza	n/a	n/a	n/a	n/a	n/a
Ponce	Caribbean Sea	n/a	n/a	n/a	n/a	n/a
San Juan	San José Lagoon	n/a	n/a	n/a	n/a	n/a
	Subtotal	n/a	n/a	n/a	n/a	n/a
	TOTAL FOR BASIN	4.53	38 553	783	6 458	39 140
BASIN: Central Venezuela						
Venezuela						
Barcelona/Pto.La Cruz	Caribbean Sea	0.45	3 799	77	636	3 857
Barquisimeto	Yaracuy	0.77	6 550	133	1 097	6 649
Caracas	Guaires	3.67	31 205	634	5 227	31 680
Cumana	Gulf of Cariaco	0.26	2 203	45	369	2 236
Departamento Vargas	Tuy	0.35	3 000	61	503	3 046
Maracay	Aragua	0.54	4 582	93	768	4 652
Valencia	Cabriales	0.87	7 377	150	1 236	7 489
	Subtotal	6.90	58 716	1 192	9 836	59 610
	TOTAL FOR BASIN	6.90	58 716	1 192	9 836	59 610
BASIN: Central system of Chile						
Chile						
Chillan	Itata	0.19	1 606	33	269	1 631
Concepcion	Biobio	0.43	3 641	74	610	3 697
Rancagua	Cachapoal	0.22	1 902	39	319	1 931
Santiago	Mapocho	5.84	49 679	1 009	8 322	50 436
Talca	Claro	0.21	1 747	35	293	1 774
Talcahuano	Pacific Ocean	0.32	2 751	56	461	2 793
Valparaiso-Viña del Mar	Pacific Ocean	0.85	7 267	148	1 217	7 378
	Subtotal	8.06	68 594	1 393	11 490	69 638
	TOTAL FOR BASIN	8.06	68 594	1 393	11 490	69 638
BASIN: Gulf of Mexico						
Mexico						
Jalapa de Enriquez	Actopan	0.23	1 945	39	326	1 974
Mexico City	Lake Texcoco/Tula	16.73	142 384	2 891	23 851	144 552
Poza Rica de Hidalgo	Purificacion	0.22	1 911	39	320	1 940
Tampico	Panuco	0.44	3 764	76	631	3 821
Veracruz	Jamapa	0.35	2 962	60	496	3 007
	Subtotal	17.97	152 966	3 106	25 624	155 295
	TOTAL FOR BASIN	17.97	152 966	3 106	25 624	155 295

Cities by major hydrographic basins, countries, and recipient water bodies		DOMESTIC SEWAGE OUTFLOWS (m3/sec)	DBO (Ton/year)	PHOSPHORUS (Ton/year)	NITROGEN (Ton/year)	SUSPENDED SOLIDS (Ton/year)
BASIN: Interior of Argentina						
11 738 238 1 966 11 916						
BASIN: Maracaibo						
Colombia						n Francisco
Santiago del Estero	Dulce	0.11	935	19	157	949
	Subtotal	1.38	11 738	238	1 966	11 916
	TOTAL FOR BASIN	1.38	11 738	238	1 966	11 916
BASIN: Maracaibo						
Colombia						
Cucuta	Zulia	0.50	4 290	87	719	4 356
	Subtotal	0.50	4 290	87	719	4 356
Venezuela						
Cabimas	Lake Maracaibo	0.24	2 045	42	343	2 076
Maracaibo	Lake Maracaibo	1.21	10 331	210	1 731	10 488
	Subtotal	1.45	12 376	251	2 073	12 564
	TOTAL FOR BASIN	1.96	16 666	338	2 792	16 920
BASIN: North Pacific						
Mexico						
Acapulco	Pacific Ocean	0.52	4 461	91	747	4 529
Aguascalientes	Verde Grande	0.29	2 483	50	416	2 520
Cuernavaca	Apataclo	0.27	2 330	47	390	2 365
Guadalajara	Santiago	2.80	23 820	484	3 990	24 183
Irapuato	Turbio	0.18	1 555	32	260	1 578
Leon	Turbio	0.71	6 031	122	1 010	6 123
Morelia	Grande	0.28	2 423	49	406	2 460
Oaxaca	Atoyac or Verde	0.15	1 309	27	219	1 329
Puebla de Zaragoza	Atoyac	0.81	6 862	139	1 149	6 966
Queretaro	Huimilpan	0.21	1 794	36	300	1 821
Salamanca	Lerma	0.12	1 019	21	171	1 034
Tepic	Mololoa	0.16	1 350	27	226	1 371
Toluca de Lerdo	Lerma	0.27	2 335	47	391	2 371
Uruapan	Cupatitzio	0.17	1 419	29	238	1 441
Zapopan	Santiago	0.12	1 009	20	169	1 024
	Subtotal	7.07	60 199	1 222	10 084	61 116
	TOTAL FOR BASIN	7.07	60 199	1 222	10 084	61 116
BASIN: Orinoco						
Venezuela						
San Cristóbal	Carapo	0.37	3 120	63	523	3 168
	Subtotal	0.37	3 120	63	523	3 168
	TOTAL FOR BASIN	0.37	3 120	63	523	3 168
BASIN: Pacific: dry climate						
Chile						
Antofagasta	Pacific Ocean	0.30	2 521	51	422	2 560
Arica	Pacific Ocean	0.22	1 894	38	317	1 923
Iquique	Pacific Ocean	0.18	1 497	30	251	1 520
	Subtotal	0.69	5 912	120	990	6 002

Cities by major hydrographic basins, countries, and recipient water bodies		DOMESTIC SEWAGE OUTFLOWS (m3/sec)	DBO (Ton/year)	PHOSPHORUS (Ton/year)	NITROGEN (Ton/year)	SUSPENDED SOLIDS (Ton/year)
BASIN: Pacific: dry climate (cont.)						
Peru						
Arequipa	Chili	0.57	4 843	98	811	4 916
Chiclayo	Lambayeque	0.36	3 029	61	507	3 075
Chimbote	Pacific Ocean	0.28	2 347	48	393	2 382
Ica	Pacific Ocean	0.15	1 244	25	208	1 263
Lima-Callao	Rimac	5.63	47 882	972	8 021	48 611
Piura	Piura	0.26	2 253	46	377	2 287
Trujillo	Pacific Ocean	0.45	3 839	78	643	3 897
	Subtotal	7.69	65 435	1 329	10 961	66 432
	TOTAL FOR BASIN	8.38	71 348	1 449	11 952	72 434
BASIN: Pacific: tropical climate						
Colombia						
Buenaventura	Pacific Ocean	0.23	1 927	39	323	1 956
Pasto	Guevara	0.28	2 372	48	397	2 408
	Subtotal	0.51	4 299	87	720	4 365
Costa Rica						
San Jose	Torres	0.26	2 195	45	368	2 228
	Subtotal	0.26	2 195	45	368	2 228
Ecuador						
Guayaquil	Guayas	1.00	8 543	173	1 431	8 673
Quito	Guayllabamba	0.74	6 314	128	1 058	6 411
	Subtotal	1.75	14 857	302	2 489	15 083
El Salvador						
San Salvador	Acelhuate	1.02	8 652	176	1 449	8 784
Santa Ana	n/a	0.46	3 943	80	661	4 003
	Subtotal	1.48	12 595	256	2 110	12 787
Panama						
Panama City	Pacific Ocean	0.65	5 521	112	925	5 605
	Subtotal	0.65	5 521	112	925	5 605
	TOTAL FOR BASIN	4.64	39 467	801	6 611	40 068
BASIN: Pampa						
Argentina						
Bahia Blanca	Atlantic Ocean	0.16	1 392	28	233	1 413
Mendoza	Mendoza	0.44	3 762	76	630	3 819
San Juan	San Juan	0.22	1 831	37	307	1 859
	Subtotal	0.82	6 985	142	1 170	7 091
	TOTAL FOR BASIN	0.82	6 985	142	1 170	7 091
BASIN: Plata						
Argentina						
Corrientes	Parana	0.13	1 132	23	190	1 149
Gran Buenos Aires	La Plata	7.35	62 582	1 271	10 483	63 535
Gran La Plata	La Plata	0.42	3 532	72	592	3 586
Mar del Plata	Atlantic Ocean	0.30	2 566	52	430	2 605
Parana	Parana	0.12	1 006	20	169	1 021
Posadas	Parana	0.10	882	18	148	896
Resistencia	Parana	0.16	1 377	28	231	1 398
Rosario	Parana	0.71	6 018	122	1 008	6 109
Salta	San Francisco	0.19	1 641	33	275	1 666
Santa Fe	Salado	0.21	1 811	37	303	1 838
	Subtotal	9.70	82 548	1 676	13 828	83 805

Cities by major hydrographic basins, countries, and recipient water bodies		DOMESTIC SEWAGE OUTFLOWS (m3/sec)	DBO (Ton/year)	PHOSPHORUS (Ton/year)	NITROGEN (Ton/year)	SUSPENDED SOLIDS (Ton/year)
BASIN: Plata (cont.)						
Brazil						
Americana	Piracicaba	0.09	768	16	129	779
Anapolis	Meia Ponte	0.12	1 012	21	170	1 027
Aracatuba	Tiete	0.08	715	15	120	726
Araraquara	Jacare Guacu	0.10	826	17	138	838
Bauru	Bauru	0.13	1 128	23	189	1 145
Brasilia	Paranua Sta Maria	0.30	2 593	53	434	2 632
Campinas	Capivari	0.42	3 571	73	598	3 626
Carapicuiba	Tiete	0.14	1 171	24	196	1 189
Cuiaba	Cuiaba	0.12	1 058	21	177	1 075
Curitiba	Belem	0.62	5 319	108	891	5 400
Diadema	Tiete	0.17	1 441	29	241	1 463
Franca	Grande	0.11	905	18	152	919
Goiania	Meia Ponte	0.52	4 433	90	743	4 501
Guarulhos	Cabuu Cima	0.29	2 491	51	417	2 529
Jundiai	Guapeva	0.16	1 324	27	222	1 344
Lajes	Caveiras	0.08	686	14	115	696
Limeira	Piracicaba	0.10	869	18	146	882
Londrina	Tibaji	0.19	1 627	33	273	1 652
Marilia	Do Peixe	0.08	703	14	118	714
Maringa	Ivai	0.12	996	20	167	1 012
Maua	Tiete	0.15	1 297	26	217	1 317
Mogi das Cruzes	Paraitinga	0.09	771	16	129	782
Osasco	Tiete	0.35	2 987	61	500	3 033
Piracicaba	Piracicaba	0.13	1 131	23	189	1 148
Ponta Grossa	Tibaji	0.13	1 079	22	181	1 095
Presidente Prudente	Santo Anastacio	0.09	805	16	135	817
Ribeirao Preto	Pardo	0.22	1 896	38	318	1 925
Santo Andre	Tiete	0.41	3 463	70	580	3 515
Sao Caetano do Sul	Tiete	0.12	1 028	21	172	1 043
Sao Carlos	Jacare Guacu	0.08	689	14	115	699
Sao Jose do Rio Preto	Preto	0.13	1 084	22	182	1 101
Sao Paulo	Tiete	5.21	44 339	900	7 427	45 015
Sorocaba	Sorocaba	0.19	1 606	33	269	1 630
Uberaba	Grande	0.13	1 137	23	190	1 154
Uberlandia	Uberarinha	0.17	1 452	29	243	1 475
	Subtotal	11.56	98 399	1 998	16 483	99 897
Paraguay						
Asuncion	Paraguay	0.32	2 692	55	451	2 733
	Subtotal	0.32	2 692	55	451	2 733
Uruguay						
Montevideo	Atlantic Ocean	0.43	3 688	75	618	3 744
	Subtotal	0.43	3 688	75	618	3 744
	TOTAL FOR BASIN	22.01	187 326	3 804	31 379	190 179
BASIN: Rio Bravo						
Mexico						
Chihuahua	Chuviscar	0.44	3 726	76	624	3 782
Ciudad Juarez	Bravo	0.71	6 034	123	1 011	6 125
Matamoros	Bravo	0.22	1 866	38	313	1 894
Monterrey	Pesqueria	2.29	19 486	396	3 264	19 783
Nuevo Laredo	Bravo	0.25	2 158	44	362	2 191
Reynosa	Bravo	0.26	2 231	45	374	2 265
Saltillo	Pesqueria	0.29	2 495	51	418	2 533
	Subtotal	4.46	37 995	771	6 365	38 574
	TOTAL FOR BASIN	4.46	37 995	771	6 365	38 574

Cities by major hydrographic basins, countries, and recipient water bodies		DOMESTIC SEWAGE OUTFLOWS (m3/sec)	DBO (Ton/year)	PHOSPHORUS (Ton/year)	NITROGEN (Ton/year)	SUSPENDED SOLIDS (Ton/year)
BASIN: San Francisco						
Brazil						
Belo Horizonte	Das Velhas	1.07	9 093	185	1 523	9 232
Divinopolis	Para	0.08	683	14	114	693
Montes Claros	Verde	0.11	957	19	160	972
	Subtotal	1.26	10 734	218	1 798	10 897
	TOTAL FOR BASIN	1.26	10 734	218	1 798	10 897
BASIN: South Atlantic						
Brazil						
Aracaju	Atlantic Ocean	0.21	1 816	37	304	1 844
Barra Mansa	Paraiba do Sul	0.09	778	16	130	790
Blumenau	Itajai	0.11	913	19	153	927
Campos	Paraiba do Sul	0.13	1 098	22	184	1 115
Canoas	Dos Sinos	0.16	1 350	27	226	1 370
Caxias do Sul	Piauhi	0.15	1 253	25	210	1 272
Duque de Caxias	Niteroi	0.23	1 929	39	323	1 959
Feira de Santana	Jacuipe	0.17	1 418	29	238	1 440
Florianopolis	Atlantic Ocean	0.11	968	20	162	983
Governador Valadares	Doce	0.13	1 095	22	183	1 112
Itabuna	Colonia	0.10	819	17	137	832
Joinvile	Sao Francisco Bay	0.16	1 368	28	229	1 389
Juiz de Fora	Paraibuna	0.22	1 889	38	317	1 918
Nilopolis	Atlantic Ocean	0.12	1 060	22	178	1 076
Niteroi	Atlantic Ocean	0.29	2 435	49	408	2 472
Nova Iguacu	Atlantic Ocean	0.36	3 100	63	519	3 148
Novo Hamburgo	Dos Sinos	0.10	833	17	139	845
Pelotas	Lagoa dos Patos	0.15	1 242	25	208	1 261
Petropolis	Piabanha	0.11	942	19	158	956
Porto Alegre	Guaiba	0.82	6 990	142	1 171	7 097
Rio Grande	Lagoa dos Patos	0.09	786	16	132	798
Rio de Janeiro	Guanabara Bay	3.77	32 108	652	5 378	32 597
Salvador	Atlantic Ocean	1.11	9 433	192	1 580	9 576
Santa Maria	Bagu	0.11	953	19	160	968
Santos	Atlantic Ocean	0.30	2 591	53	434	2 631
Sao Bernardo do Campo	Cubatao	0.28	2 403	49	403	2 440
Sao Goncalo	Atlantic Ocean	0.16	1 395	28	234	1 416
Sao Joao de Meriti	Atlantic Ocean	0.16	1 327	27	222	1 348
Sao Jose dos Campos	Paraiba do Sul	0.20	1 690	34	283	1 716
Sao Vicente	Atlantic Ocean	0.14	1 215	25	204	1 234
Taubate	Paraiba do Sul	0.12	979	20	164	994
Vitoria	Atlantic Ocean	0.11	909	18	152	923
Vitoria da Conquista	Pardo	0.09	793	16	133	805
Volta Redonda	Paraiba do Sul	0.13	1 121	23	188	1 138
	Subtotal	10.69	91 002	1 848	15 244	92 388
	TOTAL FOR BASIN	10.69	91 002	1 848	15 244	92 388
BASIN: South Pacific						
Chile						
Temuco	Imperial	0.25	2 143	44	359	2 175
	Subtotal	0.25	2 143	44	359	2 175
	TOTAL FOR BASIN	0.25	2 143	44	359	2 175

Cities by major hydrographic basins, countries, and recipient water bodies		DOMESTIC SEWAGE OUTFLOWS (m3/sec)	DBO (Ton/year)	PHOSPHORUS (Ton/year)	NITROGEN (Ton/year)	SUSPENDED SOLIDS (Ton/year)
BASIN: Southern Interior						
Mexico						
Gomez Palacio	Nazas	0.12	994	20	167	1 009
San Luis Potosi	n/a	0.37	3 160	64	529	3 208
Torreon	Nazas	0.46	3 931	80	659	3 991
	Subtotal	0.95	8 085	164	1 354	8 209
	TOTAL FOR BASIN	0.95	8 085	164	1 354	8 209
BASIN: Titicaca						
Bolivia						
Oruro	Tagarete	0.08	690	14	116	700
	Subtotal	0.08	690	14	116	700
	TOTAL FOR BASIN	0.08	690	14	116	700
BASIN: Yucatan						
Mexico						
Merida	Gulf of Mexico	0.31	2 602	53	436	2 642
	Subtotal	0.31	2 602	53	436	2 642
	TOTAL FOR BASIN	0.31	2 602	53	436	2 642
GRAND TOTAL		127.14	1 082 028	21 970	181 253	1 098 505

n/a - information has not been available.
Small differences in totals/subtotals are due to rounding.

Annex 2

INSTALLED CAPACITY OF SELECTED INDUSTRIES, BY WATER BODY

A. PULP AND PAPER INDUSTRY
(installed capacity, tons)

Location of the plant	Cellulose	Paper	Water body
Basin: Amazon			
Bolivia			
La Paz	700	1 500	Choqueyapu
Total for basin	700	1 500	
Basin: Arid Pacific			
Peru			
Chacoilayo	0	8 300	Rimac
Chiclayo Cayalti	3 000	4 000	Reque
Chosica	0	14 000	Rimac
Lima	0	5 000	Pacific Ocean
Lima Viejo	0	3 000	Rimac
Paramonga	60 000	85 000	Fortaleza
Trujillo	49 500	66 000	Pacific Ocean
Ventanilla	0	5 000	Rimac
Vitarte	0	500	Pacific Ocean
Total for basin	112 500	190 800	
Basin: Brazil, North-East			
Brazil			
Beberibe	7 500	5 100	Choro
Campina Grande	1 840	4 420	Paraiba
Fortaleza	0	310	Atlantic Ocean
Jaboatao	11 600	20 400	Jaboatao
Moreno	1 700	4 100	Jaboatao
Total for basin	22 640	34 330	
Basin: Caribbean			
Colombia			
Barranquilla	0	1 90o	Magdalena
Bogota	4 000	13 200	Bogota
Cali	137 200	203 600	Cauca
Medellin	0	3 000	Medellin
Pereira	0	5 100	Otun
Total for basin	141 200	226 800	
Basin: Central Chile			
Chile			
Biobio	66 000	64 600	Biobio
Laja	240 000	17 000	Laja
Laja Grown	0	49 000	Laja
Nacimiento	75 000	70 000	Biobio
Puente Alto	15 000	58 000	Maipo
Santiago	0	10 000	Mapocho
Talca	0	3 000	Claro
Vina del Mar	2 000	4 500	Pacific Ocean
Total for basin	398 000	276 100	

Location of the plant	Cellulose	Paper	Water body
Basin: Central Venezuela			
Venezuela			
Caracas	0	2 000	Guaires
Guacara	0	23 000	Lake Valencia
Maracay	0	63 000	Aragua
Moron	25 000	95 000	Moron
Petare	0	27 000	Guaires
Valencia	0	63 000	Quebrada Seca
Total for basin	25 000	273 000	
Basin: Gulf of Mexico			
Mexico			
Apizaco	3 600	0	Zavapan
Ayotla	58 500	18 000	Lake Texcoco/Tula
Azcapotzalco	0	19 500	Lake Texcoco/Tula
Cam. Mexico City--Laredo	60 000	77 000	San Javier
Cam. Mexico City-Texcoco	0	24 000	Lake Texcoco/Tula
Colonia Goaja	0	25 000	Lake Texcoco/Tula
Colonia Maco	0	15 000	Lake Texcoco/Tula
Colonia Panamericana	0	1 500	Lake Texcoco/Tula
Ixtapalapa	0	15 000	Lake Texcoco/Tula
Ixtapaluca	0	2 500	Lake Texcoco/Tula
La Paz	0	3 000	Lake Texcoco/Tula
Los Reyes	23 400	79 000	Lake Texcoco/Tula
Mexico City	4 100	128 000	Lake Texcoco/Tula
Orizaba	4 740	0	Blanco
San Pedro Xalostoc	5 100	0	
San Rafael	130 000	118 500	Lake Texcoco/Tula
Santa Clara	6 000	6 500	
Tlalnepantla	0	56 500	Tlalnepantla
Tlalpan	31 700	55 000	Lake Texcoco/Tula
Tuxtepec	58 100	50 000	Santo Domingo
Uaucalran de Juarez	0	20 500	
Total for basin	385 240	714 500	
Basin: Interior of Argentina			
Argentina			
Bellavista	1 500	2 000	Sali
Cordoba	0	9 000	Primero
Leales	6 000	6 000	Sali
Lib.Gral.San Martin	30 000	36 000	San Francisco
Oncativo	0	1 500	
Rio Ju	0	2 000	Cuarto
Tucuman	2 000	3 500	Sali
Total for basin	39 500	60 000	
Basin: North Pacific			
Mexico			
Atenquique	40 000	70 000	Tuxpan
Atizapan	0	8 500	Lerma
Cuernavaca	0	20 000	Apataclo
Guadalajara	0	15 000	Santiago
Puebla	0	19 000	Atoyac
Salvatierra	1 500	0	Pesqueria
San Bartolo	2 000	35 000	Lerma
Texmelucan	0	10 000	Atoyac
Total for basin	43 500	177 500	

Location of the plant	Cellulose	Paper	Water body
Basin: Northern Interior			
Mexico			
Anahuac	1 200	0	Santa Isabel
Total for basin	1 200	0	
Basin: Pampa			
Argentina			
Cipoletti	0	1 500	Neuquen
Godoy Cruz	0	30 000	Mendoza
Tornquist	0	6 000	Sauce Chico
Total for basin	0	37 500	
Basin: Plata			
Argentina			
Alma Fuerte	4 000	6 000	Tercero
Andino	0	8 500	Carcarana
Avellaneda	0	21 000	Riachuelo
Azul	2 000	3 000	Azul
Baradero	0	4 000	Baradero
Beccar	0	12 000	La Plata
Berazategui	0	6 000	La Plata
Bernal	20 000	102 000	La Plata
Buenos Aires	0	40 000	La Plata
Campana	4 000	22 500	Parana
Canada de Gomez	2 000	3 500	Canada De Gomez
Capitan Bermudez	40 000	70 000	Parana
Ciudadella	0	1 500	La Plata
Cordoba	0	4 000	Primero
Coronel Suarez	6 000	6 000	Vilimanla
General Lagos	0	3 000	Parana
General Pacheco	0	1 500	Reconquista
Hurlingham	6 000	10 000	Reconquista
Ituzaingo	0	2 500	Reconquista
Lanus	0	14 000	Riachuelo
Las Palmas	4 000	4 000	Paraguay
Lomas de Zamora	0	2 000	La Plata
Mercedes	0	1 500	Moyano
Parana	0	4 500	Parana
Puerto Piray	30 000	5 000	Parana
Quilmes	0	26 000	La Plata
Ranelagh	4 000	12 000	La Plata
Ringuelet	0	5 000	La Plata
Rosario	0	1 500	Parana
S Jose de la Esquina	6 000	6 000	Parana
Salto	0	1 000	Salto
San Fernando	0	3 000	La Plata
San Isidro	1 000	2 000	La Plata
San Justo	65 000	160 000	La Plata
San Lorenzo	3 000	7 500	Parana
San Martin	2 000	3 500	Atlantic Ocean
San Pedro	2 500	4 500	Parana
Tandil	0	2 000	Langueyo
Torcuato	0	3 000	Reconquista
Valentin Alsina	0	11 500	Riachuelo
Vellaneda	0	3 000	Riachuelo
Vicente Lopez	0	7 000	La Plata
Villa Dominico	0	15 000	La Plata
Villa G. Galvez	0	2 000	La Plata
Villa Ocampo	6 000	14 000	Parana
Wilde	0	32 000	La Plata
Zarate	64 000	76 000	Parana de Las Palmas
Subtotal	271 500	755 500	

Location of the plant	Cellulose	Paper	Water body
Basin: Plata (cont.)			
<u>Brazil</u>			
Americana	0	6 800	Atibaia
Arapoti	2 040	6 120	Barra Mansa
Araras	0	2 040	Araras
Cacador	6 800	5 100	Do Peixe
Caiciras	11 900	27 000	Juqueri
Campinas	2 380	5 440	Capavari
Canuinhas	0	1 360	Canuinhas
Capital	3 400	20 400	Tiete
Cordeiro Polis	0	10 540	Tatu
Curitiba	7 480	11 560	Belem
Embu	340	10 690	Embu Murun
Guara	0	3 400	Pontal
Guarul Hnos.	0	2 400	Cabussu de Cana
Guarulhos	13 600	10 200	Tiete
Guaynazas	0	3 400	Tiete
Irapuru	0	2 040	Da Inha
Itapira	680	3 400	Da Renha
Itaquera	0	2 380	Tiete
Itiutaba	0	4 080	Tejuco
Joacaba	5 400	10 900	Do Peixe
Jundiai	2 040	4 760	Jundiai
Limeira	2 720	21 250	Tatu
Marilia	0	3 400	Cinc
Mato Grosso	0	5 100	Mato Grosso
Mogi Guacu	68 000	17 000	Mogi Guacu
Mogi das Cruzes	0	4 100	Tiete
Monte Alegre	125 800	203 320	Tibaji
Nova	0	2 040	Independencia
Ojasco	0	2 700	Tiete
Palmas	0	2 040	Do Peixe
Paracicaba	6 800	14 960	Paracicaba
Penapolis	0	1 700	Laje
Pirassununga	850	3 740	Mogi Guacu
Pirituba Suzano	0	11 900	Tiete
Ponta Grossa	0	3 400	Refugio de Piedra
Ribeirao Pires	0	6 800	Grande
Ribeirao Preto	0	3 060	Pardo
Rio Claro	0	2 040	Claro
Salto	0	12 900	Tiete
Santa Barbara	0	2 040	Dos Toledos
Santana de Parnaiba	40 800	0	Tiete
Santo Amaro	0	2 700	Pinheiros
Sao Bernardo	0	2 380	Do Meninos
Sao Carlos	0	5 440	Jacare Guacu
Sao Paulo	9 690	76 500	Tiete
Suzano	61 200	40 100	Tiete
Valinhos	14 280	8 800	Atibaia
Subtotal	386 200	613 420	
<u>Paraguay</u>			
Asuncion	0	1 200	Paraguay
Subtotal	0	1 200	
<u>Uruguay</u>			
Juan L Lacazo	8 000	18 700	La Plata
Mercedes	4 800	9 800	Negro
Montevideo	800	27 100	Atlantic Ocean
Subtotal	13 600	55 600	
Total for basin	671 300	1 425 720	

Location of the plant	Cellulose	Paper	Water body
Basin: Rio Bravo			
<u>Mexico</u>			
Chihuahua	0	16 000	Chuviscar
Monterrey	20 400	61 900	Pesqueria
Rio Bravo	6 000	0	Bravo
San Nicolas	3 500	35 000	Pantano
San Nicolas de Garza	27 000	40 000	Pantano
Total for basin	56 900	152 900	
Basin: South Atlantic			
<u>Brazil</u>			
Adolfo Pinheiro	0	240	Paraiba do Sul
Alcantara	8 500	11 600	Da Aldeia
Alem Paraiba	0	10 370	Paraiba do Sul
Aparecida del Norte	20 400	0	Paraiba do Sul
Aracaju	170	3 400	Atlantic Ocean
Cambara	20 400	0	Das Antas
Campos	0	3 200	Paraiba do Sul
Canela	11 200	5 400	Cahi
Canoas	20 400	19 700	Dos Sinos
Cantagalo	0	2 700	Negro
Cataguases	5 100	11 220	Pomba
Cubatao	0	19 000	Cubatao
Esteio	0	4 400	Dos Sinos
Guaiba	17 000	20 100	Guaiba
Itaba Poana	0	2 700	Itaba Poana
Itajai	2 700	7 100	Atlantic Ocean
Jacare	40 800	59 160	Jaguari
Jacarepagua	0	5 100	Jacarepagua Lagoon
Juiz de Fora	0	11 220	Paraibuna
Mendes	0	9 500	Sacra Familia
Natal	680	1 700	Mucuri
Paraibuna	0	1 700	Paraibuna
Pelotas	3 400	6 600	Lagoa Dos Patos
Petropolis	0	12 200	Piabanha
Pindamonhangaba	10 200	12 220	Paraiba do Sul
Ponte Nova	680	6 120	Pitunga
Prates	0	3 400	Jequitinhonda
Rio Grandina Nova	2 700	3 400	Bengala
Rio de Janeiro	0	22 270	Guanabara Bay
Salvador	850	3 230	Atlantic Ocean
San Antonio de Padua	0	3 600	Pomba
San Leopoldo	0	6 100	Dos Sinos
Sao Geraldo	1 870	4 420	Sao Geraldo
Total for basin	167 050	293 070	
Basin: South Pacific			
<u>Chile</u>			
Valdivia	5 800	10 200	Calle Calle
Total for basin	5 800	10 200	

Location of the plant	Cellulose	Paper	Water body
Basin: Tropical Pacific			
<u>Ecuador</u>			
Quito	0	700	Guayllabamba
San Carlos	0	9 000	Guayas
Subtotal	0	9 700	
<u>El Salvador</u>			
San Salvador	0	12 800	Acelhuate
Subtotal	0	12 800	
<u>Guatemala</u>			
Escuintla	0	24 000	Michatoya
Guatemala	0	5 300	Las Vacas
Subtotal	0	29 300	
<u>Panama</u>			
Panama	0	28 000	Pacific Ocean
Subtotal	0	28 000	
Total for basin	0	79 800	
GRAND TOTAL	2 070 530	3 953 720	

<u>Source:</u> Various national sources.

B. PETROLEUM REFINERIES
(installed capacity)

Location of the plant	Barrels a/	Water body
Basin: Amazon		
Bolivia		
Camir	1 000	Parapeti
Cochabamba	25 000	Rocha
Santa Cruz	24 000	Pirai
Subtotal	50 000	
Brazil		
Manaos	9 700	Amazon
Subtotal	9 700	
Colombia		
Mocoa	1 000	Mocoa
Subtotal	1 000	
Ecuador		
Lago Agrio	1 000	Napo
Subtotal	1 000	
Peru		
Iquitos	1 200	Amazon
Pucallpa	2 500	Ucayali
Subtotal	3 700	
Total for basin	65 400	
Basin: Arid Pacific		
Peru		
Conchan	850	Pacific Ocean
La Pampilla	100 000	Pacific Ocean
Marsella	1 400	Pacific Ocean
Talara	65 000	Magdalena
Total for basin	167 250	
Basin: Brazil, North-East		
Brazil		
Fortaleza	4 200	Atlantic Ocean
Total for basin	4 200	
Basin: Caribbean		
Colombia		
Barrancabermeja	110 000	Magdalena
Cartagena	5 000	Caribbean Sea
El Guamo	2 500	Luisa
La Dorada	5 000	Magdalena
Subtotal	122 500	
Costa Rica		
Puerto Limon	12 000	Caribbean Sea
Subtotal	12 000	
Guatemala		
Puerto Barrios	11 000	Caribbean Sea
Subtotal	11 000	
Honduras		
Puerto Cortes	14 000	Caribbean Sea
Subtotal	14 000	
Nicaragua		
Managua	16 000	Lake Managua
Subtotal	16 000	

Location of the plant	Barrels a/	Water body
Basin: Caribbean (cont.)		
<u>Panama</u>		
Las Minas Colon	100 000	Lake Gatun
Subtotal	100 000	
Total for basin	275 500	
Basin: Central Chile		
<u>Chile</u>		
Con Con	69 000	Pacific Ocean
Concepcion	75 000	Pacific Ocean
Total for basin	144 000	
Basin: Central Venezuela		
<u>Venezuela</u>		
Amuay	653 000	Gulf of Venezuela
Cardon	305 000	Gulf of Venezuela
Dpto. La Cruz	195 000	Caribbean Sea
El Chaure	195 000	Caribbean Sea
El Palito	105 000	Caribbean Sea
San Roque	5 300	Guere
Total for basin	1 458 300	
Basin: Gulf of Mexico		
<u>Mexico</u>		
Azcapotzalco	105 000	Lake Texcoco/Tula
Ciudad Madero	175 000	Gulf of Mexico
Minatitlan	270 000	Coatzacoalcos
Poza Rica	27 000	Cazones
Tula	150 000	Tula
Total for basin	727 000	
Basin: Maracaibo		
<u>Colombia</u>		
Tibu	5 000	Tibu
Subtotal	5 000	
<u>Venezuela</u>		
Maracaibo	61 000	Lake of Maracaibo
Subtotal	61 000	
Total for basin	66 000	
Basin: North Pacific		
<u>Mexico</u>		
Salamanca	210 000	Lerma
Salina Cruz	170 000	Pacific Ocean
Total for basin	380 000	
Basin: Orinoco		
<u>Venezuela</u>		
Obispos	5 000	Santo Domingo
Total for basin	5 000	

Location of the plant	Barrels a/	Water body
Basin: Pampa		
Argentina		
Bahia Blanca	13 850	Atlantic Ocean
Dpto. Galvan	17 000	Atlantic Ocean
Lujan de Cuyo	105 384	Mendoza
Plaza Huincul	23 485	Neuquen
Total for basin	159 719	
Basin: Patagonia		
Argentina		
Comodoro Rivadavia	6 300	Atlantic Ocean
San Sebastian	10	Atlantic Ocean
Total for basin	6 310	
Basin: Plata		
Argentina		
Buenos Aires	118 011	La Plata
Campana	92 000	Parana
Campo Duran	27 099	Bermejo
La Plata	216 789	La Plata
Lomas de Zamora	2 000	La Plata
Quilmes	60	La Plata
San Lorenzo	33 121	Parana
Subtotal	489 080	
Bolivia		
San Andita	50	Pilcomayo
Sucre	3 000	Caine
Subtotal	3 050	
Brazil		
Araucaira	120 600	Parana
Paulinia	325 000	Pilcomayo
Subtotal	445 600	
Paraguay		
Villa Elisa	5 000	Paraguay
Subtotal	5 000	
Uruguay		
La Teja	43 000	La Plata
Subtotal	43 000	
Total for basin	985 730	
Basin: Rio Bravo		
Mexico		
Cadereyta	100 000	San Juan
Reynosa	20 500	Bravo
Total for basin	120 500	
Basin: San Francisco		
Brazil		
Betim	72 400	Paraopeba
Total for basin	72 400	

Location of the plant	Barrels a/	Water body
Basin: South Atlantic		
Brazil		
Canoas	72 400	Dos Sinos
Capuava	3 300	Atlantic Ocean
Cubatao	162 900	Cubatao
Duque de Caxias	256 200	Niteroi
Mataripe	132 700	Atlantic Ocean
Rio Grande	9 300	Lagoa dos Patos
Rio de Janeiro	950	Guanabara Bay
Santo Andre	33 800	Cubatao
Total for basin	671 550	
Basin: South Pacific		
Chile		
Magallanes	1 500	Strait of Magellan
Total for basin	1 500	
Basin: Tropical Pacific		
Ecuador		
Esmeraldas	36 000	Pacific Ocean
La Libertad	8 000	Pacific Ocean
Subtotal	44 000	
El Salvador		
Acajutla	17 000	Pacific Ocean
Subtotal	17 000	
Guatemala		
Escuintla	14 000	Michatoya
Subtotal	14 000	
Total for basin	75 000	
GRAND TOTAL	5 385 359	

Source: OLADE, 1979.

a/ Barrels per day of operation.

C. IRON AND STEEL INDUSTRY
(tons)

Location of the plant	Installed capacity	Water body
Basin: Arid Pacific		
Peru		
Chimbote	500 000	Pacific Ocean
Total for basin	500 000	
Basin: Brazil, North-East		
Brazil		
Recife	243 000	Atlantic Ocean
Total for basin	243 000	
Basin: Central Chile		
Chile		
Talcahuano	700 000	Biobio
Total for basin	700 000	
Basin: Central Venezuela		
Venezuela		
Barcelona	6 000	Caribbean Sea
Barquisimeto	79 200	Turbio
Caracas	175 000	Guaires
Total for basin	260 200	
Basin: Gulf of Mexico		
Mexico		
San Cosme Xalostoc	80 000	Zavapan
Veracruz	400 000	Jamapa
Total for basin	480 000	
Basin: Interior of Argentina		
Argentina		
Est.Gral. San Martin	210 000	San Francisco
Total for basin	210 000	
Basin: Maracaibo		
Venezuela		
Ciudad Ojeda	10 000	Lake Maracaibo
Maracaibo	12 000	Lake Maracaibo
Total for basin	22 000	
Basin: North Pacific		
Mexico		
Lazaro Cardenas	1 300 000	Pacific Ocean
San Miguel Xoxtla	450 000	Atoyac
Total for basin	1 750 000	
Basin: Orinoco		
Venezuela		
Bolivar	4 270 000	Orinoco
Total for basin	4 270 000	

Location of the plant	Installed capacity	Water body
Basin: Pampa		
Argentina		
Bragado	135 000	Salado
		... 511 000 | Tiete
Piracicaba	290 000	Piracicaba
Sao Paulo	430 000	Tiete
Subtotal	1 271 000	
Buenos Aires	2 750 000	La Plata
Campana	385 000	Parana
Tablada	260 000	La Plata
Villa Constitucion	224 000	Parana
Subtotal	3 619 000	
Brazil		
Lencois Paulista	40 000	Paranapanema
Mogi das Cruzes	511 000	Tiete
Piracicaba	290 000	Piracicaba
Sao Paulo	430 000	Tiete
Subtotal	1 271 000	
Total for basin	4 890 000	
Basin: Rio Bravo		
Mexico		
Monclova	3 300 000	Nadadores
Monterrey	1 000 000	Pesqueria
San Nicolas	555 000	Pesqueria
Total for basin	4 855 000	
Basin: San Francisco		
Brazil		
Belo Horizonte	902 000	Das Velhas
Contagem	80 000	Das Velhas
Divinopolis	209 000	Paraca
Total for basin	1 191 000	
Basin: South Atlantic		
Brazil		
Barra Mansa	210 000	Paraiba do Sul
Coronel Fabriciano	660 000	Doce
Cubatao	2 448 000	Cubatao
Ipatinga	2 763 000	Doce
Pindamonhangaba	270 000	Paraiba do Sul
Porto Alegre	336 000	Guaiba
Rio de Janeiro	786 000	Guanabara Bay
Salvador	254 000	Atlantic Ocean
San Jeronimo	179 000	Jacui
Santo Amaro	7 000	Paraiba do Sul
Sao Goncalo	56 000	Guanabara Bay
Vitoria	162 000	Atlantic Ocean
Volta Redonda	2 970 000	Paraiba do Sul
Total for basin	11 101 000	
Basin: unspecified		
Unspecified		
Unspecified	870 000	
Total for basin	870 000	
GRAND TOTAL	31 477 200	

Source: ILAFA, 1974.

D. NON-FERROUS METAL INDUSTRY
(tons)

Location of the plant	Installed capacity	Water body
TYPE OF INDUSTRY : Aluminium		
Basin: Guayanas		
Suriname		
Paranam	66 000	
Total for basin	66 000	
Basin: Gulf of Mexico		
Mexico		
Veracruz	45 000	Jamapa
Total for basin	45 000	
Basin: Orinoco		
Venezuela		
Ciudad Guayana	400 000	Orinoco
Total for basin	400 000	
Basin: Patagonia		
Argentina		
Puerto Madryn	140 000	Atlantic Ocean
Total for basin	140 000	
Basin: Plata		
Brazil		
Pocas de Caldas	90 000	Pardo
Sorocaba	120 200	Sorocaba
Total for basin	210 200	
Basin: South Atlantic		
Brazil		
Aratu	58 000	Jacuipe
Saramenha Duro Preto	60 000	Doce
Total for basin	118 000	
Total for industry	979 200	
TYPE OF INDUSTRY : Copper (refining)		
Basin: Amazon		
Peru		
La Oroya	55 000	Negro
Total for basin	55 000	
Basin: Arid Pacific		
Chile		
Chuquicamata	370 000	Loa
Mantos Blancos	31 000	Loa
Paipote	72 000	Copiapo
Potrerillos	85 000	Salado
Subtotal	558 000	

Location of the plant	Installed capacity	Water body
Type of industry: Copper (refining)		
Basin : Arid Pacific (cont.)		
Peru		
Cerro Verde	33 000	Pacific Ocean
Ilo	150 000	
Subtotal	183 000	
Total for basin	741 000	
Basin: Central Chile		
Chile		
Caletones	130 000	Cachapoal
Las Ventanas	222 600	Pacific Ocean
Santiago	16 000	Mapocho
Total for basin	368 600	
Basin: Gulf of Mexico		
Mexico		
Azcapotzalco	75 300	Lake Texcoco/Tula
Total for basin	75 300	
Total for industry	1 239 900	
TYPE OF INDUSTRY : Copper (smelting)		
Basin: Amazon		
Peru		
La Oroya	182 400	Negro
Total for basin	182 400	
Basin: Arid Pacific		
Chile		
Chuquicamata	940 000	Loa
Potrerillos	245 000	Salado
Subtotal	1 185 000	
Peru		
Ilo	456 000	Pacific Ocean
Subtotal	456 000	
Total for basin	1 641 000	
Basin: California		
Mexico		
Cananea	126 300	Bocomuchi
Santa Rosalia	45 600	Gulf of California
Total for basin	171 900	
Basin: Central Chile		
Chile		
Chagres	86 000	Aconcagua
Las Ventanas	255 000	Pacific Ocean
Total for basin	341 000	

Location of the plant	Installed capacity	Water body
Type of industry: Cooper (smelting) (cont.)		
Basin: Southern Interior		
Mexico		
San Luis Potosi	136 800	
Total for basin	136 800	
Total for industry	2 473 100	
TYPE OF INDUSTRY : Lead (smelting and refining)		
Basin: Amazon		
Peru		
La Oroya	90 000	Negro
Total for basin	90 000	
Basin: Interior of Argentina		
Argentina		
Abra Pampa	1 500	
Total for basin	1 500	
Basin: Plata		
Argentina		
Puerto Vilelas	30 000	Parana
Subtotal	30 000	
Brazil		
Panelas	19 000	Urra
Subtotal	19 000	
Total for basin	49 000	
Basin: Rio Bravo		
Mexico		
Chihuahua	136 800	Chuviscar
Total for basin	136 800	
Basin: South Atlantic		
Brazil		
Santo Amaro	22 000	Paraiba
Total for basin	22 000	
Basin: Southern Interior		
Mexico		
Torreon	210 000	Nazas
Total for basin	210 000	
Total for industry	509 300	

Location of the plant	Installed capacity	Water body
TYPE OF INDUSTRY : Zinc (electrolitical)		
Basin: Amazon		
<u>Peru</u>		
La Oroya	34 500	Negro
Total for basin	34 500	
Basin: Plata		
<u>Argentina</u>		
Borghi	13 000	Parana
Total for basin	13 000	
Basin: San Francisco		
<u>Brazil</u>		
Tres Marias	32 800	San Francisco
Total for basin	32 800	
Basin: South Atlantic		
<u>Brazil</u>		
	15 700	Paraibuna
Itaquai	5 900	Itaquai
Total for basin	21 600	
Basin: Southern Interior		
<u>Mexico</u>		
Torreon	47 880	Nazas
Total for basin	47 880	
Total for industry	149 780	
TYPE OF INDUSTRY : Zinc (smelting)		
Basin: Patagonia		
<u>Argentina</u>		
Comodoro Rivadavia	16 000	Atlantic Ocean
Total for basin	16 000	
Basin: Rio Bravo		
<u>Mexico</u>		
Rosita	61 000	Sabinas
Saltillo	30 000	Pesqueria
Total for basin	91 000	
Basin: Southern Interior		
<u>Mexico</u>		
San Luis Potosi	113 000	
Total for basin	113 000	
Total for industry	220 000	

<u>Source</u>: Non-Ferrous Metal Data, 1983, American Bureau of Metal Statistics Inc.

E. THERMAL ELECTRIC POWER GENERATING STATIONS

Location of the plant	Capacity (MW)	Water body
Basin: Amazon		
Brazil		
Belem	130	Marajo Bay
Manaos	69	Amazon
Total for basin	199	
Basin: Arid Pacific		
Chile		
Antofagasta	21	Pacific Ocean
Barquito	68	Pacific Ocean
Chuquicamata	23	
Pedro de Valdivia	24	
Tocopilla	200	Pacific Ocean
Total for basin	336	
Basin: California		
Mexico		
Ahome	41	Fuerte
Baja California	75	
Cajeme	32	Yaqui
Durango	35	Mezquital
El Fuerte	59	Fuerte
Guaymas	272	Gulf of California
Hermosillo	32	Sonora
Mazatlan	40	Gulf of California
Tijuana	307	Tijuana
Total for basin	893	
Basin: Caribbean		
Colombia		
Barranquilla	74	Magdalena
Bogota	66	Bogota
Cartagena	102	Caribbean Sea
Honda	155	Magdalena
Yumbo	53	Cauca
Zupaguria	71	Bogota
Subtotal	624	
Costa Rica		
Heredia	31	Grande de Tarcoles
Subtotal	31	
Total for basin	655	
Basin: Central Chile		
Chile		
Coronel	125	Pacific Ocean
Laguna Verde	55	Pacific Ocean
Laja	33	Laja
Santiago	100	Mapocho
Ventanas	115	Pacific Ocean
Total for basin	428	
Basin: Gulf of Mexico		
Mexico		
Altamira	316	Altamira Lagoon
Tampico	29	Gulf of Mexico
Total for basin	345	

Location of the plant	Capacity (MW)	Water body
Basin: Interior of Argentina		
<u>Argentina</u>		
Dean Funes	33	
La Banda	18	Dulce
Pilar	141	Segundo
Tucuman	80	Sali
Total for basin	272	
Basin: North Pacific		
<u>Mexico</u>		
Celaya	43	Lerma
Guadalajara	87	Santiago
Salamanca	322	Lerma
Total for basin	452	
Basin: Orinoco		
<u>Colombia</u>		
Belencito	25	Chicamocha
Paipa	99	Grande
Total for basin	124	
Basin: Pampa		
<u>Argentina</u>		
Bahia Blanca	50	Atlantic Ocean
Lujan de Cuyo	120	Mendoza
Mar de Ajo	16	Atlantic Ocean
Necochea	206	Atlantic Ocean
Neuquen	30	Neuquen
Total for basin	422	
Basin: Patagonia		
<u>Argentina</u>		
Comodoro Rivadavia	47	Atlantic Ocean
Total for basin	47	
Basin: Plata		
<u>Argentina</u>		
Atucha	370	Parana
Avellaneda	184	La Plata
Barranqueras	55	Parana
Bragado	12	Salado
Buenos Aires	2 845	La Plata
Caseros	19	Uruguay
Chascomus	3	Salado
Concepcion del Uruguay	15	Uruguay
Corrientes	175	Parana
Guemes	120	San Francisco
Gutierrez	17	La Plata
Junin	16	Salado
La Tablada	54	La Plata
Malaver	36	La Plata
Moron	36	La Plata
Olavarria	32	Tapalquen
Palpala	36	San Francisco
Parana	22	Parana
Pehuajo	12	
Posadas	48	Parana
Reconquista	3	Parana
Resistencia	108	Parana
Rio Cuarto	3	Cuarto

Location of the plant	Capacity (MW)	Water body
Basin: Plata		
Argentina (cont.)		
Rio Tercero	644	Tercero
Roque Saenz P.	17	
Rosario	226	Parana
Salta	32	San Francisco
San Nicolas	720	Parana
San Pedro	8	San Francisco
Santa Fe	37	Salado
Tartagal	13	Itiyuro
Villa Maria	51	Tercero
Subtotal	6 065	
Brazil		
Alegrete	66	Ibirapuita
Bage	446	Negro
Campinas	30	Piracicaba
Cariova	30	Das Antas
Sao Roque	450	Tiete
Tubarao	255	Palmeiras
Subtotal	1 277	
Uruguay		
Montevideo	280	Atlantic Ocean
Subtotal	280	
Total for basin	7 622	
Basin: Rio Bravo		
Mexico		
Chihuahua	76	Chuviscar
Delicias	66	San Pedro
Francisco I Madero	30	Manantial Cabecera
Monterrey	161	Pesqueria
	30	Pesqueria
Nava	38	
Rio Bravo	75	Nazas
San Nicolas	393	Pantano
Total for basin	869	
Basin: South Atlantic		
Brazil		
Campos	30	Paraiba Do Sul
Duque de Caxias	23	Niteroi
Porto Alegre	24	Guaiba
Salvador	20	Atlantic Ocean
Santa Cruz	599	Sepetiba Bay
Sao Geronimo	92	Jacui
Sao Goncalo	33	Guanabara Bay
Total for basin	821	
Basin: Southern Interior		
Mexico		
Gomez Palacio	189	Nazas
Torreon	28	Nazas
Total for basin	217	

Location of the plant	Capacity (MW)	Water body
Basin: Tropical Pacific		
Costa Rica		
San Jose	20	Torres
Subtotal	20	
Ecuador		
Cumbaya	23	San Pedro
Ximena	110	Guayas
Subtotal	133	
El Salvador		
Acajutla	70	Pacific Ocean
Soyopango	59	Acelhuate
Subtotal	129	
Guatemala		
Escuintla	58	Michatoya
La Laguna	30	Maria Linda
Subtotal	88	
Total for basin	370	
GRAND TOTAL	14 072	

Source: Various national sources.

Annex 3

LATIN AMERICA AND THE CARIBBEAN: MINING PRODUCTION, BY MINERALS, COUNTRIES AND YEARS

LATIN AMERICA AND THE CARIBBEAN: MINING PRODUCTION, BY MINERALS, COUNTRIES AND YEARS

Country	1950	1970	1980	1985
ANTIMONY (tons)				
Argentina		0.3		
Bolivia	8 781.0	11 576.0	15 465.0	8 635.0
Guatemala		261.0	556.0	90.0
Honduras		342.9	28.0	320.0
Mexico	5 868.0	4 468.0	2 176.0	3 574.0
Peru	970.6	1 167.0	655.0	263.0
Total	15 619.6	17 815.2	18 880.0	12 882.0
ARSENIC (tons)				
Brazil	1 066.8	298.0		
Mexico	8 986.5	9 140.0	6 932.0	5 000.0
Peru		772.0	2 475.0	800.0
Total	10 053.3	10 210.0	9 407.0	5 800.0
BAUXITE (1 000 tons)				
Brazil	18.6	509.8	4 152.4	6 433.2
Dominican Republic		1 086.0	510.5	
Guyana	1 668.4	4 417.2	3 052.0	2 484.7
Haiti		656.8	461.0	
Jamaica		12 009.7	12 064.3	6 239.3
Suriname	2 045.4	6 022.0	4 903.1	3 374.8
Total	3 732.4	24 701.5	25 143.3	18 532.0
BERYLLIUM (tons)				
Argentina		571.0	31.0	15.4
Brazil	2 894.0	3 333.0	550.0	1 496.8
Total	2 894.0	3 904.0	581.0	1 512.2
BISMUTH (tons)				
Bolivia	24.4	623.0	11.0	125.6
Mexico	263.2	571.0	770.0	385.0
Peru	226.9	806.2	490.0	362.6
Total	514.5	2 000.2	1 271.0	873.2
CHROMIUM (1 000 tons)				
Brazil	2.0	27.9	316.9	250.0
Cuba	1.5	8.0	10.0	10.0
Total	3.5	35.9	326.9	260.0
COAL (1 000 tons)				
Argentina	26.0	615.5	389.0	396.0
Brazil	1 959.0	2 361.3	4 984.6	7 178.0 a/
Colombia	1 010.0	2 500.0	4 113.0	9 706.0
Chile	1 995.0	1 382.4	995.6	1 369.8
Mexico	1 000.0	2 959.2	6 827.5	9 770.8
Peru	195.7	156.1	85.0 b/	85.0 b/
Venezuela	1.4	40.0	48.0	36.0
Total	6 187.1	10 014.5	17 442.7	28 541.6

Country	1950	1970	1980	1985
COPPER (1 000 tons)				
Argentina		0.5	0.2	0.1
Bolivia	4.7	8.9	1.7	2.4
Brazil		3.8	0.4	32.0
Chile	362.9	691.6	1 067.9	1 356.4
Colombia		0.1	1.4	0.2
Cuba	20.4	0.4	3.3	3.0
Dominican Republic		0.4		
Ecuador	0.5	0.2	0.9	
Guatemala			0.8	
Haiti		4.8		
Mexico	61.7	61.0	175.4	173.0
Nicaragua		3.4		
Peru	30.1	220.2	366.7	386.8
Total	480.3	995.3	1 618.7	1 953.9
GOLD (kilograms)				
Argentina	248.8		330.4	699.8
Bolivia	240.0	951.9	1 619.7	933.1
Brazil	6 080.7	5 329.0	40 434.0	62 207.0
Chile	5 984.0	1 622.9	6 835.7	17 240.1
Colombia	11 801.0	6 267.9	15 876.4	35 769.0
Costa Rica	3.6	15.6	559.9	1 088.6
Dominican Republic	14.8		11 495.9	10 486.5
Ecuador	2 998.5	265.0	7.0	31.1
El Salvador	903.6	71.6	77.5	8.7
Guyana	384.6	137.9	342.2	321.1
Honduras	1 136.7	103.7	63.0	77.8
Haiti		93.3	90.0	90.0
Mexico	12 694.0	6 166.0	5 476.9	8 864.5
Nicaragua	7 129.1	3 582.3	1 866.0	761.8
Peru	3 964.4	3 349.0	4 417.9	6 950.0
Suriname	143.4	35.4	10.9	15.6
Venezuela	1 071.9	694.2	421.9	2 267.4
Total	54 799.1	28 685.7	89 925.3	147 812.1
IRON (1 000 tons)				
Argentina	40.0	238.8	412.0	578.0
Bolivia		4.1	6.0	7.0
Brazil	1 987.0	40 233.6	100 275.0	114 695.0
Chile	2 975.9	11 265.0	8 960.0	6 534.0
Colombia		453.0	491.0	440.0
Guatemala		2.0		
Mexico	419.6	4 353.6	8 149.0	8 103.0
Peru		9 711.9	5 679.0	4 892.0
Venezuela	198.1	22 099.0	13 681.0	14 710.0
Total	5 620.6	88 361.0	137 653.0	149 959.0
LEAD (1 000 tons)				
Argentina	23.0	35.6	32.6	29.0
Bolivia	31.2	25.8	15.9	7.8
Brazil		20.3	21.8	19.2
Chile	3.3	0.9	0.5	2.7
Colombia		0.5	0.1	
Ecuador	0.2	0.1	0.2	0.2
Guatemala	3.0	1.0	0.1	0.1
Honduras	0.3	15.1	13.3	20.4
Mexico	238.1	176.6	147.2	181.6
Peru	62.1	156.8	189.1	216.2
Total	361.2	432.7	420.8	477.2

Country	1950	1970	1980	1985
MANGANESE (1 000 tons)				
Argentina		10.2	1.4	0.3
Bolivia		0.1	1.4	
Brazil	86.0	1 201.9	1 339.0	1 056.7
Chile	16.7	11.1	9.0	0.5
Colombia		0.5	21.4	20.0
Cuba	11.6	20.0		
Mexico	14.5	98.6	161.0	192.5
Peru	0.5	0.6		
Total	129.3	1 343.0	1 533.2	1 270.0
MERCURY (tons)				
Chile	11.0	13.4		
Colombia		7.4		
Dominican Republic			5.5	0.7
Mexico	128.0	1 043.0	145.0	344.7
Peru		110.2		
Total	139.0	1 174.0	150.5	345.4
MOLYBDENUM (tons)				
Chile	992.0	5 701.2	13 668.0	18 390.0
Mexico		141.1	73.9	3 696.8
Peru	0.9	606.9	2 688.0	3 827.9
Total	992.9	6 449.2	16 429.9	25 914.7
NICKEL (tons)				
Brazil		2 990.0	4 291.0	13 200.0
Colombia				14 000.0
Cuba		36 775.7	38 230.0	38 000.0
Dominican Republic			15 500.0	25 400.0
Guatemala			6 900.0	
Mexico		44.0	18.1	
Total		39 809.7	64 939.1	90 600.0
OIL (1 000 m^3)				
Argentina	3 728.8	22 793.2	28 566.0	26 716.2
Bolivia	98.0	1 402.2	1 383.9	1 140.0
Brazil	53.9	9 685.6	10 562.0	31 716.3
Chile	100.2	1 976.5	1 933.1	2 074.4
Colombia	5 414.4	12 725.5	7 303.7	10 239.0
Cuba	2.1	167.4	288.0	913.2
Ecuador	418.4	235.3	11 890.4	16 279.9
Mexico	11 746.0	29 132.0	122 822.0	159 263.0
Peru	2 388.9	4 176.0	11 345.4	10 935.1
Trinidad and Tobago	3 285.5	8 114.3	12 340.9	10 247.0
Venezuela	86 929.0	215 177.0	125 737.0	97 539.8
Total	114 165.2	305 585.0	334 172.4	367 063.9
PLATINUM (kilograms)				
Colombia	760.5	808.7	446.2	362.3
Total	760.5	808.7	446.2	362.3
SALTPETER (1 000 tons)				
Chile	1 659.7	674.1	620.4	700.0
Total	1 659.7	674.1	620.4	700.0

Country	1950	1970	1980	1985
SELENIUM (tons)				
Chile			17.0	25.0
Mexico		126.0	46.0	40.0
Peru		7.0	23.0	22.0
Total		133.0	86.0	87.0
SILVER (tons)				
Argentina		87.6	73.3	61.5
Bolivia		185.6	189.7	125.0
Brazil	0.7	12.0	44.5	66.5
Chile	37.2	76.2	298.5	505.0
Colombia	3.6	2.4	4.1	6.1
Dominican Republic			60.5	46.5
Ecuador	8.0	2.2	1.0	
El Salvador		4.8	4.8	0.6
Honduras	109.3	118.7	53.5	80.7
Haiti		0.5	0.6	0.7
Mexico	1 528.5	1 332.4	1 556.8	2 158.8
Nicaragua	4.1	6.7	5.1	1.5
Peru	417.8	1 239.0	1 339.8	1 769.8
Total	2 109.2	3 068.1	3 632.2	4 822.7
SULPHUR (1 000 tons)				
Argentina	7.7	40.0		10.0
Bolivia	7.8	16.0	11.0	2.0
Brazil		9.0	156.0	337.0
Chile	15.4	109.0	115.0	109.5
Colombia	1.2	34.0	27.0	38.0
Cuba			30.0	8.0
Ecuador		6.1	14.0	14.0
Mexico	11.2	1 381.0	2 217.0	2 190.0
Trinidad and Tobago		4.4	57.0	5.0
Total	43.3	1 599.5	2 627.0	2 713.5
TIN (tons)				
Argentina	261.0	1 172.0	600.0	270.0
Bolivia	31 712.0	30 100.0	27 271.0	18 000.0
Brazil	183.0	3 680.0	6 930.0	22 000.0
Mexico	447.0	533.0	60.0	400.0
Peru	38.2	102.9	1 077.0	3 807.0
Total	32 641.2	35 587.9	35 938.0	44 477.0
WOLFRAM (tons)				
Argentina	23.6	143.8	44.0	36.0
Bolivia	2 484.8	1 845.2	2 732.0	1 551.0
Brazil	1 371.7	1 156.2	1 116.0	1 175.0
Guatemala		40.8		
Mexico	67.9	288.0	265.8	291.0
Peru	516.2	804.2	581.0	870.0
Total	4 464.2	4 278.2	4 738.8	3 923.0

Country	1950	1970	1980	1985
ZINC (1 000 tons)				
Argentina	12.6	39.0	33.7	36.0
Bolivia	19.6	46.5	46.2	41.0
Brazil		11.0	70.0	110.0
Chile	0.1	1.5	1.1	18.0
Colombia		0.2	0.3	1.0
Ecuador		0.1	0.6	0.1
Guatemala	0.3	1.0	0.1	
Honduras	0.1	18.6	16.0	44.0
Mexico	223.5	266.4	235.8	280.0
Nicaragua				
Peru	88.0	299.0	530.8	588.6
Total	344.2	683.3	934.6	1 118.7

Source: ECLAC, "Estadísticas mineras: producción y precios en América Latina y el Caribe" (LC/R.545), 18 March 1987.

a/ 1984.
b/ 1979.

Annex 4

LATIN AMERICA AND THE CARIBBEAN: AGRICULTURAL CHEMICALS WHOSE CONSUMPTION AND/OR SALE HAVE BEEN BANNED, WITHDRAWN, SEVERELY RESTRICTED OR NOT APPROVED BY GOVERNMENTS

LATIN AMERICA AND THE CARIBBEAN: AGRICULTURAL CHEMICALS WHOSE CONSUMPTION AND/OR SALE HAVE BEEN BANNED, WITHDRAWN, SEVERELY RESTRICTED OR NOT APPROVED BY GOVERNMENTS

AGRICULTURAL CHEMICALS	LATIN AMERICA & THE CARIBBEAN	
	COUNTRY	EFFECTIVE DATE a/
1. alpha-HCH	Argentina	2 October 1980
2. beta-HCH	Argentina	2 October 1980
3. delta-HCH	Argentina	2 October 1980
4. gamma-HCH	Argentina Argentina Colombia Ecuador	20 December 1971 1 June 1972 May 1978 1985
5. ALDRIN	Argentina Argentina Argentina Argentina Chile Colombia Ecuador Venezuela	19 March 1963 30 April 1968 20 December 1971 1 June 1972 5 January 1983 6 December 1974 1985 6 June 1983
6. AMITRAZ	Argentina	24 June 1980
7. AMITROLE	Ecuador	1985
8. ARAMITE	Argentina	20 December 1971
9. ARSENIC	Ecuador	1985
10. CAMPHECHLOR	Colombia Ecuador Venezuela	December 1974 1985 1983
11. CHLORDANE	Argentina Argentina Chile Colombia Ecuador Venezuela	1 June 1972 10 June 1969 5 January 1983 6 December 1974 1985 1983
12. CHLORDECONE	Venezuela	1983
13. CHLORDIMEFORM	Colombia Ecuador Guatemala	19 July 1978 1985 April 1978
14. CHLOROBENZILATE	Ecuador	
15. DDT	Argentina Argentina Argentina Argentina Chile Colombia Colombia Colombia Cuba Ecuador Ecuador Guatemala Venezuela	19 March 1963 30 April 1968 20 December 1971 1 June 1972 1 January 1985 2 May 1977 12 May 1978 6 December 1974 1970 1985 1985 April 1980 1983

AGRICULTURAL CHEMICALS	LATIN AMERICA & THE CARIBBEAN	
	COUNTRY	EFFECTIVE DATE a/
16. DIELDRIN	Argentina	21 February 1968
	Argentina	27 March 1969
	Chile	5 January 1983
	Colombia	6 December 1974
	Ecuador	1985
	Venezuela	1983
17. DINOSEB	Ecuador	1985
18. ENDOSULFAN	Argentina	1 May 1968
	Argentina	1 June 1972
19. ENDRIN	Argentina	19 March 1963
	Argentina	1 May 1968
	Argentina	10 June 1969
	Argentina	20 December 1971
	Argentina	1 June 1972
	Chile	5 January 1983
	Colombia	September 1985
	Ecuador	
	Venezuela	1983
20. ETHYLENE DIBROMIDE (EDB)	Chile	7 February 1985
	Colombia	15 May 1985
	Ecuador	1985
21. HCH-MIXED ISOMERS	Argentina	2 October 1980
	Colombia	6 December 1974
	Colombia	12 May 1978
	Ecuador	1985
22. HEPTACHLOR	Argentina	1 June 1972
	Argentina	21 February 1968
	Argentina	1 May 1968
	Argentina	10 June 1969
	Argentina	20 December 1971
	Chile	5 January 1983
	Ecuador	
	Venezuela	1983
23. HEXACHLOROBENZENE	Argentina	19 March 1963
	Argentina	30 April 1968
	Argentina	1 June 1972
24. ISOBENZAN	Colombia	December 1974
25. LEAD	Ecuador	1985
26. LEPTOPHOS	Colombia	5 July 1977
	Ecuador	
	Guatemala	October 1977
27. MALEIC HYDRAZIDE	Guatemala	
28. MELIPAX	Colombia	December 1974
29. MERCURY	Colombia	November 1974
30. METHOXYCHLOR	Argentina	19 March 1963
	Argentina	30 April 1968
	Argentina	1 May 1968
	Argentina	1 June 1972

AGRICULTURAL CHEMICALS	LATIN AMERICA & THE CARIBBEAN	
	COUNTRY	EFFECTIVE DATE a/
31. MIREX	Ecuador Venezuela	1985 1983
32. PARATHION	Ecuador	1985
33. PARATHION METHYL	Ecuador	1985
34. PENTACHLOROPHENOL	Ecuador	1985
35. PHENYLMERCURY ACETATE	Argentina	21 December 1971
36. SILVEX	Colombia Colombia	May 1979 18 May 1979
37. SODIUM FLUOROACETATE	Colombia	May 1969
38. SODIUM METHANEARSONATE	Argentina	20 December 1971
39. TRIFLURALINE	Guatemala	
40. 1,2-DIBROMO-3- -CHLOROPRPPANE (DBCP)	Argentina Colombia Ecuador Guatemala	2 October 1980 February 1982 1985 October 1981
41. 2,4-D	Guatemala	July 1982
42. 2,4,5-T	Colombia Ecuador Guatemala	18 May 1979 1985

Source: Consolidated list of products whose consumption and/or sale have been banned, withdrawn, severely restricted or not approved by governments, Second issue, ST/ESA/192, United Nations, 1987, pp. 121-226.

a/ The effective date on which the regulation related to the use of the chemical in question came into force in the respective country.