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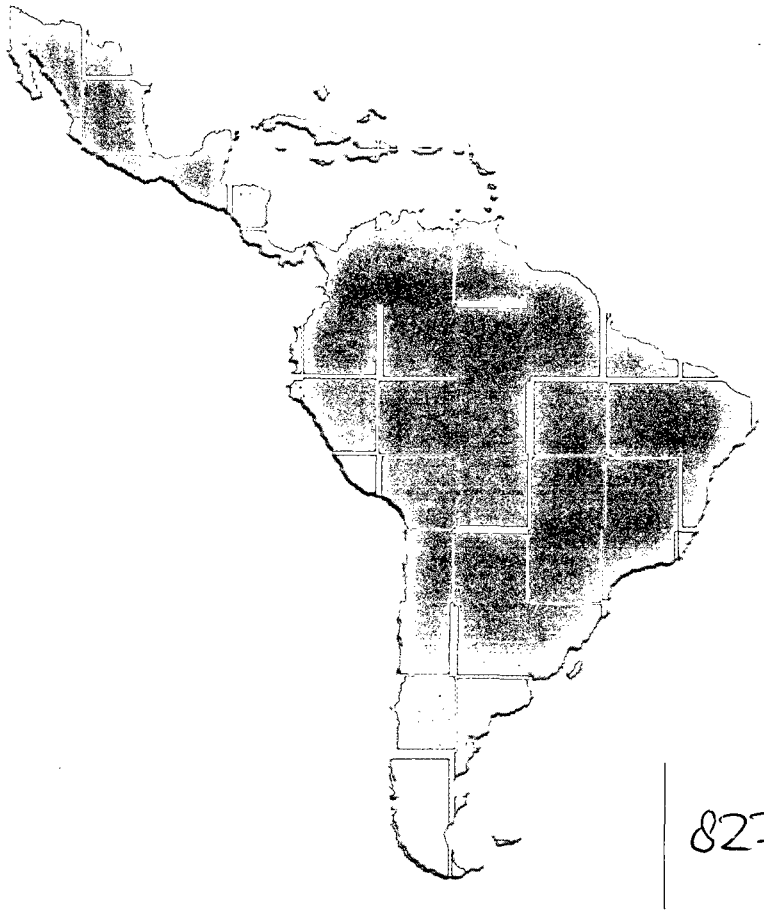
MUNICIPAL WASTE WATER AS A LAND-BASED SOURCE OF POLLUTION IN COASTAL AND MARINE AREAS OF LATIN AMERICA AND THE CARIBBEAN



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The Global Programme of Action for the Protection of the Marine Environment from Land-based Activities GPA Coordination Office
P.O.Box 16227
2500 BE The Hague
The Netherlands
Clearing house: http://www.gpa.unep.org
E-mail: gpa@unep.nl

United Nations Environment Programme (UNEP)
Regional Office for Latin America and the Caribbean (ROLAC)
Boulevard de los Virreyes # 155
Colonia Lomas Virreyes 11000
México D.F., México
Web page: http://www.rolac.unep.mx
E-mail: unepnet@rolac.unep.mx

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1. Foreword

The diagnosis presented in this document focuses on the discharge of municipal and industrial wastewater into the marine and coastal zone of Latin America and the Caribbean. This document is mainly based on a compilation of various studies that have been undertaken at the regional and national levels, as well as incorporating the results of the Latin American Workshop on Municipal Wastewater Management (LMARM in Spanish), organized by the GPA coordination office and the Regional Office for Latin America and the Caribbean, and held September 10-12, 2001 in Mexico City.

During the workshop it became patently clear that the countries had in different ways recognized the problem and most had already initiated efforts to deal with it; some through public policy, some through infrastructure and technology, and others through experiments with economic measures. These initiatives demonstrate efforts that are being undertaken in the region, nevertheless, they are insufficient. The experiences put forward during the workshop enable us to envision the range of possible solutions to select from and implement both in the countries and in the region as a whole.

The intention of this report is to present the current situation in the region and the results and recommendations resulting from the interaction of the region in the Latin American Workshop on the Management of Municipal Wastewater. In addition the document highlights the many efforts being undertaken to deal with the issue in Latin America and the Caribbean. Moreover, the document contributes elements that will enable us to visualize the important relationship between the management of watersheds and the health of marine and coastal ecosystems.

Some important goals were set as a result of the 1992 Earth Summit; the countries committed themselves to establishing quality criteria for the discharge of wastewater and to designing monitoring mechanisms by the year 2000. Similarly, they committed to the appropriate treatment of 50% of said wastewater prior to its disposal. This problem must be recognized and handled with the priority it demands, or else we will continue to face:

-Effects on public health.

-Deterioration of the coastal and marine ecosystems.

-Reduction on the exploitation availability of live marine resources, and

-Loss of economic opportunities, such as aquaculture, tourism and more.

Investment needs are many, however, the cost of inaction is exceedingly high. We should bear in mind that water and marine and coastal ecosystems are essential in a region where up to 60% of the population live in the area and where sustainable development is the only way to secure the future for everyone.

Ricardo Sánchez Sosa.

2. Introduction

Pollution from wastewater in the coastal zone is a historic alarm. Since the time of the Stockholm Agenda, warning had already been given concerning the problem of municipal wastewater. At the 1992 Rio Summit, it was said that by 2005 the problem would have to be reduced by 50%, though this has been impossible to achieve. According to UNEP, less than 20% of wastewater in Latin America receives adequate treatment, making this a serious problem demanding efficient technological and economical strategies.

The effects of wastewater on the coastal zone depend fundamentally on its physical aspects. These fixed territorial features tend to be forgotten when dealing with the management of coastal resources. All human activities developed on the coast –especially those involving the management of wastewater– on the one hand depend on the position held within a watershed for the discharge of wastewater, and on the other hand depend on the marine currents at the location where they are discharged. As a matter of fact, what will define how the discharge is diluted and its effects mitigated. Few methods have been designed to link land-based sources of pollution directly to the marine currents, and few indeed have been applied to programs for the management of coastal regions. (Beltrami & Carrol, 1978; Escofet & Burgeño, 1993).

Due to the above, the first consideration when analyzing the problem of wastewater treatment and its management is to classify the coastline of Latin America and the Caribbean based on its watersheds and type of ocean (open or semi-enclosed). This allows for a better understanding of the real and potential ecological impact caused by land-based sources of pollution, and thus becomes a fundamental sources when prioritizing (Escofet & Espejel, in press).

2.1 Large Marine Ecosystems

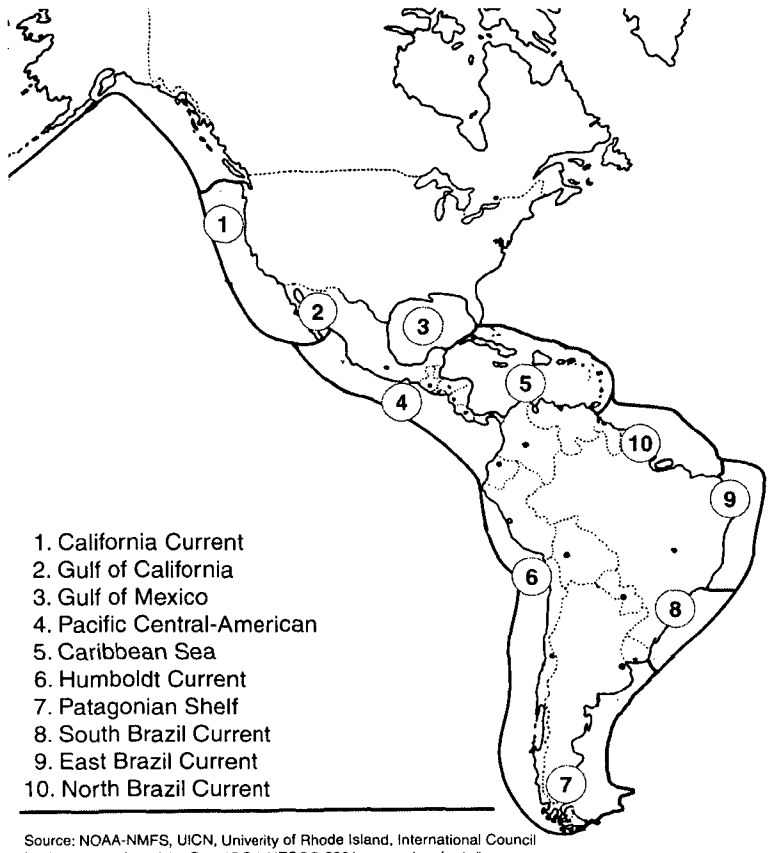
According to Sherman (1994) and Sherman and Tang (1999), there are 10 large marine ecosystems in Latin America and the Caribbean (map 1) divided into four groups:

1) Open seas delimited by important oceanic currents such as those of the North Pacific (Baja California peninsula), the South Pacific along the coast of South America, and the Atlantic south of Brazil;

2) Open seas delimited by the continental shelf such as the Mexican and Central American South Pacific, the Atlantic south of Argentina and north of Brazil;

3) Semi-enclosed seas with a high capacity for ecological load (and cleanup) such as the Caribbean and the Gulf of Mexico, and

4) Semi-enclosed seas with a low capacity for ecological load (and cleanup) such as the Gulf of California

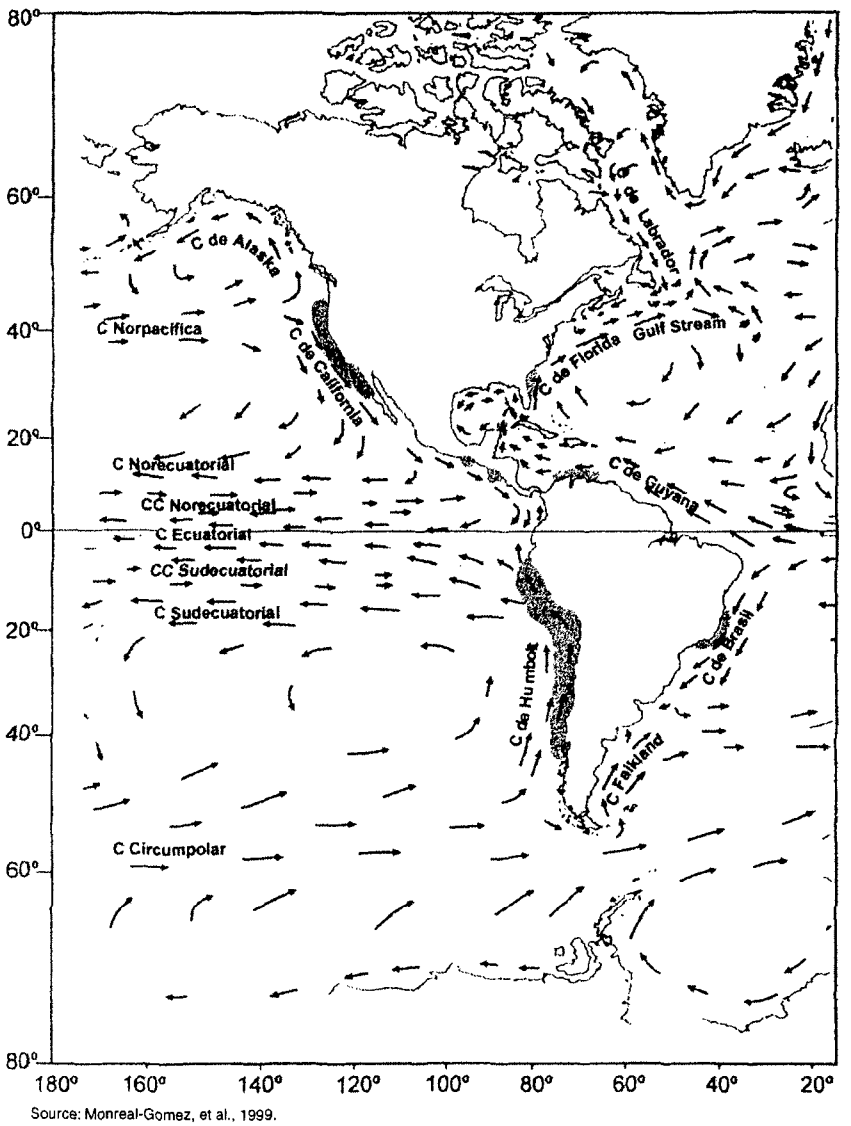


Map 1: The 10 Large Marine Ecosystems of Latin America and the Caribbean.

The conditions of these Large Marine Ecosystems (LMEs) range from the subtropical region in the northern hemisphere through the temperate region in the southern hemisphere, hence providing great diversity of ecosystems such as: kelp forests, mangrove shurbs and forests, rocky reefs, seagrass beds, coral reefs, deltas, tidelands, coastal lagoons, salt marshes, sandy beaches, coastal dunes, cobble beaches, escarpments, and even submarine wells with hydrothermal vents, among many other ecosystems.

Our vision of the immensity of the seas has led to their increasing and ongoing abuse, and as rich and diverse as they are in the Latin American and Caribbean region, we have significantly depleted their levels of production through over-exploitation, pollution and physical alterations.

The Latin American and Caribbean region comprises the southern Neartic region and the entire Neotropic region. The geo-morphology of its coasts and the winds, along with the current patterns, have given way to the development of seven highly productive zones known as upwelling zones (Monreal-Gómez, *et al.*, 1999 see map 2). These are located throughout 64,000 km of coastline, and in the 16 million km^2 of marine territory (UNEP, 2000). Aside from these upwelling zones, there are also other very important areas for productivity in the coastal and marine zone. These are the outlets of large watersheds such as the River Plate, the Amazon river, the Orinoco and the Grijalva-Usumacinta among others. In these outlets, there may be formations of deltas, coastal lagoons, and tidelands, all of which are highly productive systems, which additionally function as reproduction, spawning and feeding grounds for species, of which 70% are commercially important.



Map 2.. Main Upwellings in Latin America.

Also associated to these ecosystems are the mangrove forests, which in addition to being highly productive, also provide protection to the coastline and consume vast amounts of the nutrients that are swept through the watershed, thus reducing the eutrophication of the water column.

The mangrove forest cover ranges from 40,000 to 60,000 km^2 in the region, and is more developed along the equatorial coastline. Only the three southernmost countries: Chile, Argentina and Paraguay have no mangrove (Yánez-Arancibia, 1994).

The best-developed mangrove forests are north of the equator, along the Pacific coast of Colombia, Panama and the southern coast of Costa Rica. Similarly, the optimum tropical conditions of the Atlantic coast produce mangrove forests from the south of the Golfo de Paria (Venezuela) to Sao Luiz in Brazil. Brazil is among the three countries with the largest extension of mangrove forests in the world, along with Indonesia and Australia. Though abundant in Latin America and the Caribbean, only 11 of the 54 species of mangrove found around the world are present in the region (Tomlinson, 1986).

In the Caribbean region, the most important coastal and marine ecosystems are made up of coral reefs, which can be compared to tropical rainforests by virtue of their high productivity and biodiversity. The Mesoamerican Reef System (MRS), along the coast of Mexico, Belize, Guatemala, and Honduras, with an extension of over 700 kilometers, is the second largest barrier reef in the world. The ecosystems that form part of the Mesoamerican Reef System include coral reef barriers, coastal lagoons and mangrove forests. While this reef system is currently well preserved 60% of the coral in the Caribbean is considered to be at risk from negative impacts (GESAMP, 2001). The coral reef system provides a habitat for many species that are highly endangered, such as manatees (between 300 and 700 individual animals), river and swamp crocodiles, hawksbill and white turtles, and over 60 species of coral, among many other organisms.

Yet another ecosystem that appears alongside coral reefs and mangrove forests are seagrass beds. These systems –generally appearing in shallow waters and with low wave impact– are highly productive areas, and are determinant for some types of fishery activities, such as shrimp in the Gulf of Mexico (Vázquez-Botello *et al.*, 1996).

2.2. El Niño

El Niño, the meteorological phenomenon that concerns the region, is an oceanic and atmospheric disturbance that affects the global environment. It has existed on the planet for thousands of years, but has now increased in strength and frequency, causing mayor impact both on the natural environment, as well as on the population and on economic activities. In the region, it is manifested through an invasion of superficial equatorial waters, of low salinity and high temperature, reaching both north and south along the Pacific coast. Concern over el Niño increases when we link it to global warming and sea level rise. In 1997-98, about 117 million people around the world, were affected by El Niño, causing the deaths of more than 21,000 people, and leading to the injury or illness of another 540,000. The number of people left homeless rose to 4.9 million, and the economic damage in the region is estimated at 14 billion dollars (GESAMP, 2001).

2.3. Fishing

The most important fisheries in the region based on volume are in the Pacific Ocean, and are associated to the upwelling areas previously mentioned. These include the Humboldt Current in Peru/Chile, and the California Current off the western coast of the Baja California Peninsula. In the Atlantic, important fisheries are located in the rich waters off the continental shelf of Argentina and Uruguay, and the Falkland Islands.

Marine fishery production in the Atlantic area fell dramatically from 21 million tons in 1995 to around 11.6 million tons in 1998 (UNEP, 2000 and UNEP, 2001). In 1998, this figure represented 13.6% of worldwide marine catch (FAO, 2000). Nearly the entire catch (10.1 million tons) was captured in South America.

Peru and Chile are among the 12 top fishing countries in the world; if we extend that list to the first 20, Mexico is then included. The drop in the fishing production of these countries in 1998 was fundamentally due to adverse climate factors (El Niño), acting in synergy with the over-fishing during the last 10 years, when many South American countries double and trebled their catch (UNEP, 2000) causing prolonged reductions of the primary fishing resource biomasses. The Peruvian anchovy fell 78%, and Chilean saurel 44%. Nevertheless, the catches of these countries recovered in 1999 upon the normalization of the climatic situation, and they recorded increases close to 50% despite low product prices in the market (FAO, 2000).

In Mexico, fishing production grew-up to 4.2% in 1999 as compared to the year earlier period (758,576 tons) due to increased captures of sardine, tuna, shrimp and algae. Regardless, the figure is still much lower than that of 1997 captures (SEMARNAP 2000).

The diseases and meteorological phenomena of 1998 and 1999 caused a reduction of over 80% in the aquaculture production of shrimp in Ecuador and Peru (from 100,000 tons to 16,000 tons).

Possibilities for marine fishery growth in the region are marginal (FAO, 2000), as are those of other oceans such as the Central-Western Pacific and the Indian Ocean.

There are warning signals in the region. Population growth in coastal zones is pushing fisheries through unsustainable levels of exploitation, bringing on a risk situation not only for marine resources, but also to the integrity of the ocean itself. Regrettably, the region has no system to record indicators on the health of resources and ecosystems that would gear actions to the recovery of over-exploited populations and their environment (other than isolated proposals put forth by Peru, Chile, Argentina and Mexico).

According to the FAO (2000), 25-27% of the populations of species are insufficiently or moderately exploited, 47-50% are fully exploited, 15-18% are over-exploited with no margin for increased exploitation, and 9-10% are depleted or undergoing recovery. In other words, there is marginal room for growth in marine fisheries, and it is not only delimited spatially, but is also limited by representing only 25-27% of the world's fishing resources. In Mexico the National Fishery Chart of 2000 indicates that the possible room for growth is only 19%.

2.4 Regions of Special Interest for Conservation

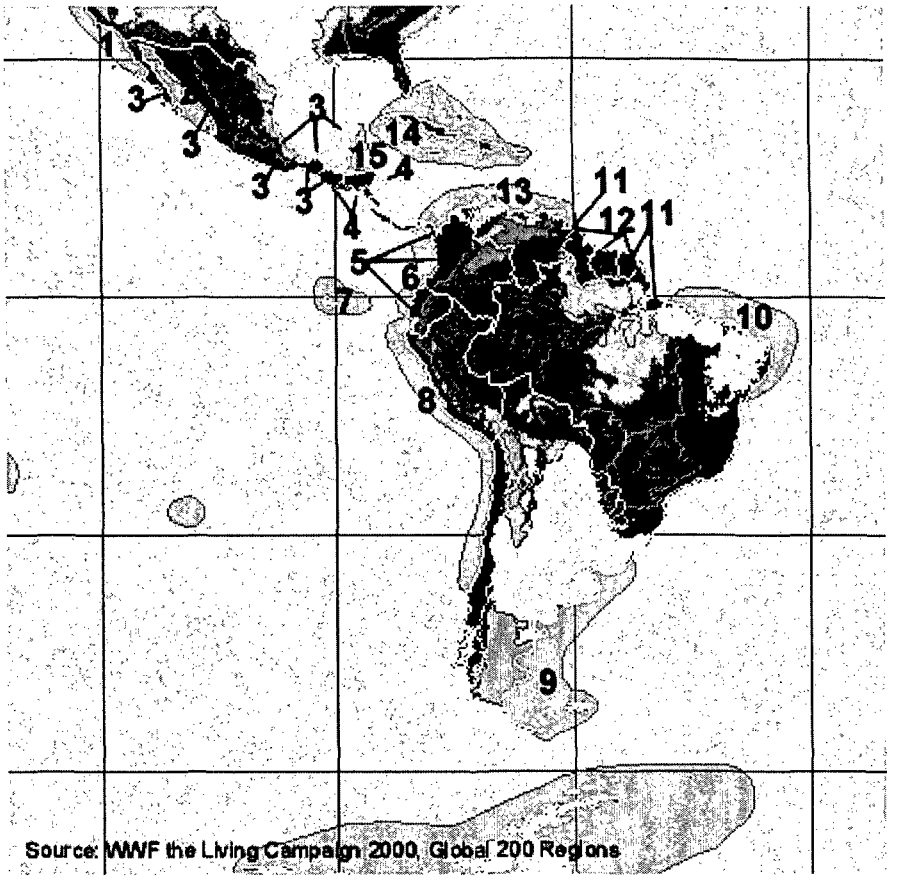
According to the WWF in the Living Campaign 2000, Global 200 Ecoregions, 15 marine ecoregions have been classified; these require special attention to ensure their conservation. These are large areas that comprise a particular group of species, communities, and environmental dynamics and conditions that require special attention due to their ecological value.

Among the major factors that have an impact on these and other ecosystems of the region are: discharge of municipal and industrial wastewater, physical alterations due to urban growth and the construction of port and industrial infrastructures, runoff from agricultural fields, increased amount of sediment due to deforestation, over-exploitation of fishery resources and the use of destructive methods, and the alteration of water patterns through damming of rivers.

It is important to understand that 70% of the damage to coastal and marine zones is caused by land-based activity (UNEP, 1995), and is often hundreds of kilometers from the coast; until strategies for the integral management of watersheds and the coastal zone are developed, it would be very difficult avoid these impacts.

These ecoregions can be seen on Map 3, and are the following:

1. Californian Current, EUA and Mexico.
2. Sea of Cortez, México.
3. Mexican Mangroves.
4. Central American Mangroves.
5. Panama Bight Mangroves.
6. Panama Bight Marine Ecosystem, Panama, Colombia, and Ecuador.
7. Galapagos Islands Marine Ecosystem, Ecuador.
8. Humboldt Current, Perú, Chile.
9. Patagonian Marine Ecosystem,Argentina.
10. Northeast Brazilian Coast Marine Ecosystem.
11. Orinoco-Amazon Mangroves.
12. Coastal Swamps of Venezuela, Tribnidad and Tobago, Guyana, Surinam, French Guyana, Brazil.
13. Southern Caribbean Sea, Panama, Colombia, Venezuela,Trinidad and Tobago, Netherlands Antilles.
14. Greater Antilles and Bahamian Marine Ecosystem, Jamaica, Cuba, Haiti, Dominican Republic, Caiman Islands, Bahamas EUA, Turks and Caicos.
15. Mesoamerican Reef.

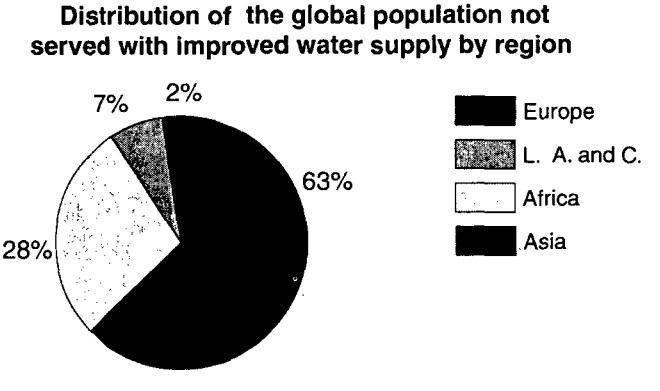


Map 3. 15 ecoregions for Latin America and the Caribbean.

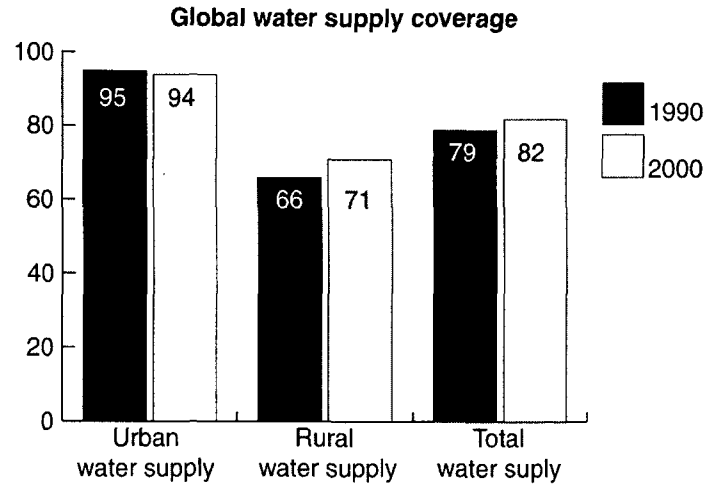
3. Status, impact and pressure from different sources of pollution

One point one billion people in the world are lacking water supply, and 2.4 billion do not have adequate sanitation services. (Graph 1)

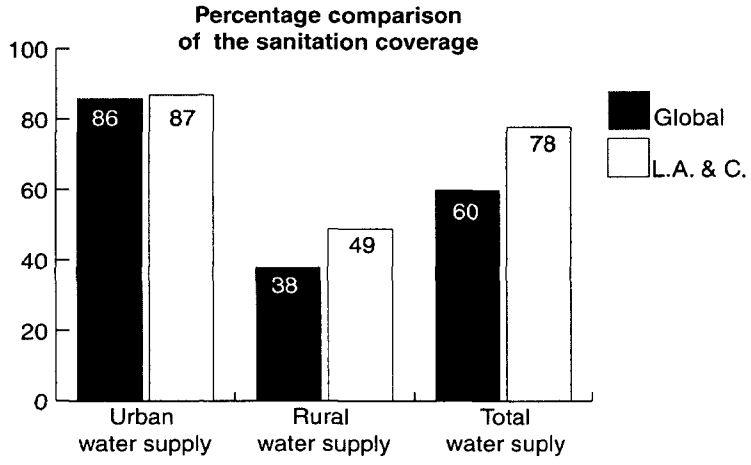
The changes that emerged in 1990 through 2000 in the global percentage of coverage in water supply and sanitation services (Graph 2), suggest there has been an increase; however, the supply of water in the urban areas appears to have decreased in relative terms, perhaps because of the lack of order and planning in the growth of cities and an increase in marginal areas of urban agglomerations. In absolute terms, the increase during this decade in the global service of water supply and sanitation was: 816 million persons with access to water supply, and 747 million with access to sanitation services. Despite this increase in absolute terms, in relative terms the percentage is not very significant, which tells us that we have merely kept pace with the growth rhythm of world population.



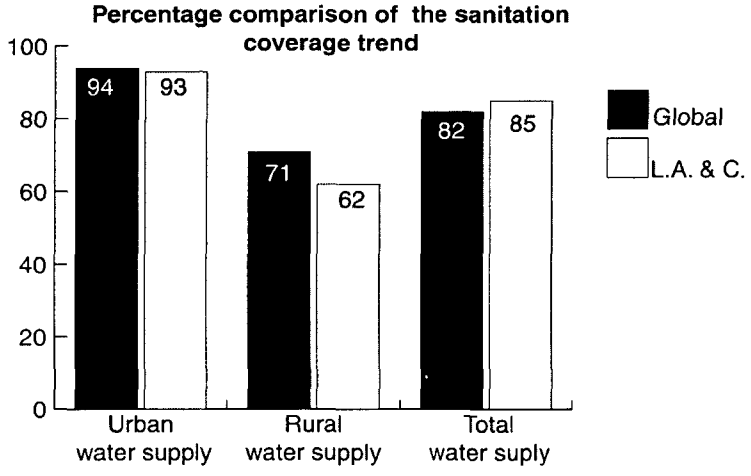
Graph 1. (WHO, 2000).



Graph 2. (WHO, 2000)



Graph 3. (WHO, 2000).



Graph 4. (WHO, 2000).

Population growth will continue to exert pressure on services, and the latter are already saturated, particularly in urban areas.

In the 2000 evaluation–based on data obtained from 99% of the population (1990 reflects only 77%), it is suggested that the region has relatively high coverage levels; for example, roughly 85% of the population has water supply services, and nearly 78% has sanitation services. (Graph 3 and 4) We would underscore that sanitation refers to directing wastewater and providing sewerage and drainage; treatment of the wastewater is not always considered as part of sanitation.

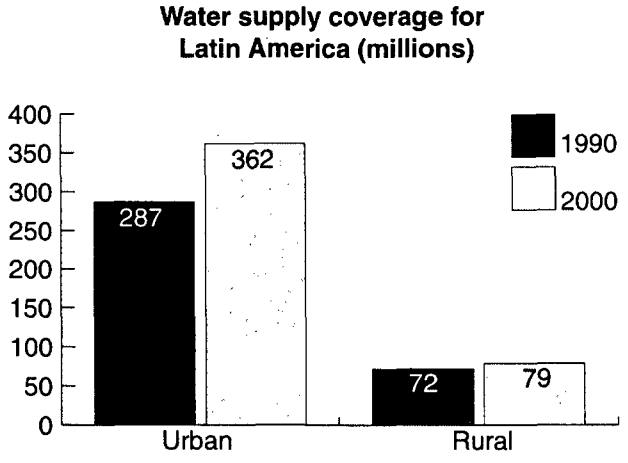
There are vast differences apparent between urban and rural zones; 93% of coverage of water supply service is provided for urban areas, whereas 62% coverage is provided for rural areas. Concerning sanitation services, 87% of urban population is supplied, as compared to 49% of rural populations (Graph 3 and 4). This discrepancy in part lies in the local definitions of "safe" and "improved" services, leading to an underestimation of coverage ignoring the possibility of having water supplies through wells or rivers at a reasonable distance, which would be suit and safe and could also be used septic pits properly operated which would also be proper and safe technology, not minding the lack of sewerage and drainage. More than 75% of the region's population has access to water supply and sanitation services. Caribbean countries tend to have the highest levels of coverage reported; only one country of the region, Haiti, reported water supply coverage at under 50% Belize and Haiti, reported coverage of sanitation services at below 50% (WHO, 2000).

A total of 78 million persons lack access to water supply, and 117 million persons are without sanitation services. In order to reach the goal set for the year 2015, approximately 123 million additional persons inhabiting urban areas and 23 million persons in rural areas will require access to a source of water, and 131 million persons in urban areas and 32 million in rural areas will require sanitation services (WHO, 2000).

Within the Latin American and Caribbean region, there are great differences in levels of coverage of water supply from country to country –and even within countries–, and differences in the percentage of rural and urban coverage. (Table 1 and Figure 5)

	Total Population (thousands)	Urban Population (thousands)	Rural Population (thousands)	% urban water supply coverage	% rural water supply coverage	% Total water supply coverage
Argentina	37032	33299	3733	85	30	79
Belize	241	131	110	83	69	76
Haití	8222	2935	5287	49	45	46
Brazil	170115	138269	31846	95	54	87
Barbados	270	135	135	100	100	100
Montserrat	11	2	9	100	100	100

Table1. Variation in percentages of coverage water supply in Latin America and the Caribbean (WHO, 2000).



Graph 5. (WHO, 2000).

3.1. Wastewater

Ninety percent of pollution from wastewater discharged into the coastal zone flows through rivers and streams that flow into the sea. This fact makes studies on the management of watersheds in the coastal zone a priority; however, solutions are implemented at the municipal level. Therefore, municipal governments must become involved in the management of wastewater in the watersheds where their municipalities are located.

In Latin America and the Caribbean –in keeping with the figures reported in GEO-LAC- 2000– it is estimated that a mere 2% of wastewater receives adequate treatment. Particularly is the fact that the quality of coastal water has decreased due to the direct discharge of municipal wastewater, with no prior treatment whatsoever. The figure reported for the Caribbean ranges from 80 - 90% of wastewater discharged into the sea with no treatment (UNEP, 1999 quoted in UNEP, 2000). This is the greatest problem in the region since the organic flux being deposited in the water bodies is not oxidized and removed. The wastewater greatly surpasses the capacity of wastewater deposits, causing eutrophication, hence anoxia in the systems, in addition to serious public health problems.

Northeast Pacific

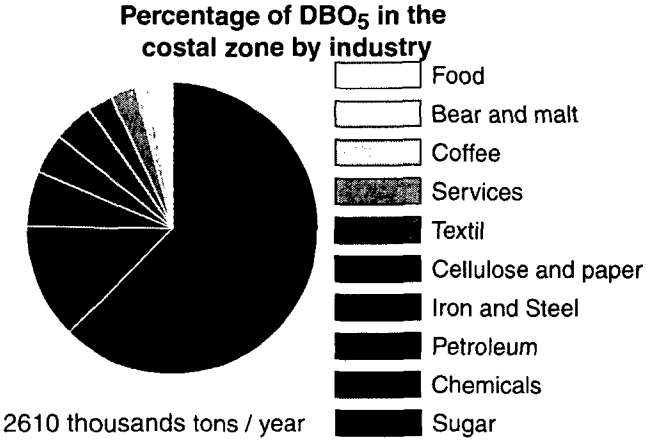
The total volume of domestic waste that reaches the Northeast Pacific through the coast, estimated in terms of the equivalent population (1999), was more than 1,172 million m^3/year, and pollutants such as Biochemical Oxygen Demand (BOD_5) surpassed 3 million tons/year. The Chemical Oxygen Demand (COD) associated to these discharges rose to 760,099.2 tons/year, and Suspended Solids (SS) 365,728 tons/year. Also flowing into the Pacific through these discharges are 6,239.5 tons/year of Nitrogen, and 51,476 tons/year of phosphorus. In comparison to other sources of coastal pollution in the region, domestic discharge constitutes the primary source of coastal water deterioration in the region (Escobar, 2001).

The reason is that most coastal municipalities are lacking treatment plants for wastewater; hence, nearly 95-98% of domestic wastewater discharge reach the Northeast Pacific indirectly with deficient or no treatment. In El Salvador, for example, ten discharges, all untreated, into coastal rivers are reported; the rest is discharged onto beaches or close to them. In the ports of La Libertad and El Triunfo there are treatment plants that are not operating due to administrative deficiencies. In Nicaragua there are 37 wastewater facilities distributed over 34 municipalities that flow into the Pacific. Most of these facilities do not have sufficient capacity to produce effective treatment. Only 1% of the total water discharged into the Northeast Pacific is treated (Escobar, 2001).

For example, in the Northeast Pacific region the discharge of suspended solids (SS) rises to 4,400 tons/day as a result of the river flux and the discharges from populations that live by rivers. It is reported that economic activity is responsible for more than 8,000 gallons/year of unspecified fuel residues deposited in the Pacific and over 27 million tons/year of solids. Moreover, the rivers –through runoff– are recipients of substances used in agricultural activity that is carried out near watersheds. An example is the coffee-growing activity, which generates approximately 3.7 million tons/year of BOD_5 in Colombia (Escobar, 2001).

Country examples of this problem are: Colombia, with over 4.5 million m^3/month of wastewater, 90% stemming from domestic and industrial activities, generating high figures of BOD_5. Nicaragua also reports that the volume of wastewater is aproximately 67 million m^3/year, of which only 6 million m^3/year are treated. Close to 15 million m^3/year of wastewater are disposed of into natural systems with no prior treatment. Managua discharges its untreated wastewater into Lake Managua at a rate of 57 million m^3/year and discharges 153,650 tons/year of solid waste. In Honduras, the most common sources of water pollution include persistent organic compounds (primarily coffee), pesticides in the coastal zone of the Gulf of Fonseca, the heavy metals resulting from mining activity, and urban wastewater which is discharged without treatment into the nearest watercourses, especially in the case of Lake Yojoa. In El Salvador, the discharge of untreated wastewater has deteriorated over 90% of rivers, surpassing the limit of the biochemical oxygen demand. This situation is particularly marked in the rivers Acelhuate, Suquiapa, Sucio and Quezalapa, affecting coastal ecosystems. In Guatemala, the groundwater beneath the principal urban centers –especially the capital- (Basins of Río Las Vacas and Lago de Amatitlán) shows high levels of biological and chemical pollution not yet quantified.

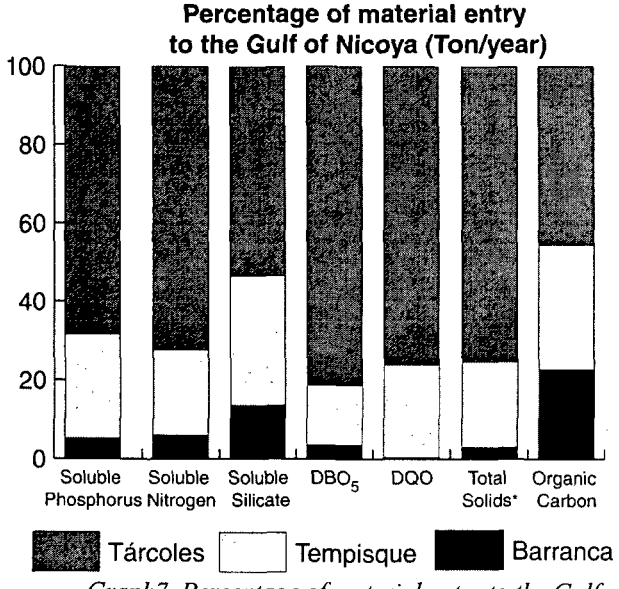
According to the studies of Arreguín, Leal and Moeller (2001), at the Mexican Institute for Water Technology (IMTA in Spanish), in 218 of the watersheds that encompass 77% of Mexican territory –where 93% of the population is located, in addition to 72% of industrial production and 98% of the surface under irrigation– 20 of the 218 watersheds generate 89% of the total flow of pollutants measured as BOD_5 (Graph 6 and Table 2). The watersheds of the rivers Pánuco, Lerma, San Juan and Balsas, receive 50% of wastewater discharge. Other watersheds showing high levels of pollution are the rivers Blanco, Papaloapan, Culiacán and Coatzacoalcos. The most polluted aquifers are located in the Comarca Lagunera district, the Valley of Mexico, the Bajío region and the Valley of the Mezquital, as well as those that lie beneath agricultural areas. The latter is the result of the agro-chemical lixiviates.



Graph 6. Principal industries in Mexico and their effluents. (SEMARNAP, 2000).

Branch	%Discharge	DBO_5 (thousands t /year)
Sugar	38.2	2,232
Chemicals	7.9	66
Petriloum	3.7	59
Iron & Steel	2.7	17
Cellulose & paper	2.7	93
Textil	1.7	33
Servicios	1.7	14
Coffee	0.9	11
Bear & malt	0.9	81
Food	0.7	4

Table 2. (SEMARNAP, 200).



Graph7. Percentage of material entry to the Gulf of Nicoya during the rainy season. (León 2001).

In Costa Rica, in a semi-enclosed sea such as the Gulf of Nicoya, according to León (2001), the effluent of soluble phosphorus reaches close to 300 tons per year; one of the watersheds (Tárcoles) accounts for nearly 70% of that figure, and the other (Barranca) contributes only 5%. We would underscore that this phosphorus represents only a fraction of the total discharge, because it doesn't include other forms such as particle and organic phosphorus. Phosphorus is strongly associated to sediment, reason why the soluble form is a conservative estimate of the influx of phosphorus that the estuary of the Gulf of Nicoya is bearing. Total soluble nitrogen (sum of nitrates, nitrites and ammonium) aproximately of 2 thousand tons per year; 75% of this amount stems from the Tárcoles watershed, with the Barranca watershed depicting the lowest amount, 6% (Graph 7 and Figure 3). Soluble nitrogen –without considering organic-N– is always more evident in runoff processes than phosphorus. The influx of biologically degradable organic matter reaches the magnitude of 20 thousand tons per year, whereas chemically degradable matter reaches figures of 270 thousand tons per year. For the latter parameters, the Tárcoles accounts for 80% of BOD_5 and 75% of COD. Total solids, if we adjust the data reported in Graph 7 over 365 days, are aproximately 650 thousand tons per year, of which the Tárcoles contributes nearly 75% and the Tempisque 22% of the flow that reaches the Gulf of Nicoya. Organic carbon amounts of aproximately 2 thousand tons per year, of which the Tárcoles contributes nearly half, while the Tempisque and the Barranca share remaining in about 25% of the whole that flows into the Gulf of Nicoya. This nutrients flow explains the high figures of N and P in the estuaries of these rivers in the Gulf of Nicoya, as well as the loss of natural dynamics of the nutrients in the estuaries.

	Barranca	Tempisque	Tárcoles	Total
Soluble Phpsphorus	15	76	196	278
Soluble Nitrogen	131	472	1575	2178
Soluble Silicate	$7X10^6$	$17X10^6$	$27,6X10^6$	$1.6X10^6$
DBO_5	$0.7X10^3$	$3X10^3$	$16X10^3$	$19.7X10^3$
DQO**	$0.8X10^3$	$41X10^3$	$132X10^3$	$174X10^3$
Total solids*	$6.5X10^3$	$48X10^3$	$166X10^3$	$220.5X10^3$
Organic Carbon	$0.5X10^3$	$0.7X10^3$	$1X10^3$	$2.2X10^3$

Table 3. (León 2001).
**Ton / 120 days (January, February, March, April)*
*** Ton / 234 days (January, February, March, April, May)*

Southeast Pacific

Along the littoral of Colombia, Chile, Ecuador, Panama and Peru, wastewater is the primary cause of pollution and is fundamentally related to large population centers. Nearly 1, 241 million m^3 household wastewater is discharged into a great number of watersheds. These effluents flow into the Southeast Pacific, resulting in 415,774 tons/year BOD_5 (Escobar, 2001). Cabrera (2001), carried out a country comparison –using the 2000 data– between urban and rural environments, and between sanitation and potable water. In this region there are 414 municipalities with 641 companies and 595 civil organizations. In Chile, 58% of services provided have been transferred from the state to the private sector.

Panama is undergoing the process of privatization through private enterprise corporations. Peru still offers state service. Of the municipalities of Colombia, 12% have treatment but it is unknown if the systems operate well, and if their effluents fulfill standards. In Ecuador 95% is untreated. In Panama only 18.9% of wastewater runs through a treatment system.

Results of this analysis show that there is no integrated work among the countries. In Chile everything moved slowly until the state took a stance on the issue. It is expected that in this country by the year 2010, 93% of wastewater will be treated, and done solely through private capital. The Superintendence of Sanitation Services established the model 15 years ago. Through privatizing the service, urban coverage rises to 99.6% and sewerage, 93.3%. Essentially 20 companies –of the 46 registered companies– handle 99% of the customers, and 89% of supply. The state is in charge of rural population. One single private company handles 36% of the customers, 7 are medium-sized companies, and 37 are small (handling 18.8% of the customers). Profitability over 10 years is on the rise, going from –1.4 to 5% this year. Potable water is still subsidized. Regulations include concession regimes, revision and monitoring of investment plans and rates, and more. Concessions are granted on pre-designated land and are subject to expiration.

This country displays foresees services planning. The Superintendence basically carries out a controling function; the rate strategy is based on the marginal long-term costs, being self-financing the objective. Additionally, rates are not to be excessive. The company "Company Model" is a simulator that plays with the variables and is highly regulated so that the rules of the game can not change. The process of establishing rates has undergone three phases, ranging from –1.2 through 463%, to settle now at a generalized 20%. The profitability rate achieved is close to 10%, and every 5 years the rate is calculated with the support of a commission of experts. The rates are based on a formula of 20 m^3, ranging from 8.5 to 32 dollars.

The coverage of treatment in Chile is variable (from 4.7 to 92%). Investment is for the treatment of wastewater. The plans forecast through 2010 are based on 2 billion dollars. The overriding principle in this country is that the polluter should pay, and the watershed system is to be gradually prorated. There is follow-up on population, because of a subsidy for the most needy families.

It can generally be said that for the region the degree, dimension and continuity of the problem makes collaboration between countries difficult (some countries devote hours to the matter, others all day). The positive thing is that there is already information and research underway on the effects of wastewater, the treatment of stabilizing pools, the rate system and on how to approach the matter of turning the investment in wastewater treatment systems over to private enterprise.

Atlantic

Rodrigues (2000) states that in Brazil it is deemed that wastewater is a financing problem, among other problems. For example, Brazil needs 20 billion dollars to collect 20% of wastewater, and treats only 9%. Regional projects must become ambitious, given that it takes from 10 to 15 years to fulfill them. It is calculated that the rehabilitation of the Bahía de Guanabara –where there are 35 rivers and 8 million

population– will require 900 million dollars, taking into accounts that human settlement are disorderly and it is uncertain what exactly is discharged. It is now known that 85% of pollution comes from 52 industries. In addition to heavy metals from oil that crosses the entire Brazilian territory, data from the De-pollution Program for the Bay of Guanabara shows an estimated influx volume of 145 m^3/second of untreated effluents, equivalent to BOD_5 in the order of 3,655 tons/day dumped onto the Brazilian coast, concentrated mostly in large urban area. (UNEP 2000). One problem is the use of a cadastre system as political propaganda. Little hospital waste is captured, and none separated for treatment.

One of the results attained during this administration was the training of 2500 professors and 3 conservation units. It is believed that problems are due to state-level decision making rather than municipal. During this period false expectations were raised, and people were led to believe that in 5 years water would be clear; this was partly due to poor media communication.

Another matter is in reference to the unforeseen technical problems that arise in precarious urban settlements, which also makes it more difficult to select sites for the disposal of sludge.

As in all regions, the integrated management of watershed is encouraged.

The coastal pollution problems that Uruguay shows appear to stem from three well-defined sources: 1.- urban area, wherein a lack of planning leads to increased end volume of liquid effluents and solid waste, increasing the flow of organic matter into the recipient of water bodies; 2.- agricultural production areas, in which fertilizers and pesticides are used, which in the end reach the coast; 3.- the influence of the River Plate, which water contains residue from the greater Plate basin, originating in Brazil and crisscrossing Paraguay and Argentina, thus resulting in a vast drainage basin that crosses through agricultural, industrial and urban areas.

Sewerage

This is one of the principal sources of pollution of the Uruguayan coastal system, compounded when considering that part of the urban liquid effluents are discharged raw or only partially treated; here it is important to underscore that the principal cities of Uruguay (Montevideo, Punta del Este, Piriápolis, Colonia del Sacramento, etc.) are located either on the seacoast or on the banks of the River Plate. Consequently, their wasteaters are discharged *in situ*. The wastewaters of Montevideo are partially discharged into the River Plate through a submarine outfall built in 1990, that discharges 2.3 kms. out at 1000l/ second.

The problem of coastal pollution in Argentina displays four well-defined types: 1.-Urban nuclei – whose location and unplanned growth lead to an increased end-volume of liquid effluents and solid waste; 2.- Agricultural production areas; 3.- The influence of the River Plate, whose waters contain residues from the greater Plate basin and, 4.- Industrial nuclei located in different points along the coastal zone (UNEP 2000a).

The AGOSBA-OSN-SHIN report (quoted in UNEP 2000 a), identifies some of the principal sources of pollution on the Argentinean River Plate coastline, attributing them basically to: untreated or insufficiently treated discharges; discharge of sewer liquids and sludge; and other additional causes.

The second most severe problem that affects the River Plate coastline is the discharge of industrial effluents, many of which are eliminated through urban sewage systems and through secondary rivers and streams of the region (UNEP 2000a).

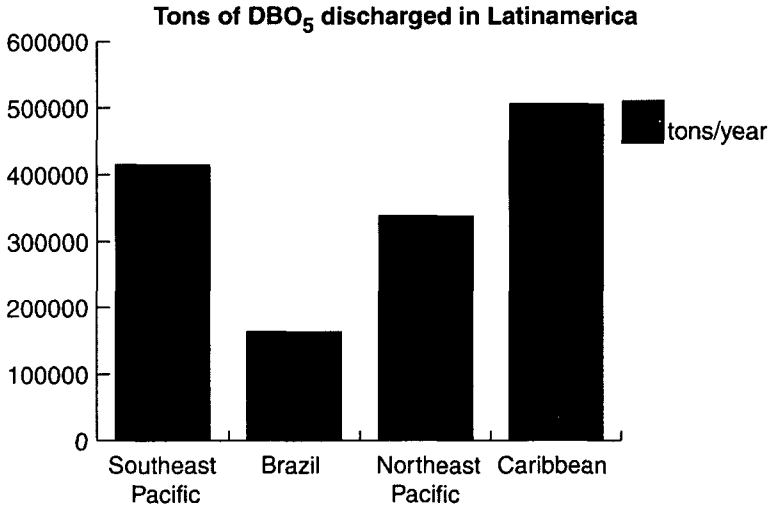
Uruguay and Argentina provided more specific data on garbage, nitrates, phosphates and polluting metals than they did for wastewater –which does not mean, of course, that discharge of domestic wastewater is not an important factor in the pollution of the coastal zone.

Caribbean

The greatest volume of pollutants that flow into the Caribbean coastal region comes from Venezuela, Cuba and Dominican Republic, located in the south Caribbean, Gulf of Mexico and Great subregions respectively. Venezuela contributes the largest volume, approximately 232,725 tons/year of BOD_5. The Caribbean region receives a total annual burden of 506,482 tons of BOD_5 . Of this figure, the Gulf of Mexico and the Southern Caribbean contribute to this figure respectively in the order of 260,000 and 110,000 tons of BOD_5 per year. According to other regions, this figure appears to be underestimated; and would have to wait for a new assessment which is being prepared an will provide a clearer and more precise evaluation (UNEP, 1994). It can be stated that coastal eutrophication of point source and non-point source of wastewater constitutes a regional problem, particularly marked in the outlying areas of large urban centers.

Bearing in mind the dearth of information on the rest of the Atlantic, we herein provide in Graph 8 a comparison of tons of BOD_5 discharged on the coasts of Latin America and the Caribbean per region.

In the Gulf of Mexico there are critical zones that are highly polluted by wastewater that is loaded with nutrients and pathogenic micro-organisms (fecal coliforms, and specific pathogenic substances). The principal coastal lagoons where oysters are cultivated in Mexico (Tamiahua, Mandinga, Pueblo Viejo, Alvarado, Mecoacán and Carmen–Machona) show levels of bacterial pollution that exceeds the permissible limits for the cultivation of mollusks. In Coatzacoalcos, Veracruz, environmental studies carried out by Vázquez-Botello *et al.* (1986), indicate high figures for coliforms and microbiological pollution in the network of potable water. Between 1995 and 1998, the littoral of the Gulf of Mexico indicated a high number of cholera cases.



Grapihc 8. (Escobar, 2001; PNUMA, 2000; PNUMA, 1994).
Note: The only Atlantic data is that submitted by Brazil.

In the Greater Antilles there are also regions highly affected by the direct discharge of large volumes of wastewater without proper treatment, causing serious organic pollution. The littoral of Santo Domingo, capital of the Dominican Republic, the Bay of Havana and the port of Kingston are typical examples.

Diseases such as cholera or hepatitis contracted through primary contact (bathing) and through the consumption of contaminated food in the coastal zone have reached near epidemic proportions in the Dominican population. This coastal pollution has led to a reduction in fishery resources in the estuaries and deltas of the rivers.

The Bay of Havana, the most important port in Cuba, currently receives around 300,000 m^3 per day of untreated urban-industrial wastewater. This bay presents a classic example of a polluted area. In the port city of Kingston, Jamaica, pollution problems in the coastal zone generated by the vast load of nutrients it bears, is causing high eutrophication processes and the progressive deterioration of the environment, leading to the reduction of fishing activity and decreased biological diversity.

In Surinam, on the other side of the Caribbean, in addition to household wastewater pollution, the intensive use of agricultural pesticides that then cause runoff into the rivers, and the over-exploitation of live resources lead to a loss of the productive and landscape aesthetics of the region.

Trinidad & Tobago has great energy potential, and its economy is primarily based on oil exploitation. However, its rivers and coastal zone are the recipients of industrial effluents, including sugar refinery activities and the cement industry, in addition to surrounding human settlements. The main problem in coastal areas of the Gulf of Paria is the elevated level of nutrients that penetrate coastal waters.

The Bay of Cartagena and the Ciénega de Tesca (marsh), in Colombia, are characterized by being highly polluted due to household urban wastewater that is discharged –primarily organic material, nutrients, chemicals and sediments– and through industrial waste and influx from fluvial sources. The Ciénega receives at present a discharge of around 60% of the city of Cartagena's wastewater. The Ciénaga has experienced the mass deaths of fish during the summer months due to reduced dissolved oxygen, and is not adequate for any primary contact activity whatsoever (GEF/UNDP/UNEP, 1998).

In Venezuela, several bays (Pozuelos, Bergantín and Barcelona, among others) receive the impact of municipal wastewater discharge, leading to serious environmental deterioration. The Bahía de Pozuelos shows high figures for bacteriological indicators which have direct repercussions on population benefits and limit the recreational use of coastal zone –this in a region that is one of the most important tourism spots in eastern Venezuela (Senior, Castañeda and Martínez, 1997).

For this region, it has been stated that only 25 treatment plants are operational, less than 10% of domestic wastewater is treated, and 40% of the treatment plants function only partially while the remainder are inoperable due to lack of training, poor maintenance, lack of budget and inappropriate technology. Yet another problem that has been accepted as such is the lack of standards, in addition to the quality of the effluents, the latrines and the septic tanks that are given poor maintenance, or are poorly designed –close to groundwater. In the Caribbean it is an accepted fact that wastewater is a significant source of coastal pollution and must be controlled as it presents a threat to sustainable development.

3.2. Other pollutants

There are other activities that affect the region significantly: agriculture and mining, classified as non-point sources of pollution because of their discharge, runoff and lixiviates with persistent organic compounds (DDT), heavy metals and nutrients (fertilizers).

Tourism

Tourism is one of the main activities of the Region. In fact, for several countries –such as the islands– it is the primary activity (43% of GDP). This activity in the region represents 12% of GDP, and is developed primarily in coastal zones (WTTC, 1993, quoted in UNEP 2000).

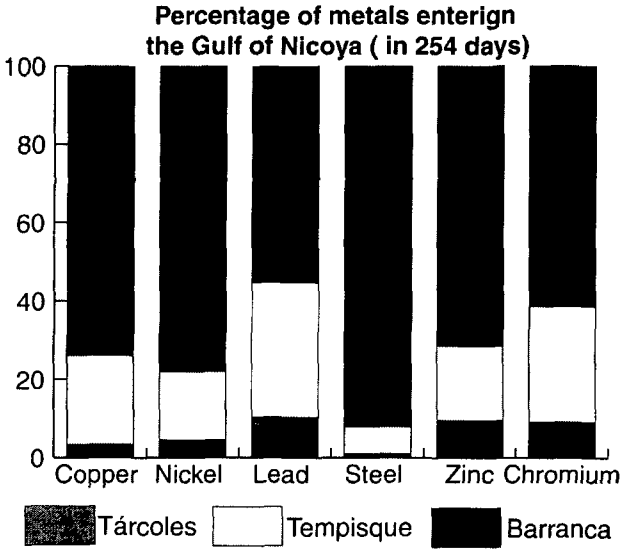
The development of mass tourism represents a serious threat –both beach tourism and cruise tourism. One of the first effects is the physical alteration of habitats. Swamps are filled in, mangrove forests are felled for the construction of infrastructure; in some cases, reefs have been destroyed to obtain construction materials or to produce ocean-front properties and build support infrastructure such as piers, airports and restaurants, among others. The tourism industry also requires goods and services that have occasionally led to the destruction of coral reefs through the discharge of domestic wastewater. All of these impacts could be solved or averted through planning, regulation, and good guidelines for the integrated coastal zone managment.

Oil

Oil extraction activities in the sea and coastal zones are highly localized yet is a fundamental part of the economy of the countries carrying out this activities. In Mexico, for example, 70% of oil reserves are located offshore. In the same way, most oil extraction in Brazil, Venezuela and Trinidad and Tobago, is carried out on the continental shelf. Technology has progressed enormously in decreasing the effects of exploration and extraction activities; nonetheless, this continues to be a high-risk activity. We often hear stories such as the recent sinking of the largest oil platform in the world (Brazil), and the sinking of an oil tanker off the Galápagos.

Based on information compiled in the study INE-SEMARNAP (2000) in Mexico, extreme impact was found due to the concentration of total suspended solids in some water bodies in the Pacific, mainly PO_4, NO_3, NO_2, Sulphure and Phenols in some water bodies, as well as active Methyl Blue substances.

In Costa Rica, according to León (2001), the quantity of copper per year that comes into the Gulf of Nicoya is close to 400 tons, of which the Tárcoles watershed accounts for nearly 75% and the Tempisque watershed another 23%. Nickel expected to enter the Gulf is close to 130 tons per year, of which nearly 80% travels through the Tárcoles and 17% through the Tempisque. Some 86 tons of lead flows in through the three rivers into the estuary, of which 55% pertains to the Tárcoles and 35% to the Tempisque. In the case of zinc, it is estimated that some 600 tons a year reach the Gulf of Nicoya, 70% stemming from the Tárcoles and nearly 20% from the Tempisque. The amount of chromium that flows in is close to 75 tons a year, with 60% share from the Tárcoles and nearly 30% from the Tempisque; the remaining 10% comes from the Barranca (Table 4 and Graph 9).



Graph 9. (León, 2001).

The figures, acording to this study, on metals explains the enrichment off the estuaries of the three rivers studied in the Gulf of Nicoya.

Quantity of Metals in Tons over 245 dats, rainy season *

Tempisque, Barranca and Tárcoles, 1998

The analysis on the distribution of pollutants of industrial origin identified the following categories of industries that are highly contaminating in the Wider Caribbean area: oil refineries, sugar processing, alcohol distilleries, food processing plants, breweries, paper industry, and chemicals industry (both organic and inorganic). Oil refineries contribute 70% of total industrial BOD_5 and 80% of oil pollutants, creating critical polluted zones in neighboring coastal areas (UNEP, 1994).

	Barranca	Tempisque	Tárcoles	Total
Copper	9	60	195	264
Nickel	4	15	67	86
Lead	6	20	32	58
Stell	0.8×10^3	5.5×10^3	73×10^3	79300
Zinc	0.4×10^2	0.8×10^2	3×10^2	420
Chromium	4.5	14.5	30	49

Table 4.

**June, July, August, September, October, November and December*

The load of sediments and the transportation of pollutants that the Bay of Cartagena generates in and of the rivers is also bearing repercussions on the deterioration of the Rosario Corals and the National Park, with the ensuing loss of scenery and ecosystems and increased murkiness and dispersion of pollutants (nutrients and pesticides) on the park's coast (UNEP/CEP,1999).

The Atlantic coast of Guatemala is a mosaic of marine and coastal inhabitants and fragile ecosystems (mangrove ecosystems, wetlands, sandy and cobble beaches, coral reefs, estuaries, etc.). The beautiful, exuberant coastal and estuarine landscape has led to accelerated development of the tourism industry. The main problem affecting the environment here is increased local immigration as a result of development of port infrastructure and the tourism industry.

The development of industries in the region and the establishment and uncontrolled urbanization of the city of Puerto Barrios in Guatemala –its principal port– are generating high levels of pollutants rich in nutrients and solids. These refer to both urban and industrial pollutants that are dumped into the sea without prior treatment. Additionally, accelerated tourism development is causing sever pressure on various environments, all extremely fragile to alterations. Another effect on the coastal environment of the region is caused by inappropriate agricultural practices and over-fishing, as well as the exploitation of fossil mineral resources. All these factors endanger the sustainable future of the region, and the maintenance and use of coastal resources in the area (UNEP/CEP,1999).

In the Caribbean, eutrophication problems arose in the nineties. An example of this is the northeastern region of the Gulf of Mexico. Forty-one percent of continental USA drains into the Gulf of Mexico through the Mississippi and its affluents. Over the last twenty years the nitrogen and phosphorus content coming from the Mississippi River now surpass 1.6 million tons, thus stimulating the growth of marine flora, causing the eutrophication of the system. Most of these nutrients are the result of agricultural runoff from the United States Midwest (UNEP, 1994).

4. Initiatives and policy in the region

Integral management

Large investments are needed in order to meet the deficit in treatment of municipal wastewater –in the order of 80%–, and to reform the legal framework and institutional arrangements for the integrated management of water. Though large investments are necessary, they alone are not enough. To solve this problem we need to incorporate concepts such as re-use, efficient use and multiple use of water –all through an integrated focus– in order to be within reach of a true solution (Jouravlev, 2001).

Institutional Arrangement

The coastal zone has been dealt with, in public administration throughout Latin America, in an isolated manner. Though there have been many institutional efforts to organise and manage this issue, they have all been proposed from the standpoint and needs of each one of the sectors involved in the littoral. For this reason, the plans and programs that involve the coastal zone are spread out in different public institutions, with no link, hence far from being an integrated policy. Though there are efforts exerted toward the integrated management of watersheds and coastal areas, these remain one of the crucial challenges that Latin America must face this century.

Once again the point of view of water use is a limitation to the formulation of integral strategies that will force us to accept the need for multiple use of water, and a reconciliation of conflicts among the various users.

The distribution of potable water becomes a political bonus in a greater degree than the treatment of wastewater and the pollution of water bodies, reason why there is a backwardness in the matter.

The elements needed for such integrated management including treatment of water must incorporate – among other things– the following:

·Participation of all actors.
·Approach to management by watershed.
·Reduction of the role of the State, limiting it to activities entailing supervision, promotion and regulation, leaving financing, execution, construction and operation in the hands of the private sector.
·Decentralisation toward local government.
·The use of economic instruments such as market, price, collection, transferable rights, and more.
·Watershed Boards as a mechanism for integrated management and as a participatory instrument.

The initiative of some countries concerning the participation of the private and transnational sectors in the management of water resources, along with decentralization processes and the provision of public services, have all led to the generation of programs whose objectives are to:

·Facilitate, protect and promote participation and private investment.
·Reduce pressure on state budgets and redirect public spending to other demands that are politically more urgent .
·Improve economic efficiency in the utilization of water resources and provision of public services related to water.

It is important to emphatically underscore that the integrated management of watersheds is not generally one of the objectives in the policies of the countries when applying the above initiatives.

4. 2. Legal Framework

This section is based on Dr. Andrei Jouravlev's excellent analysis, recently published by ECLAC (July 2001).

In order to *de-sectorize* the management agents for water, these agents must be independent entities, or be a part of the Minister of Environment or Natural Resources fields. In Argentina, the Under-Secretariat for Water Resources (SSRH in Spanish) is located within the Secretariat of Public Works of the Ministry of Infrastructure and Housing. From this vantage point, national water policy is drafted and implemented, as are the regulatory framework for its management, and programs and actions related to the development of infrastructure. The Secretariat for Sustainable Development and Environmental Policy of the Ministry of Social Development and the Environment deals with the conservation and recovery of the environment and natural resources, and similarly many other government agencies overlap with the SSRH. The provinces and other agencies have been summoned and asked to provide input on the following aspects: technical, social, economic, legal, institutional arrangements, and environmental issues. All of the foregoing is in order to design a water policy for Argentina. In the conclusions of this exercise there is mention of the need to put forth greater efforts at the legislative level. Similary, it is recommended that at the province level the design of a management strategy for the resource should be deposited in the hands of one single multidisciplinary authority. All sectors should be encouraged to participate at the province level, and the establishment of working groups at the level of watersheds should be promoted.

Barbados has an independent authority for water management (BWA) that is linked to the Ministry of the Environment, Energy and Natural Resources. The latter coordinates environmental and natural resources policy without interfering in the activities of the BWA. Nevertheless, treatment of municipal wastewater is still not satisfied.

In Bolivia, the Law dates back to 1906; other legislative instruments were added to fill in the gaps. Nevertheless, these have been insufficient, and water has been managed by sector, leading to veritable chaos. This has been despite passing the bill "Law for the Protection and Conservation of the Environment and Natural Resources Number 1333, 1992". The Law on Water as a Resource is currently under discussion; it contains a proposal that the Ministry of Sustainable Development and Planning be the National Authority on Water as a Resource, who will in turn use as an advisory and coordination body the Advisory Board on Water as a Resource, and as technical support, the National Watershed Commission.

In Brazil, when a body of water overlaps into another state, or is used as a boundary to divide two countries, or when said body of water stems from or leads beyond national territory, the Union (Federal level) will be in charge of water bodies. The states hold jurisdiction over those water bodies that are contained within state limits, except in the case of water bodies that are a product of Union works, in which case the protection and control of pollutants lies under the responsibility of all levels of government. Additionally, there is the National System for Water Resources that includes: the National Water Agency (ANA in Spanish) that is financially autonomous and belongs to the Ministry of the Environment (MMA), Water Boards at state level and Federal District level, Watershed Boards, other bodies at different levels of government, and the Water Agencies.

Chile's General Water Board (DGA in Spanish) depends on the Ministry of Public Works, and has 13 regional departments throughout the country. The DGA is non- sectorial and independent of the users, and does not implement on its own improvement works, which therefore allows it to act as a normative body and regulate impartially. Nevertheless, there continues to be persistent absence of integrated management. This has led to management of stretches or portions of watershed rather than a watershed as a whole, in addition to a lack of coordination between the use of surface water and underground water.

Colombia has effected in-depth changes in its legal and administrative structure; in 1993 the Ministry of the Environment and the National Environmental System were created. The Ministry of the Environment incorporates 39 Regional Autonomous Corporations. Also participating are the National Institute of Renewable Natural Resources and the Environment (INDERENA in Spanish), the sectorial ministries and the National Planning Department.

Costa Rica has broad but disarticulated and obsolete legislation, dating back to 1942.

Cuba has centralized its water management at the National Institute for Water Resources, which works jointly with the Ministries of Science, Technology and Environment.

Ecuador manages its water through the Ecuadorian Institute on Water Resources (INERHI) and leans toward the Agriculture and Livestock sector (irrigation systems); this was substituted in 1994 by the National Board of Water Resources (CNRH in Spanish), in addition to 9 Regional Development Corporations to whom the functions of the INERHI were transferred.

The CNRH is a collegiate body in which various ministries participate, including Agriculture and Livestock, Finance and Public Credit, Energy and Mining, Urban Development and Housing, and the General Secretariat for Planning, all presided by Environment. Its objectives are to create a management framework, generate policies and standards, and optimize the management of watersheds and the administrative regulations of resources (transference of infrastructure, operations and maintenance in the private sector) and the establishment of investment priorities.

In El Salvador there are many overlapping laws in diverse fields of action, leading to a lack of definition in assigning responsibilities. There is no multisectorial vision in the planning for the use, promotion and conservation of water. In 1997 the Ministry of the Environment and Natural resources was created (MARN

in Spanish) and in 1998 the Law on the Environment was decreed, leading to the creation of the National System for Environmental Management. MARN is responsible for monitoring the quality of the waters, and must promote the National Interinstitutional Committee for Planning, Management and Sustainable Use of Watersheds, promoting the integration of local authorities. At present a project is underway, the Water Law, which purpose it is to have an integral vision and propose the creation of the Superintendence of Water Resources, under the umbrella of the Ministry of Economy. This project will end the lack of legal definition and the sectorial focus in the management of water resources.

In Guatemala, the Ministry of the Environment and Natural Resources absorbed the National Commission on the Environment, and began to manage the use of water, but it is still operating jointly with the Ministry of Agriculture, Livestock and Food. The latter took charge in 1999 of such functions.

Toward the end of 1994, Honduras created the National Development Board for Sustainable Development (CONADES in Spanish); in 1996 the Secretariat for Natural Resources and the Environment emerged (SERNA in Spanish). CONADES advises, coordinates action, facilitates dialogue and conceptualizes the implementation of Agenda 21, and SERNA implements policies for protection and utilization. Current legislation dates back to 1927, the Law on Utilization of National Waters; nonetheless, the New Framework Law on Water is under discussion, and is designed to substitute the former one.

Jamaica reformed its water sector in 1995 through the adoption of the Water Resources Act. The Authority on Water Resources also emerged, and works jointly with the Authority for the Conservation of Natural Resources, the body in charge of environmental management, pollution control and the protection of watersheds.

Mexico's National Water Law was passed in 1992, it incorporates a broad and modern legal framework under which the National Water Commission (CNA in Spanish) operates. In 1994 it was transferred from the agricultural sector to the Secretariat on the Environment, Natural Resources and Fisheries (SEMARNAP in Spanish). As a deconcentrated organism, it strengthened its ability to exert authority.

An important result of the transference of the CNA was to reduce the pressure on the agricultural sector, and also a more integral vision of the management of water. In the last 10 years notable progress has been made in the construction and operation of treatment plants, as well as in the generation of standards. Another bonus has been the decentralization of some functions and the participation of the private sector.

During 1994, Nicaragua transformed the Nicaraguan Institute for Natural Resources and the Environment (IRENA in Spanish) into the Ministry of the Environment and Natural Resources (MARENA in Spanish). The National Commission for Water Resources was also restructured; it coordinates the design of national policies on water resources. In 1996 the National Environment Commission was established, and took charge, among other things, of promoting the integrated management of watersheds. In 1998 the Ministry of Development, Industry and Commerce (MIFIC in Spanish), took charge of coordinating the CNRH. Nevertheless, MARENA continues to dictate the standards of sustainability techniques and regulations. The same law that the MIFIC created also fostered the creation of the National Water Administration. The confusion of responsibilities has also hindered the consolidation of the water sector and controversies have arisen that make the operations of the National Water Administration difficult.

Legislation in Panama is currently under revision because it shows voids, overlapping and inconsistencies. The National Environmental Authority is in charge of ruling in terms of natural resources and the environment. Its attributes in terms of water include: coordination, monitoring, planning, formulation of policy, and pollution control. Nevertheless, the legal framework is not up to date and functional.

Paraguay also lacks a congruent legal framework; it has been updated through isolated approaches and is now somewhat disarticulated. Water is managed on a sectorial basis, and institutions are severely frag-

mented. The principal institution involved is that of the Ministry of the Environment through the General Department for the Protection and Conservation of Water Resources, that formulates, coordinates and evaluates the policies for maintaining and conserving water resources and watersheds.

In Peru, water is managed through sectors via the Department for Water and Soil, dependent on the Ministry of Agriculture, and the General Law on Water that dates back to 1969 and has not been updated. Regardless, there is a commitment on behalf of the government to draft a Law on Water. This has been thoroughly analyzed by various forums, and includes the creation of the National Board of Water as well as the Offices for Watershed Management.

In the Dominican Republic, functions overlap between various agencies in charge of water management. The main agency involved is the National Institute on Water Resources (INDRHI in Spanish), dependent on the legal framework dating back to 1962 (Law on Ground Water and Distribution of Potable Water). Nevertheless, there is at present an initiative known as the Water Code, that along with the General Law on the Environment and Natural Resources (2000) proffer a more adequate framework for the management of the resource. Thanks to this law, INDRHI fell under the coordination of the Secretariat on the State of the Environment and Natural Resources, from which position it coordinates all matters pertaining to the use and management of water resources.

Uruguay has various agencies involved in water management, using several inter-sectorial approaches which have hindered the integration process. The legal framework has shown progress; in 1993 the Technical Advisory Commission for the Protection of the Environment was established and comprised of delegates from various public and private agencies. The Working Group as Permanent Advisor to the Executive Power was also created, and is made up of the Ministers of Transportation and Public Works, Housing, Land Ordinance and Environment, Industry, Energy and Mining, and Foreign Affairs.

In Venezuela the Ministry of the Environment and Natural Renewable Resources (MARNR in Spanish) concentrates the national authority on water. Since 1996 it receives support from the National Board of Planning for Water Resources, which includes the Association of Governors and Mayors, companies providing public services related to water, national universities and user associations, among others.

The three major problems posed by the water supply and sanitation in Latin America and the Caribbean:

1. Coverage

According to the WHO/UNICEF (2000), 93% of urban population has access to potable water services, and 87% to sanitation services –sanitation being the existence of sewerage, not treatment.

Regarding rural population, the figures were in the order of 62% for potable water supply and 49% having sanitation services. In other words, in the region there are 78 million persons without access to a potable water supply, (29 million urban and 49 million rural) and 117 million without access to sanitation services (51 million urban and 66 million rural).

2. Inequity

The vast majority of those who do not have access to potable water are poor; ironically, it is they –with less income– who pay the most per liter of potable water as they are forced to buy water from private sales companies, wells, cistern tank trucks, and illegal tappinf of the public network system. Most of the above are no guarantee of the quality of water anyway, and are costlier. A poor family without potable water service pays 2 to 4 times more than a wealthy family.

The generalized use of septic tanks and latrines has often caused the pollution of ground waters and wells from which people often drink water, thus causing health problems.

3. Deficiency and Poor Quality of Services

The service of supplying potable water in half the countries of the region is intermittent (PAHO/WHO, 2001), due to the poor quality of some systems and to deficient maintenance. Reports indicate that for the large cities of the region there is a 40% loss of this resource (WHO/UNICEF, 2000). Moreover, the quality of potable water is poor and often does not comply with national provisions. To this we must add a deficient quality monitoring system. In many cities water provided from the system is disinfected at home through boiling or filtering, and often the liquid is purchased from private companies, in other words, bottled water. This lack of trust in the quality of water is due to the increasing pollution of the bodies of water resulting from lack of treatment for wastewater. It is estimated that only 14% of the water received through drainage or sewerage is treated properly

In almost all countries of the region the private sector is now included in potable water supply activities and in sanitation of wastewater. Chile's performance stands out here; the private sector has gradually joined forces with regional public companies and has attained profitability and efficiency. It is estimated that in the next then years there will be an investment of 2 billion dollars, of which 1.6 will be used for the treatment of wastewater (Brown and Saldivia, 2000 quoted in Jouravlev, 2001). One of the main proposals for the participation of the private sector is that of BOT, which stands for building, operating and transferring. This process is for the participation of the private sector and requires caution, both to protect the user and to ensure the profitability of the service for the investor. Jouravlev (2001) mentions that the balance of the present process of privatizing reforms is strongly inclined to favor the participation of the private sector, reducing the roles that the State and civil society as a whole play. It is therefore imperative that before the privatization process begins, a normative and regulatory framework be in place, in addition to the institutional arrangements of the agencies in charge.

The broad-based sectorialisation of governmental institutions has led to obstacles in the multiple use of water, due to isolated concepts in handling the priorities of water. In most countries this sectorialization process has bestowed upon the ministries of agriculture greater responsibility in the management and decision-making processes. Nevertheless, there has been greater independence of the agencies in charge and in the transfer to the environment sector as well. In some cases, mechanisms for the management of watersheds have arosen, although for the most part they are presented as proposals, and have not started-up yet, or have limited authority and resources to act.

Some of the responsibilities that are the most undefined in hands of the sectors are water pollution, urban drainage, erosion control and transportation of sediment, as well precarious settlements in flooding areas and other issues that cannot be assigned to a sector. Consequently, they have been relegated on sector agendas because they represent more cost than economic –and particularly– political benefits.

Though a multi-use approach to water is a needed and accepted fact, little has been done to attain it in an effective manner. It is not enough to include these concepts in the institutional discourse, nor designate diverse organisms to be responsible, unless the approach is congruent to development plans and budgetary allocation. It is more convenient at first to focus on attaining the integral management of water resources.

The management of watersheds must not only be limited to the water itself but must also become a part of land-use policy making, of the use and conservation of natural resources, of the prevention of natural disasters (flooding and drought) and inter-municipal and international collaboration.

Concerning the water distribution system through watersheds, one must realize that the ecological aspects of this resource include satisfying the requirements of the various ecosystems that are involved, such as the mouths of lakes, the coastal zone and the marine environment, which are all among the most vulnerable to the reduction of the resource as well as to the deficient quality of the same. This situation will alter

the physical-chemical dynamics and the well being of its live resources, hence its productive potential as well. The visualization of a water industry incorporating private sector intervention and market laws is not wrong; nevertheless, the environmental and social focus is seldom included in the laws or commercial criteria. The external aspects that the development of certain economic activities bring about, or other uses of water are not incorporated in the market analysis (Dourojeanni, 2001).

Some of the barriers that the region presents to the development of the multiple-use of water are premeditated and others are not; some stem from the selfsame water sector, institutions responsible for management, users and civil society itself, as well as other indirect or external influences such as the economic situation of the country, the culture, education and other values associated to income and population commitments. This year there have been more than 20 meetings in the region on watershed management, among which stand out: the Latin American Workshop on the Management of Municipal Wastewater, hosted by the government of the Netherlands through the Coordination Office for the Global Program of Action, and with the assistant organization of UNEP Regional Office for Latin America and the Caribbean; the Fourth Interamerican Dialogue on Water, organized by the Organization of American States (OAS) and others; the Water Fair, supported by UNEP and organized by the Government of Panama. Also taken into account as a point in favor is that each country has processes for reforming and updating the legal framework on the topic, as well as multiple initiatives on water resources, financed by international agencies and other donor agencies.

The formation of a platform for the integrated management of watersheds will not take less than 10 years, which is not in harmony with the permanence of the diverse initiatives that are generated in the countries. Often the personnel undergo great instability, frequently because agencies are created and have a name, but have neither resources nor structure, and have no legal framework to support them or an operation programme to ensure compliance of functions and the evolution and consolidation of these. Sometimes the traditional management agencies boycott the newly created ones because they (sectorial) feel threatened. Political, environmental and social interests, among others, also beset them particularly when they are not explicit in justifying their initiatives and these can be misinterpreted. Regardless, it is important to recognize the progress attained in the openness to the participation of all players, though much remains to be done. It is also important to define participation in decision-making processes and the planning of strategies and projects, as well as verify the legitimacy of these as representatives of participatory groups or sectors. Aside from the above, Jouravlev (2001), recommends that all programs that support watershed management must promote and motivate local organization at the watershed level, and not be limited to merely intervening, but rather encourage capacity building in all manners, including the diversity of interests and uses.

Initiatives

In response to the need to revert and control the impact and deterioration that civilization has caused to the environment, Agenda 21 was born in 1992, resulting from the multilateral agreements reached at the Earth Summit in Rio de Janeiro, Brazil. Its mission was to foster sustainable development and stop environmental deterioration. This document establishes in chapters 17 and 18 that the states must face the grave problems in public health and the deterioration of coastal ecosystems that result from the discharge of inappropriately treated municipal wastewater.

Agenda 21 also foresees that governments –according to the capacity and resources available and with cooperation from United Nations and other competent organizations– should have prepared by the year 2000 the following criteria: on the quality, objectives and norms referring to the elimination and treatment of nature-based waste and the assimilation capacity of the recipient body; on having sufficient

capacity to monitor the effects of waste and maintain systematic supervision, including supervision of epidemiology; to ensure that by the year 2005 developing countries are able to treat or eliminate per national or international guidelines on environmental and sanitation quality at least 50% of sewage, wastewater and solid waste generated. The overwhelming lack of compliance with these objectives is very obvious.

In 1995, UNEP re-addressed these objectives and integrated them into a document to be discussed at the Intergovernmental Conference for the Adoption of a Global Program of Action for the Protection of the Marine Environment From Land Based Activities, a meeting that resulted in the adoption of the program known as GPA. Attendees at that conference were: 108 countries, 2 United Nations bodies, UNDP and UNEP, 9 specialized United Nations agencies, 7 inter-governmental organizations and 29 NGOs.

It was recognized that priority should be granted to the treatment and management of municipal wastewater as a part of water ordinance and to conserve the quality of marine and coastal waters. The GPA recognizes that the subsistence economy of large coastal populations –particularly in developing nations, such as is the case in Latin America and the Caribbean– are based on the utilization of live marine resources.

Within the Latin American and Caribbean region there are 3 initiatives that are to be found within the framework of the Regional Seas Programme. They are: the Wider Caribbean Region, the Plan of Action for the Protection of the Marine Environment and Coastal Areas of the Southeast Pacific and the Plan of Action for the Northeast Pacific.

Under the Convention for the Protection and Development of the Marine Environment in the Wider Caribbean (Cartagena Convention), negotiations were undertaken for a Protocol on Land Based Sources of Marine Pollution, which was adopted in 1999 and to date has been signed by only 15 countries so has not yet been enforced. The Wider Caribbean region comprises 12 continental States, 13 island nations, the State of Puerto Rico, 3 French possessions, 1 territory shared by France and the Netherlands and 11 independent territories.

The Wider Caribbean Region discharges between 80-90% of domestic wastewater directly into the sea with no prior treatment whatsoever. This leads us to recognise that the problem is still in the incipient stage of attaining a solution. We do not only need the instruments and the legal framework, but also the resources to implement them. For this reason the Regional Coordination Unit is at present negotiating with the GEF for fresh, new resources, imperative to the strengthening process the region requires in infrastructure and institutional arrangements to deal with the problem posed by Land-Based Sources of Pollution.

The appropriate controls now being implemented are those contained in the PAC 40 report incorporating technologies that are appropriate for the region. If nine countries ratify the protocol, it must be fulfilled. The protocol assumes the responsibility, control and measuring of water in two classifications according to capacities. Class II is in reference to sensitive areas and does not pose a threat to health, in addition to including the indicated parameters and limitations (for example, solids at 150 mg/l) and those in Class I are waters in areas of reefs, mangroves, resorts (with total suspended solids at 30 mg/l); neither Class is to contain visible floating substances. The experience has helped identify such urgent needs as are financing, acquiring infrastructure, providing training, creating awareness and citizen participation, and follow-up and assessment. Concerning the case studies carried out in the Caribbean, it has been said that there are no ideal solutions; that it is important to change the focus from conventional to sustainable, and to go through a planning process prior to a development process. Also greatly important is to study the absorption capacity of coastal water, to include cost/benefit studies, and to promote user willingness to pay for services, thus involving society in the decision-making process.

The Plan of Action for the Protection of the Marine Environment and Coastal Areas of the Southeast Pacific emerged in 1981. Its main objective is the protection of the marine environment and coastal areas

and fostering the preservation of health and well being for present and future generations. It includes the countries of Panama, Colombia, Ecuador, Peru and Chile. Since 1983 it has been backed by an instrument on land-based sources of pollution, the "Protocol for the Protection of the Southeast Pacific from Land Based Sources of Pollution". Despite this being a binding instrument, one that was adopted over 20 years ago, the deficiencies in infrastructure and the need to seek increased integration of national policies concerning marine protection and the management of water resources are as yet unresolved, resulting in adverse consequences to the health of marine and coastal ecosystems. However, it is important to recognize the progress of certain countries, among them Chile; not only progress but also the goals established for the near future concerning the management of domestic wastewater. Chile proposes an investment of 2 billion dollars by the year 2010, which will cover 93% of its water. It is important to mention the recent diagnosis carried out for this region through the Coordination Office of the GPA..

These are not the only two regions where efforts have been made; despite the lack of adopted or ratified initiatives, there are other areas exerting efforts to assess the situation of the environmental quality of coastal and marine ecosystems. Such is the case of the Southwestern Atlantic, including the states of Brazil, Argentina and Uruguay and the Northeast Pacific, which has recently begun an initiative. Both regions have already obtained an initial diagnosis on land-based sources; though general in nature and incomplete in some areas, they do represent an important basis for designing plans of action and defining priorities, at the national and regional levels.

In the same way, in the Latin American and Caribbean region there have been other initiatives such as the Pilot Project for the Marine Watershed of the Bright of the Californias, developed within the framework of the Commission for Enviromental Cooperation in North America, and developed jointly by Canada, Mexico and the United States. This initiative has made headway in terms of consolidating the relationship organisms and personalities of the United States and Mexico. It contains many lesson learned that will be highly illustrative throughout the processes previously mentioned in the Southwestern Atlantic and Northeast Pacific.

5. Conclusions and recommendations

In Latin America less than 20% of wastewater is adequately treated. This brings serious social, economic and environmental problems to the region. The problem is essentially financial, due to the difficulty of internalizing treatment costs for this waste. Efficient strategies are needed at the administrative, educational and research levels; in addition, innovative technologies and economic instruments that are socially equitable are needed.

Various aspects are identified, such as the need for alternate financing sources, the demand to rehabilitate present infrastructure, the necessary increase to installed capacity in order to cover the deficit in the service, environmental education, training and creation of awareness in all sectors and levels, including administrative, as well as the availability of information and the ensuing participation of all players. These are all premises to advance toward the integral management of our watersheds and coasts.

More case studies are needed in tropical and arid regions, as many of the standards are based on case studies in temperate regions, whose characteristics are not necessarily shared throughout Latin America.

Studies on indicators are needed to evaluate comparatively, and on transparent databases for the use of the general public.

One of the necessities is to agree in regional indicators, for example in Table 5 are some examples of the variation among the different water quality parameters.

Quality of the water required for recreational use (not restricted)

Parameter	Guide EPA[a]	Arizona[b]	California	México City
PH	6 – 9	6.5 - 9.0	——	6.5 – 8.3
Fecal Coliforms (org/100mL)	No detectable	200 (1) 800 (2)	——	——
Turbidness (N.T.U.)	≤ 2	1	2	10
Total Coliforms (org/100mL)	——	——	2.2 (1) 23 (2)	1,000
DBO_5 (mg/L)	≤ 10	——	——	20
Residual Clorum (mg/L)	1	——	——	0.2
Estándar count in plates (Colonies/mL	——	——	——	200

Table 5. (a. EPA, 1992; b. Cuthbert, 1992; c. DDF, 1987. In Arreguín 2001).

(1) Median (2) Simple

Of the various case studies carried out in the Latin American region, it is said that there is no single solution; the fundamental principal to make headway toward the integral management of watersheds and the coastal zone is planning instruments that will ensure that matters such as land ordinance that is environmentally sustainable be in place before implementing new development. Likewise, these programs for wastewater treatment must be linked to programs for re-use, rational use and use of renewable energy.

In sum, the problems the region faces regarding wastewater are:

Administrative:

The identification and execution of national and regional actions must be based on a logical framework stemming from priority policies and objectives, and coherent strategies to reach goals in the medium and long term.

There is no planning system that incorporates the principal of land ordinance that is environmentally sustainable; it is suggested that this be done prior to development.

Because all social players are not involved in the planning process, this must be done jointly with the processes for Watershed Management and the Management of Coastal Zones. Regional programs should be established to manage this shared resource.

Compliance with commitments that the states have taken on in diverse action programs related to the management of wastewater and the conservation of fresh/aquaculture, coastal and marine has not been satisfactory. Therefore, the challenge ahead is to become committed.

Though the principle of "user or polluter pays" is applicable, it must be strengthened at a normative level.

Despite this initiative being increasingly greater, it is still important to promote and motivate the technological re-conversion to clean practices.

Because it does not appear to be urgent, it is necessary to prioritize the work on designing standards that ensure the conservation of the environmental quality of aquatic and coastal systems.

Financing:

As there are no universal recipes, it becomes necessary to seek the participation of all sectors in financing the construction and operation of the municipal treatment plants, according to local needs and idiosyncrasy.

There is as yet no rate autonomy. Therefore, fixing rates and subsidies must be geared toward ensuring sanitary services for all users of the resource.

Research:

Dealing with non-point source pollution is a far more complex matter to solve than dealing with point source pollution, but should not be left aside. More data is required on non-point source pollution.

There is a dearth of programs for monitoring, assessing and following up on the quality of water in the coastal zone. We must join efforts and also work with skilled local institutions.

Integrating studies are scarce. It is considered to be important to incorporate the cost benefit analysis, in social, economic and environmental areas.

We must homogenize the criteria for defining quality standards for water and inter-calibrate the regional and sub-regional laboratories.

Databases must be generated, which include a design for comparable indicators and methodologies so that they might be shared and ensure dissemination.

The rate systems require more research.

It is necessary to analyze and study the jurisdiction of the administration of and property of water (water market).

Environmental Education and Technical Training:

Due to a lack of social perception of the problem, as well as a lack of water culture, it is important and, indeed, urgent to implement environmental educational programs at all levels.

Because of the lack of training, it is important to incorporate programs for the management of wastewater from a broader perspective to drive institutional strengthening at all levels.

Technological:

Some countries do have installed capacity, but it doesn't work properly. Therefore, it is necessary to select the appropriate technology. Moreover, it becomes necessary to recognize that it is not merely a technological problem, but also an operational one. There is, in addition, a lack of coherence with local conditions.

We deem it convenient to analyze the technical and economic feasibility of separating pluvial sewerage from domestic sewerage to make the treatment systems more efficient.

In the case of separate systems, it is necessary to separate the flow of rainwater from domestic sewers.

The objectives of international programs that support Latin American and the Caribbean in jointly resolving the problem of wastewater dumped into the sea is an initiative that is making headway, albeit not as quickly as desired. This problem surpasses the possibilities of the governments to deal with it, and backwardness concerning it is especially apparent in countries with scarce resources. The heterogeneity of the sources of

information, as well as the programs established to deal with the problem is a fact that should be prioritized in the international agenda.

A plan that establishes planning actions between the countries and substantial support from international agencies is still lacking. Independently from financial support –which never appears to be enough and can be unequal, as is the case of the watersheds of the Californias–, there are coordination actions that are urgent for an international project that attempts to provide follow-up to actions designed to minimize impact, such as those caused by wastewater in coastal areas. Here we would underscore the need to coordinate the generation of comparable indicators; as an example, the units used to measure BOD_5, suspended solids, nitrites, etc. We have found that regional reports are not comparable and as Cabrera (2001) states, the countries of the regions themselves are not comparable.

Lastly, it is important to recognize the progress on behalf of national governments implied through just recognizing there is a problem. Some measures, as yet insufficient, have already been implemented. In the same way, it is urgent that a common agreement be drafted, one that will homogenize the way the problem is measured and determine the priorities within the countries and regions of Latin America and the Caribbean. These challenges represent the task before us. It is imperative that we join efforts over the coming years.

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The Following persons contributed to the preparation of this document

UNEP/GPA	UNEP/ROLAC
Sustantive Coordination	
Veerle Vanderweerd	Ricardo Sánchez Sosa
Authors	
Oscar Manuel Ramírez Flores	
Ileana Espejel Carbajal	
Collaborators	
Kaveh Zahedi	
Analuisa Domínguez Hernández	
Oscar Fernando Ramírez Martínez	
Vivian Ruzansky	
Antonio Díaz de León	
Claudio Amescua García	
Jorge Ronzón Lagunes	

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