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Assessment of Land-based Sources and Activities Affecting the Marine, Coastal and Associated Freshwater Environment in the South-East Pacific

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Contents

Preface

The Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (hereafter referred as the Global Programme of Action) was adopted by an intergovernmental conferences held in Washington, DC, United States of America, from 23 October to 3 November 1995. The goal of the Global Programme of Action is to prevent the degradation of the marine environment from land-based activities, by facilitating the realization of States of their duty to preserve and protect the marine environment.

The Washington Conference designated the United Nations Environment Programme (UNEP) as S ecretariat of the Global Programme of Action and requested that, as coordinator and catalyst of environmental activities within the United Nation system and beyond, it should through its programmes and secretariat role, first, promote and facilitate implementation of the Programme of Action at the national level; second, promote and facilitate implementation at the regional, including subregional, level through, in particular a revitalization of the UNEP Regional Seas Programme; and, third, play a catalytic role in the implementation at the international level with other organizations and institutions.

The Action Plan for the Protection of the Marine Environment and Coastal Areas of the South-East Pacific was adopted in 1981 by Chile, Colombia, Ecuador, Panama and Peru, together with the Convention for the Protection of the Marine Environment and Coastal Areas of the South-East Pacific (Lima Convention) and other complementary agreements, which constitute the legal framework for this Plan of Action. The Permanent South Pacific Commission (Comisi6n Permanente del Pacífico Sur-CPPS) acts as a Regional Coordinating Unit.

After 1984, two programmes: (1) Research and Monitoring of Marine Pollution in the South-East Pacific and (2) the Programme of Control and Monitoring of Petroleum Hydrocarbons, were initiated under the Action Plan, both of which were part of the Programme for Coordinated Research and Monitoring of Massive Pollution in the South-East Pacific (CONPACSE), which were set up by member countries.

In 1986, within the framework of CONPACSE, the Action Plan member countries presented national inventories, which formed the basis of information in order to draw up the 1989 Regional Inventory of pollution from land-based sources. In 1995, national consultancies were undertaken for the updating of the 1989 inventory of pollution from land-based sources. Based on these studies, the updated Regional Inventory of Pollution from Land-based sources in the South-East Pacific was prepared, under the direction of the Instituto del Mar of Peru (IMARPE).

To facilitate implementation of the Global Programme of Action around the world, UNEP organised, during the period 1996-1998, in cooperation with relevant regional and international organizations, a series of technical workshops of government-designated experts, as well as representatives of relevant international organizations, the private sector and experts of non-governmental organizations. The purpose is to strength national capabilities for protection of the aquatic environment from land-based activities, and to promote regional and subregional cooperation. More specifically, the workshops convened had the following aims:

(a) To review the general objectives of the Global Programme of Action and its implications;

(b) To identify possible elements of regional frameworks strategies, with special reference to recommended approaches by source categories;

(c) To consider the requirements for development and implementation of national programmes, including the assistance required and available for this purpose through the organizations supporting the Global Programme of Action; and

(d) To design and agree on general outlines for preparation of regional programmes of action to address land-based activities.

The present assessment on land-based activities affecting the marine, coastal and associated freshwater environment in the South-East Pacific region was prepared as a main background document for the workshop on implementation of the Global Programme of Action in the South-East Pacific (Lima, Peru, 18-21 November 1996), organized by UNEP and the CPPS.

The objective of the assessment is to present information that will assist Governments of the region, both individually and collectively, in their aims towards protecting the marine environment and achieving sustainable development of their coastal and marine areas through integrated coastal management initiatives. The assessment provides, for each country and the region as a whole, identification and assessment of problems related to land-based activities. This information serves as the basis for establishing the priorities for remedial actions. In addition, management objectives and approaches have been defined, and criteria proposed for the evaluation of their effectiveness.

The assessment had three main objectives, namely:

(a) To review relevant information and activities of the individual countries comprising the region;

(b) To identify the priorities and formulate recommendations for the problems arising from land-based activities in each country, and the region as a whole; and

(c) To provide a basis for the formulation of a regional programme of action to address land-based activities in the South-East Pacific.

The assessment was commissioned to the Instituto del Mar del Perú by the CPPS and UNEP. The document is based, among other, on national reports from Colombia, Chile, Ecuador, Panamá and Perú. The draft document was submitted to the above-mentioned workshop and was reviewed based on discussions and recommendations provided by the participating government-designated experts. The revised draft was submitted by the CPPS to the Governments of the region for their final review. Those comments have been incorporated into this final document, which has been endorsed by the Governments of the region.

The support of various organisations in the region, particularly the Institute de Mar del Perú, and of all those who contributed information to the preparation of the present assessment is greatly appreciated.

Executive Summary

This regional assessment was prepared following the guidelines included in paragraphs 16 to 24 of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities. The report carried out an analysis of the problems faced by the countries of the South-East Pacific region, Colombia, Chile, Ecuador, Panamá and Perú, with respect to the marine pollution produced by various categories of sources, which affect the quality of water in marine and freshwater areas.

This report also reviewed other forms of degradation originating in industrial wastes, and urban, agricultural, forestry and mining runoff, among others. It also identified coastal water basins whose waters flow into the seas carrying various loads of pollution from anthropogenic activities, causing serious deterioration of the environment. The results of this study indicate that wastewaters are the main source of pollution in the South-East Pacific, because of the volume of organic waste, petroleum hydrocarbons, heavy metals and pesticides that are discharged through domestic and industrial effluents, degrading the quality of the marine environment and because of the effects that these effluents have on public health and their repercussion on the economies of the countries.

In Colombia, the main polluted areas are the Tumaco and Buenaventura Bays, which show high values of organic pollution, heavy metals and petroleum hydrocarbons as a result of the pollution from anthropogenic activities, which affects the quality of seawater and coastal resources. At the present time, to promote conservation and the rehabilitation of areas affected by pollution from various human activities, programmes of environmental education have been set up at all levels, including training and technical assistance for the segment of the population involved in fisheries, forestry and agricultural operations.

In Chile, pollution from wastewaters from anthropogenic activities is one of the highest pollution loads, which is correlated with the major population centres of the country, such as regions V and VIII. Medium- and long-term programmes have been set up to minimize industrial wastes. The target is to reduce or prevent pollution by discharges from domestic sewage systems.

Ecuador has a similar problem with domestic and industrial wastewaters, which are discharged directly to the sea in the Provinces of Esmeraldas, Manabi, Guayas and El Oro. Another major source of contamination is the Guayas River, which besides organic loads also discharges insecticides thus contributing to the degradation of the Guayaquil Gulf. In order to preserve the marine and coastal ecosystem, monitoring is being carried out to define the areas affected by effluents and for the planning of actions to eliminate or minimize the effect caused by the problems identified in the coastal area.

In Panamá, wastewaters also constitute the main source of pollution; to address this, and to protect the marine environment, a rehabilitation master plan for Panama Bay has been prepared. In the rest of the country, local authorities have city sanitation projects for sewage, including wastewater treatment.

In Perú, the main pollution source are wastewaters originating in anthropogenic activities affecting the areas of Callao, Chimbote and Pisco. In the southern area, mining activities have seriously affected the marine and coastal ecosystems, because of atmospheric, agricultural and water-borne pollution. The management policy to conserve the environment is sectoral; each Ministry constitutes the competent authority for tackling the environmental matters related to projects and activities of the mining, energy, industrial, fishery, and agricultural sectors, among others. For this purpose, various management instruments have been developed, such as sectoral by-laws, technical protocols, and intersectoral coordination through the National Environmental Council.

This assessment also considers the establishment of priorities and management objectives for the most vital problems brought up by the representatives of the Governments of the countries of the South-East Pacific, based on information provided by the countries and their affordability, and mainly directed at pollution of the organic type.

PART I: REGIONAL ASSESSMENT

1. Introduction

The Action Plan for the Protection of the Marine Environment and Coastal Areas of the South-East Pacific was adopted in 1981 by Colombia, Chile, Ecuador, Panama and Peru, together with the Convention for the Protection of the Marine Environment and Coastal Areas of the South-East Pacific (Lima Convention) and other complementary agreements, which constitute the legal framework for this Plan of Action. The Permanent South Pacific Commission (Comisi6n Permanente del Pacífico Sur-CPPS) acts as a Regional Coordinating Unit.

After 1984, there began the programmes of the Action Plan on Research and Monitoring of Marine Pollution in the South-East Pacific and the Programme of Control and Monitoring of Petroleum Hydrocarbons, both of which were part of the Programme for Coordinated Research and Monitoring of Massive Pollution in the South-East Pacific region (CONPACSE), which were set up by the Action Plan member countries.

In 1986, within the framework of CONPACSE, the Action Plan member countries presented national inventories, which formed the basis of information in order to draw up the 1989 Regional Inventory of pollution from land-based sources.

In 1995, national consultancies were undertaken for the updating of the 1989 inventory of pollution from land-based sources. Based on these studies, the updated Regional Inventory of Pollution from Land-based sources in the South-East Pacific was prepared, under the direction of the Instituto del Mar of Peru (IMARPE).

On the other hand, in 1992 there began a preparatory process to prepare a global programme of action on land-based activities, in accordance with the provisions of paragraph 17.26 Chapter 27, of Agenda 21, under which United Nations Environment Programme was responsible for convoking an Inter-governmental conference for the protection of the marine environment from land-based activities, taking into account that activities carried out on land constitute the major threats to human health, productivity and the biological diversity of the sea.

For this purpose, UNEP held preliminary preparatory meetings for this intergovernmental conference, among which was the Preliminary Meeting of Experts to Assess the Effectiveness of Regional Seas Agreements, Nairobi, Kenya, 1993; the Meeting of Government-designated Experts focusing on the 1985 Montreal Guidelines for the Protection of the Marine Environment from Land-based Sources of Pollution, Montreal, Canada, 1994; and a Final Preparatory Meeting of Government-designated Experts to Review and Revise a Global Programme of Action for the Protection of the Marine Environment from Land-based Activities, held in Reykjavik, Iceland, 1995.

Finally the Intergovernmental Conference which adopted the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities, was held in Washington, D.C., U.S.A., 23 October-3 November 1995.

The Washington Conference designated UNEP as the Secretariat for the Global Programme of Action, and included among its functions the promotion and facilitation of its implementation at a national, regional and subregional level; and the revitalization of the Regional Seas Programme; and the establishment of coordination at an international level with other organizations and institutions.

In March 1996, in the Intergovernmental Meeting VII of the Plan of Action for the South-East Pacific, Lima, Peru, it was agreed, by decision No. 5, to instruct the CPPS, in its capacity as Regional Coordinating Unit for the Action Plan, to stimulate, in coordination with the member states, the review of the Global Programme of Action, within the framework of a meeting of a technical nature. To carry out this decision, the CPPS convoked a meeting of experts in Bogota, Colombia, from 31 July to 2 August 1996.

In this meeting of experts, the UNEP representative stressed the importance of the participation and contribution of the countries of the South-East Pacific in the process of adopting the Global Programme of Action, and stated that UNEP, in its capacity as Secretariat for the Global Programme of Action, was organising a series of regional meetings to facilitate discussion of the regional components of the Global Programme of Action, and that as part of this process there should be a close relationship between the Global Programme of Action and the Action Plan of the South-East Pacific. For this purpose, it was agreed to prepare a regional assessment on land-based activities in the South-East Pacific.

The present report was prepared on the basis of the Global Programme of Action guidelines and the recommendations of the meetings of experts in Lima and Bogota.

Its main objective is to identify the sources, the extent and the critical points of pollution at a regional level affecting the quality of marine, coastal and freshwater areas and the aquatic wildlife, in order to establish measures to protect these environments from land-based activities, to enable the Governments of the countries of the South-East Pacific to prepare medium and long-term management measures to prevent, reduce, monitor and eliminate the degradation of the aquatic environment. The assessment would also enable the countries of the region to have a clearer view of the problems of a single geographic area; through regional cooperation they would be able to establish with greater precision which measures for the protection of the marine and freshwater environment could be applied in these areas.

2. Methodology

This assessment is based on the guidelines set out in paragraphs 16 to 24 of the Global Programme of Action. Based on the assessment, the Strategy and Selection of Management Measures to alleviate the degradation of the coastal areas of the South-East Pacific has been prepared, following the guidelines of paragraphs 25 to 34 of the Global Programme of Action.

The methodology applied was basically to harmonize the information contained in the updated National Inventories, and in the Regional Inventory of Land-based Sources of Pollution. In the case of the estimated volumes of discharges and pollution loads of domestic wastewaters, the factors used were those proposed by the World Health Organization (WHO, 1986) for the Rapid Assessment Method for air, water and soil pollution. Information was also obtained from experts and institutions through a questionnaire sent to the National Focal Points Secretariats, to provide additional information.

3. Identification and assessment of problems

3.1 FOOD SECURITY AND POVERTY ALLEVIATION

Population growth in relation to technology in the countries of the region has shown varying degrees of progress; however, stress has been laid on activities leading to sustainable development, through the use of new technologies in industrial processes and in the conservation of the environment, where fisheries and agro-industry play an important role in the lives of the coastal populations of the South-East Pacific.

In recent years, Colombia has increased its fishery production in the Pacific Ocean to an estimated 127,000 - 156,000 tonnes per year for 1992 and 1993 (Gutierrez, 1995).

Industrial fisheries of the Colombian Pacific are basically centred on the exploitation of tunas, which reached, in 1993 and 1994 respectively, over 48,000 and 22,000 tonnes per year (Table 1). The main freshwater catches were tilapia and characinids, with catches in 1993 of 11,000 and 12,000, and in 1994, 11,000 and 8,800 tonnes per year, respectively.

The Colombian Pacific has a potential area of 100,000 hectares for harvesting shrimp, especially *Macrobrachium rosembergii.* In the alluvial valley of the Mira River, the harvesting of salt water shrimp is exploited 10 shrimp farms and an area exists for this harvesting of about 39,500 hectares. The dominant species in the area is *Penaeus stylirostris.*

Similarly, in Chile, population growth and technological development directly affect the conservation of natural resources, mainly through the pressure of increasing demand for food. The marine environment provides a food source of enormous potential for present and future generations, provided that appropriate measures for the conservation and management of the hydrobiological resources that sustain it are taken.

Chile has a favourable set of environmental conditions leading to a high productivity. The presence of upwelling sites along the coast, local atmospheric phenomena (rainfall, winds, etc.) and the provision of nutrients from rivers are conditions that encourage the existence of large spawning grounds and shoals of fish species (Benoit, 1997).

In addition to the foregoing, the Chilean fisheries sector has experienced large growth in the last decade, fundamentally because of an increase in the catch potential of the fishing vessels (Cabrera and Araneda, 1994). This catch potential is evidenced by the increase in the storage capacity of fishing vessels, besides the fact that they have increased in number. For example, in 1980-1990 the average storage capacity of vessels making up the fishing fleet of Region VIII increased by 148 m^3 from 153 m^3, which indicates a growth of 71% in just 10 years (Cabrera and Araneda, 1994).

According to the United Nations Food and Agriculture Organization (FAO) statistical yearbook (1994), Chile landed a catch of open sea species of anchovy, sardine and jack, representing 98.8 per cent of marine fish species (Table 1). Freshwater fishing of great importance to Chile is that of salmonids, which represents 100% of the landed catch of freshwater species in 1993 and 1994. Shellfish also are species of commercial importance in which bivalves is the group with the highest percentage of catch, reaching 41.9%. Microalgae are another commercial resource which reached the figure of 104,000 tonnes in 1994.

The production structure of the Chilean fishery sector basically covers two major activities: fish catching, which includes artisanal and commercial fishing; and industrial processing activities which consist of the production of fish meal and oil, the canning and freezing of fish, molluscs and crustaceans, and smoking and dry salting of fish.

In Ecuador, on the other hand, fisheries take second place to petroleum as a source of foreign exchange. Exports during 1985 were 308,000 tonnes, which means an increase of 90% on the 1982 exports, a year in which fisheries suffered the effect of the El Niño Southern Oscillation event.

Shrimp harvesting is one of the main activities of certain areas of the Ecuadorian coast; at the present time, an area of 105,431 hectares are devoted to shrimp harvesting around Guayaquil which represents 4% of the potential 149,570 hectares existing in the interior estuary of the Guayaquil Gulf (Aquaculture of Ecuador, 1997).

In 1995, the areas of mangroves, shrimp beds and salt flats amounted to a total of 332,751 hectares, of which 53.51% were given over to shrimp beds. An increase of 66.6% took place from 1984 to 1995 of areas devoted to shrimp harvesting, most of which are in full production (Aquaculture of Ecuador, 1997).

In Panama, the Gulf of Panama is the area with the greatest biological productivity, because of the great

Table 1. Landing tonnes of living marine resources in countries of the South-East Pacific

RESOURCES	YEAR	COLOMBIA	CHILE	ECUADOR	PANAMA	PERU
FISH	1993	24240	1472929	57742	118972	6827015
	1994	19453	2720388	17477	72111	9176420
ANCHOVIE	1993	48224		23756	118972	6827015
	1994	22697		39174	72111	9176420
TUNA	1993			45322	118972	6827015
	1994				72111	9176420
MACKEREL	1993					
	1994					
SARDINES	1993		725244	23484		1143243
	1994		535749	59161	40663	1598926
JACK	1993		3236244	20545		101334
	1994		4041447			189459
HAKE	1993		64262			66341
	1994					165256
CRUSTACEANS						
SHRIMPS	1993	1932	13795	100602	6785	3109
	1994	1835	17104	98731	11089	3949
LOBSTERS	1993	7327			2580	4273
	1994	8944			2576	7365
EUPHAUSIDS	1993		3261			
	1994		3834			
MOLLUSCS						
BIVALVES	1993		41134	2538	1043	
	1994		52615	2500	758	
SQUID	1993	330				118600
	1994	86			253	193573
ABALONES	1993		8574			
	1994		8111			
CETACEANS						
WHALES	1993			5277		3839
	1994			227		1589
ECHINODERMS						
SEA URCHINS	1993		31300			
	1994		39706			
SEA CUCUMBER	1993		13	12		
	1994		4	12		
OTHERS						
SPONGES	1993	2500				
	1994	2500				
RED ALGAE	1993		76894			
	1994		78637			
BROWN ALGAE	1993		78863			
	1994		103905			

Table 1. (cont.)

RESOURCES	YEAR	COLOMBIA	CHILE	ECUADOR	PANAMA	PERU
FISH						
TILAPIA	1993 1994	11046 11084			347 389	 205
CARP	1993 1994				49 39	
SALMON	1993 1994	2028	72093 94979	1260 35		1425 765
CHARACINIDS	1993 1994	12834 8832		2170 250		
CATFISH	1993 1994	 4020				
CRUSTACEANS						
RIVER PRAWNS	1993 1994	10 10		800 800		5

width of the continental shelf, the seasonal outcrop and also because of the high output from drainage basins. The open sea fish population is dominated by anchovies of the genus *Cetengraulis,* herring *(Opisthonema libertate)* and various species of anchovies *(Anchoa spp).* Major predators are found associated with these species, such as the Pacific sierra *(Scomberomorus sierra)*, barracuda and sharks. Below the thermocline, high densities of scad *(Decapterus macrosoma)* are occasionally found as well as sardines *(Etrumeus teres)* and other minor species. The available biomass of pelagic fish in the gulf varies between 70,000 and 160,000 tonnes of anchovies and herring together, judging from the catches of the anchovy fleet operating in the gulf, and these are extracted as part of the catch of the anchovy fleet. In addition, it is estimated that 80,000 tonnes of carangids exist in deeper water, which are not being caught at the present time. The demersal fish resources are estimated at about 200,000 tonnes, whose principal components are butter fish (Estromateidae), some seabass and snapper. There is a minimum exploitation of this resource (Alvarez and Manelia, 1996).

The annual catches of penaeid shrimps indicate the existence of a biomass varying between 5,000 and 6,000 tonnes. The species caught are white shrimp *(Penaes occidentalis, P. stylirostris, P. vannamei)*, crystal shrimp *(P. brevirostris)* the *carabali* shrimp *(Trachypenaeus birdi)* and the Pacific seabob *(Xiphopenaeus reveti, X. kroyeri* and *X. precipua).* In addition there is a large number of deep water shrimp (between 70 and 200 fathoms deep), consisting of nylon shrimp *(Heterocarpus vicarius)*, locally known as the large-headed shrimp, a penaeid called *colibiri* shrimp *(Solenocera agassizii)* and a crayfish known as a Chilean lobster *(Pleuroncodes planipes).* Catches of deep water shrimp have been generally around 1,000 tonnes per year. Another resource now of commercial interest are scallops *(Argopecten circularis).* This is a resource that seems to appear in great numbers in 6 to 8 year cycles.

Pelagic resources appear to be very restricted in numbers, although some commercially valuable species are found in rather small quantities, such as some tuna fish (albacore and yellow-fin tunna). Some resources, although possibly not in commercial quantities, are of commercial importance for the coastal population, such as shell molluscs, octopus, oysters, spider crab *(Mithraz spinosissimus)* and the spiny lobster *(Panulirus argus, P. guttatus and P. laevicauda)*. Based on available fishery statistics, it is estimated that the lobster catch levels may be between 200 and 400 tonnes per year.

Another important commercial fish catch in the Panama Pacific is the anchovy *(Cetengraulis mysticetus)*. The species, which is used in the making of fish meal, has an inverse behaviour to that of shrimp and fish species that use mangroves during their postlarval stage. The FAO fishery statistics (1994) indicated that the largest commercial marine species catch was of anchovy and sardine, 100% an anchovy catch in 1993 and 63.9% and 36.1% of anchovy and sardine respectively in 1994 (Table 1).

In addition to commercial fisheries, a large part of the artisanal catch consists of fish species associated with mangroves and inlets. Examples of this are the snapper *(Lutjanus spp.)*, croakers *(Micropogonias altipinnis)* and snook *(Centropomus spp.)*. The estimates for 1980 were that every kilometre of mangrove coast in the Bay of Panama represented fishery resources to the value of 100,000 Balboa a year.

In Peru, the principal fishing catch is for indirect human consumption, supported mainly by two living marine resources, the anchovy *(Engraulis ringens)* and to a lesser extent the sardine *(Sardinop sagax sagax)*. Aquaculture activity which is being carried out does not form a significant part of the national fishery production.

According to the landed catch volumes of marine resources by species between 1990 and 1994 (GMT), Peruvian fisheries almost doubled their production, increasing from 6.9 million tonnes in 1991 to 11.1 million in 1994, which establishes it in second place after the People's Republic of China in terms of worldwide catch, which in 1994 reached a new record of 106.1 million tonnes (FAO, 1994).

Using as a reference the fishery production of 1994, according to FAO statistics (1995), it can be seen that of the total catch (11.1 million tonnes), 98.5% corresponded to pelagic species, particularly the anchovy species with 9.2 million and the sardine with 1.6 million tonnes, and as far as demersal species are concerned (1.5%), the Peruvian hake is the main species with 165,200 tonnes (Table 1). With regard to coastal resources (pelagic, demersal and other groups) that are exploited by artisanal fishing, that represented 2.27% of the general total, corresponding to 38,596 tonnes a year of fish and 223,082 tonnes a year of other species (crustaceans, molluscs, echinoderms and others).

Considering the utilization of marine products, it is noted that of the total catch in 1994 (11.1 million tonnes), 93.6% goes to indirect human consumption, that is, to making fish meal and oil, totalling an amount of 2.8 million tonnes. On the other hand, for direct human consumption (fresh, canned, frozen and cured) 728,600 tonnes went to produce 253,500 tonnes of processed products.

Another important aspect is in reference to the quality of marine resources and the conditions under which food retailing is carried out. The Ministry of Health (MINSA) through the Department of Environmental Health (DIGESA) is involved in action and coordination in order to ensure food quality and to protect public health. Since 1995 these actions have been strengthened by the application of the Hazard Analysis at Critical Control Points System (HACCP). The implementation of this system has been obligatory since 1996 for establishments processing fish products such as frozen, canned and cured fish. The year 1996 saw the equipping of 45 processing factories for direct human consumption and 3 fishing vessels for processing frozen products.

3.2 PUBLIC HEALTH

The conservation and protection of health and the environment are the main concerns in the economic model posed by the United Nations Conference on Environment and Development, held in Rio de Janeiro in June 1992. The harmonious and sustained development proposed at that conference requires an appropriate management of resources and an efficient and responsible relationship between the various public and private interests. It requires laws, equitable opportunities, the adoption of concepts of environmental economy and a wide participation of all sectors in the formulation and implementation of policies (Pan American Planning Bureau, PAHO, 1994).

The population increase in the coastal areas due to high existing population growth rate and the continuous migration from rural areas to the outskirts of the main cities, together with a growing shortage of water resources programmes for the provision of water and sewerage services, given the clandestine increase in untreated domestic sewage, have all had effects on public health and on the deterioration of the coastal areas of the main cities of the countries of the South-East Pacific. In Colombia, polluted beaches are mainly to be found in the areas of Tumaco and Buenaventura. In Tumaco the following beaches are reported to be polluted: El Morro and Boca Grande, and the beaches of the inner Bay of Buenaventura, the area of Juanchaco, Ladrilleros, La Bocana, Punta Soldado and Inner Cienagas, Isla Costera, the Dagua River mouth, El Centro and Pueblo Nuevo, among others (Colombia Report, February, 1997).

At the same time the Tumaco area has problems with dumps of shavings and sawdust in the mangrove plantations, carried out in order to harvest shrimp, and this causes serious damage to the mangrove ecosystem. On the other hand, some areas of the Tumaco coast are showing signs of eutrophication, which endangers aquatic marine life.

In Chile, marine pollution along the coast is associated with the topographic configuration and the diverse industrial activity generating liquid and solid wastes which are discharged directly into the sea with very little treatment, causing grave damage to the quality of the aquatic environment and affecting marine resources and human health.

The area in the north is seriously affected by the mining and fisheries industry, by the bioaccumulation of heavy metals in bivalve molluscs and by the increase of organic matter and problems of eutrophication in the coastal area. In the central area, wastes originating from agriculture and domestic sewage are endangering human health through the pollution of fish and shellfish. Finally the south central area is considered to be the one most polluted by the high population density and by extensive and diversified industrial activities (Chile Report, October, 1996).

In Ecuador, the Guayaquil Gulf is the main body of water of the continental coast that receives approximately three quarters of the volume of discharge and load of pollution from domestic and industrial wastes, causing serious deterioration of its coastal area. Shrimping activity is one of the causes of the degradation of the coastal marine environment, with four categories of impact: pressure on all phases of the biological cycle of the shrimp, deterioration of the quality of estuaries because of the destruction of mangrove plantations, pressure on other fishery resources and the loss of habitats through the elimination of shellfish and commercial fish (Guerra, 1997).

Other areas affected by municipal sewage, are Machala, Puerto Viejo, Esmeralda, Manta, Salinas, Duran, Sucre and Santa Elena. The pollution load has increased rapidly by some 72% in the last eight years, which shows that there is a lack of proportion in the search for options to address the problems (Hurtado, 1995).

In Panama, the area with the greatest sanitation risk and with severe pollution is the Bay of Panama, and the critical points of environmental degradation are located in the Matasnillo River, Club Union, the Club de Yates inside and outside the harbour.

In Peru, the main shore areas causing greater hazards to human health and to ecosystems, because of pollution from sewage, are Paita, Chimbote, Callao and Pisco; also in Ilo, because of pollution from heavy metals, which produces a bioaccumulation of metal traces especially in bivalve molluscs.

For the past 10 years, DIGESA, in coordination with the regional health departments, has been carrying out a monitoring programme in the beach areas of the cities of Lima and Callao, in which the microbiological quality of the beach water is assessed on a weekly basis, in order to advise the local population regarding the category of water for bathing. In 1996, 75% of the sixty-nine beaches monitored were found to be in at least satisfactory sanitary condition (microbiological quality). At the same time, these assessments have helped the local authorities administering beach areas to take action directed at protecting the public health of holiday-makers.

Besides, there is an existing programme for monitoring levels and effects of pollution directed by IMARPE in selected areas along the Peruvian coast, which identifies the level of pollution present in the sea, such as metal traces, petroleum hydrocarbons and the microbiological quality, evaluating the effects of pollution on the marine community that inhabit these areas.

3.3 COASTAL AND MARINE RESOURCES AND THE HEALTH OF THE ECOSYSTEMS INCLUDING BIOLOGICAL DIVERSITY

Sustainable development, particularly in this region, also implies an appropriate management of its great biodiversity, since human health depends directly or indirectly on the variety and variability of the species' genes, both of populations and ecosystems. The marine resources provide, *inter alia,* food, medicine and the enrichment or impoverishment of biodiversity, as a result of certain practices of human activity, which constitutes a grave danger for human development and the ecological balance of the world.

Based on the foregoing, it is very important for the countries of the South-East Pacific to identify the flora and fauna that constitute an important part of the marine, coastal and freshwater ecosystems, both for the present and for the future of their people. Described below is the richness of these resources and the importance of their conservation.

The Malpelo Island is one of the most unique places in Colombia, since it harbours the terrestrial flora and fauna particularly adapted to its stony substratum. The marine fauna includes coral formation and species both of the American continental shore and of other islands in the Eastern Pacific and the Indian Pacific Ocean. Among the important species are the lizard *(Phyllodactylus),* the starfish *(Tamaria),* shrimps *(Alpheus* and *Synalpheus)* (Graham, 1975), the land crab *(Gecarcinus* (Johangartia) *(malpilensis) (Comision Colombiana de Oceanogratia,* 1997).

The largest nesting bird colony on the island is that of the boobies (*Sula*), which are represented by two species: the masked booby *(Sula dactylatra granti)* which nests in colonies on the main island (Murphy, 1945) and the red-footed booby *(Sula sula)* which restricts its nesting to the small islands of the south. There are also small nesting colonies of frigate birds, *(Fregata magnificiens),* which uses the island caves, and also tropic birds *(Phaethon aeterus).* Other birds observed were *Pterodrama phaeopygea and Puffinus pacificus.*

The Malpelo Island corals do not form a true reef, but have coral clusters that are well developed on low sloping areas in contrast to very steep areas where only ten per cent of the area is covered (Bikerland *et al*, 1975; Von Phral and Erhardt, 1985 cited in Zapata, 1994). The lack of corals in areas with a steep slope has been attributed to effects of the angle of incidence of light and the lack of support surface for reef structures.

In regard to the echinoderms of the Malpelo Island, little is known because not much work has been carried out in their regard, but perhaps the most important contribution to knowledge about this phylum was the VELERO III expedition between 1931 and 1941, which surveyed the Eastern Pacific coast from Baja California, Mexico, to Callao, Peru, establishing stations on the Malpelo Island, Gorgona, the Cupica Bay and Ensenada de Utria (Clark, 1940 cited in Pardo *et al.,* 1988). Echinoderms are apparently distributed in various areas according to depth. At 6 m there is found the boring sea urchin *(Echinometra* *vanbrunti)*, the sea urchin *(Diadema maxicanum, Eucidaris thouarsii),* the starfish *(Ophicoma aethiops);* below 6 m and down to 30 m depth, are found the lingcod *(Ophiactis savigny* and *Ophiotela mirabillis)* and the starfish *(Mitheodia bradlevy* and *Nidorella armata)*, and the sea urchin *(Tripneustes depressus).* Below this depth of 30 m are found the sea starfish *(Tamaria striae, Narcissia gracilis, Leiaster callipeplus, Asteropsis carinifera)* and the basket starfish *(Astrodictym panamense).*

The crustaceans are well represented on the island, especially the Decapods, with 14 families, 42 genera and more than 50 species reported, distributed along the corals (Brando *et al.*, 1994; crustaceans in symbiosis with coral such as Caridean shrimps of the Paleomonidae family *(Harpliopsis depressus* and *H. Spinigera);* the pistol shrimp of the Alpheidae family *(Alpeus lottini, Synalpheus charon);* crabs of the Xanthidae family *(Quadsella nitida, Domesia hispida, Liomera cinctimatus)* and species of the genera *Trapezia.* Crabs using the coral as a substratum are the marsupial crab *(Hapalocarcinus marsupialis);* crabs that live in coral caves: *Pseuddocryptochirus crescents* and crustaceans that use the basal parts of coral: Palaeomonidae *(Brachycarpus biungusiulatus, Pseudocoutierea elegans, Rhynchocinetes* sp.*)*, the barrow shrimps *(Grapthophylloides mineri),* family Alpheidae pistol shrimps *(Alpeus malleator, A. grahami, Synalpheus nobili, S. digueti, S. biunguiculatus, S. bannerorum, Pomagrathus corallinus)* among others.

Also reported are 78 mollusc species, belonging to 37 families and 58 genera, of which the most numerous are the muricides. The molluscs in Malpelo are also associated with coral: *Quoyola monodonta* live at the bottom and on the roof of the coral, and in the base of the coral live the porcelain snails *(Cypraea albuginosa, C. isabellamexicana, C. cervinetta, C. arabicula, C. robertsi* and *C. teres);* and the cones *(Conus didama* and *Conus dalli).*

Chile is a country with a shoreline of high primary productivity, considering the marine currents along its coasts and the upwellings that occur sufficiently to maintain a varied flora and fauna. In Chile, the catch of fish, shellfish and algae is one of the largest in the world, with an average annual production in excess of 6 million tonnes (INEI, 1995).

The statistics of fisheries and the catch of many seafood species, however, is constantly on the decrease, because of overexploitation, pollution and other causes, as is the case with some molluscs such as the sea snail *(Concholepas concholepas),* and some echidoderms such as the sea- urchin *(Loxechinus albus);* crustaceans such as the Juan Fernandez rock lobster *(Jasus frontalis)* and the southern king crab *(Lithodes antarctica),* sea-birds (particularly guano birds) and penguins (especially the Humboldt penguin, *Spheniscus humboldti);* mammals such as the sea otters (Mustellidae): the sea otter *(Lutra felina)* and the southern river otter and *(L. provocax),* various species of cetaceans; algae such as *Durvillea antarctica,* and the rhodoohycae used in the production of agar (Benoit, 1997).

In Panama, there are more than 2,000 km^2 of mangroves in which there are almost 200 km^2 of salt marshes. Most of the mangroves are on the Pacific coast, in particular in the Gulf of San Miguel, where there are 464,890 km^2.

The mangroves of the Pacific coast of Panama mainly consist of red mangroves (*Rhizophora* spp), and also by communities of black mangroves *(Avicennia germinans* and *A. bicolor),* white mangroves *(Languncularia racemosa),* cork oaks *(Mora oleifera)* and chestnuts *(Montrichardia arborescens).* There are other mangrove species that are of importance such as the seed mangrove *(Pelliciera rhizophorae),* frequent in the structure of mangrove swamps in the Pacific coast of Panama and they constitute a very sensitive ecosystem (Aybar and Tunon, 1997).

With regard to the interdependence between fishery resources and mangroves, there are 9 or 10 species of shrimps involved in shrimp fisheries in the Panama Pacific; six of these species need estuaries and mangroves during their juvenile phases. The fishing of shrimps in the Pacific coast of Panama represents the most important activity of the fisheries and generally the financial benefits derived from them amount to 60 to 70 million balboa a year and approximately 5,000 people make a living from this activity.

Panama has coral reefs on both coasts. There are numerous species of fish and invertebrates in these reefs, which are often enough the areas with the greatest biological diversity on these coasts. Besides their value for biodiversity, a large biomass accumulates on the reefs and part of it is harvested by the coastal people. Additionally, the spectacular beauty of the corals is an important resource for tourism in all this tropical region.

In the Panamanian Pacific, the reefs are less numerous and have less biological diversity. However, there are some in the Archipelago de las Perlas and some of the islands of the Chiriqui Gulf, where the best reefs in the Pacific are found. The fact that there are less reefs in the Eastern Pacific is explained by drops in temperature to less than 29°c in the outcrop areas, such as in the Gulf of Panama, and also because of the greater variation in tides, greater drainage from water basins and greater sedimentation. As a consequence of the intense phenomenon of El Niño which occurred in 1982 and 1983, the surface temperature of the coastal water in the Pacific at Panama increased from 28°c to almost 31°c. This warming took a heavy toll of the coral in the Gulf of Chiriqui and in the Gulf of Panama. The most recent scientific information indicates that these corals are recovering slowly, and if there is no additional pressure such as that caused by pollution, everything seems to suggest that they will once again reach their normal state (Aybar and Tunon, 1997).

The aquaculture areas of Peru, according to the General Directorate of Environmental Health in the Ministry of Health (DIGESA), have registered over 400 discharges from meteorological mining, tanneries, abattoirs, and other sources, which carry pollution loads along the Peruvian coast, besides the discharges from human settlements, which are evaluated in accordance with the general law on water in force in the country (INRENA, 1997).

In regard to biological diversity, Peru is considered one of the 12 countries denominated megadiverse, since they contain between them 60 to 70% of the biological diversity of the whole world on land; in regard to marine biodiversity the knowledge is still fragmentary.

The Peruvian coast extends over two provinces; to the north of six degrees of latitude south, there are tropical waters typical of the Panama province, which hosts a rich flora and fauna superior in number of species to the Peruana province, which typically has temperate-warm seawater and an incidence of possible changes in environmental conditions such as the tropicalization of water provoked by the El Niño phenomenon, factors which determine the instability of the ecosystem and which results in the migration of species of a tropical origin, in turn resulting in significant changes in the number of species in the community and high rates of fluctuation of density and biomass, so that the levels of biological diversity vary with the conditions of the marine environment.

In regard to the taxonomic groups in the environment of the Panama province, these are dominated by echinoderms, crustaceans and molluscs; on the other hand, in the Peruana province, in average conditions, marine worms predominate; this changes in conditions of tropicalization (El Niño phenomenon), during which crustaceans, molluscs and echinoderms increase in numbers.

The Panama province is much richer in specific diversity, and is made up generally of the seabass fish family, with 26 species occurring in Peru, carangids, with 19 out of 22, croakers with 29 out of 40, clupeoids with 11 out of 13, anchovies with 15 out of 16 species; the difference in the species of the families mentioned occur in the Peruana current.

There are also 108 bird species, belonging to 53 genera and 24 families; 5 reptile species (marine turtles), belonging to the Chelonidae and Dermochelonidae families, of which four species are endangered (Table 2) such as *Chelonia mydas agassizii, Lepidochelys olivacea, Eretmochelys imbricata* and *Dermochelys coriacea.* There are 36 mammal species, including 23 genera and 9 families, of which 6 are endangered.

In the Peruvian marine ecosystem, there are about 759 fish species, belonging to 402 genera and 169 families. Of this total, 73 species are of economic importance; this number increases to 112 if direct human consumption is considered.

The species occurring in the ecosystem of the Peruvian-Chilean current are notable for their large population sizes, in particular the anchovy *(Engraulis ringens),* the sardine *(Sardinops sagax sagax)* and the Chilean jack mackerel *(Trachuru pictaratus murphy).*

The group of invertebrates has 971 mollusc species distributed in 389 genera and 166 families, of which the gasteropods and bipods are the most diverse, with 529 and 342 species respectively. Only 5% of molluscs are commercially valuable.

There are 400 species of crustaceans (Decopods and Stomatopods), which include 73 families and 220 genera, which is 41% of all the species observed in the Eastern Tropical Pacific (Kameya *et al.*, 1996). Approximately 5% of the species are commercially valuable. Families that have the largest number of species are Xanthidae (33), Galatheidae (19), Porcellanidae (19), Grapsidae (18), Diogenidae (14) and Penaeidae (12). As far as microcrustaceans are concerned, there are 61 species of copepods, belonging to 24 families and 34 genera, 11 euphausids (1 family and 5 genera), 3 planktonic cladoserans and 40 amphipods included in 18 families.

There are also 61 species of echinoderms, 300 of marine worms, 5 of salamas, 11 of chaetognatha, 52 of foraminifera, 1 of brachiopods and approximately 35 Cnidaria.

Another large group are algae, of which 201 species of macroalgae have been identified, including *Rhodophycae, Chlorophytae, Phaeophytaea,* and *Cyanophytae,* of which 4 are used for food, including the species *Porphyra columbina, Ulva fasciata, U. papenfussi* and *Gigartina chamissoi;* 4 are used for the production of agar such as *Gracilariopsis lemanaeformis, Agardhiella tenera, Hypnea valentiae, Ahnfeltio durvillae;* and 4 are used in the production of alganates such as *Macrocystis pyrifera, M. integrifolia, Lessonia nigrescens* and carrageninas such as *Gigartina chamissoi.* There are also 234 species of microalgae, including diatomeas, dinoflagelletes, coccolithoflorids and phytoflagellates.

Biological diversity in Peru is affected by domestic and industrial wastewaters: mine tailings and wastes that pollute the sea and watercourses, causing deterioration in the sanitary quality and bioaccumulation of heavy metals in fish and shellfish.

3.4 ECONOMIC AND SOCIAL USES

The industrial development of the countries of the South-East Pacific contribute greatly to the increase of production and food security by improved water treatment techniques for public water supply, clean and non-polluting processes and technologies, the obtaining of new raw materials, and sustainable methods of forestry and fishery management.

During the last decade, the Chilean economy has experienced profound changes in its productive and institutional structures. The economic development policies that predominated in recent years, arising from the socially-oriented free market economy, have favoured individual initiative, fair competition and opening up to international trade (Chile Report, October 1996).

Chile's present economic policy clearly shows an opening to external markets, which, as a consequence, has brought intensive use of the coastal area, mainly through the shipping activity which this generates (exports, imports). The sectors with greater participation in this commercial movement are forestry, fisheries, mining and manufacturing.

The shipping of products for export generates large volumes of waste, which are discharged directly or indirectly into the sea. The disposal of these wastes causes silting on the sea bed. As a result, public works authorities must carry out dredging works from time to time on the sea bed under harbours and maritime terminals (Chile Report, 1996).

The effect on the coastal marine ecosystem varies according to the type and volume of the wastes disposed of; the most significant are those from the mining sector, particularly copper and to a lesser extent the wastes originating in the manufacture of fish meal, cellulose and farm products (fruit and vegetables).

The coastal area of Ecuador has a vital part to play and contributes to the maintenance and development of the country's economy, its industry and social conditions. Only recently has the coastal area of Ecuador been understood to be an economic entity of major importance. For this reason, studies are currently being carried out and solutions sought for problems affecting the coastal area, both those generated by nature and those originating in man-made activities.

Research studies have shown the vulnerability of the Ecuadorian coastal areas, as a result of the influence of natural phenomena such as El Niño climate change, Tsunamis, etc., and arising from the anthropogenic activity of building construction on the coastal area, deforestation and the pollution of the environment.

In the last five years, the Peruvian economy has seen positive changes, not only because of the positive results in the main economic indicators, but also because of consolidation in reversing the negative trend of previous years. The advances made during 1994 are reflected in the reduction of inflation to 15.48%, the growth of GDP by 13% and exports by 30%, with the gross investment increase of 37.7% (Central Bank of Reserve-BCR, Peru, 1994). In 1994, production increased by 13 per cent, with positive changes in the building sector (34.7 per cent), fisheries (31.5 per cent), manufacturing (17.1 per cent) and the livestock sector (13.2% (BCR Peru, 1994). In that year, the fisheries' sector production reached the highest level for the previous 15 years, an increase which was based on investments by the fishery enterprises, aimed at expanding catch capacity and, on the other hand, the greater availability of pelagic resources. In the case of the anchovy, the catch increased from 6.8 million tonnes to 9.2 millions between 1993 and 1994. A recovery in levels of catch took place for the sardine, jack and mackerel, and the major volume of fishery activity was concentrated in the ports of Chimbote, Pisco, Paita and Ilo.

In 1994, the agricultural sector grew by 13.2% with respect to 1993, and the cultivated area was 1.5 million hectares, greater by 16.5% than in 1993. The crops that had greater effects in the growth of farm production were cotton (71%), rice (44%), sugar cane (26%) and potatoes (17%). It should be pointed out that the first three crops were grown in coastal departments of Ica, Lima, Lambayeque and La Libertad (Ministerio de Agricultura de Peru, 1994).

In 1994, the mining sector grew by 4.3%, with metallurgical mining growing by 7% and crude petroleum by 0.9%. The main metallurgical mining products were iron (34.1%), gold (29.2%), and copper (7%).

This accelerated growth in production has brought with it an increase in the pollution levels, particularly in the coastal marine environment, as is the case with the fisheries sector in regard to fish meal and fish oil processing plants which are located along the Peruvian coast; in 80% of these, environmental awareness programmes have been implemented aimed at increasing productivity and improving the environmental conditions of the areas.

The massive migration of the Peruvian Andes people to the various cities and towns along the coast increases the demand for water and sewerage services, and this generates a larger volume of wastewater, discharged into the sea and affecting the coastal marine ecosystem.

4. Assessment of pollution in the South-East Pacific

4.1 SEWAGE

Sewerage waste discharges mainly organic pollution from sewage of the cities of the South-East Pacific coast with a high population density (Fig. 1), which, because of its volume constitutes the primary source of marine pollution. These directly cause various levels of degradation along the coast of the countries of the region (Figs. 2 and 3, Table 2), affecting the development of the marine communities, altering the food chains and posing serious risks to human health through the ingestion of polluted food and the pollution of beach areas, discouraging the development of tourism and altering the aesthetic appearance of the coast.

The Colombian Pacific coast, 1,392 km in length, with a population of about 317,860 inhabitants according to the 1994 census, receives an input of domestic sewage from the Ensenada of Tumaco, the Bay of Buenaventura and a further 147 smaller coastal communities distributed throughout the departments.

Virtually the total volume of municipal sewage discharged in the Colombian Pacific coast come from the Ensenada of Tumaco and the Bay of Buenaventura. In 1994 domestic discharges totalled approximately 45 million m^3, with an associated organic load of 13,230 tonnes of BOD_5. Of these amounts, Buenaventura and Tumaco input 18.8 million m^3 of domestic sewage, giving an organic load of 10,670 tonnes of BOD_5 (64.8% of the total on the coast) which is 1,320 tonnes more than was discharged in 1989 (Gutierrez, 1995).

The remaining 147 coastal settlements spread along the Colombian coast discharged 26.9 million m^3 annual volume with an associated organic load of 2,600 tonnes of BOD_5 per year. The latter figure is due to the fact that many communities with sewage discharge have considerable volumes of sewage with no reported additional organic load. As Buenaventura is the area of the greatest population density on the Colombian Pacific coast, it generates approximately 6,450 tonnes of BOD_5 per year of organic material (approximately 48% of the national total generated on the whole coast). Tumaco, inputs 4,230 tonnes of BOD_5 per year, which amounts to 31.7%.

In the coastal area of Chile, with a population of over 2 million inhabitants according to the 1993 census, there is a direct input of sewage through hydraulic systems (underwater outlets, etc.), and indirectly from 27 river basins. The areas most affected by domestic sewage discharged into the sea are the Bay of Valparaiso, and discharge of the Maipo River in the Metropolitan area of Santiago and the Bay of Concepcion.

In total there are 672.4 million m^3 per year of sewage with an associated organic load of 164,600 tonnes as BOD_5 per year. It has been assessed that the volume of direct discharge is of the order of 142.5 million m^3 per year with an organic load of BOD_5 of 38,500 tonnes per year. This indicates that approximately 82% of the volume of domestic sewage generated in Chile finished up in the sea, transported through the 27 river basins already mentioned.

Santiago in the metropolitan region, inputs a volume of 287 million m^3 per year with 77,500 tonnes of BOD_5; transported to the sea by the Mapocho River, 36% the Zanjon de la Aguada, 62% and the Maipo River the remaining volume (Table 3).

Valparaiso Bay, another area of importance on the Chilean coast because of shipping, recreation and trade activity was estimated in 1992 to have a discharge volume per year of 15,560 m^3 per year with an organic load expressed in BOD_5 of 4,198 tonnes

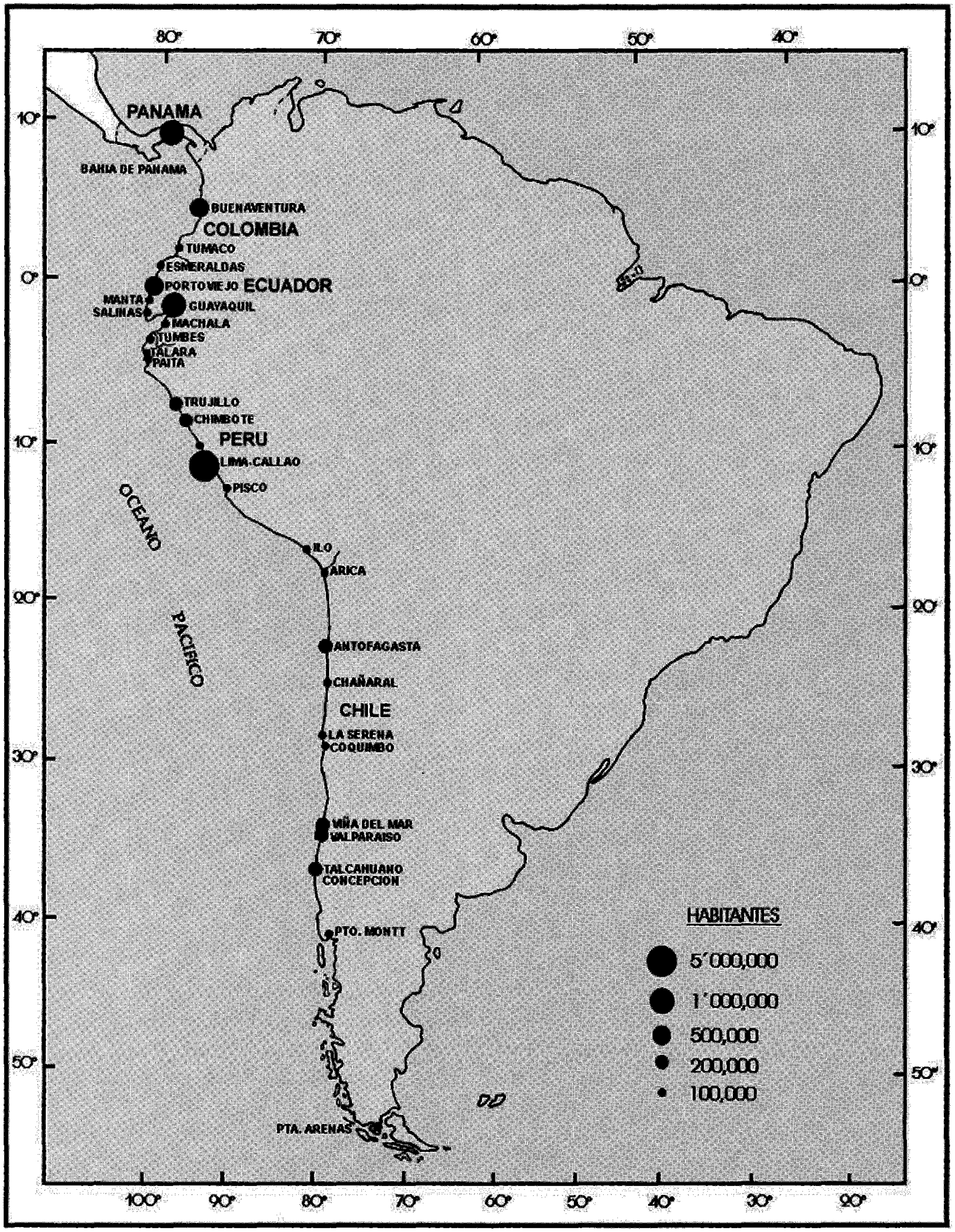

Figure 1. Population density of the main cities of the Southeast Pacific Region

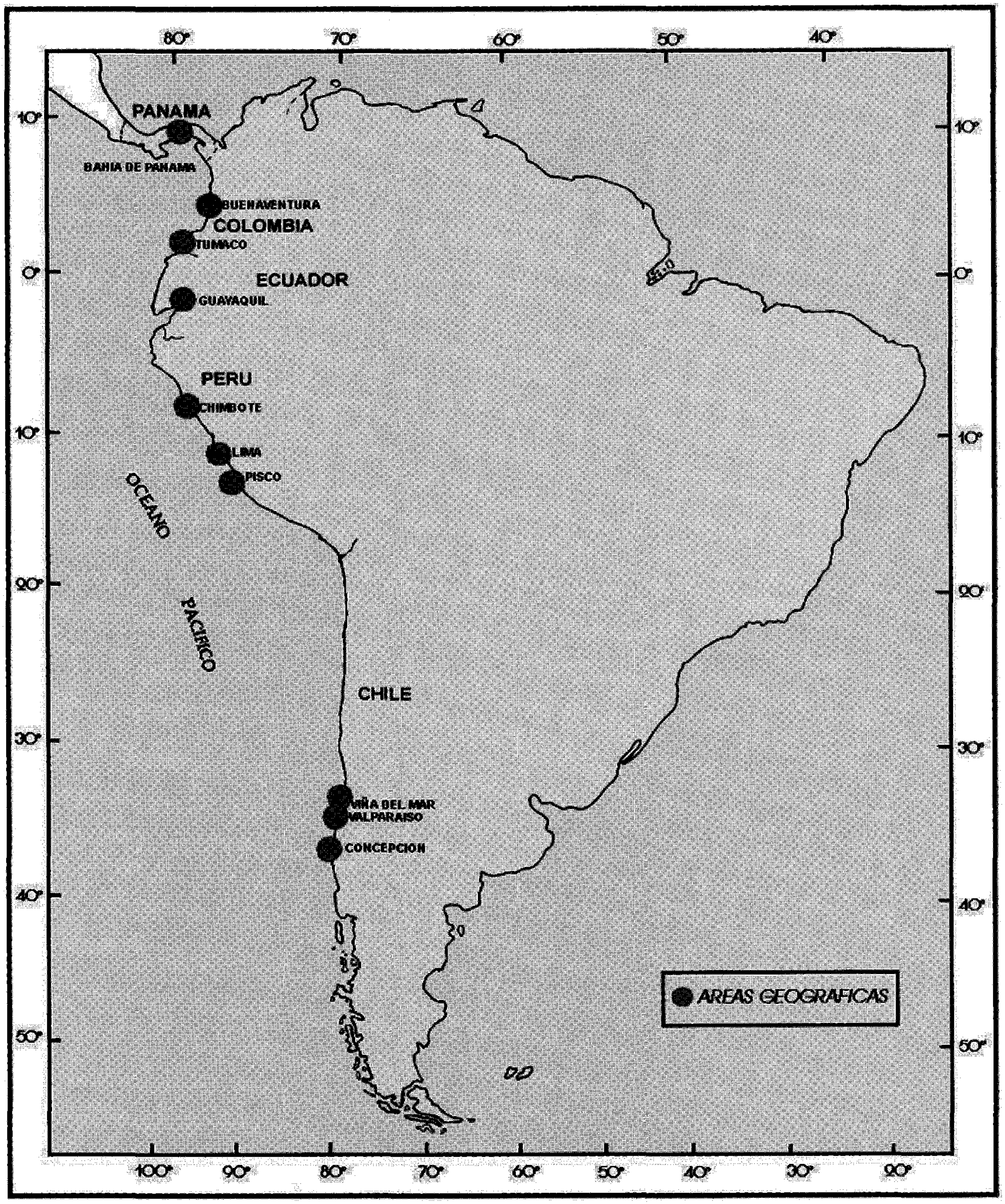

Figure 2. Geographic areas of the Southeast Pacific at risk from pollution by sewage.

Table 2: Estimated discharge volume and pollution load of sewage effluent in the South-East Pacific region, 1994-1995 (Reports on Updating of National Inventories of Land-based Pollution; UNEP/CPPS/ECO-CEPIS (PAHO) 1986. Rapid Assessment of Air, Water and Soil Pollution Sources. Translation by WHO OFFSET PUBLICATION No. 62, 1981)

Country	Discharge volumes	BOD tons/year	COD tons/year	SST tons/year	SDT tons/year	N tons/year	P tons/year
COLOMBIA							
On Sewerage	18,721	8,127	12,402	1,545	9,011	1,219	147
Off sewerage	26,982	2,550	5,914	5,914			
Total	**45,703**	**10,677**	**18,316**	**7,459**		**1,219**	**147**
CHILE(*)							
On sewerage	672,441	164,552	367,522	167,058	304,881	27,564	3,341
Total	**672,441**	**164,552**	**367,522**	**167,058**	**304,881**	**27,564**	**3,341**
ECUADOR							
On sewerage	108,189	29,196	65,210	29,640	54,093	4,890	549
Off sewerage	20,193	19,086	44,257	44,257			
Total	**128,382**	**48,282**	**109,467**	**73,897**	**54,093**	**4,890**	**549**
PANAMA							
On sewerage	78,008	50,096	35,495	16,134	29,445	2,662	323
Off sewerage	204	458	338	338			
Total	**78,212**	**50,554**	**35,833**	**16,472**	**29,445**	**2,662**	**323**
PERU							
On sewerage	418,793	113,016	252,423	114,737	209,936	18,931	2,294
Off sewerage	16,110	15,227	35,311	35,311			
Total	**434,903**	**128,243**	**287,734**	**150,048**	**209,936**	**18,931**	**2,294**

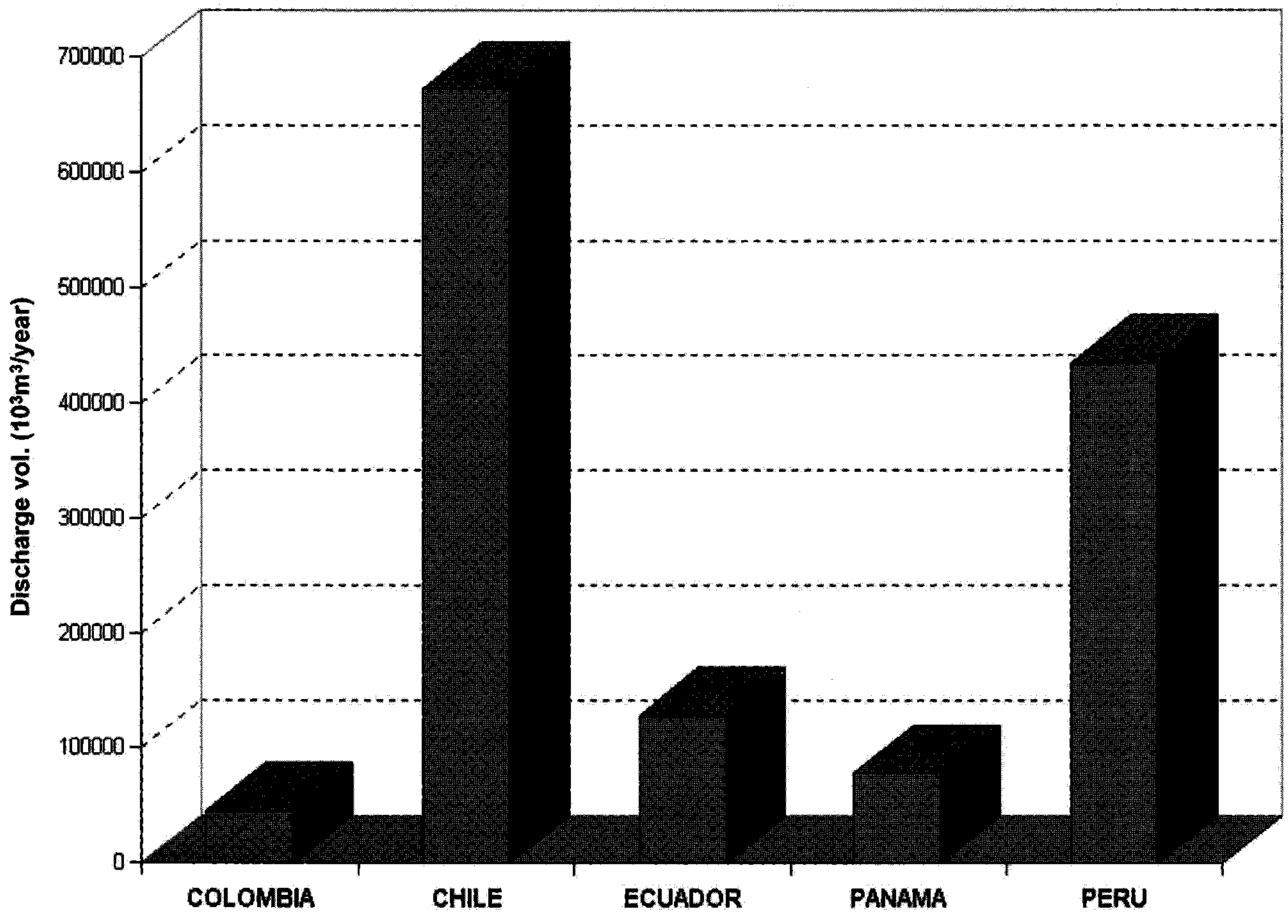

Figure 3. Estimated discharge volume and pollution load of sewage effluent in the Southeast Pacific Region, 1994 - 1995.

per year. At the present time there is no sewage treatment, and the sewage is discharged directly into the water. Since there are problems of water quality, mainly bacterial contamination, which gives rise to high a concentration of faecal coliforms, which poses risks to the health of the population.

Domestic sewage on the Ecuadorian coast is discharged directly to the sea by those provinces which have a coastline, namely: Esmeraldas, Manabi, Guayas and El Oro. These provinces have a total of 4,266,273 inhabitants according to INEC, 1991, (quoted by Hurtado, 1995), that is, 89% of the total of the coastal population of the country. Of these four provinces, those that have that largest input of pollution loading through domestic sewage are the province of Guayas and the province of Manabi (Table 3).

The volume of domestic sewage in the coastal area of Ecuador is 128.38 million m^3 per year with an associated organic load of 48,280 tonnes of BOD_5 per year. The major part of the pollution load is generated in the Guayas province, with 182,888 tonnes per year of BOD_5, a quantity that represents approximately 62.8% of the total on the Ecuatorian coast and the major part of which is made up of the pollution load from Guayaquil with 18,900 tonnes of BOD_5 per year. The rest is input by the province of Manabi with 60,150 tonnes of BOD_5 per year (20.64%), the province of El Oro with 30.5 tonnes of BOD_5 annually (10.4%) and Esmeralda with 17,700 tonnes of BOD_5 per year (6.1%).

As far as the industrial wastewater discharges on the Ecuadorian coast are concerned, these are mainly the discharges from the packing industry with 33%, the fishery industry 29% and vegetable oil refining industry 6%. These industries discharge 2.25 million tonnes per year, with an associated organic load of 965.90 tonnes per year of BOD_5 in the provinces of Quayas, Esmeraldas, El Oro and Manabi.

In Panama, domestic sewage discharges contribute a pollution load mainly to the Bay of Panama. Some 95 % of the Panamenian population have a clean water supply and 96% sanitary disposal of sewage. The main industrial activities are carried out in the communities of the Gulf of Panama in the towns of Chame, Capira, La Chorrera, Arraijan, San Miguelito, Chepo, Chaboga and Ciman with a total population of 1,072,127 inhabitants, according to the 1990 census (Table 4). The main rivers inputting wastes to the Gulf are Tapia, Juan Diaz, Rio Abajo, Matasnillo, Chilibre and Chilibrillo (Table 3).

The Metropolitan region and also San Miguelito discharge sewage to the Bay of Panama without any treatment, with a volume of sewage which is exclusively domestic in origin estimated at 78.2 million

Table 3: Main river basins affected by land-based activities sewage, mining and pesticide residues (Gutierrez, 1994; Hurtado, 1994; Delgado and Laguna, 1995; Cabrera, 1994; Sanchez and Muñoz, 1995)

COUNTRY	BASIN	ACTIVITY OR SOURCE
COLOMBIA	Rivers: Colorado, Curay Chaqui, Chilvi, Guadal, Guandarajo, Guanapi, Mexicano, Mira, Rosario Tablones, Yanaje	Metals and other sources
CHILE	Rivers: Elqui, Aconcagua, Maipo, Mapocho, Rapel Bio-Bio, Valdivia	Industrial and mining wastes, pesticide residues
ECUADOR	Rivers: Guayas, Daule, Babahoyo	Sewage and industrial wastes, Pesticide residues
PANAMA	Rivers: Matasnillo, Matias, Hernandez and Juan Diaz. River Chiriqui, Viejo, Fonseca San Felix, Tabasara	Sewage Pesticide wastes
PERU	Rivers: Moche, Santa, Rimac, Pisco, Ocona, Locumba, Sama	Mining-metallurgical wastes Industrial wastes Pesticide residues

m^3 per year, an amount calculated by using factors of per capita production of sewage determined by the Technological University of Panama[1]. This volume generated a discharge of 50,550 tonnes of BOD5[2] for that year. In Panama, industrial sources of marine pollution originate in food and agricultural production activities. Poultry feedlots and slaughter houses, flour and glucose factories, alcohol distilleries, tanneries and other manufacturing industries generate the liquid wastes that are discharged in the Bay of Panama.

Table 4: Sewage discharged into the sea in the South-East Pacific region (Gutierrez, 1994; Hurtado, 1994; Delgado and Laguna, 1995; Cabrera, 1994; Sanchez and Munoz, 1995)

COUNTRY	TYPE OF INDUSTRY	VOLUME DISCHARGED in 1000 m^3/year
COLOMBIA	Chemical	2.12
	Fisheries	207.73
	Mining	0.14
	Wood	2,052,94
	Petroleum	0.67
	TOTAL	2,236,6
CHILE	Industrial discharges with organic waste inputs	31,387
ECUADOR	Fish packing Vegetable oil refinery	2,250
PANAMA	Farming/livestock	925
	Food	6,223
	Textile/cotton	817
	Leather	210
	Paper	2,156
	Other	151
	TOTAL	10,482
PERU	Mining	32,000
	Fisheries	25,375
	Petroleum	76,148
	Other Industrial	818
	TOTAL	134,341

The Peruvian coast, over 3,073 km long and with a population of 13,275,500 inhabitants, according to the last census in 1993, has, in its coastal area close to Lima and Callao, one of the areas of greatest organic and microbiological pollution from the discharge of sewage of municipal origin. The high concentration of economic activities in this area has given rise to approximately 78.3% of the total organic load of domestic origin (expressed as BOD_5) corresponding to the whole Peruvian coast, and is discharged into the bays of Callao and Miraflores.

The total amount of domestic sewage discharged into the sea in Peru is over 434.9 million m^3 per year, with an associated organic load of 128,200 tonnes of BOD_5 annually, of which Lima and Callao are responsible for 330 million m^3 per year with an associated organic load of 89,500 tonnes of BOD_5 annually. It should be indicated that these figures refer solely to the volume of domestic production calculated in the coastal region with a direct discharge to the sea; however, there are domestic waste discharges and other industrial pollutants that are disposed of in the sea indirectly, through the 52 river basins the country has in the coastal strip.

One of the river basins that is most affected is that of the Rimac River, which is the largest coastal river in Peru, since it is the main source of water supply for the city of Lima and, at the same time, into it are discharged the wastewaters from mining, industrial and domestic activity all along its water course. This whole series of discharges has caused most of the beaches around Lima to have high microbiological pollution which is much above the standard values of bacterial measurement for recreational and commercial fishery areas.

Other Peruvian cities with significant marine pollution by sewage are: the northern city of Trujillo, which discharges 40.6 million m^3 per year of sewage with an organic load of 10,960 tonnes of BOD_5 annually; and Chimbote and the Ferrol Bay, one of the most polluted by organic and inorganic bacterial of industrial and domestic origin, with an input of 3,920 tonnes of BOD_5 per year of organic material of domestic origin. Other coastal cities with large rivers that pass through urban centres, and flowing into the Pacific, are the Pisco (Ica), Huaura and Chillon Rivers (Lima) (Table 3).

4.2 PERSISTENT ORGANIC POLLUTANTS

The present assessment has identified the pesticides that are most used in the countries of the South-East Pacific, such as the persistent organic pollutants mainly used in farming activities, and has located the areas of greater risk of pollution through these inputs which are mainly toxic, liable to bioaccumulate and are prone to dispersal through the food chain in aquatic ecosystems (Fig. 4). For this reason, the intensive use of agro-chemicals generates negative effects the marine environment and are generally transported by runoff in rainwater or irrigation from agricultural soils to the sea. It is mainly the forestry activity on the Colombian Pacific coast that requires the use of halogenated biocides as means of preserving timber regarding whose quantities there are no estimates. Intensive use of agrochemicals brings negative effects on the marine environment. They are transported to the ocean via water from rain or used for agriculture.

Analytic assessments have been carried out in various areas of the coast, such as the Bay of Buenaventura, the Bay of Guapi, the Bay of Satinga and the Ensenada of Tumaco, with negative results in regard to residues of organochlorine pesticides in marine organisms; the concentration of DDT in the sediments in the four areas mentioned remain constant.

For Chile, Bore *et al.,* (1986) point out that the presence of DDT in the outfall of the Bio-Bio River (Fig. 4), and the most frequently used insecticides are organophosphates (64%) and chlorinated hydrocarbons. The most commonly used fungicides are carbonates (58%), chlorinated hydrocarbons (31%) and mercury compounds (11%). The study indicates that the area most affected by pesticides (DDTs) is the mouth of the Bio-bio River. Also, the agricultural

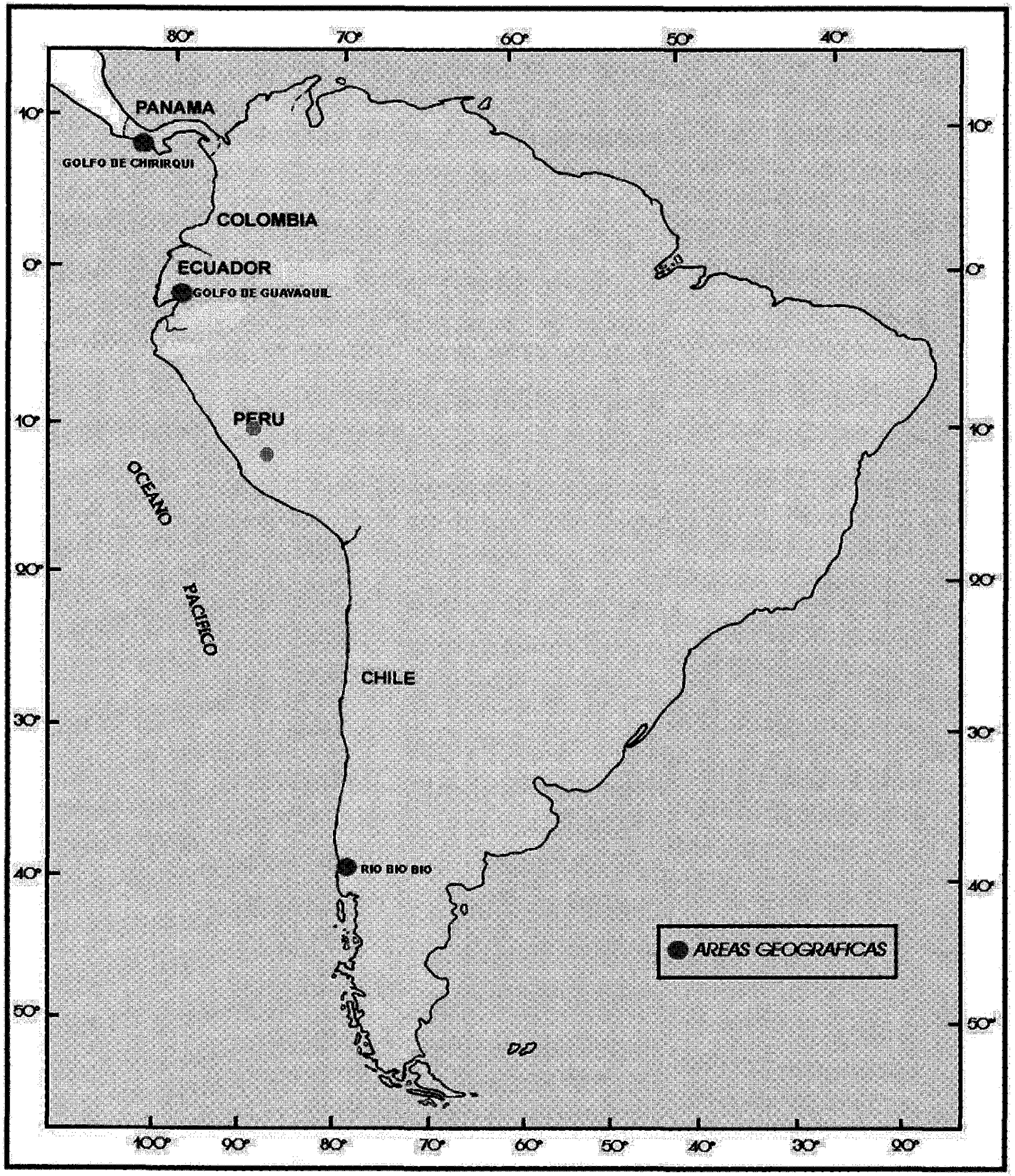

Figure 4. Geographic areas of the Southeast Pacific at risk from contamination by Persistent Organic Pollutants.

activity in Iquique uses organophosphates and organochlorinated pesticides (Dipterex, Malathion, Folidol, Afalon, etc.).

In 1993, import applications were made amounting to a total cost of US$ 77,800 CIF; of these applications, a quantity to the value of US$ 67,700 CIF was imported, corresponding to 243 different kinds of pesticides (including a number of mixtures). This quantity was approximately 97% of the total used, while the rest was produced in the country (Chile Report, October, 1997).

The area of the Gulf of Guayaquil in Ecuador is the one with the greatest concentration of agricultural production in the country. The main crops produced along the Guayas River are bananas, African palm, sugar cane, rice, soya beans, flint maize, coffee, cocoa, fruit and vegetables; in addition there are large areas of natural and cultivated grasslands (Carrera de la Torre *et al.*, 1995).

Ecuador is the main world producer of bananas for export; the largest production takes place in the basins of rivers that flow into the Gulf, and this has seen a slow increase in production in the last few years. In 1993 the increase in the banana crop was of the order of 10% with respect to the previous year. This generates a greater use of agrochemicals and pesticides, to combat the Sigatoka leaf spot disease, among others, which has given rise to conflicts between banana growers and shrimp fishermen. The latter have accused the fungicide manufacturers, after the appearance of the 'taura syndrome' responsible for this particular problem.

According to information provided by importing firms, Central Bank statistics, customs manifests and MAG 1994, is estimated that, in 1994, the area in question consumed a total of 6,400,000 kilos/litres of pesticides, equivalent to 3,200 tonnes of active ingredients for the crops in question, which corresponds to 70% of the national consumption. The banana sector has used 2,400 tonnes of insecticides/nematicides annually for the past 10 years, using products that are considered to be of restricted use (RUP). Their active ingredient formulations correspond to organophosphates and carbonates of high toxicity and contamination. Among the pesticides imported are Aldrin, Lindane, DDT, Mirex and Heptachlor, which are applied excessively and produce accumulation in time.

The pesticides which are highly persistent and are commonly imported by Panama are Aldrin, Benlate, Birlene, Clordane, 2.4D, DDT, Dieldrina, Eldrin, Heptachlor, Lindan and Telodrin. In 1984, the imports of these products amounted to close to 7,000 tonnes, of which 90% were for use in agriculture and 9% for domestic use. Almost 80% of the pesticides imported are utilised in the Pacific watershed.

In the Bay of Panama, analysis for organochlorinated pesticides does not show any pollution. Analyses showed that B-BHC, Linadno, Heptaclor, Aldrin and Mirex were not detectable. The highest accumulation of pesticides in sediments in the Bay of Panama is located opposite a waste landfill which is at present not in service at the mouth of the Juan Diaz River.

In view of the pattern of circulation in the Bay of Panama, which moves eastwards, it seems that the Bayano River is a source of pesticides, probably from the plantations of 8,000 hectares of sugar cane and 5,000 of rice that exist in that area, which are fumigated with pesticides. There is also evidence of pesticides in the marine biota of the Pacific and an accumulation of herbicides in the coral of the Uva Island in the Gulf of Chiriqui.

In Peru, time approximately 548 chemical products of synthetic and biological origin are marketed for use in the control of pests and plant disease in the main crops, and these are mainly used on the Peruvian coast. The major agricultural valleys for agro-industrial production and cereal products are Tumbes, Chira, Piura, Zana, Jequetepeque, Moche, Santa, Casma, Pativilca, Huaura, Canete, Pisco, Ocona, Tambo, Locumba and Sama. Imported products made up 371 of the pesticides, while 215 were manufactured in Peru. In 1991, 16,400 tonnes of pesticides were used including both phosphates and chlorine products and some others. This volume corresponds to 833 different products, (Ministerio de Agricultura, 1993).

4.3 RADIOACTIVE SUBSTANCES

Radioactive substances have entered the marine and coastal environment of the countries of the South-East Pacific as a result of activities of nuclear testing, medical applications, management and disposal of radioactive wastes and from the risks posed by the transport of radioactive material.

In Colombia, the Institute of Nuclear Science and Alternative Energy (INEA) carries out national programmes for Radiological Protection and Nuclear Safety, the results of which have not in these past few years detected the presence of any significant radioactive pollution in the various environments of air, water and foodstuffs. The levels measured were below the maximum permissible levels and, for this reason, the levels of radioactive pollution at the time in which these tests were carried out indicated exemption as far as radiological hazard to human health is concerned.

On the Chilean coast, biological samples were taken in 1995 from Arica, Valparaiso, Concepcion, San Vicente, Valdivia (Estuary), Puerto Montt, Castro and Punta Arenas, so that Laboratory of the Chilean Commission of Nuclear Energy (CCHEN) might carry out analysis by gamma spectrometer, to check any possible radioactive contamination in these areas. The results were negative and identified only the element potassium-40, the main natural radionuclide in the marine environment. The range of activity in Bq/kg in these areas was 12 ± 1 to 87 ± 3 (Comision Chilena de Energia Nuclear , 1994).

Ecuador, between January and April 1990, from 03°15'S - 80°24'W to 32°05'S - 72°04'W, carried out a study on the concentration of Cs - 137. A spectrographic analysis of the samples showed that the quantity of Cs - 137 was below the limits of detection. The values that were inside the limit of detection varied between 2.9 to 4.6 Bq/m^3.

In Panama, the Department of Radiological Health is responsible for the inspection and assessment of all sources of radioactive material countrywide. Industry has a very limited application of these sources. They are fully sealed and do not represent a radiological hazard to the marine ecosystem. It is important to point out that the kind of radioactive material is for medical applications, I-131 and H-3; for industrial non-destructive testing, Ir-192 and Co-60; in respect of non-irradiated nuclear fuel, a mixture of plutonium oxide and highly enriched uranium; in respect of irradiated material, spent fuel.

The materials described are transported through the Panama Canal; and this is therefore considered the greatest potential source of radioactive pollution. An average of 10 ships per month with radioactive cargoes transit the Canal, and at least two carry cargoes with a high level of radiation and are highly radiotoxic. These cargoes come from various places in America, Europe and Asia, although half of the annual cargo originates in the United States.

In the Peruvian coast, since 1993 frequent sampling has been carried out to determine the presence of Cs-137, but the values found were below the minimum detectable. The presence of K-40 in the samples analyzed are due to the fact that this is a natural radionuclide.

4.4 HEAVY METALS

As a result of human activities, mainly industrial, metallurgical mining and agricultural activities, among others, metallic elements both organic and inorganic, are emitted to the environment at various levels of concentration, causing the deterioration of the marine and freshwater environment, and also affecting the marine biota following the bio-accumulation processes of elements that are toxic to human consumers.

The sources of pollution caused by metals in the Colombian Pacific coast originated in the activities of mining alluvial gold and platinum in rivers, pro-

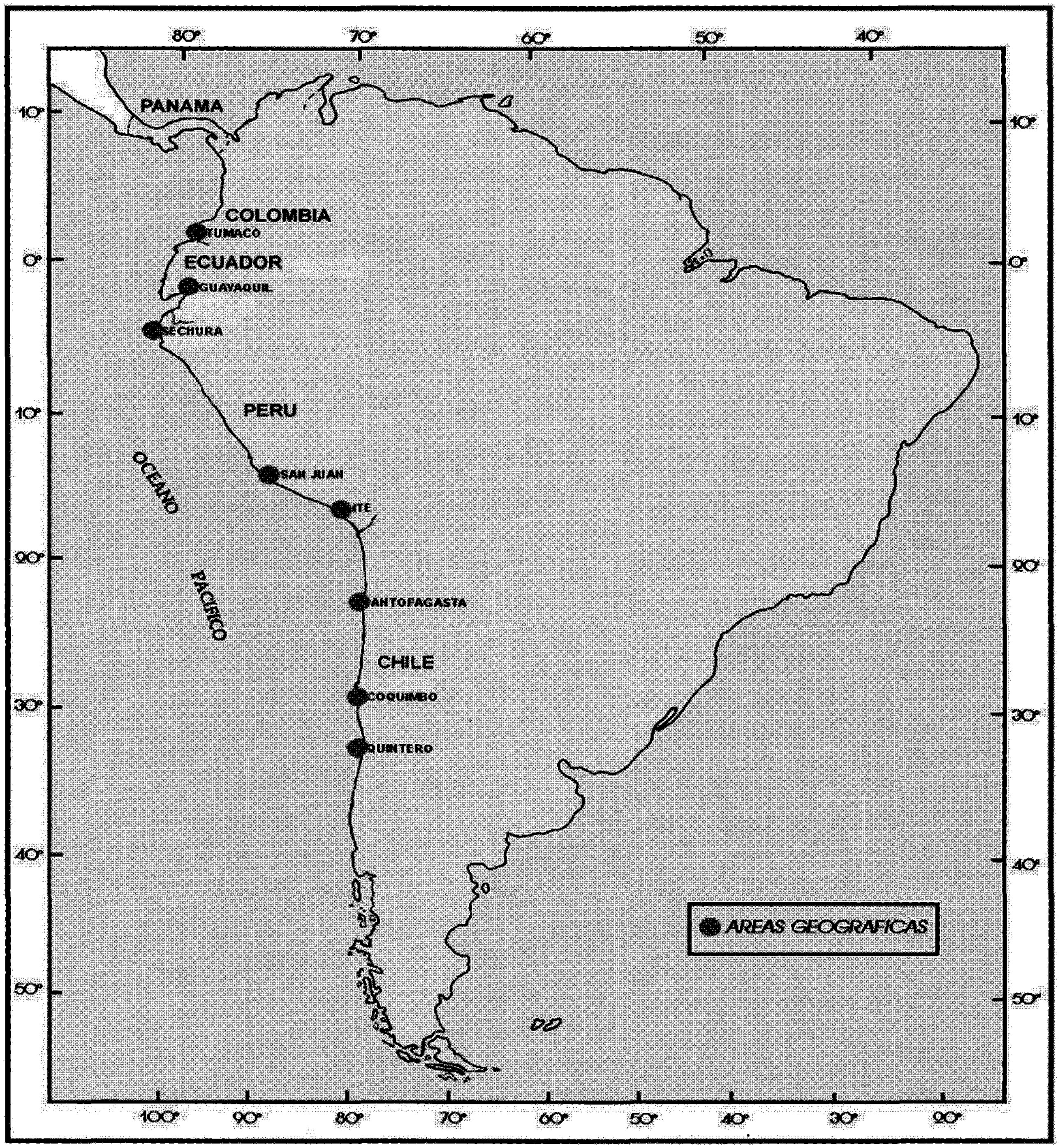

Figure 5. Geographic areas of the Southeast Pacific at risk of pollution by heavy metals.

ducing an erosion impact in the watercourses and beds of rivers, as well as increasing their turbidity. One of the gold extracting areas in the community of Barbacoas contaminates the Telembi River. The Mira and Curay rivers also show high concentrations of mercury. These are rivers that discharge water into the Ensenada of Tumaco (Fig. 5).

In Chile, according to the National Geological Service, which in 1988 carried out a cadastral survey, that the number of mining plants located between the Chilean regions II and XI reached 427 mines, which owned 808 mine residue deposits. Of all the mining enterprises, only 21 had tailings ponds. At present, although the Maritime Authority enforces a control over the impact that these discharges produce on the aquatic environment, there are still some specific problems in the Tocopilla and Taltal sectors of region II and Quintero in region V. Research on metal traces in surface waters and on the river beds of the Babahoyo, Daule and Guayas rivers, were carried out in 1982, 1985 and 1988 by the National Fisheries Institute. The concentrations of copper and lead in the Daule River were maintained inside of what is permitted by the Environmental Protection Agency (U.S. EPA). However, cadmium was observed to have the maximum permissible levels for fish life (1.2 ug l^{-1} Cd) and above this figure in two river stations (4 ug l^{-1} Cd); this last station is located close to the industrial area.

In July 1994, the Direccion General de Marina Mercante (DIGMER) of the Armada de Ecuador, made a study on metal traces in sediments, such as copper, zinc, lead, cadmium and chromium. The amounts found were in the ranges of 40 to 1'13 ug/g, 116 to 556 ug/g, 125 to 218 ug/g, 0.5 to 1.5 ug/g and 3.5 to 24.5 ug/g, respectively. An analysis of the concentration of trace metals, obtained in various bodies of water have shown variability in time, so that further information is needed in order to determine the causes of this behaviour and their effects on the biota. The Babahoyo and Guayas rivers show concentrations of copper that are slightly above the figure referred to, and cadmium was lower than the values referred to respectively. The sampling was done in 1996. Another element that has been analyzed is mercury, which is utilised in the extraction of river gold, and which represents a hazard to crayfish fishing in the mining area of Ecuador. However, the analyses carried out on shrimp for export do not exceed the permissible limits, i.e. 0.05 mg per kg of shrimp.

Pollution caused by mining activity in Panama is mainly through alluviation, particularly gold and platinum. The studies carried out in the Bay of Panama (D'Croz, 1987) on various taxonomic marine groups do not show accumulation above the levels accepted internationally. These results are to be expected since there are no heavy industries discharging high levels of metal traces to the aquatic environment.

In regard to pollution from the combustion of gasoline engines of land transport vehicles, according to data from the Statistics and Census Office of the Auditor-General's office, total registrations of vehicles amounted to 156,878. In 1995, the Ministry of Energy and Mining, in an inventory of mining enterprises along the Peruvian coast, identified a total of 24 enterprises with 30 mines having *"in situ"* residue deposits for tailings and slag. Only three of these discharged wastes into the coastal marine environment.

The end products of these mines are minerals: ground barite sulphate, ground bentonite, Portland cement, copper, lead, zinc, cadmium, sulphuric acid, white cement, other non-metallic products, carbon, iron, gold, copper and molybdenum concentrates, copper-silver blist and calcium carbonate.

4.5 NUTRIENTS

Eutrophication processes in the marine and coastal areas can result from the presence of nutrients in the marine environment as a consequence of human activities. This mobilization of nutrients can produce an increase in productivity and "red tides" through an excessive macro and micro algae growth, with the consequent depletion of oxygen because of the high organic load generated, and the consequent asphyxiation of marine fauna. The discharge of wastewaters of domestic origin and the discharge of rivers in the coastal areas of the countries of the South-East Pacific are the main causes of the increase in nutrients in the marine environment The excess of nutrient discharges in the coastal areas produces eutrophication and brings as a consequence the re-

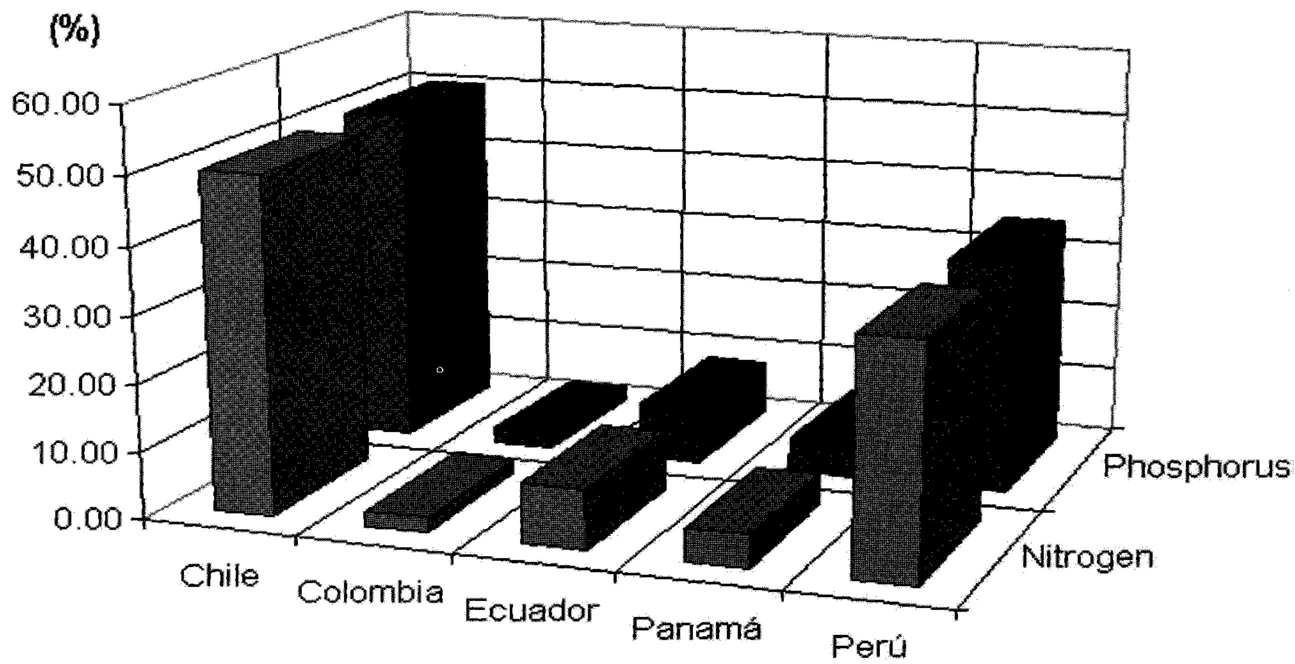

Figure 6. Nutrient pollution load (nitrogen and phosphorus) of Southeast Pacific countries, 1994.

duction of dissolved oxygen, fish kills and the excessive growth of algae and similar species.

In the Colombian Pacific, the nutrient loads by population for 1994, such as nitrogen and phosphorus were estimated at 1,219 tonnes and 147 tonnes respectively. The coastal population, in the case of nitrogen, was responsible for virtually 100% of the input of pollution load, while in the case of phosphorus this input was 95.5%. It should be pointed out that the shoreline population is made up of 147 human settlements identified along the coast which have no access to any water supply, sewerage system or technical disposal of solid wastes. The input of pollution loads of nitrogen and phosphorus for that same year for Buenaventura and Tumaco was extremely low (Fig. 6).

The coastal area of Chile has direct inputs of domestic sewage and indirect inputs through 27 river basins. The most affected areas from the point of view of organic pollution are the Bay of Valparaiso, the discharge of the Maipo River, with the discharges of the metropolitan area of the city of Santiago and the Bay of Conception. In industrial fisheries, there are three main fishing areas along the Chilean maritime coastline. The northern area is mainly devoted to pelagic fisheries; the central-southern area has mainly demersal fisheries of fish, crustaceans and benthic fauna; the southern area has mainly salmon fishing. These activities cause organic pollution mainly in respect of the industrial processing, made up of production lines for fish meal and oil. The estimated nutrient loads by population for 1994 show a figure of 30.398 tonnes of nitrogen and 3.684 tonnes of phosphorus. The areas that are most polluted by organic material are the Bay of Valparaiso, the Maipo River and the Bay of Concepcion.

In Ecuador, discharge of organic wastes in the province of Guayas is 3.7 times more than in the province of Manabi; 5.8 times more than in the province of El Oro; and 13.3 times more than in the province of Esmeraldas. This is the province where shrimping activity is carried out with large discharges and a high presence of nutrients. Nitrogen is estimated at 16.9

tonnes per year, which 71.8% corresponds to Guayas, 21.8% to Manabi and 3.2% to Esmeraldas and El Oro, respectively. The wastes discharged through river basins carry large organic loads (Fig. 6).

The Bay of Panama constitutes the most critical example of pollution by municipal sewage effluent, those that are discharged without any treatment through 20 sewage outfalls and three rivers: Matasnillo, Matias Hernandez and Juan Diaz. Recent estimates show that the load of domestic wastes from the city of Panama generates a load of 10,914 tonnes of BOD_5 per year, equivalent to 92% of the total organic load of Panama in the Pacific. As a consequence of these discharges, high concentrations of nitrogen and phosphorus are generated in most of the polluted areas of the bay, generally 5-15 ppm of nitrogen and over 4 ppm of phosphorus. Domestic municipal discharges are responsible for a high load of the nitrogen, phosphorus and suspended solids. The load of nutrients introduced into the Bay of Panama through the Juan Diaz River has been estimated in 1,700 kg/day of BOD_5 through 850 kg/day of suspended solids.

Several eutrophication symptoms are evident in the Bay of Panama, such as low values of DO and a low diversity of benthic fauna. Phosphorus is found in the range 0.3 to 0.32 mg/l and for some areas with values less than 0.06 mg/l. Concentration of Chlorophyll "a" is in the range of 2.64 to 3.14 mg. As a consequence of this nutrient enrichment, values of up to 30 mg of chlorophyll "a" per cubic meter are found during the dry period (Croz, 1986). In the specific case of the damming of the full-flowing Bayano River to form a lake of the same name, the reservoir became highly eutrophic in few years, and the quality of water dammed lowered in quality.

In Peru, the main productive activities on the coast are related to the food industry in which commercial fishing activity generates considerable volumes of nitrogen and phosphorus inputs into the water along the coast. The city of Chimbote inputs 79.62 tonnes of phosphorus per year and 656.86 tonnes of nitrogen per year, which originates from the untreated domestic sewage discharged into the Ferrol Bay. In Lima, the organic load in nitrogen is 13,501.27 tonnes per year and 1,036.62 tonnes per year of phosphorus. This situation causes a proliferation of algae and the emission of a sulphurous gases degrading the quality of the marine environment.

4.6 OILS (HYDROCARBONS)

Oils are substances originating in land-based sources (geological origin); their refined products are volatile or are degraded in the marine environment with a varying persistence in the water column and in sediments and organisms. Along the South-East Pacific coast areas have been identified that are liable to accidental discharges of petroleum (Fig. 7) and for these, National Contingency Plans have been drawn up to combat petroleum spills.

Among the industrial wastes that pollute the coast of the Colombian Pacific, are petroleum hydrocarbon wastes in seawater. The area with greatest pollution is the Bay of Buenaventura, in which the highest volumes of petroleum derivatives are handled; this is the reception area, at the petroleum jetty, for aromatic hydrocarbons and refined petroleum which supplies part of the demand of western Colombia and its chemical industry. Every month at this jetty, tankers unload approximately 50,000 tonnes of gasoline and a large quantity of aromatic hydrocarbons.

Another source of pollution is the area of the Ensenada de Tumaco, which has a large movement of light petroleum hydrocarbons such as gasoline, diesel and lubricating oils, at the ECOPETROL terminal, which has an input of 800,000 barrels of petroleum a month, and generates 10,000 barrels of wastewater which are discharged into the inner Bay of Tumaco, after oxidation in a series of tanks (Marrugo, 1990).This movement of petroleum and its refined products generates a volume of liquid wastes of 670 m^3 a year, with 2,410 tonnes of BOD_5 annually. Other sources are tankers which come to the port to load crude oil and discharge part of their ballast with oils in it less than three miles from the coast. An additional source of oil pollution in the

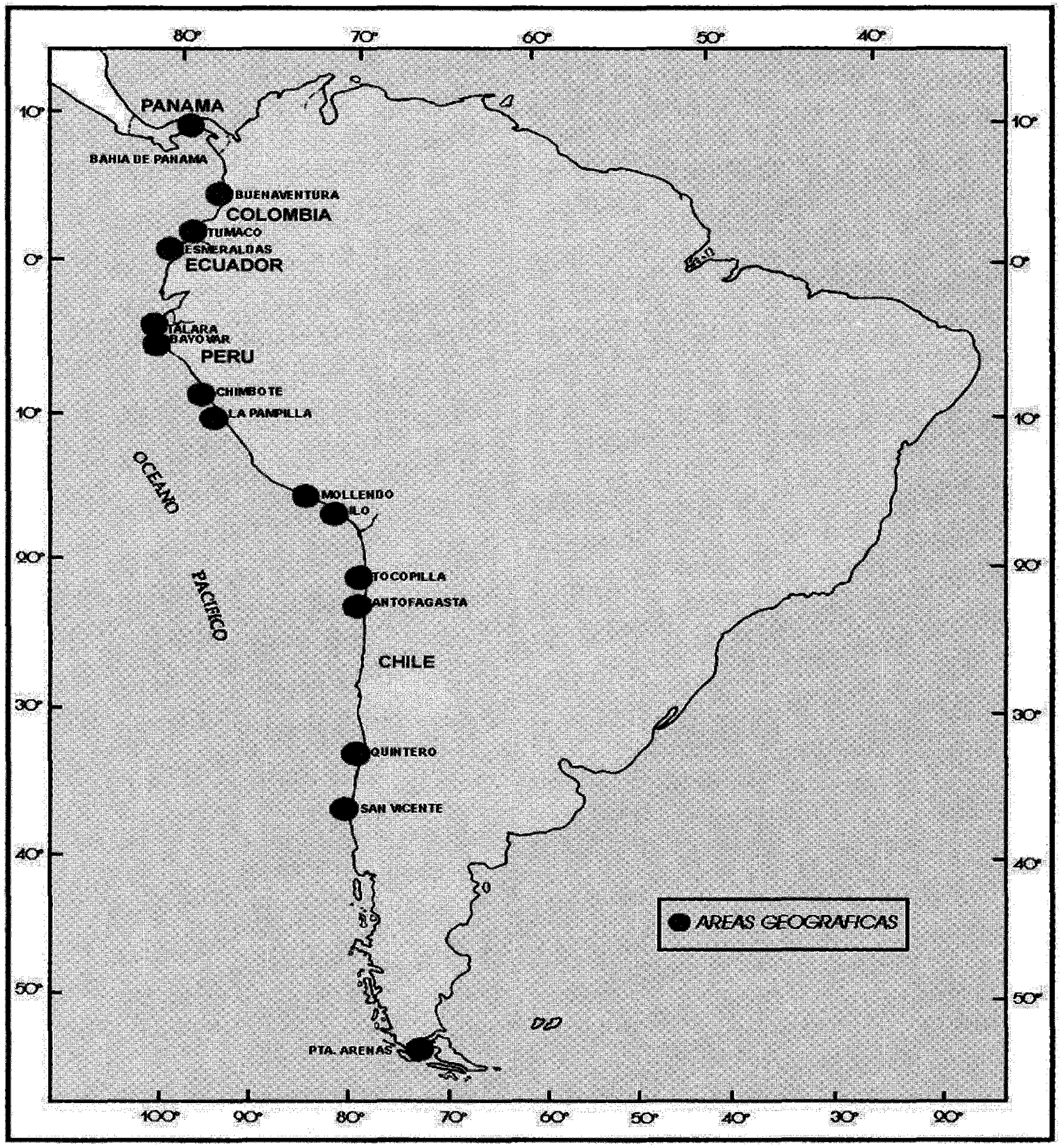

Figure 7. Geographic areas of the Southeast Pacific at risk from pollution by petroleum hydrocarbons.

region are petrol stations that are usually located on docks or floating platforms, where the fishery or other vessels carry out oil changes, in the various inlets of the Colombian Pacific coast.

In Chile, there are three areas with significant levels of marine oil pollution by petroleum hydrocarbons, as is shown in Figure 7: the marine coastal area of region V (Puerto Quintero), the marine area of region VIII (close to the port of San Vicente) and the marine area of region XII (near the city of Punta Arenas). Antofagasta and Tocopilla are also centres of heavy oil pollution. Accidents occur in loading and unloading diesel, crude oil, base oils, gas, methanol, etc.

In Ecuador, effluents from refinery plant on the coast at Esmeraldas and La Libertad are a potential factor of oil pollution. The Teaone River has hydrocarbons from the Esmeraldas refinery which discharges indirectly into the sea through the river almost 3 million m^3 of wastewaters a year. The use of lubricants by automotive vehicles is also a factor; engine oil changes are eventually discharged directly or indirectly into bodies of water. Other sources of pollution by oils and petroleum are the use of agricultural oil in fumigation operations and the use of diesel in the shrimping industry to combat "bottle fly".

In Panama, most of the maritime transport of petroleum is connected with the Panama Canal, trans-Isthmian oil pipeline or the coastal shipping at the ports of Balboa and Vacamonte. In the port of Balboa, almost 2,000 ships a year are supplied with fuel oil, which implies the transport of almost 15 million barrels a year. In the port of Vacamonte fuel oil is supplied to a fishing fleet of close to 3,000 vessels, and in addition tuna the fleet uses the port for its fuel supply. The port of Balboa in the Gulf of Panama and Puerto Armuelles in the Gulf of Chiriqui have been singled out as the areas with most oil pollution in the Pacific coast of Panama. Most of the discharges are of diesel oil, bunker oil or dirty ballast. The trans-Isthmian oil pipeline is another potential source of pollution by hydrocarbons for inland and marine waters; the pipeline has a maximum piping capacity of 700,000 barrels per day. The pipeline crosses the two most westerly provinces of the country over a distance of 130 km, transporting from the Pacific to the Caribbean the crude oil that is brought from Alaska in super tankers.

The oil industry activity in Peru includes exploration, drilling (in the sea and on land), processing and distribution and is carried at the coastline, mainly in the north of the country and including the Peruvian forest. The main drilling activity is carried out in the north-east area particularly on the continental shelf. The crude oil from this area is processed in the refineries at La Pampilla and Conchan, both situated on the central Peruvian coast. The main crude and refined storage facilities are to be found in Talara and La Pampilla. Along the coast, there are 12 distribution centres, each with a different capacity of storage, the most biggest of which are Eten, Salaverry, Chimbote, Supe, Callao, Pisco, Mollendo, San Nicolas e Ilo. In these areas there is a high risk of petroleum release at the point of shipment, and there have been spills of diesel, crude and kerosene on three occasions in last five years. The worst incidents were a release of 14,000 barrels of kerosene in 1990 and 438 barrels of crude oil in 1995. An assessment of the levels of petroleum hydrocarbons in selected and high risk areas such as Talara, Paita, Chimbote, Callao and Pisco during 1995 showed that the area of Chimbote is the one with the highest concentration of dissolved or dispersed petroleum hydrocarbons, expressed in crysene units (Jacinto *et al.*, 1995).

4.7 SEDIMENT MOBILIZATION

Modifications of the physiography of the South-East Pacific coast is due in great part the natural sedimentation which has positive consequences, such as the maintenance of coastal habitats such as estuaries, mangroves, etc. Among the negative aspects of the sedimentation rate is the disappearance of rocky substratas for benthonic communities inhabiting rocky areas, and this may also become a threat to fragile ecosystems such as coral reefs which are the home of marine algae and others. On the other hand, sedimentation has the characteristic of retaining polluting elements such as trace metals, pesticides, various toxic substances so that in the end it become itself the cause of pollution.

In Colombia, the Ensenada de Tumaco has the following rivers flowing into it: Colorado, Curay, Chagui, Chilvi, Guadal, Guandarajo, Guanapi, Mexicano, Mira, Rosario, Tablones y Yanaje, which in fact are sources of pollution because of their input of metals and other substances picked up as they flow to the sea, causing a lowering of the salinity levels in the Ensenada. The Bay of Buenaventura is totally covered with mangroves and criss-crossed with inlets and canals facilitating communication, considering the significant tidle changes every six hours, varying between 0 and 4 metres; just like River Tumaco, its waters are quite diluted by inputs from land by gullies small streams that descend from the western range of the Andes. This causes the formation of deltas and numerous inlets, with heavy sedimentation, nutrient changes, the presence of heavy metals and other substances contaminating the sediment.

In Chile, the growth of forestry activities has produced strong pressure on soil resources, which has had some indirect effects on the marine environment. Forest logging and sawmill industries produce significant volumes of wastes which generate pollution by organic particles in the water courses or directly into the sea. This type of discharge suffocates the marine fauna, particularly fauna living in inter-tidal waters. Industrial effluents also contain a large amount of organic material especially fishery effluents, which cause changes in the quality of the marine environment, even causing point sources of asphyxia which are a grave threat to the larvae hatching areas of marine resources, as well as causing low diversity benthonic microfauna.

The inventory of mangroves carried out by Panama through the Natural Geographical Institute shows that in the past 30 years 5,647 ha have been lost. This process appears to occur mainly on the Pacific coast, in particular, on the east-east of the Gulf of Chiriqui. It is estimated that half of the areas that have been destroyed are currently used for livestock and agriculture, even though the soil is not the most appropriate for this kind of use. After the 1970s, the demand for land for development of shrimp ponds has also entailed the destruction of the mangroves beside the nitrate fields, which are the most appropriate areas in the development of nitrate extraction. Another pressure on the mangroves is urban expansion, mainly of the area of Juan Diaz. In this case, the limitations of legislation and lack of monitoring prevented the implementation of effective conservation policies established by the competent authorities. Another cause of the destruction of mangroves can be oil spills, which occur from time to time, as mentioned before.

4.8 LITTER

Litter is any persistent manufactured or processed solid material which is discarded or abandoned in the marine and coastal environment. Litter in the marine environment destroys coastal habitats and interferes with biological production in coastal areas. Litter not properly disposed of continues to be a problem in all the countries of the South-East Pacific (Fig. 8).

In the Colombian Pacific coast, 28% of urban dwellings have their garbage collected. Buenaventura produces 250 tonnes a day of solid wastes, of which 180 tonnes are collected, leaving a deficit of 70 tonnes a day. The systems for disposal or treatment of solid wastes do not exist, so that once collected they become a new focus of pollution, since they are left in the open air. Tumaco has no systems for treatment or disposal of garbage, and produces 70 tonnes a day, of which 60% remains uncollected and is left in the open air on beaches and other open spaces. Estimates for 1994 of solid municipal wastes generated in the Pacific from the Ensenada de Tumaco and the Bay of Buenaventura are of the order of 225,808 tonnes.

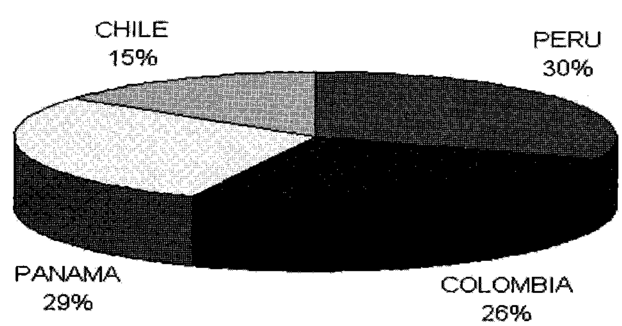

Figure 8. Volume of undisposed wastes in the Southeast Pacific.

In Chile, as in other countries, the development of cities and their industrial areas gives rise to the generation of large quantities of waste of a very varied kind, which affects in some way or other the quality of life of the people and also the environment. In Chile, 2.5 million tonnes of urban wastes are generated every year, of which 80% is subject to relatively good sanitary disposal and for the 20% remaining there is at least some degree of control. Regarding solid industrial wastes, their quantity and quality are not really well known. By indirect methods (INVENT), it is estimated that in Chile approximately 1.5 million tonnes annually of industrial wastes are generated, of which 133,000 correspond to harzadous wastes, the final disposal of which is virtually unknown both to the authorities and the people themselves.

Since 1990, Panama has improved its handling of solid wastes for the metropolitan area, in regard to the collection and final disposal of wastes, as there is a sanitary landfill in Cerro Patacon, whose second phase was inaugurated, with a design with geomembranes to prevent leaching percolation to groundwater and also the earth cover has improved.A serious problem persists, however, since there is no classification of wastes, and domestic, industrial and hospital wastes are all dumped together.

In the city of Panama, 90%of the load of solid waste is generated domestically, reaching 289,706 tonnes a year, while the remaining 10% is from industrial activity, giving an estimated 32,792 tonnes a year of solid wastes from production. The industrial activities that generated the greatest amount of solid wastes are those related to the manufacture of aluminium which is responsible for about 60% of the total solid wastes generated.

In the Peruvian coast, the volume of solid waste generated is 4,645 tonnes per day, the most of which is generated by the city of Lima which reaches a figure of 4,121 tonnes per day or 88.72% of the total produced along the coast. Of the total produced by Lima, the domestic solid wastes reach an amount of 3,297 tonnes and only 824 tonnes is of industrial and hospital origin. The component of the waste is very diverse; organic material is between 40 and 60%; paper and carBODard 10 to 15%; builders rubbish 5 to 15%; plastics 5 to 8%; metals 5 to 10%; glass 2 to 3%; cloths and others 2 to 8%. Lima has two sanitary landfills to the north and south of the city, with sufficient capacity to accommodate the solid wastes of the whole metropolitan area over a minimum period of 20 years (Paredes, 1995). Another city reports significant volumes of solid wastes is the city of Chimbote-Coishco, with 290 tonnes per day.

5. Physical alteration in problem areas

Table 5 give details of the coastal areas affected by land-based activities and its causes in the coastal area.

Along the Pacific Colombian coast there are four departments which are, from north to south Choco, Valle, Cauca and Nariño. The main cities are Buenaventura and Tumaco, which are connected with the interior of the country by road. The mountainous coast is dominated by the foothills of the Baudi Mountains, and has rocky peninsulas alternating with bays and inlets with sandy beaches, with also a variety of landscapes and geomorphological processes.

The low lying alluvial coast is broken in three sections where tertiary formations reach the sea forming rocky fronts, the largest of which determines the coastline for 40 km. Based on the various categories of erosion previously defined, the pattern of the Colombian Pacific coast may be quantified as follows: the coastline affected by erosion 25%; by medium grade erosion trend, 50%; coastline with a light or stable erosion 24 %, with a strong tendency to erosion 2 per cent. According to Gonzalez and Marin (1989), the causes of erosion on the Pacific coast are natural phenomena, since there are 220 dredging works and no major structures of docks, moles or jetties, and very few dams in the upper courses of rivers that flow into the Pacific, that might retain part

Table 5: Coastal areas affected by land-based activities and their causes.

COLOMBIA

AREA OR REGION	AREA	CAUSE
Department of Nariño	Ensenada de Tumaco	Domestic, municipal, oil and industrial activities
Department of Valle del Cauca	Buenaventura	Domestic, municipal, oil activities

CHILE

	AREA	CAUSE
Arica	Bay of Arica, port sector, costa sector, Chichorro, south shoreline, sector fisheries sector	Domestic wastes, port activity. Domestic and industrial wastes
Iquique	Bay of Iquique sector, Coastal sector,industrial area and fishing dock	Domestic, industrial and port activity wastes
Tocopila	Port sector, Sector south Punta Algodonales	Industrial wastes, port activity and domestic wastes
Mejillones	Bay of Mejillones, beach sector and fishing	Domestic and industrial wastes
Antofagasta	North sector, (Port) sector	Domestic, industrial and port activity wastes
Chanaral	Bay sector	Mineral and domestic wastes
Caldera	Bay sector	Domestic, industrial and port activity wastes
Coquimbo	Coast sector Penuelas y mouth of Elqui river	Domestic, industrial and port activity wastes
Quintero Concon	Mouth of Aconcagua Rivers Sector mouth of Aconcagua River	Domestic and industrial wastes Domestic and industrial wastes
Valparaiso	Molo sector, Playa Ancha, coastal sector, Marga-Marga estuary	Domestic and port activity wastes
San Antonio	Shoreline between the port and mouth of Maipo River	Domestic, industrial and port activity wastes
Talcahuano	Bay of Concepcion, Penco sector, Mouth of Andarlien River, el Morro canal and Port sector	Domestic, industrial and port activity wastes
San Vicente	Bay sector	Domestic, industrial and port activity wastes
Coronel	Bay sector, Caletta Lo Rojas	Domestic and industrial wastes
Valdivia	Calle Calle and Valdivia Rivers	Domestic, industrial and port activity wastes
Corral	Port sector	Domestic, industrial and port activity wastes
Puerto Montt	Bay Sector y Tonglo Canal	Domestic, industrial and port activity wastes
Chiloe	Urban shoreline, islands and canals	Domestic, industrial and port activity wastes
Chacabuco	Bay, port sector	Domestic, industrial and port activity wastes
Punta Arenas	Urban and industrial shoreline	Domestic, industrial and port activity wastes

ECUADOR

AREAS OR REGION	AREA	CAUSE
Esmeraldas	Esmeraldas River	Domestic and industrial Petroleum, electric power, shrimping activity wastes
Manabi	Manta Bay of Caráquez	Domestic and industrial wastes, fishery and others
Guayas	Guayas River, coastal area, Salt Stuary, rivers Daule and Babahoyo	Domestic, industrial, fisheries, fishing port, shrimp aquaculture activities
El Oro	Salinas and Hieuylá estuary, Puerto Bolivar, Machala	Industrial wastes, port and aquaculture activities

PANAMA

AREA OR REGION	AREA	CAUSE
Panama	Bay of Panama Gulf of Chiriqui Matazmillo Matias Hernandez and Juan Diaz Rivers	Food industry activity Mining, mettalurgical form activity Port activities

PERU

AREAS OR REGION	AREA	CAUSE
Tumbes	Tumbes River Mangrove deforestation Talara, Paita and Bayovar Bays and general coastal area Chira River	Domestic wastes Aquaculture wastes Domestic wastes Industrial and Petroleum
La Libertad	Trujillo coastal area Moche River	Fluvial residues and discharges, agroindustrial mining activities
Ancash	Bay of Ferrol, Chimbote and coastal area, Lacramarca River	Domestic, industrial, fisheries and smelting industry, fishing wastes
Callao - Lima	Bay Miraflores and Callao coastal area, Rimac, Chillon Rivers	Domestic and industrial wastes Shipping activity
Ica	Bays Paracas and Pisco National Reserve of Paracas Coastal area, Rio Pisco River San Nicolas de Marcona	Industrial fishery, wastes, shipping activity Mining wastes
Aarequipa	Matarani, Molledo, Tambo Rivers Coastal area and bay	Domestic, industrial wastes, fishery and shipping activity
Moquegua	Bay of Ilo, Ilo River	Mining, smelter, agricultural pollution
Tacna	Ite, Lucumba and Sama Rivers Bays and coastal area	Mining and agricultural wastes

of the sediments brought to beaches.

In the coastal areas of Chile there are conflicts of interest in regard to shoreline features such as beaches, dunes, marine terraces, between recreational uses, industrial uses and urban uses, all of which vie for similar places and claim conditions of incompatibility. In the central coastal area of Chile, certain fragile units have been recognized, such as beaches, most of which have a sedimentary balance, but are affected, however, by the impact of the numbers of holiday makers, the discharges of sewerage systems, and buildings which affect their aesthetics. Semistabilized sand dunes showing a loss of plant cover (urban expansion) may look like becoming active again, for example, the case of urban expansion inside the Puerto de San Antonio, where moving sands affected the settlements established. The active dunes also support installations that transform their morphology, as happened in the Bay of Quintero, where the installation of industrial plants led to the construction of roads and railways, thus causing the definitive loss of a stretch of sandy coast for leisure or residential uses or any other which was not industrial.

In the Ecuadorian coast, the erosion processes are noticeable through the destruction of ecological niches such as the cutting of mangroves or random fishing of marine organisms living along the coastline, the excessive use of beaches which have become like roads and the utilization of sand as a building construction material. Cases of erosion can be observed around Libertad, a petroleum and tourist port with a great deal of commercial activity. Erosion processes are at work in the breakwater built along the shoreline with the idea of recovering land from the sea. The retaining wall was partially destroyed by wave action, allowing the sea to penetrate and endanger the urban area (Garces, 1989). The Bay of Caraquez has wide beaches with gentle slopes on which buildings have been built, and these are now continuously under threat from tides. This problem was aggravated with by the El Niño phenomenon. Another affected area is San Vicente, which also has wide beaches with gentle slopes, which are used as roads during the low tides, causing a destruction of the marine biota proper to ecosystems of the sandy substratum. Another case is Esmeraldas, a port with petroleum, fisheries and tourism, which was built at the mouth of the Esmeraldas River; a breakwater was built opposite the port, and now causes very serious sedimentary processes, requiring continuous dredging in order to retain the required depth.

In Panama, the Gulf of Chiriqui and its hydrographic basin typically have rivers that flow from the central Andes, range and flow straight down to the Pacific: the Chiriqui Viejo, Fonseca, San Felix and Tabasara, all of which transport large volumes of sediment that enrich the coast, which is lined with mangroves such as *Rizophora, Avicennia* and *Pelliciera.*

In the map of erosion in Peru prepared by ONERN, it is shown that the main erosion processes are deflation, sand dune areas, river erosion, flood erosion, thermal erosion, gully erosion, landslides, alluvia, washaways and intense sheet erosion (Alvarez, 1989). These erosion processes lead to the destruction of ecosystems and produce the fluvial transport of sediment which in the Peruvian rivers is around 1.5 to 2 million km^2 per year when El Niño is active. This sediment transports inputs from human activities (people and mining), together form plentiful marine sedimentation and the formation of active deltas in the Tumbes, Pisco and Locumba (Bay of Ite).

In the Locumba River, the delta sedimentation caused by the input of 30 million km^2 a year of tailings has brought about a land movement of 1 to 2 km along 20 km of beach line and a submarine sedimentation from 0.20 to 1 metres deep and stretching 15 km out to sea. On the north coast, at the resort of Las Delicias de Trujillo, erosion of the beach took place when a pier was built out from the coastline and a social club built on it, on which the waves by refraction concentrated their action on the structure and heavily eroded the adjacent sandy beach (Teves, 1989).

Erosion is also quite active on the shoreline of Tumbes, between Caleta Cruz and the Canal

Internacional (the border between Peru and Ecuador), mainly due to the action of the River Tumbes and the River Guayas, which flow into the Gulf of Guayaquil and whose hydrographic-oceanographic influence affects the area mentioned. On the shoreline of Tumbes there is a heavy deposition of sediment which results in constant morphological change and the incorporation of new areas of land. In a period of 30 years, the area of the Hermosa Beach has been widened by a strip of about 400 m wide. In Puerto Pizarro, in general and along the shoreline, from Caleta La Cruz to the border, there is a continuous formation of a series of sand bars parallel to the shore and close to it (ONERN, 1989).

6. Sources of pollution and other forms of degradation

6.1 POINT SOURCES

In the present assessment, activities have been identified that generate pollution loads in the aquatic environment and continuously discharge wastes. In Figure. 8 can be seen the percentage of most of the industrial activities carried out in the countries of the region.

The main industrial wastes contaminating the Colombian Pacific originate in the fishery industry, the timber industry, petroleum refineries and other residues originating from activities in the port. The biggest discharges are around Buenaventura and Tumaco, jointly with the municipal wastewaters, since there is no separation between the system for domestic wastewaters and industrial wastes. This makes it difficult to classify liquid wastes as exclusively of industrial origin, so that an overall estimate is made, like the increase in BOD_5 which the municipal sewage undergoes because of its mixture with industrial wastes. It was therefore estimated in 1994 that in the industrial sectors of Buenaventura and Tumaco an industrial pollution load of approximately 48,000 tonnes of BOD_5 a year was being generated. Of this amount, the fishing industry generated 40,000 tonnes of BOD_5 a year, while the timber industries contributed about 5,800 tonnes of BOD_5 a year (Fig. 9). The main industries established in the Colombian Pacific and that have a part to play in marine pollution are:

Fishing industries: these are basically established primarily in Buenaventura with a few in Tumaco; there are about 26 industries that process and market fishery resources. There is estimated to be 402 m^3 a year of discharge volume from the fishing industry with associated organic load of 40,200 tonnes of BOD^5 annually;

Timber industries: established mainly in Tumaco, these generate a volume (strictly industrial) of 147,000 m^3 a year with a pollution load of 5,800 tonnes of BOD_5 annually (second largest pollution load input for the industrial sector in these areas);

Chemical industry: this is established primarily in Buenaventura, and it is estimated that in 1994 the discharge volume was 2,120 m^3 a year with 1,900 tonnes of BOD_5 annually; and

Mineral processing: non-metallic minerals are processed in Buenaventura and generate a volume of wastewater of 138 m^3 a year and 33 tonnes of BOD_5 annually.

In Chile, the industries with the greatest impact on the deterioration of the marine environment are mining industries extracting copper, cellulose and wood pulp factories and the fishing industry. The largest contributions to the organic load, the product of industrial waste liquids, are input by the basins of the Maipo River, the Aconcagua River, the Andalien River and the Bio-Bio River, without taking into consideration their dilution flow rates. The most affected marine areas are the Bay of Valparaiso and the Bay of Concepcion. Among the surveys carried out, country-wide, of various establishments, an analysis was made of 1,432 industries (73.3%) 238 sanitation services for sewage collection (12.2%) and 284 health institutions (14.5%). The percentages of industrial discharge by type of receptor showed that 64.4% discharged into the sewerage system, 15% into the ground, 6% to rivers and 5.8% to the sea. Only the number of industries was taken into account, without distinguishing flow rates or pollution loads.

Mining industry: according to the maritime authority (DIRECTEMAR), the body responsible for protection of the marine environment, there are 21 mining enterprises, located in Antofagasta (2), Sierra Gorda, Taital (5), Tocopilla (3), Michilla (1), Chanalar Caldera y Calderila, Hasco (1), Puerto Aysen and Puerto Cristal, among others.

Fishing industry: Chile is a country along whose extensive shoreline pelagic and domestic fisheries have been developed on a large scale; in the decade of the 1990s, the hold capacity of the fishing fleet of region VIII increased from 148 m^3 to 254 m^3, which indicates a growth of 71% in just 10 years.

In 1992, Chile took a total catch of fishery resources of 6,628,365 tonnes, which 95% were fish, 2% molluscs, 1.9% algae and 0.4% crustaceans.

Approximately 69% of the industries registered in Ecuador are found in the coastal area. The principal activity centre is the province of Guayas, with 2,923 industries (92.5%) of the total in the coastal area. Between 1983 and 1984 the manufacturing industry was the commonest (metal products, machinery, food products, drinks, tobacco, chemicals, tanneries, oils and fats factories and petroleum derivatives). Food product industries are currently on the upsurge and represent 68% of total industry.

The total estimated discharge volume from a random sample statistical analysis (53 industries) was 55.2 m^3 a year, with 65% of the discharge in the province of Guayas, which corresponds to 30,049 tonnes a year, followed by Manabi with a discharge volume

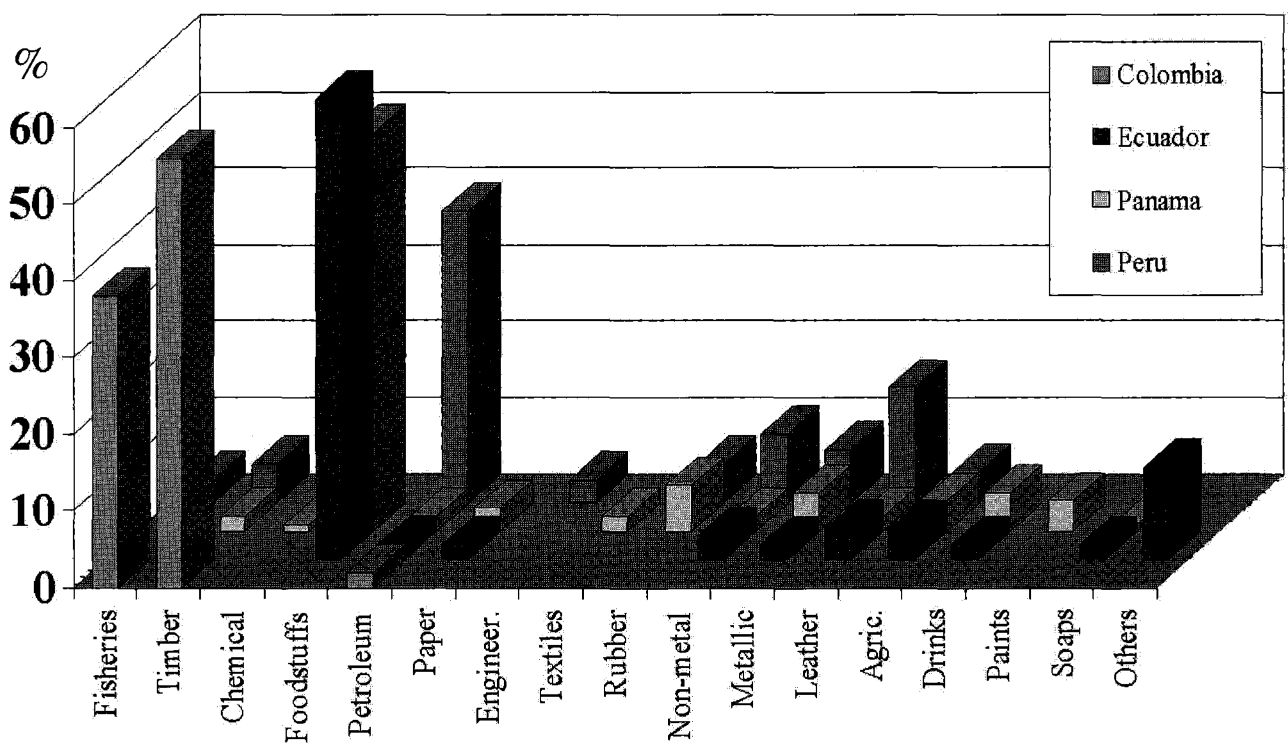

Figure 9. Percentage relationships of types of industry in the Southeast Pacific.

of 4,544,446 m^3 a year which represents 8%, the El Oro province with a volume of 6,500 m^3 a year which represents 12% and Esmeraldas, with 15% which means 8,094,050 m^3 a year.

Fishing industry: at discharge points low levels of DO were reported and high levels of organic load such as BOD, DQO, suspended solids and in some cases the presence of oil. One of the greatest discharges, which takes place in the Posorja area (province of Guayas) was estimated at 2.8 million m^3 a year, from the industrial fisheries sector. The areas of Monteverde and Anconcito in the province of Guayas have also deteriorated, while in Manabi the areas of Manta and Salango are affected by the discharge of 1,420 million m^3 a year dumped from the fishing industry. In Guayaquil, there are seven smaller fish processing industries.

Manufacturing industry: This consists mainly of industries manufacturing carbodard, which cause a thermic change in the receiving body water (effluents at high temperature), together with changes in the pH (presence of colouring agents and products used in the industrial process). The areas with the highest incidence of this type of activity are: Guayaquil, where the volume of discharge exceeds 8 million m^3 a year, and Machala with over 5 million m^3 a year.

Oils and fats factories: this is another large item in the Ecuadorian industrial sector, located in the area of Guayaquil; a volume close to 5 million m^3 a year of effluents was reported, with high BOD_5, DQO and oils in the area of discharge (discharge through outfalls).

Metallurgical industry: this industry discharges considerable volumes of wastewater generated by the industrial process; it discharges heavy metals and provokes a considerable change in pH values. It exceeds the permissible limits of discharge of SS and STD, by almost 15 million m^3 a year of the indirect discharge volume of liquid wastes.

The volume of liquid wastes contributed by the industrial sector in the Bay of Panama represents only 12% of the total volume of liquid wastes dumped in that area; however, the polluting effect associated with those discharges is considerable, and represents 43% of the pollutant load as BOD_5 of the total that the bay receives. The industrial discharge volumes are estimated at 10.5 million m^3 a year, with an associated organic pollution load of 38,100 tonnes of BOD_5 a year. The industrial liquid wastes of the greatest significance in the bay of Panama are:

Food-processing industries: the plants devoted to this activity report the largest discharge volume of wastewaters, with a value of over 5,000 tonnes BOD_5 a year;

Agriculture and livestock production: primarily the feedlots for animals (livestock and poultry) generate a large input of pollutants. The poultry sector is very active in the Bay because of the large production, and a considerable input of pollutant load is generated, exceeding 30,000 tonnes of BOD_5 a year. The discharge volume generated by this type of activity exceeds 9 million m^3 a year.

The coastal area of Peru receives industrial discharges from fisheries, iron and metallurgical and petroleum activities, which greatly degrade the marine environment. The total volume dumped in the sea from these three activities alone is estimated to be 162.2 million m^3 a year. The organic load associated with this volume exceeds 145,000 tonnes of BOD a year. However, the existence of numerous manufacturing industries situated all along the coast, above all in Lima and Callao, considerably increase that volume and pollution load.

Fishing industry: fishing activity in Peru is mainly concerned with the catch of maritime fish resources, such as pelagic, demersal and coastal species. Judging from the volumes of the catch of maritime resources by species between 1990 and 1994 (TMB), Peruvian fisheries almost doubled their production, from 6.9 million tonnes in 1991 to 11.6 million in 1994, which puts the country in second place, after China, in world capture, which in 1994 hit a new record of 106.1 million tonnes (FAO, 1994).

The industrial fishing activity generates pumped water and outfalls with high concentration of organic loads that are dumped in the marine environment, using technologies that do not succeed in reducing the pollution loads below the levels of the standards in force in the fishery sector. The areas of greatest pollution from fishing activity are in Chimbote, Paita and Pisco. Lack of adequate control of dumping has created azoic areas and high eutrophication in closed areas such as the Ferrol and Paracas bays, where the poor circulation of water increases the negative effects.

Mining industry: mainly three out of a total of 24 mining industries have direct discharges into the marine environment on the Peruvian coast, all of them located in the south, where most of the mining for copper takes place. The greatest effect is on the shoreline, specifically in the Ite Bay, where until the end of 1996 and for almost 33 years about 19 million tonnes a day of mine tailings were dumped (originating in the Toquepala and Cuajone mines) in the sector called Playa Inglesa, with serious effects on the marine fauna and changing the physiography of the beach front.

6.2 DIFFUSE SOURCES

These are mainly in relation with run-off waters, produced in the upper reaches of water basins, flowing through places where mining, building and agricultural activities take place, among other pollutant activities in the area.

In 1983, forestry operations in Colombia had an area available for forestry activity of 4,623,800 ha. For the decade 1974-1984 an estimated 1,500 ha were available for logging, to obtain a volume of 163.5 thousand m^3 and there were 140 active sawmills. The total volume of waste produced by the timber industry on the Colombian Pacific coast has been estimated at 570,000 m^3, of which the Department of Nariño has 66%, Valle has 14%, Choco has 12% and Cauca has 8%. In the Ensenada de Tumaco, the destruction of the mangrove forest by landfills of wood shavings and sawdust used for shrimp farming has currently caused the loss of 2,592 ha of mangrove due to this activity. Another cause is the use of the forest for domestic use.

In Chile the largest population growth is taking place in the river basins of the Elqui, Aconcagua, Maipo, Mapocho, Rapel, Bio-Bio, Valdivia rivers, and for this reason these rivers are the ones with greater pollution. The main sources of industrial, mining and agricultural wastes are in various geographic locations; however, as far as the degradation of the quality of the aquatic environment is concerned, the most relevant industrial discharges are those arising from mining of copper, from cellulose and paper factories and from industrial fisheries. The most significant inputs of organic load are the product of the liquid industrial wastes that come from the basins of the Maipo, Aconcagua, Andalien, Bio-Bio rivers, no matter how diluted their flows are. The marine areas most affected in respect of organic load are Valparaiso Bay and the Bay of Concepcion. Problems of pollution produced by effluents from the mining industries occur principally in areas in the north of the country, where large volumes of tailings and residues are deposited in the sea, producing embankments and degradation of the flora and fauna. Regarding use, there are 61 sub-basins affected by domestic wastes (17.3% of the total of the country). There are 640 discharges of sewage, 1,248 water sources, 989 agricultural catchments, 184 recreational areas, 62 catchment dams for clean water and electric power generation and 13 industrial catchments.

In Ecuador, the impact of deforestation in many areas of the Ecuadorian coast, due to the cutting of trees, the burning of vegetation, and the timber, agriculture and livestock activity, can be observed in the quality of soils, which has a direct influence on the national economy and on agricultural, forestry and livestock productivity. Overcutting of plants on the coast, for example, mangroves, in order to build shrimping ponds or for use as fuel and other purposes, are the main causes of deforestation. Decrease of the plant cover, which physically fixes sediments and keeps them united, brings as a consequence a greater runoff of water on the surface. The rains and the mechanisms of river drainage can intensify the runoff, causing erosion. This may be accelerated in locations with greater slopes and on flat land where there is greater depth.

The lack of vegetation also accentuates the effects of the mechanism of sediment transportation, since the ground is exposed to the force of the wind and the waves. On salt flats, the building of ponds for shrimp increased the rate of sedimentation, since all the material extracted was deposited on flats. The construction of dykes, retaining walls and breakwaters were intended to strengthen the shoreline, but the most negative effect of these structures is the resulting undercutting due to wave reflection, which causes the loss of sediment out to sea. While the intensity and damage caused by undercutting depends on many factors, such as the design of the structures, *inter alia,* an example of erosion is the destruction of the retaining walls of the Samarina Hotel, in the breakwater of the town of Libertad, and the beach in this sector is slowly being eroded.

In Panama, the Chiriqui Gulf and its water basin typically have rivers flowing from the Central range of the Andes and flowing straight down to the Pacific; the main ones are: the Chiriqui Viejo, the Fonseca, the San Felix and the Tabasara. In this Gulf, studies have been carried out on organochlorine and organophosphate pesticides.

The Bay of Panama also has three rivers flowing into it, the Matasnillo, Matias Hernandez and Juan Diaz, and the nutrient load input by the Juan Diaz River has been estimated at 1,700 kg a day of BOD_5 and 850 kg a day of suspended solids. In the mouth of this river is found the highest accumulation of pesticides in sediments in the whole Bay of Panama, due to the proximity of a sewage outfall, that is no longer in operation. The Matasnillo River is also a source of bacteriological pollution for the Bay of Panama, and values have been reported of 160 thousand NMP per 100 ml.

In Peru, numerous bays, including Paita, Chimbote, and Paracas are in the process of reversion with respect to the pollution accumulated over many years especially in Chimbote (over 40 years), due to the alleviating measures being implemented by the fishing and metallurgical industries. In a pollution study of the basins of the Moche, Rimac and El Santa rivers, it was discovered that the Moche River is mainly contaminated by metals such arsenic, cadmium, lead, copper, zinc and iron, which are discharges of mine tailings, and the focus of pollution is located in the area of Quiruvilca. The Santa River is of good quality in its higher reaches but, downstream, the quality deteriorates because of the presence of concentrations of lead from mining, which make it inappropriate for many uses. The Rimac River also shows pollution by mine tailings in its upper reaches because of the drainage of mines situated on the western slopes of the Andes.

7. Areas of concern

In the various geographical areas of the shoreline of the South-East Pacific, the countries of the region have areas that are affected by anthropogenic activity, and areas that are vulnerable to pollution have also been identified and evaluated. These areas, situated along the coast of the South-East Pacific are described below.

In Colombia, the Ensenada de Tumaco has the following rivers flowing into it: the Colorado, Curay, Chagui, Chilvi, Guada, Guandarajo, Guanapi, Mexicano, Mira, Rosario, Tablones and Yanaje, which are sources of pollution, because of their inputs of metals and other substances picked up as they flow towards the sea, and their estuary waters are a mixing area which lowers the salinity of the Ensenada and has an impact on the marine biota of the area.

The Bay of Buenaventura is totally covered with mangroves and criss-crossed with inlets and canals facilitating communication, considering the significant tidal changes every six hours, varying between 0 and 4 metres; just like Tumaco, its waters are quite diluted by the river inputs from land, by gullies and small streams that descend from the western range of the Andes. This causes the formation of deltas and numerous inlets with heavy sedimentation, nutrient changes, the presence of heavy metals and other substances contaminating the sediment.

The growth of forestry activities has produced strong pressure on soil resources, which has had some indirect effects on the marine environment. Forest logging and sawmill operations produce significant volumes of residues which generate pollution by organic particles in the water courses or directly into the sea. This type of discharge suffocates the marine fauna, particularly fauna living in inter-tidal waters.

Other industrial effluents also contain a large amount of organic material, especially fisheries effluents, which cause changes in the quality of the marine environment, including point sources of asphyxia, causing great damage to the larvae hatching areas of marine resources, and also causes a low diversity of benthonic microfauna.

Chile has critical areas for marine pollution, with various different effects which the most affected are areas of discharge of domestic and industrial wastewaters into the Bay of Valparaiso and the Bay of Concepcion. In the metropolitan region of Santiago, the main rivers receivers of sewage are the Zanjon de la Aguada and the Mapocho, which directly receive about 60% and 35% respectively, of all the sewage of Santiago. A large part of the volume of sewage produced daily in the country is used for the irrigation of vegetables and other items of direct human consumption.

In Ecuador, the expansion of the shrimping sector has caused a significant degradation in the coastal environment with four categories of impact: pressure on all phases of the biological cycle of the shrimp, deterioration of the quality of estuaries, with the destruction of mangrove forests, pressure on other fishery resources, the loss of habitat by the migration or elimination of populations of shellfish and fish, which greatly affects small-scale fishing. Another aspect that affects the coastal areas is the introduction of exotic species, such as tilapia, which has invaded rivers, swamps and estuaries, displacing native species and causing a strong impact on the ecosystem of inland waters (Coello, 1996). Besides the foregoing, the processes of erosion of the Ecuadorian coast are caused by the various activities following on urban development, which among other effects have caused the destruction of beaches, the alteration of aquatic ecosystems, etc.

An inventory of mangroves carried out by Panama with the help of the National Geographic Institute shows that in the past 30 years, 5,647 ha have been lost. This process appears to occur mainly on the Pacific coast, in particular on the East coast of the Gulf of Chiriqui. It is estimated that half of these areas that have been destroyed are currently used for livestock and agriculture, in spite of the fact that the soil is not appropriate for those uses.

After the 1970s, the demand for land for development of shrimping ponds has also entailed the destruction of mangroves close to the salitres, which are the most suitable locations for the construction of the ponds. The areas most affected were Cocle and the Peninsula of Azuero, in the Pacific. Another pressure on the mangroves, comes from urban expansion, particularly in the Juan Diaz area. In this case the limitations of the legislation and the lack of monitoring prevented the implementation of effective conservation policies established by the competent authorities. Another cause of the destruction of mangroves can be oil spills, which occur from time to time, as mentioned in the paragraph about this pollutant.

In the extreme north of the Peruvian coast, is found the last mangrove forest of the South-East Pacific its location is in the coastal area of Tumbes which, according to the latest report of the National Institute of Natural Resources in 1992, was said to have lost, in 10 years, 1,294 ha of mangroves and, for other reasons, 497 ha out of a total of 5,964 ha existing in 1982. An activity that has caused a strong impact on the coastal area is the fishing industry due to the alteration and loss of soil in the installation of fish processing plants and the deterioration of the quality of sea water, due to the effluent discharge from the fish meal and oil manufacture in bays and inlets with poor seawater circulation, which is the case of the Bay of Chimbote and the Bay of Paracas.

Another activity with strong impact which has caused the destruction in habitat and the loss of fishery resources, is the mining of copper in the extreme south of the Peruvian coast. The areas of Ite and Tacna have received an input of mine tailings from two copper mining centres over a period of 30 years, which has been depositing in areas close to the waste discharge. This has provoked an alteration in the physiography of the coastline, covering the rocky substrata with sediments, which cause the disappearance and/or migration of the banks of shellfish which sustain small-scale fishing.

PART II. ASSESSMENT BY COUNTRY

1. Introduction

In the South-East Pacific, land-based activities causing pollution and degradation of the marine environment in general, are basically: discharges of wastewaters of domestic and industrial origin and the discharge of wastes from the mining-metallurgical sector; also relevant to some extent as point sources are outfalls of agriculture origin and petroleum storage depots and refineries.

Discharges flowing into the sea directly or indirectly through the sewage network are using the rivers and canals of the coastal areas of the region as a receptor, with or without treatment (the latter in most cases), at both domestic and industrial levels.

The classification of pollutant loads has been addressed according to the recommendation given in the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities, giving the category of sources.

2. Colombia

2.1 IDENTIFICATION AND ASSESSMENT OF PROBLEMS

2.1.1 Food security and poverty alleviation

Colombia has increased its fishery production in the Pacific to an estimated 127,000 tonnes and 156,000 tonnes a year for 1992 and 1993 respectively. The fisheries are mainly based on the catch of tunna.

The Colombian Pacific has a potential area of 100,000 ha for harvesting shrimp, specially *Macrobrachium rosembergii,* and there are currently large coastal areas where the harvesting is done through shrimp farms, thus providing food and work for the population of those areas.

2.1.2 Public health

In Colombia, the main polluted areas are the beaches of Tumaco and Buenaventura. In Tumaco, the following beaches are reported to be polluted: El Morry and Boca Grande; and in Buenaventura, the area of Juanchaco, Ladrilleros, La Bocana, Punta Soldado and Cienagas Interiores, Isla Costera, the Dagua river mouth, *inter alia.*

2.1.3 Coastal and marine resources and ecosystem health, including biological diversity

The marine fauna in Colombia includes coral formations and species both of the American continental shore and the oceanic islands in the Pacific and the Indian Oceans. Among the important species are the lizard *Phyllodactylus,* the starfish *Tamaria,* two shrimp species *(Alpheus* and *Synalpheus)* and the land crab *(Cecarcinus malpilensis).*

The pelagic-coastal and pelagic-oceanic fish species, of which there is a large number as well as a wide variety around the Malpelo Island, belong to the Panamanian province and species common to the Indo- Pacific. The families with greater representation are Carangidae (more than 30 species), Serranidae (14 species), Carcharhinidae (13 species) and Pomacentridae (9 species).

2.2 ASSESSMENT OF CONTAMINANTS

2.2.1 Sewage

The large volume of municipal sewage discharged in the Colombian Pacific coast is from Tumaco and the Bay of Buenaventura. In 1994, domestic discharges totalled approximately 45 million m^3 a year, with an associated organic load of 13,230 tonnes of BOD_5. Of these amounts, Buenaventura and Tomaco input 18.82 million m^3 of domestic sewage giving an organic load of 10,670 tonnes of BOD_5 (80.6%

the total on the coast) which was 1,320 tonnes more than was discharged in 1989. The remaining 147 coastal settlements spread along the Colombian coast discharge 26.9 million m^3 of annual volume with an associated organic load of 2,560 tonnes of BOD_5 pear year. Buenaventura is the area of the greatest population density on the Colombian Pacific coast; it generates approximately 6,000 tonnes of BOD_5 a year of organic material, approximately 48.7% (Fig. 10).

The wastewaters of industrial origin that pollute the Colombian Pacific coast come from the fishing industry, the timber industry, petroleum refineries and other residues from shipping activities. The largest discharges are around Buenaventura and Tumaco, at the municipal outfalls, since there is no separation between the domestic sewerage system and that for industrial wastes. This makes it difficult to classify waste liquids of exclusively industrial origin, so that the estimate is given overall as an increase in BOD_5 undergone by the municipal sewerage because of its mixture with industrial wastes.

It is thus estimated that for 1994, in the industrial sector of Buenaventura and Tumaco there was an industrial pollution load of approximately 48,000 tonnes of BOD_5. Of this amount, the fishing industry generates 40,000 tonnes of BOD_5 a year while the timber industries contribute around 5,800 tonnes of BOD_5 a year.

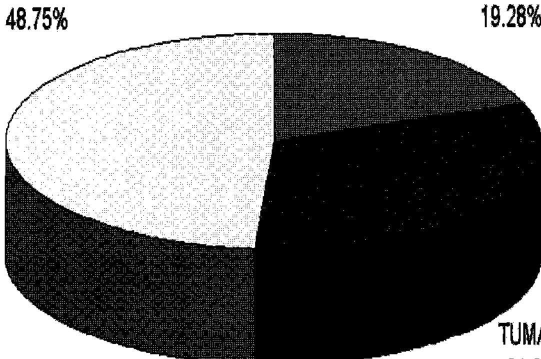

Figure10. Volume of BOD_5 discharged in the Colombian Pacific (tonnes/year), 1994.

2.2.2 Persistent organic pollutants

An assessment carried out in the Bay of Buenaventura, the Bay of Gulpi, the Bay of Satinga and the Ensenada de Tumaco, yielded negative results in regard to residues of organochlorine pesticides in marine organisms and the concentration of DDT in sediments in the four areas remains constant.

2.2.3 Heavy metals

The sources of pollution caused by metals in the Colombian Pacific coast originated in the activities of mining alluvial gold and platinum in the rivers that drain into the Pacific, among which are the Telembi, Mira, and Curay (Fig.11). Thus water contaminated by toxic metal residues is discharged into the shore area of the Colombian Pacific and constitutes a great danger for marine biota.

2.2.4 Nutrients

In the Colombian Pacific, the input of nitrogen and phosphorus, calculated as a percentage in relation to the other countries of the region is quite low (Fig.6) and what there is comes from discharges of wastewaters in Buenaventura and Tumaco and from the water basins that flow into the Pacific.

2.2.5 Oils (hydrocarbons)

The area of greatest pollution in the Colombian Pacific is the Bay of Buenaventura (Fig.12), in which the handling of the greatest volumes of petroleum derivatives takes place. This is the area in which, at an oil jetty, aromatic hydrocarbons and refined petroleum are delivered, part of the consumption of western Colombia and its chemical industry.

Other polluted areas are the Bays of Malaga and Cupica and the Ensenada de Tumaco (Fig.12), because of the large movement of light petroleum hydrocarbons such as gasoline, diesel and lubricating oils which are unloaded in the ECOPETROL depot; 10,000 barrels of wastewaters are generated and discharged into the inner bay of Tumaco after oxidation

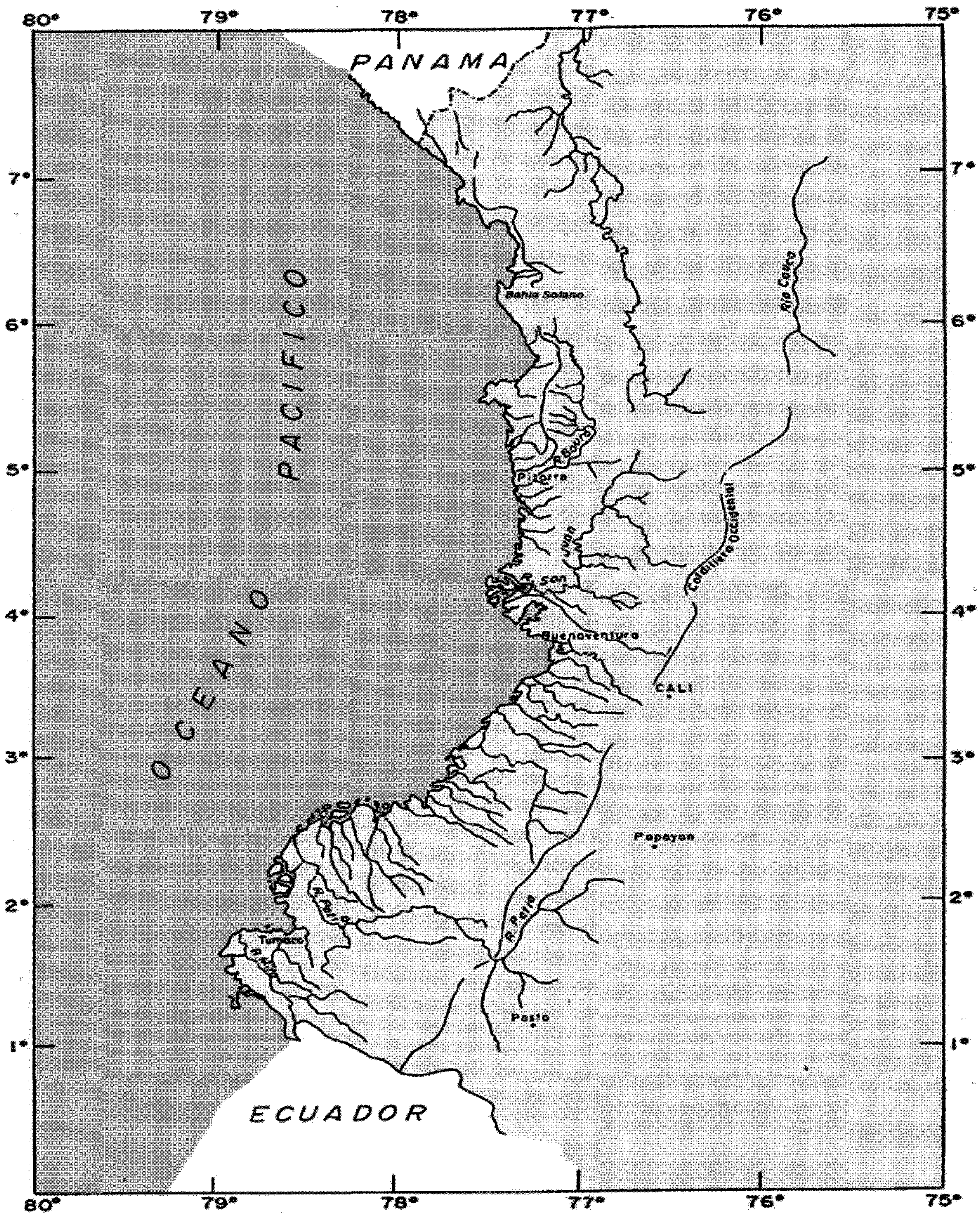

Figure 11. Hydrographic map of the Colombian coast.

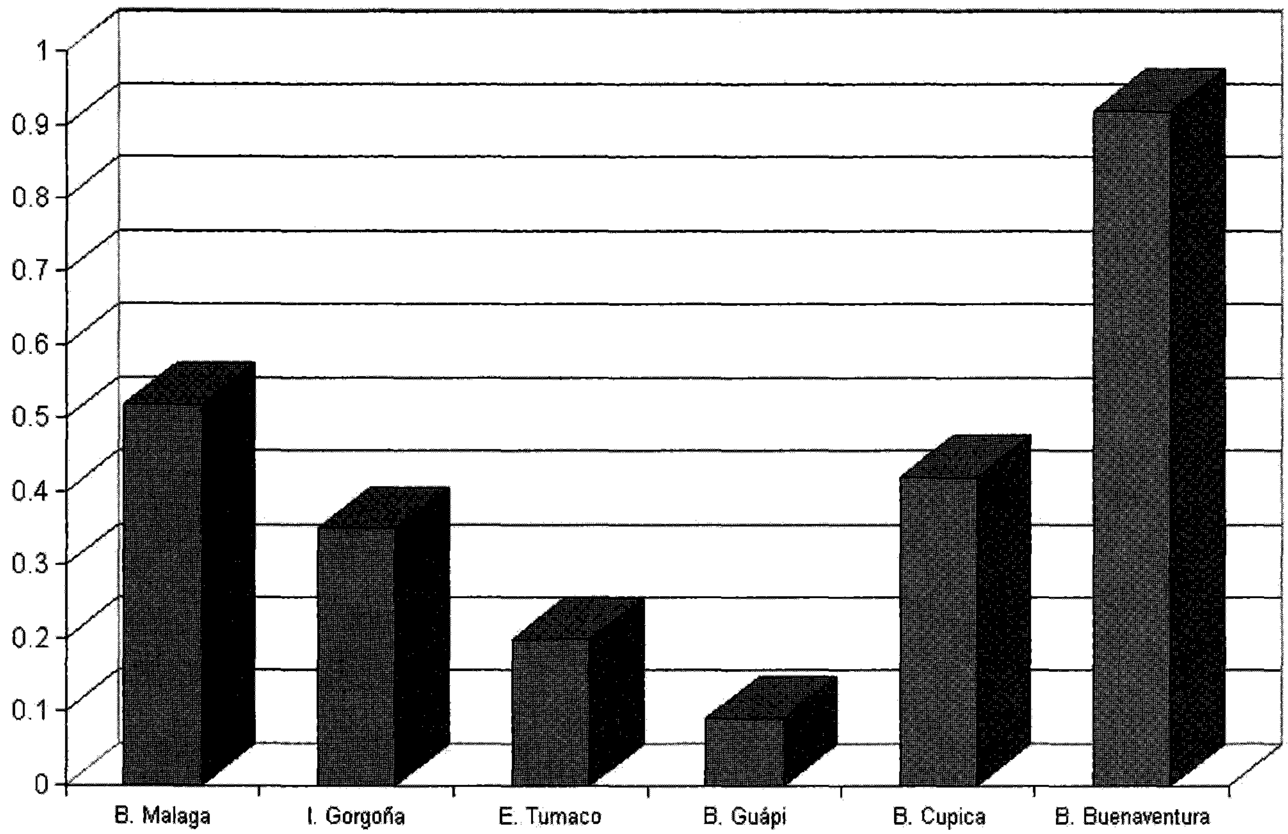

Figure 12. Average values of H.D.D. in sea water on the Colombian coast, 1992.

in a series of ponds.

2.2.6 Sediment mobilization

The Colombian Pacific coast is affected by erosion (about 25%), medium grade erosion (50%), and a light or stable erosion (24%) and with a tendency to erosion (2%). The causes of this erosion are natural, since there are no man-made activities such dredging works, construction of large structures such as jetties, breakwaters, etc., and also since there are very few dams in the upper reaches of the rivers flowing into the Pacific and that might retain part of the sediment being brought to beaches.

2.2.7 Litter

In the Colombian Pacific coast, only 28% of households have their garbage collected. Buenaventura produces 250 tonnes a day and another large city, Tumaco, produces 70 tonnes a day of which —% and 60% remain uncollected respectively and are left uncovered in the open air.

3. Chile

3.1 IDENTIFICATION AND ASSESSMENT OF PROBLEMS

3.1.1 Food security and poverty alleviation

The productive structure of the Chilean fishing sector basically covers two main activities: fish catching which includes artisanal fishing and industrial fishing, and, industrial processing activities which consist of production lines for fish meal, oil, the canning and freezing of fish, molluscs and crustaceans and the smoking and dry salting of fish.

3.1.2 Public health

On the Chilean coast, the main polluted areas have been identified as the area of Viña del Mar and Valparaiso in region V and Concepcion in region VIII; these cities have a some 2,728,084 inhabitants and diversified industrial activities. There are problems of water quality, mainly of bacterial contamination, which gives rise to a high concentration of faecal coliforms, posing a risk to the public health of the population (ESVAL and ESSBIO SA). Notwithstanding the pollution is decreasing bacause recent operation of one sea outfall.

There are also large discharges from the 27 water catchment areas, through the basins of the Elqui, Aconcagua, Maipó, Rapel, Bio-Bio and Valdivia and other rivers (Fig. 13); the greatest population growth is also in these river basins.

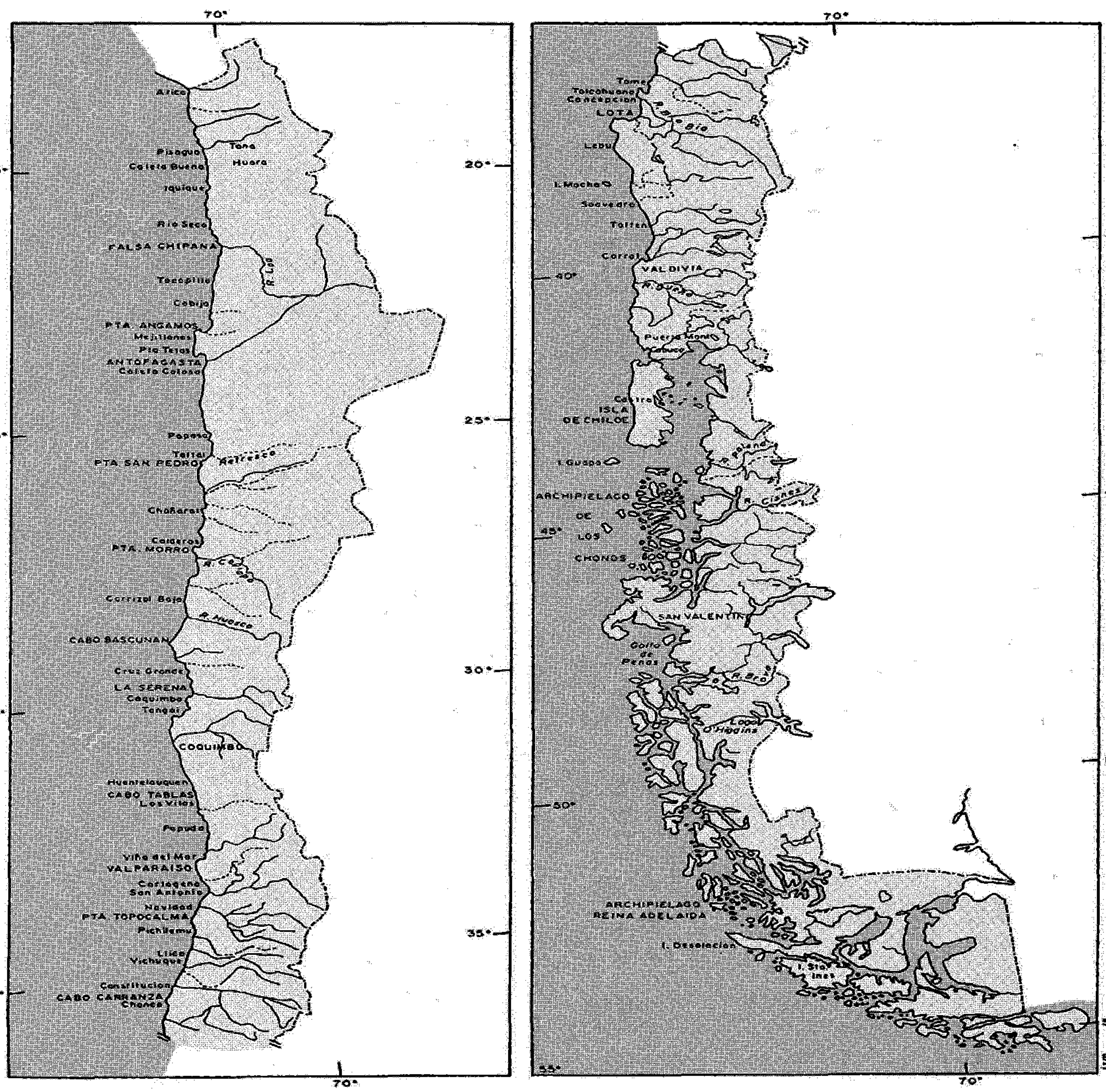

Figure 13. Hydrographic map of the Chilean coast.

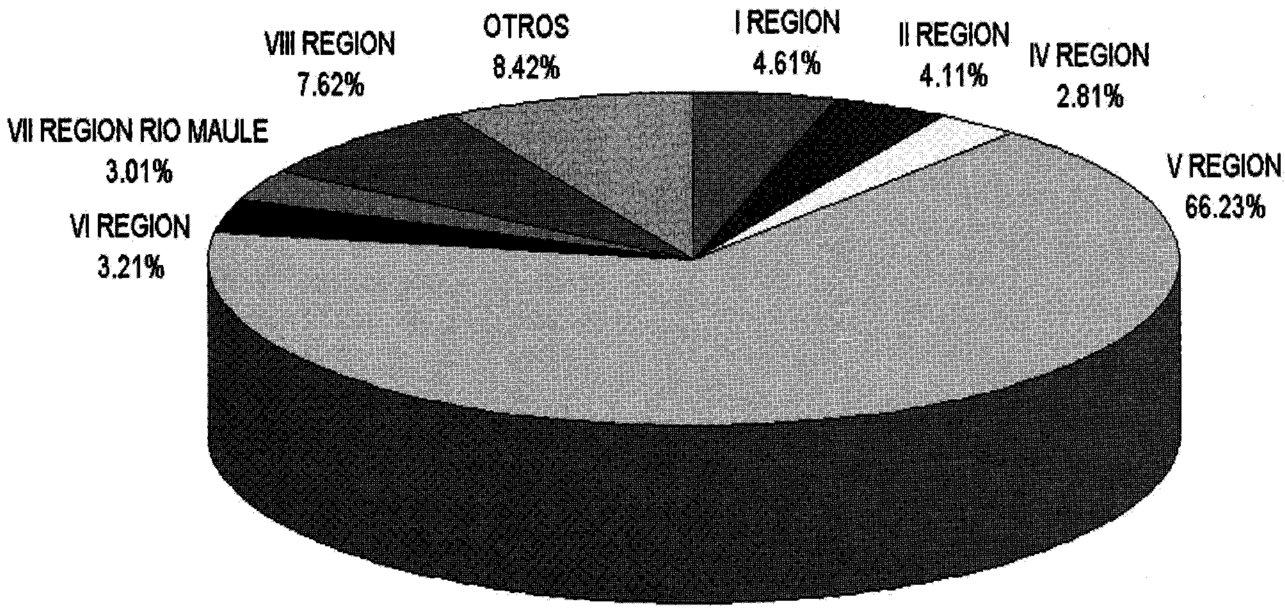

Figure 14. Volume of BOD_5 discharged in the Chilean coast (tonnes/year), 1994.

3.1.3 Coastal and marine resources and ecosystem health, including biological diversity

In 1994, Chile had a production of over 6 million tonnes from the catch of fish, shellfish and algae, which places it among the top countries in the world for fisheries. In the extraction of marine resources, some resource populations are overexploited or endangered by marine pollution, as happens in the case of seven species of molluscs and mammals.

3.2 ASSESSMENT OF CONTAMINANTS

3.2.1 Sewage

There is a direct input of sewage through hydraulic systems (underwater outlets, outfalls, etc.) and indirectly from 27 river basins. The areas most affected by domestic sewage discharge into the sea are the Bay of Valparaiso and the discharge of the Maipó River in the metropolitan area of Santiago and the Bay of Concepcion.

In total there are discharges of 672.4 million m^3 a year of sewage with an associated organic load of 164,600 tonnes of BOD_5 a year (Fig. 14). It has been assessed that the volume of direct discharge is of the order of 142.5 million m^3 a year with an organic load of BOD_5 of 38,500 tonnes a year. This indicates that about 82 per cent of the volume of domestic sewage generated in Chile finishes up in the sea, transported by the 27 river basins already mentioned.

Valparaiso Bay, another area of importance on the Chilean coast because of the shipping, recreation and trade activity, was estimated in 1992 to have a discharge volume a year of 15,560 m^3 a year with an organic load expressed in BOD_5 of 4,980 tonnes a year. At the present time there is no sewage treatment and the sewage is discharged directly into the receiving body of water.

In Chile there is a great diversity of industrial activity, whose waste discharges cause a negative impact on the environment, and these according to Fig. 15 may vary from dumping in the sea (8.3%), in the ground (11.1%), in rivers (16.9%), in irrigation canals (2.95%) and in sewerage systems (57.3%).

However, the latter discharges indirectly into the sea. In Table 6 is shown the number of discharges by industries, health institutions, sanitary services corresponding to the different types of discharge-receiving body. The principal industries are those related to the metallurgical activity of copper-working, cellulose and paper pulp factories and the fishing industries.

The sectors that are most affected under this heading are the Bays of Valparaiso (region V), Talcahuano and Concepcion (region VIII); the Bio-Bio River flows into the latter area and it is a river on whose banks there are large paper-making factories that input pollutant loads into the aquatic environment. The most significant inputs of organic load of industrial origin, however, are the watersheds of the Maipó River, and the Aconcagua, the Andalien, and the Bio-Bio rivers. These rivers have a total volume of discharge of 333 million m^3 a year with a load of 91,500 tonnes of BOD_5 a year (amounts estimated in low water level conditions of these rivers). A statistical study of industry examined a random sample of 1,432 units and found that 65.5% have provision for disposal in a mixed form (domestic and industrial wastes together discharged by the municipal sewerage system), 15.5% in the ground, 6.4% into rivers and 6% directly into the sea.

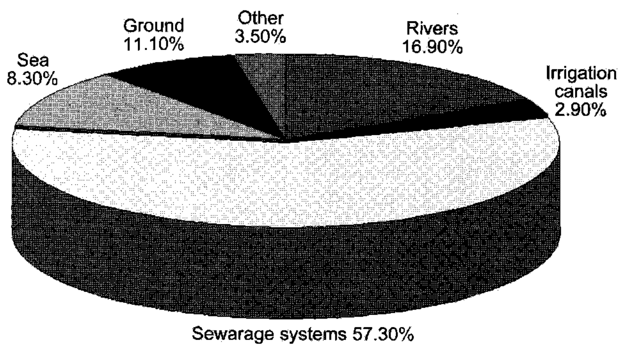

Figure 15. Discharge of wastewater of industrial origin in Chile according to type of receiving body, 1993.

Mining industry: this mostly affects the northern part of Chile. Region II and region V still show signs of pollution from mine tailings from copper mining plants, despite the alleviation measures demanded by the authorities. A precedent is the region III, where there used to be many copper-concentrating plants, which provoked a major embankment in the Chanaral bay. The discharges of tailings considerably reduce the pH value of the sea water in the dis-

Table 6: Number of discharges according to the type of receiving body in Chile (National Survey of Liquid Industrial Wastes Department of Sanitary Services, 1993)

DISCHARGES	INDUSTRIES	HEALTH INSTITUTIONS	SANITARY SERVICES	TOTAL
River	154	3	436	593
Lake	6	0	9	15
Sea	141	0	149	291
Irrigation	87	1	11	100
Canal	1,591	419	0	2,010
Sewerage	374	9	8	391
Ground	79	1	27	107
Others				
TOTAL	2,432	435	640	3,507

charge area, and affect its buffer capacity, with consequences on the marine flora and fauna.

Fishing industry: since Chile is yet another country that exports products derived from hydrobiological resources (particularly fish meal and salmon), it has areas that have been affected by this activity. Historically, the northern area (regions I, II, III and IV) have always been the most significantly affected in the country, and discharge wastes directly or indirectly into the sea; however, the central south area (which involves regions V to X) the present time has surpassed the north especially in region VIII. It is in region VIII, classified as environmentally sensitive, that the Bay of Concepcion is located, where organic wastes are discharged whose sedimentation and stabilization produce unpleasant odours.

3.2.2 Persistent organic pollutants

In Chile the insecticides that are most used are organophosphates (64%) and chlorinated hydrocarbons (32%), and also DDTs have been detected in the mouth of the river of Bio Bio River (VIII), which is the area most impacted by pesticides. In Iquique (region I) the pesticides used for agricultural activities are organochlorinates and phosphorates such as Dipteryx, Malathion, Folidol, among others.

3.2.3 Heavy metals

Chile is a country with intense mining activity, and between regions II and XI there 427 mining sites, with over 800 mine residues deposits. At the present time there is a strict environmental control in the areas where discharges from this activity are introduced into the marine environment, however, some problems still persist in sectors of region II and V (Tocopilla, Taltal and Quintero).

3.2.4 Nutrients

Along the coast of Chile there are discharges of domestic sewage, directly or indirectly, flowing through 27 water basins. One of the industries which inputs organic loads into the marine environment is fisheries, mainly carried out in the northern area where pelagic fisheries take place. It is estimated that in 1994 the loads of nitrogen were 30,398 tonnes a year and phosphorus 3,684 tonnes a year.

3.2.5 Oils (hydrocarbons)

In Chile pollution by petroleum hydrocarbons is mainly in the coastal area of region V (Puerto Quintero), the marine area of region VIII (close to the port of San Vicente) and the marine coastal area of region XII (close to the city of Punta Arenas). Historically, Antofagasta and Tocopilla were also centres of high pollution under this heading. Primarily, the cause is accidental releases in the loading and unloading of diesel, crude oil, base oils, methanol, gas, etc.

4. Ecuador

4.1 IDENTIFICATION AND ASSESSMENT OF PROBLEMS

4.1.1 Food security and poverty alleviation

The fishing industry in Ecuador occupies a second place behind petroleum as a foreign exchange earner. In 1993, the catch of commercial fish species was as follows: anchovy 34.8%, tunna 15.8%, mackerel 30.2%, and sardine 15.6%. In 1994 the FAO statistics (1994) did not give figures for the catch of mackerel, anchovy that year amounted 12.8%, sardines 43.4%, tunny 28.7% and jack 15.1%.

On the Ecuadorian shoreline, shrimp farming is one of the main activities; at the present time, an area of 105.431 hectares is devoted to shrimp farming, which represents 4% of the potential of 149,570 hectares existing in the inner estuary of the Gulf of Guayaquil (Aquaculture of Ecuador, 1997).

4.1.2 Public health

In Ecuador, the Gulf of Guayaquil is the main body of water receiving the pollution load, which carries approximately three quarters of the total volume of the wastes and pollution load that originates in anthropogenic activity. Other areas affected by municipal wastes are Machala, Puerto Viejo, Esmeralda, Manta, Salinas, Duran, Sucre and Santa Elena. The Guayas River and others that flow into the Gulf of Guayaquil carry wastes of domestic and industrial origin, pesticides and petroleum hydrocarbons which contribute to the degradation of the area (Fig.16).

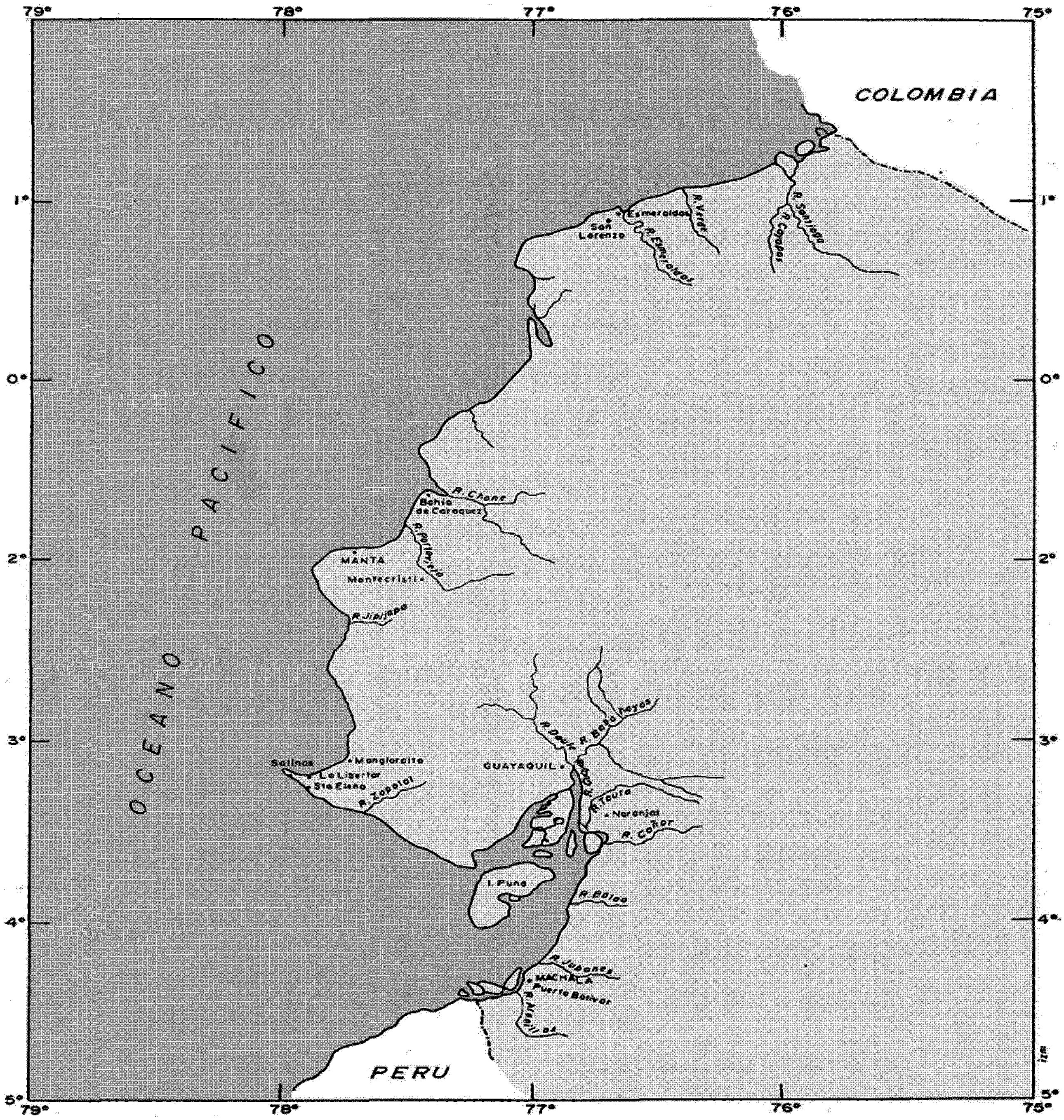

Figure 16. Hydrographic map of the Ecuadorian coast.

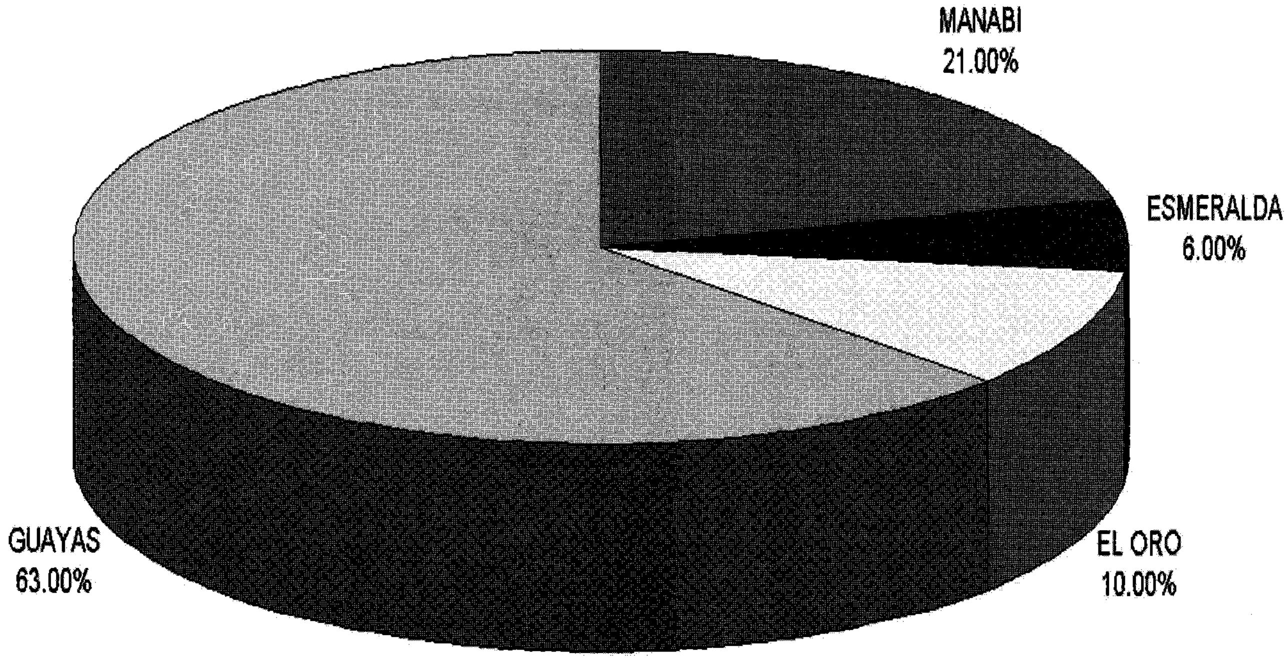

Figure 17. Volume of BOD_5 discharged in the Pacific coast of Ecuador (tonnes/year), 1994.

4.1.3 Coastal and marine resources and ecosystem health, including biological diversity

The protected area of the Parque Machalilla contains 64 species of plants, 20 species of birds, 5 species of reptiles, 20 species of native and migratory birds. Among those observed were the blue-footed booby *(Sula nebouxii)*, the masked booby *(Sula dactylatra)* and the red-footed booby *(Sula sula)*, the tropical bird *(Phaeto aethereus)* and the albatross *(Diomeda irrorata)*.

Also reported were the sea lion *(Zalophus californianus wollebaecki)*, the sperm whale *(Physeter macrocephalus)*, the common dolphin *(Delphinus delphis)*, the pilot whale *(Glopicephala macrorhynchus)* and the spotted dolphin *(Senella attenuata)*.

The coastal populations of the parks' area of influence are mainly involved in fishing and tourism.

4.1.4 Economic and social uses

In Ecuador, the coastal area has contributed to the support of the economy, and to the development of industry and social benefits. For this reason, research has currently been started to address problems brought about by natural phenomenon such as El Niño, climate change, tsunamis, etc., and provoked by mankind, which affects the area.

4.2 ASSESSMENT OF CONTAMINANTS

4.2.1 Sewage

On the Ecuadorian coast, domestic sewage is discharged directly into the sea by those provinces that have a shoreline such as Esmeraldas, Manabi, Guayas and El Oro. These provinces are home to 98% of the whole coastal population of the country; together, they have a total of 4,266,273 inhabitants (INEC, 1991). Of these four provinces, those that have the greatest input of pollutant load from domestic sewage are the province of Guayas and the province of Manabi. The volume of domestic sewage in the coastal area of Ecuador is of the order of 128.38 million m^3 a year, corresponding to an associated organic load of 48,208 tonnes of BOD_5. It is the province of Guayas that has the most of the pollutant load with 30,160 tonnes of BOD_5 a year generated, an amount which represents approximately 62.5% of the total on the coastline and most of which is made up of the pollutant load of Guayaquil with 18,900 tonnes of BOD_5 a year, the rest is input by the province of Manabi with 10,130 tonnes of BOD_5 a year, the province of El Oro with 5,020 tonnes of BOD_5 a year, and finally Esmeraldas with 2,980 tonnes of BOD_5 a year (Fig. 17).

Industrial wastewaters originate from the 69% of industries registered in Ecuador that are to be found in the coastal area (Fig. 18). The main centres of activities is the province of Guayas with 2,923 industries (92.5% of the total of the coastal area). The fishing industry reports low levels of dissolved oxygen (DO) and high levels of organic load such as BOD, suspended salts and fats at the discharge points. One of the largest discharges in the Posorja area of Guayas province by the industrial fishing sector is estimated at 2.8 million m^3 annually.

The manufacturing industry dedicated to the fabrication of carBODard is the cause of changes in temperature and pH. The areas where the main incidents of this type of activity occur are Guayaquil (where a volume of 9 million m^3 a year is discharged) and Machala (with over 6 million m^3 a year). Other large industries are the edible oils and fats factories that report a volume of over 5 million m^3 a year of wastewaters with a high fats content at the area of discharge.

The metallurgical industry discharges considerable volumes of liquid waste generated by the industrial process; it discharges heavy metals, provokes considerable changes in pH and exceeds the permissible limits of discharge of SS and SD. The volume of indirect discharge of liquid wastes is assessed at almost 15 million m_3 a year.

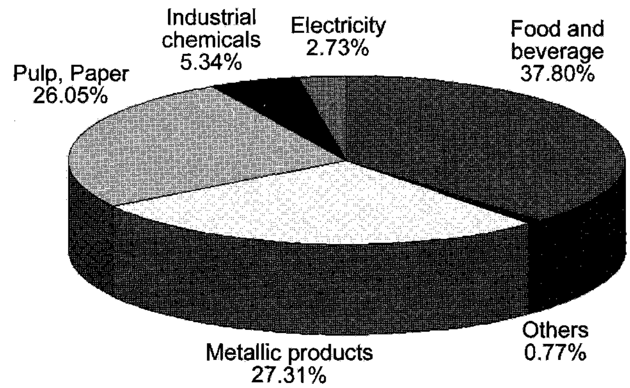

Figure18. Discharge of wastewater in Ecuador by type of industry.

4.2.2 Oils (hydrocarbons)

In Ecuador the effluents from coastal refinery plants in Esmeraldas and Libertad are a potential factor of pollution by petroleum hydrocarbons. The Teatone River reports the presence of hydrocarbons from the Esmeraldas refinery, which carries out an indirect discharge into the sea through the river of about 3 million m^3 a year of liquid wastes.

4.2.3 Persistent organic pollutants

Most of the agricultural production in the country is concentrated in the area of the Gulf of Guayaquil, and the principal crops are bananas, African palm, sugar cane, rice, hard maize, cotton, coffee, cocoa, fruit and vegetables, and in addition, there are large areas of natural and cultivated grasslands (Carrera de la Torre *et al.*, 1995).

Ecuador is the main world producer of bananas for export; the past few years have seen a steady increase in production. In 1993, the increase in the banana crop was 10% with respect to the previous year, which also gives rise to a greater use of agrochemicals and pesticides. The banana sector currently uses annually 2,400 tonnes of insecticide-nematicides for the past 10 years, using chemicals that are considered to be of restricted use. Its formulation of active ingredients correspond to organophosphate and carbonate products of high toxicity in pollution potential. Among the pesticides imported are Aldrin, Lindane, DDT, Mirex, Heptachlor, etc.

4.2.4 Heavy metals

From 1982 to 1988 research on metal traces in surface waters and at depth in the Babahoyo, Daule and Guayas rivers were carried out by the National Fisheries Institute. Findings of concentrations of copper and lead in the Daule River were found to be within the permissible limits set by the Environmental Protection Agency (U.S.A). However, cadmium was observed to be at the maximum permissible levels for fish life (1.2 ugl^{-1} Cd) and above this (4 ugl^{-1} Cd) in two river stations, one station of which was located close to the industrial area.

In July 1994, DIGMER carried out a study of sediments of trace metals such as copper, zinc, lead, cadmium and chromium. The values were within a range of 40 and 113 ug/g, 116 to 556 ug/g, 125 to 218 ug/g, 0.5 to 1.5 ug/g and 3.5 to 24.5 ug/g respectively. The concentration of trace metals obtained in the various bodies of water varied with time; it is hoped to have further information in order to determine its effects on biota.

The extraction of river gold represents a threat to the catching of crayfish, because of the use of mercury; however, the analysis carried out on shrimp for export does not exceed the permissible limits, i.e. 0.05 mg per kg of shrimp (Chalen, 1994).

4.2.5 Physical alteration and habitat destruction

Expansion of the shrimping sector has caused a significant degradation of the coastal environment. Also, the introduction of exotic species such as tilapia, which has invaded rivers, dams and estuaries, and replaced native species. The process of erosion as a consequence of anthropogenic activities has caused the loss of beaches and alteration of the aquatic ecosystems.

5. Panama

5.1. IDENTIFICATION ASSESSMENT OF PROBLEMS

5.1.1 Food security and poverty alleviation

In Panama, the Gulf of Panama constitutes the area of greatest biological productivity because of its wide coastal shelf and seasonal currents; pelagic fish such as the anchovy *Cetengraulis* and the herring *Ophisthonema libertate* are the dominant resources, whose biomass may reach 70,000 to 160,000 metric tonnes in industrial fisheries. Demersal resources also occupy an important place in fisheries and it is estimated at about 200,000 metric tonnes mainly made up of stromateidae (pomfret), some serranidae (seabasses) and snappers (Alvarez y Manelia, 1996).

Another important resource is shrimp with catches of the order of 5,000 to 6,000 metric tonnes. Species frequently caught are white shrimp *(Penaeus occidentalis, P. styllirostris, P. vannamei),* the red shrimp *P. brevirostris,* the carabali shrimp *(Trachypenaeus birdi* and the Pacific seabob *(Xiphopenaeus reverti, X. kroyeri, X. precipua).*

Artisanal fishing is mainly supported by fish that are associated with mangroves and estuaries such snappers, drum fish and snook.

5.1.2 Public health

The Bay of Panama is heavily polluted, and is therefore a main source of danger to human health. From studies carried out by Manelia, (1995), various critical points of pollution have been identified, such as the Matasnillo River, the Club Union, the Yacht Club inside and outside of the Darsena (Fig. 19).

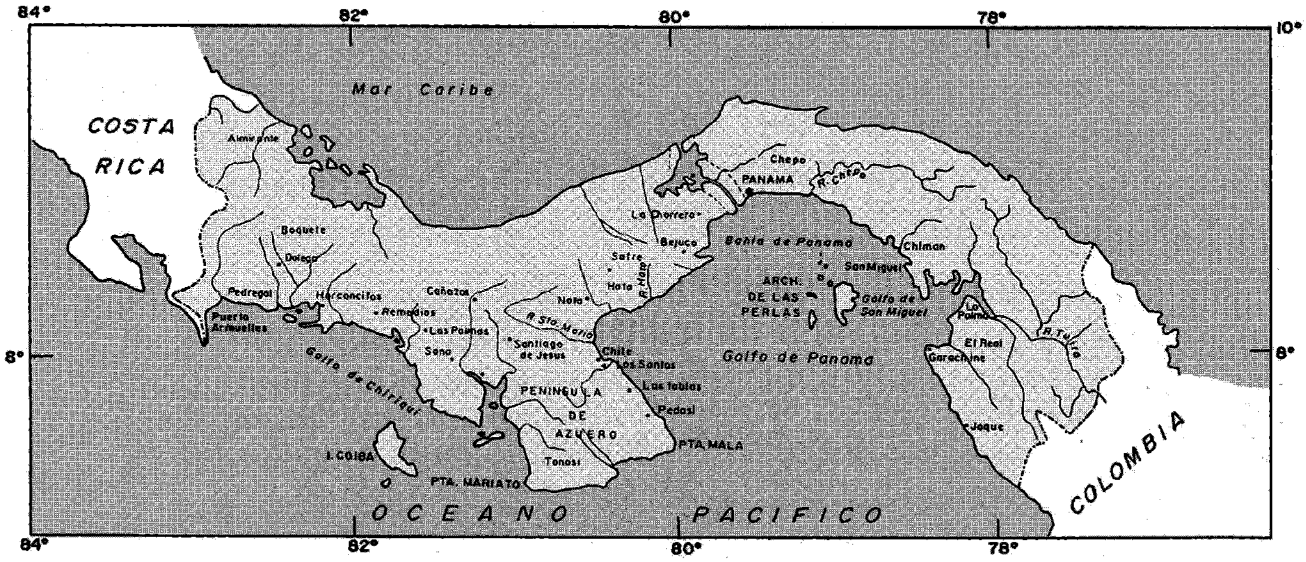

Figure19. Hydrographic map of the Panamanian coast.

5.1.3 Coastal and marine resources and ecosystem health, including biological diversity

In Panama there are about 2,000 km^2 of mangrove forests, in the midst of which are found almost 200 km salitres. Most of the mangroves are found in the Gulf of San Miguel, and the most represented of species are the red mangrove *Rizophora* spp., the black mangrove *Avicennia germinans* and *A. bicolor,* the white mangrove *(Laguncularia racemosa),* the cork tree *(Mora oleifera)* and the chestnut *(Montrichardia arborescens).*

Shrimp fishing is one of the main fisheries in Panama, and earns substantial profits, between 60 and 70 million balboa a year and over 5,000 people are supported by means of this activity.

The coral reefs shelter many species of fish and invertebrates, so that this is an area of great diversity and tourist potential.

5.2 ASSESSMENT OF CONTAMINANTS

5.2.1 Sewage

The main pollutant source is the discharge of domestic wastewaters into the Bay of Panama. According to the 1990 census, the population of the communities around the Gulf of Panama was of 1,072,427 inhabitants. The heaviest concentration of people is in the city of Panama (Metropolitan Region) and San Miguelito, which have a total of 827,828 inhabitants, representing 77% of the population. The metropolitan region and San Miguelito discharge their sewage into the Bay of Panama without any kind of treatment, with a volume of wastewaters exclusively of domestic origin estimated at 78.2 million m^3 a year, which constitutes 92% of the volume of BOD_5 dumped in the Panamanian Pacific (Fig.20).

5.2.2 Industrial effluents

In Panama the main industrial sources of marine pollution originate in food and livestock production activities. The chicken feedlots and slaughter houses, flour and glucose factories, alcohol distilleries, tanneries and others generate liquid wastes that are directly discharged into the Bay of Panama.

The volume of liquid wastes input by the industrial sector in the Bay of Panama represents only 12% of the total amount of liquid wastes discharged in that area, however, the polluting potential associated with these discharges is considerable, and represent 43% of the pollutant load as BOD_5 of the total discharged into the Bay. The foodstuff production factories report the greatest volume of discharge of wastewaters, with an amount of over 5,000 tonnes BOD_5 a year.

The animal fattening feedlots (livestock and poultry) generate a large input of pollutants. The poultry sector around the Bay is very large and this magnitude of production generates a considerable input of pollutant load, exceeding 30,000 tonnes of BOD_5 a year. The volume for this type of activity generates a discharge volume exceeding 9,000 m_3 a year.

5.2.3 Oils (hydrocarbons)

The maritime transport of petroleum is in relation to the Panama Canal, the Trans-Isthmian Pipeline and the shipping activity in the ports of Balboa and Vacamonte. In the port of Vacamonte fuel is provided to a fishing fleet of over 3,000 vessels, to which should be added the tunny fleet that uses the port for its fuel supply. The ports of Balboa in the Gulf of Panama and Puerto Armuelles in the Gulf of Chiriqui have been identified as having the heaviest oil pollution on the Pacific coast of Panama. The majority of the releases correspond to diesel, bunker oil and dirty ballast.

The Trans-Isthmian Pipeline is another potential source of contamination by hydrocarbons of inland and marine waters; it has a maximum capacity of 700,000 barrels a day. The pipeline crosses the two westernmost provinces of the country and is 130 km long, transporting from the Pacific to the Caribbean the crude oil that arrives in supertankers from Alaska.

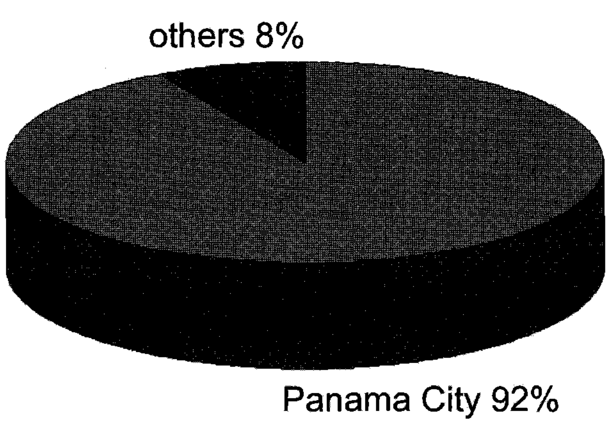

Figure 20. Volume of BOD_5 discharged in the Pacific coast of Panama (tonnes/year), 1994.

5.2.4 Persistent organic pollutants

The strongly persistent pesticides and those commonly imported by Panama are Aldrin, Benlate, Birlene, Clordane, 2.4D, DDT, Dieldrina, Eldrin, Heptachlor, Lindane and Telodrin. 90% of the importation of these products is for agriculture and 9% for domestic uses.

According to the National Environment Commission (CONAMA), the levels of organochlorine pesticides do not show pollution, since the amounts of B-BHC, Lindane, Heptachlor, Aldrin and Mirex are not detectable. The highest accumulation of pesticides in sediments in the bay of Panama are located opposite a sewage discharge, currently out of use, at the mouth of Juan Diaz River.

There is also evidence of pesticides in the marine biota of the Pacific and an accumulation of herbicides in the coral reefs of the Uva island in the Gulf of Chiriqui.

5.2.5 Litter

In Panama the handling of solid wastes of the metropolitan area has gradually been improving in regard to collection and the final disposal of garbage. There is currently a sanitary landfill in the Cerro Patacon, which has geomembranes to provide leachate percolation protection for groundwater and its earth covering has been improved. But the problem persists as there is no classification of wastes; domestic, industrial, hospital and other wastes are all disposed of together.

Ninety per cent of the load of solid wastes in the city of Panama is generated by the population, and reaches a figure of 289,706 tonnes a year, while 10% originates in industrial activity, with an estimated 322,792 tonnes a year of solid wastes from production. The industrial activities generating the greatest quantity of solid wastes are those involved in the manufacture of aluminium, which generates about 60% of the total solid wastes.

5.2.6 Physical alteration and habitat destruction

Since the decade of the 1970s, the development of shrimp farming has caused the slow destruction of marginal mangroves and salitres, with Cocle and the Peninsula of Azuero being the most affected areas. Urban expansion has also impacted on mangrove forests and the most obvious cases is the Juan Diaz area.

6. Peru

6.1 IDENTIFICATION AND ASSESSMENT OF PROBLEMS

6.1.1 Food security and poverty alleviation

In Peru the mainstay of the fisheries is the anchovy *Engraulis ringens* and to a lesser extent the sardine *Sardinops s. sagax.* Aquaculture in Peru has been developed in such a way as not to interfere significantly with the national fisheries production.

According to statistics of the Ministry of Fisheries, of a total national catch in 1994 (3,064,000 metric tonnes gross), 91% was used for the manufacture of fish meal and oil, and 253,000 tonnes for direct human consumption (fresh, canned, frozen and smoked) (Table 7). As expected, catches decreased in 1995 and 1996. The main fishing ports are Coishco, Chimbote, Pisco and Chancay (Table 8).

6.1.2 Public health

In regard to public health in Peru, for the past ten years the Ministry of Health has been operating a Monitoring Programme for Beach Areas, in coordination with the Regional Health Departments, in the cities of Lima and Callao, through which a weekly check is made on the microbiological quality of beach waters, in order to advise the population of its classification for bathing: very good, average, poor, very poor. At the same time, the Peruvian Instituto del Mar carried out a programme of monitoring of microbiological quality of sea water and marine resources of commercial importance in the areas of Paita, Chimbote, Huacho, Calla, Pisco, Mollendo, Ilo and Ite.

These assessments have helped local governments administering their beach areas to take actions to protect the public health of holiday-makers. In the capital, the company that provides the water supply and sewage system (SEDEPAL) has been carrying out sewage treatment, one of which is the project of treating sewage for use in irrigating the San Bartolo plains.

6.1.3 Coastal and marine resources and ecosystem health, including biological diversity

Peru is considered as one of the so-called megadiverse countries, because these contain 60 to 70% of the biological diversity of the planet, which makes us responsible for its conservation. In the Peruvian marine ecosystem there are about 759 fish species, belonging to 402 genera and 169 families. Of these, 73 are of economic importance, a number which may rise to 112 if direct human consumption is taken into account. The species that occur in the ecosystem of the Peruvian-Chilean current are notable for the size of their populations, for example, the anchovy *Engraulis ringens,* the sardine *Sardinops sagax sagax* and the jack mackerel *Trachurus picturatus murphy.* There are 400 species of crustaceans, including 73 families and 220 genera. About 5% of these species are of commercial interest.

eru has critical environmental areas along the coast, ith problems such as the deforestation of mangroves, the salinization of soils, sea and air pollution (Table 9), which is a problem that should be taken into account to take appropriate measures to preserve marine biodiversity.

6.1.4 Economic and social uses

The main economic activities that are developed along the Peruvian coast are fisheries, mining, agriculture and various manufacturing industries. The greatest problem in Peru is the marked centralization of economic activities, which has given rise to approximately 72.2% of the total organic load of domestic and industrial origin corresponding to the Peruvian shoreline being discharged into the bays of Callao and Miraflores.

The Peruvian Government has initiated a campaign to promote tourism, taking into consideration the great touristic potential of the country and in order to develop an activity that will bring in foreign exchange and help employment.

6.2 ASSESSMENT OF CONTAMINANTS

6.2.1 Sewage

The total flow of domestic wastes discharged into the sea in Peru is over 434.9 million m^3 a year, with an associated organic load of 128,200 tonnes of BOD_5 annually. Of this amount, Lima and Callao are responsible for 330 million m^3 a year with an associated organic load of 89,500 tonnes of BOD_5 annually from these cities. Other large cities with marine pollution from domestic wastes in Peru are the north-

Table 7: Fisheries production for indirect and direct human consumption: years 1994, 1995 and 1996

YEAR	INDIRECT HUMAN CONSUMPTION				DIRECT HUMAN CONSUMPTION						PRODUCTIO N
	MEAL		OIL		CANNED		FROZEN		SMOKED		TOTAL
	GMT	%	GMT	%	GMT	%	GMT	%	GMT	%	GMT
1994	2,337	32.1%	474	98.7%	47	32.5%	181	34.5%	25	39.1%	3,064
1995	1,774	-24.0%	379	-20.0%	59	25.2%	118	-35.2%	36	45.0%	2,366
1995	1,044	-14.9%	265	-9.6%	38	9.6%	42	6.1%	18	14.4%	1,407
(1)											

(1) Data corresponding to the first semester of 1996. Percentage variations with respect to first semester of 1995. Amounts in thousands of gross metric tonnes (GMT).

Source: Statistics, Ministries of Fisheries.

Table 8: Main landing sites for fish on the Peruvian coast years 1994-1995 (Statistics, Ministry of Fisheries. Memorandum Information Conservera Roddy S.A.)

PORT	1994		1995	
	MT	%	MT	%
Coishco-Chimbote	3,972,800	37.1	11,421,186	20.7
Pisco	1,441,485	13.5	1,053,172	15.3
Chancay	758,904	7.1	692,642	10.1
Paita	683,134	6.4	604,672	8.3
Ilo	525,857	4.9	527,900	7.7
Chicama	193,376	1.8	378,232	5.5
Parachique	220,634	2.1	310,011	4.5
Tambo de Mora	211,674	2.0	364.765	5.3
Huarmey	475,937	4.4	171,169	2.5
Callao	235,603	2.2	166,447	2.4
Vegueta	552,878	5.2	149,811	2.2
Huacho			149,220	2.2
Casma	437,626	4.1	144,075	2.1
Supe	399,286	3.7	140,729	2.0
Matarani			124,830	1.8
Planchada	142,415	1.3	122,174	1.8
Samanco	232,651	2.2	117,199	1.7
Mollendo	50,602	0.5	76,570	1.1
Pucusana	68,655	0.6	61,448	0.9
Atico	94,494	0.9	58,738	0.9
Salaverry			31,867	0.5
TOTAL	10,698,011	100	6,866,857	100

ern city of Trujillo, with discharges of 40.6 million m^3 a year of domestic wastes with an organic load of 10,960 tonnes of BOD_5 annually; Chimbote, which involves one of the bays most polluted by organic material of industrial and domestic origin, with an input of 3,920 tonnes of BOD_5 a year of organic

Table 9: Critical environmental areas of the coastal region (ONGRN, 1986. Office of the National Resources. Environmental Profile of Peru)

AREA	PROCESSES	ENVIRONMENTAL EFFECTS AND TRENDS
1. Tumbes	. Deforestation of mangroves and dry forest, grassland, excessive hunting. . Severe soil salinization . High seismicity	. Extinction of endemic flora and fauna . Elimination of tourist attractions . High cost of rehabilitation and reconstruction
2. Chira-Piura	. El Niño phenomenon (rainfall, floods, erosion, soil salinization, deforestation, petroleum pollution). . Accelerated urbanization	. Natural disasters (destruction of infrastructure, loss of forest, sedimentation of reservoirs, etc. . Low quality of life . Cost of rehabilitation very high
3. Chimbote-Santa	. Marine and atmospheric pollution, smelters and fisheries, fluvial and mining pollution. . Floods, gullies, heavy erosion . Soil salinization . Danger of tsunamis	. Urban environmental quality inadequate, direct effects on human health . Destruction of villages (70,000 disappeared in 1970) . Loss of water resources . Depletion of industrial fishing
4. Chilon-Rimacy (Lurin (Lima)	. High seismicity . Urban and industrial expansion . Gullies, landslides, seismicity . Danger of tsunamis . Accelerated urbanization . Poor urban management . Erosion of river basins	. Increased unemployment . Loss of quality of ecological components . High pollution of sea, rivers, groundwater, atmosphere and soil. . Critical urban environmental quality . General ill health . Extreme poverty and malnutrition . Lack of food products . Insufficient wheat production
5. Tambo-Ilo-Locmba	. Extreme drought . Mine tailing pollution and residual gases . High seismicity . Overexploitation of water resources . Windborne sand . Gullies and floods . Heavy atmospheric pollution from mining industry . Accelerated urban growth . Degradation of aesthetics and natural landscape of the marine ecosystem . Loss of biological diversity	. Negative impacts on crops and loss of crop production in three valleys . Critical urban environmental quality . Direct effects on human health . Loss of water resources, river and marine . Loss of grasslands . Low quality of life . Poor urban management

material of domestic origin (Fig. 21). Peru has 53 catchment basins whose waters flow into the sea with polluted loads (Fig. 22) and those coastal cities with large rivers that pass through urban centres before flowing into the Pacific, such as the Pisco River (Ica) and the Chillon River (Lima).

(Table 9 continued)

AREA	PROCESSES	ENVIRONMENTAL EFFECTS AND TRENDS
6. Trujillo - Moche	. Pollution by wastes and fluvial discharges . High mining pollution in the Moche river basin . Industrial urban development not planned ecologically . Occurrence of external geodynamics processes	. Depressed social conditions . Degradation of recreational marine resources ecosystems . Negative impacts on human health by atmospheric, aquatic, epidemiological and toxic factors. . Loss of river water resources (shrimp, fish, etc.) . Decrease of sanitary quality of agricultural products

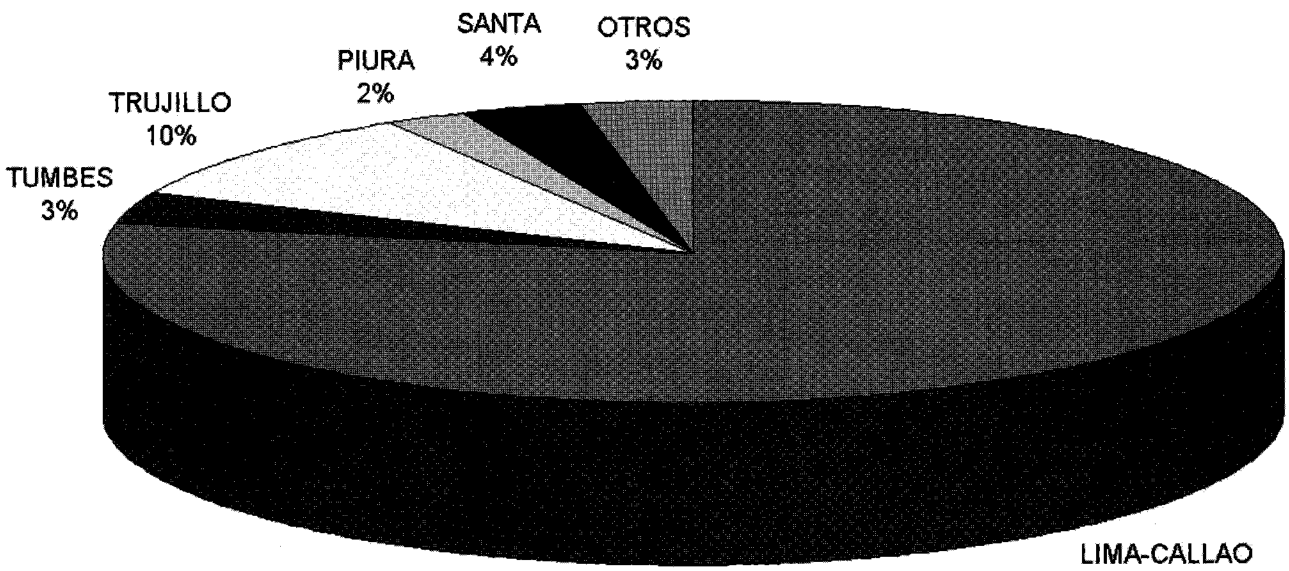

Figure 21. Volume of BOD_5 discharged in the Peruvian coast (tonnes/year), 1995.

6.2.2 Industrial wastes

The Peruvian coast has discharges from the fishing, mining-metallurgical and petroleum industries, which are those that have the worst effect in degrading the marine environment. The total volume discharged into the sea, considering these three headings alone, is estimated at 162.2 million m^3 a year. The organic load associated with this volume is over 145,000 tonnes of BOD_5 a year. However, the existence of numerous industries, basically manufacturing ones, located all along the coast, (above all in Lima and Callao), considerably increase this volume and pollutant loads.

Fishing industry: most of the industry is concentrated in the areas of Chimbote, Paita and Pisco, as well as other coastal cities, where the industry processes fish meal and oil. The lack of adequate control of discharges have created azoic areas and eutrophication in closed areas such as Ferrol and Paracas bays, where the poor circulation of water increases the negative effects (Fig. 23).

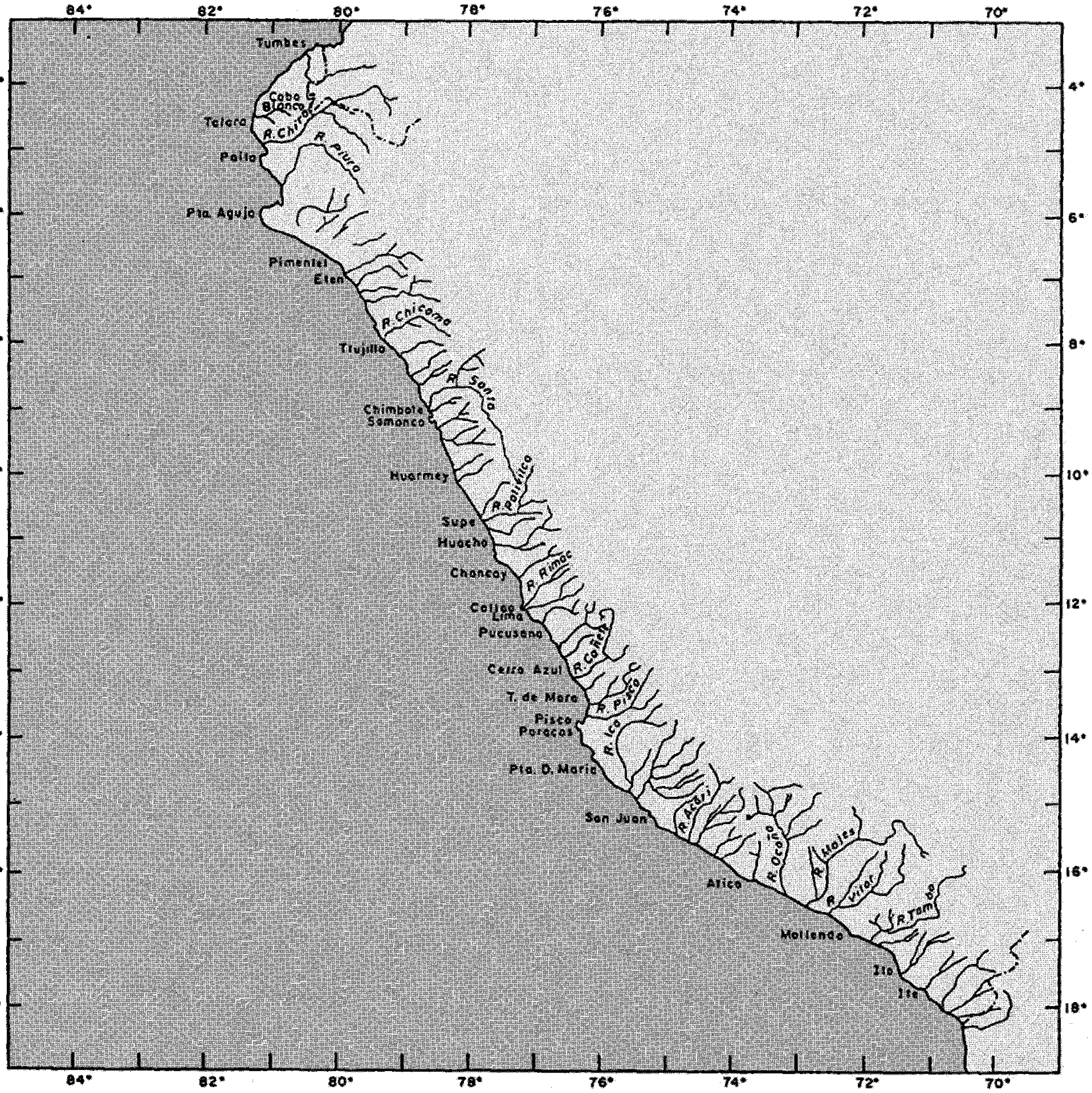

Figure 22. Hydrographic map of the Peruvian coast.

6.2.3 Oils (hydrocarbons)

The petroleum industry in Peru includes exploration, drilling (in the sea and on land), processing and distribution, and is carried out along the coast, mainly in the north of the country which includes the Peruvian forest. Most petroleum drilling is carried out in the north-west particularly on the continental shelf. Crude petroleum from this area is processed in the refineries of La Pampilla and Conchan, both situated in the central Peruvian coast. Along the coast there are 12 distribution depots with a varying capacity for storage, the largest of which are Eten, Salaverry, Chimbote, Supe, Callao, Pisco, Mollendo, San Nicolas and Ilo.

In these geographical areas there is a high risk of petroleum spills at the time of shipping and spills have taken place of diesel, crude oil and kerosene three times in the last five years. The worst release was that of kerosene with 14,000 barrels spilt in 1990 and crude petroleum, 438 barrels, in 1995.

6.2.4 Persistent organic pollutants

In Peru there are currently 548 chemical products of synthetic or biological origin that are used to control pests and diseases of the main crops, and these are principally in or along the Peruvian coast. Of the pesticides, 371 products are imported while 215 are manufactured in Peru. In 1991, 16,400 tonnes of pesticides were used, both phosphates and chlorinates and some others. This volume corresponds to 833 different products (Fig. 24).

6.2.5 Heavy metals

In 1995 the Ministry of Energy and Mines identified, in an inventory of mining companies along the Peruvian coast, a total of 24 companies with 30 mining plants having deposits of residues *in situ* , tailings and slag. Of these, only three deposit their discharges in the coastal marine environment. The final products of these plants are minerals of ground

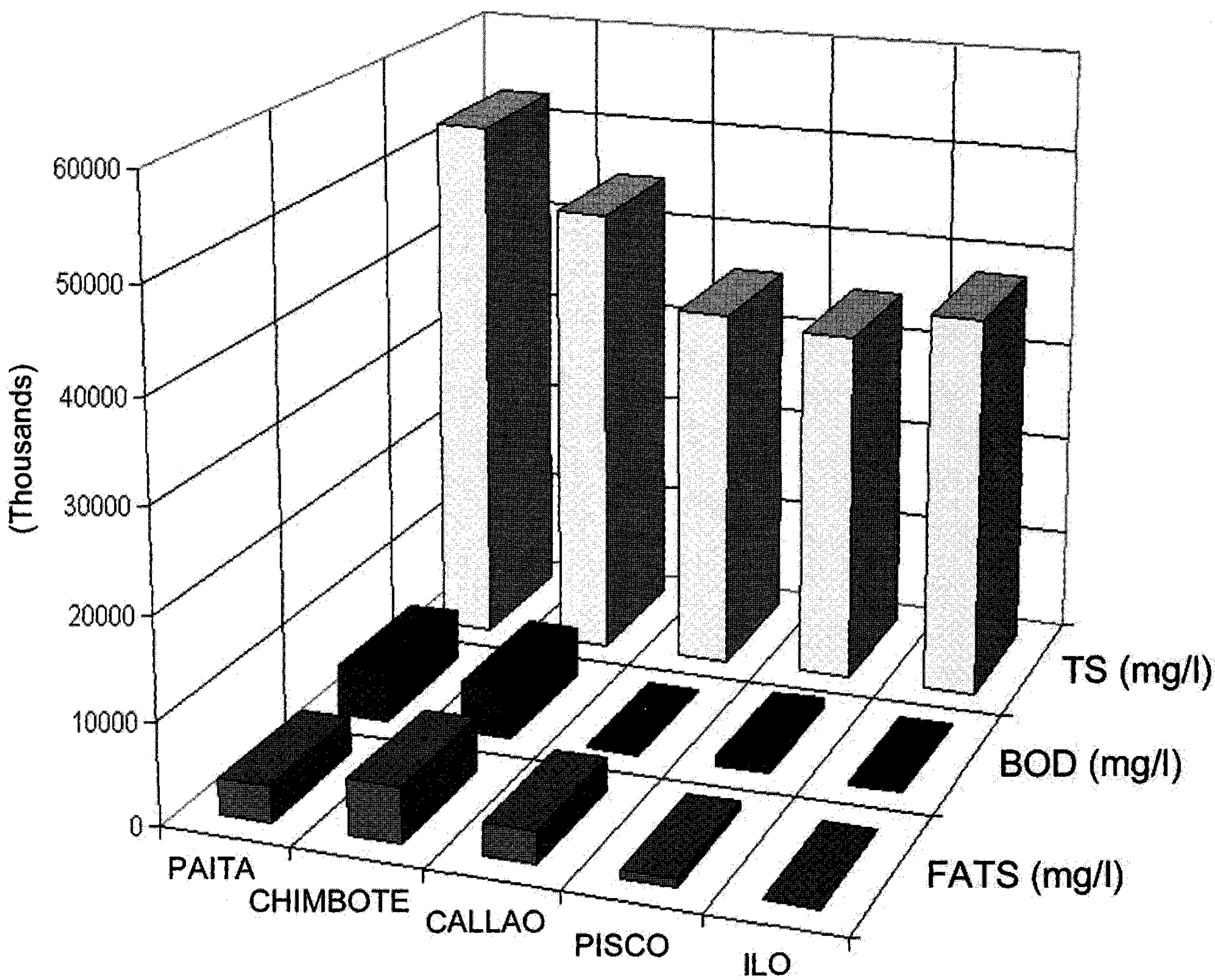

Figure 23. Analytical values of total solids, BOD_5 and fats obtained from general outfall effluents from the processing of fish meal in various Bays of the Peruvian coast, 1995.

barite, ground bentonite, Portland cement, copper, lead, zinc, cadmium, sulphuric acid, white cement, other non-metallic products, carbon, iron, gold, copper and molybdenum concentrate, copper-silver blist and calcium carbonate.

On the south coast of Peru, 90,000 tonnes a day of tailings are discharged in the Playa Inglesa, Ite, Department of Tacna, originating in the refining plants of the mines of Toquepala and Cuajone. At present, since December 1996, a tailings pond has been in operation in Quebrada Honda, where tailings are deposited.

6.2.5 Physical alterations and habitat destruction

In the wetlands and ecosystems associated with the marine ecosystem, the factors that cause physical alterations and the destruction of habitats are the extraction of reeds for artisanal use, the extension of agricultural land, the expansion of lobster fishing and urban development. The most affected areas are the National Sanctuary of the Lagunas de Mejia (Arequipa), Pantanos de Villa (Lima), inlets and mangrove forests (Tumbes) and reeded areas. Commercial fisheries have also caused destruction of habitats in Paracas.

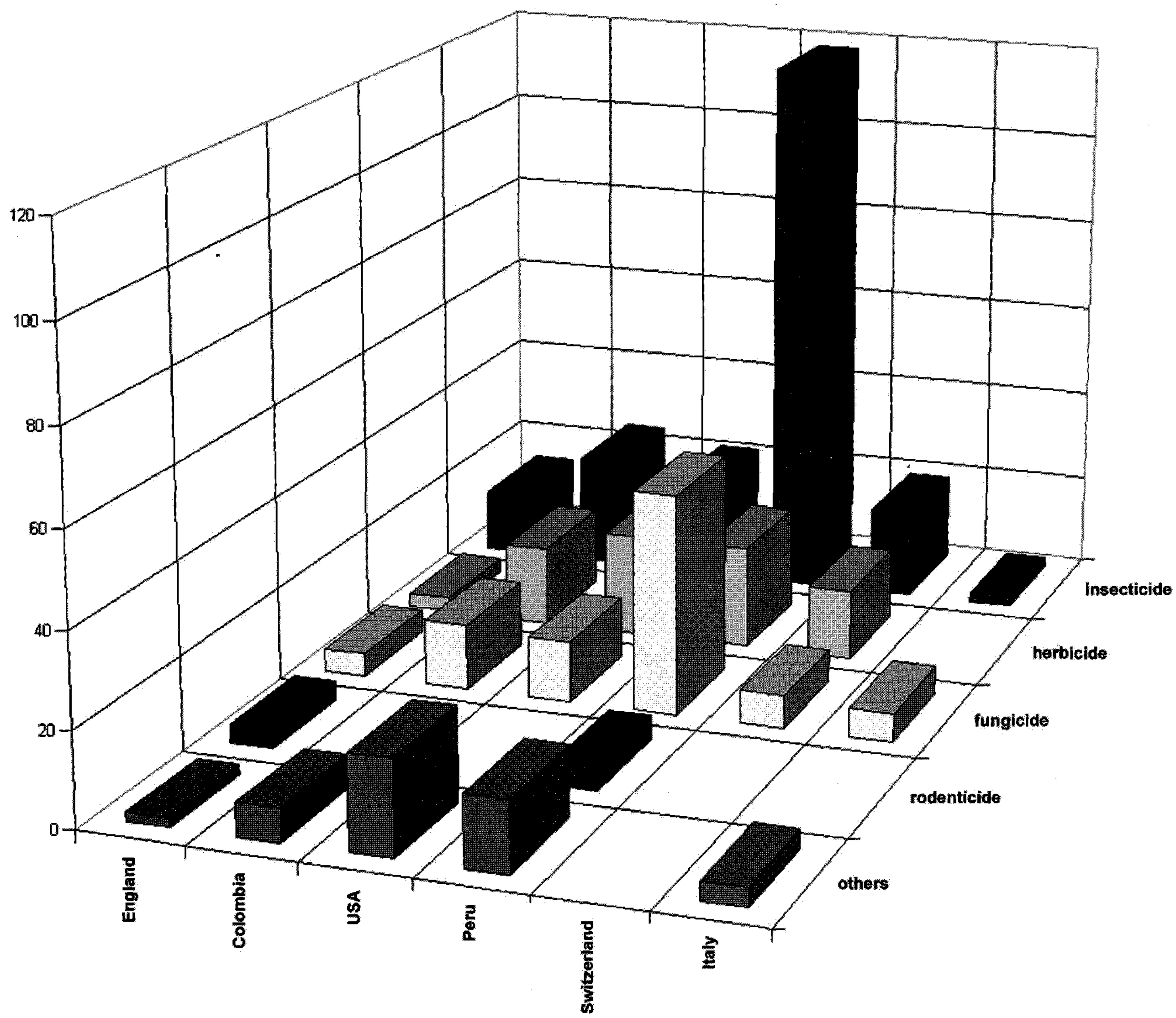

Figure 24. Number of local and imported pesticides in Peru according to use.

PART III. ESTABLISHMENT OF PRIORITIES AND MANAGEMENT OBJECTIVES

Priorities were established based on information provided by the countries and on their affordability, and they were mainly aimed at the organic type of pollution.

In the case of Peru and Chile, information was available on mining pollution, because of the economic importance of that activity in those countries. In the present document, the components of greatest significance were identified by their polluting characteristics and considering the volume of the organic load of the effluents, the effects of these on public health and the ecosystem, with their economic implications. Consequently, it was possible to determine an order of priority that provided the starting point for the planning of actions to counteract the negative impacts generated by anthropogenic activity. Below are given in details the management action that the country members of the Plan of Action for the South-East Pacific will carry out; in some cases priorities were given in their programmes and/ or projects for the protection of marine and coastal areas of the South-East Pacific.

5.1 Colombia

In the Colombian Pacific shoreline, actions will be taken to define areas of production, conservation, rehabilitation and special management of mangroves, as well as forest management. Also, surveillance and monitoring of commercial and artisanal fishing activities, and surveillance and monitoring of shrimp fishing and river delta artisanal fishing. Capacity-building and technical assistance for the people involved in fishing, timber and agricultural activities. Improvement of teams and technology to provide better treatment of raw material and conservation of the environment.

5.2 Chile

Establishment of programmes to reduce industrial wastes, with the target of reducing the production of these wastes by 30%. The targets established to reduce or prevent pollution with loads originating in domestic sewage systems for the year 2000 aims at increasing to 52% the part of the population with sewerage services.

5.3 Ecuador

One of the priority actions is the updating of permanent information on pollution sources, point discharges, prioritization and identification of critical discharge points for setting out the areas to be monitored, establishment of an easily updatable register of polluting sources, allowing actions to be centred on specific problems to delimit the present and future uses of the coastal areas, to plan actions to restore or minimize the effects caused by the problems identified.

To strengthen the participation of the various institutions (local authorities, NGOs) and the private sector in the waste management programmes. To carry out monitoring and surveillance programmes on the areas prioritized. Ecuador, as shown on table 11, considers the principal pollution source to be the wastewaters originating in the main drainage basin (the Guayas River), which also inputs pesticides, and petroleum hydrocarbons because of the intense shipping traffic.

5.4 Panama

The principal project for the protection of the marine environment established in Panama is the Panama Bay sanitation, which is in the course of being formulated. In the rest of the country there are sanitation projects for cities by means of sewerage systems which include wastewater treatment. As can be seen from Table 11, this type of pollutant is the most relevant and has the greatest impact in the Bay of Panama, and after it in importance come, as pollutant sources, hydrocarbons and pesticides.

5.5 Peru

The management policy in the fishery sector is at a stage where commitments made by industrialists are being implemented, backed by a technical-regulatory framework, which needs to be complemented and strengthened. The regulations for environmental protection in fishery activities are currently being revised and the Monitoring Protocol for fishery effluents is at a stage of public discussion seeking technical regulation that will make it possible to apply surveillance and monitoring systems.

Also being implemented is the radiological environmental surveillance programme in the area of influence of the RACSO Nuclear Centre, which is being supervised by the competent authority.

In regard to the priorities to be attached to pollution sources, as set out in Table 10, the domestic and industrial waste waters are certainly relevant; the National Superintendence of Sanitation Services (SUNASS) is initiating action in order to correct sewerage problems in the cities on the coast, and establish new sanitation networks in rural areas or small cities. Also, primary treatment systems are being installed, and in some cases, secondary ones, for sewage.

In regard to oil exploration and drilling, the monitoring of ships and drilling rigs is being carried out to avoid pollution through the discharge of oily wastewaters (reduction of bilge), and also the monitoring of provisions to regulate against the pollution of the sea by industrial activity.

In the agricultural sector, the permissible maximum limits have been set for the emission of pollutants and also a protocol for the monitoring of pollutant emissions, the regulation of the environmental impact assessment of agricultural sector programmes and projects, and monitoring of the degradation of renewable natural resources in the country. In accordance with these current regulations, each ministry is the competent authority that should concern itself with the environmental matters of activities and projects in its own sector. For this reason, various management instruments have been developed (sectoral regulation, technical protocols, intersectoral coordination, etc.) for the sectors: mining, power, industrial, fisheries, agriculture, among others, that are involved in the protection of the environment.

The development of the environmental plan of the industrial sector is being carried out with the agreed and integrated support of international aid organizations and within a plan of permanent coordination with public and private entities, as well as concerned academic institutions and NGOs, reconciling opinions and criteria to allow us to avoid duplicating efforts and to benefit from the experience obtained in the implementation of environmental management of various entities at home and abroad.

To reduce and monitor environmental degradation, for the conservation of ecosystems and the sustainable development of natural resources, to guarantee and to raise the quality of life of the population, within the scope of sectoral competence.

Table 10: Prioritization of pollutants in the countries of the Southeast Pacific

COUNTRIES OF THE REGION	POLLUTANT PRIORITIES	AREAS AFFECTED
COLOMBIA	Domestic wastewaters	Ensenada de Tukmaco and Bay of Buenaventura
	Petroleum hydrocarbons	Bay of Buenaventura
	Heavy metals (mercury)	Ensenada de Tumaco
CHILE	Domestic wastewaters and nutrients	Bay of Valparaiso. Maipo River mkouth Santiago Metropolitan area, Bay of Concepcion
	Petroleum hydrocarbons	Region V: Puerto æQuintero; Region VIII, Puerto de San Vincente, Region V, Punta Arenas
	Persistent organic pollutants (POPs)	Bio-Bio River mouth
ECUADOR	Persistent organic pollutants	Guayas River mouth (Gulf of Guayaquil), Province of Manabi
	Petroleum hydrocarbons	Gulf of Guayaquil
	Domestic wastewaters	Guayas River salt estuary
PANAMA	Petroleum hydrocarbons	Bay of Panama
	Persistent hydrocarbons	Ports of Balboa and Vacamonte
	Persistent organic pollutants	Isla Uva in the Gulf of Chiquiri
	Domestic wastewaters	Bay of Callao, Rimac river basin, Bay of Ferrol-Chimbote
PERU	Heavy metals	Bay of Ite in Tacna
	Persistent organic pollutants	Bay of Callao and Ite
	Petroleum hydrocarbons	Chimbote, Callao and Talara

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