UNEP

REGIONAL SEAS

Overview on Land-based Sources and Activities Affecting the Marine, Coastal and Associated Freshwater Environment in the Upper Southwest Atlantic Ocean

UNEP Regional Seas Reports and Studies No. 170

UNITED NATIONS ENVIRONMENT PROGRAMME
2000

Contents

Preface

The Global Programme of Action (GPA) for the Protection of the Marine Environment from Land-Based Activities (UNEP (OCA)/LBA/IG.2/7) was adopted by an Intergovernmental Conference held from 23 October to 3 November 1995 in Washington, USA. The GPA aims at preventing the degradation of the marine environment from land-based activities by facilitating the realisation of the duty of States to preserve and protect the marine environment.

The Intergovernmental Conference also designated the United Nations Environment Programme (UNEP) as Secretariat of the GPA, and requested that, as coordinator and catalyst of environmental activities within the United Nations system and beyond, it should through its programmes and secretariat role:

(a) promote and facilitate implementation of the Programme of Action at the national level;
(b) promote and facilitate implementation at the regional, including subregional level, through in particular, a revitalization of the UNEP Regional Seas Programme; and
(c) play a catalytic role in the implementation at the international level with other organizations and institutions.

The present overview was prepared at the request of the UNEP/GPA Coordination Office in response to decision 19/14: B of the 19th Session of the Governing Council of UNEP (Nairobi, 27 January-7 February 1997) on the expansion of the activities related to the Global Programme of Action to all Regional Seas Programmes and the support to the implementation and strengthening of a programme of cooperation between Argentina, Brazil and Uruguay for the Upper Southwest Atlantic, focusing this support on projects and activities related directly to the GPA.

To facilitate implementation of the GPA by States, UNEP has provided support to the preparation of various national and regional assessments on land-based sources and activities which affect the coastal, marine and associated freshwater environments. The present report follows as close as possible the suggested outline by UNEP with inputs from the 17th Session of the UN Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) held in Nairobi, April 1997.

This Overview was prepared based on documents, publications and reports made available by researchers, international organisations and the scientific literature. A draft of the report was reviewed at a Workshop on Implementation of the Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities in the Upper Southwest Atlantic, Brasilia, Brazil (39 September-2 October 1998). The present version includes the modifications and additional information provided at the Workshop on the problems and measures to control land-based sources and activities which affect the Upper Southwest Atlantic.

This Overview will also be used as input to provide data and information for a global review being prepared by GESAMP on land-based sources and activities affecting the quality of the marine, coastal and associated freshwater environment (under the leadership of UNEP).

Acknowledgements

The author is greatly indebted to all those persons and institutions that have collaborated to the preparation of the present report, by not only contributing available information of their laboratories or offices, but also by providing bibliographical support. Special thanks are due to:

Argentina: Authorities at the Dirección de Recursos Acuícolas e Ictícolas, Secretaría de Recursos Naturales y Desarrollo Sustentable (Buenos Aires), specially Lic. Oscar Padín, Lic. Laura Benzaquen and Lic. Silvia Giangiobbe; Lic. Lucio Janiot (SHIN) and C.F. Javier Valladares (ARA); Dr. Adán Pucci (CENPAT); Dr. Hugo Freije (UNS) and Lic. Silvia De Marco (UNMdP).

Brazil: Authorities at the Ministério do Meio Ambiente, Recursos Hídricos e Amazônia Legal (Brasilia); Prof. Dra. Angela de Luca Rebello Wagener (PUC-RJ); Prof. Dr. Luiz Drude de Lacerda (UFF-RJ) and Prof. Dr. Luis Felipe Niecheski (FURG).

Uruguay: Authorities at the Dirección Nacional de Medio Ambiente-DINAMA (Montevideo); Lic. Ana Perdomo (SOHMA); Lic. Guillermo Verazay and Dr. Juan Oribe Stemmer (CTMFM).

Executive Summary

This overview provides a regional assessment of land-based sources and activities, which affect the marine, coastal and associate freshwater environment in the Upper Southwest Atlantic. The main land-based activities which may impact these environments are identified and prioritized for countries of the Upper Southwest Atlantic, which include the marine and coastal ecosystems of Argentina, Brazil and Uruguay, from Cape São Tomé in Brazil (22°30'S) to the north of Valdés Peninsula in Argentina (42°S).

Elements needed for the development of a Regional Programme of Action to implement the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities in the region are discussed. These elements were derived based on management objectives identified, and the strategies and programmes designed to reach such objectives.

1. Introduction

The Upper Southwest Atlantic is a very extensive, complex area, consisting of different marine and coastal ecosystems. Its high availability of natural resources offers a substantial contribution to the economical development of the region. Among the main economical activities carried out within this region, fishing and processing of fishery products, as well as tourism, deserve to be recognised. These activities are highly related to the development of other economical activities, which provide work and welfare to many people from the region.

Thus, the protection of the marine environment should be a main goal within the countries that comprise the region, taking into account its high richness, socio-economical importance and potential for future development. Within this framework, the protection of coastal and marine ecosystems against the adverse effects of pollution should be included, for the assurance of a sustained utilization of its resources, as well as its users' health.

The continuous degradation of the marine environment can produce damage to human health by the contamination of marine products, and by direct contact and/or ingestion of contaminated marine water. On the other hand, damage produced on marine ecosystems adversely affects not only tourism exploitation, but also regional fishery potential, which are both significant economic sources for the countries in the region. In addition, the protection and preservation of biological diversity is essential for the future of human health. The prevention of species' extinction is of significant importance, taking into account that they may provide, food, medicine and/or biological control systems against pests and pathogens (WHO, 1992).

In general, the main sources of marine pollution are linked to land-based activities including urbanization and coastal development (dredging, filling operations), energy generation plants, tourism and recreation centers, urban residues, industrial activities, oil bunkering, transport and refinery, coastal mining activities, modification and/or transformation of ecosystems (salt marshes, coastal lagoons).

In the present report, the main land-based activities that may affect the marine, coastal or freshwater ecosystems in USWA countries are reported and prioritized. The specific management objectives are defined, as well as strategies to achieve them, needed for the development of action programmes, are discussed.

2. Characteristics of the Upper Southwest Atlantic Ocean (USWA)

The region considered in the present report is very extensive, and includes the marine and coastal ecosystems of Brazil, Uruguay and Argentina, located between Cabo São Tomé in Brazil (22°30´ S) and the northern part of Península Valdés in Argentina (42° S) (***Figure 1***). It is a large area (approximately 3,350 km of marine littoral), with a high percentage of the population from these countries inhabiting the coast or the shore of rivers associated to coastal systems.

2.1. OCEANOGRAPHIC CHARACTERISTICS OF THE REGION

The region includes two different climatic areas. The overlap of both areas confers very particular characteristics to the region. These are :

Tropical area, which includes Rio de Janeiro and São Paulo states (in Brazil). This area is dominated by the warm Brazil current, which is a branch of the Equatorial Current, and is characterized by the high water temperatures (22 -27°C).

Temperate area, which includes Paraná, Santa Catarina and Rio Grande do Sul states (in Brazil), the Río de la Plata influence area (Uruguayan coast and Buenos Aires Province, Argentina), and the provinces of Rio Negro and Chubut, also in Argentina.

The regional oceanography is influenced by two oceanic current systems: the *Brazil Current* which flows from north to south, and the *Malvinas Current* which flows northerly. Thus, the general circulation in the USWA is characterized by the Brazil Current flowing southerly along the continental margin of Brazil, and the Malvinas Current flowing northerly along the slope of the Argentinian continental shelf (Garzoli & Bianchi, 1987). Both currents are restricted to depths lower than 1500 m (Martos, 1989), and meet at the mouth of the Río de la Plata, between the Rio Grande do Sul state (in Brazil) and southern Buenos Aires province (in Argentina). This creates a strong and wide frontal zone known as the Atlantic Subtropical Convergence (Deacon, 1937), which marks the division between subtropical and subantarctic waters (***Figure 2***).

Within the southeastern coast of Brazil, three main water types are identified : *Tropical waters* (proper of the Brazil Current) with a mean temperature of 25°C and salinity values higher than 36.5‰; *South Atlantic central waters*, with temperatures between 10 to 20°C and salinity of 35-36‰; and, *Coastal waters* which present the least variation between summer and winter.

Within the area shared by Argentinian and Uruguayan waters, a core of frontal systems is produced. These are characterized by a high time-space variability, as well as great biological productivity, which are both due to the different origins of confluence waters (Brandhorst & Castello, 1971). Salinity presents a sharp gradient, which varies from 33-34‰ typical of subAntarctic waters which are transported by the Malvinas Current along the continental shelf to values typical of the Río de la Plata estuary, which varies between 0 and 33‰ (Hubold, 1980a; 1980b).

Along the coast corresponding to the Argentinian continental shelf, three water types are recognized : *(i) Malvinas waters, (ii) Continental shelf waters*, and *(iii) Coastal waters* (Lusquiños & Valdez, 1971 ; Lusquiños & Schrott, 1983). Martos & Piccolo (1988) divided the Argentinian Continental Shelf into two sections : (1) a *coastal region*, with depths less than 40 m, in which the mix due to wind and tides produces vertically homogeneous waters throughout the year and (2) an *external shelf*, with depths varying between 40 and 90 m, with an upper stratum of higher temperatures from spring to autumn, and a strong stratification at the bottom. Salinity distribution shows lowest values southward, with a progressive increase northward, where values near 34‰ are reached (Piola & Scasso, 1988).

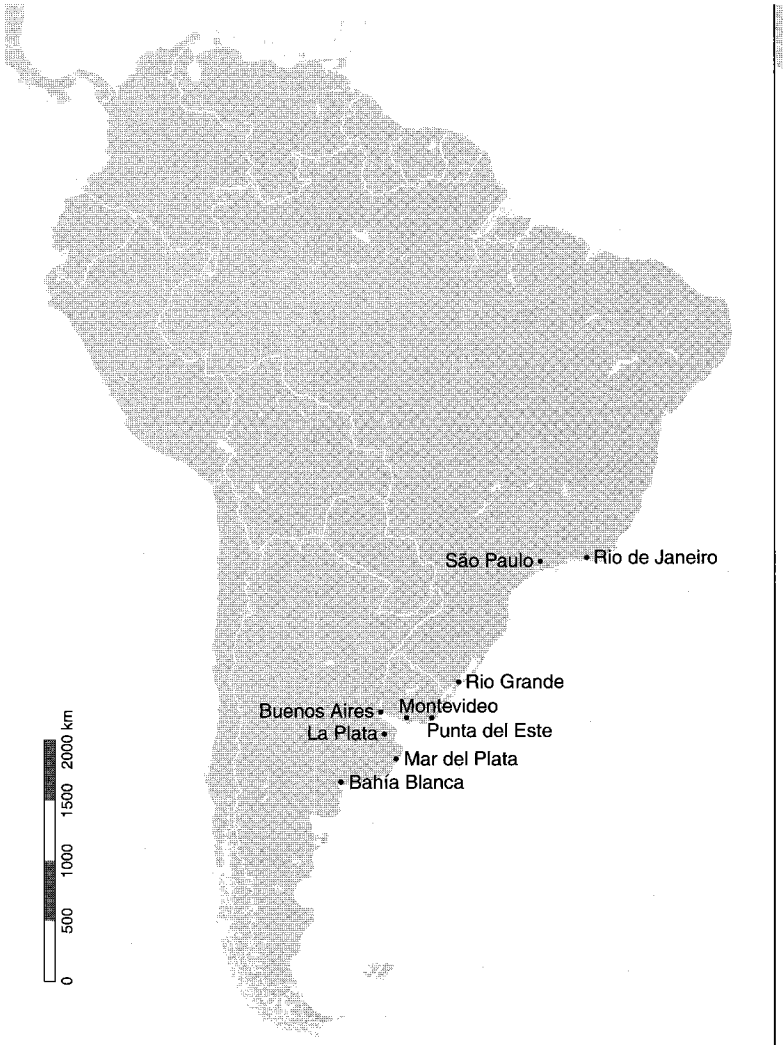

Fig. 1: Countries comprising the Upper Southwest Atlantic

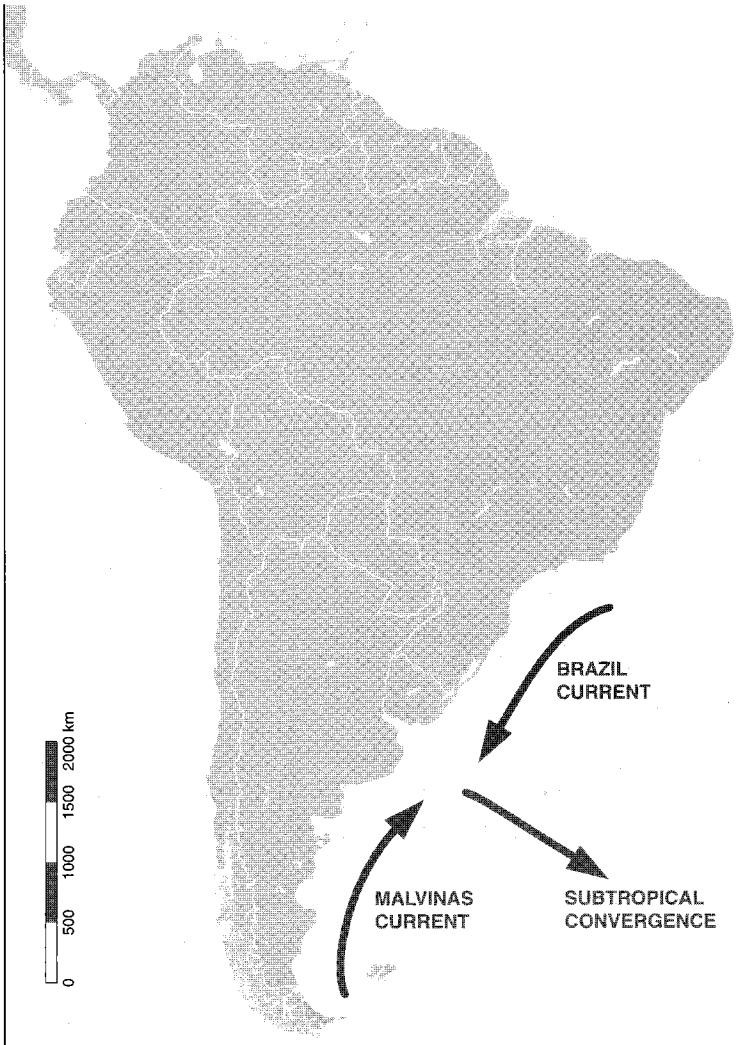

Fig. 2: Main currents in the region

The Patagonian continental shelf is characterized by an integral mix, produced by tide effects (Glorioso, 1987). This condition produces several shelf frontal systems (Bowman, 1977), which are highly important not only as productive systems, but also as spawning and nursery areas for many fish and shellfish species of commercial importance (IOC, 1989).

It should be pointed out that the mean circulation of the Argentinian continental shelf follows a north-northeastern direction, with current speeds between 2 and 20 cm/sec (Forbes & Garrafo, 1988).

2.2. BIOLOGICAL CHARACTERISTICS

Considering that the USWA region includes climates which, as mentioned in the previous paragraphs, varies from subtropical to temperate and its different physiographical structures, a great variety of ecosystems comprise its coastal environment, such as mangroves, shoals, dunes, estuaries, coral reefs, beaches, wetlands, as well as large inland water bodies (**Figure 3**) which flow into this system and significantly influence it.

Fig. 3: Main rivers in the region

All these ecosystems have great importance in the region, considering that they are not only the natural environment for development and reproduction of a high percentage of the marine biota, but also because of their capabilities for regulating interactions between land and sea. In fact, coastal systems are subject to intensive natural dynamics, based on interactions of *marine processes* (waves, tides, currents, oscillations in sea level linked to glatio-eustatic or neotectonic processes, etc.), *climatic* (winds, precipitation, storms, etc.), or *land processes* (river mouths or inland water bodies, continental run-off, etc.). The sum of these natural actions on the morphological entities which integrate the coastal environment, generate constructive and destructive processes, whose equilibrium is responsible for the coastal zone features. However, this delicate equilibrium, consequence of the balance from the *sea-atmosphere-continent* permanent interaction, can be rapidly modified and/or destroyed by human activities carried out without appropriate planning and management measures. Among these activities, the following can be pointed out : coastal urbanization, harbour activities, waste from urban sewer systems or disposal of untreated wastewater, industrial waste disposal, etc.

Each ecosystem integrating the coastal zone has an important role in the region's dynamics. The impact they receive may partially or completely deteriorate its dynamics, and in turn significantly affecting the whole system.

FISHERIES IN THE REGION

Commercial fishing is one of the most important activities in the Upper South-West Atlantic Ocean. Total captures amounting close to 2.136.000 tons have been reported for the region (FAO, 1994). In addition, a total capture close to 362.500 tons of freshwater crustaceans was recorded for the same area (FAO, 1994). Individual total captures for each country in the region have been reported by FAO in the order of 950.000 tons for Argentina, 820.000 tons for Brazil and 121.000 tons for Uruguay. These amounts indicate the great importance of this activity for the three countries, which significantly impact several regional economic processes. Nevertheless, each country's catch effort is concentrated on different species, both freshwater and marine (*i.e.*, see ***Tables 1*** and ***2***), with different target species for each country, i.e. hake and squid for Argentina; *Sciaenidae*, sardines and crustaceans for Brazil ; hake and *Sciaenidae* for Uruguay (Otero *et al.*, 1982).

This important activity provides a great source of employment for the region, not only for fishermen but also for people involved in related harbour activities (shipping supplies, stevedores, transporters, etc), processing and handling of fish products, marketing, exportation, etc. In this context, the development of such activities naturally generates environmental impacts on the coastal zone, through shipping problems (oil spills, dredging, etc), consequences of fishing methods (discards of non-marketable fish, by-catch species, etc), waste from fish processing plants etc.

ENVIRONMENTS OF PARTICULAR IMPORTANCE IN THE REGION

Among the large variety of environments in coastal zones of the Upper Southwest Atlantic two of great ecological importance deserve attention : *mangroves* in tropical and sub-tropical areas ; and *wetlands* in the temperate ones.

M*angroves,* which in the Southwest Atlantic are restricted to the subtropical coasts of Brazil, constitute the natural habitat of several invertebrate, fish, bird and mammal species. Mangroves provide a great food source in detritus to filter feeders (molluscs, decapod crustaceans, fishes); and are critical to the production of nutrients and organic matter for adjacent hydrographic systems (UNESCO,1984). However, this type of ecosystem is also the target of numerous human interventions, such as dredging and filling for urban development, aquaculture complexes, agriculture encroachment, etc. (IUCN, 1983).

A role similar to that described for mangroves is carried out by *wetlands* from temperate coasts of the Southwest Atlantic, being one of the coastal areas of greatest ecological importance in the marine littoral of Argentina and Uruguay (UNESCO, 1982). In these cases, most of the wetlands are *salt marshes*, characterized by marginal vegetation which do not contain trees (as in the case of mangroves) but halophyte plants (mainly *Spartina densiflora, S.montevidensis* and *Salicornia* sp.). Wetlands are responsible for the generation of large volumes of organic matter exported to the coastal system. They exhibit great biodiversity and act as nursery grounds for numerous species of fish, birds, and invertebrates. (Boschi, 1988).

3. Pollution in the Upper Southwest Atlantic Marine Environment

Through numerous publications, reports and communications by researchers from the three countries involved and elsewhere, a significant amount of data on the occurrence, distribution, dispersion and effects of contaminants in the coastal zone of the USWA have been generated during the last twenty-five years. In essence, localised problems of faecal contamination; turbidity increase; heavy metal, hydrocarbon and pesticide contamination have been detected almost along the entire USWA coast (Tommasi, 1987 ; Rebello, 1991 ; Marcovecchio *et al.*, 1994 ; Marcovecchio, 1996).

In general, the most important conflicts identified for this region are related to the: (1) *location of large urban areas* (with the associated problems of sewage discharge and final disposal of solid residues, land drainage, inappropriate land use, high levels of organic matter in water bodies, etc.), (2) *location of large industrial nucleus* (which can cause problems from contamination by heavy metals, synthetic chemical compounds, hydrocarbons, TCDD and/or TCDF and PCBs) , (3) large *agriculture production areas* (with associated fertilizer, agrochemical and pesticide loads) and (4) *drainage basins of larger rivers* (through which residues and/or dumping from wide areas are concentrated and transported) (Turekian, 1971; Ruivo *et al.*, 1972).

From the available information it is possible to determine that the USWA region is not being severely polluted throughout its extention, but problems are due to point-sources of pollution which have caused local crisis of different magnitude. Nevertheless, their effects may impact large areas in the region (CARP, 1989 ; Montone & Weber, 1987 ; Rezende *et al.*, 1987). A detailed regional mapping exercise of land-based sources of pollution that affect coastal marine or related freshwater systems, would allow for the design of a Regional Plan of Action which would assist in addressing their impact.

3.1. ANALYSIS OF LAND-BASED SOURCES OF POLLUTION FOR EACH COUNTRY IN THE USWA

This section, includes the information obtained from each country in the USWA region, based on projects and activities developed in these countries. It also establishes priorities, objectives and development strategies that will allow the elaboration of a Regional Plan of Action as previously mentioned.

3.1.1. Brazil

3.1.1.1. INTRODUCTION

The Brazilian coastal zone represents a challenge for pollution control and environmental management, keeping in mind its large extension, great diversity of both physiographical and biological forms, and variety of development processes which occurs in it. Among these, intense urbanization, port and industrial activities, and large scale tourism operations may be mentioned as examples of processes which generate *conflicts of use*, not only of space but also of resources, creating different types of impact (Freire *et al.*, 1998).

In a Report of the Ministério do Meio Ambiente, dos Recursos Hídricos e da Amazônia Legal (MMA) indicates that concerns related to marine pollution can be interpreted, considering three basic topics : *(i) Main pollution sources ; (ii) Effects on economical activities ; (iii) National and International strategies and actions for decreasing impacts on the marine environment* (MMA, 1996).

The Brazilian area within the Upper Southwest Atlantic (USWA) region includes five States : Rio de Janeiro, São Paulo, Paraná, Santa Catarina and Rio Grande do Sul, with a coast of about 2829 km, which represents 33% of the national coast. Two different climatic areas are represented : a tropical one (Rio de Janeiro and São Paulo) and a temperate one (Paraná, Santa Catarina and Rio Grande do Sul).

3.1.1.2. MAIN POLLUTION SOURCES

Based on the above mentioned report (MMA, 1996), it was established that the main critical points of the Brazilian coast are associated to some of the following factors : (i) *Location of the large metropolitan areas*, with consequential increases of liquid and solid waste volumes for final disposal, which increased organic matter loads, promoting algae growth, reducing dissolved oxygen concentrations, and hence eutrophication. In addition, the introduction of litter results in visual pollution on beaches and in harbours, interfering with the functioning of drainages, and damaging coastal species, (ii) *Location of large industrial centres*, whose waste includes heavy metals and organic compounds which concentrate in seawater and sediment, and can be transferred to the marine biota (crustaceans, molluscs, fishes, mammals, birds, etc.), and eventually to Man and (iii) *Occurrence of estuarine-lagoon areas*, which result in a natural settlement for productive enterprises (aquaculture, raw-material manufacturing, etc.) as well as serving as transitional zones between large rivers and marine areas.

3.1.1.2.1. Characteristics of Urban Occupation

Brazil has an area close to 8.5 million km^2, where the coastal zone occupy 442.000 km^2, representing near 5.2% of the national territory. According to the 1991 National Census data, Brazil has 146 million inhabitants, and around 32.5 million live in coastal municipalities, which represents 22% of the total. This leads to a demographic density of 87 inhabitants/km^2 for the coastal zone, which is five times higher than the mean national density (17inhabitants/km^2). In addition, half of the Brazilian population lives within a distance of 200 km from the coast, which indicates that close to 70 million inhabitants impact on coastal ecosystems.

It is of great importance to take into account that five of the nine metropolitan regions of Brazil are located along the coast (representing near 15% of the country's population) and that if another six important coastal cities are added- near 25 million people inhabit this region. Considering that a large part of this population (those inhabiting suburbs and peripheries) lack basic urban services, then this results in one of the main pollution sources to the marine environment within Brazil (MMA, 1996). As an example, it could be said that Rio de Janeiro, because of its lack of urban services, can be considered one of the cities with most critical environmental situation in the coastal zone (Freire *et al.*, 1998). Two different types of trends for urban development are observed in the Brazilian coastal zone : (i) One typical of great metropolis (*e.g.*, Rio de Janeiro or São Paulo), and (ii) that of adjacent or concentrated smaller cities (*e.g.*, Santos, São Vicente, Guarujá, Cubatão). In this urban spreading scenario, hardly 20% of the coastal population is connected to a sewerage system with corresponding effluent treatment. Therefore, extrapolating data from the Decontamination Programme of Guanabara Bay to the rest of the Brazilian coastal zone, it is estimated that 145 m^3/sec. of raw sewage are discharged, equal to 3655 ton/day BOD into the Brazilian coast, mainly concentrated close to large urban centres. On the other hand, around 90% of the collected solid urban waste are disposed of in open dumps with close to 50% of these located near rivers, lagoons, coastal or conservation areas. It has been estimated that the coastal population generates around 56,000 tons/day of solid waste, and only 42,000 tons/day are collected (Freire *et al.*, 1998).

3.1.1.2.2. Spatial Characteristics of Industries in the Coastal Zone

The following classification of the large industrial complexes located in the Brazilian coastal zone has been proposed by Egler (1995) : (1) Chemicals ; (2) Metal-mechanics ; (3) Agronomic Industries ; (4) Textile and footwear ; (5) Civil Construction.

Chemicals: recently established, they are present in different areas of the coastal zone, not only exploring but exploiting natural resources (from salt to oil). They include chlorine-alkali plants, fertilizers, petrochemicals and derivatives of oil and natural gas, etc.

The effects of chemical industries on the coastal environment are quite important ; *i.e.,* the strong impact of the Cubatão/Capuava complex which has contaminated 11,800 km^2 of mangroves; the environmental degradation of the Bay and Estuary of Santos as well as the whole Baixada Santista ; and the gradual disappearance of the Mata Atlântica in the area of the Biological Reserve of Serra de Paranapiacaba.

Metal-mechanics: it is present in different forms at the coastal zone (mineral extraction, metalurgic plants for both ferrous and non-ferrous compounds, naval industry, etc). Near landing terminals for iron and steel works, large industrial plants have been established (*i.e.,* in Cubatão and Santa Cruz, etc).

Agronomic Industries: the impacts produced by this type of activity on the coastal zone occur through different ways: the increase of both exportation and importation processes have generated the establishment of large amounts of silos and grinders, intense transportation, increase of cultivated surfaces with the associated technological changes, etc.

Textiles: these are scattered not only in the coastal zone close to the largest urban centres but also in smaller centres with intense activity (*i.e.,* Joinville in Santa Catarina). Special attention must be taken with the location of tanneries and textile manufacturers, both considered highly polluting activities.

Civil construction: it includes activities as cement production, sand extraction, etc. This industrial activity has a high correlation with the growth of coastal cities, the increase of industrial centres, the occupation of environmentally strategic areas and increase of infra-structure services etc.

3.1.1.2.3. Pollution in the Coastal Zone and in the Continental Shelf

Recent overviews on this topic have indicated that serious problems of water pollution persist in the region (Niecheski & Tommasi, 1996), despite the great efforts of Rio de Janeiro and São Paulo States since the ´70s to improve their status.

Rio de Janeiro State: Two sub-basins which drain into Guanabara Bay are the areas with the highest water pollution because of industrial activities. The situation is worsening given the extensive harbour activities, oil terminals and dumping of sewage wastes.

Different researchers have reported the occurrence of several types of pollutants in the area ; for example, concentrations of heavy metals in Guanabara and Sepetiba Bays have been reported by Lacerda *et al.* (1988), Rebello (1991), and Marins *et al.*(1996) (***Tables 3, 4*** and ***5***). The biophysical-chemical properties of coastal waters from Rio de Janeiro are strongly influenced by industrial activities and discharges of untreated domestic sewage into Guanabara and Sepetiba Bays, as well as outer areas, through a submarine outfall (Rebello, 1991) ; in fact, an input of 20 m^3/sec of raw sewage effluents into Guanabara Bay has been measured, which produces a high nutrient load in the system (total nitrogen: 30 μM and soluble phosphorous: 2.5 μM) (Rebello, 1991). In addition, Lacerda *et al.* (1989) and Lacerda (1996) postulated that mangroves from Sepetiba Bay retain a great amount of heavy metals, and thus can be considered an efficient selective biogeochemical barrier. The most impacted areas of Rio de Janeiro State are Guanabara Bay and the Bay of Ilha Grande Bay because of oil spills. To date, information on the chronic effects of this kind of pollution is extremely scarce. The occurrence of eutrophication processes in the coastal lagoons of Rio de Janeiro (*i.e.,*Tijuca, Camorim and Jacarepaguá) has been reported (Niecheski & Tommasi, 1996).

São Paulo State: Coastal systems of São Paulo suffers the effects of residues from different origins introduced into their waters. As an example, Santos Bay and Channel as well as the estuarine-lagoon region of Iguapé-Cananeia present high pesticide and detergent residues. The beaches, Bay and estuary of Santos-São Vicente have shown to be polluted (coliforms, heavy metals, pesticides, detergents and oil) along with indications of eutrophication.

Among the numerous reports of environmental assessments in the region by different researchers are studies on metal levels of the Cananeia -Iguapé estuarine system (Eysink, 1988), and of organochlorine compound levels in Ubatuba and São Sebastião, at the coast (Montone & Weber, 1987)(***Table 6***). Poffo *et al.* (1996) reported that 18,200 tons of oil have been spilled in the coasts of São Paulo State between 1974 and 1994 due to different types of accidents. The recovery of such environments have required the mobilization of several thousand tons of sand and sediments, which were consequently lost to the coastal system. Zanardi *et al.* (1996) have reported concentrations of dispersed/dissolved poly-aromatic hydrocarbons (DDPAHs) in the coast of São Sebastião between 0.15 and 10.02 μ/L.. Boldrini & Pereira (1987) have reported the levels of Cu, Pb, Zn, Hg, Cd and Cr in water, sediments and fish from Santos Bay and the estuaries of Santos and São Vicente (***Table 7***).

Great efforts by the State of São Paulo have been carried out to improve the pollution situation mainly from faecal contamination. However, despite such efforts by the State no epidemiological studies link seawater bathing and water-born diseases or fish and shellfish ingestion with such ailments (Niecheski & Tommasi, 1996).

Paraná State: little information exists on marine pollution in the coasts of Paraná State. In the areas close to Paranaguá and Antonina harbours there are two degraded mangrove areas due to serious organic pollution. Regarding water quality in Paranaguá Bay, nutrients have not shown a conservative behaviour, and a strong organic matter remineralization process occurs. The Matinhos and Caiobá beaches had a critical faecal pollution problem, which is improving significantly to the treatment system installed in the region a few years ago (Niecheski & Tommasi, 1996).

Santa Catarina State: The Conceição Lagoon in Santa Catarina Island has received severe environmental impacts (mainly because of faecal pollution), despite its ecological and touristic importance.

There is evidence that effluents from the Carbochemical Catarinense Complex (in the municipalities of Imbituba, Tubarão, Jaguaruna and Içara) are discharged into sea with very high levels of acidity, iron oxides and heavy metals as result of residues from mineralization processes. Other studies have demonstrated the occurrence of heavy metal pollution in Babitonga Bay, close to Joinville. Pollution problems from oil or oil derivatives were identified in the areas of the oil terminal in Itajaí, Imbituba and Laguna harbours (Freire *et al.*, 1998). It should be pointed out that several scientific reports for the area ; *i.e.*, Heinzenet *et al.* (1989) measured metal contents in the North and South Bays, and in the Itacorubí mangroves, in Florianopolis (***Table 8***), as has also been reported by Sierra de Ledo *et al.* (1996) for different mangroves from the region (***Table 9***).

Rio Grande do Sul State: the Lagoa dos Patos is the largest coastal lagoon from Brazil, with an area of approximately 10360 km^2. Together with the Mirim Lagoon they form a lagoon complex which opens into the Atlantic Ocean, and could displace up to 25,000 m^3/sec during the rainy season.

In the region of greater Porto Alegre (5^{th} largest Brazilian city) several industrial areas with different characteristics exist such as petrochemical, metal-mechanic, pulp and paper and refineries, whose effluents are discharged into the rivers of the region. This fact, together with the disposal of urban effluents are responsible for the pollution in the estuarine and riverine systems of the area. The annual balance of nutrients in the Lagoa dos Patos estuary demonstrates that this environment has higher dissolved nitrogen, phosphorous and silicon than those concentrations attributed to continental input. This fact agrees with the occurrence of "red tides", through the appearance of massive blooms of *Microcystis aeroginosa* in the Lagoa dos Patos, as well as of *Gyrodinium aureolum* along the Rio Grande do Sul coast. It is important to mention the studies of Baish *et al.* (1988) and Cunha (1990), who have examined metal levels in the Lagoa dos Patos (Rio Grande do Sul) and adjacent areas (***Table 10***).

3.1.1.3. IDENTIFICATION AND ASSESSMENT OF THE MAIN SOURCES OF POLLUTION

The degradation of the marine environment represents problems for public health, which can be felt for example through contaminated seafood and the use of seawater for recreational purposes (tourism, etc) or through handling and processing of seafood.

A. Determination of the nature and seriousness of the problem

One of the most important problems affecting coastal, marine and riverine Brazilian ecosystems is the disposal of *urban liquid effluents*, which may be done in a raw state or after primary treatment, and subsequently discharged directly in the environment or via submarine outfalls. It is important to note that five of the nine metropolitan areas from Brazil are located on the coast (representing around 15% of the total country population), and -if another six important littoral cities are added- close to 25 million people inhabit the coastal area. A significant percentage of this population that lives in the periphery or metropolitan areas lacks basic urban services, which can be identified as one of the main pollution sources to the Brazilian marine environment (MMA, 1996).

According to information presented by Brazil during UNCED´92, near 20 million inhabitants have no access to treated drinking water, 75 million live in areas without sewerage systems, and 60 million without collection services for solid wastes (CIMA, 1991). As an example, the same report uses data obtained in the Programme for Decontamination of Guanabara Bay and extrapolates it to the entire coastal zone, estimating a sewage effluent volume of 145 m^3/sec, which is equivalent to a load of 3655 tons/day BOD discharged along the Brazilian coast (MMA, 1996).

A second environmental problem which produces severe impacts on the coastal, marine and riverine systems is *industrial effluents discharge*, which affects large areas of the country. Such activities produce not only damages to the largest urban areas nearby where industrial complexes are usually located but also affect the associated river basins which function as carriers of such effluents into the coastal zone. For example, this is the case of the *Paraíba do Sul basin* with an area close to 55,450 km^2- which receives the discharges of 158 cities and towns (38 of them from Rio de Janeiro State and 34 from São Paulo).

Regarding discharges from industrial complexes, the major industries (metals, steel makers, large-scale chemical industries, etc) have strict self-control systems, and count with reliable databases, usually verified by Environmental Control Agencies. By contrast, enforcement in smaller scale industries is not as strong and hence their data are less reliable (MMA, 1996). Discharges from these industries include heavy metal residues, synthetic compounds, hydrocarbons and a variable amount of organic matter (Pfeiffer *et al.*, 1988).

A third group of environmental problems which deserve to be outlined are *harbour activities*, because of their potential to impact coastal systems. They include both effluents as discharged by ships as well as from activities on land. The potential for impacts significantly increases in terminals for oil reception, such as São Sebastião (S.P.) and Angra dos Reis (R.J.). However, oil pollution indexes have significantly decreased with the application of the International Maritime Organization (IMO) rules. Major efforts to significantly reduce their effluents has been undertaken by oil refineries, most of them located in the coastal zone.

Lastly, another group of environmental problems to be considered as potentially harmful to coastal, marine and riverine ecosystems are those by *farming operations*. Among the main effects identified linked to agricultural production within the Brazilian area comprised in the USWA region, are the following:
(1) *Uncontrolled use of chemical fertilizers*, highly soluble or inappropriate for tropical conditions, which percolate towards the underground water reservoirs, reaching rivers, coastal lagoons or bays, which can suffer eutrophication processes. (2) Another impor-

tant item are *pesticides* (for example, organochlorine compounds), used in high amounts, which can pollute water, soil, sediments, biota, and be transferred to man, through food. Pesticides application effects can be detected in the basins of the largest rivers in the region, *e.g.* Paraíba do Sul, as well as their associated coastal zone. In this context, data illustrating such impacts have been reported by The International Mussel Watch (1993) (***Table 11***) and by Taniguchi *et al.*(1996) on organochlorine residues in bivalve molluscs from different points of the Brazilian coast (***Table 12***).

The quantification of this problem is very complex, given the diffuse character of the corresponding sources.

B. Identified Pollutants

Keeping in mind the information presented in previous paragraphs, different types of pollutant activities which affect coastal, marine and riverine environments in the Brazilian USWA region were identified. Based on the documentation analyzed and personal consultations, the following pollutant activities deserve attention:

Sewage Disposal: this is the main source of pollution in the Brazilian coastal system, being responsible for large amounts of organic matter and nutrient inputs to the environment, which can interfere with the balance of receiving systems. A high percentage of urban effluents are discharged raw, or with primary treatment, and are disposed through direct discharges or via submarine outfalls. Close to 75 million people live in areas without sewerage or pluvial systems (CIMA, 1991). The situation is extremely critical for peripheral areas of larger cities, where there are no basic urban services, and more dramatic in marginal settlements. The availability of sewerage systems and the management of urban liquid effluents have significantly improved (from 42.2% to 54.8%) during the ´80s in Brazil, although such improvement in rural areas was minor (from 2.9% to 7.3%) (CIMA, 1991). Data on urban effluent discharges are included in ***Table 13*** which illustrates their corresponding impact on the coastal zone.

Persistent Organic Pollutants (POPs): different types of POPs have been detected in many places of the Brazilian coast, as well as in related freshwater systems. These residues, usually organochlorine compounds (*i.e.,* DDT, HCHs, or HCB) or PCBs are found in both abiotic and biological segments of the coastal zone and large rivers of the region. The information reported by Montone & Weber (1987) (***Table 6***) is of relevance in this context. The occurrence and distribution of these kind of compounds are related to the use of farming-chemical products, utilized to optimize farming production, and to industrial residues disposed into inland water systems transporting these substances to the coastal zone.

Nutrients: One of the main path for magnification of nutrients inflow into aquatic systems -mainly inorganic nitrogen (nitrate, nitrite, etc.) and phosphorous (orthophosphate, polyphosphate) compounds- are untreated (or partially treated) urban liquid effluent discharges. In addition, large amounts of organic matter can be introduced in the environment leading to the significant depletion of dissolved oxygen levels. Large rivers and inland water systems can also act as a source of nutrients and organic matter for the coastal environment. The Paraíba do Sul basin with 55,450 km^2 receive an oxygen demand close to 144.500 kg BOD/day from domestic wastes and 433.500 kg BOD/day from industrial organic wastes, while a simultaneous high input of nutrients is introduced (***Table 14***)(Carneiro *et al.,* 1997). Relevant reports should be considered *i.e.*, those indicating that Rio de Janeiro waters are strongly influenced by industrial activities and untreated domestic effluents discharges, not only in Guanabara and Sepetiba Bays but also in offshore waters through a submarine oufall (Rebello, 1991). An input of 20 m^3/sec of untreated effluents has been measured at Guanabara Bay, producing a high nutrient load in the system (total nitrogen : 30 µM, and soluble phosphorous : 2.5 µM)(Rebello *et al.*,1986 ; 1988).

Sediments and Litter Disposal: many Brazilian coastal States carry out dredging of estuaries and coastal lagoons in order to improve navigation conditions with corresponding sediments usually trans-

ported to mangroves and other marginal areas, which are known for Paraná, Rio de Janeiro and São Paulo. Furthermore, land filling with sediments contaminated with toxic industrial residues has been carried out in several places of the Baixada Santista, S.P., and sediments from harbour dredging (not always of best quality) have been dumped into offshore waters (Tommasi, 1987).

Solid waste management is becoming increasingly complicated, given their usually complex mix of domestic and industrial residues. In several cases, these wastes are located *in open dumps* or in s*anitary landfills* of different quality and complexities. These kind of deposits produce serious environmental and sanitary problems, and it has been estimated that 70% of admissions to public hospitals are linked to illnesses produced by inadequate sanitary services or by their absence (CIMA, 1991). Mangroves, coastal rain forests, coastal lagoons and estuaries have historically been significantly impacted as they were used as waste dumping sites. These kind of practices were observed in Paraná, Rio de Janeiro, São Paulo and Santa Catarina.

Oil Exploitation, Refinary and Transport: this activity is of high environmental risk, mainly because of possible accidents (spills, pipeline breakages, accidents during transport, etc). Available data indicate that 70% of oil is transported by oceanic navigation, 27% by coastal navigation and only 3% by fluvial navigation (ROCRAM, 1989). São Sebastião Channel has shown to be the most critical area in the Brazilian coast because of oil spills, although these kind of accidents have also occurred in other coastal systems, such as Ilha Grande Bay (Rio de Janeiro) and Tramandaí (Rio Grande do Sul) and others. In this sense, CETESB (1990) has recorded 75 accidents for the coast of São Paulo State between 1986 and 1990, with oil or derivatives spilling volumes ranging from 3 m^3 to 120,000 L (although many such events were not immediately assessed). Accidents from oil extraction platforms have also been recorded (*i.e.,* at Campos basin, Rio de Janeiro), but they have not been adequately assessed.

C. Physical Modification

One of the most serious environmental problems of the Brazilian coast is invasion and destruction of different ecosystems, usually for new tourism development, which is a significant obstacle for sustainable development, biodiversity conservation, and development of important economical activities (*i.e.,* several fisheries). This permanent pressure for the creation of new residential areas, clubs, and resorts, is usually felt in habitats such as mangroves, coastal lagoons, coral reefs, wetlands, dunes, estuaries, coastal rain forests, beaches or rockeries, all of them environments of high productivity and biodiversity. The pressure from development over time, can be observed in the coastal areas of Rio de Janeiro, São Paulo, Santa Catarina and Rio Grande do Sul States.

The extraction of mining materials for construction (sand, clay, stone, granite, gravel, etc), not only for construction of new tourism developments but also for building of infrastructures is another severe physical perturbation on coastal marine and riverine environments. These activities produce a significant mobilization of such materials as well as large perturbations, but unfortunately they have not been adequately assessed.

Finally, dam building for electric energy generation seems to be a significant environmental problem which interferes with aquatic ecosystems. Dam building is significantly increasing, and it has been estimated that this trend will continue on next century (Petts, 1990). The Paraíba do Sul and Parnaiba basins are an example of this kind of development in the USWA region. Many rivers of the region and their flows have been affected not only by the construction of dams but also by sediments deposition due to deforestation and erosion processes linked to adjacent farming areas and inadequate operations management. Consequently, rivers and streams usually transport a very high load of suspended sediments, which produce a significant increase in turbidity in associated coastal zones.

D. Pollution Sources and Other Forms of Degradation

Considering the available information, the following *pollution sources* have been identified, as well as *other forms of degradation* affecting coastal, marine and riverine ecosystems in the Brazilian USWA:

Sewage Disposal: the discharge of liquid effluents -both domestic and industrial- is the main pollution source for the region, through the input of nutrients, organic matter, and occasionally heavy metals, POPs and hydrocarbons. Rivers mouths and streams similarly function as pollution sources in non-urbanized areas. A combination of high nutrients and organic matter can produce *eutrophication* in systems with restricted circulation.

Harbour Activities and Oil Terminals: main sources are materials resulting from dredging harbours for navigation channels (and the associated landfilling of coastal habitats), oil spills, malfunctioning of transport systems and/or loading and unloading of fuel.

Industrial Residues: include liquid effluents and solid wastes, usually containing organic matter, heavy metals, POPs, and hydrocarbons.

Farming Activities: include not only fertilizer and pesticide residues used for production optimization, but also the whole continental drainage transported through rivers and streams to the coastal zone.

Physical Degradation of Ecosystems: includes all the effects of invasion/degradation of aquatic ecosystems for new urbanization, mainly for tourism purposes. Other forms of degradation are the landfilling of different ecosystems (mangroves, wetlands, etc) with dredged materials or solid wastes and mining and extraction for construction.

Solid Wastes, Litter and Sediments: include both domestic and industrial wastes, usually disposed in different final sites (open rubbish dumps, sanitary landfills etc). Excessive sediment load due to dam construction, deforestation or erosion linked to farming practices must also be considered.

3.1.1.4. ESTABLISHMENT OF PRIORITIES

Based on the information available and consultations held for the preparation of the present report, the following points can be made regarding trends in coastal management in Brazil:

- The use of *macrozonation* as a main tool for environmental coastal regulation, including social, environmental, economical, political-strategic, territorial and scientific-technological criteria (Becker, 1996).
- Declare the entire coastal zone as priority for territorial planning, keeping in mind the vulnerability of its natural systems (Moraes, 1995).
- Attain a consolidation of linkages between industrial and territorial policies, which would allow planning for sustainable development in this zone (Gonçalves Egler, 1995).
- Implement the National Coastal Management Programme, to re-establish a culture of integrated and participatory planning (MMA, 1996).

On the basis of this diagnostic carried out for the coastal zone of Brazil within the USWA as well as on the above trends in coastal management, the following problems have been identified as priorities for this zone:

1st Priority: ***To treat liquid effluents along with adequate disposal systems to ensure no impacts (or at least, minimize them) on the receiving environment.***

In this way, an overload of organic matter and nutrients will be avoided not only in rivers and streams, but also in the associated coastal zone. It will also prevent the input of industrial residues (heavy metals, hydrocarbons, POPs, etc) which could be transported by them. Such efforts would entail actions in urban areas (*i.e.,* improvements, optimization and

sanitation of sewerage systems; establishment of sewage effluent treatment systems prior to discharge; establishment of submarine outfalls or other adequate disposal systems) and in rural areas (sanitation of rivers and streams receiving regional or effluents of smaller towns; establishment community systems of effluent treatment, etc.).

2nd Priority: ***To prevent physical alterations/ destruction of coastal, marine and riverine habitats associated with the creation of new urban centres or the expansion of urban/city limits.***

These actions require the revision and update of legislation (at the national, state and municipal levels) which regulates land-use and activities which modify habitat structure (*i.e.*, coastal dredging and landfilling; deforestation; construction over dunes or beaches; conversion of mangroves, wetlands, for agricultural purposes etc), including harbour operations and activities.

3rd Priority: ***To eliminate the sources of both industrial and agricultural pollution which affect coastal, marine and riverine systems within the region.***

The sanitation of large river basins from the region is necessary as they receive not only industrial residues -heavy metals, hydrocarbons, POPs, organic matter- but also those from agricultural activities –fertilisers and pesticides. The same is true for adjacent coastal zones which receive the direct discharges of many industries. In addition, a strict control programme for elimination of industrial effluents and of harmful chemical products in farming is required along with incentive programmes for the use of low toxicity pesticides.

4th Priority: ***To establish adequate solid waste and litter final disposal sites, as well as management programmes to address sediment inputs which are irregularly introduced into the system.***

This is a problem related with large urban centres and its solution can assure the conservation of underground water reservoirs (which otherwise may be polluted by percolates), improve health and quality of life (considering the effects of open dumps and the proliferation of rodents and other disease vectors), and address environmental problems (*i.e.*, landfilling of mangroves, wetlands and coastal lagoons). River dams in the region should count with a management programme, to avoiding functioning as a sediment trap which could modify environmental conditions of the area.

5th Priority: ***To optimize the extraction, transport and storage of oil and derivatives.***

In this way, accidents risk (*i.e.*, spills, problems with terminal loading and unloading, breakage of pipelines etc) which require long recovery times for the environment and have very high economic cost could be decreased to a minimum. These problems affect not only coastal zones or large rivers, but also oceanic areas (oil extraction platforms, transoceanic transport, etc).

3.1.1.5. SETTING MANAGEMENT OBJECTIVES FOR PRIORITY PROBLEMS

The concept of the National Environmental System -SISNAMA- from Brazil is based on a central structure that governs the entire environmental control and management system, designed on the basis of socio-economical-environmental sustainability (MMA, 1996). The expectations contained within this framework are as follows :

- Improve and guarantee the environmental quality and sustainability of development.
- Preserve and promote possibilities for the use and benefits of natural resources and scenic values.
- Facilitate a better quality of life for the people, based on environmental health principles.
- Promote the fulfilment of provisions in international agreements related to the

environment or to the quality of life.
- Encourage the participation of the private sector in forums to develop an *entrepeneurial* spirit in the decision-making process regarding the environment, combining financial support sources with the appropriate technical staff.

Taking into account the information in previous sections, the following general management objectives are identified:

- Enforce and implement existing laws, regulations and/or rules on the protection of the marine environment, including the National Coastal Management Plan, as well as strict control systems.
- Implement control programmes of coastal, marine and riverine pollution due to sewage disposal without previous treatment.
- Implement control programmes of coastal, marine and riverine pollution, both of industrial and agricultural origin.
- Minimize the impact of new developments on coastal and marine systems, and develop recovery programmes of affected habitats.
- Standardise local programmes of quality control of ecosystems, integrating them into a National Programme, which should relate to relevant international programmes.
- Include all aspects of coastal management problems in national, state or local mandatory education programmes.

3.1.1.6. IDENTIFICATION OF STRATEGIES AND ACTIONS

In order to attain the above mentioned objectives, the application of the following strategies and actions is recommended :

- Establish the mandatory use of Environmental Impact Assessment (EIA) for any medium or large scale, private or governmental project to be developed within the coastal zone.
- Site, design and build sewage treatment systems, in order to avoid damage to any coastal ecosystem.
- Update both solid waste collection and final disposal systems in order to avoid detrimental environmental conditions.
- Ensure that both public and private sectors count with trained personnel to carry out and coordinate the implementation of Coastal Zone Management systems and Environmental Impact Assessment (EIA).
- Carry out efforts for the recovery of degraded and heavily damaged habitats by human activities.
- Establish water quality monitoring programmes, including measures for environmental enhancement and maintenance with an evaluation of horizontal and vertical distribution of oxygen, nutrients, salinity and inorganic substances.
- Identify and implement measures for the conservation of coastal, marine and freshwater protected areas, in order to maintain their habitats' integrity and biodiversity.
- Monitor all industrial discharges, especially those linked to chemical industries, based on regulations that would enable to assure the fulfilment of local standards for discharge of effluents to the marine environment.
- Reach agreement on monitoring and work strategies with the other countries of the Region that would ensure a common approach to addressing problems of land-based activities.

3.1.1.7. EVALUATION OF THE EFFECTIVENESS OF PROPOSED STRATEGIES AND ACTIONS.

- Establish a continuous programme for environmental quality assessment of coastal, marine and freshwaters in the Brazilian USWA (sediment, water, biota) to serve as baseline data, until research on the status of such environments are completed.
- Conduct epidemiological studies on the

relationship between water quality of habitats, the health of users and quality of food from aquatic origin.
- Carry out monitoring programmes with an advanced technological framework including remote sensing, GIS, and advanced statistical analysis for evaluation of the status of the environment and consequently the efficiency of proposed strategies.
- Develop water quality indexes, to enable rapid evaluations of the effectiveness of applied measures. These indexes should include the variations in key water parameters (dissolved oxygen, temperature, turbidity, nitrates, total phosphorus, faecal coliform density, total organic carbon and total solids).
- Carry out regular cost-benefit analysis of the control options employed.
- Use computer models and simulation techniques in order to forecast the impact of planned projects, and compare these results with those obtained by monitoring programmes carried out from selected strategies.
- Create a regional environmental database, the success of which depends on continuous contact with other countries in the USWA, intercalibration laboratory exercises and critically discuss results obtained with neighbours.

3.1.1.8. PROGRAMME SUPPORT ELEMENTS

The Ministerio do Meio Ambiente, Recursos Hídricos e Amazônia Legal is the central coordination and environmental management agency of Brazil. This agency generates the specific policies for the management, coordination and preservation of the different environments in the country. This Ministry has elaborated a National Coastal Management Programme, through its Secretaria de Coordenação dos Assuntos do Meio Ambiente. Its implementation will no doubt result in significant benefits for the country's coastal ecosystems.

This National Coastal Management Programme (PNGC) is carried out in the framework of a Federal Action Plan for this region. In this context two work and discussion *forums* have been created: *(i)* The Permanent Technical Chamber for Coastal Management, responsible for environmental management issues in the coastal zone and legislation related to the constitutional mandate of Federal scope, and *(ii)* The Group for Integration of Coastal Management (GI-GERCO) which functions in the framework of the Interministerial Commission for Sea Resources (CIRM).

Joint efforts by all these institutions (at national, state and municipality level) are resulting in the elaboration of an *Ecological-Economic Zonation* (which at present includes 40% of the coastal zone) and of 15 management plans. In addition, the necessary equipment for implementation of the *Information System for Coastal Management* (SIGERCO) is being incorporated in different states, as means of integrating states' efforts into a National Programme. All of this knowledge which is being generated allows for interactions with other governmental programmes on related issues *i.e.,* National System for Conservation Units; National Policy for Water Resources ; National Programme for Marine Sciences (it includes Brazilian participation at the Intergovernmental Oceanographic Commission –IOC, Global Observation Ocean System –GOOS, Biodiversity Conservation Programme, etc).

The capacity established to carry out the National Coastal Management Programme includes the interaction of 44 public and private institutions working in different aspects of environmental monitoring such as sampling and methodological harmonisation; quality of air, soil, water, flora and fauna; oceanography and meteorology.

3.1.2. Uruguay

3.1.2.1. INTRODUCTION

The coast of Uruguay in the Upper Southwest Atlantic (USWA) is the shortest in the region, and two

different areas can be identified here, even though a significant overlap exists between the two. These are : *(i) The Atlantic littoral*, which includes the coastal zone between Punta del Este and the Chuy ; and, *(ii) The Argentinian-Uruguayan Maritime Front*, created under the framework of the "Rio de la Plata and its Maritime Front Agreement", signed by both countries in 1973. Although, the second area includes a large part of the first one, it is convenient to consider them separately, given that they differ in several functional characteristics.

3.1.2.2. MAIN POLLUTION SOURCES

Coastal and marine pollution problems in Uruguay seem to originate from three well known kinds of sources : *(i) Urban centres*, which locations and unplanned growth produce higher sewage and solid waste volumes, increasing organic matter discharges into receiving water bodies, *(ii) Areas of Agriculture Production*, where fertilisers and pesticides are applied and which ultimately will reach the coastal environment, and, *(iii)The Area influenced by Rio de la Plata*, whose waters contain residues from the large La Plata Basin, which originates in Brazil and flows through agriculture, industrial and urban areas across Paraguay and Argentina.

The information reviewed shows that no data on marine pollutants from Uruguayan coasts existed before 1980s. Up to that decade surveys had been limited to control the condition of beaches and rivers from a bacteriological perspective. From the 1980s Uruguay has concentrated its efforts in monitoring and environmental studies of La Plata River, together with Argentina.

As an example, Kurucz (1987) has found high contents of organochlorine compounds (a-HCH: 10-100 ng/L ; g-HCH: 20-150 ng/L ; dieldrin: 15-130 ng/L) in the Uruguayan coastal zone, close to Andreoni Channel and Chuy River, on the border with Brazil.

One of the most important studies on La Plata River has been carried out under the coordination of the Commission for Administration of La Plata River (CARP, 1989), including scientific institutions from both Argentina and Uruguay, which provided a complete update of the environmental condition of the river (***Table 15***).

Moyano *et al.*(1991) have studied the occurrence of pollutants in intertidal sands close to Montevideo, reporting that the most polluted area was the Pantanoso Stream followed by the Paraguay sewage outlet, which receives about 75% of Montevideo's industrial discharges. In a later study Moyano *et al.* (1993) have determined high levels of heavy metals, aliphatic and polynuclear hydrocarbons sediments from Montevideo (***Table 16***).

3.1.2.3. IDENTIFICATION AND ASSESSMENT OF MAIN SOURCES OF POLLUTION

Different studies in several areas of the Uruguayan coast, as well as in La Plata River and other inland water bodies, have allowed the identification of several pollution sources that generate (or could generate) detrimental effects on the environment, making food production, recreational activities and other benefits difficult.

A. Determination of the Nature and Seriousness of the Problem

One of the most serious environmental problems in the Uruguayan coast of the USWA is the *discharge of domestic liquid effluents*, usually in a raw state or after primary treatment, which may be directly introduced in the environment or through submarine outfalls. The areas influenced by Montevideo receive the highest impact, considering its high population (close to 1.2 million inhabitants), high industrial density (near 46% of total of the country, including tanneries, chemicals, textiles, galvanic-plastics, refineries, etc). A sanitation network is at present being improved and receives large amounts of raw industrial residues (IMM, 1985). Most of the tanneries are located in two areas, the basin of Pantanoso stream and the basin of Carrasco stream, most of which use chromium in tanning and consequently it

has been estimated that the chromium load originated by Montevideo´s tanners is closed to 660 tons/yr (Moyano *et al.,* 1991).

Lead and mercury pollution seem to be the most important from chemical industry effluents originated respectively by paints and batteries factories (representing around 360 kg Pb/yr) and by chlorine-alkali plants (inputs 1.1 ton Hg/yr). A high amount of hydrocarbons is introduced into the atmosphere by refineries (2600 to 4570 tons/yr), which is equivalent to those of the entire Uruguayan vehicles fleet (close to 3000 tons/yr) (García Agudo, 1990). Moreover, nearly 180 m^3/day of water saturated with hydrocarbons is imputed into refinery effluents (Moyano *et al.,* 1991).

Lastly, *activities linked to agriculture production* are another group considered as a potential generator of impacts in the coastal, marine and freshwater systems of Uruguay. This activity is one of the most economically significant for this country, especially the production of cereals, rice, and pasture for cattle. Agriculture activities are developed inland, and different types of chemical compounds are usually applied to improve both the quality as well as the volume of the harvests. Fertilisers are used to increase the nutrient loads in the soil, and biocides for the control of different kind of pests (insects, harmful grasses, etc.). These compounds can contaminate not only soils but also the underground water reservoirs, surface freshwater, and the coastal and marine areas via large rivers.

B. Identified Pollutants

Different kind of pollutants affect the coastal, marine and riverine environments of Uruguay, as demonstrated by the bibliography consulted. Amongst them, the following groups should be mentioned :

Sewage Disposal: this is one of the main pollution sources in the Uruguayan coast, considering that part of the effluents are discharged in raw state or partially treated and their effects can produce an unbalance of the corresponding ecosystems. It is important to remark that main Uruguayan cities are located on the coast or along La Plata River (*i.e.,* Montevideo, Punta del Este, Piriápolis, Colonia del Sacramento), and their effluents are consequently discharged in these environments. In the Montevideo area the situation is complicated by inhabitants of the periphery and city suburbs, where the lack of basic urban services is significant. This situation is more dramatic in marginal settlements of these areas. A part of Montevideo´s liquid effluents are discharged into the La Plata River through a submarine outfall built in 1990, whose outlet is at 2.3 km from the coast, discharging near 1,000 L/sec.

Persistent Organic Pollutants (POPs): different concentrations of POPs have been detected in several places of the Uruguayan coast or in the La Plata River. Among others, different concentrations of organochlorine compounds (*i.e.*, a-HCH ; g-HCH ; dieldrin ; HCB ; heptachlor ; heptachlor epoxide ; aldrin)(***Table 15***). The activities linked with agriculture production have generally been recognized as the main source of these compounds to the coastal zone, through streams or small rivers that reach the marine littoral or the La Plata River.

Nutrients: the most significant nutrient sources in the coastal, marine and riverine systems seem to be urban liquid effluent discharges, irrespectively of the natural cycles which regulate their concentrations. The areas with highest nutrient concentrations in La Plata River (NO_3 : 1.28-59 µmol/L ; NH_4 : 0.62-30.1 µmol/L ; NO_2 : 0.01-4.26 µmol/L ; PO_4 : 0.01-4.52 µmol/L) coincide with areas close to urban effluents discharges or outlets of streams of neighbouring small town (CARP, 1989). Moreover, very high amounts of organic matter enters the system from the same sources, which in particular conditions could produce significant depletions of dissolved oxygen at certain points in the river. This situation is limited to focused areas, keeping in mind the enormous water volume circulation in La Plata River which is close to 20000 m^3/sec, with corresponding seasonal variations, making it practically impossible a generalisation of this problem.

Solid Wastes Disposal: domestic solid residues from the urban centers are generally disposed in systems varying from open *rubbish dumps* and *sanitary landfills* with different degrees of design, quality and efficiency. It is commonly possible to observe solid wastes in particularly plastic along the coastal areas, mainly those of Montevideo. This phenomenon significantly increases during the rainy season, either because of drainage system oversaturation or from obstruction of streams and smaller rivers by waste. Montevideo's average waste collection varies between 900 to 1,000 tons/day.

Oil Transport and Store: La Plata River is the main route for tanker ships transporting oil or derivatives, not only to the largest harbour of Montevideo but also the upper basins of Paraná and Paraguay rivers. The activities of this kind of ships such as tanks or bilge cleaning and occasional spills, produce a significant impact on the eastern coast of Uruguay, which includes important touristic centers. For example, a monobuoy for oil supply functions at José Ignacio, 25 km from Punta del Este, the most important touristic nucleous of the country. A tanker ship transporting oil has run aground on Punta del Este's coast in February 1997, producing a large spill on its beaches and shoals with the consequent environmental and economical damages to this city.

C. The Physical Modification

For many years the coast of Uruguay has suffered severe degradation and modifications. These processes have been generally linked to the development of new urban centres (towns, infrastructure for tourism, docks and marinas, etc). Jackson (1988) has briefly described the erosion and degradation problems that Montevideo coast has suffered to develop its harbour as well as warehouses and railway terminals of the area.

Similarly, the submarine outfalls which discharge sewage effluents between Punta Brava and Punta del Este (Punta Brava, Atlántida, La Paloma and Punta del Este) or the outfall of the José Ignacio oil terminal usually require both maintenance and continuous transport of materials. Nevertheless, the potential impact that these modifications can produce on the coastal zone has not been adequately evaluated.

D. Pollution Sources and Other Forms of Degradation

As a result of the analysis based on the available information, the following *Sources of Pollution* as well as *Other Forms of Degradation* for coastal, marine and freshwater ecosystems of Uruguay have been identified :

Sewage Disposal: the discharge of liquid effluents both domestic and industrial is the main pollution source for the region, producing the input of nutrients, organic matter, and occasionally heavy metals, POPs and hydrocarbons.

Farming Activities: through these activities, fertilisers and different types of biocides (and their derivatives) are introduced into the system. They can be introduced not only in a direct form (rain, wind, etc) but also indirectly via streams and rivers. Results demonstrate that these activities are a significant pollution source for Uruguayan coasts. Soil erosion produced by inadequate agricultural practices can also be included under this item.

Industrial Residues: These are mainly restricted to Montevideo and its influence area, and include liquid effluents and solid wastes, usually containing organic matter, heavy metals, POPs, and hydrocarbons.

Physical Degradation of Ecosystems: this is one of the problems producing the most severe damage to the Uruguayan coastal zone. It includes all the effects of invasion/degradation of aquatic ecosystems due to new urban developments, mainly for tourism purposes. Mining activities for construction have to be included as another source of impact in the coastal zone.

Solid Wastes, Litter and Sediments: include both domestic and industrial wastes, usually disposed in different final sites (open rubbish dumps and sanitary landfills).

Harbour Activities and Oil Terminals: refers to materials resulting from dredging in harbour navigation channels and the associated landfilling of coastal habitats, oil spills, transport systems and deficiencies in the loading and unloading fuel systems.

3.1.2.4. ESTABLISHMENT OF PRIORITIES

Based on the information available and consultations held for the preparation of the present report, the following are the main problems which affect the coastal zone of Uruguay in the USWA :

- The *unplanned growth of coastal urban centres*, with a range of environmental problems as previously described (increasing sewage discharge, eutrophication and others).
- The coastal zone must be understood as a special area, with its own functioning and requirements which demand *territorial management and planning* designed to preserve their extremely vulnerable natural systems.
- Strengthen the linkages between environmental policies and those of other sectors such as industrial and economics which would allow to enhance the control and management of land-based pollution sources.
- Develop a programme on *Sustainable Development Planning for the Coastal Zone*, which would allow for the rational use of its resources and the preservation of its habitats and ecosystems.
- Develop a *National Coastal Management Programme*, addressing all issues previously described, including a component on integrated and participatory planning.

1st Priority: ***To treat liquid effluents along with adequate disposal systems to ensure no impacts (or at least, minimize them) on the receiving environment.***

On the basis of this diagnostic carried out for the coastal zone of Uruguay in the USWA, as well as of the above mentioned actions, the following have been identified as priorities for this zone:

Addressing this problem would minimise one of the most severe issues which impact on the Uruguayan coastal, marine and freshwater systems, allowing for the sanitation of environments of significant importance. Currently, an overload of nutrients and organic matter inputs to the La Plata river and the Uruguayan Atlantic coast occurs not only through urban effluent *'formal'* discharges (submarine outfalls, etc) but also *'informal '* ones (streams, rivers, etc). Other kinds of potentially dangerous residues (*i.e.*, heavy metals, hydrocarbons, POCs, etc) might also be included in such discharges, as pointed out in the literature. Ways to resolve this situation must necessarily include: *infrastructure works in urban areas* (*i.e.,* improvements, increase efficiency and upgrade sewage networks; construction of sewage effluent treatment systems appropriate to the selected receiving environments) and in *rural areas* (*e.g.* programmes for sanitation and environmental recovery of streams and rivers receiving effluents from small communities or farming areas; development of community programmes for small-scale effluent treatment, which have demonstrated to be fully successful in other Latin-american countries, etc.).

2nd Priority: ***To eliminate the sources of industrial pollution which affect coastal marine and riverine systems in the region.***

A significant input of toxic wastes coming from industries into the main streams and/or secondary rivers of the region has been pointed out in the bibliography. Thus, the establishment of a clean-up programme for main inland water bodies of Uruguay is required to avoid the input of these kinds of compounds (*i.e.*, heavy metals, hydrocarbons, POCs, biocides, etc) into La Plata river and the Uruguayan Atlantic coast. Furthermore, a strict control programme for elimination of industrial effluents of low quality should be established to minimize environmental impacts.

3rd Priority: ***To eliminate the sources of agriculture pollution which affect coastal, marine and riverine systems in the region.***

The importance of agricultural and farming activities in Uruguay was demonstrated in the analyzed bibliography through the volume of chemical compounds used in optimising operations. Thus, the establishment of a clean-up programme for main inland water bodies of Uruguay is required to avoid the input of these kinds of compounds (*i.e*, fertlizers, insecticides, herbicides, biocides, etc) into La Plata river and the Uruguayan Atlantic coast. In addition, a strict control programme for commerce and application of agricultural chemicals is required to minimise environmental impacts. The development and application of an *award system* (*i.e.*, tax discounts and other incentives) should be considered for farmers who use low toxicity pesticides and of *penalties* (*i.e.*, tax increase, etc) in opposite cases.

4th Priority: ***To prevent physical alterations/ destruction of coastal, marine and riverine habitats associated with the creation of new urban centres or the expansion of urban/city limits***.

The expansion of new urban centres or infrastructure development on coastal, marine and freshwater natural systems have been recognised as a significant environmental problem in Uruguay. The updating and enforcement of legislation at different levels (national, state and municipal) which regulate land-use as well as activities modifying habitat structure (*i.e.,* coastal dredging and filling ; deforestation ; construction over dunes or beaches ; expansion of farming, etc.) must be carried out. Actions should include provisions to address sound environmental operations of harbours.

5th Priority: ***To establish adequate solid waste and litter final disposal, avoiding environmental impacts on coastal systems.***

This is a major concern affecting coastal systems in Uruguay, which must be tackled to improve both environmental conditions and the health of populations. Solutions to be devised should include an adequate selection of environmental areas apt for final solid waste disposal and of most appropriate disposal technologies and management programmes (*i.e.*, sanitary landfill; sorting and recycling ; biogas generation ; etc), considering both environmental and economic abilities of the country. Addressing this problem will assist in the protection of underwater reservoirs, wetlands, marshes and coastal lagoons and will improve the quality of life of populations.

3.1.2.5. SETTING MANAGEMENT OBJECTIVES FOR PRIORITY PROBLEMS

The use of natural resources including those of the coastal zone have a central role in the socio-economic structure of Uruguay, indicating that the establishment of a Planning, Management and Control System is fundamental to guarantee the sustainable use and future conservation of ecosystems. Thus, the expectations and goals arising from this analysis are extremely similar to those derived for Brazil (see section 3.1.1.5) and are reinstated below as follows :

- Improve and guarantee the environmental quality and sustainability of development.
- Preserve and promote possibilities for the use and benefits of natural resources and scenic values.
- Facilitate a better quality of life for the people, based on environmental health principles.
- Promote the fulfilment of provisions in international agreements related to the environment or to the quality of life.
- Encourage the participation of the private sector in forums to develop an *entrepeneurial* spirit in the decision-making process regarding the environment, combining financial support sources with the appropriate technical staff.

Taking into account the information in previous sections, the following general management objectives

are identified:

- Develop a National Coastal Management Plan, including provisions for territorial zoning of the coastal area, as well as regulations for land-use and for minimising the impacts of new developments on coastal systems.
- Carry out control programmes of marine and coastal pollution due to untreated sewage disposal.
- Implement control programmes for marine and coastal pollution both of industrial and agricultural origin.
- Develop recovery programmes of affected habitats by any of the mentioned sources.
- Standardise local programmes of quality control of ecosystems, integrating them into a National Programme, which should relate to relevant international programmes.
- Include all aspects of coastal management problems in national, state or local mandatory education programmes.

3.1.2.6. IDENTIFICATION OF STRATEGIES AND ACTIONS:

In order to attain the above-mentioned objectives, the application of the following strategies and actions is recommended, which once again mirror in its majority, those proposed in the case of Brazil (see section 3.1.1.6):

- Site, design and build sewage treatment systems, in order to avoid damage to any coastal ecosystem.
- Establish water quality monitoring programmes, including measures for environmental enhancement and maintenance with an evaluation of horizontal and vertical distribution of oxygen, nutrients, salinity and inorganic substances.
- Update both solid waste collection and final disposal systems in order to avoid detrimental environmental conditions.
- Carry out awareness programmes on the use of low toxicity pesticides, and encourage its use through the application of economic incentives for farmers (taxes exemptions, credit rates and others)
- Establish the mandatory use of Environmental Impact Assessment (EIA) for any medium or large scale, private or governmental project to be developed within the coastal zone
- Carry out efforts for the recovery of degraded and heavily damaged habitats by human activities
- Identify and implement measures for the conservation of coastal, marine and freshwater protected areas, in order to maintain their habitats' integrity and biodiversity.
- Ensure that both public and private sectors count with trained personnel to carry out and coordinate the implementation of Coastal Zone Management systems and Environmental Impact Assessment (EIA).
- Monitor all industrial discharges, specially those linked to chemical industries, based on regulations that would enable to assure the fulfilment of local standards for discharge of effluents to the marine environment.
- Reach agreement on monitoring and work strategies with the other countries of the Region that would ensure a common approach to addressing problems of land-based activities

3.1.2.7. EVALUATION OF THE EFFECTIVENESS OF PROPOSED STRATEGIES AND ACTIONS

- Establish a continuous programme for environmental quality assessment of coastal, marine and freshwaters in the Uruguayan USWA (sediment, water, biota) to serve as baseline data, until research on the status of such environments are completed.
- Develop water quality indexes, to enable rapid evaluations of the effectiveness of applied measures. These indexes should

include the variations in key water parameters (dissolved oxygen, temperature, turbidity, nitrates, total phosphorus, faecal coliform density, total organic carbon and total solids).
- Conduct epidemiological studies on the relationship between water quality of habitats, the health of users and quality of food from aquatic origin.
- Carry out monitoring programmes with an advanced technological framework including remote sensing, GIS, and advanced statistical analysis for evaluation of the status of the environment and consequently the efficiency of proposed strategies.
- Use computer models and simulation techniques in order to forecast the impact of planned projects, and compare these results with those obtained by monitoring programmes carried out from selected strategies.
- Carry out regular cost-benefit analysis of the control options employed.
- Create a regional environmental database, the success of which depends on continuous contact with other countries in the USWA, intercalibration laboratory exercises and critically discuss results obtained with neighbours.

3.1.2.8. PROGRAMME SUPPORT ELEMENTS

The Ministerio de la Vivienda, Ordenamiento Territorial y Medio Ambiente (MVOTMA) is the central agency for environmental management and coordination in Uruguay. This Ministry generates specific policies for territorial planning, environmental management and preservation of ecosystems for the entire country. Regarding coastal zone management and planning, this Ministry, through the Dirección Nacional del Medio Ambiente, DINAMA- is taking part in the preparation of a *Programme on Integrated Management of the Coastal Zone of La Plata River* (GIZC), which is a continuation of the Programme *"Ecoplata 1"*, developed in previous years. This Programme counted with the participation of several institutions from Uruguay (SOHMA, INAPE, Universidad de la República, DINAMA, and several non-governmental organizations) and Canada being financially supported by CIID (Canada). The *Programme on Integrated Management of the Coastal Zone of La Plata River* (GIZC) is currently under preparation and its implementation will result in significant benefits for this country's coastal ecosystems.

In order to attain an effective implementation of this programme which is highly complex and the objectives established previously some suggestions are provided below which may be useful :

- Establish and emphasize a *coordination* system that would assure the participation in the Programme, in different degrees, of all agencies having a role on coastal and marine activities.
- Enforce the implementation of all legislation, regulation, rules and standards related to the control of coastal activities.
- The institutional arrangement and financial capabilities of MVOTMA should be the appropriate for the implementation of programmes and the application of corresponding strategies. If not : *i) They should be enhanced*; or, *(ii) Other available support facilities should be tapped within the country* (for example, Universities, Research Centers, National Navy, etc.) *through cooperation agreements.*
- Ensure that qualified staff, experts and technicians and the support needed for the implementation of programmes and strategies selected (for example, CZM or EIA) are available.
- Review and update the available legislation related to marine environment protection, in order to maintain an effective legal framework
- Build on and use existing local, national and regional networks in order to avoid duplication and profit from previous experiences (*i.e.*, Technical Commission of the Maritime Front

-CTMFM, Commission for Administration of La Plata River –CARP, Regional Group ASOS in the framework of IOC, etc).

3.1.3. Argentina

3.1.3.1. INTRODUCTION

The coastal zone of Argentina as included in the Upper Southwest Atlantic Ocean (USWA) can be basically divided in three areas : *(i) The Argentinian - Uruguayan Maritime Front*, created under the "Rio de la Plata and its Maritime Front Agreement" framework and signed by both countries in 1973; *(ii) The Atlantic coast of Buenos Aires Province*, which is included in the area described in *(i)*, but deserves to be considered separately because of its characteristics; and, *(iii) Coastal Zone of San Matías Gulf*, in the argentinian Patagonia.

Among these three areas, the first one receives more attention, bearing in mind that La Plata River is under the La Plata Basin influence, a large drainage system including areas from four countries (Brazil, Paraguay, Uruguay and Argentina) and flowing across industrial, agriculture and urban zones.

3.1.3.2. MAIN POLLUTION SOURCES

Coastal and marine pollution problems in Argentina seem to have four well known kinds of sources : *(i) The urban centers*, whose location and unplanned growth produce high sewage and solid waste volumes, increasing organic matter loads into receiving water bodies. *(ii) Areas of Agricultural Production*, where fertilisers and pesticides are applied indiscriminately which will eventually end up in the coastal environment; *(iii) The Area influenced by Rio de la Plata,* whose waters contain residues from the large La Plata Basin which originates in Brazil and flows across Paraguay, Uruguay and Argentina, including agriculture, industrial and urban areas; and, *(iv) The industrial centres*, located in different points of the coastal zone and including quite different activities (metallurgical, textile, petrochemical, pharmacological, etc).

Among the studies done on the La Plata River influence area, is worth mentioning the one coordinated by the Commission for Administration of La Plata River (CARP, 1989), and carried out by the Hydrographic Service of the Argentine Navy (SHIN) and the Hydrographic, Oceanographic and Meteorological Service of the Uruguayan Navy (SOHMA). This study determined the hydrographical conditions of both the river and mixing waters, as well as the distribution of pollutants in water and sediments. Relevant data reported in this work is presented in ***Table 15***.

In 1991, Janiot & Roses have determined the occurrence and distribution of 14 organochlorine pesticides, including a-HCH, g-HCH, d-HCH, aldrin, dieldrin, heptachlor, DDD, DDE and DDT among others (***Table 17***). Segneur *et al.* (1991) have found the same pesticides in two migratory fish species from La Plata Basin, *Salminus maxillosus* and *Prochilodus lineatus*, and reported values below those recommended by FAO as apt for human consumption.

In 1992, AGOSBA-OSN-SHIN studied environmental conditions in the Argentine coastal area of La Plata River, determining high concentrations of toxic heavy metals, nutrients, pesticides and coliform bacteria (***Table 18***). It is important to remark that this information was recently updated (AA-AGOSBA-ILPLA-SHN, 1997) by the Permanent Council for Water Quality Monitoring in the Southern Coast of La Plata River. Moreover, heavy metal concentrations have been recorded in tissues of several fish species from Samborombón Bay, in the outer area of La Plata River (Marcovecchio *et al.*, 1989 ; 1992 ; 1993) (***Table 19***).

Numerous studies have also been developed in the southeastern coast of Buenos Aires Province, and among others, data reported include concentrations of heavy metals in marine sediments (Ferrer *et al.*, 1993), in marine organisms (Scampini *et al.*, 1993 ; Andrade & Marcovecchio, 1994 ; Scarlato *et al.*, 1994 ; Andrade *et al.*, 1996.a) , in sediments (Ferrer *et al.*, 1996.a) (***Table 20***) and in suspended particulate matter (Andrade *et al.*, 1996.b) (***Table 21***) from the

Mar Chiquita Coastal Lagoon.

One of the best-studied environments in Argentina is the Bahía Blanca estuary, in the southern area of Buenos Aires Province, where a large harbour and one of the largest industrial centres of the country are located. Among others, studies assessing the occurrence and distribution of heavy metals in seawater (Villa & Pucci, 1985 ; 1987 ; Villa, 1986 ; 1988 ; Andrade *et al.,* 1996.c ; 1996.d) (***Table 22 and 23***), surface sediments (Pucci *et al.,* 1980 ; Sericano & Pucci, 1982 ; Marcovecchio *et al.,* 1986 ; Pucci, 1988 ; Ferrer *et al.,* 1996.b) (***Table 24 and 25***), and in the biota characteristic of this environment (Marcovecchio *et al.,* 1988.a ; 1988.b ; 1991 ; Marcovecchio, 1994) have been reported (***Table 26***). Furthermore, studies on the occurrence and distribution of pesticides have been carried out, and residues of HCH, lindane, heptachlor, aldrin and DDT,among others, have been recorded (Sericano & Pucci, 1984.a ; 1984.b ; Sericano *et al.,* 1984) (***Table 27***).

Lastly, among the scientific studies in the Patagonian area, it is worth noting the papers of Esteves *et al.* (1996.a) with data on urban pollution at San Antonio Bay, and that of Commendatore *et al.* (1996) on heavy metals and hydrocarbons distribution in the Patagonian coastal zone.

3.1.3.3. IDENTIFICATION AND ASSESSMENT OF THE MAIN POLLUTION SOURCES

Problems considered under this item are those which can produce degradation in the coastal, marine or freshwater environments, resulting in structural or functional environmental alteration, or in detrimental effects to human health through seafood contamination, or use of seawater for recreational activities or food preparation.

A. Determination of the Nature and Seriousness of the Problem

Among the problems affecting coastal marine and freshwater environments of Argentina, the discharge of *domestic liquid effluents* must be considered, given that they are usually eliminated in raw state or after primary treatment through submarine outfalls or direct discharges. Therefore, the fact that the most densely settled cities from Argentina (Rosario, Santa Fe, Buenos Aires and outskirts, La Plata and outskirts) are located along La Plata river basin or along the Atlantic coast (Mar del Plata, Necochea, Bahía Blanca, etc) must be underlined. Thus, around 20 million people inhabit the Argentinian coastal area of interest to this report. It must be also noted that a great part of this population in the outskirts of these cities lacks basic urban facilities (drinking water access and sewage systems, solid waste collection and disposal, etc.). These problems constitute one of the main pollution focus of the aquatic systems in Argentina.

According to a report of AGOSBA-OSN-SHIN (1992) the entire population of Buenos Aires city counts with drinking water facilities, whereas this figure decreases to 51% of the population in the periphery of town. The same study indicates that the entire population of Buenos Aires city is served by sewage facilities and system, but only 33% of the population in the outskirts has access to it. It must be remarked, however, that the government of Buenos Aires Province has begun and has already constructed a great amount of sanitary infrastructure within the last three years, in order to solve this situation within the periphery of Buenos Aires.

The AGOSBA-OSN-SHIN report also identifies the main pollution sources for the Argentinian coast of la Plata river, which are mainly due to: (1) Untreated or poorly treated water discharges; (2) Discharge of effluents or muddy sewage; (3) Contaminated rainwater; (4) Hydrocarbon spills; (5) Waste dumping; (6) Sedimentation of organic solids.

The above problems are of less concern in the Buenos Aires Atlantic coast, because of the characteristics of the receiving environment which presents open coastal waters without natural barriers and very intensive dynamics. In addition, most of the cities in the area either already have domestic sewage treat-

ment systems or they are being currently developed.

The second problem which specially affects the La Plata river coast is *industrial effluent discharges*, most of which are disposed through the sewerage systems of urban centers and through secondary rivers or streams in the region (Riachuelo, Luján, Matanza, Sarandí, Santiago, and channels and ducts). These industrial effluents are responsible for the occurrence of heavy metals, hydrocarbons, pesticides, tensoactive substances, phenols and PCBs, among others, in water and sediment from La Plata river (AGOSBA-OSN-SHIN, 1992). Moreover, several reports indicate that effluents from these industries (petrochemical, textile, pharmacological, metalurgic, food industries) include heavy metal, synthetic and hydrocarbon residues, and variable amounts of organic matter (i.e. Pucci., 1988 ; Marcovecchio *et al.*, 1994).

Agricultural-linked activities are considered as another important problem that also generates environmental impacts on coastal, marine and freshwater environments in Argentina. In this sense, the use of fertilisers and pesticides for the enhancement of production, as well as the intensive land use (which originate erosion processes) and monocultures (which cause soil depletion and desertification) must be mentioned. Agrochemical products can reach coastal and marine systems through continental run-off and through main rivers which open into the La Plata river (Salado, Samborombón, etc.) or into the Atlantic coast (Colorado, Negro, etc.). As an example, in 1995 the *International Mussel Watch Project* presented a Final Report on the monitoring of organochlorine compounds and PCBs in the marine environment through bivalve molluscs. Specimens from sampling stations located in the Argentinian coast (Hudson, Atalaya, Mar del Plata, Pehuén-có, Arroyo Parejas, etc.) presented OCs and also, in some cases, PCBs contents (I.M.W.P., 1995).

Lastly, *harbour activities* deserve to be considered as another problem, due to their potential ability to impact on coastal marine and freshwater systems. These activities include operations for effluent discharge operations, vessels' maintenance and fueling, and support activities on land. The most affected areas in Argentina are those associated with Buenos Aires, La Plata, Rosario, Mar del Plata, Necochea and Bahía Blanca harbours. Due to the application of the International Maritime Organization (IMO) rules, oil pollution indexes have been sharply reduced. An important effort is being observed in refineries in order to reduce the amount of their effluent discharges. A Cleaning Harbour Programme is currently being implemented in Buenos Aires Province, where the most important harbours are located.

B. Identified Pollutants

Based on a review of relevant literature bibliographic different groups of pollutants could be identified. These impact in different ways and in different magnitudes in the Upper Southwest Atlantic Ocean in Argentina. Among them, the following deserve to be considered:

Sewage Systems: this is likely the main pollution source for the Argentinian coast and it is responsible for the inputs of great amounts of organic matter and nutrients, which under particular conditions can produce an unbalance of ecosystems. This is highly critical within the area of La Plata river, particularly around Buenos Aires and La Plata cities, and their outskirts. A high percentage of liquid urban effluents are discharged to the receiving environment raw or partially treated through direct discharges or by way of an outfall. As previously reported, towns in the periphery of Buenos Aires and La Plata lack of basic services and there are no sewage disposal systems. The governments of Buenos Aires city and of Buenos Aires Province are presently developing sanitation programmes in order to provide a solution to this problem.

Persistent Organic Pollutants (POPs): This kind of residue has been detected in different areas from the Argentinian coast (La Plata river, Bahía Blanca, Río Negro, etc.) not only in abiotic but also in biotic ecosystem components. Synthetic compounds most commonly detected are organochlorine compounds

(*i.e.*, DDTs, HCHs, HCB), as well as PCBs. Generally, the occurrence and distribution of these compounds within aquatic ecosystems are linked to the use of agrochemicals in the improvement of agriculture production, and to industrial wastes' disposal in continental streams and/or within the coastal zone.

Nutrients: the most significant nutrient sources for the coastal, marine and riverine systems are mainly inorganic nitrogen compounds (nitrates, nitrites, ammonium) and phosphorus compounds (orthophosphates, poliphosphates). These are conveyed to the environment via untreated urban liquid effluents discharges. Moreover, very high amounts of organic matter enters the environment from the same sources, which in particular conditions could produce significant dissolved oxygen depletions in punctual areas of the system. At the same time, great rivers and continental water bodies which open into the coastal zone act as nutrient and organic matter sources. As an example, a mean oxygen biological demand (BOD) of 2.78 mg / L (equivalent to 31.59% oxygen saturation), with minimum values of 0 mg / L has been reported off Riachuelo and 0.2 mg / L at Punta Colorada (AGOSBA-OSN-SHIN, 1992).

Sediments and Solid Waste Disposal (litter): Within some areas of the Argentinian coast, dredging programmes of navigation channels to provide easier access to harbour areas, and usually the materials obtained are disposed into coastal zones. These operations are carried out in La Plata River, Necochea and Bahía Blanca. This may result in two adverse effects: (1) inappropriate landfills of low laying zones of ecological importance (estuaries, wetlands and salt marshes) and (2) mobilisation of pollutants contained in the dredged sediments.

Regarding solid domestic residue deposits, they are often composed of both domestic and industrial wastes, thus their treatment is difficult to be managed. Treatment and disposal vary from *rubbish open dumps* to *sanitary landfills of* different quality and complexities. Ecosystems such as wetlands and salt marshes have been historically used for the accumulation of litter in Argentina.

Oil Exploitation, Refinary and Transport: This is a critical source of polluting activities, mainly because of the potential for accidents (due to spills, pipeline breakages, accidents during transport, etc.). La Plata river, Paraná river, and Bahía Blanca have been the most affected areas from these activities. The greatest oil refinery in Argentina is located near La Plata city making this the most vulnerable area given the high volumes of operations. Other large refineries and petrochemical centers are located near Bahía Blanca.

C. Physical Modification

One of the most critical environmental challenges in this region is the invasion, degradation and destruction of different ecosystems. This occurs usually in order to create new urban developments or tourism facilities.The loss or degradation of such ecosystems are surely detrimental in many ways to the sustainable development of the region. Impacts are felt in biodiversity conservation and development of economic sectors such as small scale fisheries and aquaculture. This systematic invasion and degradation usually occurs in the most productive environments with great biodiversity and ecological importance, such as coastal lagoons, salt marshes, wetlands, beaches, estuaries, dunes and rocky reefs. The conversion and alteration of such habitats have occurred along most of the Argentinian coast, as in the la Plata riverine coast and the Atlantic coast of Buenos Aires province (municipalities of de la Costa, Pinamar, Villa Gessell, Mar del Plata, Necochea and Bahía Blanca).

Mineral extraction of the production of building materials (sand, clay, granite, etc.) is another activity resulting in physical perturbation within this region. In 1995, as an example, mineral and rock production in Buenos Aires province was 24.875.610 tm (9.32% various clays, 16.93% granite, 17.53% limestone, 7.12% cuarcite, 18.61% sands and 22.01% tuff and/or soil (Production Ministry of Buenos Aires province – Direction of Geological and Mineral Resources – Mining Department, *personal communication*). Lastly, the building of dams, dikes or embankments

for electric energy generation results in further processes of physical modification within the La Plata basin. Petts (1990) estimates that this projection will continue to increase during the next century. It must be pointed out that many rivers from the region are modified not only because of dike building, but also because of sediment deposition due to deforestation and erosion within neighbouring areas used for agriculture. All these water streams carry large amounts of suspended particulate matter, which results in great increase of turbidity in the zones in which they flow to.

D. Pollution Sources and Other Forms of Degradation

Through an analysis of the available information, the following *pollution sources* and other *forms of degradation* have been identified in coastal, marine and freshwater ecosystems from the Upper Southwest Atlantic area of Argentina:

Sewage Systems: the discharge of liquid domestic and industrial effluents have shown to be the main pollution source within the region, which implies an input of nutrients and organic matter (and occasionally heavy metals, hydrocarbons and POPs). Thus, secondary rivers and streams of the region function as sources for these pollutants to enter less urbanised areas. It is important to keep in mind the effects caused by the combination of high nutrient concentrations and organic matter within restricted circulation systems, which can result in eutrophication processes.

Agriculture and Farming Activities: includes pesticide and fertiliser residues, which as a result of their use for enhancement of agriculture production, reach aquatic systems by means of continental run-off and through rivers and streams. Organochlorine, organophosporous, nitrogen and phosphorous compounds, are basically those compounds mostly concerned.

Industrial Residues: includes liquid as well as solid industrial effluents which can also contain organic matter, heavy metals, POPs and hydrocarbons.

Harbour Activities and Oil Terminals: refers to all the potential accidents linked to oil manipulation and operations (spills, malfunction of loading/unloading and transport systems), as well as products resulting from dredging of harbour channels and associated landfills of coastal habitats.

Physical Degradation of Ecosystems: includes all effects produced on coastal systems (invasion, degradation, destruction) by new urban developments (tourism complexes). Landfills with sediments resulting from dredging or with solid residues in ecosystems of interest (saltmarshes, wetlands,etc.) should also be considered in this category. Mineral extraction activities for construction impacting on coastal ecosystems must be also included.

Solid Wastes, Litter and Sediments: include both solid domestic and industrial wastes, usually disposed in different final sites (open rubbish dumps and sanitary landfills). Attention should also be given to the surplus sediment loads due to river dikes, deforestation and soil erosion effects resulting from inadequate farming practices.

3.1.3.4. ESTABLISHMENT OF PRIORITIES

Considering the information reviewed in previous sections and consultations held in the region, the main problems affecting the coastal zone of Argentina within the Upper Southwest Atlantic, as well as its influence area, have been identified . It is clear that the problems elsewhere in the USWA are also found in Argentina. On the basis of this diagnosis, the following priorities are identified:

1st Priority: ***To treat liquid effluents along with adequate disposal systems to ensure no impacts (or at least, minimize them) on the receiving environment***

Fulfilling this priority would minimise the undesired effects of excess organic matter and nutrient discharges into rivers and streams, as well as into the

costal zone itself. At the same time, the industrial residues input which are commonly transported by these means (heavy metals, hydrocarbons, POPs, etc.) will be avoided. Among ways to address this problem area are infrastructure works in urban areas (*i.e.,* improvements, increase efficiency and upgrade sewage networks; construction of sewage effluent treatment systems appropriate to the selected receiving environments) and in *rural areas* (*e.g.* programmes for sanitation and environmental recovery of streams and rivers receiving effluents from small communities or farming areas; development of community programmes for small-scale effluent treatment, which have demonstrated to be fully successful in other Latin-American countries, etc.).

2nd Priority: ***To control and eliminate the sources of industrial pollution which affect coastal marine and riverine systems within the region.***

A significant input of toxic wastes coming from industries into the main and secondary streams and rivers from the region has been detected. In a smaller scale, a similar process has been observed within Bahía Blanca region. Thus, the establishment of a sanitation programme for the main inland water bodies from these regions is needed in order to avoid the input of these compounds (heavy metals, hydrocarbons, fertilisers, POPs, biocides, etc.) into the coastal areas. A strict control programme for the quality of industrial effluents will be needed, to assure minimisation of environmental impacts.

3rd Priority: ***To establish systems for the control and elimination of pollution which affect coastal, marine and riverine areas within the region.***

Farming activities in Argentina are of great significance, and consequently large volumes of chemical compounds are used for their optimisation. Thus, a clean-up programme for the main inland water bodies, in order to avoid inputs of compounds (fertilisers, insecticides, herbicides, biocides, etc.) into La Plata river and the Argentinian Atlantic zone is required. Such efforts should be coupled with strict control programmes for commerce and application of agricultural chemicals, in order to ensure minimal environmental impacts. In addition, the establishment of an *award system* (*i.e.*, tax discounts and other incentives) should be considered for farmers who use low toxicity pesticides and of *penalties* (*i.e.*, tax increase, etc) for the opposite case.

4th Priority: ***To control and avoid physical alteration/destruction of coastal marine or riverine habitats associated with the creation of new urban centres or the expansion of urban/city limits.***

To address problems associated with urban development in coastal areas is of major importance in Argentina. Among measures to be taken are the strict enforcement of legislation and control programmes according to regulations for land use; enhanced planning for activities which modify habitats (dredging and filling, deforestation, new interferences, and construction on dunes or beaches). Environmental enhancement of harbour operations would also require attention.

5th Priority: ***To plan, develop and implement adequate systems for solid waste and litter final disposal.***

There are serious environmental problems affecting coastal systems from Argentina related to the management of solid wastes. These must be solved also in order to improve human health from associated areas. A starting point is the selection of adequate environmental areas for final solid waste disposal, and the application of appropriate technologies in line with economic and environmental conditions in the country. Addressing this priority area will allow for the protection of underwater reservoirs, avoid detrimental filling of wetlands, marshes and coastal lagoons and improve human health.

3.1.3.5. SETTING MANAGEMENT OBJECTIVES FOR PRIORITY PROBLEMS

The use of natural resources including those in the coastal zone has a central role in the socio-economic structure of Argentina. This points out to the serious need for the full implementation of a Planning Programme and a Control and Management System which guarantee their sustainable exploitation and the conservation of the concerned ecosystems. Taking this into account and in order to attain the identified priorities, the following General Management Objectives are proposed:

- Apply and enforce existing laws, regulations and /or rules for the Protection of Coastal, Marine and/or Riverine Environments, including the NationalCoastal Management Programme, and strict control systems.
- Implement Control programmes of marine, riverine and coastal pollution due to untreated sewage disposal
- Develop Control programmes of marine, riverine and coastal pollution due to industrial residues.
- Perform Control programmes of marine, riverine and coastal pollution due to agricultural activities
- Standardize local programmes of Quality control of Ecosystems, and integrate them into a National Programme, which should relate to relevant international programmes
- Mimimise the impact of new urban or tourism developments on marine, riverine, and coastal ecosystems, and implement Recovery Programmes for degraded habitats.
- Include all aspects of coastal management problems in national, state or local mandatory education programmes.

3.1.3.6. IDENTIFICATION OF STRATEGIES AND ACTIONS:

In order to attain the above mentioned objectives, the application of the following strategies and actions is recommended:

- Site, design and construction of sewage treatment systems, in order to avoid damage to any coastal ecosystem.
- Establish seawater quality monitoring programmes, including measures for maintenance and improvement of quality, and also the evaluation of horizontal and vertical oxygen, nutrients, salinity and inorganic compounds distribution.
- Monitor all industrial discharges, especially those linked to chemical industries, based on regulations that would enable to assure the fulfilment of local standards for discharge of effluents to the marine environment.
- Carry out efforts for the recovery of degraded and heavily damaged habitats by human activities
- Update both solid waste collection and final disposal systems, in order to avoid environmental detrimental conditions.
- Establish the mandatory use of Environmental Impact Assessment (EIA) for any medium or large scale, private or governmental project to be developed within the coastal zone.
- Identify and implement measures for the conservation of coastal, marine and freshwater protected areas, in order to maintain their habitats' integrity and biodiversity
- Ensure that both public and private sectors count with trained personnel to carry out and coordinate the implementation of Coastal Zone Management systems and Environmental Impact Assessment (EIA).
- Reach agreement on monitoring and work strategies with the other countries of the Region that would ensure a common approach to addressing problems of land-based activities. Establish the mandatory use of Environmental Impact Assessment (EIA) for any medium or large scale, private or governmental project to be developed within the coastal zone.

3.1.3.7. EVALUATION OF THE EFFECTIVENESS OF THE PROPOSED STRATEGIES AND ACTIONS:

- Establish a continuous programme for environmental quality assessment of coastal, marine and freshwaters in the Argentine USWA (sediment, water, biota) to serve as baseline data, until research on the status of such environments are completed.
- Conduct epidemiological studies on the relationship between water quality of habitats, the health of users and quality of food from aquatic origin.
- Carry out monitoring programmes with an advanced technological framework including remote sensing, GIS, and advanced statistical analysis for evaluation of the status of the environment and consequently the efficiency of proposed strategies.
- Develop water quality indexes, to enable rapid evaluations of the effectiveness of applied measures. These indexes should include the variations in key water parameters (dissolved oxygen, temperature, turbidity, nitrates, total phosphorus, faecal coliform density, total organic carbon and total solids).
- Carry out regular cost-benefit analysis of the control options employed.
- Use computer models and simulation techniques in order to forecast the impact of planned projects, and compare these results with those obtained by monitoring programmes carried out from selected strategies.
- Create a regional environmental database, the success of which depends on continuous contact with other countries in the USWA, intercalibration laboratory exercises and critically discuss results obtained with neighbours.

3.1.3.8. PROGRAMME SUPPORT ELEMENTS

The Secretaría de Recursos Naturales y Desarrollo Sustentable is the central agency for environmental management and coordination in Argentina. This Secretaría is responsible for specific policies for territorial planning, environmental management and conservation of ecosystems for the entire country. It counts with its own scientific and technical staff and interacts with other areas of interest to land-based activities in support of the proposed aims, as established in previous sections. To date most of its efforts have concentrated on the La Plata Basin, considering that this is the natural system which receives the largest anthropogenic impacts and includes the highest population. Furthermore, the Secretaría is working to fully implement the National Coastal Management Programme, whose aims are clearly complementary of other National Programmes, *i.e.*, The National Oceanographic Plan, which is a scientific programme on marine issues including an important component on *Coastal Areas*, being coordinated by the Secretaría of Science and Technology and CONICET. The National Coastal Management Plan also complements the efforts of Provinces to improve their environmental conditions. For example, the new laws for Buenos Aires on "Location of Insdustries" and "Environmental framework", which include the application of EIA for new developments.

In order to attain an efffective implementation of this programme which is highly complex and the objectives established previously some suggestions are provided below which may be useful :

- Establish and emphasize a *coordination* system that would assure the participation in the Programme in different degrees, of all agencies having a role on coastal and marine activities.
- Enforce the implementation of all legislation, regulation, rules and standards related to the control of coastal activities.
- The institutional arrangement and financial capabilities of Secretaría de Recursos Naturales y Desarrollo Sustentable should be appropriate for the implementation of programmes and the application of corresponding strategies. If not : *i) They*

should be enhanced; or, *(ii) Other available support facilities should be tapped within the country* (for example, Universities, Research Centers, National Navy, etc.) *through cooperation agreements.*

- Ensure that qualified staff, experts and technicians and the support needed for the implementation of the programmes and strategies selected (for example, CZM or EIA) are available.
- Review and update the available legislation related to marine environment protection, in order to maintain an effective legal framework
- Build on and use existing local, national and regional networks in order to avoid duplication and profit from previous experiences (*i.e.,* Technical Commission of the Maritime Front -CTMFM, Commission for Administration of La Plata River – CARP, Regional Group ASOS in the framework of IOC, etc).

4. Regional Analysis of Land-based Pollution Sources

4.1. ESTABLISHMENT OF REGIONAL PRIORITIES.

Priority issues for the region were established on the basis of the nature and severity of the problem, types of pollutant, physical alteration and destruction of habitats, sources of degradation, and nature and extent of the affected area. The severity of the problems were assessed on the basis of the available information on public health, food security, status of coastal and marine resources, ecosystem health and their social-economic benefits and uses.

Based on the outcome of the country-by-country analysis (Chapter 3 of this Report), it is clear that there are a number of similar problems and impacts in coastal areas caused by land-based sources and activities among the three countries, despite differences in oceanographic, climatic and biological regimes. Such similarities are reflected in the countries' sections that establish priorities and management objectives, identify strategies and measures and outline how to evaluate their effectiveness, which are essentially the same for Argentina, Brazil and Uruguay.

The inadequate discharge of urban sewage is the main source of environmental deterioration, and therefore should be considered as the regional top priority. The discharge of untreated or partially treated effluents result in a serious problem for the coastal zone, and the magnitude of its effect is directly related to the oceanographic characteristics of the receiving body (type of circulation, currents' speed, storm frequency, tide variations, etc.). In some cases, the inadequate design of submarine outfalls can produce the retention of effluents within the coastal area. In this context, nutrients overload, particularly nitrogen and phosphorus compounds, is widely reported as resulting in significant ecological changes within the ecosystems. Such changes including alterations in planktonic communities which develop atypical blooms and subsequent oxidation of large amounts of organic matter leading to dissolved oxygen depletion (Korringa, 1982).

The magnitude of the increase in tourism activities for the three countries, particularly in the coastal areas, require immediate implementation of clear guidelines and regulations dealing with conservation and preservation of affected coastal and marine ecosystems and habitats. The most common effects from this source are: discharge of large sewage volumes to the coastal zone (partially treated or without any treatment); disposal of large volumes of solid wastes (mainly litter) which produce landscape pollution and interference with drainage systems damaging coastal species; overpopulation of traditional tourist sites leading to the generation of new exploitation areas, usually for foreign tourists.

The need to preserve the integrity of coastal, marine and riverine ecosystems facing the expansion of urban centres points to the need for a Territorial Planning and Land Use System for the region. Such a system should include special consideration for the coastal zone given its characteristics, along with appropriate requirements for its conservation. Problems in this area are related to dredging and landfilling operations due to growth of new urban centres, tourist and/or industrial complexes, aquaculture farms, etc. The effects of these processes have been largely described (Margalef, 1982 ; Valiela, 1986), including removal of large sediment volumes which result in the smothering of benthic communities and adverse effects on the surrounding ecosystems, *i.e.,* colmatation with general decrease in productivity in the sea including fisheries production.

The importance of adequate control and management of industrial and farming effluents/residues that reach the coastal zone is also widely documented. Heavy metals (mercury, lead, cadmium, copper, chromium, etc) are identified among the residues contained in industrial effluents. Among other effects

they may produce alteration of enzymatic activity, theratogenic, mutagenic and/or carcinogenic effects, impair reproduction, or cell damage, not only in marine organisms but in humans (Risebrough, 1989). Those residues can also include hydrocarbons, synthetic compounds, polychlorinated biphenyls (PCBs), dioxins and furans among others (Safe *et al.,* 1987 ; Tanabe *et al.,* 1987 ; Kannan *et al.,* 1996), all of them responsible of critical damages on marine organisms and humans.

Briefly, the priorities for the Region can be summarized as :

- Inadequate discharge of liquid urban effluents
- Pollution due to industrial effluents.
- Pollution related to the inadequate use of agrochemical products.
- Degradation of aquatic environments due to expansion of urban limits
- Inadequate final disposal of urban solid residues.
- Activities related to extraction, transport and storage of oil or derivates.

4.2. ESTABLISHMENT OF OBJECTIVES FOR THE MANAGEMENT OF PRIORITY PROBLEMS

Based on the information analysed, and on the priorities suggested for the integrated management of the coastal zone within the USWA, the following objectives are selected :

- Establish and/or harmonize legal instruments among the three countries (laws, regulations, rules, guidelines and standards, etc.), in order to allow similar lines of action to address environmental problems of the coastal zone.
- Develop institutional agreements within each country in order to integrate coastal activities under the framework of a Coastal Management Plan that would, in the future, enable the application of the same scheme at a regional scale.
- Identify national, regional and international, public or private financial mechanisms and sources, that would enable the design, implementation and management of a Coastal Management Plan mentioned above at the regional level.
- Improve the capability of national and regional experts to deal with environmental problems, as well as with related public awareness.
- Create and/or increase regional capabilities to manage large-scale environmental problems, such as coastal erosion or transboundary circulation of pollutants or hazardous substances.

4.3 IDENTIFICATION AND SELECTION OF STRATEGIES AND ACTIONS

- Develop national integrated coastal zone management programmes, which should coordinate all the sectoral activities developed within land and waters of coastal areas.
- Detrimental effects produced by impacting activities (shoreline alteration, dredging, landfilling, etc.) should be included within Development Regional Plans.
- Establish Monitoring Programmes for all industrial discharges, especially those of chemical industries, so as to assure the fulfilment of local standards and of established criteria for effluent discharge to the marine environment.
- Carry out tourism activities in the coastal zone according to Regional Development Plans which should assure not only the integration of environmental objectives, but also development strategies.
- Establish a regional System for Coastal Protected Areas for the protection of environmentally sensitive and/or highly fragile areas, and for the conservation and preservation of genetic pools of regional biodiversity.
- Strengthen the use of EIA to all tourism or coastal development projects, public or private, within coastal areas.

- Promote exchange of information related to coastal and marine environmental protection.
- Establish and implement sewage treatment systems, set quality criteria for effluent discharges into the marine environment, and carry out Monitoring Programmes to ensure fulfilment of criteria and standards.
- Develop and implement Programmes for Monitoring Water Quality that ensure quality maintenance and/or improvement. Programmes should include regular testing in different coastal locations, including bathing and offshore areas.
- Establish Restoration Programmes of ecosystems and/or habitats degraded or destroyed due to tourism or other human activities.
- Guarantee that the design and functioning of submarine outfalls for the disposal of sewage are appropriate, in order to prevent damage to natural systems, its components (plankton, benthic communities, etc.) and related human benefits (drinking water, bathing areas, fisheries, aquaculture, etc.).
- Consider adopting technologies for reducing the impact of effluent discharge on the coastal and marine environment, which have been proven to be efficient and economically viable.

4.4. EVALUATION OF THE EFFECTIVENESS OF THE PROPOSED STRATEGIES AND ACTIONS.

The following list, while not exhaustive, suggests possible evaluation measures which countries may wish to implement:

- Long-term certification of procedures used for the assessment of resources and environmental quality (sediment, water, biota) based on national or regionally established criteria.
- Implementation of continuous National Monitoring Programmes which would allow for the detection of changes in the environment, before they become irreversible.
- Cost benefit analysis for the control options proposed, while examining the status of the resources and monitoring programmes.
- Develop a *pollution index* (a simple and single value) which should be used within the region to review trends in seawater quality and compare pollution degrees in different locations within the region through a common scale. It would also be useful for the assessment of the effectiveness of policies and measures to protect the marine environment from land-based activities.
- Encourage the use of computer models and simulation techniques in order to forecast impacts of planned projects, and to compare results with those obtained by the Monitoring Programme
- Promote an extensive and detailed coastal survey within the whole region, including habitat and sensitivity mapping techniques, inventory lists of rare or endangered species, mapping of pollution sources and location (industries, outfalls, river or freshwater outfalls, harbours, etc)., remote sensing of oceanographic parameters, and GIS application; and use this information as *baseline* for comparison with future investigations.

4.5 PROGRAMME SUPPORT ELEMENTS

The topics which need to be supported, in order to attain the objectives of this programme, an adequate performance, and to allow for its further development, are the following :

- Enforce the legal, institutional and financial capabilities of Environmental Management Agencies of countries in the region, to facilitate the implementation of control measures, monitoring strategies and proposed programmes.
- Improve the scientific and technological capabilities of countries in the region in order

to enhance contributions to relevant aspects of proposed strategies and programmes.

- Strengthen the Environmental Protection Authorities of countries in the region, in order to allow the efficient implementation of national and regional legislation.
- Establish intergovernmental mechanisms to integrate all policies related to marine and coastal environmental protection, at national and regional scales.
- Take advantage from the efforts and experiences of other working groups of the Region (CTMFM, ASOS-IOC, etc.) to accelerate the implementation process of strategies and programmes.
- Explore ways and means of potential financial support at national, regional and/or international levels that would allow the initiation and development of these strategies and programmes.

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