Overview of Land-based Sources and Activities Affecting the Marine, Coastal and Associated Freshwater Environment in the West and Central African Region

UNEP Regional Seas Reports and Studies No. 171

Note: The preparation of this Report was commissioned by UNEP, United Nations Environment Programme from Prof. E.S. Diop, (currently Senior Programme Officer, Division of Environmental Information, Assessment & Early Warning) under Project FP/1100-96-01. Design and layout by Mwangi Theuri, UNEP.

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For bibliography purposes this document may be cited as:

UNEP: Regional Overview of Land-based Sources and Activities Affecting the Coastal and Associated Freshwater Environment in the West and Central African Region. UNEP/ GPA Co-ordination Office & West and Central Africa Action Plan, Regional Co-ordinating Unit (1999). 110 pp.

ISBN: 92-807-1800-3

Front cover picture: *Some aspects of aquatic invasive weeds in African coastal lagoons* (top left). *Aerial view of the Port of Dakar, Senegal* (middle). *Sand consolidation impacts resulting from Senegalese Chemical Industries discharges, South Coast of Dakar* (bottom). Photo by S. DIOP.

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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 in Washington, DC., from 23 October to 3 November 1995. The goal of the Global Programme of Action is to prevent degradation of the marine environment from land-based activities, by facilitating the realisation by States of their duty to preserve and protect the marine environment.

The Washington Conference designated the United Nations Environment Programme (UNEP) as Secretariat of the Global Programme of Action and requested that, as co-ordinator 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 sub-regional level through, in particular a revitalisation of the UNEP regional seas programme; and

(c) Play a catalytic role in the implementation at the international level with other organisations and institutions.

The present overview was commissioned by the Co-ordination Office of the GPA in co-operation with the Regional Co-ordinating Unit (RCU) of the West and Central Africa Action Plan (WACAF/RCU) to assist the countries of the West and Central African region in their efforts to protect the marine environment and achieve sustainable development. This overview will also be used to provide data and information for a global review on land-based sources and activities affecting the quality of the marine, coastal and associated freshwater environment, currently being prepared (under the leadership of UNEP) by the working group in Marine Environmental Assessments of the Joint Group of Experts of the Scientific Aspects of Marine Environmental Protection (GESAMP). The present overview identifies and assesses the problems related to land-based activities for countries for which information was found and the region as a whole.

Executive Summary

This document provides a regional overview on land-based sources and activities affecting the marine, coastal and associated freshwater environment in the West and Central African region.

It addresses natural conditions and processes, anthropogenic impacts and its socio-economic implications, including losses of cultural heritage sites. This overview also contains information on emerging and forseeable problems in the region, proposing priorities for action including regional and international activities for cooperation.

This document encompasses the following nations: Angola, Benin, Chad, Congo (Democratic Republic), Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mauritania, Nigeria, São Tomé and Principe, Senegal and Togo.

In summary, information received from various WACAF countries and obtained from a number of other sources shows that the major issues related to the marine, coastal and associated freshwater environment pollution in the region include:

(a) The decline of water quality, due to land-based human activities, such as the introduction of sewage and waste water from industrial, domestic and agricultural run off as well as coastal urbanization;
(b) Physical degradation and habitat modification; and
(c) Fishery resources depletion and the loss of marine biodiversity.

The socio-economic and cultural implications can be tremendous in terms of income reduction arising from a loss of fisheries stocks and catches, recreation and tourism amenities, increase of water treatment and coastal protection costs.

Because of the lack of detailed scientific data on coastal, marine and freshwater environment in the WACAF region, a certain degree of uncertainty prevails in assessing the pollution load in general. There is an urgent need for a precise qualitative and quantitative assessment of the significant sources of land-based pollution in the region.

Background

The Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) is designed to assist States to take actions individually or jointly within their respective policies, priorities and resources, that will lead to the prevention, reduction and control and/or elimination of degradation of the marine environment, as well as to its recovery from the impacts of land-based activities.

To facilitate the implementation of the Global Programme of Action, since 1996 UNEP has been organizing, in cooperation with relevant regional organizations, a series of regional technical workshops of government-designated experts. Such workshops also included representatives of relevant international organizations, funding agencies and, whenever possible, the private sector and experts from non-governmental organizations, as a means of strengthening national capabilities for protection of the aquatic (coastal, marine and freshwater) environment from land-based activities, and to promote regional and subregional cooperation. In this context, a regional workshop on the implementation of the GPA was convened in Abidjan, 25-28 November 1997 counting with the participation of 21 states from the region (UNEP(Water)/GPA/WACAF/RW.6). The main objectives of the Regional Workshop were:

(a) To discuss both the draft of the regional overview for West and Central Africa and the regional programme of action presented at the meeting;

(b) To identify possible elements of regional framework strategies, with special reference to recommended approaches by source categories (chapters II-III of the Global Programme of Action);

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

(d) To design and agree on general outlines for the preparation of a regional programme of action and strategies focused on land-based activities.

In order to address these four fundamental questions, this regional overview closely follows a layout recommended by the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) and was prepared making full use of existing relevant information in relation with the WACAF national experts and authorities, despite some actual constraints, such as communication, documentation and information exchange.

The present overview consists of the six main chapters, while the seventh part, based on national reports received by UNEP, contains a country-by-country analysis of land-based sources and activities to serve as guidelines for all 25 WACAF countries involved and taking an active part in this regional cooperation.

I. INTRODUCTION

This overview covers not only the West African coastal countries, the coastline of which stretches some 8,000 km from Mauritania to Namibia (**Fig. 1**), but also some landlocked countries such as Burkina Faso, the Central African Republic, Chad, Mali, and Niger, which potentially contribute to the pollution from land-based sources affecting the freshwater environment. The coastal region and the adjacent uplands areas (from the continental margin to the offshore island nations) offer a varied and wide range of habitats and biota with a high biological diversity. The continental shelf along the coast is narrow in general with an average width of 20-50 km (which reaches a maximum of 100 km off the shore of Guinea-Bissau). One of the main characteristics of this marine and coastal region of Africa is the presence of seasonal upwellings, which explain the presence of substantial commercial stocks of demersal and pelagic fish in the coastal waters (World Bank Report, 1994). Indeed, the economy of most of the countries presented in this report is highly dependent on their coasts and on the marine environment.

A. Natural conditions and processes

1. Regional morphology and river basin drainage

Four narrow coastal sedimentary basins, with a few volcanic intrusions and outcrops of hard rock forming the major capes, have developed on the edges of the coastline: the Senegalese- Mauritanian basin, the Côte d'Ivoire basin, the Niger basin (Delta) and the coastal basins from Gabon to Angola (R.E. Quetennec, 1987).

All along these four coastal sedimentary environments there is strong influence of the pattern of river basins drainage. Five major river systems drain the whole coast from Senegal to Congo. Among the most important rivers are: the Niger, which drains an area of over 1 million km^2; the Volta river, with a drainage basin of 390,000 km^2 (World Bank, 1994); the Congo river, the second largest mean annual run-off and catchment area in the world, with freshwater run-off and sediment discharge estimated at 30-80 tons/km^2. However, for energy, irrigation and flood control purposes, most of these rivers have been dammed, with, as a consequence, significant alteration of their hydrology and their sediment flow, creating inevitable downstream impacts and accelerating coastal erosion processes. In terms of impact, the coastal basins, particularly along the Niger delta, are gradually subsiding because of the natural geology of the area, but also because of human activities, such as oil mining and natural gas exploitation. On the other hand, and within the Niger freshwater river basin, the existing agro- chemical and agricultural run-off, the sedimentation load and the urban and industrial waste waters have certain notable impacts when considering the level of groundwater contamination and water-quality degradation. These sources of pollution are directly affecting the environment not only of the coastal countries but also that of some landlocked countries such as Mali, Niger and others. Toward the coast, the potential in terms of sea-level rise and its impacts is also great: shoreline retreat and erosion, increased frequency of submergence of the coastal wetlands and salt-water intrusion into estuaries and coastal aquifers, etc.

2. General oceanography, coastal morphology and processes

Off the West and Central African coast, five distinct and relatively persistent oceanic currents are of importance (**Fig. 2**), in respect of transport of substances, water temperature, meteorology and biological conditions. They are:

(a) Benguela current, flowing along the South West African coastal zone (Namibia, Angola);

(b) Guinea current flowing eastward and south-eastward, which carries warm waters along the coast of Gulf of Guinea, near the Equator;

(c) Guinea current constitutes the continuation of the Equatorial counter-current;

(d) South Equatorial current, which flows some distance from the coast, between 10°S and the Equator;

(e) Canary current which flows south-westward along the coast in the northern part of the WACAF region (Mauritania, Senegal, etc.). It feeds both the Guinea current and the North Equatorial current (**Fig. 2**).

Both the Canary and Benguela currents transport cool waters towards the Equator and have current speeds of

adjacent to the coast. The cool and richer upwellings waters prevail along the north-western part from November to April/May; along limited parts of the northern parts of the Gulf of Guinea, and strongly in winter along the southern coastline (August), weaker in summer (November-February) (World Bank Report, 1994).

High precipitation and numerous rivers on the central West African coast generate large masses of warm (above 24°C.) and low salinity (less than 35%) waters, the so-called Guinean waters.

In terms of **coastal morphology**, we observe from Mauritania to Angola, successions of:

(a) Sandy arid coastal and plains bordered by eolian dunes (Mauritania, North coast of Senegal, Angola);

(b) More or less sandy marshy alluvial with estuaries and deltas, colonized by mangrove vegetation (south of Senegal, Guinea-Bissau and Guinea, Sierra Leone);

(c) Rocky scarps and sandy beaches, alternating with mangrove vegetation (Sierra Leone, Liberia, eastern Nigeria to Gabon);

(d) Low sandy coastal plains which alternate with lagoons along the Gulf of Guinea (Côte d'Ivoire, Ghana, Togo, Benin, Congo estuary up to the Angolan border);

(e) Huge marshy areas formed by the Niger delta, with mangroves indented by fluvial channels which are subject to tidal influence.

Finally, a number of islands and archipelagos can be found in the Atlantic ocean off the coast of West Africa (Canary and the Cape Verde Islands; Bissagos archipelago) and in the Eastern part of the Gulf of Guinea (Sao Tome and Principe and Annabon in Equatorial Guinea).

In terms of **coastal processes, physical alteration, habitat modification and destruction,** coastal erosion constitutes a serious problem in many West African countries. The rate of the coastal retreat can average several metres per year (for example in Fajara, Serekunda in the Gambia; in Keta, Ghana; in the Saloum, Senegal). Although the coastline is highly subject to natural erosion and sedimentation processes due to high wave energy, strong littoral transport, etc., erosion has been intensified by human activities, notably through sand mining and exploitation, disturbance of the hydrological cycles, river damming, port construction, dredging, mangrove deforestation, etc. These examples are particularly relevant for the Western part of Africa and mainly for the coastal countries in the Gulf of Guinea (Benin, Côte d'Ivoire, Ghana, Nigeria, Togo).

3. Ecosystem and species diversity

A large variety of ecosystems and habitats exist in the western and central coasts of Africa. Among them are located:

(a) Wetlands habitats, where mangrove forests are the most apparent features (more than 25,000 km extension from Senegal to Angola). The areas of highest mangrove concentration are located along the coasts South of Senegal, Guinea and Guinea Bissau, Sierra Leone and mainly in the Niger Delta. Although these mangrove forests are less diverse in terms of species than those found in East Africa, they are the best-developed and most extensive in Africa. Most of the coastal wetlands provide unique ecological conditions and habitats for migratory birds. They function also as a nursery for valuable fish and shellfish species, but remain unprotected with regards to natural and human influences and exploitation;

(b) Coastal lagoons, which are found mainly in the Gulf of Guinea, from Côte d'Ivoire to east of Nigeria. They are associated with freshwater rivers, deltas, and estuaries and include a wide range of tidal swamps and seasonal marshlands;

(c) Seagrass beds which are not very well developed in West Africa, although they exist in some estuaries and deltas mouths (Cacheu, Casamance, Geba and Saloum). While there are no true reefs along the West African coast, this is mainly due to the cool waters of the Benguela and the Canary currents;

(d) Sandy beaches, particularly in the Western African coast, along Mauritania and north of Senegal, but also in the central part of Africa, along Angola and Namibia. They are considered important nesting ecosystems, in particular for sea turtles. Their exposure to strong currents and swells make them

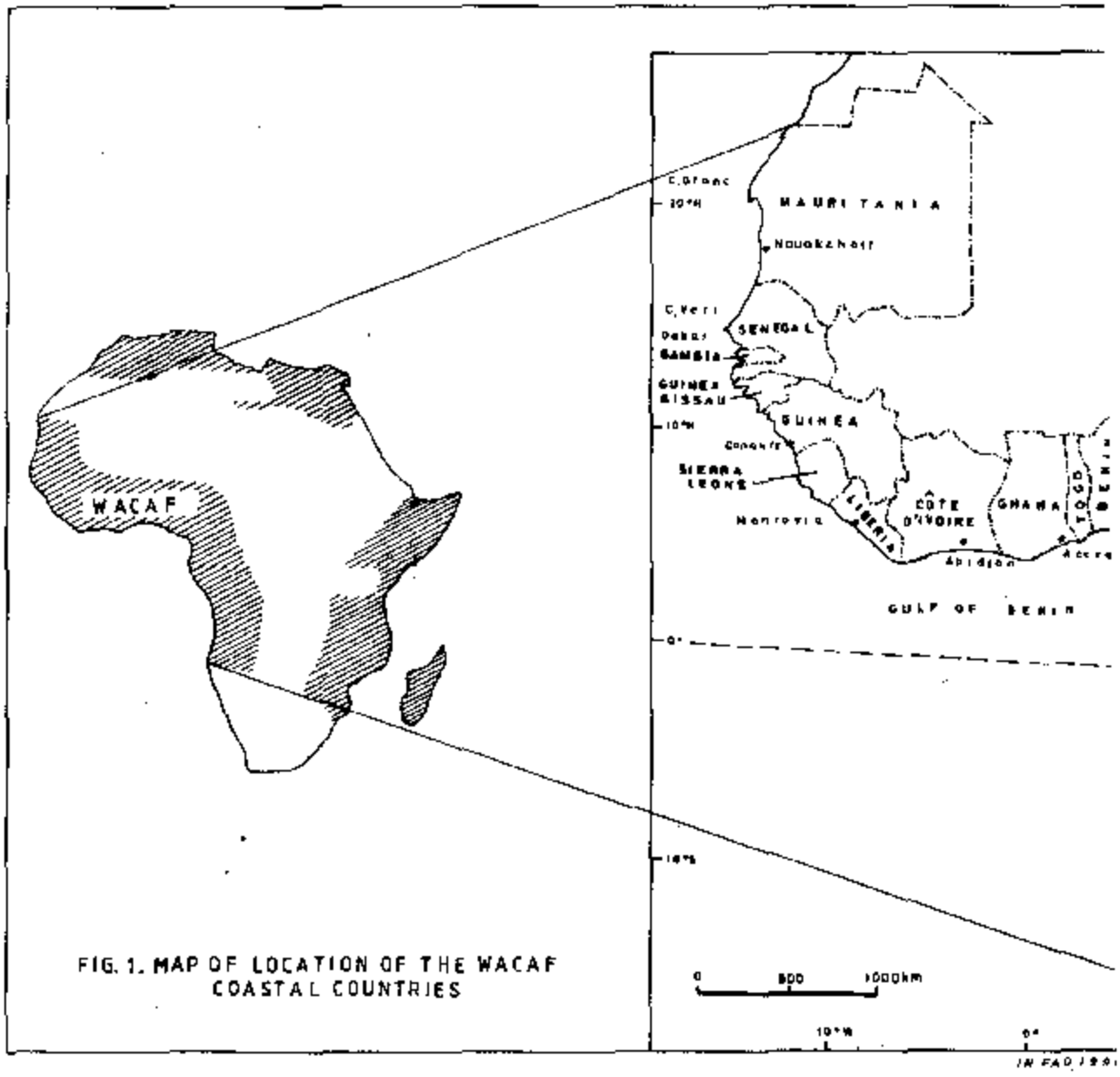
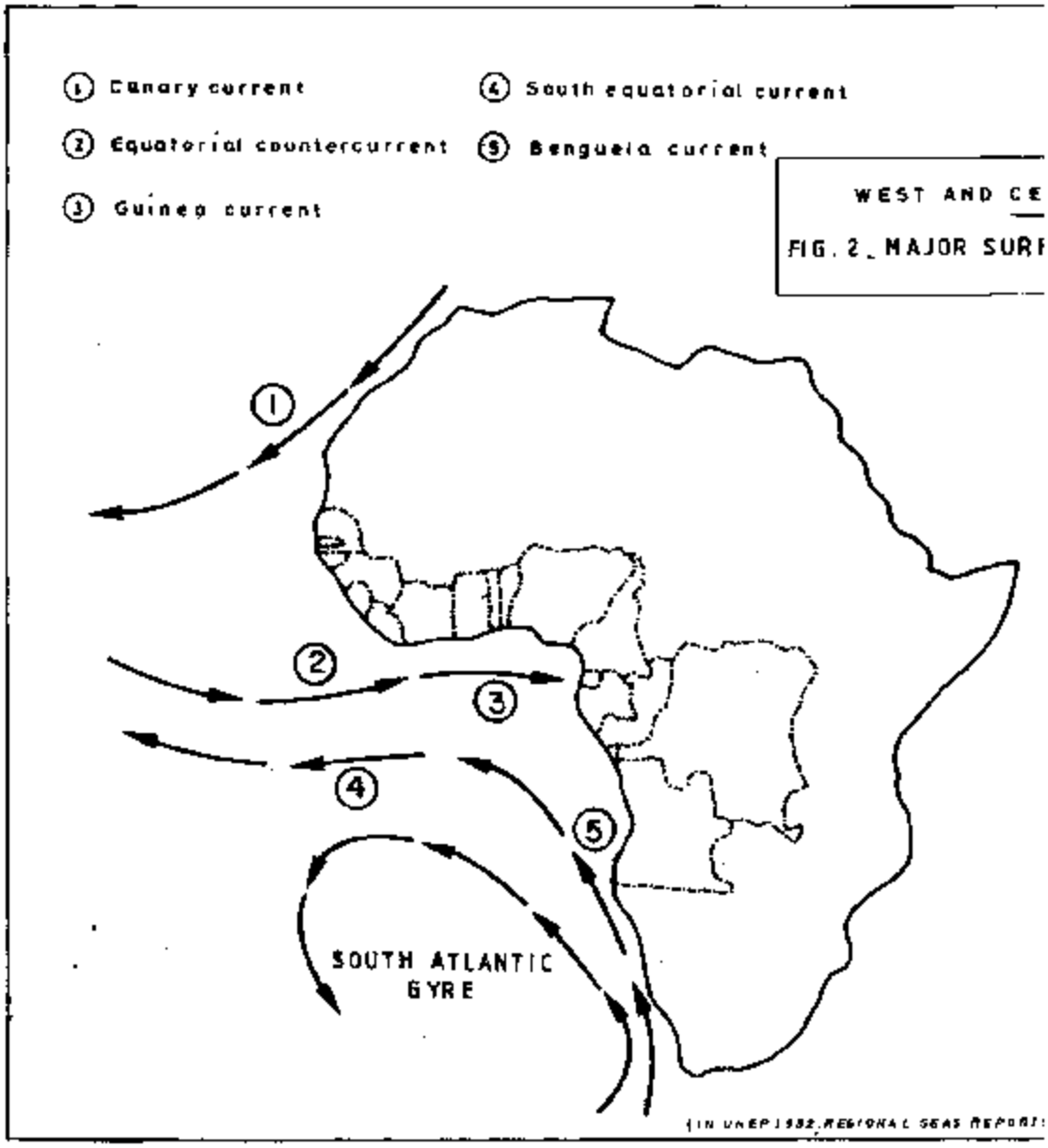


FIG. 1. MAP OF LOCATION OF THE WACAF COASTAL COUNTRIES


① Canary current
② Equatorial countercurrent
③ Guinea current
④ South equatorial current
⑤ Benguela current
WEST AND CE
FIG. 2_MAJOR SURF
①
②
③
④
⑤
SOUTH ATLANTIC
GYRE
(IN UNEP 1982 REGIONAL SEAS REPORT

Again, the most important factor characterizing the open ocean waters not only off the Gambia, Mauritania and Senegal but also off the coast of Angola and Namibia, is the quasi-permanent presence of upwellings, driven by the Canary currents in the North and those of the Benguela in the South. These areas are well known for their high productivity and their rich fish production. Pelagic and demersal fish are found with a large variety of other fish species as well as various species of crustacean, lobsters, deep sea shrimps and prawns (**Fig. 3**). However, these marine and coastal areas, including their upstream freshwater regions are at present affected by man's activities: over-exploitation and impacts from the land-based settlements and activities in terms of industrial, agricultural, urban and domestic sewage run-off and other mining activities such as oil and gas, etc. (in particular, off the coasts of Angola, Gabon and Nigeria).

A large variety and diversity of marine resources species characterize the coastal marine waters of West and Central Africa (**Fig. 3**). In particular, the wealth of estuaries, deltas, coastal lagoons and the nutrient rich upwellings cold waters make a major contribution to the diversity of fish life. The tropical West African coasts has an estimated 239 fish species, of which some are well known: *Sardinella aurita, S. maderensis, Thunnus albacares, etc.* as pelagic species; *Arius* sp., *Pseudotolothus typus and senegalensis, Dentex* sp., *Octopus vulgaris, Cynoglossus* sp., and others as demersal species. Pelagic tuna fish also constitute an important industry in the western part of Africa, including the Cape Verde and Canary Islands.

On the other hand, the presence of invertebrates such as intertidal molluscs (*Anadara* sp. *Crassostrea g.*, etc.), reptiles (turtles, crocodiles), marine mammals such as the West African manatee (*Trichechus senegalensis*) and some shark species often threatened by hunting and trapping demonstrates the variety of the species in the western and central part of Africa (World Bank Report, 1994). The most remarkable collection of migratory birds, millions of which seasonally visit the West African coast and mainland regions, shows the importance of preserving and maintaining the existing wetlands in this part of Africa. Large concentrations of seabirds are found seasonally in Mauritania, Senegal, Gambia and Guinea Bissau: these include *Larus genei, Geochelidon nilotica, Sterna maxima albididorsalis, etc.*, as well as the regionally large populations of great white pelican, white-breasted cormorant, Caspian tern. Many of the islands have large seabird nesting sites, for example in the Cape Verde Islands. The Gulf of Guinea islands, near Principe and Sao Tome also have sizeable sites with colonies of terns, noddies and boobies. It is because of this species diversity and fauna richness that conservation and preservation policy has been or is being undertaken by some western and central African countries through the creation and implementation of marine and coastal protected areas (Banc d'Arguin and Djawling in Mauritania, Djoudj in Senegal, etc.). Planned for the near future is the implementation of the protected coastal areas in Abuka, in the Gambia; in the Bissagos Archipelago, Guinea Bissau; in Aby lagoon, Côte d'Ivoire; in Sakumo and Korle lagoons, Ghana and in Lekki lagoon, Nigeria).

B. Anthropogenic impacts: demography and urbanization, industrial, agricultural activities and development

Between Mauritania and Namibia, along the Atlantic coast, an estimated 46 millions inhabitants occupy a narrow coastal margin of some 60 km wide (World Bank Report, 1994). The highest population density centres are located in some key cities along the coast, such as Accra-Tema, Abidjan, Cotonou, Dakar, Douala, Lagos, Port Harcourt, etc. These high population concentrations could explain the rapid population growth rate and the migration movements between rural and urban areas, which result in an increase of the mean urban population growth and a rapid expansion of the coastal populations (which, in the WACAF region, represents an average of more than 25 per cent of the countries' population).

Indeed, urbanization in the West African coastal areas dates back to the pre-colonial period, with the very first commercial activities which took place in the coastal regions. Later, the urban expansion has been favoured by the strategic coastal situation of the main West African cities, with the attendant concentration of facilities (natural harbours, economical, political and cultural nodes, as well as port and industry facilities). The build-up in recent times of infrastructure, economic and social investments in these urban centres has generated a polarization of activities with a huge attraction of surrounding populations from the rural areas in particular.

Even though the level of industrial development is still low in West and Central Africa, the rate of industrialization is increasing along the coastal areas. As an example, an estimated 60 per cent of the industries in countries bordering the Gulf of Guinea countries are located in coastal cities (UNDP/GEF, 1993), in particular in Nigeria, Côte d'Ivoire, and Ghana. Industries range from textile, leather, food and beverage

producing countries, such as Nigeria, Gabon, and Angola (**Fig. 3a and 4a in Annex II**), production is heavily concentrated in offshore and shoreline installations (World Bank Report, 1994).

Both the increasing rates of the urban population growth (with an average 4-7 per cent growth rate) and the industries have created negative synergies in terms of human and environmental impact along the coastal regions. A variety of pollutions from sewage, garbage, industrial and solid waste disposal, oil spills from shipping operations can be found in increasing amounts in the municipal sewage (**Fig. 4**). The deterioration of water quality is one of the most important aspects of environmental degradation occurring in the coastal, marine and freshwater areas in the WACAF region. This deterioration is exacerbated by the often untreated domestic sewage and industrial effluents and being discharged directly into coastal waters. The total annual biochemical oxygen demand (BOD) load from municipal sewage was estimated in 1984 to be 62,535 tons in the northern zone, 205,612 tons in the middle zone and 20,314 tons in the southern zone (**Table 1 and Fig. 4**).

From industrial pollution, total annual BOD for the whole WACAF region was estimated for the same period to be 47,269-tons (**Table 1**). Various analyses of the water have shown that most of these discharges contain a heavy load of nutrients, pathogens, micro-organisms, organic material, sedimentary particulates, and also trace metals and synthetic compounds. This type of pollution maybe even more severe and have more negative impacts around the most industrialized large urban cities: Lagos, Abidjan, Conakry, Dakar, etc. Indeed, in these large cities, most of the pollution originates from BOD5 (12 per cent), total suspended sediments (21 per cent) and chemical oxygen demand (COD, 46 per cent) - **Table 2**. Significant point sources of marine pollution have been detected around coastal petroleum mining and processing, releasing quantities of oil, grease and other hydrocarbon compounds into the coastal waters of the Niger delta and off Angola, Cameroon, Congo and Gabon.

The agricultural run-off from the irrigation patterns in the river valleys and flood-plains (i.e. Senegal river delta, interior Niger delta, Volta delta, etc.), including the elevated concentrations of nutrients and pesticides also contribute to increased eutrophication in the estuaries, deltas, coastal and freshwater environments in West and Central Africa. Moreover, the use of a wide range of persistent organic pollutants (POPs), although the most dangerous of these are banned, including DDT, aldrin and dieldrin and other organo-phosphorous pesticides, increase the water pollution in the region. River inputs carry considerable amounts of sediment, as a result of soil erosion and deforestation which contribute to the siltation of coastal habitats and the decline of water productivity. This phenomenon, combined with the pollutants load, may explain the considerable problems encountered now in most of the freshwater aquatic areas, such as the Côte d'Ivoire, Nigeria and Benin coastal lagoons, with the presence of significant seasonal invasive aquatic weeds. The same harmful phenomena are now found in the northern part of West Africa, in the Lac de Guiers and in the Senegal river delta.

Although tourism constitutes an important industry in many West African coastal countries, including Côte d'Ivoire, the Gambia, Ghana, Guinea and Guinea-Bissau, it can have a severe impact along the coast from Dakar to Douala. The construction of hotels and other recreational facilities located directly on the shore have been responsible for the clearing of coastal vegetation, the filling of the wetlands and the increasing load of the sewage and solid waste; this can be exacerbated by the lack of maintenance infrastructures.

The over-exploitation of marine life and the degradation of nurseries and habitats is today a phenomenon which is accelerating. As a consequence of over-fishing in the highly productive West African offshore and coastal waters, the region is facing a situation where the fish stocks have been depleted. The fishing activities, which are an important earner of foreign exchange in the economy of several West African countries, must be carefully managed, with an appropriate quota for the exploitation of different species, use of appropriate fishing gear and fishing methods, adequate legislation and regulatory measures, reduction and/or elimination of the pollution of the coastal waters from both land and marine based sources.

C. Socio-economic implications of anthropogenic alterations including losses of cultural heritage sites

Agriculture is and will remain the main economic activity of most of the 25 WACAF countries, which include all the coastal countries from Mauritania to Namibia and the landlocked countries covered by this report (Burkina Faso, Central African Republic, Mali, Niger). However, unsustainable agriculture practices and loss of the land

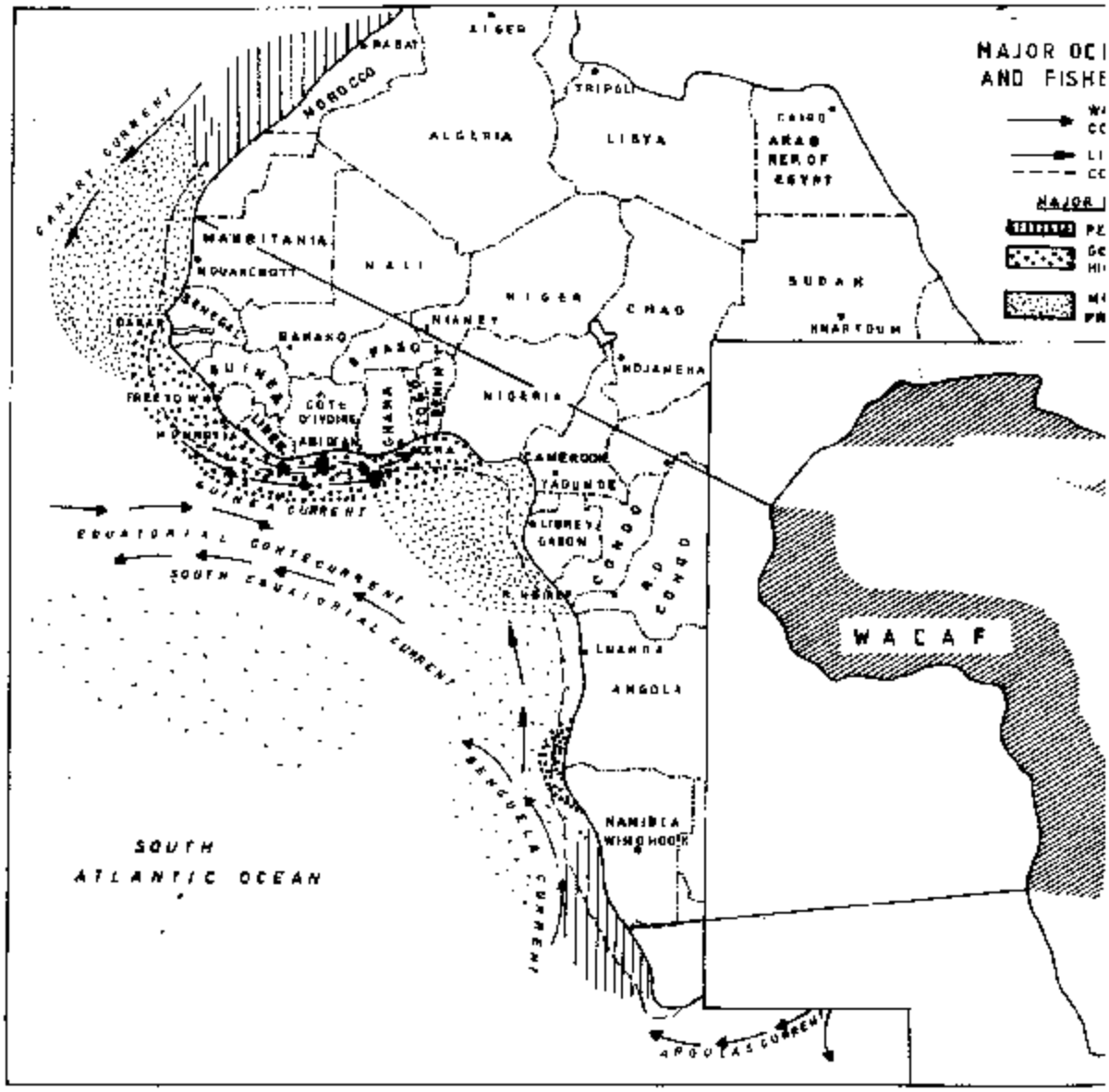


FIG. 3. OCEANOGRAPHICAL FEATURES AND COASTAL RESOURCES IN WACAF REGION

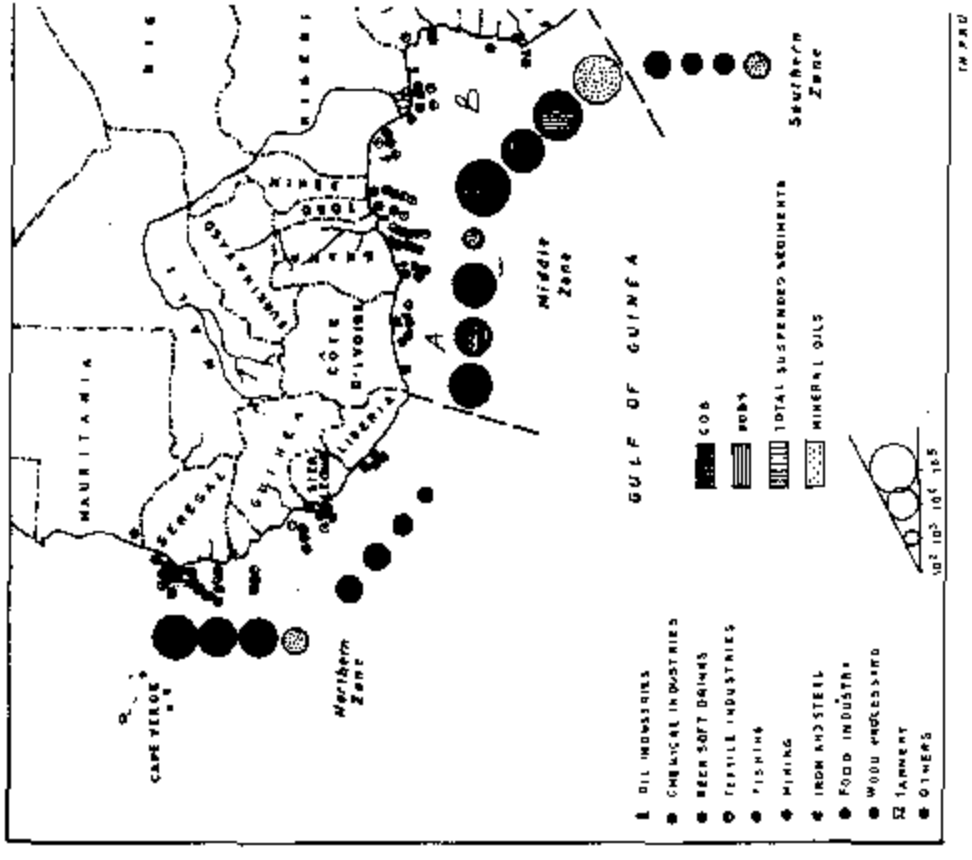


FIG. 4 – MAJOR INDUSTRIAL POLLUANTS IN THE WEST AND CE

Table 1. Estimated amount of municipal sewage in comparison with industrial pollution in the WACAF Region.

ZONES	Estimated population***	Municipal sewage				Industrial pollution			
	1000*	BOD_5 t/year	%*	SS /year	%*	BOD_5 t/year	%**	SS t/year	%**
Northern	17.350	62.535	21.6	88.930	21.6	15.320	24.5	18.542	20.8
Middle	117.960	205.612	71.1	292.401	71.1	29.962	14.6	61.243	20.9
Southern	36.800	20.814	7.3	29.598	7.3	1.986	9.5	1.360	4.6
TOTAL	172.110	288.961	100.0	410.929	100.0	47.269	16.3	81.145	19.7

* Percentage of the total amount of municipal sewage in the Region

** Percentage on industrial pollution of the amount of municipal sewage in certain zones

*** Estimated population of the Region, but without Mauritania, Cape Verde and Namibia (Africa South of the Sahara.

Source: UNEP, 1984 Regional Seas Reports and Studies. n° 4

Most of these countries are considered as "poor countries", according to their annual gross national product, which ranges from less than US$ 300 (in countries such as Niger and Sierra Leone) to more than US$ 3,500 in Gabon and US$ 1,500 in Namibia (World Resources Report, 1996/1997). As a consequence of this poverty, which is made worse by the increasing population pressure on available species and resources, there is a significant negative impact on the quality of the marine, coastal and freshwater environments of the WACAF region, especially in terms of land-based sources of pollution.

Domestic sewage and other wastes, but also coastal and upstream non point sources of pollution from agricultural, forestry and hazardous waste sites constitute sources of contamination of the drinking freshwater and the water quality in general, both for the surface and groundwater resources. Indeed, the water quality degradation is generally associated with health problems because of the presence of pathogens and other micro-organisms, excess of nitrates and persistent organic micro-pollutants, etc. Another phenomenon needs to be pointed out and concerns more specifically the contamination of groundwater by salt intrusion due to over-fishing of the coastal aquifers in the heavily populated areas where potable water infrastructure and supply are lacking. This is generally the case in all the suburban areas of the African coastal countries and in particular in the concerned WACAF countries. In these cases, strategies for mid- to long-term management planning for a sustainable supply of freshwater to populations must be focused both on adequate waste water treatment and on the reduction of diffuse sources of pollution, but also through continuing and concerted actions with the full participation of local users, populations and stakeholders.

It is clear, consequently, that human interference (with the land-based activities) in the region, superimposed on natural degradation processes in the coastal and marine areas could induce huge disturbances with large impacts in the concerned environments (loss of habitats and productivity and biodiversity, water quality decline with consequences in the coastal population health, changes in the natural coastal and marine environment equilibrium with very often, increasing harmful effects; i.e., microbiological and bacteriological contamination in the Bay of Hann, near the city of Dakar; and in Ebrie and Lagos lagoons, around Abidjan and Lagos.

As far as cultural heritage sites are concerned, coastal zones in West Africa have been areas of human settlement for a long time. Early evidence of human occupation of the rich mangrove fishing areas are confirmed through the discovery of shell middens and pottery in many estuaries and deltaic islands (Saloum, Casamance). Additional evidence of pre-colonial occupation of the West African coastal regions exists at Grand Popo and Ouidah on the coast of Benin; colonial buildings of considerable architectural interest can also be found in Porto Novo, Benin, and Grand Bassam in Côte d'Ivoire. Indeed, archaeological and historical sites are located in all these African coastal countries; particularly in Equatorial Guinea, Gambia, Ghana and Senegal. These cultural heritage sites must be preserved and included, as integral parts, in the coastal and marine protected areas, to protect them from severe damage as a result of unplanned urbanization, pollution and intensive industrialization.

II. REGIONAL OVERVIEW OF LAND-BASED SOURCES OF POLLUTION: IDENTIFICATION AND ASSESSMENT OF PROBLEMS

As already mentioned in the report, the major environmental issues for the WACAF marine, coastal and associated freshwater environments are directly related to:

(a) Water quality deterioration, mainly around urban areas, eutrophication and associated impacts on environment and public health;

(b) Pollution of coastal and associated freshwater environments, from industrial and agricultural activities;

(c) Physical alteration and degradation, coastal erosion and habitat modifications;

(d) Loss of fisheries resources and marine biodiversity; and

(e) Increasing atmospheric pollution.

As part of the regional overview analysis, this chapter will first of all consider **the most significant sources of land-based pollution which affect marine, coastal and associated freshwater environments.** At the same time, and whenever appropriate, the nature and severity of the problems occurring in the region will be

Detailed studies and analysis through the whole WACAF region, including the landlocked countries, show clearly that sewage constitutes the main source of pollution as a result of land-based activities. All the countries assessed reflect high urban, domestic loads, sometimes from industrial origin, which include BOD, suspended sediments, nutrients, bacteria and pathogens (**Fig. 4; Tables 1 and 36-40 in annex I**). The annual total BOD for the WACAF region was estimated to be 288,961 tons from municipal sewage and 47,269 from industrial pollution, while the annual total suspended sediments (TSS) was estimated around 410,929 tons from municipal sewage and 81,145 tons from industrial pollution. Again, the rapid growth of urban populations is far beyond the capacity of relevant authorities and municipalities to provide basic and adequate services such as water supply, sewage and other waste water treatment facilities. As consequences of all these domestic and organic biodegradable material discharges, contamination of the water quality, surface waters as well as shallow aquifers and groundwater, is a current phenomenon, mostly in the sub and peri-urban areas, where the conditions of overcrowding and poverty are increasing with the growing number of people.

The main consequences are: public health risks from the presence of sewage pathogens, eutrophication or oxygen depletion due to excess load of nutrients and organic carbon as well as contamination of the marine and human organisms through the aquatic food chain. Indeed, in all the confined bays and the near shore zones around the large cities, such as Dakar, Nouakchott, Conakry or around the most important coastal lagoons in the region: i.e., in the Gulf of Guinea with the Ebrie, Togo, Nokoue, Lagos lagoons, the water quality deterioration resulting from the insidious sewage run-off phenomenon, in particular during the rainy season, posed a major risk to the coastal and marine environment and to people health. The chronic lack of hygiene in most of these environments results in an increase in the number of infections among the population, in particular among children, with the result that epidemics of typhoid, hepatitis and malaria are common.

Finally, poverty itself is a major contributing factor to the present degradation of the coastal and marine environments, since it constitutes a major impediment for the adoption of new practices or behaviour which are less damaging to these environments. The presence of bilharzia and other water-borne diseases constitutes another important health risk resulting from the deterioration of the quality of water in the freshwater environment. This is due in particular to the changes occurring as a result of the construction of river dams. Good examples can be found in the Senegal, Volta and Niger river basins (**Tables 3 and 4** give some statistics on bilharzia infection of people living in the downstream Senegal river basin).

The other following priority issues/problems, by source-category, are:

(a) Intensive use of recycling **nutrients, pesticides, and other herbicides** as well as **organo-chlorine substances** in agriculture, including certain forms of POPs, which can lead to an excess of agricultural run-off ;

(b) **Physical alteration, including habitat modification and coastal destruction in areas of concern; i.e. the coastal erosion** phenomenon in sandy shorelines, and in critical habitats such as mangroves, nursery areas and feeding grounds;

(c) **Litter, solid wastes and plastics, including marine debris;**

(d) **Trace metals, oils, hydrocarbons, including other synthetic organic chemicals micro-pollutants,** from industrial and ports activities; and, to an increasing extent,

(e) **Atmospheric pollution resulting from gaseous and particulate emissions**, the primary aspects of pollution coming from industries and vehicles in particular, around big cities (Lagos, Dakar, Abidjan, Douala).

As agriculture constitutes one of the major sources of income in the region, its intensification (through irrigation and extension to marginal lands) has led sometimes to the excess use of **nutrients, pesticides** and **other herbicides** and **organo-chlorine substances**, including certain forms of **POPS - Tables 7, 8, 10 and 11**. The intensity of the use of POPS varies from country to country depending on the type of agriculture but they can constitute a source of pollution, which may be of importance for the WACAF region. Various examples can be found in Benin, Cameroon, Côte d'Ivoire, Nigeria and Sierra Leone (**Tables 10 and 11**). Because of the non-existence of substitutes not only for pesticides, but also for substances against diseases and public health vectors, chlorine insecticides have been used for more than 30 years. This is likely to continue if

The physical alteration and habitat modification of the West and Central coastal region through natural and man-made erosion processes is one of the predominant problems of the region. Some significant examples of coastal erosion in West and Central Africa have been given by R. E. Quelennec, 1987:

(a) In Senegal and in Gambia, the area most affected by the coastal erosion phenomenon is Rufisque (with a mean recession of 1.5m/year), Sangomar, sand spit located on the delta of the Saloum river, littoral North of Banjul (with 10-15m in the last 30 years);

(b) In Liberia, with a mean recession of 2m per year at Monrovia;

(c) In Côte d'Ivoire, with spectacular coastal recession at Port Bouet (more than 10m in 2-3 days, when the phenomenon was aggravated by the construction of the Vridi canal);

(d) In Ghana, with an average of more than 6m/year West of Accra, since the construction of the Akosombo dam, with the present aggravation of the coastal retreat around Keta;

(e) In Togo and Benin, and due to the construction of the large breakwaters for the Ports of Lome and Cotonou, coastal retreat has sometimes exceeded 150m in 20 years, East of Lome; retreats of more than 300 to 500m had been observed East of the port of Cotonou.

(f) In Nigeria, particularly, around Victoria beaches, where recession of more than 500 m have been recorded since the construction of the Lagos Harbour in 1907;

(g) In Gabon and in Angola, occurrences of rapid downslides at the northern part of Cape Lopez, littoral of Gabon and very often long sand spits (restingas) breached along the Angolan coast, have been recorded.

The littoral of the WACAF region has been (and continues to be) subject to significant coastal erosion processes, linked to natural and man-made causes. The consequences can be sometimes tremendous, with loss of infrastructures, houses, roads, etc.

The other main preoccupation in the WACAF region, as a major source of pollution from land-based activities is constituted by **litter, solid wastes, plastics and other marine debris** which threaten marine life, degrades the visual amenities of marine and coastal areas, with negative effects on tourism and general aesthetics. This is particularly frequent along the beaches of the main WACAF large cities: Dakar, Conakry, Abidjan, Lagos, Douala. This situation constitutes a direct consequence of the growing population densities and their increasing poverty, as well as the difficulties for the local municipalities and governmental authorities to continue to provide the populations with adequate basic services (i.e. solid waste final disposal).

Although in the WACAF coastal, marine and freshwater environments, the load of **trace and heavy metals, oils, hydrocarbons, including other synthetic organic chemicals micro-pollutants** out of industrial wastes and effluents, ports and harbours, are rather small compared to other regions (**Tables 40-44**), with a few localized exceptions (in the Gulf of Guinea - **Tables 5 and 6**), it is becoming more and more a source of concern for the ecology and the health of those environments, mainly in the middle and southern zones, as mapped in **Fig. 4.**

All these major (point and non point) sources of degradation from land-based activities show that norms, adequate legislation, reduction of the various types of waste, discharge treatments, follow-up campaigns as well as public education and awareness are an absolute need for the whole WACAF coastal and landlocked countries. To this end, the formulation of realistic and coherent strategies which aim at preventing the degradation of the freshwater, coastal and marine environments from land-based activities must be a high priority for the region.

In total, the major contaminants originate from various domestic discharges and run-offs (including markets, hospitals, etc.) as well as industrial facilities (from breweries, food, textile, wood processing). Oil, gas and related products predominate mainly in the Gulf of Guinea, and partly along the Nigerian, Gabonese, Congolese and Angolan coasts, where beach pollution by oil in the form of tar balls and oil spills, is frequently observed.

Of secondary importance and depending on the concerned countries, the other sources of pollution are constituted by upstream dumping inputs and agricultural run-off, but also the poor maintenance of vehicles that

As observed in almost all the WACAF countries, coastal erosion constitutes a major problem, with relative coastal retreat rates. Among its causes appears sea level rise, with a lot of uncertainties which however should allow the African coastal countries to adopt precautionary and preventive approaches, when managing their coastal areas.

As major results of land-based activities which affect the coastal regions, critical habitats such as coastal wetlands, mangroves, lagoons, etc. as well as the many spawning and nursery ground areas they include, are threatened and sometimes degraded; examples have been given in Côte d'Ivoire, Ghana, Guinea, Nigeria and Senegal with the consequences already depicted in the earlier chapters.

III. EMERGING AND FORESEEABLE PROBLEMS

As far as pollution from land-based activities is concerned, the major emerging issues and problems in the WACAF region could worsen in the near future if preventive and adequate measures are not taken. Those issues are linked to:

(a) Increasing sewage and solid wastes of domestic origin and their effects on public health and water quality decline;

(b) More and more intensive use of recycling nutrients, pesticides, other herbicides and organo-chlorine substances;

(c) Increasing trace metals, oils, hydrocarbons, including other synthetic organic chemicals micro-pollutants, from industrial activities, ports; and, to an ever increasing extent;

(d) Atmospheric pollution resulting from gaseous and particulate emissions, from industries and vehicles.

Although much uncertainty still surrounds the issue, predicted sea-level rise as a consequence of global warming must be taken into account, because of its possible impact in terms of coastal erosion and land losses, saline water intrusion and ground water contamination, socio-economic, natural resource and other potential coastal environmental risks.

Other emerging problems could result from the impact of climatic change (i.e., drought phenomena and their consequences in the marginal areas), the loss of biodiversity in coastal, freshwater and marine resources, due in particular to downstream impacts from bacterial and toxic sewage, particularly in the main urban environments, agricultural run-off and industrial pollution, which could lead to the collapse of sizeable fish and other coastal and marine resources.

In all the above cases, the application of preventive, precautionary and anticipatory approaches that will help to avoid irreversible degradation and to reduce long term risks seems to be imperative.

IV. STRATEGIES AND MEASURES

In addition to the priorities underlined in the above chapter and in order to anticipate the foreseeable and growing problems, States within the region should promote sustainable use of the coastal, marine and freshwater environments. To reach this goal, the application of integrated coastal area management approaches could constitute a first step. Indeed, most of the WACAF countries (i.e., Benin, Côte d'Ivoire, Gambia, Guinea, Ghana and Senegal) have now initiated National Environmental Action Plans (NEAP) through which the Integrated Coastal Management (ICM) approach could be applied. The present strategies and actions must be focused on controlling and reducing degradation of the coastal, freshwater and marine environments, as results of land-based activities. The future regional plan of action must take into account the priority source-categories from land-based activities and include the needs of the various countries, as well as the available means, and the possible support elements. Individually, Governments and authorities are responsible for:

(b) Localization of the industries in less vulnerable areas preceded by environmental impacts assessments;

(c) Use of clean production technologies and the best port reception facilities;

(d) Implementation and enforcement, when needed, of the legislation;

(e) Land-use planning and the improved application of agro-chemicals, including whenever possible, nutrient recycling;

(f) Finding other alternatives, in view of the possible impacts of POPs, as set forth in **Tables 7 and 8**.

(g) River basin and coastal watershed sustainable management;

(h) Coastal and marine resource surveillance, including adequate aquacultural methods and practices;

(i) Improvement of oil production and implementation of contingency plans, including MARPOL, for the region (**Fig. 5; and Fig. 3a, 4a, 6a and 7a in annex II**).

Of course, the effectiveness of these measures and strategies supposes a certain number of conditions which are not met at all in the majority of the WACAF countries and which are based on: good scientific and information data; best available techniques; best environmental practices and product substitutes; sufficient technical human resources, equipment and financial means; adequate legislation and regulatory measures; good economic instruments and incentives; and a long-term planning and monitoring system.

It is important therefore that efforts be made by the countries themselves, first of all, to design their own priorities, and thereafter to create the conditions for the successful implementation of programmes of action, through the harmonization of their existing laws, by making provisions with a view to resolving internally the potential conflicts which often arise from the conflicting use of watersheds and coastal and marine areas, and by minimizing the constraints arising from inadequate funding possibilities.

V. PRIORITY FOR ACTION INCLUDING REGIONAL AND INTERNATIONAL COOPERATION ACTIVITIES

Despite the limited availability, within the WACAF region, of detailed scientific information, reliable data and observations (with the exception of a very few countries such as Benin, Côte d'Ivoire, Nigeria and Senegal), priorities have been established from the source-categories criteria. Attempts have also been made to identify the near future emerging problems which could affect the freshwater, coastal and marine environments. It is important, therefore, that the priorities for action be based on the identified major issues for the WACAF region which are:

(a) Increasing sewage;

(b) Intensive use of pesticides, herbicides and organo-chlorine substances in agriculture;

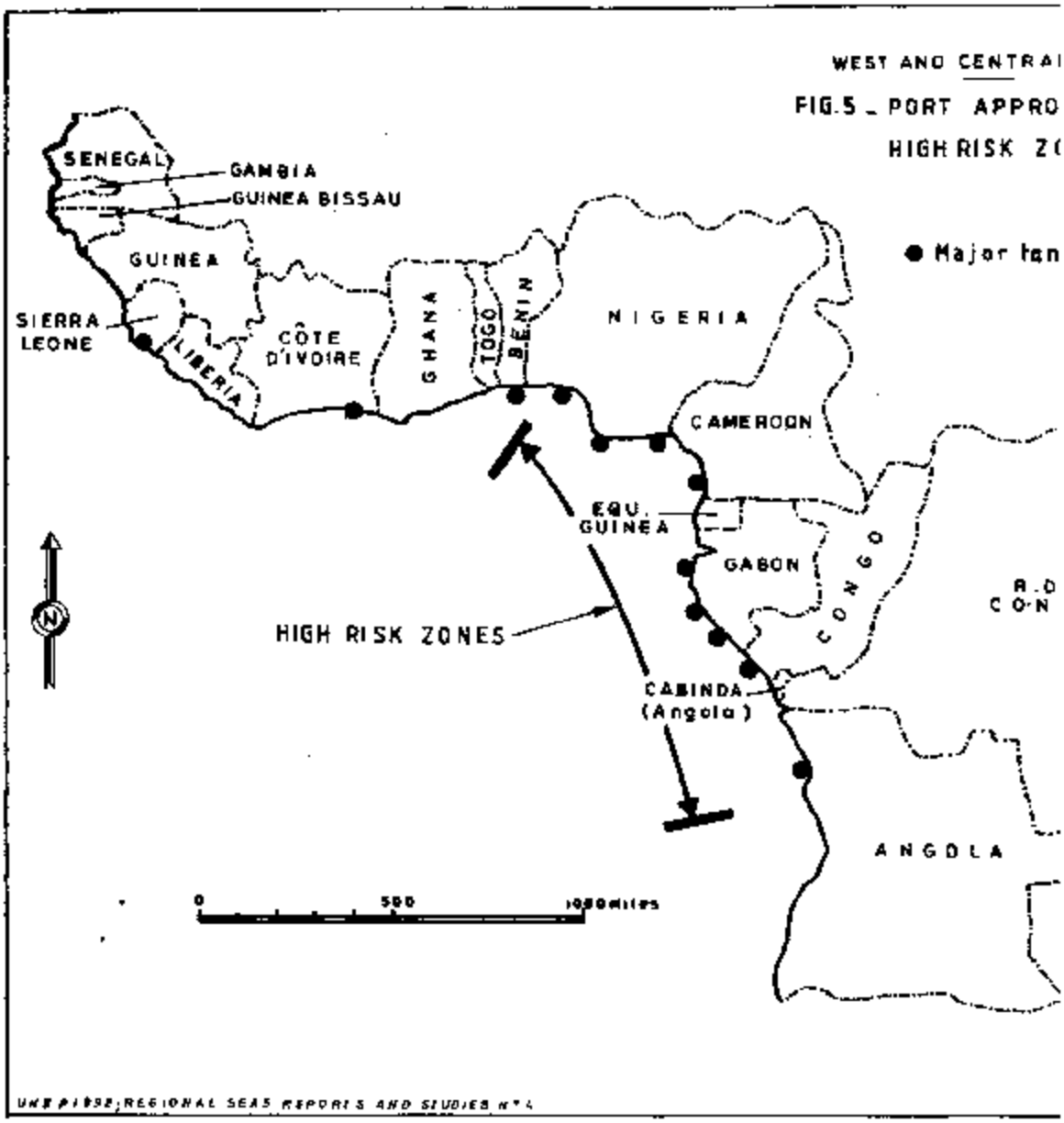
(c) Physical alteration, including habitat modification, coastal erosion and potential effects of the sea-level rise;

(d) Litter, solid wastes and plastics, including marine debris;

(e) Trace metals, oils, hydrocarbons and other synthetic organo-chemical micro-pollutants;

(f) Atmospheric pollution resulting from gaseous and particulate emissions.

One of the first actions is to determine the scale of the coastal, marine and freshwater environment degradation, taking into account the priority source-categories identified for the region, which may be of either natural or man-made origins. This will be only carried out if comprehensive scientific studies are undertaken at national and regional levels. The national environmental action plans developed by most of the WACAF countries could constitute an adequate framework and the basis for future actions.


WEST AND CENTRAL
FIG.5 _ PORT APPRO
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GAMBIA
GUINEA BISSAU
GUINEA
SIERRA LEONE
LIBERIA
CÔTE D'IVOIRE
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TOGO
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NIGERIA
CAMEROON
EQU. GUINEA
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UNEP 1982 REGIONAL SEAS REPORTS AND STUDIES N° 4

At the same time, certain common problems to WACAF countries (such as global warming and the potential impact of sea level rise; threats to wetlands and marine biodiversity; land/ship-based activities as sources of pollution of the freshwater, coastal and marine environments) should be addressed through appropriate regional support, in the framework of the relevant major international conventions which have been ratified by most of the WACAF countries: examples are the MARPOL Convention, the UNEP regional seas convention, the Convention on Biological Diversity, the United Nations Framework Convention on Climate Change and the United Nations Convention on the Law of the Sea.

Other actions could be proposed at different levels:

Thus, at the national level, the following actions are proposed:

(a) Conduct, in the most vulnerable areas, of coordinated programmes for the monitoring of nutrients, including bacteriological contamination (either from domestic or industrial activities, especially BOD and nutrients);

(b) Conduct of studies on environmental impact assessment and land-use within the major drainage basins, giving particular attention to the various loads, nutrients, particulates, metals, etc.;

(c) Collection of data on agro-chemicals and other biocides, in particular within the upper river basins;

(d) Comprehensive environmental institutional and legislation mechanisms, including the identification of the commonalties within the WACAF regions;

(e) Building capacities to formulate and implement action programmes dealing with freshwater, coastal and marine environments, taking into account the various constraints due to lack of technical, manpower and financial resources.

At a regional level, the action plan to be implemented must be realistic and must:

(a) Integrate, in a coordinated manner the existing on-going national and/or regional projects, dealing with the protection of the freshwater, coastal and marine environments and very often funded or executed by the same international agencies United Nations Development Programme (UNDP), World Bank, Food and Agricultural Organization (FAO), International Maritime Organization (IMO), the United Nations Cultural Organization (UNESCO), the European Union, and non-governmental organizations such as International Union for the Conservation of Nature (IUCN), the World Wildlife Fund (WWF), ECOWAS, African Development Bank (ADB), the Organization of African Unity (OAU) and its Scientific, Technical and Research Commission (STRC), the United Nations Industrial Development Organization (UNIDO);

(b) Encourage the implementation of joint subregional programmes based on commonalties as well as cooperation, networking and technical assistance for countries in need;

(c) Encourage specialized training sessions in items dealing with ICM and joint research programmes, including non-governmental organizations, stakeholders, and local authorities, as these sessions could also serve as exchange of experience, public education, awareness and sensitization.

At an international level and due to all the constraints identified in the chapters above, there is a need for:

(a) Institutional capacity building, human resources development and expertise mobilization, procurement of cleaner technologies in waste management and industrial production as well as innovative technologies relevant to each source-category of impacts from land-based activities;

(b) Facilitation to identify and access to opportunities and sources (bi- and multilateral, human and financial) and at the same, the implementation of efficient clearing house mechanisms within the WACAF regional coordinating unit;

(c) International cooperative agreements and actions should be undertaken in conjunction with the other parts of the world where similar exercises are initiated.

VI. MAIN CONCLUSIONS AND RECOMMENDATIONS

This regional overview contains broadly, enough information to draw a preliminary assessment of land-based sources of pollution affecting the coastal, marine and freshwater ecosystems of the WACAF region. Particular emphasis has been made on the detrimental social and economic implications that land-based sources of pollution can generate, including poor human health, water quality decline and loss of amenities and economical values in the coastal areas. Based on the inventories made and taking into account the source-category priorities criteria, it has been noticed in the majority of the countries that sewage with very high domestic loads, including BOD, suspended sediments, nutrients, pathogens and bacteria constitutes the first issue of greatest concern. Linked to this source-category, many industrial loads can be compared to domestic discharges, in particular when they are constituted by organic biodegradable material.

The other issues of concern are related to the use of pesticides, herbicides and organo-chlorine substances in agriculture; the physical alteration, including critical habitat modification and the coastal erosion, the proliferation of litter, solid wastes and plastics, including marine debris and the existence of increasing trace metal loads, oils, hydrocarbons and other synthetic organic chemicals micro-pollutants and finally, atmospheric pollution resulting from gaseous and particulate emissions, which is becoming more and more serious, in particular around the major cities within the WACAF region.

It is important, however, to mention that loads of metals and heavy metals, such as cadmium, lead, copper, etc. are generally small, with some exceptions (**Table 6**); the same applies to complex toxic organic chemicals and dioxins, which are not often observed in the region, except in some critical areas. However, priority must be given to the implementation of a monitoring programme for these substances as their presence could lead to the irreversible degradation of the coastal, marine and freshwater environments. It should also be stressed that before taking any remedial action, the first priority is to prepare the best possible results based on detailed scientific investigation. Therefore, it is important to begin any assessment in the region which aims at preventing and/or reducing the degradation of the coastal, marine and freshwater environments, from land-based activities with:

(a) Localization and quantification of fluxes and substances discharged into the concerned environments;

(b) An assessment of pollutant quantities in the sediments and in the various organisms, as the same as their propagation;

(c) An assessment of the degraded areas as well as a socio-economic and epidemiological study of these areas;

(d) An evaluation of the need for waste water treatments, adequate solid waste final disposal and the use of clean technologies;

(e) Implementation of an adequate institutional framework as well as efficient regulatory and legislative measures.

All these actions need to be accompanied by continuous campaigns to sensitize major groups, ensuring public awareness and the involvement of all actors, including local populations, non-governmental organizations and stakeholders.

VII. COUNTRY BY COUNTRY ANALYSIS OF LAND-BASED SOURCES AND ACTIVITIES, BASED ON THE COUNTRY-REPORTS[1].

A. Angola

1. Introduction

Estimated at approximately 1,650 km long, the Angola coast is one of the longest in West and Central Africa. The country itself has a surface of 1,246,700 km^2, with a population of around 12 million inhabitants. Almost 40 per cent of this population is concentrated in the coastal area in the largest Angola cities, among them Luanda, the capital city, with 3 million inhabitants, Lobito, Benguela, Namibia, and Soyo.

The coastal zone is composed of arid sandy plains and cliffs in the North. The Benguela cool current constitutes the most important characteristic of the Angola marine environment, well known for its richly populated fisheries and productive marine waters. Besides its important coastal region, the country has a number of rivers which pour into the Atlantic ocean, among which: Kwanza, Cunene, Lwei, Zambeze, Chiluangu and Lucola.

2. Identification, study of main sources of pollution and establishment of priorities by source-categories

The major Angolan problems result from the twenty-year civil war which has paralysed the main economic activities, including agricultural exploitation, food and manufactory industries. The coastal zone however, is subject to physical degradation and to various forms of pollution. Among the main sources of pollution are:

(a) Sewage from urban, domestic origin;

(b) Detritus, marine debris and solid wastes;

(c) Discharge from functioning industries, such as oil mining in Soyo and Malongo, cement factories and soap, edible oil and breweries manufacturers in Luanda, in addition to port installations and the oil refinery;

(d) Physical modification, including coastal erosion, of the littoral, particularly in Porto Amboim, Sumbe.

(a) Pollution from sewage, liquid and solid wastes and industrial waste waters

This pollution constitutes one of the major types of marine environmental degradation which take place around large cities. Although little information and data are available, the main pollution sources are domestic wastes (sewage, detritus and solid wastes) and the few industrial effluents which are still functioning (oil mining in Soyo, oil refineries, a cement factory, soap and edible oil manufacturers, port infrastructures, and breweries in Luanda, and harbour and port infrastructure in Lobito). As indicated in **Table 9**, the highest annual total values recorded in 1982 were of oil and grease releases (3,766 tons) and COD from industries (2,076 tons). In addition, there is oil exploitation off the coast which could lead to some oil-spills into the ocean, notably in the Cabinda province.

It is difficult to estimate the level of this pollution and the exact nature of pollutants from industrial effluents and waste waters is not known as there are no studies on the subject. However, it is clear that the Luanda coastline is affected. Indeed, terrestrial water run-off as well as sewage and other industrial waste waters are discharged directly into the sea without any treatment. In addition, the Luanda bay is increasingly poor in fish. The situation is similar in Lobito where there is a port with a naval site.

(b) Physical littoral modifications, including coastal erosion

Coastal erosion constitutes the main cause of the littoral physical degradation, either due to natural factors (currents, waves, storms, etc.), or human factors (vegetation degradation, anarchical occupation and construction in fragile coastal zones). This type of degradation, which dates back decades ago, has increased on the one hand with the migration of populations escaping the war from the inner country towards the coastal zones, and on the other hand, with the quasi-absence of an urbanization policy for the big cities (Luanda, Benguela, Lobito, Sumbe, etc.).

Between Luanda and Lobito, coastal erosion has already caused considerable damage. In some localities

Luanda where areas situated in low topographical areas near the coastline of Mussulo island have been completely destroyed by the erosion. Between the localities of Benguela and Namibe, however, the intensity of the erosion is relatively low.

3. Recommended solutions

Two solutions are recommended. Firstly, the implementation of an efficient institutional framework which is able to coordinate the continuous monitoring of the environment; and secondly, to undertake the management of the degraded zones.

(a) Coordinating Institutions and continuous monitoring of the environment

Until December 1992, Angola had no institution in charge of managing the problems related to the environment. In 1992, a State Secretariat of Environment was created to elaborate a global policy for the management of the environmental problems. Despite the lack of financial means and sufficient qualified personnel for tackling the main causes of the degradation of the Angola environment, awareness-raising activities such as a national symposium on environment, various seminars, and the evaluation of the state of the environment, have been initiated. However, a number of these actions have not been followed up. In recent months, the State Secretariat has become a Ministry, which may in the coming years initiate the development of best-practices to tackle the problems related to the country's environment. But it will be necessary for the Ministry to build and strengthen capacity through training and the provision of adequate institutions.

(b) Degraded coastal areas management

There are currently three management projects whose studies have been completed. Proposals based on their findings are now being submitted to relevant donor partners for funding. They are:

i. Integrated management of the marine ecosystem of the Benguela cold current;

ii. Integrated management of Okavango (Zambeze) river basin;

iii. The Lobito-Benguela urban management project.

Studies on the management of Luanda Bay are underway. All these projects are aimed at reducing and/or eliminating the negative impact caused, on the one hand, to the coastal and marine environment, and the rational management of aquatic resources on the other hand. Their completion should allow a fundamental equilibrium of the Angola marine and coastal ecosystems to be restored. In addition, a Permanent Technical Commission for the Protection of the Marine Environment has been set up. It is composed of representatives of the ministries concerned with the environment, oil, transportation, public works and tourism. Some private enterprises are also represented. This commission will endeavour to:

i. Proceed in defining marine water boundaries;

ii. Define the whole coast in functional units based on physical and/or environmental characteristics;

iii. Prepare projects of measures and regulations related to the protection of the marine and coastal environment of Angola; and

iv. Initiate studies of all nature related to coastal and marine ecosystems and to Angola coastline environment.

The project to study the coastal system from the Kwanza river mouth to Benguela city is under preparation. The government estimates that the implementation of this commission will allow it to evaluate and solve problems of the coastal area for at least a 10-year period.

4. Constraints

The implementation of a global environmental management policy in Angola comes up against several

(a) Institutional constraints

If the recent creation of the Ministry of Environment constitutes an important step in addressing the environmental questions at a decision-makers' level, efforts are yet to be made to develop a national legislation protecting the environment, in conformity with international conventions already ratified such as those related to international waters and biological diversity.

(b) Financial and technical constraints

A large part of the government's financial resources were used to finance the civil war. In addition, and because the environment is not given a high priority, the Ministry of Environment only receives 0,03 per cent of the national budget. Although technical and financial difficulties are considerable, with no mechanisms for the internal financing of the projects or programmes affecting the environment, a fund for the protection of the coast has been created whose resources will be fed by oil, fishing and submarine resources mining.

(c) Socio-economic constraints

As stated above, most of the population currently settled on the coast originates from the inner part of the country. The precarious conditions in which they live do not allow them to respect the environment. As long as these living conditions are not improved or the people's repatriation to their regions of origin does not take place, the Angolan coastal environment will continue to suffer.

5. Assistance

The country has already benefited from international financial assistance. The three projects whose studies are completed have been jointly funded by UNDP, UNEP and World Bank. Angola is also benefiting from the regional cooperation through two major projects, one of which covers Namibia and South Africa, and the other, Botswana and Namibia. One of the obstacles to the elaboration and implementation of projects and programmes in favour of the environment is the absence of specialized trained manpower. There are no training institutions in this field in Angola and assistance in this respect is therefore essential.

6. Strategies

In Angola, the current strategy for protecting the coastal and marine environment from the impact of land-based activities is reflected in the urban management projects of Luanda and Lobito-Benguela cities which recommend the processing and treatment of domestic sewage, as well as the integrated management of Benguela cold current ecosystems. Unfortunately, effluents from some manufactories continue to dump their chemicals into the ocean without any preliminary control or treatment. In spite of its weak financial and technical means, the strategy of the Environment Ministry is the following :

(a) Revision of the former legislation and adoption of new laws in line with the related international conventions for the protection and preservation of the environment;

(b) Education and awareness raising of the local population, with the participation of non-governmental organizations;

(c) Decision-makers' training;

(d) Involvement in scientific research in order to identify with better accuracy, pollution sources and to determine the marine pollution indicators.

The regional cooperation, already committed to the accomplishment of some projects, will be strengthened in the training and scientific research domains.

B. Benin

1. Introduction

Benin is situated in the Gulf of Guinea, between Togo and Nigeria with a coastline length of around 125 km. Its total population is 5 million inhabitants with an urban population estimated at 1.5 million inhabitants. Cotonou, the capital city, with 555,000 inhabitants, is in the south-east of the country, south of Lake Nokoue, along the Atlantic ocean. More than 75 per cent of the country's industrial activities take place in Cotonou, where the majority of the infrastructures and equipment of Benin (port and airport, main market facilities, hospitals, etc.) are also located. Due to the increasing population growth (2.9 per cent per year) and the rapid urbanization in Cotonou and its surroundings (nearly 4.5 per cent per year), all available areas are populated, including the low-lying zones, with negative consequences on inhabitants in terms of drainage, sanitation, salubrity and water supply.

The hydrologic regime is largely influenced by the rainfall (with an average of 1,300mm/year for 100 days). A series of freshwater rivers (partly flowing towards the north via the Niger river, but mainly to the south in the Atlantic ocean; Mono and Couffo rivers), lakes and coastal lagoons constitute the hydrological network of the country.

It is mainly around Cotonou that agro-industrial activities have had a serious effect on the freshwater, coastal and marine environment. While the agro-chemical and agricultural run-off constitute the main source of pollution inland, urban and domestic run-off and solid wastes are the main ones around the major cities, and particularly in Cotonou.

2. Identification and assessment of main pollution sources, establishment of the priority source-categories

Five main source-categories from land-based activities affect the coastal, marine and freshwater environment of Benin:

i. Industrial and urban/domestic sewage;

ii. Litter, solid wastes, plastics and marine debris;

iii. Physical alteration, including habitat modification and coastal erosion;

iv. Agro-chemicals, fertilizers and other biocides, mainly around agricultural areas; and

v. Synthetic organo-chemical micro-pollutants and hydrocarbons from industrial wastes, atmospheric pollutants from carbon and nitrous mono-dioxyde released in the environment.

(a) Industrial and domestic sewage

Agricultural and food industries, including breweries, food processing, and edible oil manufacturers are the main contributors to the industrial sewage and run-off which contaminates and degrades the fresh and coastal waters. Urban sewage liquid comes from domestic effluents and refuse, mainly around Cotonou and the other cities such as Porto Novo, Ouidah and Grand Popo. Sewage and waste water treatment facilities do not exist in Benin and all the liquid discharges are dumped directly into lagoon waters (Lake Nokoue for Cotonou) or in the near shore waters. Some of the public health problems can be explained by the contamination of the ground water by septic tanks used by residents in the suburbs. Also, more than 90 per cent of the population in Cotonou have no sewage evacuation system. This analysis raises again the problem of poverty alleviation as linked to the degradation of coastal and marine resources and general health of the ecosystem.

(b) Litter, solid wastes, plastics and marine debris

This type of "macro-waste" is generally found around the large cities (Cotonou, Porto Novo, Ouidah) and can be explained by the low capacity of the municipalities to install proper solid waste final disposal (from 87,000 tons in 1986, solid waste had reached 150,000 tons in 1992). A large proportion of this waste is collected mainly from residential and commercial areas, but also from markets, hotels, industries and factories. They

(c) Physical alteration, including habitat modification and coastal erosion

As pointed out in the introduction, all the coastal countries along the Gulf of Guinea, including Benin, have been subjected to coastal degradation and coastal erosion. This phenomenon is extensive in some portions of the coastal zone of Benin (East of Cotonou harbour, PLM Hotel, Sobeprim). A large part of the increase of coastal erosion is due to the construction of jetties for the protection of Cotonou harbour. Although the coast is eroded by natural factors (such as the strength and strong impacts of the swells, storms frequency and possible sea-level variations which need to be further investigated), human actions, through jetties and harbours settlements, dams construction; i.e. on the Mono river, coastal sand mining), have largely contributed to the acceleration of the phenomenon.

As a consequence of these disturbances, ecological and hydrological disruptions (such as the case of the Mono river dam), have threatened critical habitats and degradation of parts of the remaining mangrove forests, etc.

(d) Agro-chemicals, fertilizers and other biocides

We know that these land-based source-categories are mainly impacting the areas around the agricultural regions. In particular, the excess of nutrients and other pesticides and herbicides can have important consequences on the superficial and groundwater supplies of water, on fauna and flora, particularly near the lakes, lagoons and other rivers and near shore environments. For example, the little data and information obtained so far on pesticides shows that from 1,100,000 litres in 1991, the quantity of imported pesticides had reached 2,310,000 litres in 1996. Besides, during the 1994-1995 campaign, more that 100,000 tons of chemical fertilizers were used.

(e) Other synthetic organo-chemical micro-pollutants, hydrocarbons, and other metals from industrial wastes including atmospheric pollutants from nitrous oxide and carbon mono-dioxyde release

These types of land-based source-categories mainly originate from chemical industries (oil refineries, metallurgic and cement factories). Cotonou and its surroundings constitute their main area of concentration; furthermore, the proximity of the harbour, the airport and the other industrial infrastructures contribute to the high concentration of this land-based source-category, compared to the rest of the country. Although, it seems that the toxic effluents of the industrial waste and run-off is not really significant (low concentrations of toxic substances as indicated in **tables 10 and 11**), there is a need for more exhaustive and complete measurements in order to have precise figures on the contribution of this land-based source-category to the degradation of the Benin coastal and freshwater environments (including the contribution of industries and traffic vehicles to air pollution, notably around the large cities).

3. Management objectives for priority problems

As already shown in previous chapters, the priorities established for the land-based source-categories are closely related to issues of food security, public health, poverty, coastal and marine resources, as well as to socio-economic benefits and uses. It is important therefore, to envisage the following management objectives:

(a) Evaluation of possible provisions for installation of adequate sewage (industrial and domestic) systems and outfalls and final solid waste disposal;

(b) Ensuring that all the liquid effluents are treated before their discharge into coastal, lagoon or freshwater areas;

(c) Enforcing and implementing the existing laws, regulations and measures in order to protect the coastal, marine and freshwater Benin environments;

(d) Constructing industries in less vulnerable areas and encouraging the use, as much as possible, of clean production technology;

(e) Developing integrated coastal management programmes which not only include precautionary approaches and anticipate the possible future change of the Benin coastal area, but also integrate protection measures as far as the coastal zone is concerned (better localization of the sand mining areas, better observance of the buffer zone for the coastal area occupation, etc.)

4. Identification and selection of strategies and measures

In order to achieve the above stated objectives, the following strategies and measures are recommended:

(a) Implementation of appropriate and coherent integrated coastal management plans which involve all actors; from the local communities to the private sector including the municipalities, non-governmental organizations, etc.;

(b) Encouraging the use of environmental impact assessment studies in all projects (development or tourism), to be implemented in the Benin coastal areas or which may have any impact in the freshwater or marine environments;

(c) Reducing the adverse impact of sewage and other industrial and agricultural run-off as well as litter and solid waste disposal on public health, coastal and marine resources, lagoon, coastal and marine biodiversity;

(d) Reinforcing the protection measures of the littoral against coastal erosion, as part of the coast is submitted to coastal degradation (East of Cotonou Harbour);

(e) Establishing rehabilitation and restoration programmes for Benin's critical habitats (i.e. mangroves, lakes and lagoons ecosystems), which are suffering decline and loss of their resources and biodiversity;

(f) Information, sensitization, and education programmes must be undertaken for the benefit of all concerned actors, as well as their involvement in all Benin programmes dealing with the protection of the coastal, marine and freshwater environments;

(g) Creating a national observatory to continuously monitor pollution from land-based activities.

5. Evaluating the effectiveness of strategies and measures

A number of measures must be set out in order to measure the effectiveness of the proposed strategies and to:

(a) Ensure the continuous assessment (through the development of indicators) of the water quality and the Benin freshwater, coastal and marine resources;

(b) Evaluate and reinforce (if necessary) the effectiveness of policies, laws and regulations/legislation related to management and protection of the freshwater, coastal and marine areas;

(c) Set up regular epidemiological control programmes for the most exposed populations which are prone to health risks due to coastal or lagoon bad water quality or contaminated groundwater supplies;

(d) Develop a comprehensive and detailed coastal and lagoon survey, including mapping through classical methods or GIS, coastal sensitivity index maps, land-use planning, watershed management, proposed protected areas as well as areas to be developed. This could constitute part of the integrated coastal management plan to be implemented;

(e) Develop a cost-benefit analysis of the different options

6. Programme support elements

The Ministry in charge of the environment, as well as the other concerned structures dealing with the management and protection of the coastal, freshwater and marine areas will constitute the main responsible entities. As Benin has already developed a national environmental action plan (NEAP), the programmes and strategies to be adequately implemented could be undertaken in this framework. In addition, better coordination is needed for existing programmes, as well as ensuring their continuity, the consolidation of the manpower capacities, a better involvement of traditional and religious authorities, and local collectivities, non-governmental organizations, as far as the protection of coastal, lagoon and marine areas is concerned.

C. Chad

1. Introduction

Chad is a landlocked country and among the largest States in West and Central Africa. Chad covers an area of 1,284,000 square km with a population of about 6,300,000 people. Most of the permanent water courses are located in the southern tropical country zone such as Lake Chad, Logone and Chari rivers as well as many other more or less permanent water courses.

Lake Chad, which is the most important lake situated to the Southern limit of the Sahara, is located in the sinking part of the old drainage basins of the African continent. It covers an area of 2,500,000 ha during the low waters period. The surface waters of Lake Chad constitutes a large potential for agricultural and fisheries sector.

2. Main source categories from land-based activities

Those which affect Lake Chad have been identified as:

(a) Sewage and waste waters from urban domestic and industrial origin;

(b) Solid wastes and plastics;

(c) Agro-chemical substances, such that fertilizers, pesticides and other herbicides, mainly used in cotton fields;

(d) Sedimentation in some water courses, mainly resulting from surface run-off phenomena with the construction of the oil pipeline, as well as the future oil project of Lake Chad construction of which will commence in the near future.

3. Constraints to the elimination of these forms of pollution

These are economic (poverty and reduced access to funding sources), technical (lack of data and adequate information, inadequate equipment, limited human resources), institutional (absence of appropriate regulation and programmes of environmental management).

4. Solutions and envisaged strategies

These include the following:

(a) Carrying out environmental impact studies for all development projects which have the potential to affect the river basin slopes, as seems to be the case of the future oil project of the Lake Chad basin;

(b) Taking appropriate measures to treat waste water before its discharge in aquatic environments;

(c) Implementing monitoring and preservation programmes of surface waters which currently constitute one of the first priorities of the Chadian authorities;

(d) Involving non-governmental organizations in training, information, communication and awareness-raising efforts of local populations for a better management of the aquatic environment of Chad.

5. Required assistance

With the construction of the pipeline for the export of oil from Chad, the Lake Chad basin project is going to generate various types of liquids and solid wastes, resulting from the various oil installations. These potential negative impacts will have to be controlled and managed by adequate treatment, most notably for industrial and domestic wastes and waste waters.

In this regard, some directives for managing waste have been developed for the Lake Chad basin project which further recommend practices for reducing wastes and for their re-use, processing and elimination. Substantial financial assistance will be required in order to avoid the irreversible degradation of the aquatic environment and to ensure the reduction of long-term risks.

6. Programme support elements

Among other countries of the sub-region, Chad adopted a law defining the general principles for the protection of the environment on 17 July 1998. This instrument responds to the problem of new options for sustainable development, the mining of natural resources, and the necessity to preserve a healthy environment for present and future generations.

It is against these important questions that the Ministry of the Environment and Water has taken the initiative to elaborate this law in order to reply to the challenges not only for the environment in general, but equally for the development of oil and gold mining.

Various national and international non-governmental organizations are equally concerned with strategies and programme implementation whose purpose is in line with the protection of the environment.

D. Democratic Republic of Congo

1. Introduction

Located in the heart of the African continent, the Democratic Republic of Congo has a huge territory of 2,345,000 km^2. In 1995, the population was estimated at 42 million inhabitants with an estimated annual increase of 3.1 per cent and a low density (15-17 inhabitants per km^2). The Democratic Republic of Congo has 37 kilometres of open coastline on the Atlantic ocean where a strong oil activity is taking place due to the presence of the Golf Oil Company (ZAGOF) and the mining company ZAIREP. Tourism and fishing also occupy an important place in the Congo economy with beaches and mangrove reserves featuring as tourist attractions. Industrial activity, which is very diversified, creates acute and complex problems of pollution in the marine environment, especially around the big cities which host most of the industries (chemistry, oil, metal processing, paper and painting factories, food processing). Industrial waste water is dumped directly in freshwater, without any treatment. Similarly, harbour activities sometimes result in oil spills during discharge in Ango Ango or Banana. Urban solid and liquid wastes are no longer treated. They are generally dumped into the aquatic environment. Despite of the lack of detailed scientific information, and thanks to bibliographical data collection, it has been possible to identify some sources of pollution due to land-based activities affecting the marine, coastal and continental freshwater environment.

2. Identification, study of the main sources of pollution and establishment of priorities by source categories

Five main sources of pollution from land-based activities have been identified in the Democratic Republic of Congo:

(a) Sewage of an industrial and urban domestic origin;

(b) Solid wastes;

(c) Metals and heavy metals, hydrocarbons including oils and atmospheric pollutants;

(d) Physical coastal modifications and the critical habitats destruction;

(e) Agro-chemical substances and products, including pesticides.

(a) Sewage from industrial and domestic origin

Sewage from textile, chemical, plastic and painting industries are loaded with toxic metals such as chromium, mercury, lead, cadmium and zinc. We can add to these industries those engaged in food processing, and those in construction and using metals which represent a significant polluting impact. These industries are equipped with waste recycling systems. Indeed, 95 per cent of these factories have no epuration and their discharges are dumped directly into rivers and freshwater systems. Some domestic inhabitants are equipped with wells and septic tanks, but these facilities are of questionable efficiency.

(b) Solid wastes

The major problem for the whole country is related to the discharge of waste in urban as well as in rural environments, directly into the freshwater and drainage systems. In urban areas, the harmful status of the drainage system, the proliferation of refuse, the general unhealthy status are the main causes of water pollution. In addition to these factors, there is inadequate rainfall and sewage evacuation of all kinds, inadequate collection of solid waste and evacuation in the majority of Congo's cities, degradation of urban refuse-dumps and the lack of processing facilities.

(c) Metals and heavy metals, hydrocarbons including oils and atmospheric pollutants

The Congolese littoral, notably the Atlantic ocean waters is subjected to permanent source-categories of pollution; among them, discharges from oil industries, and also from shipping activities taking place without any control and in the absence of adequate and appropriate regulation. Besides and among other different sources of air pollution, some examples can be given originating from:

(b) Industrial activities, mainly metal and chemical industries, cement factories;

(c) Vehicle emissions, mainly around big cities;

(d) Physical modifications of the littoral and destruction of critical habitats

The Congolese coast, which extends for 37 km along the Atlantic ocean, is characterized by a mangrove environment. Some fauna are today seriously endangered, particularly the manatee, the marine turtle and many migratory birds. The production of charcoal from mangrove woods and the pollution caused by hydrocarbon discharge generate serious problems for these forms of critical habitats. Some authors estimate the mangrove losses at almost 40 per cent of the total surface mangrove areas at the mouth of the Congo river.

(d) Agro-chemical substances and products, including pesticides

Among the agro-chemical substances recommended for sustaining agriculture in the DRC are organic and chemical fertilizers which are used to increase crop yields; and pesticides (insecticides, herbicides and other biocides); it is known that intensive use of these fertilizers and other herbicides leads to water pollution and to their eutrophication. Regarding the insecticides, they contain mainly synthetic organic or inorganic compounds (DDT, DDD, lindane, chlordane, etc.) whose toxicity is proved. Other pesticides used in agriculture are equally toxic, but to our knowledge, no study has been carried out to assess the impact of their utilization in the marine, coastal and freshwater bodies.

Table 12 summarizes the major land-based sources and impacts of pollution in the Democratic Republic of Congo.

3. Objectives of management concerning priority problems

Pollution of the marine environment is dominated by solid, liquid and gaseous management wastes. Priorities for the elimination of source-categories of pollution have been established in relation to the issues of poverty, public health, food security in particular and socio-economic issues in general. The following management objectives can be established:

(a) Quantitative and qualitative evaluation of the main sources of pollution due to land-based activities and affecting the coastal and marine environment;

(b) Evaluate possibilities for the solid waste treatment and sewage, including their recycling;

(c) Protection of critical habitat sites that could suffer from tourism through the implementation of integrated management programmes of the coastal zone;

(d) Control of all forms of pollution (soil, air, water);

(e) Identify and strengthen existing laws and regulations concerning the protection of the marine environment;

(f) Provision of technical and financial support to the Democratic Republic of Congo through the Ministry of the Environment and Tourism, so as to allow it to prevent and/or reduce the pollution and degradation of the marine, coastal and freshwater environment, caused by land-based activities

(g) Establish information education and awareness-raising programmes for the population.

4. Identification and selection of strategies and measures

In order to realize the above general management objectives, the following measures and strategies are recommended:

(a) An integrated management approach of coastal zones, including mapping of the coastal degradation susceptibility as well as that of drainage of adjacent river-basins;

(c) Assistance programmes for small-scale farmers need to be initiated in order to encourage them to increase productivity using cultural practices as opposed to chemical fertilizers;

(d) Setting-up of a monitoring system, based on the London Convention, on the handling of pesticides (on the Matadi-Kinshasa axe, in particular);

(e) Environmental impact assessments for any development project to be carried out in the littoral; and to promote institutional capacity development (non-governmental and governmental organizations) to manage and execute environmental impact studies;

(f) Promotion of a system of clean technology;

(g) Encouraging local populations, the public and the private sectors to take control of their activities and to protect of the coastal and marine environment;

(h) Identify the most convenient sources of financing for setting up programmes for the protection of the coastal and marine environment in the Democratic Republic of Congo.

5. Evaluation of strategies efficiency and proposed measures

A certain number of criteria have to be taken into account in order to establish the efficiency of strategies and proposed measures:

(a) Ensure the continual assessment of the water quality and the Democratic Republic of Congo coastal, marine and aquatic resources environment;

(b) Set up regular epidemiological control programmes for the most exposed populations to health risks due to water quality deterioration;

(c) Evaluate and reinforce the efficiency of policies, regulations, laws and existing legislation in close cooperation with management and protection of the marine, coastal and freshwater environment of the DRC.;

(d) Demonstrate by case-studies and determine using cost-benefit analysis, the economical effectiveness for the preservation of the environment;

(e) Evaluate success and failures of proposed measures for better adaptation;

(f) Make detailed scientific studies using modern and efficient technology, including geographical information systems, models, statistical analysis, etc., would help to evaluate the efficiency of strategies and proposed measures.

6. Programme support elements

Since its creation in 1975, the Ministry of Environment, Conservation of Nature and Tourism has been charged with the promotion and coordination of all activities related to the environment, conservation of nature and tourism and permitted to take all initiatives and measures leading to the full realization of this mission, in accordance with developments in science and technology. In 1996, the Government adopted the National Environmental Action Plan of the Democratic Republic of Congo which serves as a framework of action for the management of the environment.

E. Côte d'Ivoire

1. Introduction

The coastline of Côte d'Ivoire is estimated at 560 km long; it is one of the longest coastlines of the countries situated in the Gulf of Guinea. The country itself has an approximate surface area of 322,000 km^2 with a population of more than 14 million inhabitants. Côte d'Ivoire has a population growth estimated at 3.4 per cent per year. The urbanization rate is approximately 45 per cent. Apart from Abidjan, the industrial capital city which has a population of more than 3 million inhabitants and a density of approximately 300 people/km^2, Côte d'Ivoire has more than 20 cities of more than 100,000 inhabitants. The annual urban increase rate varies from 8 to 10 per cent.

The mean annual rainfall varies from 2,300mm in the south to 900 mm in the north, demonstrating the transitional climates from dry tropical in the north to humid equatorial in the south. From inland to the coast, mainly north to south, there are at least 9 main rivers which form the main drainage system of the country; many of these rivers flow south towards the huge lagoon system (more than 300 km long and a total surface of 1,200 km^2) composed of three main lagoons: Grand Lahou, Ebrie and Aby - Fig. 6 -. Abidjan, the main city, is located around the Ebrie Lagoon, which empties into the sea through the Vridi Canal. The economy of Côte d'Ivoire is still dominated by agriculture with a majority of agro-industrial units concentrated in Abidjan (more than 60 per cent). Some of these appear to contribute to the land-based source-categories of pollution (mainly industries engaged in food and beverage processing, breweries, wood, edible oil, etc.), besides the other industries, such as leather, textiles, dyes, chemicals.

The impact of the pollution on the coastal lagoons, the freshwater environment and the near shore zone of Côte d'Ivoire has been clearly proved. The pollution load is mainly from industrial and urban/domestic origins, but also from agricultural run-off. The most impacted area is around Abidjan, because of its industrial concentration and its high urbanization rate.

2. Identification and assessment of main pollution sources, establishment of the priority source categories

To sum up, five main source-categories of pollution are affecting the lagoon, coastal, freshwater and marine environments in Côte d'Ivoire:

(a) Industrial and urban, domestic sewage, as well as from agricultural run-off;

(b) Agro-chemicals, including pesticides, herbicides and other biocides, plus nutrients load and certain forms of POPs;

(c) Physical alteration, notably coastal erosion as a principal factor of the physical modification of coastal features;

(d) Solid wastes, litter, plastics and marine debris;

(e) Metals and heavy metals, oils and hydrocarbons including the atmospheric pollutants.

(a) Industrial and domestic sewage, including some forms of agricultural run-off

Sewage constitutes the main source-category of pollution which contributes to the degradation of the freshwater, lagoon, nearshore and coastal environments in Côte d'Ivoire (**Tables 13, 14 and 15**). It occurs mainly around the large cities, in particular around Abidjan, where most of the domestic, urban run-off and industrial wastes are discharged into the lagoons (Ebrie lagoon). Total annual BOD load is estimated to be 110,000 tons, while yearly DOC load is around 253,564 tons and total suspended sediments, around 231,364 tons. Abidjan and San Pedro have sewage and waste water treatment facilities. However, it is not the case elsewhere; further inland in Agboville, Bouake, Bouafle, Ferkessedougou, where waste water and sewage are dumped directly into freshwater rivers and lagoons.

Table 15 shows high values as far as total annual BOD and TSS are concerned. They were estimated in 1997

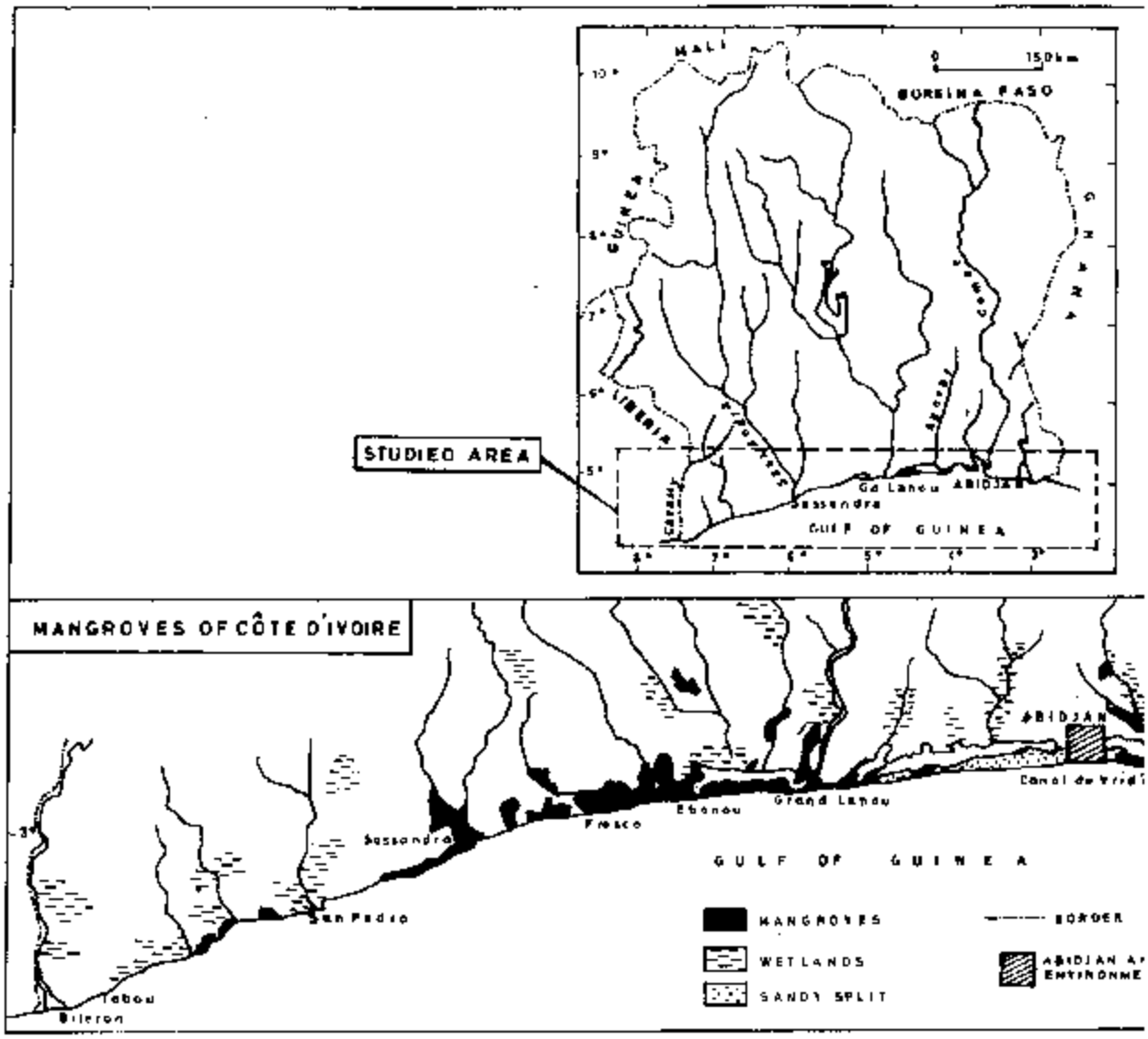


FIG. 6 _ MAP OF LOCATION OF CÔTE D'IVOIRE COASTAL ZONE

quality decline, bacteriological and microbiological contamination constitute the main consequences in particular in the most polluted lagoons; i.e. bays of Bietri, Cocody, Koumassi, and Marcory (**Table 14**). Certain effects are observed, notably related to public health, in particular for population living around these lagoons; on the lagoon and freshwater resources, there is loss and decline and on the ecosystem biodiversity is threatened. The proliferation, during these 10-15 years of seasonal invasive and harmful aquatic weeds and floating plants has a relationships with the large sewage discharges into the Ivorian aquatic environment.

(b) Nutrients load, including some organo-chlorine and phosphate substances

These types of source-categories of pollution are mainly predominant around the agricultural lands and the irrigated areas. Most of the substances used have a chemical origin: posticides, herbicides and other biocides, including certain forms of POPs (DDT and PCB have been noticed in the sediments of the lagoon, Ebrie; FAO, 1994). **Table 16** indicates significant concentration of toxic substances residues, in particular PCB's, DDT's and lindane). The excess of nutrients dumped into the freshwater (or infiltrated in the groundwater) contribute also to the water enrichment and consequently to its potential eutrophication, as is the case during rainy seasons. This factor partly explains the explosion in the Ivorian coastal lagoons of invasive and harmful aquatic weeds during the main rainy seasons. Although some measurements have been obtained, more follow up and continuous availability of data is necessary in order to follow up more closely on the evolution and fate of these contaminants, in particular in the lagoon, freshwater and coastal aquatic environments in Côte d'Ivoire.

(c) Physical alteration, including habitat modification and coastal erosion

As already described, in the coastal countries of the Gulf of Guinea, coastal erosion constitutes one the main factors in the physical degradation of the coastal features in Côte d'Ivoire. Regular follow-up measurements and monitoring programmes exist as far as the coastline evolution study is concerned. Indeed the most typical areas of coastal erosion are within the Grand-Lahou - located in the western part of the coastal country - and Abidjan areas, mainly East of Vridi canal (Port-Bouet and Grand-Bassam bays. For example, up to 2m/year of coastal erosion have been recorded in Grand-Lahou, with a lot of degradation on tourist and historical sites; while around Abidjan areas, tourist infrastructures are threatened by an erosion of 1.5 m/year.

As is the case in Benin, this phenomenon can sometimes take alarming proportions, particularly during the strong storm periods. A large part of the coastal erosion acceleration is due to human actions (construction of jetties for the protection of Abidjan harbour and the Vridi canal, coastal sand mining), although the coastal erosion process has been created by natural factors (intense and strong impacts of the swells, storms frequency and possible sea-level positive variations). The impact of this coastal degradation on the shoreline evolution and the destruction of critical habitats could be very serious in the future. Precautionary approaches should be recommended in order to minimize the loss and degradation which might happen in the future.

(d) Litter, solid wastes, plastics and marine debris

Because of the increasing quantities of refuse of a domestic and industrial nature resulting from rapid urbanization, garbage and solid waste are generally accumulated around major cities. Examples are cities such as Abidjan, San Pedro, Bouake, Daloa, each of which have more than 50,000 inhabitants. Large amounts of waste are created in both residential and commercial areas; but also from markets, industrial areas and hospitals - i.e. approximately, 100,000 tons per year of solid waste have been recorded for the city of Abidjan alone, of which one-third is treated; the remaining is recycled, recuperated or incinerated. Industrial wastes, but also of agricultural, chemical or biomedical origin are washed away into the sea by rains, storms and tides where they are dumped directly on beaches or in river basins. Indeed, a large part of the marine debris found on the coast comes from land, due to improper waste disposal and management. This has a negative impact on the aesthetics, in particular when the sandy beaches along the coasts, which are set aside for tourism, are affected by the proliferation of tar balls and other debris from shipping and fishing activities as well as beach littering. Examples are around the main coastal cities: Port Bouet, Vridi, Grand Bassam.

(e) Metals and heavy metals, oils, hydrocarbons including the atmospheric pollutants

Because of the increasing rate of industrialization in Côte d'Ivoire (similar in Nigeria and Ghana), there is a growing urban population growth, and a broad array of industries which have huge impacts on the freshwater, lagoon and coastal environments. From various studies and measurements, we have identified [illegible]

of land-based source-categories are mainly originated from chemical industries (oil, hydrocarbons and mining, petroleum and gas refineries, metallurgic factories, pharmaceuticals, paints, leather treatment industries).

The metal concentration values shown in **tables 17 and 18** are among the highest in the region. Abidjan and its surroundings form the main area of industrial concentration (more than 65 per cent); furthermore, with the proximity of the harbour and other infrastructures, the congestion of these land-based source-categories are getting higher and higher. It seems that the toxic effluents of the industrial waste and run-off, while not dramatic, tend to be more and more significant in some Ivorian aquatic areas, such as the bays located around Abidjan (Banco, Cocody, Bietri, Marcory; **Tables 16, 17 and 18**). In this domain, more regular data and measurements are needed, particularly in the Ivorian lagoon systems. This will allow a better identification of the most dangerous land-based source-categories from industrial facilities which contribute to the degradation of the Ivorian coastal and freshwater environments.

Other sources worth mentioning are the atmospheric emissions from industries and other sources - fuel and gas oil combustion, waste incineration, vehicles nitrous oxide and mono/dioxide carbon and substances released in the air as well as various organic compounds and particles. Most of those pollutants originate from domestic or road traffic sources (**Table 19**).

3. Management objectives for priority problems

Taking into account the source-categories identified and their impact on the coastal and marine resources and the health of the ecosystem, their effect on the biodiversity, public health and poverty alleviation, and on socio-economic benefits and uses, it is important to envisage following management objectives:

(a) Upgrade adequate urban/domestic and industrial sewage installation systems and waste water treatment facilities, including solid waste final disposal, in particular, for Abidjan and the large cities;

(b) Reduce the adverse impacts of sewage and other solid waste disposal on public and ecosystem health; monitoring the bacteriological contamination levels and the excess of nutrient load as well as industrial waste should constitute one first step;

(c) Encourage waste water treatment before any discharge into the freshwater, lagoon and near shore coastal environments;

(d) Increase the control on the use of agro-chemicals and biocides as well as other forms of POPs, while looking for possible alternatives options and land-use techniques;

(e) Reinforce the decentralization process as well as the existing laws, regulations and measures to protect the freshwater, coastal and marine environments in Côte d'Ivoire.

4. Identification and selection of strategies and measures

To achieve the overall management objectives, the following strategies and measures are recommended:

(a) Develop an appropriate ICM plan whose principal aim will be to control and regulate all development projects within the Ivorian coastal area; these plans should be better defined within the NEAP of Côte d'Ivoire;

(b) Use of EIA must be made a prerequisite for any coastal, watershed or marine development project;

(c) New industries must be better located to protect the most sensitive and critical areas from the negative effects of land-based activities;

(d) Exhaustive monitoring programmes must be set up to control the discharge of pollutants into the Ivorian aquatic environment (from municipal waste, industrial effluents, solid waste and agricultural run off);

(e) The private sector and other local industries must be encouraged to use clean production technologies, including efficient use of water and energy;

5. Evaluating the effectiveness of strategies and measures

The following measures need to be established in order to successfully ensure the effectiveness of the proposed strategies:

(a) A continuous assessment programme dealing with environmental quality of the aquatic environment of Côte d'Ivoire (water, sediments, fauna and flora);

(b) Use of science and technology, including, new mapping techniques, GIS, modelling, to ensure efficient implementation of the monitoring programmes, ICM plans, environmental impact assessments for possible solutions;

(c) A cost-benefit analysis and the evaluation of success or failures of proposed measures and programmes;

(d) Detailed surveys and evaluation of the policies and laws related to the protection of the Ivorian freshwater, lagoon, coastal and marine environments should be developed.

6. Programme support elements

In Côte d'Ivoire various institutions are directly involved in the implementation of strategies and programmes dealing with the protection of the coastal, marine and freshwater environments. Among the governmental institutions, we have the Ministry of Environment, Construction and Housing, the Ministry of Industry, Mining and Energy, the Ministry of Higher Education and Scientific Research, the Ministry of Agriculture and Animal Resources, the Ministry of Equipment, Transport and Tourism, the Ministry in charge of Economy and Finance. Various Ivorian and international non-governmental organizations, as well as some private societies contribute also to efforts for the protection of the aquatic environment in Côte d'Ivoire. Important legislation exists regarding the protection of the environment in general. Other laws and legislation related more specifically to the industrial environment, water, sanitation, etc. are under preparation. The main problem will be how to apply more efficiently the existing control measures and how to improve them. The following support elements are recommended, in order to ensure adequate implementation of the proposed strategies:

(a) Encourage better coordination between the various programmes, agencies, and technical departments, in particular when actions are executed within the same ecosystem (the aquatic environment);

(b) Ensure better involvement of local communities, stakeholders, non-governmental organizations, authorities and private sectors;

(c) Ensure the review, update and reinforcement, whenever necessary, of the legislation, regulations and standards related to the protection of the Ivorian freshwater, coastal and marine environments;

(d) Ensure the cost-effectiveness and the continuity of proposed programmes which aim at reducing and controlling the pollution of Ivorian aquatic environment from land-based activities;

(e) Information, education and sensitization of the public and the main actors must constitute an important component of the proposed integrated coastal areas management programmes in Côte d'Ivoire.

F. Gambia

1. Introduction

The Gambia is one of the smallest countries in Africa. It is almost completely surrounded by Senegal except for the 80 km total coastline facing the Atlantic ocean - **Fig. 7.** The country itself is approximately 480 km long; and at all points, it is less than 50 km wide. Banjul, the capital city, is situated on an island near the estuary of the Gambia river. According to the 1993 census, the total population of the Gambia was 1.026 million inhabitants. With a population growth of 4.1 per cent per year, the Gambia has a density of 96 inhabitants/km^2, which makes it the fourth most densely populated on the continent. The urban population accounts for one third of the total population with the remaining population living in the rural areas. The Gambia lies within the sahelian belt and the weather is characterized by erratic rainfall which has negative effects on agricultural production. Indeed, most of the agriculture is rain-fed with very few irrigation practices, because of the relatively low quantities of the groundwater resources. However, more than 80 per cent of the drinking water supplies in the Gambia derive from groundwater. While the country is highly dependent on tourism, the economy of the country is mainly based on agriculture and trading, with very few industrial activities.

2. Identification and assessment of main pollution sources, establishment of the priority source-categories

Four main sources of pollution from land-based activities have been identified in the Gambia:

(a) Fish processing;

(b) Sewage from domestic waste water in Banjul, the capital city;

(c) Litter, including some marine debris;

(d) Physical alteration, in particular coastal erosion, mainly around Banjul and the areas of Fajara and Bakau caused by structures on the beach - **Fig. 7.**

(a) Sewage

Although agriculture is a major type of land use within the Gambia, sewage from domestic excreta and urban waste water disposal especially in Banjul, constitutes one of the major source of pollution affecting the coastal, marine and freshwater environments. There is no sewage treatment plan and the domestic waste waters are discharged directly into the main estuary and rivers. In other areas generally, septic tanks and latrines pits are commonly used. Regular monitoring which has been carried out shows that there are coliforms and relatively important BOD especially near discharge areas. - **Fig. 8 and Table 20.**

(b) Litter, domestic solid wastes and other marine debris

Solid wastes collected from households include: food leftovers, paper, plastics, construction wastes, grass and other cuttings. Solid waste comes from residences, commercial buildings, markets, recreational areas, offices, schools, hospitals, hotels and tourism facilities, industries (fish and food processing, textile, etc.). An average of 40 tons per day (Gambia Report, 1993) of refuse is collected from Banjul and Kanifing Municipal Council (KMC). The main problem with this waste is in its management in terms of collection frequency or regularity and its proper disposal. For the time being, the site of waste disposal (Bakoteh) for KMC and its environments seems inadequate, because of population pressure, improper site management, the risk of polluting the groundwater drinking water resources and the health risks posed by those scavenging as the area is not fenced.

(c) The effects of coastal erosion

Coastal erosion constitutes one of the most serious issues which affect the littoral of the Gambia, in particular along the Greater Banjul Area (GBA). The effects of coastal erosion in the Gambia is rather alarming because

most threatened coastline. In the past, human disturbances have intensified the process, with sand mining at Bijilo and Kolofi. Today, all these sites have been closed and are subjected to strict control by the Gambian National Environmental Agency (NEA) and sand mining activities have been transferred inland (In Kartong). As far as critical habitat modification is concerned (i.e. mangrove areas), it is mainly due to man-made activities resulting from building construction, mining and conflicting uses with tourism, fisheries, road, forestry mining.

(d) Agro-chemicals, including fertilizers, pesticides and herbicides, around the agricultural areas

Little scientific data exists on the significance of agricultural pollution, because concentrations of nutrients or pesticides and other biocides have not been regularly determined for the freshwater, groundwater or coastal waters of the Gambia. However, from the few data available (**Table 21**), coastal and surface waters are affected to a certain extent by pollution from agricultural and agro-chemical run-off, in particular, the chemical fertilizers which affect the soil structure and pollutes the environment when get washed (**Table 21**).

The other land-based source-category of pollution which can affect the marine, coastal and surface water environments originates from the industrial waste water disposal. Indeed, the industrial sector, although underdeveloped and still on a small scale, contributes through its discharges in the Gambian estuary. The most common industrial effluents range from Banjul Breweries to waste water from the soap and plastic factories. Very few of these waste waters are recycled and indeed, most of the discharges remain untreated, for example 450,000 litres of liquid waste from breweries (Gambia Report, 1993). Still, regular programmes for the measurements of the pollutants load need to be undertaken, in order to appreciate the contribution of the industrial waste to the pollution of the water environment.

3. Management objectives for priority problems

The priority established for the source-categories of pollution seems to be in very close relationship with the problems of poverty, public health, food security, ecosystem health and resources exploitation, with consequences on socio-economic benefit and uses. It is therefore important to set up the following management objectives:

(a) Provide the required financial and technical support to the national environmental agency (NEA) to allow it to succeed in preventing and/or reducing the degradation of marine, coastal and freshwater environments from land-based activities;

(b) Control of coastal and marine pollution caused by sewage, industrial liquid waste, litter, agro-chemicals, including fertilizers and other biocides;

(c) Evaluate the possibilities for waste water treatment, before any discharge to the coastal or surface water;

(d) Resolve the problem of the solid disposal, and reduce the health risks for the population living around the waste disposal sites;

(e) Control future alteration and destruction of the coastal area (mainly due to coastal erosion), including critical habitats modification and protection from tourist activities, through implementation of effective integrated coastal management;

(f) Reinforce the existing laws and regulations to protect the coastal and marine environment;

(g) Review and enforce appropriate environmental awareness programmes, including sensitization and education.

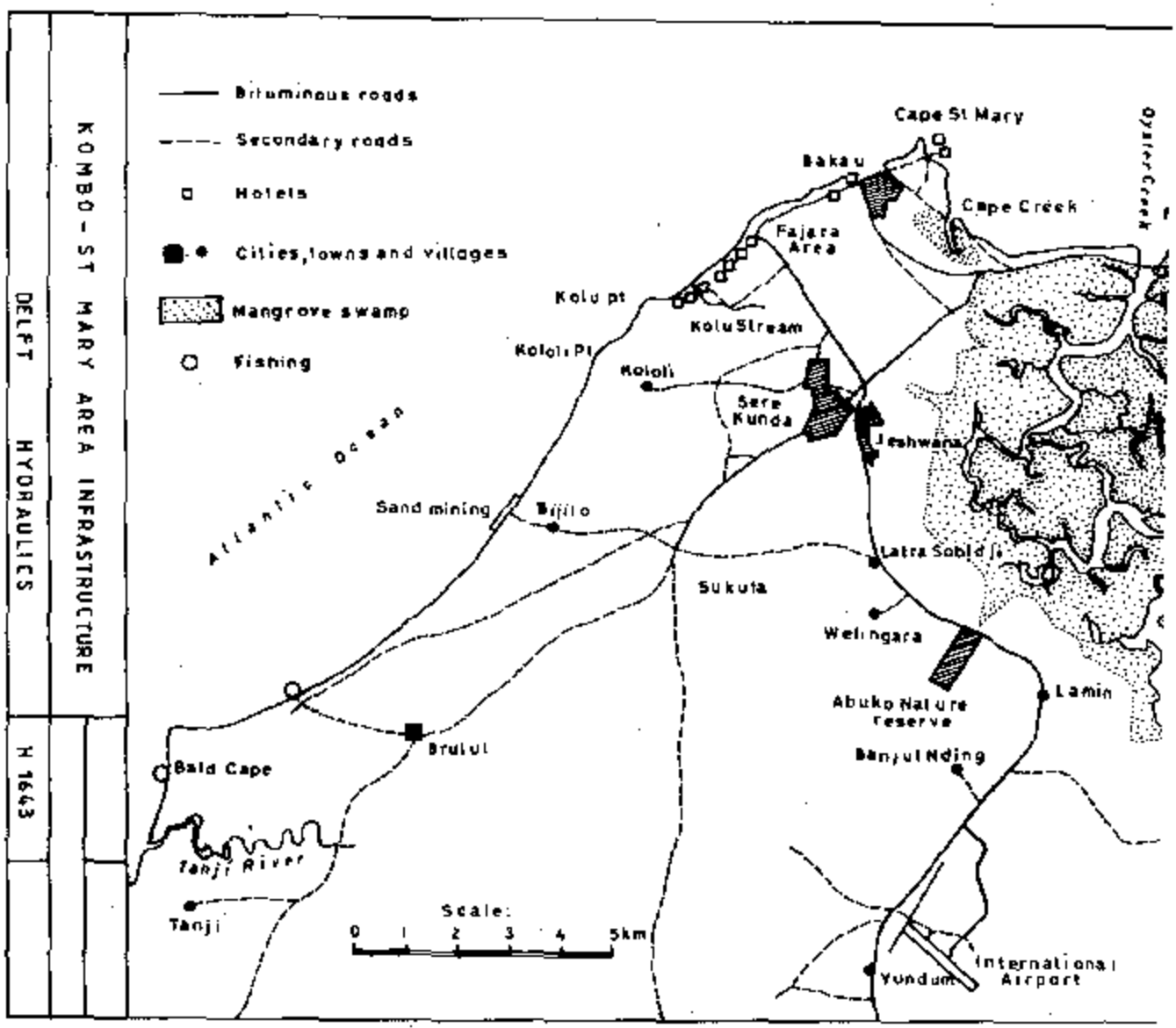


FIG. 7 MAP OF LOCATION OF THE GAMBIAN COASTAL ZONE

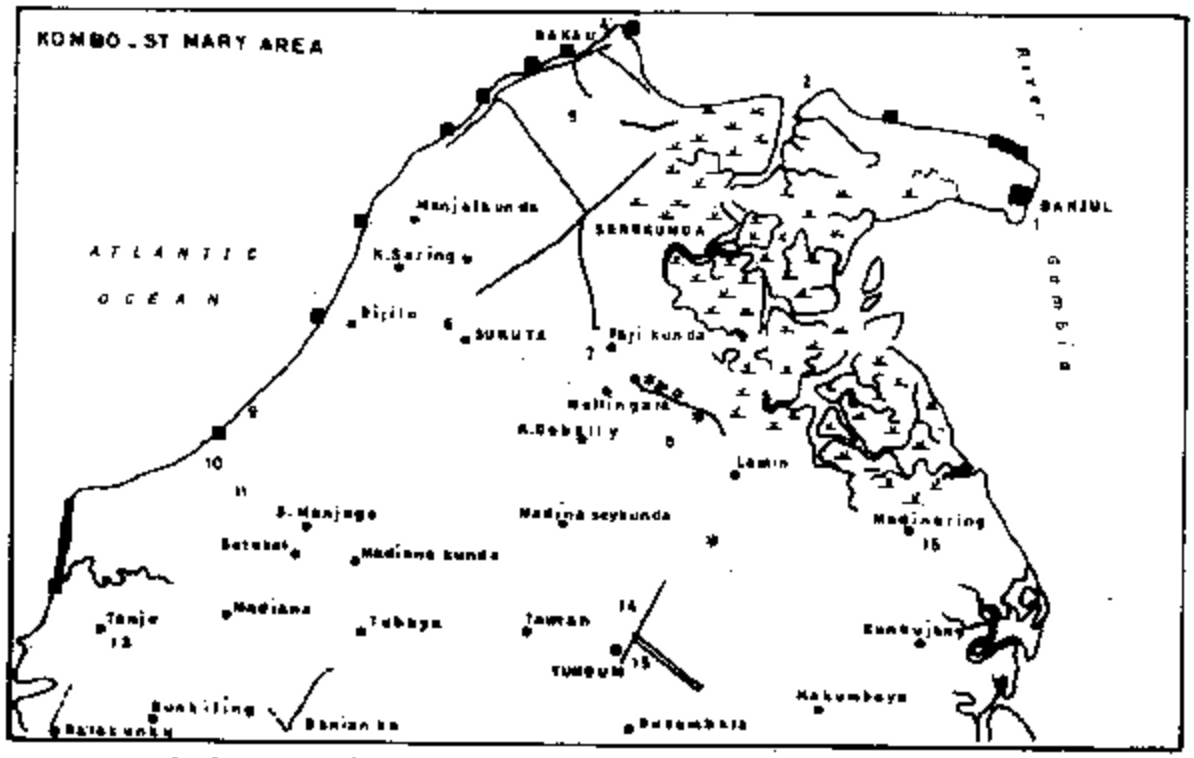


FIG.8 - SAMPLING POINTS ALONG THE GAMBIAN ESTUARY

Table 20. Results of faecal coliform counts obtained from various sampling points along the Gambia estuary.

Sampling points	N° of samples collected	X Total coliform count (in 100mls)	X feacal coliform count (in 100mls)
1. Banjul wharf (100m) from sea outfall 950m from beach	5	67	15
10. Banjul wharf beach	5	>1000	>1000
2. Sea outfall area	5	41	29
3. Atlantic hotel beach	5	>1000	24
4. Lands office beach	5	>1000	28
5. Opposite lands office beach (ie 100m from sea outfall)	5	45	7
6. Nursing shool beach	5	>1000	26
7. Parkers creek	5	>1000	124
8.Oyster creek	5	>1000	200
9. Wadner beach	5	>1000	96

X = average

4. Identification and selection of strategies and measures

To achieve the overall stated management objectives, the following strategies and measures are recommended:

(a) Development and implementation of a comprehensive integrated coastal management plan which should involve all the stakeholders and regulate governmental and private projects development within the coastal area;

(b) Implement the use of EIA for all coastal development projects;

(c) Decentralize industrial, tourist and other economic activities which are mainly taking place around the Great Banjul Area, one of the most critical and sensitive areas to negative impacts from land-based activities;

(d) Monitor all discharges, from urban, domestic, agricultural or industrial run-off, by implementing comprehensive monitoring programmes which should provide base-line data relevant to coastal, surface water and marine pollution;

(e) Encourage the public, local communities and private sector (including tourism industry) to avoid through their activities, the destruction of the coastal habitats and environment;

(f) Identify and implement coastal and marine protected areas to maintain the richness and biodiversity of their habitats.

5. Evaluating the effectiveness of strategies and measures

The effectiveness of the proposed measures and strategies can only be met if a certain number of criteria are established, among them:

(a) Simple water quality indicators should be developed, in order to help continuous monitoring of the water quality;

(b) Epidemiological studies must ascertain the possible correlation between the health of the population and the decline in water quality in the most densely populated areas along the Greater Banjul Area (GBA);

(c) Evaluate the degree of success and failure of the adaptation of proposed measures and regulations;

(d) Detailed surveys using geographical information systems, modelling and statistical analysis should help to evaluate the effectiveness of the control strategies and programmes.

6. Programme support elements

The National Environmental Agency (NEA), set up in July 1993, is responsible for coordinating, monitoring and implementing management and protection programmes, regulations and acts related to the environment in the Gambia. There exists, in addition, sectoral legislation such as those of Forestry, Wildlife Department and the Department of Water Resources. In order to ensure better coordination with sectoral ministries involved, as well as the private sector and the community interests, various working groups have been assigned tasks to address specific issues, develop recommendations and facilitate actions. In 1992, the Gambian Environmental Action Plan (GEAP) was adopted and it represents the national environmental action plan through year 2002. Fortunately, provision has been made to regularly monitor and assess the impact of the GEAP every two years by adjusting approaches, strategies and needs. It is therefore important to adequately implement the proposed strategies developed in the previous chapter and to ensure that following support elements are met:

(a) Include the national programme and strategy to prevent or reduce the degradation of coastal, marine and surface water environments from land-based activities in the GEAP priorities;

(b) Adopt or enforce regulations that preserve and protect the coastal and marine environments;

(d) Ensure a better involvement of all the stakeholders (local populations, private sector, state institutions, municipalities, non-governmental organizations) in the implementation of the national programme and strategy;

(e) Ensure a better coordination to avoid overlapping and conflicts between the various agencies, departments, private and sectoral programmes dealing with the marine and coastal areas management, development and protection;

(f) Train and consolidate the technical capacities of the existing manpower and reinforce the human resources;

(g) Ensure the cost-effectiveness of the proposed programme which aims at reducing and controlling the land-based activities which may affect the marine, coastal and surface water environments.

G. Ghana

1. Introduction

Ghana is a coastal state in West Africa on the Gulf of Guinea. It is bounded on the east by Togo, to the west by Côte d'Ivoire and the north by Burkina Faso. Ghana has a total surface area of some 239,460 km^2 with a population estimated at 15 million (1984 census) and an annual average population growth rate of 3 per cent. What is described as coastal and marine zone has been defined to include the 200 nautical mile limit (EEZ) and the landward limits of a line of over 50 lagoons, creeks, swamps and wetlands together with intervening rivers.

The coastline stretches for 550 km along the Gulf of Guinea from east to west (**Fig. 9**). It is generally a low lying area, not more than 30m above sea-level. Seaward, it has a rather narrow continental shelf extending outward to between 25 and 35 km except off Cape Coast and Saltpond where it reaches up to 80 km. Ghana is fairly well watered. It is drained principally by the Volta river system (the Black, White and Red Voltas and the Oti river) from the north and diagonally across eastward to open into the Gulf of Guinea at Ada; an overall drainage basin of some 390,000 km^2. It is estimated that about 60 per cent of the drainage system lies outside the bounds of Ghana. The rest of the country is drained into the sea from the West and towards the East by the Tano, Ankobra, Butre, Pra, Kakum, Amisa, Nakwa, Ayensu and Densu rivers. Some of these rivers (Densu, Ayensu, Nakwa and Amisa flow into the sea through lagoons. Some of these lagoons (50) along the coastline are very small, less than 1 km^2 in surface area, others large, 50 km^2 and 250 km^2.

The coastline area is closely settled and is characterized by both numerous rural settlements and towns. Three of the major urban agglomerations in the country, Accra - Tema, Cape Coast and Sekondi - Takoradi are located on the coast (**Fig. 9**). Over 60 per cent of all industries in Ghana are located in this area.

2. Major coastal, marine and freshwater sources of pollution

(a) Land-based sources of pollution

The principal land-based sources of pollution are human, domestic, municipal, industrial (including mining) and agricultural discharges which are usually untreated and unregulated.

The municipal or domestic sewage originates from households, markets, transport terminals, and restaurants of all sorts and contains organic matter, nutrients, micro-organisms, parasitic organisms, oils, petroleum products and trace metals. Industrial pollutants arise from textile, food beverage, petroleum refining and handling and mineral exploitation and processing industries. Improper land preparation for agricultural purposes and fuel wood and lumber exploitation lead to deforestation resulting in erosion and sediment-load transport by rivers coastward.

These pollutants which enter the coastal and marine environment untreated and unregulated may be prioritized for attention, locally and regionally, as sewage and solid wastes; habitat alteration and physical degradation; industrial and mining sources of pollution; urban and domestic run-off; agricultural chemicals such as pesticides and fertilizer as nutrients; litter particularly non-degradable materials including plastics; sediments carried from eroded fields in floods; oil hydrocarbons from petroleum processing, handling and disposal of spent products.

Heavy or trace metals from industrial and municipal wastes; and lastly POPs and micropollutants from synthetic pesticides and industrial discharges.

(b) Coastal pollution

The coastal zone is rapidly developing. Almost 60 per cent of all industries in the country are located in this zone, principally in the Accra-Tema metropolitan area which covers less than 1 per cent of the total area of Ghana.

This concentration of industrial activity has led to the continuous immigration of people in search of jobs from the inland and rural areas to the coastal industrial centres. Along the coastline of Ghana, since discharges

SOME COASTAL LAGOONS OF GHANA

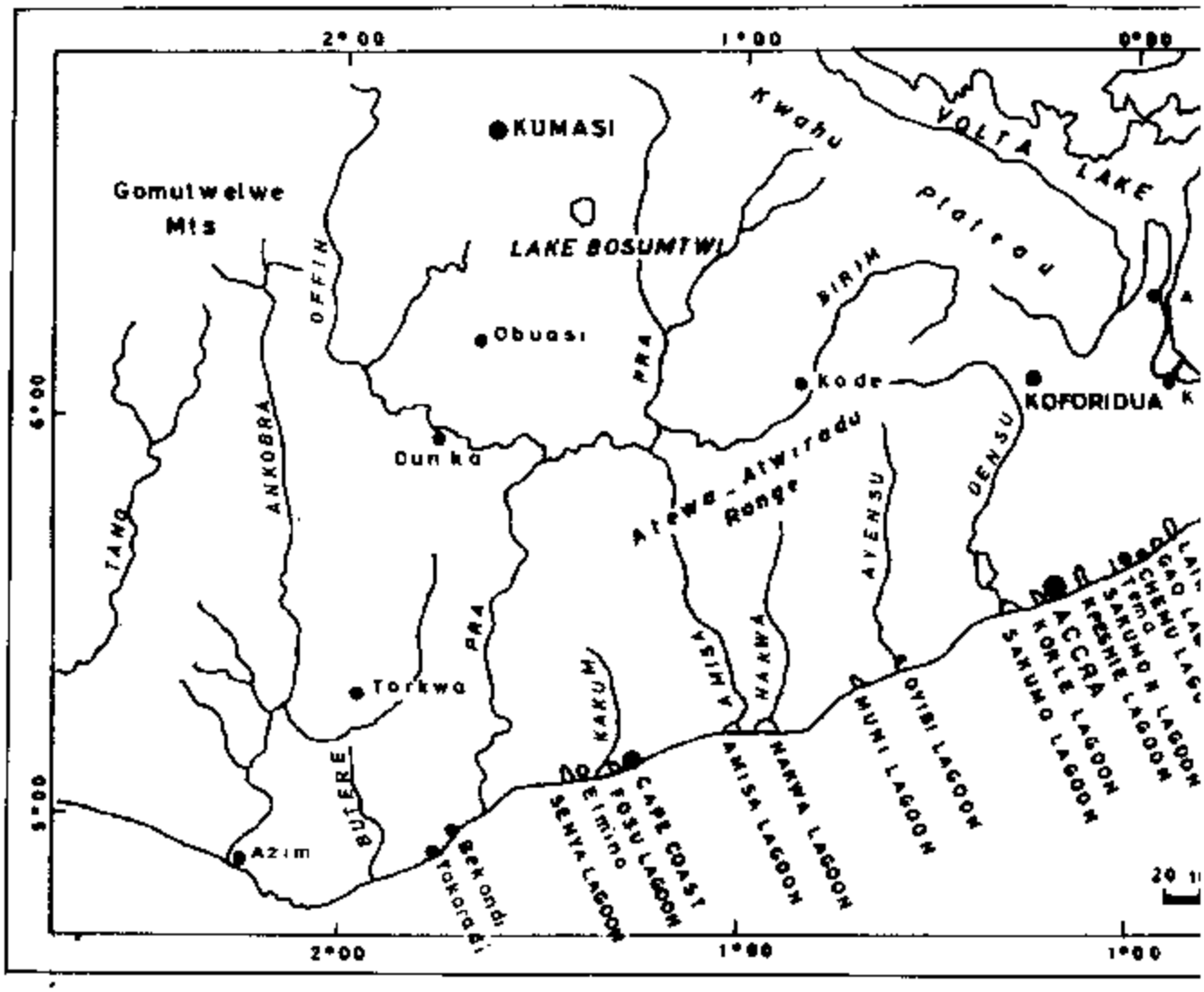


FIG. 9 - MAP OF COASTAL ZONE OF GHANA

densities. The 1984 Census recorded some 116 settlements along the 550 km coastline. Thirty of these had populations of over 5,000 while 32 had a population of between 2,000 and 5,000 inhabitants.

Urban, heavily populated catchments (e.g the Densu basin and the Odaw basin) are likely to carry polluted waters arising from both point and diffuse sources. Generally, domestic sewerage and organic industrial wastes as well as wastes from agricultural and forestry products are the main sources of organic pollution of coastal wetlands in Ghana.

Domestic sewerage is characterized by the presence of human excreta, consumed food residues and cleansing agents. It is invariably rich in bacteria and high in Biochemical Oxygen Demand (BOD). Organic industrial wastes originate mainly from processing industries such as fruit and vegetable canneries, dairies, abattoirs and breweries (**Fig. 4**). They are characterized by high BOD and nutrient levels. These wastes are generally easily bio-degradable; but they can lead to eutrophication, excessive organic growth, changes in pH, oxygen depletion, loss of aesthetics and quality of the receiving waters.

Discharges from textiles, chemical and pharmaceutical-industries especially in industrial zones (e.g.Tema) contribute significantly to organic loading of waters (coastal waters). Furthermore, industrial and domestic effluents contain heavy metals, oils and suspended solids in variable concentration which enter the coastal marine environment. The estimated average metal concentration is still low, except few Hg and Pb values measurements (**Table 22 and 23**).

(c) Urban development

There are about 30 settlements with populations of over 5,000 inhabitants in the coastal area of Ghana. In these urban centres, problems exist with regard to planned expansion and delivery of infrastructure and other utility services especially sanitation, drainage facilities and water supply.

These problems, including the extraction of coastal clay, sand and stones for construction and the disposal of human waste, lead ultimately to environmental degradation and human health hazards; and pose serious risks of pollution to the adjoining coastal and marine environment.

(d) Sand mining

The growth in the economy in recent times has increased the rate of urbanization and construction. As sandcrete and concrete are favoured building materials, there has been increasing pressure on these resources. Thus, there has been the tendency to destroy the beaches by direct removal of sand and stones resulting in changes of the beach profile and disturbance and destruction of the fauna of the beaches. The removal of sand from one beach can cause sea erosion at another as the beach replenishment material has been removed.

3. Existing and foreseen solutions: measures and legislation

The existing pollutants of the coastal marine environment, their source and nature have been identified. Future ones will be anticipated and identified from information to be provided by the Environmental Impact Statements (EIS) which are filed or provided by all development agencies, industrial, manufacturing etc.

The Environmental Protection Agency (EPA) of Ghana has been set up and is empowered to ensure the effectiveness of the National Environmental Action Plan; i.e., the sound and sustainable environment for development.

Accordingly, the EPA has undertaken a review of existing legislation on the environment with the view to making appropriate modifications for effective enforcement and application. It has also provided guidelines for Environmental Impact Assessment (EIA) and set up measures to provide information for early action, as appropriate. Measures are being taken by all relevant agencies including District Assemblies and technical government agencies to prevent, control and, where possible, eliminate the sources of pollution. The measures include processing, recycling and safe disposal of wastes. The "polluter-pays" principle will be applied where necessary. The major emphasis is on awareness creation, education and community participation. The important role being played by non-governmental organizations in this regard is noteworthy.

The foregoing measures notwithstanding, Ghana recognizes also the need to formulate an environmental health action plan to focus on the human health aspects. This will no doubt impact positively on the general environment including the coastal and marine areas.

4. Constraints

The main constraints derive from the lack of technical know-how and the resources to clean up existing pollutants; lack of effective public education, awareness and poor compliance with otherwise simple sanitary, environmental and regulatory measures.

Inadequate financial and logistic support for these and other equally pressing socio-economic development programmes also constitute a constraint.

5. Assistance

Through the World Bank, Ghana has developed its National Environmental Action Plan and identified local technical institutions and agencies to undertake the implementation of various aspects of the Plan. These include pollution source identification, data collection and data-base creation; monitoring, clean-up programmes of existing problem areas and awareness creation. As stated above, financial and logistic support including technical equipment, chemicals and transportation are required in addition to human resource capacity as assistance to ensure the realization of the objective of the Plan.

6. National strategy and programme support elements

Ghana believes that the effective implementation and coordination, locally and regionally, of the activities involved in the various programmes listed below will ensure sustainable environmental conditions in our marine and coastal ecosystem. Ghana proposes also the involvement of the OAU and ECOWAS in these regional activities.Meanwhile the following measures have been taken:

(a) An Environmental Protection Agency (EPA) has been established and vested with the appropriate authority for environmental matters;

(b) A National Environmental Action Plan (NEAP) has been produced;

(c) All relevant national technical institutions have been identified and associations with the NEAP;

(d) The Ghana Environmental Resource Management Programme (GERMP) has been planned to help the Government implement the NEAP;

(e) Ghana is signatory to various international conventions related to the problems of sustainable development and regional and international cooperation in matters of the environment;

(f) In response to UNCED (1992) and Agenda 21 Ghana is involved in the following:

i. ICAM (Integrated Coastal Area Management Program).

ii. International Geosphere Biosphere Programme (IGBP).

iii. Land and Ocean Interactions in the Coastal Zone (LOICZ).

iv. The Gulf of Guinea Large Marine Ecosystem Regional Project.

v. The Lower Volta Mangrove Project (LVMP) of Ghana.

vi. The WACAF programme of the Regional Seas Programme of UNEP.

vii. The Global Programme of Action for the Protection of the

viii. Marine Environment from Land-based Activities.

H. Guinea

1. Introduction

The maritime front of the republic of Guinea is 346km long. It has an irregular shoreline deeply penetrated by the sea through large estuaries. The Guinean continental shelf has a surface of 43,000 km^2 around which is situated the largest submerged surface of the west African coast in form of polygon oriented North-South-East. Guinea covers an area of 245,857 km^2 with a population increase estimated at 2.8 per cent per year. Its economy is based on agriculture and mineral exploitation. Conakry, the capital city, with an increase rate of approximately 10 per cent, is host to the majority of the economical activities of the country. This increase may be explained both by the decline in mortality rate due to better health and sanitary facilities, but also by the contribution of the rural population transfer that represents 7 per cent the total urban population increase.

From the interior to the coast, essentially from north to south, there are eight rivers that flow to the sea through estuaries (**Table 24**). The Guinean littoral is characterized by the presence of mangroves (rhizophoracea and avicenniacea) on an approximate surface area of 1 million hectares, according to the Mangroves Management Scheme of Guinea (SDAM-1990 - **Fig. 9a and 9b**). There are five mangrove forests regulated on the Guinean shoreline and classified, in order of priority, as follows:

(a) Soumba-Konkouré (actually in an on-going development stage);

(b) Tabounsou (already heavily exploited);

(c) Forécariah (scattered exploitation);

(d) Moteba Rio-Pongo (still being protected);

(e) Rio-Nunez (local exploitation).

Among those five mangroves entities, only the Soumba-Konkouré has obtained the support of the European Economic Commission (EEC) in 1992 with the implementation of a pilot-project for the rational management of the mangroves of Sangaréah Bay.

The majority of the industries are concentrated on the coast (70 per cent) and many of them present a certain number of risks concerning sources-categories of pollution due to land-based activities (mining, food industries, breweries) which affect the marine environment. The impacts of pollution on Guinean marine and coastal zones has been clearly addressed in the National Environmental Action Plan synthesis document (PNAE/Guinea, 1994). The pollution load is mainly from industrial, urban and agricultural origin.

2. Identification of the main sources of pollution and establishment of priorities by source-categories

There are six main sources-categories of pollution due to land-based activities which affect the coastal and marine environment:

(a) Sewage from urban and industrial origin (including domestic sewage);

(b) Discharges from agro-chemical origin, including pesticides, herbicides and other organo-chlorine and organo-phosphorus substances (Persistent Organic Pollutants) notably around intensive agricultural zones, in addition to the excessive nutrient load;

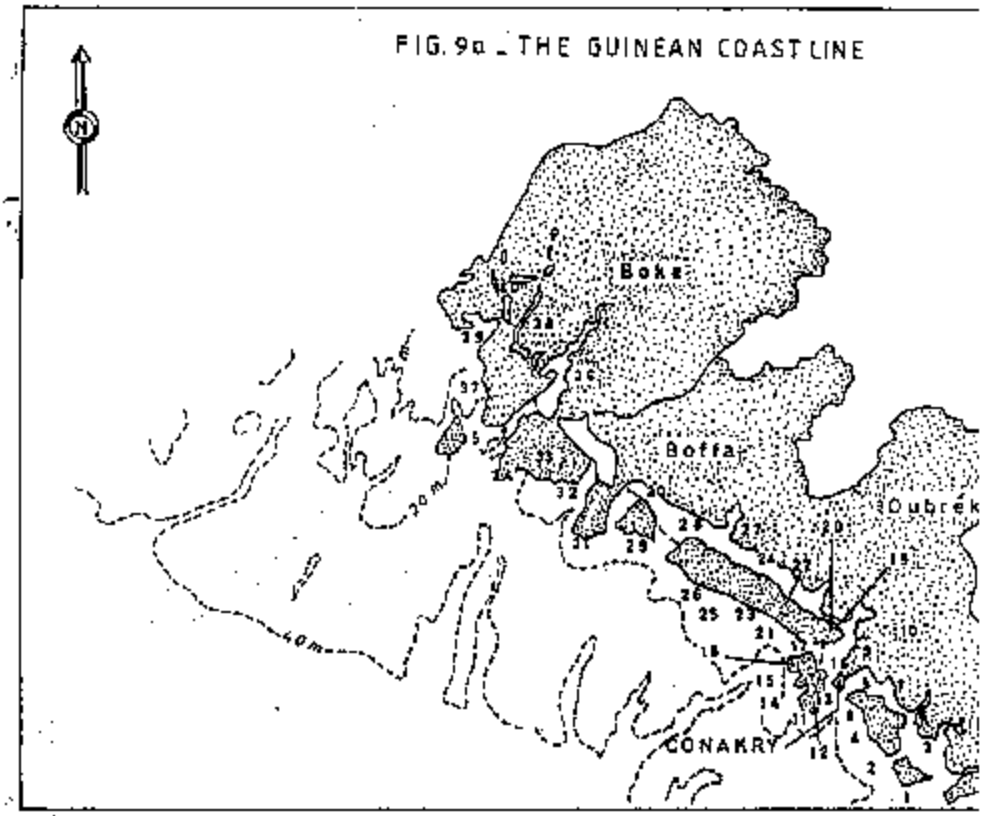
(c) Physical modifications of the littoral especially coastal erosion, salinization, over-exploitation of the mangroves, sedimentation, siltation and the soil acidification;

(d) Solid wastes, detritus, plastic materials and marine debris;

(e) Heavy metals and traces metals, oils and hydrocarbons from industrial waste waters and port activities;

(f) Atmospheric pollutants for which raw data show the public health risks and their impacts (emissions in the atmosphere of monoxide and nitrogen oxide, aluminium and carbon due to mining units emissions and other various industries on the one hand, and on the other hand, to vehicles emissions, especially around large cities)

FIG. 9a _ THE GUINEAN COAST LINE



N° ACTIVITY AREAS	N° ACTIVITY AREAS	N° ACTIVITY AREAS	N° ACTIVITY
1 SOURINENE	11 KOYA	21 KHONEBOMBO	31 KEP BAAM
2 SIBKOBI	12 MEREYIRE	22 DOUNKHUI	32 BAMA FOU
3 SOURE GHAMDI	13 PORLA	23 KIKOIADI	33 YONGONS
4 GUENE KHUMTI	14 RIBA	24 KONDE SOULY	34 BATEAU
5 KOKIMODIA	15 KOLIA	25 MANKOURAN	35 DOU POUL
6 BARODABON	16 SIGNAL	26 KAFOKA	36 KILIKS
7 KHILIFILI	17 SEGHEMA	27 KITEKATA	37 NOUMPO
8 TEKNEFOUMOU	18 SORO	28 FATALA	38 TONKIMA
9 FALRIS BAAMA	19 BORADABON	29 BONGOLON BAAMA	40 KAMOJAB
10 YELI SOUDE	20 WONKOU	30 GORE	

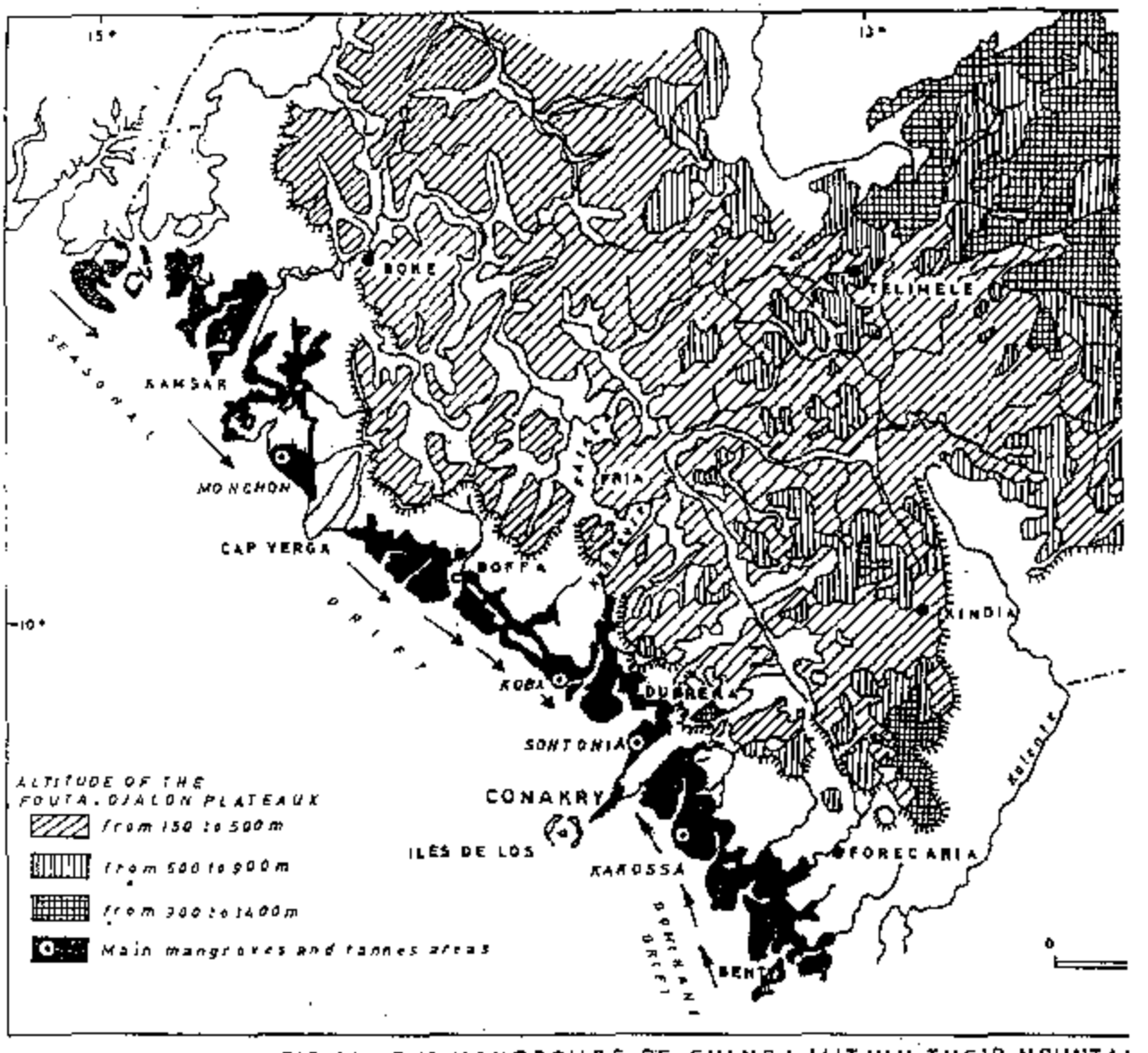


FIG. 9b _ THE MANGROVES OF GUINEA WITHIN THEIR MOUNTAI
AND MARINE CONTEXT

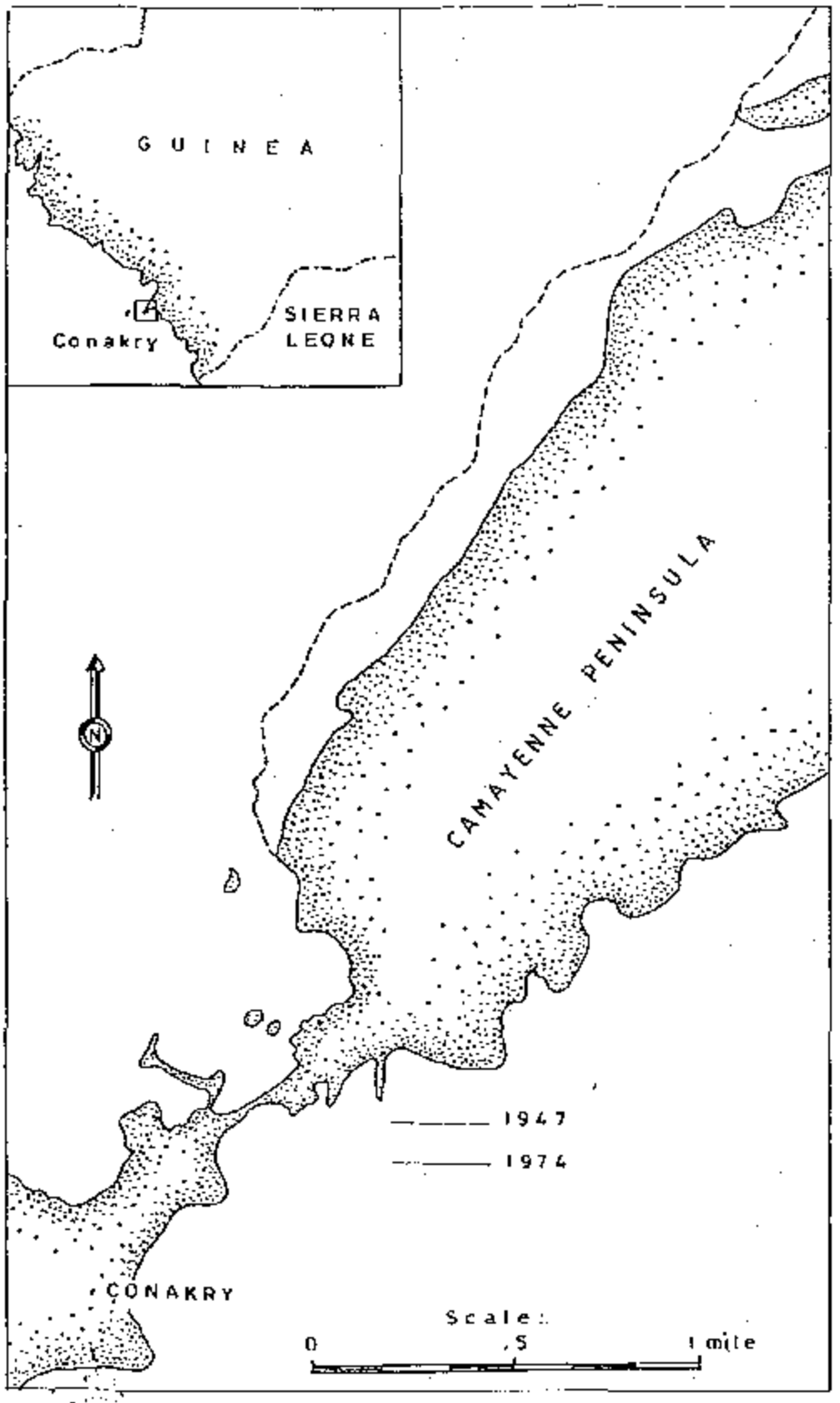


FIG. 9C. COASTAL RETREAT ON THE WEST SIDE OF THE CAMAYENNE PENINSULA. 240 m. AROUND BETWEEN 1947 AND 1974

(a) Industrial and domestic sewage

This source of pollution constitutes one of the main factors which contribute to the degradation of the coastal and marine environment in Guinea. Apart from the sewage evacuation system, located in Kaloum near an island and other installations in the city of Kamsar (Boké), the major part of the sewage evacuation is performed by septic tanks and by spreading on the soil. In Guinea coastal regions, there are currently no facilities for sewage processing or pre-treatment. Industrial waste is neither controlled nor processed. Waste water raises acute problems, leading in most cases to eutrophication of coastal waters, but also to bacteriological and microbiological contamination as is the case of the Konkouré river which flows into the Sangaréah bay.

(b) Discharges from agro-chemical origin, including pesticides, herbicides and other Persistent Organic Pollutants

These types of pollution are of agricultural origin. They generally predominate around irrigated areas. The Konkouré river mouth and the delta of Fatala river constitute concrete examples, with most of the substances of a chemical origin (fertilizers, pesticides, herbicides and other biocides, including some types of persistent organic pollutants). The excess of nutrients which infiltrate underground or superficial waters contribute in general to water enrichment and consequently to their potential eutrophization especially during the rainy season.

Although significant information has been obtained about this type of coastal pollution, continuous acquisition of data on the evolution of various contaminants in the Guinean aquatic environment has become a necessity.

(c) Physical coastal modifications, destruction of critical habitats and coastal erosion

Coastal erosion process, especially on the sandy or muddy littoral, constitutes one of the main factors of the degradation of the Guinean coast. Studies undertaken by the Centre de Recherches Scientifiques de Conakry/Rogbane (CERESCOR) have shown rapid recessions of the shoreline. The most affected areas are situated in Koba in the northern part of the coast, Tabounsou in the southern of the coast and in the vicinity of the Conakry peninsula area; in Koba and Tabounsou, more than 1.8 m per year of coastal retreat have been reported. As a result, there is a serious threat to tourist infrastructures on the coast as well as some residential constructions built along the shoreline **(Fig. 9c)**. Among the causes of this erosion, we can identify the process of sand mining on the beaches for construction purposes. A large part of the coastal erosion process increase is due to hydrodynamic and morpho-sedimentary effects as well as human activities (construction of protection dikes around Conakry harbour, dredging of channel access, coastal sand mining, anarchical occupation of the littoral by various constructions). These natural ecological or human modifications can lead, if they persist, to biological diversity losses and even to the degradation of the entire ecosystem.

(d) Detritus, solid wastes, plastic materials and marine wastes

Detritus, solid wastes, plastics and marine debris are generally found around big cities such as Conakry, Dubréka, Boké, Coyah, all cities located close to the coast or adjacent to drainage-basins water courses. Waste processing services currently offered consist mainly of their collection and transportation to non-controlled dump sites generally located in the urban area and without any regulation plan. As an example, one of the mining dump sites in Conakry, which extends for a surface of 2 hectares, is surrounded by living quarters. Environmental and security problems created by this dump site are enormous (superficial water table contamination, loss of historical and aesthetic attraction values, degradation of the marine and coastal ecosystems). Examples also exist of contamination of coastal waters of the Sangaréah Bay and the accumulation of solid wastes and marine debris in the northern part of Conakry.

(e) Heavy metals, hydrocarbons and atmospheric pollutants

The very few studies on marine and coastal water contamination by metals, hydrocarbons and other micro-pollutants have shown that these sources of pollution originate from industries, ports and harbour areas and thermal centres. This different type of pollution is concentrated around Kamsar mining units (Boké) and Friguia-Kimbo with the discharge of red mud into Konkoure river. Near Conakry, resulting from its industrial

of used oils which are discharged directly into the sea through rain water evacuation canals. The Conakry harbour receives between 500 and 600 ships, which gives an idea of the increasingly large concentration of these pollution source-categories.

It is worth pointing out that toxic effluents from mining and industry discharges are responsible for the pollution of some important river and bays located around Conakry and its surroundings (for example, through the discharge of caustic substances). This is why it is particularly important to proceed with observations and measures, mainly in the city of Conakry and its periphery. This would allow the most affected zones to be identified by industrial and mining run-off, and also determine the most sensitive areas in terms of pollution from land-based activities. Similarly, the control of oil refuse pollution has become necessary because of frequent shipping operations and possible accidental oil spills and the deposit of other harmful chemical products.

The other important sources of pollution worth mentioning in Conakry, Kamsar and Friguia concern emissions of gas, smoke, dust in the atmosphere and other substances from industrial and agricultural factories, vehicles and mining units.

3. Management objectives and strategies concerning the priority problems

The National Environmental Action Plan has established priorities for the source categories of pollution depending on the nature of the problem, the type of contaminants, the affected areas and their impact on biodiversity. The management objectives of the National Environmental Action Plan are the following:

(a) To provide the required financial and technical support to the National Environmental Office for it to reach its objectives of prevention, reduction and elimination of the pollution and the degradation of the marine, coastal and freshwater environment from land-based activities;

(b) To ensure the control of the marine environment and adjacent waters against pollution due to man or land-based activities and to evaluate the effects of pollutants prior to any discharge in the coastal, marine and freshwater environment;

(c) To update a national record of classified installations and other terrestrial activities and proceed to recommendations which aim to protect and manage the environment with regard to a number of activities among which are, solid wastes and sewage treatment, recycling systems and other forms for reducing public health risks;

(d) To ensure the protection of critical habitats as well as the littoral against coastal erosion phenomena (in particular, by implementing integrated coastal management programmes);

(e) To strengthen and apply legislative measures (an environment protection and development code) and economic incentives to encourage the use of non-pollutant technologies.

4. Institutional and financial constraints

In order to tackle environmental problems regarding the coastal and marine areas, the NEAP has planned the implementation of a national coastal authority which could integrate the protection of the marine and coastal zones to the socio-economic development policies. This coastal authority may be installed at the National Environmental Office and should have the responsibility to coordinate, control and implement management and protection programmes for the Guinean environment. Different ministerial departments, agencies and non-governmental organizations which are an integral part of this authority would attempt to tackle specific problems related to marine and coastal environment and to facilitate actions to be conducted.

The National Environmental Office has benefited from assistance from FAO through the Integrated Coastal Management Project (WACAF/II). However, institutional, financial and logistical support to NED is necessary in order to allow it to better ensure the coordination of activities aimed at improving the protection of the Guinean coastal and marine environment in a longer perspective.

5. Programme support elements and national strategy

The National Environmental Office was created in March 1986 and is responsible for the implementation of

the NEAP. While the development of these programmes and strategies constitute positive steps for the management of the Guinean littoral, concrete actions resulting from these programmes should be developed. For this purpose, the following elements are recommended:

(a) Ensure better coordination between the various sectoral plans which concern the marine, coastal and aquatic environment in general, but also between departments and agencies whose mandate quite often overlap;

(b) Promote better community-based participation, including women, socio-economic actors, non-governmental organizations and scientists by means of development actions in coastal and river-basins areas;

(c) Reinforce national capacities in terms of human resources and develop strategies aimed at improving the living standards of coastal populations;

(d) Integrate main target groups in integrated coastal management policies in order to protect more efficiently the coastal and marine environment from degradation due to land-based activities;

(e) Ensure education and awareness programmes of the public by their integration in the management programmes which aim at a sustainable protection of the coastal regions;

(f) Adhere to agreements and appropriate international and regional programmes in view of a more efficient coordination of activities to be implemented in the framework of the program of action.

It will be necessary in this case to evaluate and create a regional clearing-house which will favour the cooperation between States and national institutions involved in scientific and technical for the prevention and/or the reduction of the land-based activities impacts on the coastal and marine environment.

I. Guinea-Bissau

1. Introduction

With a surface area of about 36,000 km^2 , Guinea-Bissau possesses a coast of more than 300 km long, characterized by multiple estuaries. In addition, Guinea-Bissau is surrounded by a group of islands in the form of an archipelago (the Archipelago of Bissagos), on a widened and shallow continental shelf. The coastal waters of Guinea-Bissau, like other countries located on this eastern side of the Atlantic ocean, are characterized by their wealth of fisheries production, due to the presence of coastal upwellings. A great part of the population of Guinea-Bissau (more than 79 per cent) is concentrated in coastal regions especially in the region of Bissau, the capital, where one finds most of the small transformation industries (food industries especially), with port activities and some light chemical industries.

2. Identification of the main source categories of pollution from land-based activities

The main source categories of pollution that have been identified are the following:

(a) Sewage and waste waters from urban and domestic origin;

(b) Solid wastes, detritus, and marine debris;

(c) Industrial wastes, oil and hydrocarbons;

(d) Physical and habitat modifications, especially coastal erosion.

While the main problem with these source categories of pollution is of a technical nature, they also present institutional, economic and human constraints such as the lack of technical personnel, financial resources, problems of the poverty, lack of institutional frame and structures, of scientific data, of waste water processing policy, integrated management plan.

3. Envisaged solutions and strategies

(a) Elaboration of integrated management plan for the whole coastal region and its resources;

(b) Protection of threatened species and the most sensitive habitats, particularly the mangroves;

(c) c) Elaboration of management plans of solid wastes and used waters;

(d) Strengthening in terms of training and institutional capacities;

(e) Education and awareness of populations for a better protection of the marine and the aquatic environment.

Several actions have been envisaged within the elaboration of the national environmental action plan. Some of these actions aim mainly at protecting the coastal region and its associated resources. In this framework, the role of the non-governmental organizations and the local populations is particularly important.

J. Liberia

1. Introduction

Liberia, a tropical country on Africa's west coast, has a total land area of 111,369 square kilometres and a coastline of 560 km. The geography of Liberia is characterized by several physiographic zones parallel to the coast. The physiographic zones include:

(a) Coastal plains that are in turn characterized by a relatively straight coastline with sand bars, long beached salt and freshwater lagoons and a few promontories;

(b) Rolling hills parallel to the coastal plains which have elevation in the order of 90m with numerous hills, valleys and water courses;

(c) Plateau and mountain ranges which are behind the rolling hills with table lands up to 300m in the height and mountain ranges up to 600m.

Liberia is drained by several rivers; the drainage patterns of the river systems are determined by geological structures and relief's. The drainage system consist of the six major principal rivers: Mano, Lofa, St. Paul, St. John, Cestos and Cavalla, plus numerous smaller rivers and creeks owing to the heavy traffic of foreign materials entering the marine environment.

Precipitation in Liberia is heavier than that for most parts of West Africa. On the average, Liberia receives nearly 4,000 mm of rain per year; but geographic and monthly deviations are considerable. Liberia has a wet season from May to October and a dry season from November to April. As far as the marine resources are concerned, the exploitation of fishes is essential to the diet of Liberians. Commercial fishing is carried out on a large scale by fishing companies, and thousands of coastal dwellers also depend on traditional fishing methods for employment and subsistence. Large scale coastal pollution could thus have serious social and economic consequences.

2. Identification of major sources of marine pollution from land-based activities

A qualitative assessment of the marine environment in Liberia indicates that it is extremely polluted from several sources, namely:

(a) Coastal erosion and modification of coastal habitats;

(b) Industrial wastes processes;

(c) Domestic sewage and solid waste;

(d) Oil pollution.

Coastal erosion has been severe in Monrovia, in Buchanan and Greenville as a result of land-based activities. Between 1981-1997, about 100m of beaches have been lost. Among the causes are sand-mining, harbour and hydro-dam construction. In terms of mangrove areas which serve as a breeding ground for some marine resources, exploitation of the mangrove species is gradually increasing because of the need of firewood, as a result of increasing population growth. The only industrial process currently in operation that has an impact on the marine environment is the rubber processing company of Firestone. Other source categories of pollution are:

(a) Oil pollution - the oil refinery terminal at the Port of Monrovia is potentially at risk from third-party damage to the pipeline, low standards of maintenance, inadequate reception facilities for oil ballast and bilges, and accidents arising from facilities being used by insufficiently trained personnel. Furthermore, there is also a tendency for garages to dump their spent oil everywhere which eventually finds its way to the marine environment through domestic and other drainages;

(b) Sewage - the inadequacy of sewage treatment facilities have made it possible for raw sewage to be dumped directly to the ocean or to the rivers which ends up in the ocean as well. Furthermore, the

(c) Disposal of solid wastes - the lack of adequate solid waste disposal facilities constitutes a major problem. Residents who live near the water courses or beaches, use them to dump their garbage leading to the pollution of the marine environment;

(d) Mining - before 1990, Liberia was one of the largest iron mining countries in West Africa. Mining was done by open caste system where over-burden is openly dumped. During heavy rains, lateritic materials are washed down the rivers which render then red and in turn they are washed into the marine environment.

3. Management constraints

At the moment, there are several constraints to the management of the Liberian environment in general and the marine environment in particular. The first constraint is the lack of political will. Given the present state of economy, after seven years of war, the political leaders in Liberia find that nearly all their energies are devoted to reconstruction and the means to attract capital investments. On the other hand, people burdened by the rising cost of living and the civil war, food shortages, unemployment in the face of inadequate or social security systems, find it difficult to comprehend the benefits of sound environmental management, which benefits are not readily visible in the short term.

Secondly, environmental management and policies are fragmented across several institutions and agencies and are not coordinated. Also, there are no adequate laws requiring people to protect the marine environment. Thirdly, there is the lack of trained manpower and the lack of environmental education and awareness, the benefits of which lead to socio-economic development and better health. Fourthly, there is the added constraint of cost; many instances of sound environmental practices appear to be costly in the short term, and are seldom subject to economic analysis which in most cases would show that they will be beneficial in the long-run.

4. Programme support elements

As Liberia is just emerging from war, it is hoped that sound policies will be adopted towards the marine environment. At the moment, there are plans to strengthen the institutional framework and Liberia, as a member of the West African community, intends to cooperate fully with member states in terms of protecting the environment. A comprehensive study is underway that will assess the overall environment in Liberia; in this framework, marine environment will be appropriately addressed. This will be followed by an environmental management plan which will include environmental awareness components.

Priority areas are:

(a) Beach erosion as Liberia continues to lose several metres of the coastline each year;

(b) Pollution of the beaches by oil which make them unusable for tourism;

(c) Sewage and solid wastes management.

5. Assistance

As most of its institutions were destroyed during seven years of war, assistance to Liberia will be required in the following:

(a) Funds;

(b) Training;

(c) Transfer of technology;

(d) Equipment.

K. Mauritania

1. Introduction

With an approximate population of 2 million and a surface area of 1,085,000 km^2, Mauritania is located in a desert zone (4/5 of the country). The two larger cities of the country (Nouakchott and Nouhadibou) are located on the coast which spreads over 600 kilometres. The southern part of the country is drained by the Senegal river that flows into the Atlantic ocean after crossing all agricultural zones of the country.

2. Identification of the main sources of pollution due to land-based activities

The main sources of the coastal waters pollution are:

(a) Sewage and waste waters from mining, urban and domestic origin;

(b) Solid wastes and other detritus;

(c) Wastes from oils and hydrocarbons which result from port activities, and which remain weak at the scale of the Mauritania;

(d) Agricultural run-off which results from the utilization of agro-chemical products (fertilizers, pesticides, herbicides), particularly in the Senegal river valley.

The pollution problem does not appear so alarming along the Mauritanian coast, however, precautions need to be taken in the southern part of the country, notably in the Senegal river valley where, due to the increase in soils and changes in land management policies, the high level utilization of fertilizers and other agro-chemical products have begun to cause problems.

3. Measures and strategies

In the framework of the marine environmental protection against pollution due to land-based activities, it is important to adopt a certain number of actions, among which:

(a) Awareness-raising campaigns to limit the discharge of waste waters into the Senegal river;

(b) In the regional cooperation context, in particular in the framework of the Organization pour la Mise en Valeur du Fleuve Sénégal, legislative measures should be recommended to limit activities leading to an increase in the pollution of river water;

(c) Education, training and information of the public remains a priority for Mauritania. International support should be requested to carry out these programmes.

L. Nigeria

1. Introduction

The total surface of Nigeria is about 923,770 square kilometres, (which corresponds to approximately one seventh of the total mainland area of West Africa) and a coastline length of 853 km. The current estimated population is about 100 million with 40 per cent of the population living in urban centres. The population continues to grow rapidly with an average annual increase of about 2.8 per cent. The country has 12 cities with more than 500,000 inhabitants. Much of Nigeria's population and economic activities are located along the coast. About 20 per cent of the population are located in the coastal areas. Out of the 36 States in the country, 8 of them (Lagos, Ogun, Ondo, Delta, Bayelsa, Rivers, Akwa Ibom and Cross River) are located in the coastal zone - **Fig. 10 and 11**. The Nigerian coastal zone and its resources have vast implications for the economy. The Niger Delta, a major geographic feature in the Nigerian coastal zone, is depository for oil and gas-accounting for over 80 per cent of the external revenue of the country. In 1978, Nigeria established an Exclusive Economic Zone (EEZ) which is an area beyond and adjacent to the sea and extending 200 nautical miles from the baseline. The EEZ covers an area of 210,900 km^2 within which Nigeria exercises sovereign rights for the purpose of exploration, mining, conservation and management of the natural resources.

Nigeria has over 3,000 industrial establishments with about 80 per cent of them concentrated in the coastal zone. Industries located in the Nigerian coastal zone include iron and steel, fertilizer plants, aluminium smelting plants and manufacturing industries such as textiles, food, plastics, pharmaceuticals, cement, soaps detergents, paints, brewing and wood pulp and paper. About 80 per cent of Nigeria's manufacturing industries are located in Lagos and environs. As a result of the heavy industrial activities of this zone, both freshwater and marine waters serve as sinks of pollutants thereby altering the dynamics of the coast environments.

The Nigerian coastal zone is dominated by extensive stretches of sandy beaches, lagoons, mud beaches, a major deltaic complex (the Niger delta) and many estuaries. Three of the four major drainage systems in the country terminate in the Atlantic Ocean; among them:

(a) The Niger river basin drainage system with its major tributaries (Benue, Sokoto-Rima, Kaduna rivers);

(b) The Atlantic drainage system to the east of Niger made up of Cross, Imo rivers, etc.;

(c) The Atlantic drainage system to the west of the Niger consisting of the Ogun, Owewa, Benin rivers.

The coastal zone experiences a tropical climate consisting of rainy season (April to November) and dry season (December to March), with a very wet coastal area with annual rainfall greater than 3,000 mm and an arid region in the north eastern part with annual rainfall less than 600 mm.

The coastal zone resource is one of the richest in the continent. It has a diversity of fish and shell fish of about 199 species belonging to 78 families in the brackish and marine environment. The mangroves vegetation occupy a total area of 9,723 km^2, while total forest reserve is about 305 km^2. The mangroves provide breeding and nursery grounds for many commercially important species of fish and shellfish. The forest reserves include important timber species of great economic value. The coastal zone, especially the Niger Delta, is a prolific oil producing province where major oil discoveries have been made (**Fig. 13**). Nigeria's current oil reserves are estimated at 21 billion barrels and its gas reserves are approximately 11 trillion cubic feet. Nigeria is blessed with quite a number of sandy beaches along its 853 km coastline.

2. Identification and assessment of main pollution sources, establishment of the priority sources categories

Six major sources-categories of pollution from land based activities affecting the lagoon coastal, marine and associated freshwater environments have been identified:

(a) Domestic sewage/industrial and urban;

(b) Solid wastes, litter and plastics, including marine debris;

(c) Agro-chemicals including pesticides, herbicides fertilizers and other biocides, plus nutrient load and

(d) Physical alteration, including habitat modification and coastal erosion, also alteration by flooding deforestation and sand mining;

(e) Atmospheric pollution resulting from gaseous and particulate emissions from industries and vehicles in particular around Lagos and Port Harcourt;

(f) Trace metals, oils hydrocarbons, including other synthetic organic chemicals micro-pollutants, from industrial wastes and effluents and ports and harbour activities.

(a) Industrial and domestic sewage

There is high concentration of population and industries along the Nigerian coastal area especially in Lagos which, with a population of about 6 million, is the largest and most industrialized town located in the coastal zone. Others include, Port Harcourt, Warri, Escravos, Forcados, Brass, Bonny and Calabar. Most of these towns have poor sanitation and water supply facilities. Domestic wastes are disposed directly into the lagoons, creeks and rivers. The excessive dumping of pollutants lead to serious disturbance of ecosystems (e.g eutrophication, reduction of biodiversity and depletion of dissolved oxygen in Lagos lagoon (**Fig. 12 and Table 25**). Total bacterial counts in Lagos lagoon range from 10.35 CFU/ml x 108 to 25.92 CFU/ml x 108; while coliform counts range from 0.32 CFU/ml x 108 to 15.20 CFU/ml x 108.

It was estimated that about 80 per cent of Nigeria's industries are allocated in the coastal zone and about 80 per cent of effluents and emissions are discharged without any form of treatment. The absence of sewage treatment facilities is very pronounced along the coastal zone especially in Lagos and Port Harcourt. As a result, organic pollutant levels in surface and ground water in these cities are extremely high. Epidemics of waterborne diseases including outbreaks of typhoid, cholera, hepatitis and malaria is very common in these areas, thus adversely affecting the health and productivity of the labour force. Many illnesses in the Niger Delta and environs are water related. The negative impact of this pollution transcends international boundaries due to strong littoral transport system which are carried from point sources upstream to neighbouring countries along the coast. A noticeable case in the past couple of decades is the proliferation of harmful aquatic weeds and floating plants, especially water hyacinth which has grown beyond Nigeria's territorial waters.

(b) Trace metal, oils, hydrocarbons including other synthetic organic chemical, micro pollutants, from industrial wastes and effluent and ports and harbour activities

Land-based sources of oils include chronic operational and accidental discharges and emission from oil exploration, exploitation, refining and storage. Intensive oil and gas exploration and mining activities has been recognized as a major source of pollution in the Niger delta, with over 500,000 ha of mangroves. The Niger Delta is one of the largest wetland system in West Africa and it is also the centre of Nigeria's Petroleum and natural gas industries (**Fig.** 13).

Seismic surveys are usually followed by drilling activities during which drilling muds, cuttings and other products are discharged directly into the swamp and other bodies. Accidental blow outs during drilling operation are less frequent but when they occur, large coastal areas are devastated e.g. Texaco Funiwa - 5 blow outs, 8 kilometres off the Sangana estuary in which 37 million litres of crude oil were spilt. Leakages are a common occurrence in Nigeria coastal zone. These are as a result of leakages from the oil pipeline or from marine tankers that lift crude oil and refined products. It is estimated that about 2,300 m^3 oil is spilled in about 300 separate accidents annually.

The environmental impact of these spills has been devastating as it is responsible for mass fish mortalities, destruction of mangroves and gross contamination of underground water.

(c) Solid wastes, litter and plastics including marine debris

The burgeoning urbanization and industrialization of coastal cities have continued to increase the volume of solid wastes to an unprecedented level in the past two decades. In most major coastal cities like Lagos, Port Harcourt, Warri and Calabar some of the domestic and industrial solid wastes end up in nearby creeks, rivers and lagoons. This problem is not unconnected to the lack of efficient institutional framework for solid waste

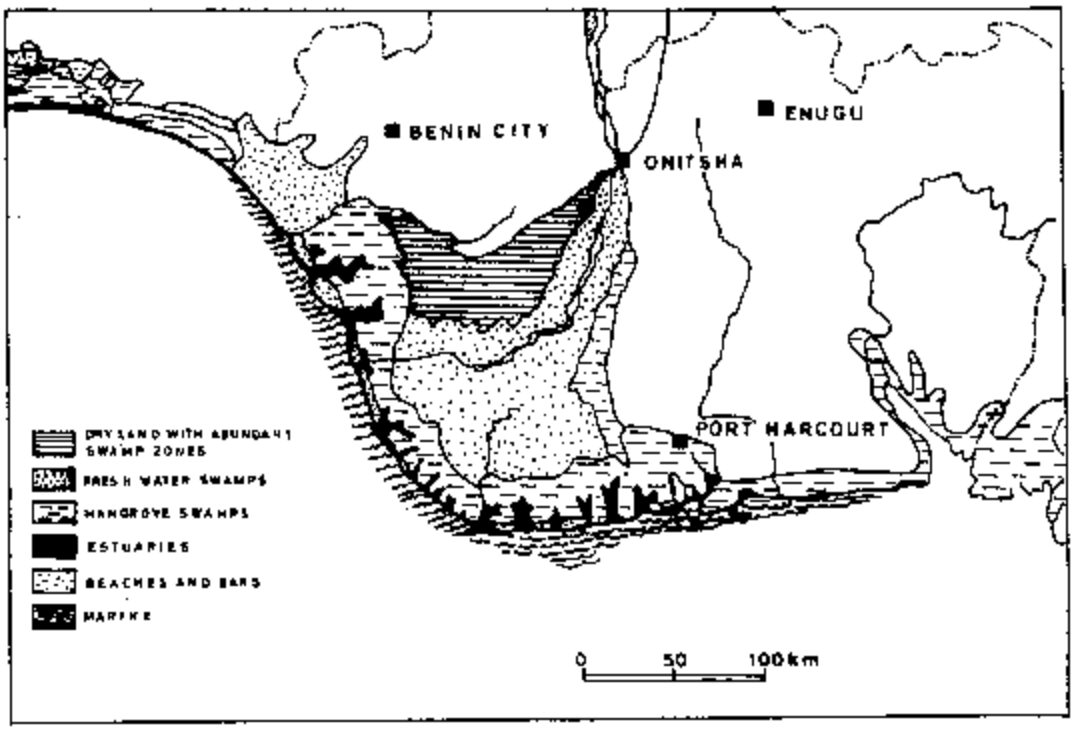


FIG. 10 _ GEOLOGICAL MAP OF THE NIGERIAN COASTAL ZONE (Allen, 1965)

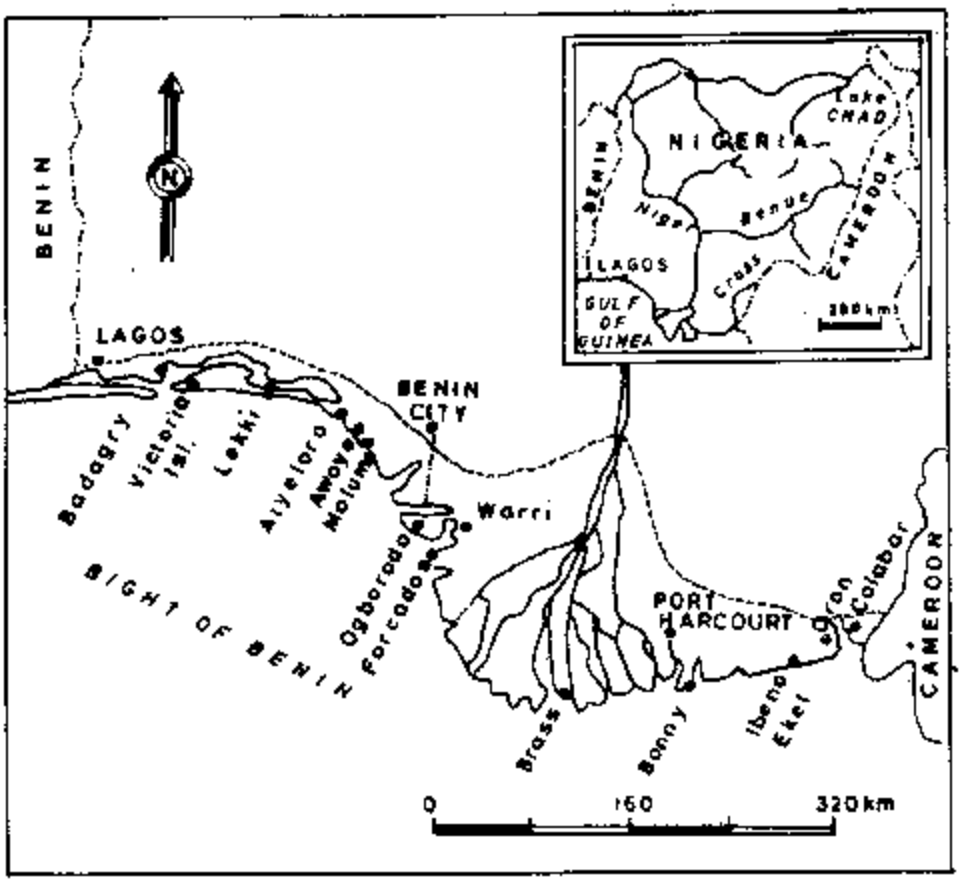


FIG. 11 _ THE NIGERIAN COASTAL ZONE AND IMPORTANT COASTAL TOWNS AND SETTLEMENTS

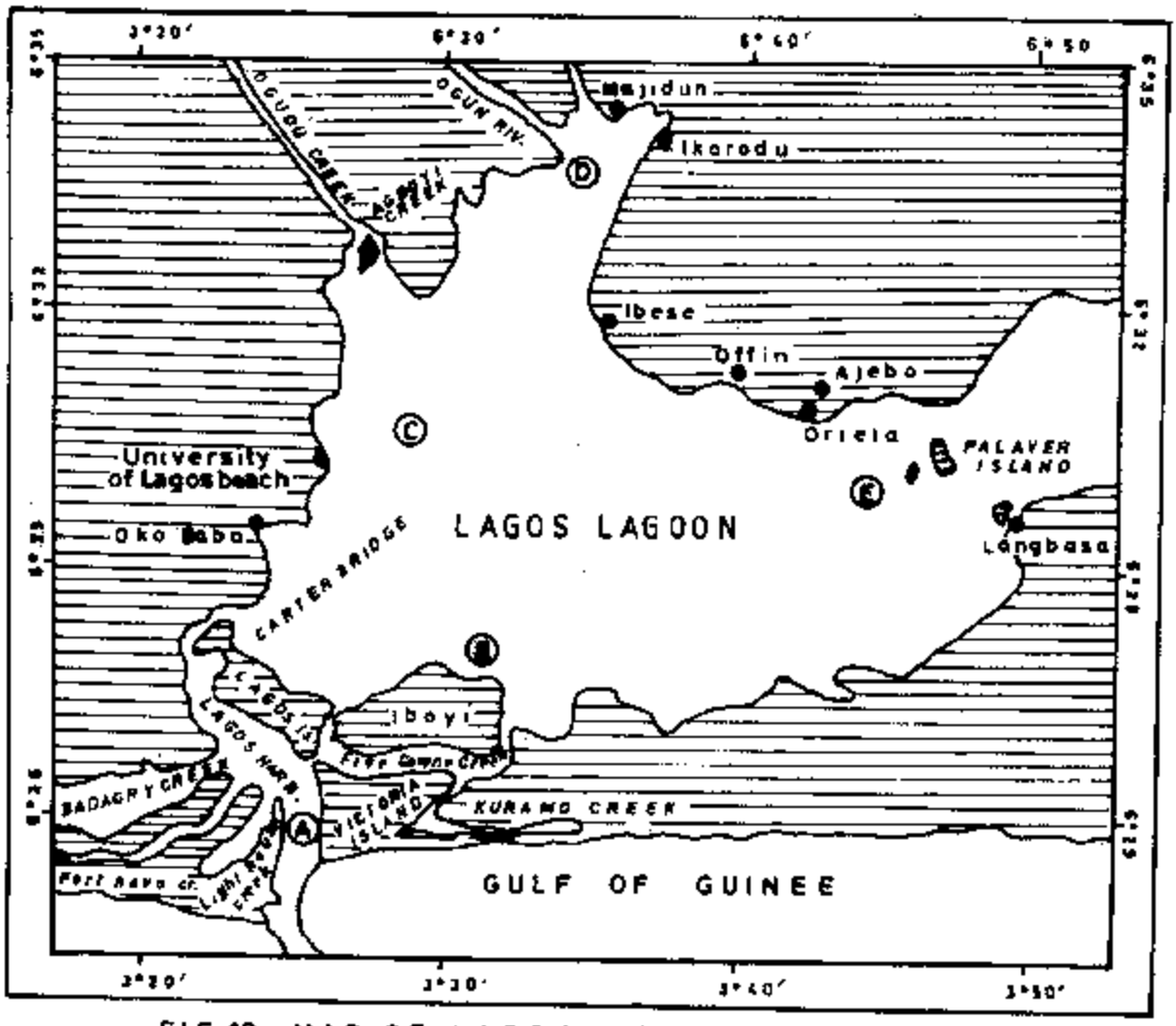
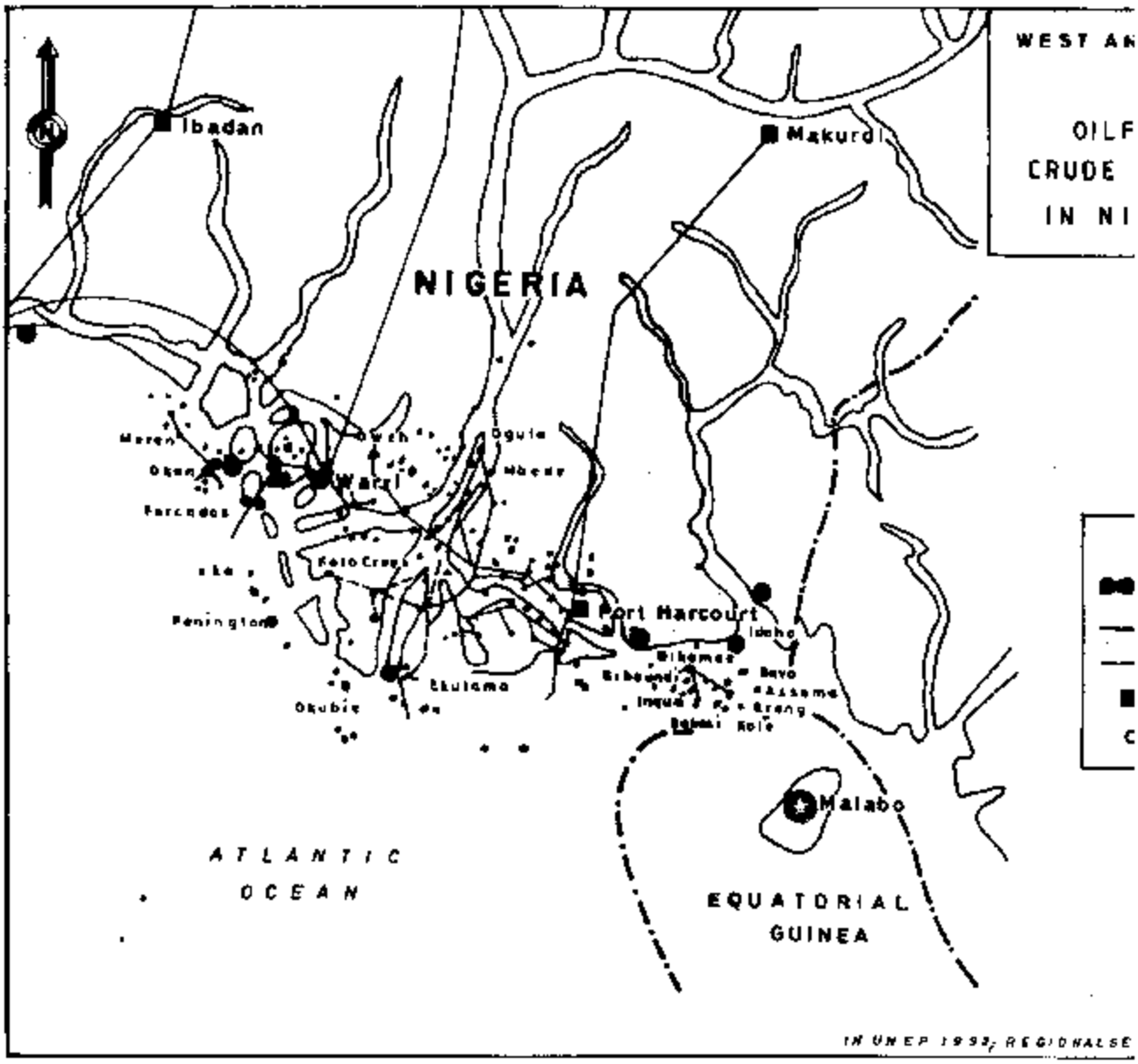


FIG.12 - MAP OF LAGOS LAGOON

Table 25. Microbiological properties of water samples obtained from Lagos Lagoon

S/N°	Sampling station	Nature of sample	Total bacterial count (CFU/ml x 10^6)	Coliform counts (CFU/ml x 10^6)	Hydrocarbon counts (CFU/ml x 10^4)	Fertilizers percentage
1/A	Lagos Harbour	Surface	12.48	9.84	3.20	0.0026
		Bottom	25.92	5.40	18.72	0.0072
2/B	Ikoyi	Surface	10.56	9.60	7.68	0.0073
		Bottom	17.62	0.65	11.04	0.0063
3/C	Unilag	Surface	11.04	11.60	5.28	0.0005
		Bottom	14.30	0.32	1.92	0.0013
4/D	Ogun river	Surface	13.92	15.20	2.40	0.002
		Bottom	16.80	9.50	3.26	0.002
5/E	Palaver island	Surface	19.01	12.60	6.90	0.004
		Bottom	10.35	2.24	10.56	0.010



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The severe pressure from solid wastes has caused a decline in the biological diversity and productivity of the marine and coastal environment. Most of the litter in the coastal and marine environment especially in Lagos environs originates from industrial wastes, marine debris from shipping, recreational and coastal vessels and fishing activities, waste dumps at the periphery of rivers and coastal waters, windblown litter from beach resort areas and coastal settlements. While some of the litter is dumped directly into the coastal environment, some is also channeled through rivers (Ogun, Imo, Benin, Cross, Niger and its estuaries) and municipal stormwater network systems. Plastic debris from the fish industry as a result of discarded and lost plastic fishing gear also add to the littering of coastal water. Litter is known to aggravate the stressed condition in the brackish water system of mangrove forest and has a negative effect on the tourism industry and general aesthetics, and results in a reduction in marine safety.

(d) Physical alteration, including habitat modifications and coastal destruction

The Nigerian coastal zone has been experiencing several problems as a result of physical alteration and habitat modification. These problems include beach erosion, flooding, sand mining, deforestation, pollution, salt water intrusion and subsidence.

Coastal erosion is a common feature along of the entire Nigerian Coastline. Apart from the natural forces such as waves, flooding, tidal regimes, nature of topography and nature of beach sediments which are responsible for the erosion, human activities such as beach sand mining, dredging, construction of harbours and protection structures have played vital roles in aggravating erosion along the Nigerian coastline. For example, the Victoria beaches in Lagos have witnessed a coastal recession of more than 500 m since the construction of the Lagos Harbour in the 1907 and an estimated erosion of 25 - 30 m per year. The low lying transgressive Mahin mud beach is also subjected to rapid erosion. Consequently, erosion poses a great danger to coastal communities and settlements and their economic activities.

The low nature and topography of the entire Nigerian coastline render the area very vulnerable to flooding especially at high tide and in the rainy season. Extensive areas of the backbeach are perpetually wet and water-logged. The coastal areas especially the Niger delta experiences high rainfall. The poor drainage allows storms waters to collect in the hollows which eventually flood large areas within the coastal settlements.

Deforestation along coastline of Nigeria involves the destruction of large mangrove areas for agricultural purposes, oil exploration activities and as a source of fuel wood. The uncontrolled felling of mangroves renders the environment very susceptible to erosion and flooding since mangrove trees also tend to reduce the impact of waves, tides and longshore current along the coast. It is been estimated that about 50 per cent of mangroves in Nigeria have been lost as a result of deforestation.

Unregulated sand mining along the beaches has contributed immensely to the degradation of the coastal zone. Sand mining activities for beach replenishment, land reclamation and construction purposes are common features along the Nigeria coastal areas. Furthermore, the entire Nigerian coastal zone consists of young sedimentary rock which is still undergoing the process of compaction. The fluid extraction of water, crude oil and gas has been recognized as a major cause of subsidence. In Nigeria, the extraction of crude oil and gas from the coastal areas particularly in the Niger Delta has been going on for more than four decades. In view of the big volume of fluid withdrawal from the young sedimentary rocks, it is believed that the Nigerian coastal area could be undergoing gradual subsidence.

In total, the effects of all these include loss of habitat, biodiversity and breeding grounds of commercially important fish species and crustaceans. Furthermore, the ecology and the dynamics of the coastal environmental have been changed.

(e) Agro-chemicals including pesticides, herbicides, fertilizers and other biocides plus nutrient load and certain forms of POPs

The Nigerian coastal and marine environment is constantly fed by over a dozen major rivers and other estuaries which include the complex Niger river basin drainage system which has over ten major tributaries. All these rivers transverse through agricultural zones and major industrial cities (e.g Kano, Kaduna, Warri and Port Harcourt). Consequently, the rivers are fed with agricultural and agro-chemical run-off, most especially chemical fertilizers, pesticides, herbicides and other biocides and some of POP'S and varieties of nutrient

DDT. The coastal water bodies receive some substance surface run-off and drainage from the hinterland, and domestic and industrial effluents through outfalls and various contaminants from ships at ports. Some of these organic chemicals and especially the POP'S which persist in the environment, are very toxic thus interfering with biological production and pose grave health hazard to the coastal communities. These substances are liable to accumulation in seafood and prone to long-range transport and deposition which has transboundary implications.

(f) Atmospheric pollution resulting from gaseous and particulate emissions from industries and vehicles

About 20 per cent of the total number of industries in Nigeria are concentrated within the coastal zone and emit pollutants which are not only confined to the atmosphere or soil near the source of emission, but are dispersed and deposited in coastal waterbodies. Apart from emissions from manufacturing industries, a large proportion of the associated gas produced with crude oil is flared.

About 80 per cent of natural gas production in Nigeria, most which is associated gas, is flared. This disposal of associated gas has been a major problem in the Nigerian oil industry as the country has become the largest gas flaring country in the world. Nearly 1,000 standard cubic feet (SCL) of gas is produced in Nigeria with every barrel of oil. Vehicular emission (especially around Lagos and its environs, with about 6 million people) contribute in no small way to the atmospheric pollution and water contamination. These large-scale emissions of pollutants (mainly sulphur dioxide and nitrogen oxides) have contributed to the acidification of coastal soils and some waterbodies, thus altering the ecology and dynamics of the coastal environment. Apart from the acidification of the soil gas, flaring causes elevated temperature vegetation damage, and impacts on human health.

3. Management objectives for priority problems

The priority established for the land-based source-categories of pollution show a clear and direct relationship with the problems of poverty, food scarcity, ecosystem balance and resource exploitation with a negative impact on socio-economic benefits and uses. It is therefore imperative to evolve the following management objectives;

(a) Upgrading and in some cases adequate provision of urban/domestic and industrial sewage installation systems and waste water treatment facilities especially for Lagos, Port Harcourt, Calabar, Warri and other industrial coastal cities;

(b) Strident control mechanisms for coastal and marine pollution caused by domestic wastewater, sewage, agrochemical including fertilizer and biocides and the industrial wastes;

(c) Development of a comprehensive monitoring programme to control the influx of waste discharge into the Nigeria's coastal water bodies. It is important to monitor the biological, chemical and physical parameters;

(d) Resolve the problem of the solid waste final disposal to reduce the health hazard to the population living at the coast;

(e) Develop control mechanisms for future alteration and destruction of the coast including critical habitat modification and protection from tourist activities via the effective implementation of integrated coastal management plans;

(f) Effective enforcement of the existing laws and regulations to protect the coastal and marine environment;

(g) A comprehensive programme of environmental education and awareness to provide people with adequate information on the nature of the coastal and marine environment, sources and causes of environmental pollution.

4. Identification and selection of strategies and measures

(a) Marine and coastal area resources

for diverse and often conflicting industrial and socio-economical activities, so that the continued viability of all aspects and ecosystems will be secured.

(a) Development and implementation of comprehensive integrated coastal management plan for control of land, coastal and marine-based activities to minimize pollution and coastal and marine resources project development impacts;

(b) Provide data and operational standards for project planning and implementation, for example, in fishing, dredging, and mining;

(c) Identify and map critical and sensitive habitats to enable project designs to take appropriate steps to minimize damage and disturbance to breeding, nesting and feeding areas of all species;

(d) Establish coastal protection measures based on a careful evaluation of detailed local situation and socio-economic and cultural needs;

(e) Establish national and regional contingency plans for marine tanker accidents and oil well blow-outs;

(f) Preparation of a comprehensive inventory of land-based sources of pollution.

(b) Sanitation and waste management

Environmentally sound management of waste requires an understanding of a range of treatment, disposal and re-use options available for sanitary and industrial effluents, raw domestic wastes and storm water. In order to ensure that improper handling and disposal of wastes do not lead to the spread of disease and the pollution of land, air and water, priority shall be given to the environmental studies of industrial effluents as well as the variety of solid and liquid wastes generated in the various ecological zone of the country especially those very close to the sea. Appropriate guidelines shall be introduced for their collection and disposal. These will be achieved via:

(a) Study of the most reliable treatment systems that are appropriate for local domestic and industrial wastes;

(b) Engineering design of appropriate or adaptable waste disposal and treatment systems that will take into consideration the geological and environmental setting and encourage recycling;

(c) Giving existing industries some form of incentive to encourage them to install pollution abatement. Regulations should be introduced to make it mandatory for new industries to install such facilities before commissioning permits are granted;

(d) Improving the adverse impact of sewage and solid waste disposal on human health and ecosystem via sound and elaborate environmental programmes;

(e) Setting up and enforcing standards for adequate sanitary facilities for the disposal of human and other solid wastes in dwellings, housing estates and public facilities in both urban and rural areas;

(f) Establishment of monitoring programmes including periodic surveillance of approved waste disposal sites and their surroundings and waste water treatment systems;

(g) Establishment of an early warning system for the identification of potential waste disposal hazards;

(h) Provision of information on the appropriate methods and technologies for treatment and disposal of wastes;

(i) Regulation, registration and licensing of all major land-based waste disposal sites and systems;

(j) Introduction of effective protective measures against the indiscriminate discharge of particulate matter and untreated industrial effluent into rivers, estuaries, lagoon and coastal water taking.

(c) Toxic and hazardous substances

As part of the environmental policy, necessary administrative rules and legislation will be operated to govern the monitoring, introduction, manufacture, import, sales, transportation, use and disposal of toxic, hazardous and radioactive substances in Nigeria. The appropriate governmental agencies shall therefore:

(b) Control the generation of toxic, hazardous and radioactive wastes and ensure that those banned are stringently controlled:

(c) Monitor the effects and control all phases in the lifecycle of all substances likely to have an adverse impact on human health and environment;

(d) Determine and use environmentally safe and technologically sound techniques for the disposal of

(e) toxic, hazardous and radioactive wastes;

(f) Set up regional framework and standards for the proposed "DUMP WATCH" against transboundary movement of toxic, hazardous and radioactive wastes and for the achievement of environmentally sound management of hazardous substances.

(d) Agricultural chemicals and pesticides

Although the use of agricultural chemicals, notably fertilizers and pesticides (and including herbicides and other biocides) in the right circumstances brings about a dramatic increase in agricultural production, their improper use does create environmental hazards (**Table 29** indicates some residual concentrations of oil and other chlorine substances). Strategies to minimize the adverse impacts to chemicals on human and the environment will entail:

(a) Rogulating the production, use, storage, transportation, marketing, sale and disposal of agricultural chemicals;

(b) Encouraging programmes to produce crop varieties which will require minimum amounts of agro-chemicals taking into account their genetic capability;

(c) Maintaining a register of up-to-date approved agro-chemicals with guidelines for their use:

(d) Providing "Safe Use of Pesticides Guides" which will specify minimum permissible levels for named pesticides;

(e) Monitoring pesticides and agro-chemical residues levels in air, soil, water, sediments, flora, fauna and human, and the environmental fate of all agro-chemicals in use;

(f) Mounting programmes to develop environmentally sound alternatives such as organic fertilizers;

(g) Encouraging integrated best-management practices.

(e) Air pollution

Strategies for achieving a clean air situation include:

(a) Establishing ambient air quality standards and monitoring stations at each designated zone;

(b) Provision of standards for factories and other activities which emit pollutants into the air;

(c) Licensing and registering of all major industrial air polluters and monitoring their compliance with laid down standards;

(d) Provision of guidelines for the abatement of air pollution;

(e) Prescribing stringent standards for the level of emission from automobile exhausts and energy generating plants and stations;

(f) Setting up standards to minimize the occurrence of "acid rain";

(g) Promoting regional cooperation aimed at minimizing the atmospheric transportation of pollutants across international boundaries.

(f) Forestry, wildlife and protected areas

It is true that there have in recent years been increasing deforestation and soil degradation and deterioration

productivity of the natural vegetation, protecting wildlife, maintaining genetic diversity and avoiding forest and soil destruction. The strategies for achieving these objectives include:

(a) Promoting the rational exploitation of forest resources to meet domestic consumption needs and to achieve a significant export activity on a long-term basis;

(b) Regulating forestry activities to enhance conservation and environmentally sound management practices;

(c) Monitoring the quantitative and qualitative changes of forest cover and their effect using conventional and modern technology such as multispectral satellite imagery;

(d) Assessing the state of natural vegetation resources and identifying endangered sites and species for priority action;

(e) Protecting forest reserves and flora and fauna in danger of extinction for scientific, recreational and other cultural purposes;

(f) Establishing germplasm conservation programmes;

(g) Increasing support for non-governmental organization and community tree-planting programmes.

(g) Land-use and soil conservation

The planning, improvement and management of land demands and approach at all levels embraces all aspects of the human environment, both natural and man-made. Accordingly, the following strategies shall be adopted:

(a) Establishing guidelines for land-use and soil management, and the necessary framework to implement them;

(b) Mounting programmes to predict natural hazards and for developing methods for their prevention;

(c) Developing a comprehensive and long-range national programme for erosion management and control in the shoreline;

(d) Increasing public awareness and the danger of soil degradation, its seriousness, causes and remedies.

(h) Public participation

In order to achieve the goals and objectives set out in the preceding sections, actions will be undertaken to raise public awareness and promote understanding of the essential linkages between the environment and development, and to encourage individual participation in environmental improvement efforts through:

(a) Ensuring broad public participation in consensus-building towards defining environmental policy objectives;

(b) Adopting community-based approaches to public education and enlightenment through culturally relevant social groups, voluntary associations and occupational organizations;

(c) Giving due attention, in the pursuit of environmental goals, to the role of non-governmental organizations and community groups and especially the contributions that can be made by youth and women's groups.

(i) Legal arrangements

The purpose of a legal framework as an integral part of a National Environmental Policy is to consolidate, strengthen, provide and extend legislation for environmental protection and improvement in all spheres whilst also providing for implementation and enforcement procedures. Therefore, the following actions shall be taken to :

(b) Harmonize the various existing environmental protection laws;

(c) Make it a constitutional duty of governments - Federal, States and Local - to safeguard the environment and aspire to have a safe and healthy nation;

(d) Encourage and institute incentive measures for installation and provision of anti-pollution equipment and devices;

(e) Stipulate procedures and regulations for implementing the national environmental policy.

(j) Environmental impact assessment

All coastal development projects must be subjected to Environmental Assessment screening process and when warranted, an environmental impact assessment study (EIA) before commencing them.

5. Evaluating the effectiveness of strategies and measures

It is imperative for the following criteria to be properly established in order to successfully ensure the effectiveness of the proposed strategies.

(a) Establishment of adequate environmental standards as well as monitoring and evaluating the changes in the coastal and marine environment through sound management;

(b) A large number of case-studies shall be carefully identified and implemented for evaluating, various problems of the environment and for drawing up guidelines for approaches, methodologies, and resource management strategies;

(c) Constant epidemiological studies must be carried out to establish the possible correlation between exposed population health and water quality degradation;

(d) Development of comprehensive coastal and lagoon surveys, including mapping through classical methods or geographical information systems, modelling and statistical analysis to help evaluate the effectiveness of the control strategies and programmes;

(e) Cost-benefit analysis of the adopted options should be evaluated on a regular basis.

6. Programme support elements

In December 1988, the Federal Government issued a Decree establishing the Federal Environmental Protection Agency with the former Environmental Planning and Protection Department of the Federal Ministry of Works as a nucleus. In 1989, the Federal Government approved the "National Policy on the Environment". Nigeria is committed to a national policy that ensures sustainable development based on a proper management of the environment in order to meet the needs of the present and future generations. This policy aims to provide a rational, practicable, coherent and comprehensive approach to pursuit of economic and social development in a way that minimizes contradiction and duplication while enhancing cooperation and effectiveness at all levels. Since the health and welfare of all Nigerians depend on mankind, the transition to sustainable development as rapidly as possible, this national policy on the environment provides the concepts and strategies which will lead to the procedures and other concrete action required for launching Nigeria into an era of social justice and sustainable development as we enter into the 21st century. The goals of the National Policy are to:

(a) Secure for all Nigerians a quality of environment adequate for their health and well-being;

(b) Conserve and use the environment and natural resources for the benefit of present and future generation;

(c) Restore, maintain and enhance the ecosystems and ecological processes essential for the functioning of the biosphere to preserve biological diversity and the principle of optimum sustainable yield in the use of living natural resources and ecosystems;

(d) Raise public awareness and promote understanding of essential linkages between environment and development and to encourage individual and community participation in environmental improvement

(e) Promote cooperation in good faith with other countries, international organizations and agencies to achieve optimal use of transboundary natural resources and effective prevention or abatement of transboundary environmental pollution.

M. Sao Tome and Principe

1. Introduction

The Democratic Republic of Sao Tome and Principe, consisting of two main islands and several other smaller ones, is located 300 km from the Gabonese coast. The total area of the archipelago is 1,000 km^2 of which 850 km^2 is covered by Sao Tome and approximately 140 km^2 by Principe. The population is estimated at 120,000 inhabitants, according to a 1991 census.

Considering the heavy rain in the country and the fragile coastal ecosystems, the most serious problems related to marine and coastal environment are due to huge quantities of sediments carried by rivers, which contribute to the degradation of the aquatic environment.

2. Identification, study of the main sources of pollution and establishment of priorities by source categories

The main sources of coastal and marine environment pollution identified are as follows:

(a) Industrial and domestic sewage;

(b) Solid wastes, detritus, plastics and marine debris;

(c) Physical modifications of the shoreline, including the degradation of tho critical habitats and coastal erosion;

(d) Agro-chemical wastes made up mainly of fertilizers and other biocides;

(e) Oil residue wastes and other hydrocarbons, most often due to uncontrolled shipping operations off the coast of the archipelago.

(a) Industrial and domestic sewage

Only a few studies have been carried out on water quality; however, these studies reveal contamination by human wastes, harmful discharges, pesticides and toxic biocides used in agriculture. A number of the diseases affecting the population are water-borne and due to the quality of water (**Table 9** indicates that biochemical oxygen demand (BOD) and total suspended sediments (TSS) constitute the major pollutants, although the values are low). Only 20 per cent of the population have access to fresh water supply. Analyses undertaken in seven natural sources which supply fresh water to Sao Tome city indicated that they were all contaminated by a concentration of fecal wastes higher than standards regularly admitted for freshwater supply.

Superficial water is contaminated by organic residues and by toxic substances, mainly resulting from the use of pesticides. The absence of water treatment facilities constitutes one of the main causes of the degradation of the population's health conditions. Beyond the effects on health, the economic and environmental impacts of water pollution are considerable.

(b) Solid wastes, detritus, plastics and marine debris

Solid wastes are essentially made up of three components: non-toxic solid wastes (such as non-degradable substances), organic residues and those coming from purification systems, toxic and harmful substances.

In Sao Tome city and its surroundings, non-toxic solid wastes pose a growing ecological problem particularly for human health, notably in public discharges and along the beaches; such situations create serious problems for tourism development. The other major concerns are due to the fact that solid residues, organic discharges and toxic substances are often evacuated without any sorting, which constitutes a potential threat for the freshwater supply and also for soil contamination. There is, within the country's public investment programme, a project for solid wastes treatment, although the allocated funds for this programme seem insufficient to tackle the problems of waste sorting and treatment.

c) Physical modifications of the shoreline including the degradation of the critical habitats and coastal erosion

Coastal erosion in Sao Tome, particularly in the southern part of the country, has reached an alarming rate. Some infrastructures (roads, housing, etc.) are seriously threatened. Studies to be undertaken should seek possible options in terms of costs for reducing, in the short term, the threat of coastal erosion phenomenon.

Beach mining is also cause for concern. The Government has banned sand mining along the islands' beaches, with only a few exceptions. Intensive beach sand mining poses an ecological threat to the equilibrium of critical habitats such as the mangroves or estuaries ecosystem; it can also constitute a real threat to tourism development. Research undertaken in the framework of this study indicates that sand mining can be a viable activity (economically and ecologically), if carried out in appropriate conditions and if the sand is considered as a renewable natural resource. Meanwhile, any sand mining on a large scale should be subject to a comprehensive assessment of its environmental impacts.

(d) Agro-chemical wastes essentially consisting of fertilizers and other biocides

The inappropriate use of these chemical substances can constitute a serious threat, not only for the environment and human beings, but also for fauna and flora. Some of the substances currently used in Sao Tome and Principe have been banned elsewhere in the world for environmental reasons. Some small-scale farmers use DDT against certain crop diseases. Only very limited information is available in the country concerning the impact of these substances, however, and there is no protection mechanism against their potential toxic effects. In some cases, oils and other hydrocarbon residues are added to these polluting source-categories, usually as a result of uncontrolled shipping operations off the coast of the Sao Tome and Principe archipelago; but, here again, there is a lack of reliable quantitative and qualitative data at the country level.

3. Management objectives concerning the priority problems

When setting priorities, account must be taken of the main limitations on the institutions and the human resources of the country. In general, a number of improvements have to be made at different levels, for example:

(a) National environmental policy;

(b) Institutional framework for environmental management;

(c) Project selection, which should be made in accordance with the importance of environmental factors and the findings of environmental impact studies;

(d) Education, training and awareness-raising measures;

(e) Necessity, in the long-term, to initiate specialized training sessions on national environmental priority problems (i.e., pollution due to land-based activities) and to reinforce the capacity to realize environmental impact assessments and studies.

A number of areas could thus be considered as priority areas, including:

(a) Policy and programme formulation, oriented towards halting population growth; this is particularly important for island countries where space is already limited;

(b) Implementation of a land-use and management plan (with zones reserved for agriculture, industry, energy production and reserved areas);

(c) Implementation of a protected areas system and buffer zones sufficiently well planned to avoid conflicts concerning land use and to ensure that the local population enjoys the benefits arising from such activities as tourism development. The participation of all administrative economic and private sectors would then be requested;

(d) Economic and sectoral programmes and policy initiatives, based on a strategy of preventive policy, with decentralized and specific objectives, with a view to improving efforts aimed at managing the

4. Evaluation of the efficiency of the proposed strategies and measures

The following measures should be conducted, to ensure the efficiency of proposed strategies :

(a) Monitoring programme, to study the quality of the environment of Sao Tome and Principe (water, sediment, fauna and flora);

(b) Use of scientific techniques, including new mapping technologies, GIS, and modelling, to ensure efficient implementation of monitoring programmes, integrated management plans, environmental impact studies and cost-benefit analyses, taking into account their development potential, relative success or failure and proposed measures and programmes for their better adaptation;

(c) Detailed studies and analyses, as well as assessment of policies and legislation relating to the protection of the aquatic environment of Sao Tome and Principe.

5. Programme support elements

In addition to the concern of government authorities for the protection of the marine, coastal and aquatic environment in general, a number of initiatives have been developed at the community level through non-governmental organizations. There are several international non-governmental organizations in the country, including: AMI, Leigos para o Desenvolvimento and Nueva Frontiera. National non-governmental organizations such as the Institute of Ecology, the Association for Development and Ecology and Zanto Adil, constitute small organizations with limited resources whose capacity is too weak to influence government policy. The survival and growth of national non-governmental organizations depends to a considerable extent on the policy and public legislation which regulate the formulation and the functioning of these organizations at the community level.

Non-governmental organizations and local populations play a very important role in the protection of the coastal and marine environment, mainly in the practical implementation of the strategy for the protection of endangered species such as turtles, but also for the protection of the most exposed and fragile beaches, especially from uncontrolled sand mining.

N. Senegal

1. Introduction

Senegal is located in the most western part of Africa, with a coastline of 700 km (**Fig. 14**). Large parts of Senegal's economic activities are concentrated on the coast and consist of fishing, tourism, industrial and agricultural activities. In addition, two-thirds of the country's population is concentrated on the western side of the country. Dakar, the capital city with its main suburbs, now transformed into departments (Pikine and Rufisque), has a population of more than 1.5 million inhabitants out of a total population of 7.5 million. Linked with development activities, the increasing population growth as well as the rapid urbanization of the main cities located mostly near the coast (more than 5 per cent), explain the major environmental disequilibrium and its negative effect on the coastal, freshwater and marine areas.

Around the major cities, the industrial development in fishing, tourism and recreation has a negative impact on the environment and on human health. As a result of the country's location in the sahelian region and due also to the severe impact of the drought phenomenon (particularly in the northern part of the country), several projects have been instituted with the aim of damming the major rivers and revitalizing the fossil valleys. In future years, significant impacts may result from these watershed management projects; i.e. freshwater habitat modification, changes in sediments and nutrients load, water quality deterioration and threats to health and sanitation.

2. Identification and assessment of main pollution sources, establishment of the priority source categories

Five main source-categories from land-based activities affecting the coastal, marine and freshwater environment have been identified:

(a) Sewage resulting mainly from domestic and industrial waste waters;

(b) Excess of nutrients load, including some organo-chlorine and phosphate substances, around the most intensive agricultural areas; i.e. the Senegal river valley;

(c) Physical alteration, including critical mangrove habitat modification and coastal erosion;

(d) Litter, including solid wastes, plastics and marine debris;

(e) Trace metals, oils, hydrocarbons coming from industrial wastes and effluents, ports and harbours.

With regard to the effect of atmospheric pollutants, only limited preliminary and estimated figures have been obtained, showing the health risks of the release of nitrous and carbon mono-dioxide in the atmosphere, in particular near the urban areas.

(a) Sewage

This source of pollution constitutes one of the main contributors to the degradation of the coastal, marine and freshwater environment in Senegal. It occurs in particular near large cities and around densely populated areas: Dakar and its surroundings are a good example. Because of the low capacity of the main sewage and waste water treatment facility, most of the domestic and urban waste effluents are dumped directly into the coastal waters, contaminating them particularly in the naturally protected coastal areas such as the bays around Dakar (**Fig. 1a and 2a** as well as **tables 34 and 35** indicate sizeable bacteriological contamination in some bays in Dakar). Sewage generally originates from domestic and urban effluents, but also from waste emanating from industrial and food factories. The main consequences of the sewage pollution are the eutrophication of the coastal waters, their bacteriological and microbiological contamination, and the possible development of some seasonal harmful algae blooms; for example, the most polluted bay in Dakar, the Bay of Hann - **Fig. 15 and Table 31**.

(b) Nutrients load, including some organo-chlorine and phosphate substances

These are the typical forms of agricultural run-off pollution which predominate around the large irrigated

and other biocides more or less persistent in the coastal and marine environment. Very little data have been obtained to measure the degree of contamination of the concerned environments.

(c) Physical alteration, including habitat modification and coastal erosion

All along the Senegalese coastline, and particularly in the southern part, coastal erosion, which is one of the first forms of physical alteration of the coast, is dominant. It is exacerbated by the existing high wave energy and the strong littoral transport in the so-called "Small Coast". The most relevant examples in this area are Rufisque, la Pointe de Sangomar, Guereo but also in the northern part of the coast of Senegal where sedimentation processes are predominant; i.e. la Langue de Barbarie. Human disturbances intensify the phenomena, in particular with the sand mining activities which take place in the south coast as well as the shell and gravel mining and the engineering works which act as sediments traps. The river dam construction for irrigation purposes also accelerates the coastal erosion process off the coast of the Senegal river mouth.

As far as the critical habitats are concerned, including the nurseries and feeding grounds, changes are occurring mainly in the mangroves areas, in the estuaries and the coastal watersheds. The examples of the Senegal, Saloum and Casamance estuaries are the most relevant where the environmental modifications (either natural or from man-made origin) can lead to a loss of diversity in breeding areas, and to a certain extent to the complete loss of the ecosystem.

(d) Litter, solid wastes, plastics and marine debris

Litter and solid wastes are generally found around major cities like Dakar, Saint-Louis and Kaolack, which are located near the coast or adjacent to river basins. A large portion of this litter, waste and marine debris originate from the land, due to improper waste treatment and management. As a consequence of this improper waste disposal, they are contaminating the surrounding coastal and freshwater environments and can introduce substances and pathogens which cause loss of aesthetic values as well as physical and hydrological damages to the coastal and marine ecosystems; i.e. contamination of the coastal waters near the Bay of Hann, around Kaolack and near Ndar-Tout/Saint Louis, due to litter and solid wastes dumped on the beaches.

(e) Trace metals, oils, hydrocarbons and other synthetic organo-chemical micro-pollutants

Most of the studies which have been carried out on the contamination of the coastal and marine waters by heavy metals, oils and hydrocarbons and other micro-pollutants have shown that the pollution originates from the industries, ports and shipping areas - **Tables 30, 31 and 32** show for Dakar high BOD and COD values, which are 11,200 tons and 29,520 tons per acre. Indeed, this source of pollution, although small, is mainly concentrated around Dakar because of the existing facilities. Indeed, the soils, water, fauna and flora contamination by metals have been measured around Dakar. The results which have been obtained show very low metal concentration which range from 19 to 25 mg/100gr for Cu and 4 to 6 mg/100gr for Pb, only in some samples, while Cd and Cr are nearly absent from the measurements - **Fig. 15 and Table 33**. However, even if small traces of some metals have been found in certain samples, more attention must be given to this type of source of pollution, due to the rapid expansion of the industry in this region.

Oils and hydrocarbons are only observed around the Dakar harbour, and sometimes near the main oil refinery industry of Mbao. However, and despite the financial means which will be required, more oil wastes pollution controls need to be effected off shore because of the frequent shipping operations and the possibility of accidental oil and chemical spills.

3. Management objectives for priority problems

The priorities for the source-categories of pollution have been established, based on the nature and severity of the problem, the type of contaminants, the physical alteration and the destruction of the environment, the nature and extent of the affected areas. Because of the importance of sewage pollution in the marine, coastal and freshwater environments in Senegal, and its consequences on the ecosystem and public health, food security and poverty alleviation, loss of biodiversity and socio-economical benefits and uses, the following management objectives must be set up:

(b) Reduce the adverse effects of sewage effluents on the health of populations living near the most polluted coastal waters, around some bays of Dakar and on the marine resources and their habitats, around the mangrove areas;

(c) Reduce the application of agro-chemicals and other biocides with other possible alternatives and improve land-use techniques in intensive agricultural areas, in particular in the Delta of Senegal river;

(d) Ensure that all waters are adequately treated before their discharge into coastal and marine waters, following the national or international health and environmental quality standards; i.e. in the Bay of Hann;

(e) Undertake, as a matter of priority, to treat the domestic and urban waste waters near the large cities (Dakar, Kaolack, Saint-Louis);

(f) Develop tourism facilities with adequate sewage installations and treatments, particularly in the Southern coast of Senegal;

(g) Monitor the bacteriological contamination level, the excess nutrient loads as well as the industrial wastes and effluents which affect the coastal, marine and fresh and groundwater Senegalese environments - **Fig. 16** indicates the high values of nitrates load compared to World Health Organisation (WHO) acceptable norms.

4. Identification and selection of strategies and measures

The following strategies and measures are recommended in order to achieve the overall management objectives:

(a) Development and implementation of coherent integrated coastal management areas programme, which involve not only local populations, communities, stakeholders and municipalities, but also the private sector, non-governmental organizations, youth and women associations. This process should be facilitated within the framework of the Senegalese National Environmental Action Plan which has recently been signed;

(b) Construct or upgrade treatment facilities in order to reduce the excess waste water flows (i.e. only 10,000m^3/day of wastewater are treated in Dakar out of a total of 100,000m^3/day).

(c) Initiate environmental impact assessments for all government or private sector large scale coastal projects, and reinforce the existing regulations and laws related to the management of coastal and marine areas; this is particularly important around large cities, such as Dakar.

(d) Promote adequate sewage systems and solid waste collection and final disposal, in particular for the urban areas;

(e) Encourage the private sector to use clean production technologies, including the efficient use of energy and water; this is particularly important in the southern coast of Senegal and the valley of Senegal river;

(f) Water quality research and monitoring programmes should be established on a regular basis, including the current freshwater, coastal and marine water quality assessments and measures;

(g) Provide training to Senegalese technicians and staff in both integrated coastal management and environmental impact assessment techniques, in order to ensure a rational and sustainable development of coastal, marine and freshwater environments;

(h) Rehabilitate the degraded coastal and marine areas through coherent management programmes, such i.e. as mangrove replanting, dune repair with appropriate species, prohibition of waste water discharges in the most affected areas;

(i) Control the production, importation and use of the most persistent pollutants, including pesticides and use alternative biocides;

(j) Identify the most suitable sources of funding (with the private sector, or with the bilateral and/or multilateral partners) for the implementation of long-term programmes.

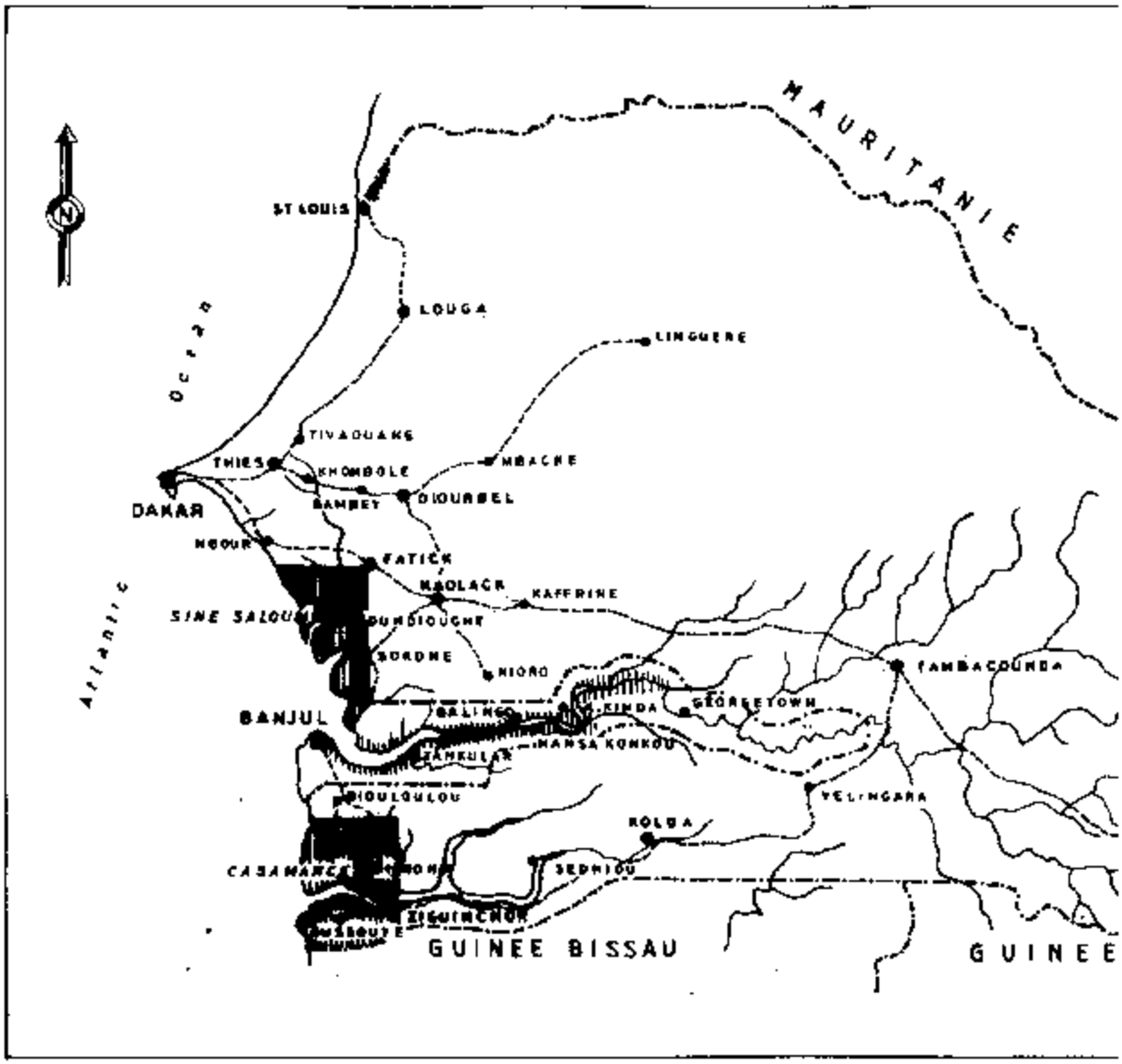


FIG.14_MAP OF LOCATION OF SENEGAL

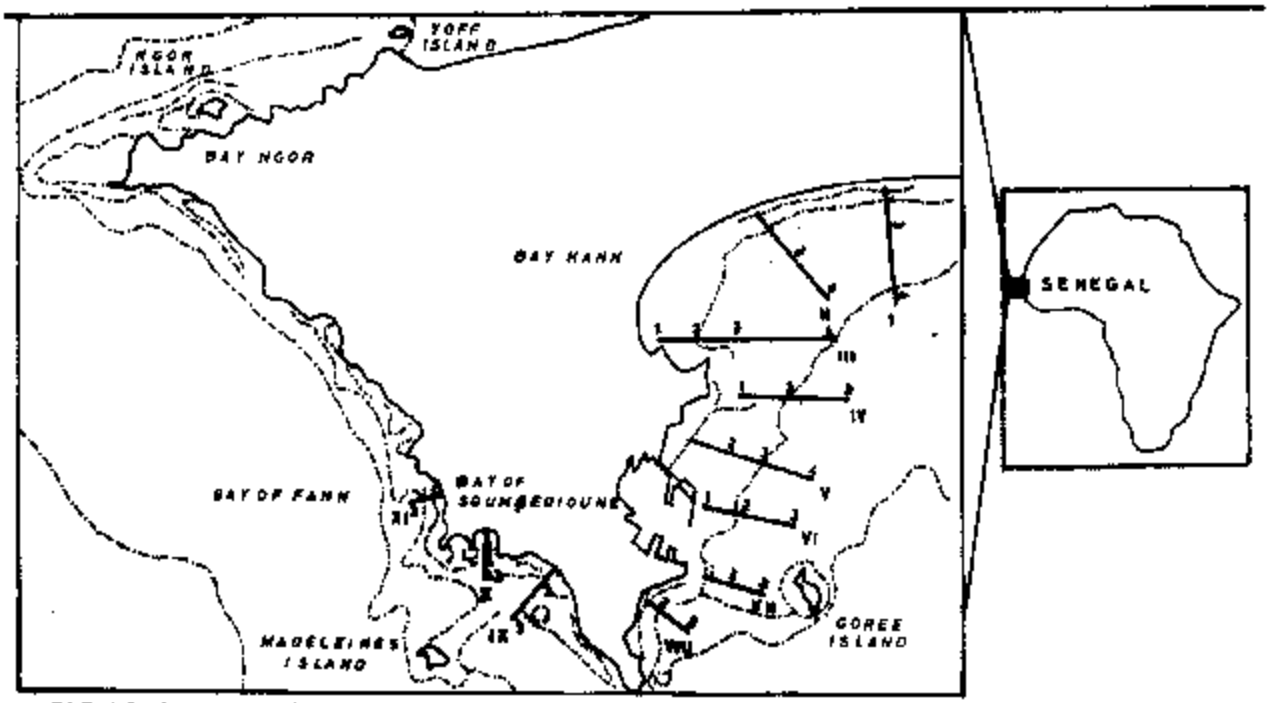


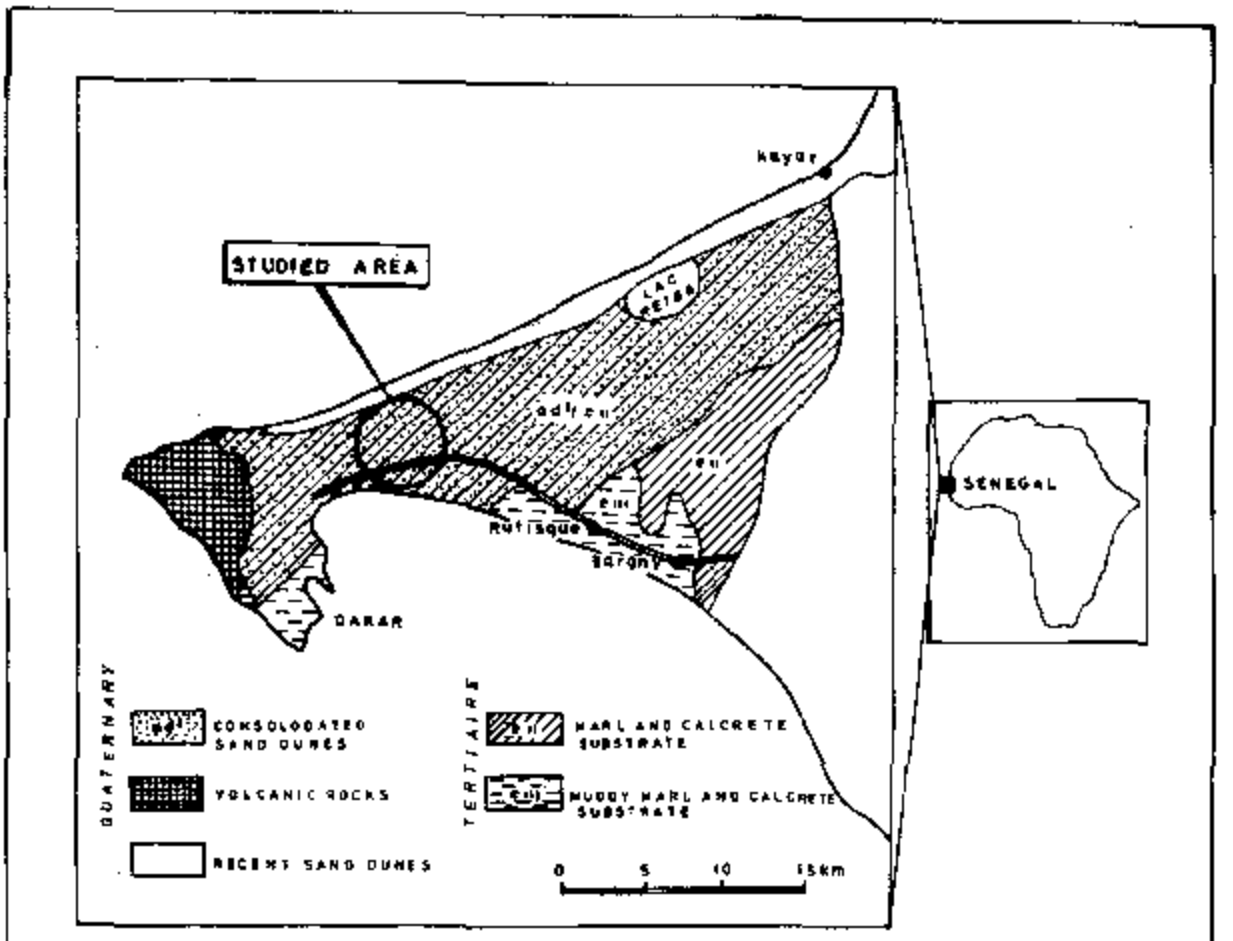
FIG.15. SAMPLING MAP

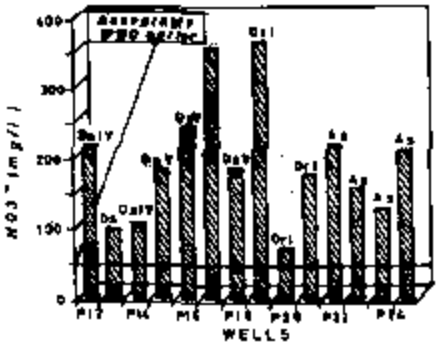
Table 31. Bacteriological contamination of the waters around Dakar

Radiales counts	Total bacterials 100ml/37°C	E. Coli. 100 ml/44°C	Total coliformes 100 ml/37°C	Total entercoques 100 ml/37°C	Sulfo-reduction 20 ml/37°C	Staphilocoques 37°C
II.1 (-2m)	>10 000	present ≥10	>100	>100	0	>100
II.2 (-4m)	>10 000	present ≥10	>100	>100	0	>100
II.3 (-6m)	>10 000	present ≥10	>100	>100	0	>100
II.4 (-8m)	800	0	>100	0	0	>100
IX.1 (-2m)	>10 000	present ≥10	>100	>100	0	>100
IX.2 (-6m)	>10 000	present ≥10	>100	>100	0	>100
IX.3 (-10m)	2 800	present ≥10	>100	>100	0	>100
IX.1 (-2m)	>10 000	present ≥10	>100	>100	present ≥0	>100
IX.2 (-3m)	> 9 000	present ≥10	>100	>100	present ≥0	>100
IX.3 (-5m)	> 1 100	present ≥10	>100	> 7	≥0	>100

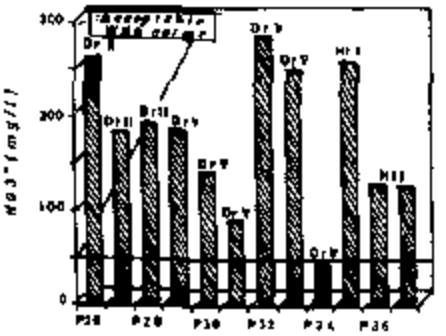
Table 33. Metal contamination of the fauna

Radiales	Sample	Species	Cu mg/100 gr	Hg ug/100 gr	Pb mg/100 gr	Cr mg/100 gr	Cd mg/100 gr
Ia	PC	*E. alleteratus*	-	-	-	10.48	-
Ia	PO	*Liza sp.*	-	-	-	7	-
Ib	PC	*Sphiraena sp.*	-	-	-	-	1.17
Ib	PO	*E. motonoptorus*	19.44	-	-	-	-
Ib	PPK	*S. aurita*	-	-	-	-	1.07
VIIIa	PPK	*S. aurita*	1960	-	-	-	-
IXa	PC	*Sphiraena sp.*	24.52	-	-	-	-
Ib	PC	*Sphiraena sp.*	-	1.48	-	-	-
Xc	PC	*Trachinatus sp*	-	126	-	-	-
XIb	PPK	*Sarpa salpa*	-	-	5.90	-	-
XIc	PC	*Trachinotus sp.*	-	-	4.60	-	-





NITRATES IN YEUMBEUL GROUNDWATER



NITRATES IN YEUMBEUL GROUNDWATER

FIG 16 NITRATES LOAD IN SOME GROUNDWATER WELLS AROUND

K. Evaluating the effectiveness of strategies and measures

In order successfully to measure the effectiveness of the proposed strategies, some criteria need to be established:

(a) Development of water quality indicators, in a simple and comprehensive manner, in order to continuously monitor the water pollution; adequate administrative structures in relation with relevant research centres must be designated for that purpose;

(b) Effectiveness of policies and measures to reduce urban, industrial wastewater and excessive agricultural nutrient run-off, including port reception facilities and adequate contingency plans, should be evaluated through field visits, organized within the countries of the region;

(c) Cost-benefit analysis of the adopted options should be carried out on a regular basis;

(d) Development of comprehensive and detailed freshwater, coastal and marine surveys, including mapping through GIS, coastal sensitivity indexes development, modelling of the functioning of the major river, estuarine and delta systems (Senegal, Saloum and Casamance rivers). These programmes and techniques should help to ensure efficient implementation of integrated coastal management plans.

6. Programme support elements

The Ministry of Environment and Nature Protection is the main entity responsible for formulating policy, standards, guidelines for the protection of the environment in Senegal. However, as far as the protection of the freshwater, coastal and marine environments is concerned, different research, administrative and scientific structures used to intervene, not always in a coordinated manner (i.e. universities, fisheries departments, oceanographic centres, ministries departments and directions, research centres and organisms). Thus, to increase efficiency, undertaken research and actions need to be well coordinated through a higher Commission/or Agency; which is not currently the case. The Senegalese National Environmental Action Plan has been recently validated, with an important component for the freshwater, coastal and marine environments and their sustainable use and rational management. As a programme support element, this National Environmental Plan constitutes a good framework and opportunity for the freshwater, coastal and marine environment protection from land-based activities.

A national action plan devoted to the protection of the coastal, marine and continental waters (superficial and groundwater), has also been recently validated and adopted. This programme has been funded by UNDP and is executed by IMO in close relation with the Ministry of Environment and Nature Protection and the Ministry of Economy and Finance. Other research and management programmes existed in the recent past 10-12 years, dealing with the protection, rehabilitation and restoration of the bays and coastal environments of Senegal.

Nowadays, even if all the development of these projects constitute positive steps for the coastal management of Senegal, actions resulting from those programmes are yet to be developed in order to ensure adequate implementation of the strategies proposed. For this purpose, the following support elements are recommended:

(a) Ensure a better involvement of local communities and authorities, stakeholders, private sector, women, non-governmental organizations, etc. with a good linkage with the scientific community through the programmes and actions developed in the freshwater, coastal and marine areas;

(b) Ensure better coordination between the various coastal and marine programmes, the departments and agencies whose mandates very often overlap and sometimes exhibit conflicting relationships;

(c) Build and consolidate the technical capacities of the existing manpower in order to ensure realistic and efficient programmes implementation and follow up, as far as ICM is concerned;

(d) Ensure the continuity of the various cost-effective programmes which aim to control and reduce the land-based sources of pollution;

(f) The legal aspects, as well as the regulations and standards aiming at controlling and reducing the land-based sources of pollution must be effectively implemented and reinforced; .

(g) Education and public awareness must constitute one of the corner-stones of the integrated management programmes to be undertaken in the concerned aquatic environments.

O. Togo

1. Introduction

The Togolese littoral space is narrow (50 km length). However, the coastal area is an integral part of the large marine Gulf of Guinea ecosystem characterized by its transboundary environmental problems. Lome, the capital, is situated on the coast. The city is characterized by a relatively high concentration of the county's urban population as well as its industrial and socio-economical activities. Besides the phosphate industry located along the coast, there are some other light industrial units specializing in agricultural manufacturing, and industries engaged in food and organic matter transformation as well as the presence of the port. Due to land-based activities, coastal erosion, loss of biodiversity and the decline of the productivity constitute the major problems identified on the marine, coastal and lagoonal environment of Togo.

2. Identification of the major sources of pollution

Six main sources of pollution affect the marine, coastal and lagoonal environments of Togo. These are:

(a) Sewage from urban and industrial waste waters;

(b) Clay and other dissolved matters from mining origin;

(c) Solid wastes, marine debris and plastics;

(d) Agro-chemicals with pesticides, herbicides and other biocides;

(e) Physical modifications of the coast and more particularly, coastal erosion;

(f) Industrial wastes with traces of hydrocarbons and atmospheric pollutants.

(a) Sewage

Sewage originates from urban and industrial waste waters, and most industries deposit their used waters in aquatic environments. The Togolese phosphate industry has very high annual loads of discharges (2.45 million tons - **Table 9**) discharges, which explains the high TSS value measured on the coastal waters. Among the pollutant industries are food processing plants, in particular Benin Breweries, whose waste waters are dumped into the Zio river and some transformation units of vegetable products. The same phenomenon concerns tourist and mining industries whose waste waters are also dumped directly on the beach and in the sea water. In cities such as Lome and Aneho, sewage and domestic disposals contaminate especially lagoon waters. For example, nine open sewage outlets have been counted on a beach of approximately 10 km long. In fact, neither the municipality of Lome nor the industries, have waste water processing stations. One of the major consequences on the lagoonal ecosystems such as Lome lagoon, is the decline of water quality, eutrophication as well as bacteriological and microbiological contamination. Indeed, Lome lagoon is polluted, especially near the markets; this has a major impact on the health of riverine populations due to a lack of hygiene and salubrity.

(b) Clays and dissolved matters from mining origin

Due to the fact that the Togolese Phosphate Office has no treatment station, clays from the washing of phosphates are poured directly in the neighbouring sea, polluting the marine system between Togo and Nigeria. Thus, the sea is yellow, posing a health problem to the marine ecosystem on the near continental shelf and causing the depletion of coastal fisheries stocks in this secto

(c) Solid wastes, marine debris and plastics

Solid wastes and detritus are often observed in the large coastal cities, in particular around Lome, near the markets and along the beaches. This proliferation of waste products may be explained by the lack of adequate equipment and the non-existence of treatment stations. While the marine debris appears to be insignificant, waste plastic matter is a serious problem.

(d) Agro-chemical discharges constituted of pesticides and herbicides

The recent development of the cotton culture, due to the fact of its high profit, has increased the utilization of agro-chemical products such as pesticides and herbicides in agricultural zones, with all foreseeable consequences on the contamination of the surface and underground waters, the fauna and the flora. Furthermore, the proliferation of gardening practices and vegetable agriculture explains partly the increasing utilization of fertilizers.

(e) Physical alteration including habitat modification and coastal erosion

One of the most serious problems of the Togolese coast is that of coastal erosion. Over an area of approximately 35 kilometres, between the port and the protected sector, the coast retreats by approximately 10m per year due to the sedimentary deficit caused by the port (and its dike) which blocks the sediment transit on its western side and causes the coastline to retreat in the eastern part of the port of Lome. Furthermore, the sporadic opening of the lagoonal pass near Aneho as a result of storm waves and the lagoon flood pressure allows the penetration of marine waters which disturb the ecosystem of the Togolese brackish lake. However, the brackish lagoonal waters provoked by freshwater contribution from the Mono river leads to an ecological disequilibrium. These variations in the quality of the water contribute to the change in the habitats of various areas.

(f) Industrial discharges (hydrocarbons) and atmospheric pollutants

These sources of pollution are generally concentrated around the port of Lome where most of the industries are situated. These industries, whose discharges have a negative effect on the aquatic environment, include cement and oil which contribute considerably to the air pollution from the fuel-oil and gas combustion. This form of pollution is made up mainly of substances constituted by monoxide, nitrogen and carbon dioxide, as well as others chemical substances.

3. Constraints

The main constraints are institutional (with the lack of appropriate regulations as well as a lack of adequate structures for controlling these forms of pollution and water treatment); financial, technical (i.e., no integrated management plan of the coastal environment; lack of information and data on the state of the pollution; lack of equipment and the need for a waste treatment station for water purification).

4. Assistance programmes

Assistance has been provided for implementation of the environmental action plan by the World Bank; and the assistance awareness programme for local populations by the European Union. The required assistance focuses on the strengthening of institutional and human capacities and resources.

5. Recommended strategies

Above all, the objective is to reach a better aquatic environmental quality of Togo. Therefore it is important to:

(a) Implement an integrated management plan of the coastal region with the participation of populations, stakeholders, local communities and non-governmental organizations;

(b) Recommend, for all development projects known or suspected to have negative impacts on coastal regions, to initiate environmental impact studies;

(c) Envisage monitoring programmes for the various origin discharges in the Togolese aquatic environments;

(d) Strengthen the legislation in view of a best control of pollution due to terrestrial activities in marine, coastal and freshwater environments of Togo;

(e) Implement awareness programmes, as well as education, training and information ones for the benefit of all users of Togolese aquatic environments;

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ANNEXES

Tables and Additional Figures

ANNEX I

List of Additional Tables

Table 1. Estimated amount of municipal sewage in comparison with industrial pollution in the WACAF Region. See Fig. 4 in the text

Table 2. Main contaminants and their sources in the WACAF Region.

POLLUTANTS	PRODUCING INDUSTRY	%
BOD_5 (12 %)*	Beer	22.0
	Edible oils	17.3
	Textiles	15.9
	Total	55.2
SS (20.7 %)	Fertilizer	29.5
	Textiles	23.6
	Edible oils	8.8
	Total	61.9
Oil + grease (18.4 %)	Petroleum refining	90.0
	Edible oils	7.1
	Total	97.1
COD (45.7 %)	Textiles	52.0
	Edible oils	11.4
	Beer	7.7
	Total	71.1
Ammonia nitrogen	Petroleum refining	90.7
	Textiles	37.2
Phenols	Wood products	31.9
	Total	69.1
Total chrome	Leather	33.5
	Textiles	33.0
	Total	66.5
Fluoride	Fertilizer	59.9
	Aluminium	40.0
	Total	99.9
Cyanide	Steel and fabrication	100.0
Total phosphorus	Fertilizer	100.0

* Estimated mass of pollutant as a percentage of the total amount of pollutants released to the Region.

Source: UNEP, 1984. Reg. Seas Rep.& Studies. n° 46

Table 3. Percentage of admission to hospital because of severe intestinal bilharzia cases at the Richard-Toll health centre (January-March 1992: 77/187 soit 41,2%)

Period	Number of hospital admission due to intestinal bilharzia	Total number of hospital admissions	%
1988	13	523	2,5
1989	103	1 169	8,8
1990	188	628	29,9
1991	291	722	40,3
Total	595	3 042	19,6

Hospital admission reasons: severe dysentery = + dehydrated; severe diarrhoea; severe anaemia = hospital admission + blood transfusion; persistent colics; HTP Syndrom

Table 4. Number of stool examinations, subjects infected with *Schistosoma mansoni* and the percentage of stool examination being infected.

Period	Number of stool examinations	Number of subjects infected with *S. mansoni*	%
May-December 1987	47	0	0
January-March 1988	119	1	0,8
April-June 1988	105	2	1,9
July-September 1988	111	12	10,8
October-December 1988	131	14	10,7
January-March 1989	129	20	15,5
April-June 1989	232	34	14,7
July-September 1989	965	360	37.0
October-December 1989	2 086	1 492	71.5
January-March 1990	2 542	2 007	79,0
April June 1990	1 562	864	55,3
July-September 1990	1 985	1 209	60,9
October-December 1990	1 458	969	66,5
January-March 1991	1 087	622	57,2
April-June 1991	1 369	635	46,4
July-September 1991	1 184	783	66,1
October-December 1991	1 343	728	54,2
January-March 1992	1 345	853	63,4
April-June 1992	1 347	949	70.4
Total	19 149	11 524	60.2

Results are obtained by direct faecal smear

Table 5. Oil resources and oil production rate in some countries of the WACAF Region. (World in figures, 1978; Hann et al., 1981; Petroleum Statistics, 1979) - See Fig. 4

COUNTRY	Resources 10^6 tonne	% of total WACAF Region resources	Production rate 10^6 tonne/year	% of total WACAF region production	Res/Prod* (years)	Production rate (PR) 10^3 t/year	Offshore production rate (OPR) 1.000 t/day	% OPR/PR
Middle zone								
Nigeria	1951.5	81.8	104.6	80.5	18.6	265.85	61.1	23.0
Cameroon	22.7	0.95	0.6	0.45	37.8	1.6	1.6	100
Gabon	108.0	4.5	13.0	10.0	8.3	26.5	19.55	73.8
Southern zone								
Congo	66.0	2.8	2.4	1.85	27.5	4.4	4.35	98.9
D.R. Congo	20.0	0.84	1.2	0.92	16.7	3.15	3.15	100.0
Angola	217.0	9.1	8.2	6.28	26.5	20.9	15.0	71.8
Total WACAF Region	2 385.2	100.0	130.0	100.0	18.3 average	322.4	104.75	32.5 average

* Estimated periods for exhaustion of oil resources in countries, taking into account present production rate.

Source: UNEP, 1984. Regional Seas Report & Studies. n° 46.

Table 6. Average metal concentration in marine sediments (µg/g dry weight)

Localities	Hg	Cd	Pb	Cu	Zn	As	Fe ($x10^3$)	Reference
GULF OF GUINEA								
Ebrie Lagoon, Côte d'Ivoire	0.35		57.6	37.0	187		52.40	Koudio et trefy, 1987
Lagos Lagoon, Nigeria		4.10	178.9	15.0	147		36.38	Okoye et al., 1991
Atlantique Coast, Nigeria	0.10	2.30	67.5		72.5	6.2		Ndiokwere, 1984
NON POLLUTED SEDIMENTS								

Table 7. Concentration of oil and chlorine substances in sediments of inland and coastal waters in Africa (ng/g, dry weight)

Localities	Dieldrine	aHCH	HCB	yHCH (Lindane)	Heptachlore	Aldrine	Endosulfan	References
INLAND WATERS of West and Central Africa								
Ogunpa r., Ibadan, Nigeria	0.9 (ND-1.8)	0.7 (ND-2)		0.5 (ND-1.2)	ND	ND	ND	Sunday, 1990
Ona R., Ibadan, Nigeria	0.3 (ND-0.5)	0.5 (ND-0.9)		ND	ND	ND	ND	Sunday, 1990
Oniyara R., Nigeria	2.0 (ND-6)	0.1 (ND-0.4)		0.9 (ND-2.0)	ND	ND	ND	Sunday, 1990
Lokki Lag., Nigeria	4560 (190-8460)	18.6 (ND-116)		1.1 (0.11-4.9) 2.3 (0.5-19)	64 (ND-1845)	56 (ND-347)	30 (7-1155)	Ojo, 1991 Marchand & Martin, 1985
Ebrie lag., Côte d'Ivoire	17.8 (ND-125.8)	3.2 (0.01-33.4)	0.4 (ND-3.3)	3.0 (0.07-19.8)	0.9 (ND-6.8)	15.7 (0.07-62.1)		Kaba, in press

ND = Not detected

Table 8. Concentration of oil and chlorine substances in sediments of inland and coastal waters in Africa (ng/g, dry weight)

Localities	p,p' DDE	p,p'-DDD	p,p'-DDT	Total DDT	PCB	References
INLAND WATERS of West and Central Africa						
Ogunpa r., Ibadan, Nigeria	13 (ND-32)	ND	0.1 (ND-5.3)		ND	Sunday, 1990
Ona r., Ibadan, Nigeria	7 (ND-14)	ND	1 (ND-2)		ND	Sunday, 1990
Oniyara r., Nigeria	9 (ND-50)	ND	ND		4 (ND-14)	Sunday, 1990
Lokki lag., Nigeria	263 (11-555)	ND	88 (ND-438)		46.7 (2-213)	Ojo, 1991
Ebrie lag., Côte d'Ivoire	7.4 (0.1-149)	28.4 (0.2-803)	15.7 (0.2-354)	17.1 (1.1-997) 46.2 (2.5-242.8)	355.5 (8.5-1014)	March.& Martin,85 Kaba, und. press

Table 9. Comparison of methods to estimate mass of discharged pollutants into the ocean in seven countries of the West and Central African Region (Tons per year)

Type of industry	BOD5	SS	Oil and grease	COD	Ammonia nitrogen	Phenols	Total chromium	Fluoride	Cyanide	Total phosphorus
Côte d'Ivoire										
Guidelines	5 216	3 507	815	14 173.7	75.3	5.9	8.8	21.9		65.2
Industry visited	14 880	4 650	536	39 450						
Togo										
Guidelines	1 708	23 898	250	3 885	62.6	1.2	1.6	2 310	9.0	7 000
Industry visited	710	2 450 425	36	2 040						
Sao Tome & Principe										
Guidelines	38	18	27	43						
Industry visited	47	390								
Cameroon										
Guidelines	2 187	4 800	259	5 139		2.2	2.1	334		
Industry visited	10 400	9 000	196	32 000						
Gabon										
Guidelines	897	381	5 601	1 840	54.8	54.0	3.8			
Industry visited	1 400	5 200	42	37 200		5.6				
Congo										
Guidelines	1 085	606	1 265	2 656	10.0	3.5	2.4			
Industry visited	402	330	48	800		0.2				
Angola										
Guidelines	449	497	3 766	2 076	41.8	2.7	4.2		0.5	
Industry visited	720	402	115	2 284			1.5			

Note: The difference of two orders of magnitude between the values obtained from the guidelines and from the industry visited for SS in Togo is because United States phosphate mining operations are carried out utilizing a holding pond or some other preliminary treatment for waste waters before discharge of what is termed raw waste. Since nearly all SS in industrial waste come from phosphate mining operations in Togo, this is

Table 10. Concentration of oil and chlorine substances in fishes in African coastal and marine areas (ng/g, wet weight)

Localities/species		p,p'-DDE	p,p' DDD	p,p' DDT	DDT total	PCB	References
West and Central Africa Fishes							
Nigeria		3.72 (0.13-14.70)	0.12 (ND-1.05)		4.37 (0.15-18.60)	40.9 (11.0-225)	Osibanjo and Bamgbose, 1990
Sierra Leone		15 (2-36)		1 (2-30)	46 (7-116)	90 (3-825)	Portmann et al., 1989
Benin		0.23	1.79	1.86	3.88		Soclo and Kaba, 1992
Côte d'Ivoire					1.92 (0.13-4.3)*		Kaba, 1992
Cameroon					89.5 (ND-393)	196 (ND-983)	Mbi and Mbome, 1991
Molluses and Crustaceans							
Nigeria:	shrimps, crabs, oyster, snail				37.0 (4.73-152)	94.5 (37-287)	Osibanjo and Bamgbose, 1990
Côte d'Ivoire:	shrimps				1.0 (0.17-1.9)*		Kaba, 1992
Cameroon:	shrimps				244 (76-540)	342 (ND-705)	Mbi and Mbome, 1991
Cameroon:	oyster				112 (ND-181)	209 (ND-716)	Mbi and Mbome, 1991

*) Values converted in weight by dividing original values in dry weight by 3. ND = Not detected

Table 11. Concentration of oil and chlorine substances in fishes in African coastal and marine areas (ng/g, wet weight)

	Localities/species	Dieldrin e	HCB	γHCH (Lindane)	Heptachlore	Aldrine	Endosulfa n	References
West and Central Africa FISHES								
Nigeria			0.92 (0.04-9.48)	0.83 (ND-5.30)	1.29 (ND-21.40)	2.85 (ND-54.60)	0.16 (ND-4.95)	Osibanjo and Bamgbose, 1990
Sierra Leone				12.4 (2-55)				Portmann et al. 1989
Bénin		0,29	<0.016	0.10	0.02	<0.006		Soclo and Kaba, 1990
Cote d'Ivoire		0,46		0.41 (<0.03-0.8)*	0.1 (<0.6-0.23)*	0.18 (0.03-0.7)*		Kaba, 1992
Gambia			0.58	0.029	0.15			Jallow, 1988
Cameroon				1.60 (ND-7.31)		2.4 (ND-13.3)		Mbome and Mbi, 1991
Molluses and Crustaceans								
Nigeria:	shrimps, crab, oyster, snail		0.22 (ND-0.80)	0.80 (ND-1.69)	1.35 (ND-4.16)	0.52 (ND-1.94)	2.41 (ND-21.0)	Osibanjo and Bamgbose,1990
Côte d'Ivoire:	shrimp			0.31 (<0.03-0.73)*	0.37 (0.17-0.9)*	0.65 (0.17-1.3)*		Kaba, 1992
Gambia:	shrimp			0.74	1.08			Jallow, 1988
Gambia:	oyster		3.07	0.18				Jallow, 1988
Cameroon:	shrimp		1.74	0.98 (0.28-1.76)		ND		Mbome and Mbi, 1991
Cameroon:	oyster			1.44 (ND-5.3)		1.71 (ND-12.0)		Mbome and Mbi, 1991

Table 12: Major land-based sources and impacts of pollution in the Democratic Republic of Congo

Major sources of pollution	Impacts on populations	Impacts on the economy	Impacts on poverty	Need for solutions	Impacts on public health
A. Human Settlements					
1. Fecal pollution	2	2	2	2	2
2. Solid wastes	2	2	2	2	2
3. Eutrophica-tion	1	1	1	1	1
4. Nitrates	1	1	1	1	1
5. Radioactivity	1	1		1	1
B. Industries					
1. Industrial effluents	2	2	2	2	2
2. Industrial discharge	2	2	2	2	2
3. Chemical products	2	2	2	2	2
4. Textiles dyes	2	2	2	2	2
5. Heavy metals	2	2	2	2	2
6. Thermal discharge	1	1	1	1	1
7.Bacteriological discharge	1	1	1	1	1
8. Acidification	1	1	1	1	1
C. Mining					
1. Mining effluents	2	2	2	2	2
2. Oil residues	2	2	2	2	2
3. Industrial exploitation effluents	2	2	2	2	2
4. Oil products	2	1	1	1	1
D. Agriculture					
1. Fertilizers + pesticides	1	1	1	1	1

Impacts: 1 = Low ; 2 = High

Table 13. Pollutant load and discharges from sewage and domestic effluents. (Métongo, 1997)

	Discharges Volume (m^3/year)	BOD_5 t/year	DOC t/year	TSS t/year	Nitrates t/year	Phosphates t/year
Houses connected in the sewer system	67.500	18.222	40.700	18.500	3.052	370
Houses not connected in the sewer system	97.100	91.797	212.864	212.864		
Total	164.600	110.019	253564	231364	3052	370

Table 14. Bacteria concentration in the urban lagoonal environment in Abidjan (Adingra and Arfi, 1997).

Parameters	Indicator	Concentrations	
		Maximum	Minimum
Fecal Streptococcus	Bacteria number/ 100 ml	10.000	0
Fecal Coliforms	"	100.000	0
Total Coliformes	"	100.000	100

Table 15. Pollutant load profile from industrial sources by activity (Métongo. 1997).

Industries	Pollutants load		BOD5		COD		TSS		Oil		Nitrates	
	103 m^3/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%	t/yr	%
Food industriy	16.268	29,0	40.307	8.4	4.037	61.8	61.340	2.0	1.731	83.3	1.477	1,06
Textile	3.344	6.0	1.907	0.4	640	9.8	884	0.03				
Breweries	3.228	5.7	1.620	0.33			2.257	0.07				
Food Agro processings	31.776	56,7	435.760	90.7			3.043 593	97.9			137.743	98,9
Oil refineries	994	1.8	837	0.2	1.394	21.4	246	0.01	319	15.3	87	0.05

Table 16. Variations of total oil concentrations (ppm) and organo-chlorine residues (pph) in the sediments of Abidjan Lagoon. (Murchand and Martin, 1985)

Station	HC (ppm)	PCB (ppb)	Lindane (ppb)	DDE (ppb)	DDD (ppb)	DDT (ppb)	DDT (ppb)
Chenal central Ouest	46-596	3-77	0,6-19	0-4,5	0,5-11	0-18	2-25
Baie de Banco	408-1790	117-170	0,5-7	4-8	5,5-23	0-30	13-60
Baie de Cocody	636-1606	40-55	0,5-1,7	7	0,5-7	0-2	8-16
Zone portuaire	293-455	36-46	3,3	5	4,9-12	3-7,6	19
Baie de Marcory	2440	187	9,7	149	803	45	997
Baie de Biétri	57-1194	4-194	0,5-0,9	1-17	0,2-47	0-7	2-72
Baie de Koumassi	35-314	2-151	0,5-4,2	2-18	1-11,4	0-2,5	6-32
Chenal central Est	191-565	3-213	0,5-2,2	0-10	0,2-35	0-113	1-159
Ile Boulay	477	2-32	0,5-1,1	0-3,4	0,5-7	0-6,4	2-17

Table 17. Metal concentration (mg/kg of dry sediment - fraction <63m) of Grand Lahou and Aby Lagoon (Mélongo, pers. comm.)

Localities	Co	Cr	Cu	Fe	Mn	Ni	Zn
Bays of Aby Lagoon							
Adiake	12.0	105.30	19.30	51.05	196.40	75.70	64.95
Etuossika	7.40	43.10	11.05	21.0	87.40	22.80	73.55
Mama	32.05	123,85	11.90	102,15	222,20	85.85	103.75
Assomlan	17.90	95,20	21.40	97.20	268.60	63.70	90.80
Akougnoube	14.05	118,60	42,55	137.15	84.70	59.50	112.55
Grand-Lahou Lagoon							
	12.45	129,80	16,80	47.10	141.45	65.85	50.80
	17.30	277.50	15.60	27.60	153.65	43.10	68.85
	27.70	173.25	20.60	94.35	253.05	67.80	10.90
	19.30	146.75	16.90	79.10	243.35	49.80	103.40
	14.50	254.0	16.15	89.40	224.10	51.25	78.90

Table 18. Metal load (mg/kg of dry sediment-fraction <63 m) of lagoonal sediments of Ebrie and sand beaches (Urban areas of Abidjan) (Arfi et al., 1994).

Stations	Cr	Cu	Fe (g/kg)	Hg	Mn	Pb	Zn
Lagoon							
1	156,0	30,20	48,10	0,086	403,60	31,20	157,6
2	118,75	43,00	49,90	0,281	221,3	16,50	79,3
3	1718,0	3,00	61,21	0,381	234,35	54,00	211,6
4	465,2	29,55	40,70	0,146	156,15	9,50	47,10
5	286,3	55,4	67,00	0,270	169,25	61,30	139,0
6	429,40	76,30	52,21	0,490	182,30	88,75	268,7
7	357,85	40,60	56,20	0,300	208,30	17,00	55,6
8	134,55	42,45	56,90	0,098	364,6	18,00	46,3
9	134,55	51,70	61,21	0,270	377,6	41,20	139,0
10	108,8	33,25	50,77	0,048	429,65	15,85	92,6
11	68,7	12,90	19,80	0,390	520,8	10,55	88,0
12	120,25	49,25	61,93	0,540	533,85	41,20	398,4
13	20,65	2,95	1,30	0,063	24,00	3,95	5,50
Sand beach							
PL1	17,00	6,00	7,70	0,070	39,45	3,75	9,90
PL2	117,95	9,10	6,75	0,070	67,75	1,50	9,95
PL3	57,00	6,20	12,05	0,035	68,65	3,00	15,90
PL4	28,65	5,25	16,50	0,035	87,65	2,25	18,00
PL5	24,00	8,25	11,20	0,035	112,30	1,50	16,35

Table 19. Pollutant load from atmospheric emissions (Métongo, 1997).

Sources	Particulate material		SO_2		NOx		Hydrocarbons (oils)		CO	
	t/year	%	t/year	%	t/year	%	t/year	%	t/year	%
Domestic Sources	8.552	42.10	307	13.3	3.251	23.5	640	7.4	640	0.7
Industrial Sources	9.571	47.10	609	26.4	237	1.7	58	0.7	18	0.02
Electricity Central	123	0.60	42	1.8	1.565	11.3	15	0.2	78	0.08
Road Traffic	1.622	8.0	189	8.2	7.349	53.0	6.811	78.4	87.563	97.4
Aerial Traffic	11	0.05	15	0.70	120	0.9	286	3.3	407	0.45
Maritime Traffic	440	2.15	1.144	49.6	1.332	9.6	874	10.0	1.221	1.35
Total	20319	100	2306	100	13854	100	8684	100	89927	100

Table 20. Results of faecal coliform counts obtained from various sampling points along the Gambia estuary.see Fig. 8 in the text

Table 21. Various pesticides and their concentrations in some samplings (in ppm: 1ppm = mg/l) - The Gambia.

Pesticides Water sampling	Dimethoate	Dieldrine	Bendiocarde	Fenitrothion	pp'DDT	Parathion méthyl
Bansang (1)	2	2	50		25	
Pirou (2)		72				150
Sudowol (3)	32	75				75
Kulari (4)				45		2
Basse (5)	18			250	26	
Fatoto (6)		180	201		27	
Safi (7)	0.02		200		25	

Table 22. Average metal concentration in inland fish waters (µg/g Wet weight)

Localities	Hg	Cd	Pb	As	Cu	Zn	Mn	Fe	Reference
FISHES									
Kpong Basin, Ghana	0.053	<0.10	0.43		0.36	5.6	0.63	3.8	Biney, 1991
Wiwi river, Ghana	0.37	0.19	0.47		0.38	3.0			Biney et Beeko, 1991
Niger delta, Nigeria	0.034	0.03	0.48		0.70	4.8	1.1	5.4	Kakulu et al., 1987
MOLLUSCS *Macrobrachium* sp.									
Low-Volta, Ghana	0.04	<0.10	4.36		11.0	16.1			Biney, 1991
Niger delta, Nigeria	0.02	0.04	2.47		8.5	14.1			Kakulu et al., 1987a
Egeria radiata									
Low-Volta, Ghana	0.05	<0.10	1.37		4.5	20.2			Biney, 1991
OMS norm	5	20	20		30	1000			Kakulu et al., 1987a

Table 23: Solid waste pollution loads from industrial processes and percentage contributions

Industry and process	Production unit	Prod. 10^3 u/year	Solid Waste		Nature of Waste	% Contribution
			kg/ unit	t/year		
Canning of fruits and vegetables	t	2880.5	50	14400.25	Peels, cores, seeds etc.	24.34
Vegetable oil refining	t	312.2	4.7	1149.3	Purification mud soaked in oil	3.03
Beer brewing	t	10.5	20	201	Spend hop, grain residues, yeast etc.	0.35
Wool souring	t	0.13	95	12.3	Dirt, wool, fly and sweeps	0.02
	t	0.13	570	74.1	Sludge from waste water treatment	0.13
	t	0.13	6700	141	Sludge from waste water treatment	1.28
Wool dyeing and finishing	t	0.13	38	4.34	Flock, dye and chemical containers etc.	<0.01
Cotton(yarn preparation)	t	17.4	32	356.8	Fibre and yarn	0.95
Weaving	t	3.4	11	37.4	Fibre and yarn and cloth	0.06
Dyeing and finishing	t	3.4	7	23.8	Cloth and flock	0.04
	t	3.4	20	68	Waste water treatment	0.12
	t	3.4	2300	7820		13.54
Pesticide production	t	0.188	200	37.6	Containers, bags, 1.5% active toxic/material etc.	0.07
Manufacture of synthetic resins, plastic and fibres	t	7.2	N/A			
Latex paint	t of paint	0.831	5.8	4.8	Paint sludge, waste solvents etc.	<0.01
Synthetic organic pharmaceutical chemicals	t	0.65	800	520	Paint sludge, waste solvents etc./Heavy metals 4.5%	0.90
	t	0.65	600	3000	Dry solid waste	1.76
Other rubber products	t	4.9	175	1032.5	Rubber waste, filters etc.	1.75
Iron Foundries	t of casting	24.3	142	3451.0	Slag, dust, refractories with heavy metals	5.98
	"	24.3	600	14580.0	Casting sand with heavy metals & phenols	25.25
	"	24.3	32.8	797	Sludge with heavy metals	1.38
Steel Foundries	"	4.005	180	3124	Sand (heavy metals & phenols)	5.41
	"	4.005	361	1445	Sludge, dust, refractories (heavy metals)	2.50
	"	4.005	36.4	146	Sludge (heavy metals)	0.25
Scrap smelting	t	40	75	3000.0	Scrubber sludge (Cr, Cu, Pb, Zn)	5.20
Electroplating of Cu	t of Cu electrodes	0.02	9	0.18	Cu in the effluent treatment sludge (cyanide may also be present)	<0.01

From C. A. Biney and R. Asmah, 1994. Assessment of water, air and land pollution. Sources in Accra-Tema Metropolitan area, Ghana - HO Regional report - regional Office for Africa - IAB Technical. Report No. 135

Table 24: Hydrological characteristics of Guinean coastal river-basins

River number	River names	River-basins Surface (in km²)	Mean annual river flow (in km3/year)	Population of the river-basin	Mean river-basin population density
1	Cogon	8.502	11.471	155.436	18
2	Tinguilinta	5.031	7.685	93.935	19
3	Kapathez	2.609	5.383	57.515	22
4	Fatala	5.967	10.443	138.630	23
5	Konkouré	18.695	23.122	564.106	30
6	Soumbe	2.765	6.404	763.196	276
7	Boffon	2.226	4.563	47.126	21
8	Méliéhouré	1.049	2.310	22.658	21

Table 25. Microbiological properties of water samples obtained from Lagos Lagoon. See Fig. 12 in the text

Table 26. Residual concentration of oil and chlorine substances in inland African waters (ng/g, wet weight)

Localities	Dieldrine	aHCH	HCB	yHCH (Lindane)	Heptachlor e	Aldrine	Endosulfan	References
West and Central Africa - Nigeria								
South-West (Ogun & Oyo States)			12.7 (9-130)	25.6 (7-106)	50 (1-300)		173 (3-904)	Amakwe, 1984
South-east (Cross & Akwa Ibom States)		1.8 (0.2-7.4)		4.4 (0.6-13)	0.3 (ND-1.0)		14 (ND-89.6)	Fayomi, 1987
Ibadan	68 (ND-173)	0.15 (0.04-0.24)		248 (0.2-598)	0.5 (0.1-1.3)	5.5 (ND-14.9)	ND	Osibanjo & Jensen, 1980
Oyo, Lagos & Cross River States		1.8 (0.2-5.0)				1.4 (0.1-3.8)		Amakwe, 1984; Fayomi, 1987

Table 27. Concentration of oil and chlorine substances in inland and coastal African waters (ng/l)

Localities	Dielcrine	HCH	HCB	yHCH (Lindane)	Heptachlore	Aldrine	Endosulfan	References
West and Central Africa Nigeria								
Ibadan, rivers	250 (17.8-657)	150 (1-302)	17 (ND-92)	100 (7-297)	72 (4-202)	20 (ND-40)	98 (ND-430	Nwankwoala and Osibanjo, 92
Ogun river				13.3 (1.4-41.9)	0.25 (ND-0.8)	40 (5.1-49)	116 (ND-260)	Agunloye, 1984; Tongo, 1985
Imo river				0.2 (ND-0.6)	4 (ND-11.4)	13 (ND-40)	13 (ND-41)	Agunloye, 1984; Tongo, 1985
Cross river			1.0 (ND-2.5)	0.3 (ND 1.1)	2 (ND-8.6)	36 (ND-143)	20 (ND-80)	Agunloye, 1984; Tongo, 1985
Awba reservoir, Ibadan			0.8 (ND-2.5)	61 (9-167)		18 (12-29)	20 (ND-30)	Agunloye, 1984; Tongo, 1985
Kainji Lake				0.12 (ND-0.24)	0.47 (ND-3.48)	0.55 (ND-3.05)		Adeniji et al., 1991
Ero, Ondo Reserv R.	560			2.0	3.3	3.1	ND	Oguniowo, 1991
Ero river, Ondo	740			2.0	ND	ND	ND	Oguniowo, 1991
Osse river, Ondo	2150			2.0	5.0	ND	ND	Oguniowo, 1991
Owesse R., Ondo	1120			6.4	1.5	ND	ND	Oguniowo, 1991
Aponua R., Ondo	1380			4.8	4.6	3.5	ND	Oguniowo, 1991
COASTAL WATERS Nigeria Lagos Lagoon	8 (ND-24)		2 (0.8-4.1)	182 (16-634)	ND	53 (9-190)	29 (ND-86)	Tongo, 1985

ND = not detected

Table 28. Concentration of chlorine substances and oil in inland and coastal african waters (ng/l)

Localities	p,p' DDE	p,p'-DDD	p,p'-DDT	DDt total	PCB	Références
INLAND WATERS WACAF - **Nigeria**						
Ibadan, rivers				310 (ND-1266)		Nwankwoala and Osibanjo, 1992
Ogun river					87 (ND-244)	Agunioye, 1984; Tongo, 1985
Iwo river					121 (ND-241)	Agunioye, 1984; Tongo, 1985
Cross river					120 (ND-470)	Agunioye, 1984; Tongo, 1985
Awba reservoir, Ibadan					330 (ND-1000)	Agunioye, 1984; Tongo, 1985
Lac Kainji				3.88 (ND-10.05)		Adeniji et al., 1991
Ero river reservoir, Ondo	ND	ND	ND	ND	ND	Oguniowo, 1991
Ero, ondo rivers	ND	ND	ND	ND	ND	Oguniowo, 1991
Osse, Ondo rivers	ND	ND	ND	ND	ND	Oguniowo, 1991
Owesse, Ondo rivers	ND	ND	ND	ND	ND	Oguniowo, 1991
Apomu, ondo	ND	ND	ND	ND	ND	Oguniowo, 1991
COASTAL WATERS West and Central Africa						
Nigeria: Lagos Lagoon	3 (ND-15)	83 (ND-344)	ND	2500 (ND-9000)		Tongo, 1985

ND = Not detected

Table 29. Residual concentration of oil and chlorine substances in inland and coastal African fishes (ng/g, wet weight)

Localities	p,p' DDE	p,p'-DDD	p,p'-DDT	Total DDT	PCB	References
West and Central Africa - **Nigeria**						
South-west (Ogun & Oyo States)	3.4 (2-30)	7.8 (2-60)	2.9 (3-18)	20.6 (3-161)	28.7 (8-130)	Amakwe, 1984
South-east (Cross & Akwa Ibom States)	1.8 (ND-4.2)	0.7 (ND-8)		2.5	3.8 (0.7-14)	Fayemi, 1987
Ibadan		3 (0.2-6.6)	7 (ND-23)	15 (0.5-36)		Osibanjo & Jensen,80

Table 30. Pollutant discharged into the sea (in tons per acre) (source/ BRGM/Dir. Environ., 1986)

INDUSTRIES	BOD	COD	Oil/Grease	Phenol	Nitrate	Phosphate
SONACOS	2230	5580	1400	-	-	-
SOTIBA	150	27	-	2,592	-	-
ICOTAF	50	628	-	0,892	-	-
SAR	113	315	43,2	0,54	23,4	-
NSOA	61	153	7,3	-	-	-
PECHE (Cumul)	-	-	367	-	-	-
CCV	24	302	-	0,42	-	-
ICS Mbao	-	-	-	-	-	115
CSL	3	16	0,8	0,017	1,5	-
National Total	11200	29520	4164	4,6	25,5	115

Table 31. Bacteriological contamination of the waters around Dakar. See Fig. 15 in text

Table 32. Industrial Pollutant load (source: stratégie d'assainissement du Grand-Dakar)

Zone	Position	BOD_5	COD	Total N	Total P	Hm Cm
V	Port	12000	25000	1400	300	900
IV	Canal VI	2800	6000	490	150	150
III	Sodida	200	600	50	10	-
II	Abattoir	5400	9000	850	180	180

Table 33. Metal contamination of the fauna. See fig 15 in text

Table 34. Bacteriological contamination of the fauna. Dakar. See Fig. 1a in Annex II

Table 35. Chemical and bacteriological characteristics of waste waters around Dakar. See Fig. 2a in Annex II

Table 36. Estimated quantity of pollutants discharged to the ocean from industrial sectors in the West and Central African Region (Northern zone). See Fig. 4 (Tons per year)

Type of industry	BOD_5	SS	Oil & grease	COD	Ammonia nitrogen	Phenols	Total chromium	Fluoride	Cyanide	Total phosphorus
Petroleum refining & handling	116.1	74.2	44.1	331.1	25.0	0.6	1.5			
Edible oils	4 984.1	4 356.3	3 129.0	12 471.5						
Beer	418.2	193.9		459.2						
Soft drinks	154.4	212.2		387.1						
Soap & detergents	63.7	108.5	7.7	159.3						
Fish & shrimps		2 338.4	557.0							
Sugar	779.8	962.2		1 945.6						
Textiles	230.0	587.8		1 657.8		4.1	4.1			
Paint	0.5	0.8		1.3						
Rice	2.8	1.6		7.0						
Dairy products	20.0	30.0		51.2						
Fruits & vegetables	27.5	33.9		68.6						
Meat	0.6	1.0	0.3	1.5						
Leather	5 334.0	6 660.0	1 000.0	13 000.0			134.0			
Fertilizer		381.6						38.2		114.6
Asphalt	0.7	0.6	0.2	4.1	0.4	0.1	0.1			
Metal working & coating	0.3	1.7	0.1	0.8	0.1	0.1		0.7		
TOTAL	12 132.7	15 944.7	4 738.3	31 746.1	252	47	1396	389		1146

Table 37. Estimated quantity of pollutants discharged to the ocean from industrial sectors in the west and Central African region (Northern zone) - See Fig. 4 (Tons per year)

Type of industry	BOD_5	SS	Oil & grease	COD	Ammonia nitrogen	Phenols	Total chromium	Fluoride	Cyanide	Total phosphorus
Petroleum refining	598.3	379.9	227.9	1 662.0	1235	2.8	7.6			
Edible oils	515.9	451.1	323.9	1 290.4						
Beer	1 704.5	792.3		1 876.0						
Soft drinks	192.2	264.3		480.6						
Alcool & blending of spirits	0.4			1.0						
Soap & detergents	84.1	143.5	10.1	211.1						
Fish & shrimps		490.8	125.3							
Sugar	68.8	14.4		171.6						
Textiles	10.2	26.1		126.9						
Explosives	1.0	20.5		2.7		0.2	0.2			
Paint	0.3	0.5		0.8						
Flour	3.7	3.3		9.3						
Fruits & vegetables	7.4	9.1		18.4						
TOTAL	3 186.8	2 595.8	6872	5 850.8	1235	30	78			

Table 38. Estimated quantity of pollutants discharged to the ocean from industrial sectors in the West and Central African region (Area marked **B** on the Middle zone of the map[a] in tons per year). See Fig. 4

Type of industry	BOD_5	SS	Oil & grease	COD	Ammonia nitrogen	Phenols	Total chromium	Fluoride	Cyanide	Total phosphorus
Petroleum refining & handling	1 386.0	712.0	59 528.4	3 850.0	286.2	6.6	17.6			
Edible oils	698.0	610.4	438.2	1 745.6						
Beer	5 371.3	2 490.8		5 897.9						
Soft drinks	726.8	998.9		1 822.0						
Soap & detergents	276.8	471.9	33.0	691.9						
Textiles	5 428.6	10 426.1		79 864.7	0.1	113.2	113.2			
Paint	236.4	355.6		592.0						
Dairy products	0.2	0.3		0.6						
Wood products (plywood, veneers, lumber)	96.5	20.4		242.0		108.3				
Pulp & paper	1 179.0	2 526.0		2 949.0						
Alcohol & blending of spirits	0.1	0.1		0.2						
Tubes & tyres		1.7	0.4							
Steel & fabrication		2.3					0.1	0.1		0.1
Matches	...	...								
Glass	...	...								
Fruits & vegetables	25.7	31.7		64.1						
Aluminium		500.0						233.5		
Blankets & linen	...	...								
Rubber	4.5	7.3	1.9	91.						
Shoes	...	...								
Batteries	9.4	2 340.0		23.4						
Fishing		1 921.0	102.0							
Flour	60.0	60.0		150.0						
Sugar	158.1	33.1		394.7						
Canned meat	0.8	1.3	0.4	2.0						
Cement	3 791.4			9 514.0						
TOTAL	20 449.6	29 510.9	60 104.3	107895.4	286.3	228.1	1308	3336		1

a/ 93.6 tonnes per year of lead and cadmium are also discharged.

Table 39. Estimated quantity of pollutants discharged to the ocean from industrial sectors in the West and Central African region (in the Area marked A on the Middle zone of the map). See Fig. 4 (Tons per year)

Type of industry	BOD_5	SS	Oil & grease	COD	Ammonia nitrogen	Phenols	Total chromium	Fluoride	Cyanide	Total phosphorus
Petroleum refining & handling	537.0	241.2	204.5	1 496.3	111.4	2.6	6.8			
Edible oils	1 828.6	1 599.0	1 148.0	4 575.6						
Beer	2 007.4	930.9		2 204.2						
Soft drinks	241.6	332.1		605.9						
Alcohol & wine bottling	187.2	257.4		469.6						
Soap & detergents	93 6	159.5	1 .2	234.0						
Textiles	684.5	752.2		8 519.2		12.1	12.1			
Paint	0.5	0.9		1.5						
Flour	57.7	51.3		144.7						
Dairy products	189.0	283.5		483.0						
Fruits & vegetables	82 1	101.3		204.8						
Meat	1.4	2.2	0.7	3.4						
Fertilizer		23 525.9	0.9		6.3			2 330.8		7 063.0
Asphalt	27.8	22.4	9.1	164.1	16.2	0.2	0.5			
Steel		14.4	4.4		36.6	0.6			9.0	
Aluminium		1 874.4					0.6	1 250.2		
Metal plating & coating		44.6						1.1		2.2
Cement	1 355.0			3 400.3						
Coffee	1 875.0	150.0		4 686.9						
Cocoa products	329.7	288.3	207.0	824.9						
Wood products (plywood, veneers, lumber)	13.2			33.2		2.6				
TOTAL	9 511.3	31 731.5	1 585.8	28 050.7	1705	181	200	2 582.1	9.0	7 065.2

Table 40. Estimated quantity of pollutants discharged to the ocean by industrial sectors in the West and Central African Region (Southern zone). See Fig. 4 (Tons per year)

Type of industry	BOD_5	SS	Oil and grease	COD	Ammonia nitrogen	Phenols	Total chromium	Fluoride	Cyanide	Total phosphorus
Petroleum refining & handling	342.1	238.0	4 948.6	1 165.3	61.1	1.8	4.8			
Edible oils	164.1	143.5	103.0	410.6						
Beer	900.7	417.7		989.0						
Soft drinks	56.7	77.9		141.8						
Soap & detergents	5.9	10.1	0.7	14.7						
Fish & shrimps	...	...								
Sugar	77.4	16.2		193.4						
Textiles	144.7	369.8		1 797.8		2,6				
Explosives	...	...					2,6			
Paint	<0.1	<0.1		<0.1						
Flour	96.6	85.7		242.1						
Dairy products	...	...								
Wood products (plywood, veneers, lumber)	198.4			496.1		2.1				
Pulp & paper	...	...								
Cement	...	...								
Tubes & tires		0.1	0.1							
Steel		1.0	0.3		2.4	0.1			0.5	
Total	1 986.6	1 359.9	5 052.6	5 450.8	635	65	74		5	

Source: UNEP. 1982. Regional Seas Reports & Studies. N°2

Table 41. Metal concentration in marine sediments from African regions (µg/g Dry weight)

Localisation	Hg	Cd	Pb	Cu	Zn	Mn	Fe(x10³)
INLAND WATERS							
North Africa		0.15-0.20	7.3-10.6	38.0-85.6	94-139	387-958	0.46-58
West and Central Africa	0.21-0.33	0.16-0.20	13.4-16.7	24.7-30.3	16-62	295-352	55-60
East Africa	<0.05	0.27-1.02	6.02-18.1	0.96-6.2	2.54-140	53-550	1.18-69
South Africa	0.02-0.28	0.19-1.0		10.5-41.0	36-289	150 350	12 16
COASTAL WATERS							
North Africa	0.12	2.02-2.20		12-14	35-51		
West and Central Africa	0.10-0.35	2.30-4.10	57.6-67.5	13-37	73-187		1.1-4.5
South Africa	0.019	0.23	48.4	6.7	41		3652

Source: FAO, 1994

Table 42. Metal concentration in fishes sampled from marin African regions (µg/g Wet weight)

Localities	Hg	Cd	Pb	As	Cu	Zn	Mn	Fe
FISHES Inland waters								
North Africa	0.010	0.004-0.15	0.67	0.031	1.77-3.70	7.4-8.0	0.9	11.2-12.6
West & Central Africa	0.034-0.053	0.02-0.019	0.43-0.48	0.036	0.18-0.70	3.0-5.6	0.63-1.1	3.8-5.4
East Africa	0.044	0.04-0.12	0.17-1.1	0.26-0.40	0.15-2.0	2.2-22	0.74-1.8	0.53-4 7
South Africa		0.01-0.02	0.02-0.17		0.30-1.08	6.6 11.8	0.24 5.4	
COASTAL WATERS								
North Africa	0.077	0.004	0.07		1.65	4.23		
West & Central Africa	0.06-0.17	0.10-0.26	0.36-2.28		0.46-11.3	4.55-27.5		
East Africa		0.04-0.36	0 22-6.48		0.36-2 04	4.67-40.8		
MOLLUSCS								
West & Central Africa								
Penaeus sp.	0.033-0.17	0.10-0.25	0.50-510		4.68-23.6	13.9-240		
Crassostrea gasar	0.072-0.13	0.17-0.65	2.09		5.8-24.5	407-1205		
South Africa								
C.magaritacea			0.05		4.0	229		

Source: FAO, 1994

Table 43. Metal concentration comparison in sediments sampled from various regions of Africa and the World (µg/g dry weight)

Localities	Hg	Cd	Pb	Cu	Zn	Reference
African Inland waters	0.24	0.37	23.2	26.3	82.5	This study
	(0.02-0.60)	(0.10-1.0)	(7.3-63)	(0.96-41)	(2.54-140)	
African Coastal water	0.19	2.78	57.8	19.4	92	This study
	(0.10-0.35)	(2.0-4.1)	(48-68)	(12-37)	(35-102)	
North-east Ontario Lake				10.5-2900	130-448	Bradley and Morris, 1986
Narragansett Bay, United-States		0.06-2.45	17-81	36-98	53-168	Eisler et al., 1977
Tawe Riv., Wales.		39	862	326	5107	Vivian and Massie, 1978
Liverpool Dock, U.K.			109-613	90-1592	734-2087	Bellinger and Benham, 87
Portsmouth port, U.K.		0.5-3.3	49-114	26-72	61-210	Soulsby et al.,1978
Evoikos Gulf, Greece	0.4-1.1				52-147	Angelidis et al., 1981
Malacca Detroit		ND*-.25	6.5-35-3	1.0-26.3		Sen Gupta et al., 1990
Bahrain		0.02-0.05	1.70-15.1	5.60-10.0		Sen Gupta et al., 1990
Kuwait	13-106	0.09-0.23	3.3-68	20.1-21.9		Sen Gupta et al., 1990
Saudi Arabia	50-170	2.5-5.0	0.6-4 2	5.4-16.6	4.0-23	Linden et al., 1990
Hong Kong	3-37			22	96	Gomez et al., 1990
South China Sea		0.41-2.39		1.94-9.21	12.5-49.9	Gomez et al., 1990
Djakarta Bay	0.05-4000	5.0-400		10-780	60-7140	Gomez et al., 1990
Port of wellington, New-Zeland			22-6740	15-216	55-2270	Brodie et al., 1990
Fiji						

Table 44. Metal concentration comparison in fishes sampled from various regions in Africa and the World (µg/g Wet weight)

Localities	Hg	Cd	Pb	Cu	Zn	Reference
African Inland waters	0.035 (0.01-0.053)	0.053 (0.004-0.19)	0.31 (ND*-0.67)	0.85 (0.18-2.0)	7.16 (2.0-11.8)	This study
African coastal waters	0.095 (0.06-0.17)	0.069 (ND-0.26)	0.69 (0.07-1.83)	0.80 (0.40-1.65)	4.76 (4.23-5.55)	This study
British Rivers	0.17 0.023-0.32)	0.15 (ND-0.35)	0.87 (ND-4.30)			Mason, 1987
Tyrrhenion North Sea	1.21 (0.11-2.81)	<0.02	<0.20	0.37 (0.24-0.44)	3.92 (2.92-5.19)	Leonzi et al., 1986
Finland Lakes	0.77 (0.50-4.06)					Surma-Aho et al., 86 Sen Gupta et al., 90
North of Indian Ocean	0.01	0.90	0.62	0.81		
Bahrain	0.004-1.07	0.00003-0.071		0.10-0.47		Linden et al., 1990
Malacca Detroit	0.01-0.58	ND-0.10	ND-1.20	0.05-0.75	1.70-10.8	Gomez et al., 1990
Indonesia	0.02-0.20	0.02-0.03	0.09-0.68	0.33-0.68	0.30-9.96	Gomez et al., 1990
Thailand Gulf	0.01-0.10	0.01-0.06	0.01-0.09	0.50-1.25	6.20-11.8	Gomez et al., 1990
Philippines	0.01-1.10	ND-0.36	0.01-0.08	ND-4.43	0.20-58.4	Gomez et al., 1990
Hong Kong	ND-0.40	ND	ND-0.30	ND-1.10	0.80-25.4	Gomez et al., 1990
New-Zeland	0.02-1.10	0.01-0.03	0.03-0.18	0.12-0.75	0.80-5.1	Brodie et al., 1990
Papua New-Guinea	0.03-0.40	ND-0.10	ND-0.30	0.30-0.70	3.0-5.0	Brodie et al., 1990

Source: in FAO, 1994

ANNEX II

List of Additional Figures

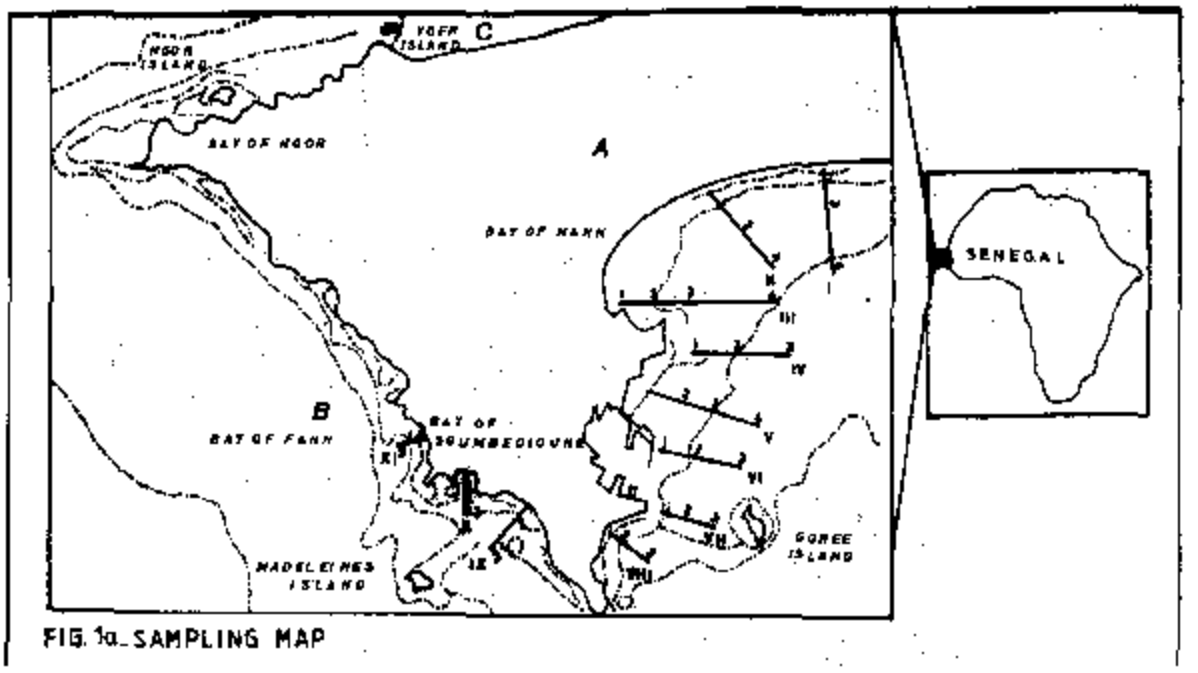


FIG. 1a_SAMPLING MAP

Table 34. Bacteriological contamination of the fauna. Dakar.

Radiales	Samples	Aeroblal micro-organism /gr	Total coliformes/gr	Staphyloco-ccus	Anaerobic sulphur-reduction /gr	Salmonelles	Conclusion
I	PD	$1,6x10^3$	100	<50	<5	Absent	Acceptable
	PP	$1,5x10^3$	<5	<50	<5	Absent	Satisfactory
II	PD	$5x10^4$	185	500	5	Absent	Not satisfactory
	PP	$2x10^4$	75	50	trace	Absent	Not satisfactory
III	PD	$3x10^4$	75	500	20	Absent	Not satisfactory
	PP	$1,4x10^3$	5	250	15	Absent	Acceptable
V	PD	$2x10^4$	<5	50	trace	Absent	no contamination
	PP	$3x10^4$	<5	100	trace	Absent	no contamination
VIII	PD	$4,3x10^3$	150	<50	trace	Absent	Not satisfactory
	PP	$1,7x10^3$	175	100	trace	Absent	Not satisfactory
IX	PD	$3,2x10^3$	<5	350	<5	Absent	Satisfactory
	PP	$2,7x10^3$	<5	200	trace	Absent	Satisfactory
X	PD	$2,1x10^3$	115	<50	<5	Absent	Not satisfactory
	PP	$1,4x10^5$	7 100	<50	trace	Absent	Not satisfactory
XI	PD	$5,9x10^3$	145	<50	5	Absent	Not satisfactory
	PP	$3,5x10^2$	<5	<50	<5	Absent	Not satisfactory
N		$5x10^4$	10	100	2	Absent	

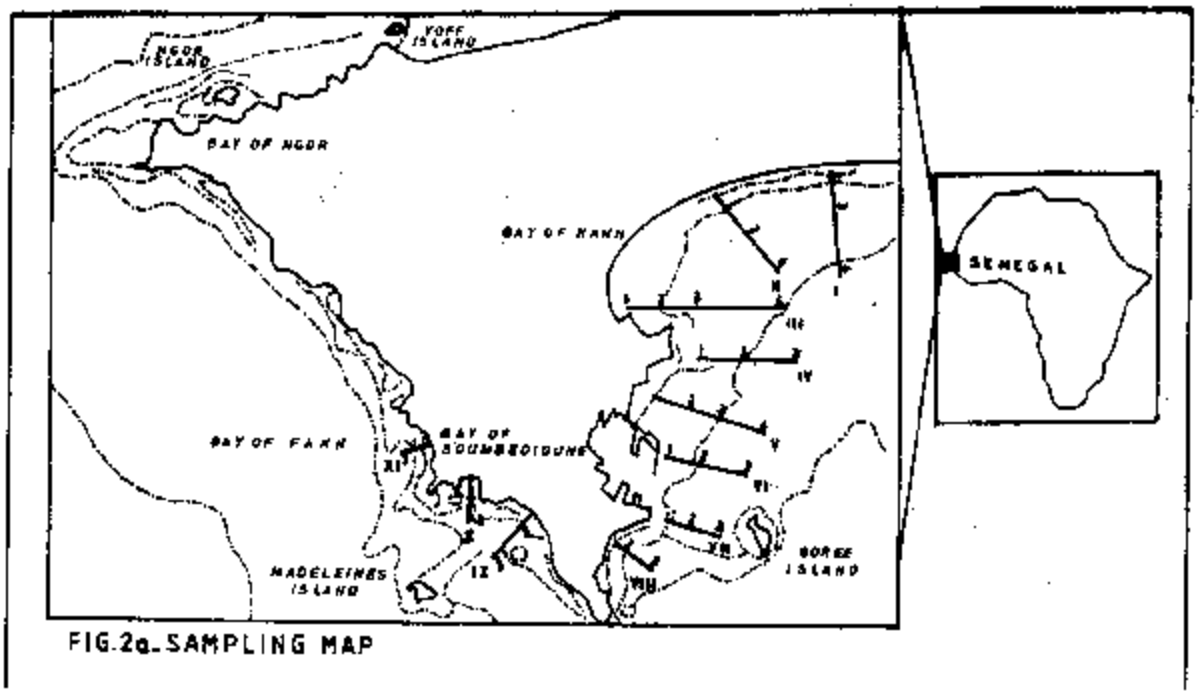
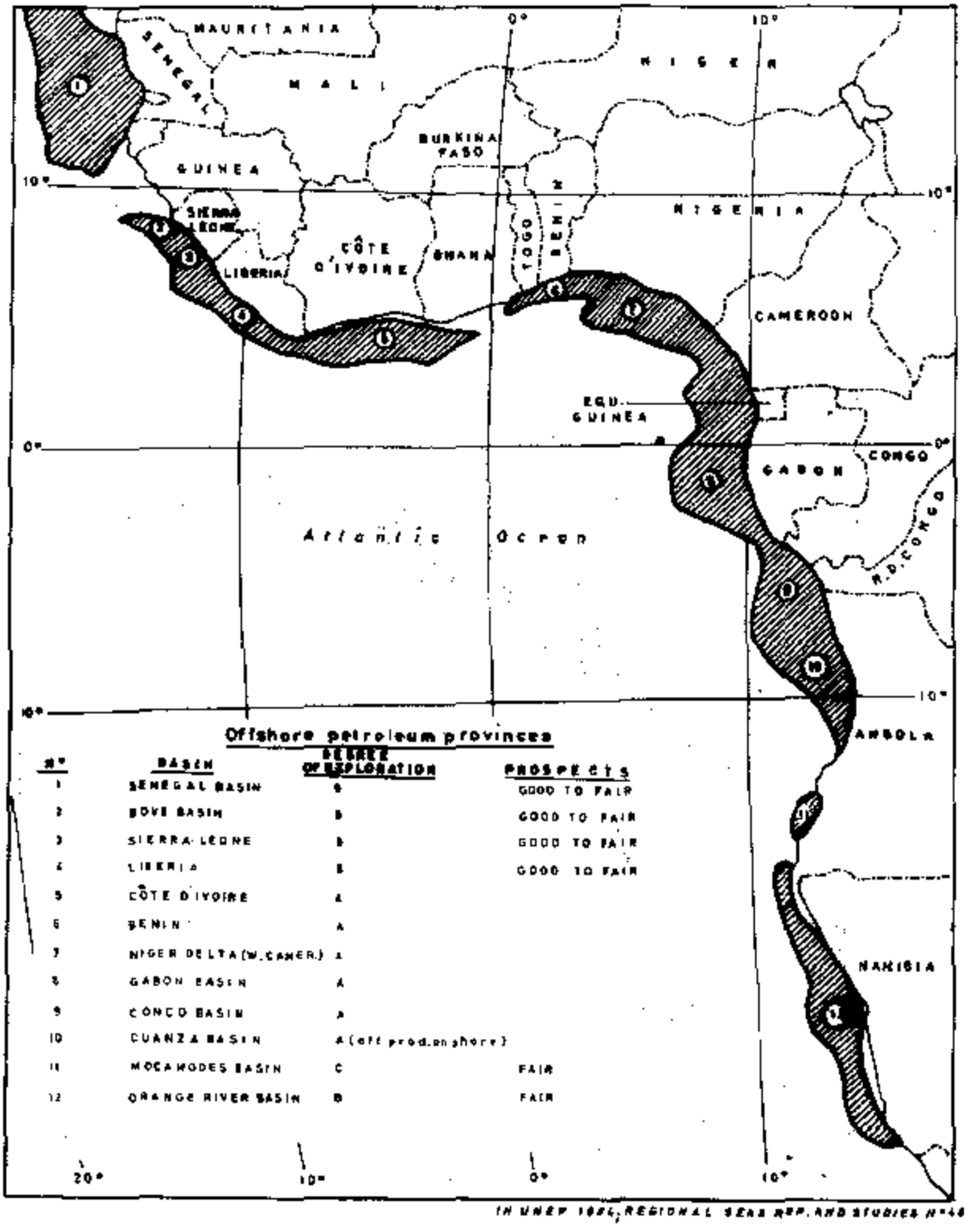


FIG.2a-SAMPLING MAP

Table 35. Chemical and bacteriological characteristics of waste waters around Dakar

Station/parameter	TSS mg/l	MD ml/l	COD mg 02/l	BOD_5 mg 02/l	NH4+ mg N/l	NKe mg P/l	PO4 mg P/l	CF 100 ml	TC 100 ml	COD/ BOD_5
Pikine A	395	15	1281	732	42	170	36	$18x10^7$	$26x10^7$	2,3
	1 010	9	1761	810	86	108	86	$15x10^7$	$21x10^7$	1,6
University B	570	20	1811	900	64	106	59	$13x10^7$	$17x10^7$	2,07
	1 850	18	977	626	38	91	36	$10x10^7$	$15x10^7$	1,6
Cambérène C	640	23	2098	820	68	131	57	$26x10^7$	$29x10^7$	2,6
	4 490	17	1130	729	46	97	37	$14x10^7$	$19x10^7$	1,4

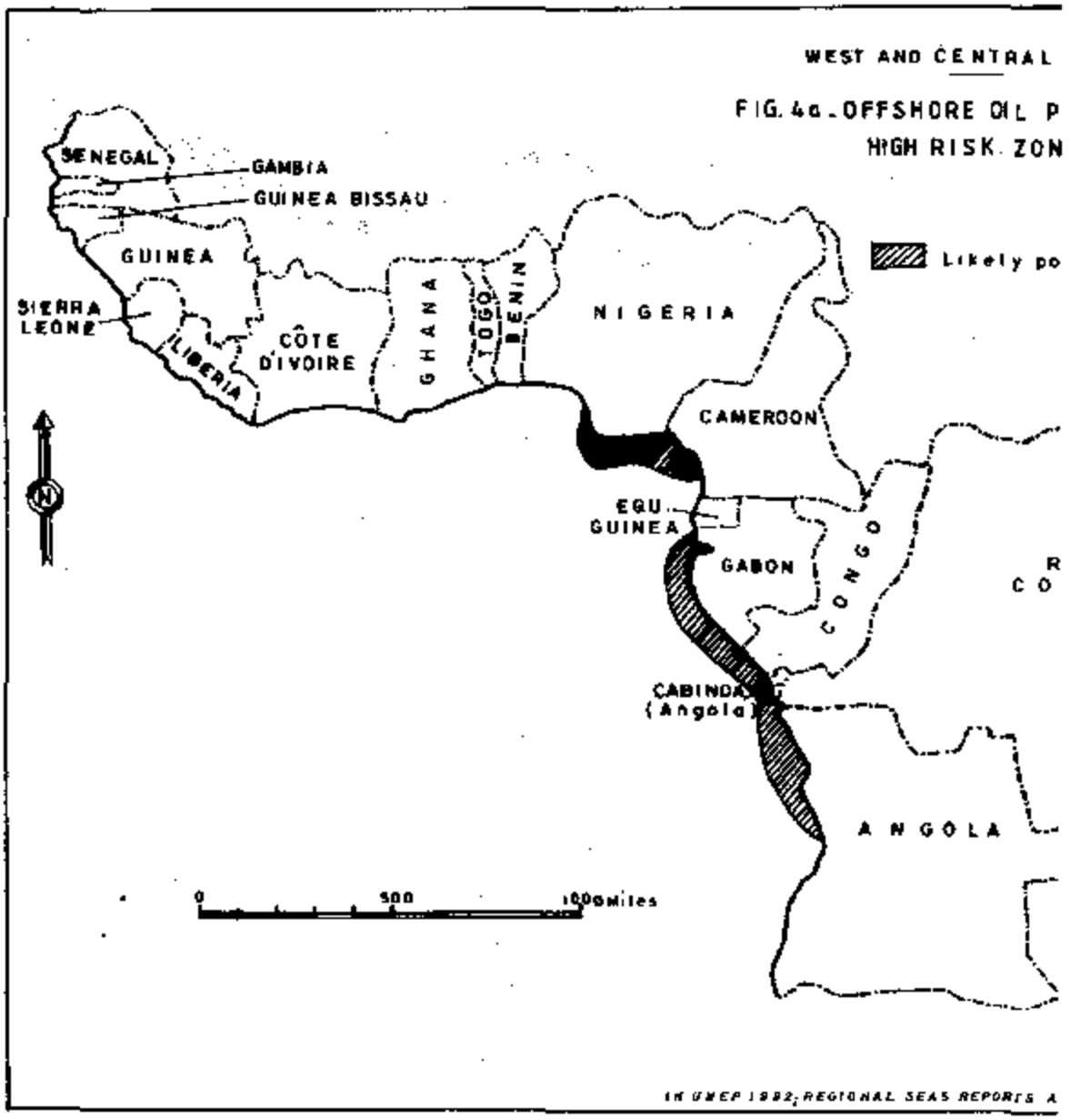


Offshore petroleum provinces

N°	BASIN	DEGREE OF EXPLORATION	PROSPECTS
1	SENEGAL BASIN	B	GOOD TO FAIR
2	BOVE BASIN	B	GOOD TO FAIR
3	SIERRA LEONE	B	GOOD TO FAIR
4	LIBERIA	B	GOOD TO FAIR
5	CÔTE D'IVOIRE	A	
6	BENIN	A	
7	NIGER DELTA (W. CAMER.)	A	
8	GABON BASIN	A	
9	CONGO BASIN	A	
10	CUANZA BASIN	A (off prod. on shore)	
11	MOCAMODES BASIN	C	FAIR
12	ORANGE RIVER BASIN	B	FAIR

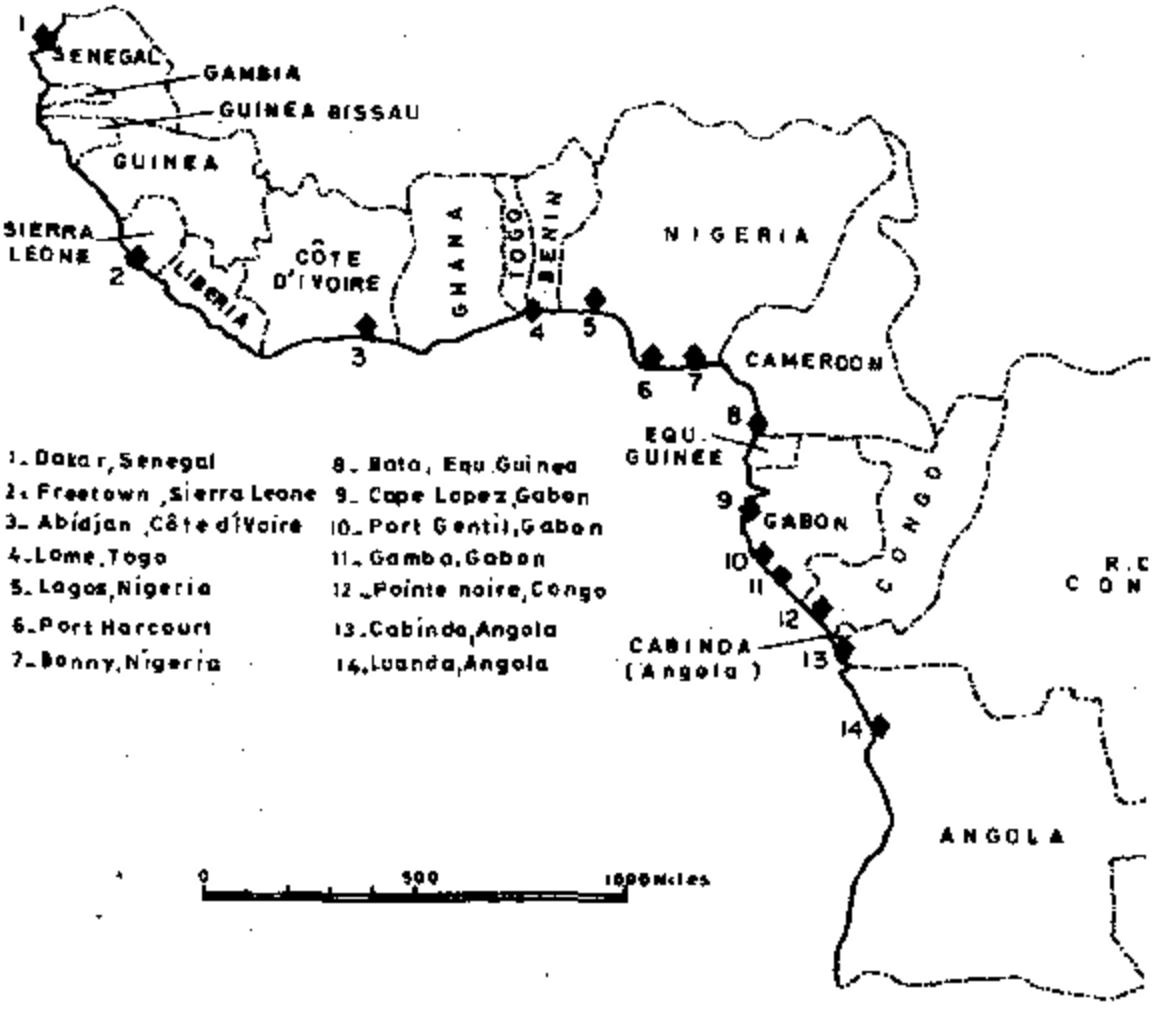
IN UNEP 1984, REGIONAL SEAS REP. AND STUDIES N°46

FIG. 3a. OFFSHORE PETROLEUM PROVINCES OF THE WACAF REGION (CHUKUMERIJE 1981)


WEST AND CENTRAL
FIG. 4a - OFFSHORE OIL P
HIGH RISK ZON
Likely po
SENEGAL
GAMBIA
GUINEA BISSAU
GUINEA
SIERRA LEONE
LIBERIA
CÔTE D'IVOIRE
GHANA
TOGO
BENIN
NIGERIA
CAMEROON
EQU. GUINEA
GABON
CONGO
CABINDA (Angola)
ANGOLA
0
500
1000 Miles
IN UNEP 1982; REGIONAL SEAS REPORTS A

WEST AND CE

FIG.5a. MAJOR TA



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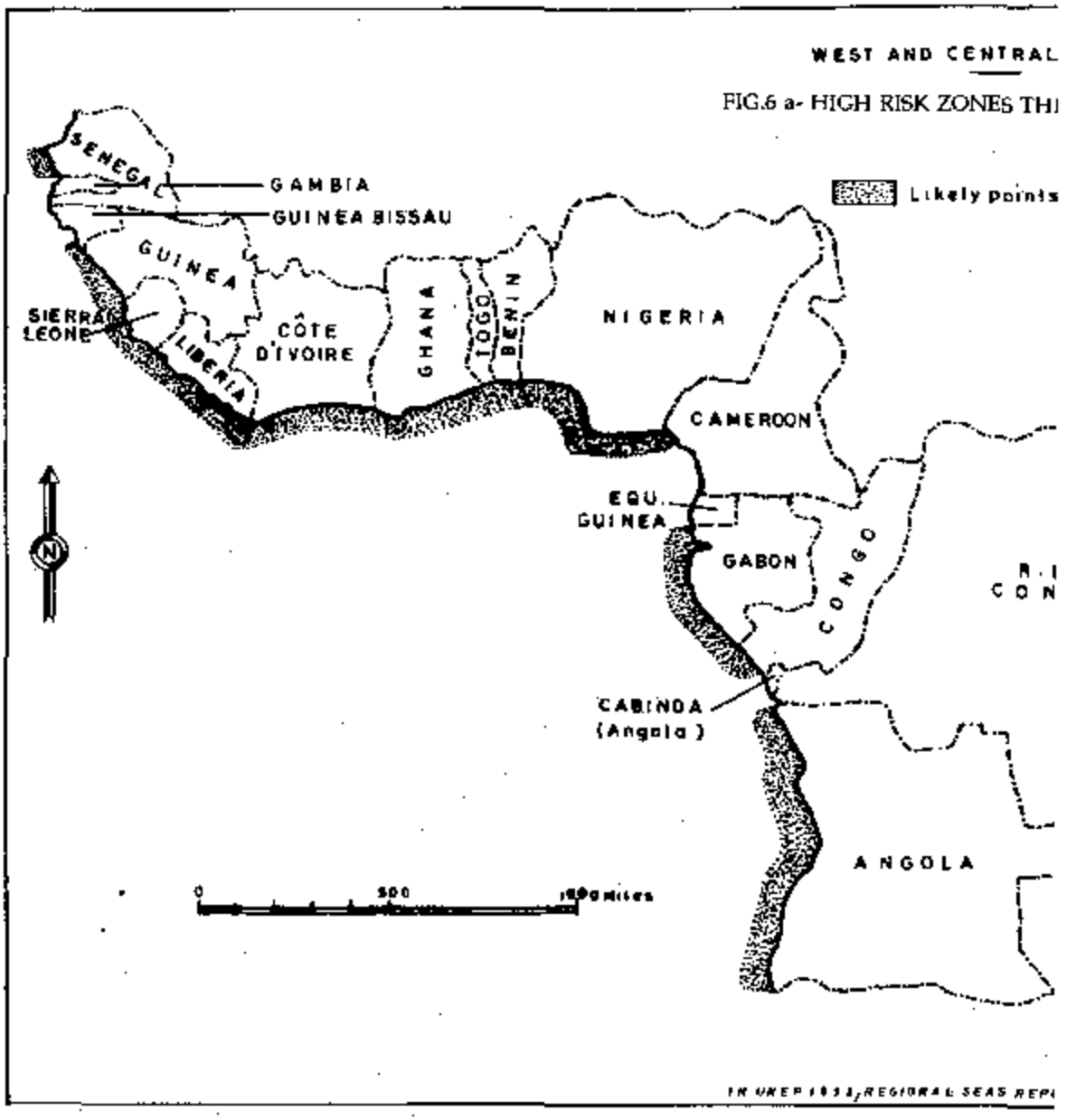
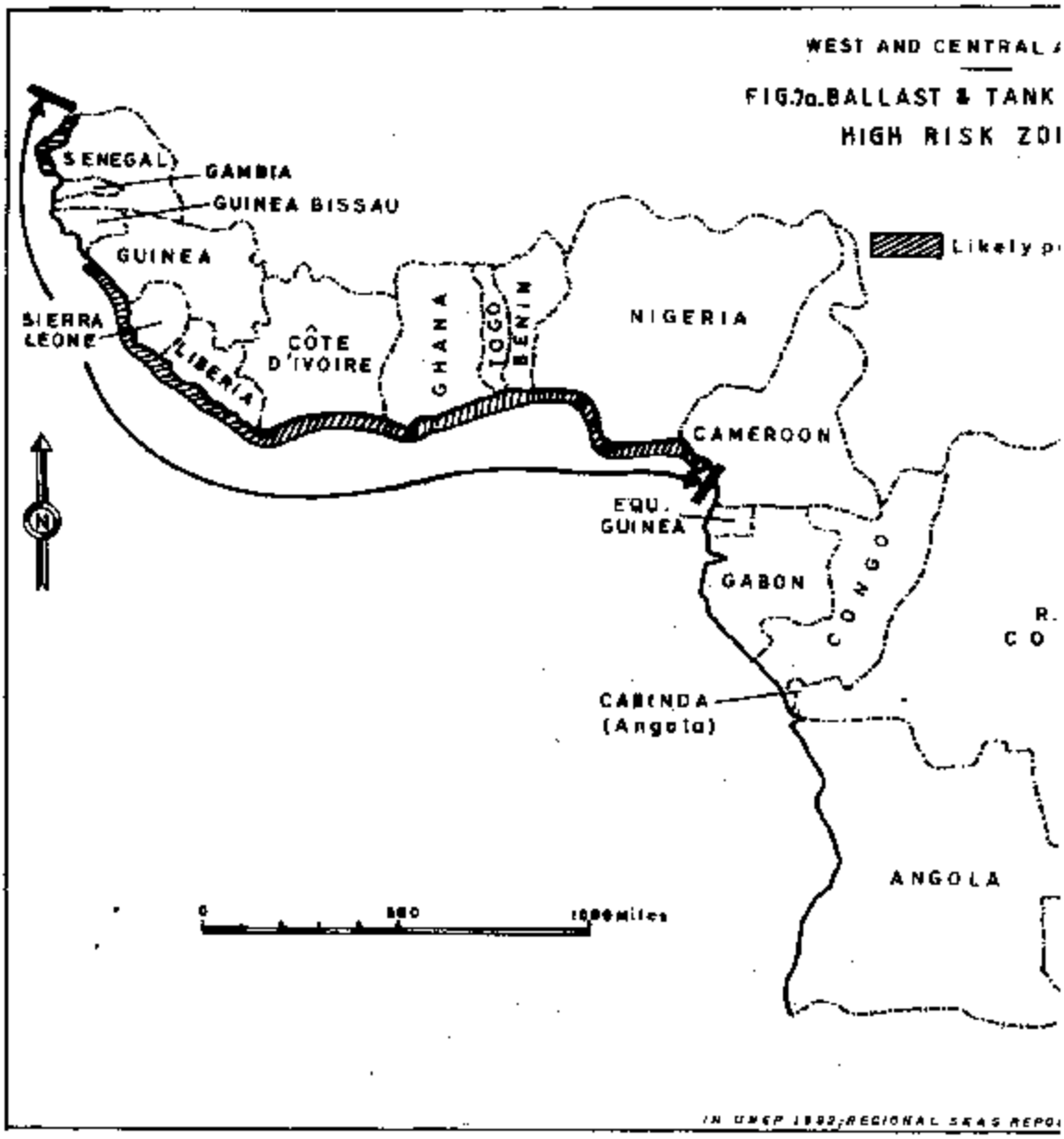

WEST AND CENTRAL
FIG.6 a- HIGH RISK ZONES THI
Likely points
SENEGAL
GAMBIA
GUINEA BISSAU
GUINEA
SIERRA LEONE
LIBERIA
CÔTE D'IVOIRE
GHANA
TOGO
BENIN
NIGERIA
CAMEROON
EQU. GUINEA
GABON
CONGO
CABINDA (Angola)
ANGOLA
N
0
500
1000 Miles
IN UNEP 1983 REGIONAL SEAS REPO


WEST AND CENTRAL A
FIG.7a.BALLAST & TANK
HIGH RISK ZOI
Likely p
SENEGAL
GAMBIA
GUINEA BISSAU
GUINEA
SIERRA LEONE
LIBERIA
CÔTE D'IVOIRE
GHANA
TOGO
BENIN
NIGERIA
CAMEROON
EQU. GUINEA
GABON
CONGO
R.
CO
CABINDA (Angola)
ANGOLA
N
0
500
1000 miles
IN UNEP 1992/REGIONAL SEAS REPO

ANNEX III

Acronyms

African Development Bank (ADB)
Biochemical Oxygen Demand (BOD)
Chemical Oxygen Demand (COD)
Economic Community of West African States (ECOWAS)
Environmental Impact Assessment (EIA)
Exclusive Economic Zone (EEZ)
Food and Agricultural Organization (FAO)
Integrated Coastal Management (ICM)
International Maritime Organization (IMO)
World Conservation Union(IUCN)
National Environmental Action Plan (NEAP)
Organization of African Unity (OAU)
Persistent Organic Pollutants (POPs)
Scientific and Technical Research Committee of OAU (STRC)
Total Suspended Sediments (TSS)
United Nations Development Programme (UNDP)
United Nations Cultural Organization (UNESCO)
United Nations Environment Programme (UNEP)
United Nations Industrial Development Organization (UNIDO)
West and Central African Region (WACAF)
World Wide Fund for Nature (WWF)