REGIONAL SEAS

UNITED NATIONS ENVIRONMENT PROGRAMME

The status of oil pollution and oil pollution control in the West and Central African Region

UNEP Regional Seas Reports and Studies No. 4

Prepared in co-operation with

INTER-GOVERNMENTAL MARITIME CONSULTATIVE ORGANIZATION

UNEP 1982

Note:

This document has been prepared jointly by the Inter-Governmental Maritime Consultative Organization (IMCO) and the United Nations Environment Programme (UNEP) under project FP/0503-79 17 as a contribution to the development of the Action Plan for the protection and development of the marine environment and coastal areas of the West and Central African Region.

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PREFACE

The Regional Seas Programme was initiated by UNEP in 1974. Since then the Governing Council of UNEP has repeatedly endorsed a regional approach to the control of marine pollution and the management of marine and coastal resources and has requested the development of regional action plans.

The Regional Seas Programme at present includes ten regions and has over 120 coastal States participating in it. It is conceived as an action-oriented programme having concern not only for the consequences but also for the causes of environmental degradation and encompassing a comprehensive approach to combating environmental problems through the management of marine and coastal areas. Each regional action plan is formulated according to the needs of the region as perceived by the Governments concerned. It is designed to link assessment of the quality of the marine environment and the causes of its deterioration with activities for the management and development of the marine and coastal environment. The action plans promote the parallel development of regional legal agreements and of action-oriented programme activities.

By Decision 88 (V). C of 25 May 1977, the Governing Council of UNEP requested the Executive Director to initiate the development of an action plan for the West and Central African Region.

After a preparatory process, which included a number of experts meetings, fact finding missions and in-depth studies on resources and environmental problems of the region, the Conference of Plenipotentiaries on Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region (Abidjan 16-23 March 1981) adopted:

- the Action Plan for the Protection and Development of the Marine Environment and Coastal Areas of the West and Central African Region;

- the Convention for the Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region; and

- the Protocol Concerning Co-operation in Combating Pollution in Cases of Emergency.

GE.82-00626

The Governments of the region also established a trust fund to support the activities called for in the Action Plan. UNEP was designated as the secretariat of the Action Plan and the Convention.

This report was prepared as a contribution to the development of the Action Plan for the West and Central African Region. One of its main objectives is to provide the Governments of the Region with an overview of the current status of oil production, transportation, pollution, and pollution control along the coasts of West and Central Africa.

The report is a synthesis of information and data available from governmental and industrial sources, in technical and popular publications, and from meetings and materials gathered during a fact-finding mission undertaken by four IMCO consultants in June-July 1980 to four primary oil-producing countries in West and Central Africa. Technical discussions and graphics have been augmented with general background information, as well as professional interpretations of the implications of oil production and pollution in West and Central Africa.

Thus, the report provides an information base on which can be built a technological understanding and an organizational structure for dealing with critical oil-related problems. It is intended to serve as a source document for projects whose focus is the development of effective programmes for assessing and dealing with oil pollution in the target area. Additionally, it is hoped the report will supply a useful input into assessments concerning the need to establish an oil spill control and response centre in the West and Central African Region.

The four IMCO consultants who prepared the report are Mr. R.W. Hann Jr., Mr. G. Massart, Mr. L. Cabaniols, and Mr. H.N. Young.

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The consultants and their associates are particularly indebted to the authors of previous reports referenced herein, which deal with the West and Central African region. They also are indebted to governmental and industrial officials and other personnel who provided assistance during a trip by the consultants to West and Central Africa.

In addition to funding provided by the United Nations Environment Programme through the Inter-Governmental Maritime Consultative Organization, this report has been supported by Texas A and M University, The National Center for the Exploitation of the Oceans (CNEXO), and the Port of Marseilles through participation of their staff members in this project.

SECTION I

INTRODUCTION

This report addresses the current status of oil production, transportation, pollution, and pollution control along the coast of West and Central Africa, from Senegal to Angola.

The text is a synthesis of information and data available from governmental and industrial sources, in technical and popular publications, and from meetings and materials gathered during a fact-finding trip by a mission in June-July 1980 to four primary oil-producing nations in West and Central Africa. Technical discussions and graphics have been augmented with general background information, as well as professional interpretations of the implications of oil production and pollution in this area.

Thus, the report provides an information base on which can be built a technological understanding and an organizational structure for dealing with critical oil-related problems. It is intended to serve as a source document for projects whose focus is the development of effective programmes for assessing and dealing with oil pollution in the target area. Additionally, it is hoped the report will supply a useful input into assessments concerning the need to establish an oil spill control and response centre in the West and Central African Region.

Of equal importance is the role this report plays in a larger, comprehensive action plan for the development and protection of the West and Central African Region.

Background

The West and Central African Region has been recognized by the Governing Council of the United Nations Environment Programme (UNEP)[1/] as a "concentration area" in which UNEP, in close collaboration with the relevant components of the United Nations system, will attempt to fulfill a catalytic role in assisting the developing States of the West and Central African Region to formulate and implement, in a consistent manner, a commonly agreed upon Action Plan.

Recognizing the complexity of the problem and being aware of numerous ongoing activities, numerous preparatory activities were undertaken to provide a sound basis for the adoption of the Action Plan for the Protection and Development of the Marine Environment and Coastal Areas of the West and Central African Region.

1/ Decision 88.C(v) of 25 May 1977.

At the IOC/FAO/WHO/UNEP International Workshop on Marine Pollution in the Gulf of Guinea and Adjacent Areas (Abidjan, 2-9 May 1978) petroleum hydrocarbons (mainly from maritime transport) were identified as a major source of marine pollution in the region. The report of the Workshop notes that:

> "Pollution by petroleum hydrocarbons is increasing in the coastal waters and on the beaches along the whole coast of the Gulf of Guinea and adjacent areas. Effects observed locally indicate that some damage is being done to the coastal ecosystems and fisheries resources. The origin of this pollution is primarily the heavy maritime transport of crude oil, and to a lesser extent the local exploration, exploitation and refinement of petroleum. The presently available information on the extent of this type of pollution is very fragmentary and inadequate. Therefore, a continuous surveillance of the trends in the pollution of beaches and coastal waters of the Gulf of Guinea and of the adjacent areas is recommended." 2/

Taking into account the recommendations of the Abidjan workshop the present report has been prepared under the joint sponsorship of IMCO and UNEP to provide useful background information on which co-operative activities for the control of oil pollution may be based.

The need for co-operation among geographically contiguous countries on such matters as marine pollution became evident a number of years ago as ocean-bounded nations found themselves unprepared for the increased incidence of oil and effluent along their shorelines. Many factors were conspiring to expose coastlines which had been relatively invulnerable or which were approaching tolerable limits to a full brunt and range of marine pollutants: commercial and industrial growth along the coast, increased maritime transit of the world's trade goods, and the initiation of new patterns and routes for water-borne trade, to name a few.

Oil in Africa

Africa is a relative newcomer to the petroleum industry. Twenty-five years ago her oil production was considered statistically insignificant, and not without reason: in 1958, no more than 0.5 percent of the total world production of 907 million tons was extracted from the continent.[6] The estimates of oil reserves were hardly more exciting, listed at 9.7 billion barrels in 1961.[7] Most early oil was pulled from Egyptian fields at Sudr and other places near the Gulf of Suez as they were the only fields of any importance in Africa. However, by the early 1960s, oil had been found in Algeria, Angola, Gabon, Nigeria, the Congo and Libya.

2/ Report of the IOC/FAO/WHO/UNEP International Workshop on Marine Pollution in the Gulf of Guinea and Adjacent Areas, Abidgan, 2-9 May 1978, pages 7 and 8.

The pattern of discoveries suggested the existence of an oil-bearing sedimentary area offshore, running nearly continuously along the western coast of the African continent, from the southern tip of Morocco to the southern tip of South Africa. Concurrent onshore exploration in West Africa was conducted primarily in swamp and river delta areas, since a non-oil bearing basement rock appeared to extend throughout the region right up to water's edge.[8] The overall success of these exploration and production operations is summarized in Table I-1, which cites the change in known crude oil reserves between 1961 and 1979, including world totals as a comparative index.

Comparative production ratios indicate that initially onshore sites were more vigorously exploited: in May 1970, Africa's offshore oil accounted for 550,000 barrels per day (b/d) compared to 760,000 b/d onshore.[9] However, these ratios today tend to vary with area and annual production, for a number of reasons: the greater number of known offshore sites; the economic advantages of having production nearby to terminals, ports, pipelines and refineries; and the expediency of avoiding internal communications and transportation in most of the countries involved.[10] These reasons help to explain why there currently is an almost solid block of offshore exploration and production operations stretching around the bulge of Africa. Combined with the consideration of how rapidly this all has happened, they also explain why the shape of Africa's oil map tends to be rather protean, depending on new strikes, production increases and the development of ancillary industries.

Throughout this report, statistics and discussions are presented which reiterate both the fortunate and unfortunate aspects of oil exploitation in West and Central African over the last 20 years. In discussing the current status of oil production and pollution, it is not inappropriate to mention some general reasons why petroleum from this region is in great demand and the effects this has had on West and Central Africa.

The Demand for Oil

There is not much mystery to West and Central Africa's meteoric rise in the world oil market. International regard and demand for petroleum as a whole has changed drastically in the last two decades, and not without Africa's input. It is not surprising that the rate of development in any of the new oil-bearing nations should have roughly paralleled the increased pressure for supply.

TABLE I-1

CRUDE OIL RESERVES OF THE WORLD

(Based on 1979 production)

	Bill. Barrels 1961	Bill. Barrels 1979	% Change 1961 to 1979	% Av. Annual Gain	% of Free World Total 1961	% of Free World Total 1979	Years Supply
Algeria	5.5	8.4	+ 52	2.4	2.0	1.5	21
Egypt	.7	3.1	+ 343	8.6	.3	.6	17
Libya	3.0	23.5	+ 683	12.1	1.1	4.3	31
Nigeria	.3	17.4	+ 5700	25.2	.1	3.1	21
Other Africa	.2	4.6	+ 2200	19.0	.1	.8	23
Total Africa	9.7	57.0	+ 488	10.3	3.6	10.3	24
Abu Dhabi	3.5	28.0	+ 700	12.2	1.3	4.4	52
Iran	35.0	58.0	+ 66	2.8	12.9	10.6	51
Iraq	26.5	31.0	+ 13	.7	9.8	5.6	25
Kuwait	62.0	65.4	+ 5	.3	22.8	11.9	81
Neutral Zone	6.0	6.3	+ 5	.3	2.2	1.1	30
Oman	nil	2.4	n/a	n/a	---	.4	22
Qatar	2.3	3.8	+ 65	2.8	.9	.7	21
Saudi Arabia	52.0	163.3	+ 214	6.6	19.2	30.1	48
Other Mid-East	.8	3.8	+ 375	9.0	.3	.7	15
Total Mid-East	188.1	362.0	+ 92	3.7	69.4	65.5	46
United States	31.8	27.1	- 15	none	11.7	4.9	9
Canada	4.2	6.8	+ 62	2.7	1.6	1.2	14
Mexico	2.5	31.2	+ 1148	15.0	.9	5.7	59
Venezuela	17.6	17.9	+ 2	.1	6.5	3.3	21
Other W. Hemisphere	4.6	7.4	+ 61	2.6	1.7	1.3	14
Total W. Hemis.	60.7	90.4	+ 49	2.3	22.4	16.4	17
Australia	nil	2.1	n/a	n/a	---	.4	13
Indonesia	9.5	9.6	+ 1	.1	3.5	1.7	17
Other Asia	1.4	7.6	+ 443	9.9	.5	1.4	25
Total Asia	10.9	19.3	+ 77	3.2	4.0	3.5	19
Western Europe	1.7	23.8	+ 1300	15.8	.6	4.3	29
Total Free World	271.1	552.5	+ 104	4.0	100.0	100.0	32
Communist Nations	34.3	90.0	+ 162	5.5	---	---	17
World Total	305.4	642.5	+ 110	4.2	---	---	28

SOURCE: Petroleum Outlook Vol. 33, No. 6 (June 1980): 42. This work cites the Oil & Gas Journal (no date), API and others.

Oil has become a strategic commodity because of its critical role in the maintenance of industrialized economies. Because reserves tend to be concentrated in a few areas of the world, it has become especially strategic for some industrialized areas - Western Europe and Japan, for example - which consume more petroleum than they produce. That fluctuations in the supply or cost of supply can have resounding effects worldwide has been seen in the recent changing emphasis on levels of consumption and the development of alternative energy sources in countries which rely substantially on foreign imports. In addition, oil is a non-renewable resource, and, in most present uses, it is irreplaceable. Previously-dismissed efforts to reclaim or reprocess petroleum lost during spills or industrial use now are attempted not only because of economics - oil is too costly to waste - but also because of prudence - oil is too precious to waste.

Besides the fact that the region has sizeable reserves, there are two particular reasons why West and Central African oil is of special interest to the rest of the world. Most resources have proven to be a high-quality light crude which gives greater gasoline yield after basic refining, and the low sulphur content is preferable to many countries faced with increasingly stringent environmental standards.

In addition, West and Central Africa's location relative to primary buyers is favourable. Prior to 1967, the bulk of the world's crude oil traffic passed through the Suez Canal on a 5,500-mile trek to Europe. Closure of that inland waterway necessitated an 11,300-mile trip around the Cape of Good Hope, compared to much shorter jaunts from West Africa, where new producers were looking for ready markets. Given the cost of shipping petroleum by sea - about $1.00 per barrel[11] - the savings through shorter shipping distances should not be discounted in analysing the value of West and Central Africa's oil supplies.

What also should not be discounted is the significant difference between oil production and oil consumption in West and Central Africa, as indicated in Table I-2. The exportable surplus has enabled nations to strengthen domestic economies and to diversify away from the few cash crops and minerals which traditionally have provided support. For West and Central Africans, oil is a source of hard currency as well as a source of raw materials and new forms of energy.

However, despite the influx of new capital and the rapidity of concomitant development, West and Central Africa is still dealing with many basic and essential

TABLE I-2

WORLDWIDE PETROLEUM PRODUCTION AND DEMAND FOR 1978

(thousands of barrels per day)

	Production	Demand	Production-Demand Ratio
NORTH AMERICA, TOTAL	**13,053**	**21,219**	**0.62**
Canada	1,578(2)	1,725	0.91
Mexico	1,207	787	1.53
United States	10,268(2)	18,707	0.55
SOUTH AMERICA, TOTAL	**3,548**	**3,621**	**0.98**
Argentina	452	529	0.85
Brazil	160	1,056	0.15
Colombia	131	(3)	...
Trinidad and Tobago	232	(3)	...
Venezuela	2,166	275	7.88
Other South America	407	1,761	0.23
WESTERN EUROPE, TOTAL	**1,762**	**13,968**	**0.13**
France	20	2,330	0.01
Germany, West	102	2,852	0.04
Italy	27	1,969	0.01
Netherlands	30	762	0.04
Norway	356	173	2.06
United Kingdom	1,082	1,896	0.57
Other Western Europe	145	3,986	0.04
AFRICA, TOTAL	**6,120**	**1,294**	**4.72**
Algeria	1,225	107	11.45
Egypt	464	156	2.97
Libya	1,993	70	28.47
Nigeria	1,910	121	15.78
Other Africa	528	840	0.63
MIDDLE EAST, TOTAL	**21,602**	**1,713**	**12.61**
Iran	5,207	530	9.82
Iraq	2,629	124	21.20
Kuwait	1,865	157	11.88
Saudi Arabia	8,530	412	20.70
Other Middle East	3,371	490	6.88
FAR EAST AND OCEANIA, TOTAL	**2,842**	**8,568**	**0.33**
Australia and New Zealand	445	720	0.62
Brunei and Malaysia (1)	455	(3)	...
India	254	550	0.46
Indonesia	1,637	305	5.37
Japan	11	5,055	0.00
Other Far East and Oceania	40	1,938	0.02
SINO-SOVIET COUNTRIES	**13,600**	**12,350**	**1.10**
China	2,005	(3)	...
Cuba	2	(3)	...
U.S.S.R.	11,215	8,450	1.33
Eastern Europe (excluding U.S.S.R.)	378	(3)	...
Other Sino-Soviet	...	3,900	...
TOTAL WORLD	**62,527**	**62,733**	**1.00**

(1) Includes Singapore.
(2) Includes natural gas liquid production.
(3) Data not available.

SOURCE: Twentieth Century Petroleum Statistics 1979 (Dallas: DeGolyer and MacNaughton, 1979), p. 2. This source cites the U.S. Dept. of Energy, "Statistics Canada", "World Oil", and "Oil & Energy Trends".

problems, which naturally affects priorities. In the matter of oil, several production-related concerns have received primary attention: the fact that domestic consumption is far lower than production, thus obliging industries to orient themselves to foreign markets; the need to expand refining capabilities, since most exported oil now leaves West and Central Africa as crude; and the need to develop ancillary, petroleum-consuming industries.

It is not surprising, then, that the issue of oil pollution should not appear first on a list of priorities, although with forethought and careful planning, many pollution problems can be averted. It is the aim of this report to provide information about the conditions in West and Central Africa which give rise to oil pollution and the approaches a nation can take to prevent it. To present this information, the report is divided into seven sections, including this chapter, an introduction.

Section II provides basic geographic, geologic, oceanographic and meteorologic data about the West and Central Africa region, thus supplying a foundation for subsequent statements about the causes of oil pollution.

Section III presents data on coastal and offshore oil production in the area, as well as information about major coastal refinery systems. It also discusses pollution resulting from these two activities and gives an analysis of the probability of a major spill due to production within West and Central Africa.

Section IV describes crude oil and by-product transportation throughout West and Central Africa, with ports and tanker routes graphically represented. The known or projected oil pollution resulting from tank washings, bilge pumpings or other chronic causes are discussed, as are past or potential accidental spills from transportation-related activities.

Section V deals with the potential impact of an oil spill on the environment and the economy of West and Central African countries. Specific regional environmental systems are presented to permit extrapolation of oil clean-up problems or ramifications.

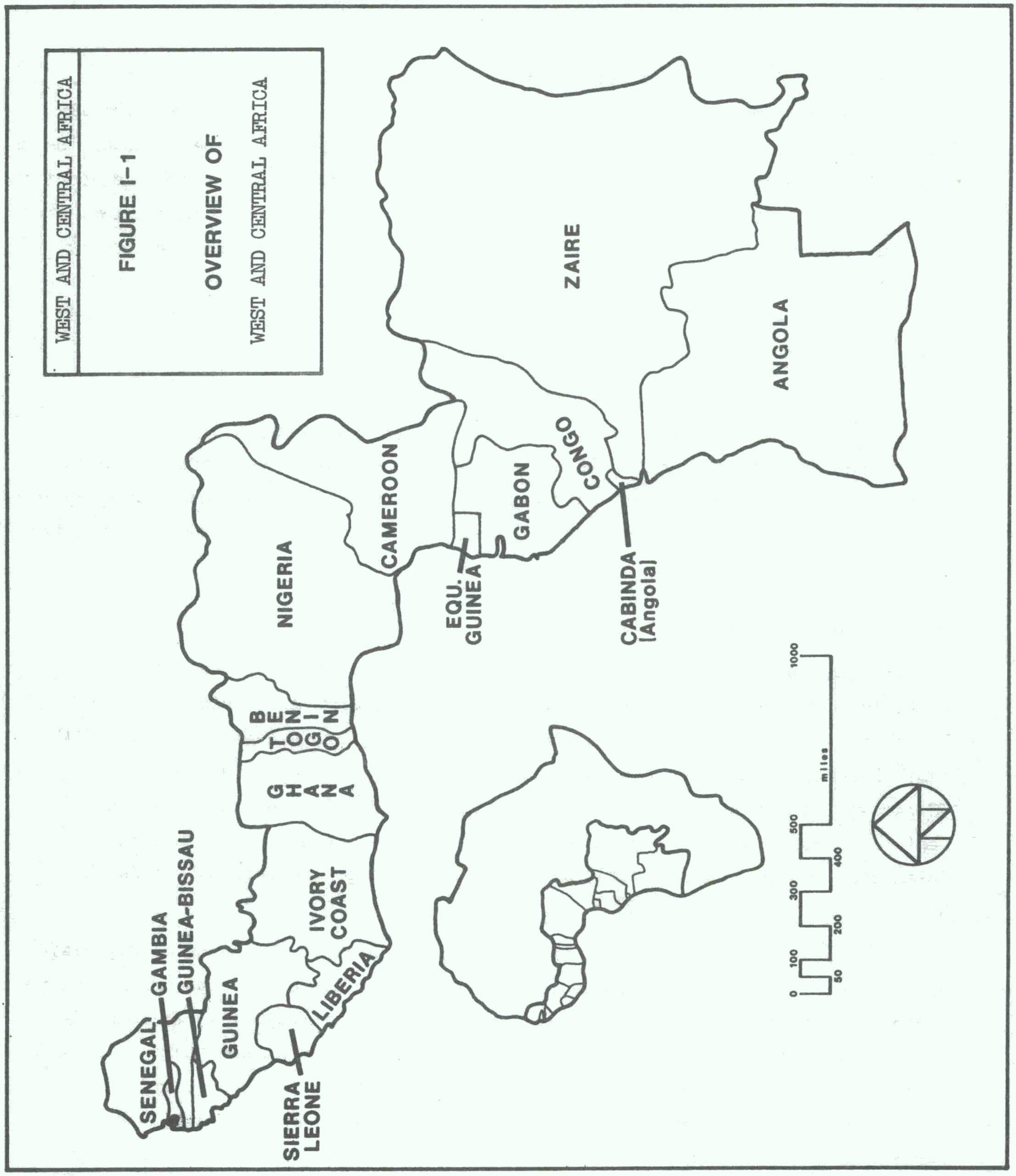
Section VI describes the administrative and legal tools currently used for the control of oil pollution on the international, national and local levels. Existing pollution problems and response capabilities are discussed on a country-by-country basis, concluding with an analytical overview.

Section VII concludes the report with suggestions regarding governmental and intergovernmental protection and control of oil pollution in West and Central Africa.

Additional pertinent information has been included in two appendices at the end of the report.

Appendix 1 provides a series of profiles about oil production within each country, including notes on production levels, historic perspective and current statistics. Charts comparing African oil and natural gas figures to international figures also are included. Appendix 2 provides conversion charts which interrelate weights and units for oil shipment in both English and metric values.

Subsequent references to "West and Central Africa" refer to nations on the western coast of the continent from Senegal to Angola. The nations within this region are shown in Figure I-1.



WEST AND CENTRAL AFRICA

FIGURE I-1

OVERVIEW OF
WEST AND CENTRAL AFRICA

SECTION II

ENVIRONMENTAL PARAMETERS IN OIL POLLUTION

In addition to having access to the benefits of oil production - that is, new sources of currency, energy, raw materials and influence - Africa naturally has inherited some of the less attractive aspects, oil pollution being among the foremost. Subsequent sections of this report present data and discussions about how oil pollution can or has occurred in the region, but to apply this information, it is necessary to understand: (a) the environmental elements which generally influence the dispersion and containment of petroleum in the ocean and its impact on coastal systems; and (b) specific environmental conditions as they exist in the countries in the West and Central African Region.

The following pages deal with the general oceanographic, meteorologic and topographic conditions that conspire to affect oil pollution, and with their appearance in West and Central Africa. However, because this report covers such an extensive and diverse area, only general remarks will be made about geographic and geologic features. A discussion of biologic and economic systems which enter into the matter is presented in Section V.

Geologic and Geographic Features

Stretching along 4,500 miles of Atlantic Ocean shoreline, the west coast of Africa embodies 17 countries between Senegal and Angola, within latitudes 16° north to 18° south. Lying south of the great Sahara Desert and north of the Namib Desert, it includes over one-fifth of the African land mass and about 30 percent of her people. The Gulf of Guinea is tucked along the southern and western coasts of Ghana, Togo, Benin, Nigeria, Cameroon and Gabon, and the islands of Macias Nguema Biyogo, São Tomé and Príncipe are located within the Gulf.

The more northern countries of the region - those as far south as Nigeria - are part of Africa's Basement Complex, with outcroppings of igneous and metamorphic rocks in most areas. These rocks have been worn down through time to form plateau surfaces between 180 m. to 490 m. (600 to 1,600 ft.) in altitude and are limited by edges along which erosion is active and rivers fall. Material carried away during major erosion cycles was deposited in fringing seas and gulfs; these sediments were uplifted and now cover, in varying thicknesses, about one-half of West Africa's Basement Complex. Found within the sandstone deposits of the

Secondary and Mesozoic Age ($\pm$ 160 million years B.P. [before present]) and later periods are the rich oil reserves around Nigeria.

Several climatic zones characterize the more northern areas of the West African coast: (a) an Equatorial climatic region in Cameroon and southern Nigeria, where rain falls all year, and temperatures and humidity are always high; (b) a West Tropical region along the Ghana to Guinea coast, which has heavy but seasonal rainfall, alternating with a dry season; (c) a Coastal climatic zone in eastern Ghana to Benin, where the rainfall is low but the air is humid; and (d) a Tropical climatic region in the northwestern fringes, where dry and rainy seasons alternate.

A natural barrier - volcanic highlands between Nigeria and Cameroon - divide the West African coastal countries, causing a different geography between the two regions. Countries that lie south of the Cameroon and Bamenda Highlands form the western edge of the East Africa Rift Valley; their interior lands fall within the great Congo Basin, formed by the deposition of rocky erosion from surrounding plateaux and subsequent subsidence. The southwestern fringes of the region are southern hemispheric desert while northern hemispheric desert is found at the opposite end of the region. The climatic range between Cameroon and Angola is both Equatorial and Tropical, and this diversity also is seen in vegetation, local climates and local topography.

Three major soil types are found within these coastal countries. The predominant are Latosolic soils of equatorial and savannah regions, which are poor, acid and lacking in mineral nutrients. In addition, pockets of Lateritic soils with essentially the same characteristics are found. Red Loams are seen in the southern tropical areas; these are fairly fertile.

River systems throughout West and Central Africa are extensive and complex. The flows of these systems affect pollution control activities along their banks, and their discharges influence offshore transport of spilled oil. Charts usually are available to show monthly outflow of major rivers into surrounding seas; such data is pertinent in delineating both the areas and times of year when water discharge would be a factor in determining whether oil will impact a coastline.

Oil and the Environment

To recognize how local environmental factors might interact with a mass of oil floating freely at sea, it is useful to understand the dispersion process that normally characterizes a slick. A brief discussion of this follows.

When petroleum or petroleum products are released into the ocean, weathering processes immediately begin to alter their nature and to influence their spread. The former occurs because of chemical and physical properties of the oil; the latter is a result of air-sea dynamics, which include the force and direction of winds and currents, the severity of swells and waves, and the temperature of the sea and the air. The varying flows of major ocean currents, pushed by major air movements such as trade winds, of course will influence the direction or long-range movement of spills. These factors together are used to determine the speed at which a slick will move: the speed can be estimated by geometrically adding the current speed and 3.5 percent of the wind speed. In addition, immediate local effects such as sea conditions or ambient temperature can influence the rate at which natural dispersion action takes place.

As noted in a National Academy of Sciences report on petroleum in the marine environment[12], the fate of oil at sea occurs in several stages. Initially, the fluid spill spreads rapidly because of gravitational and surface chemical effects. While the density and viscosity of the spilled petroleum are factors here, surface constituents generally cause the spill to spread into extremely thin layers which may be monomolecular at the outer edges of the slick. Thus surface-to-volume ratio of the spill is increased, and a greater exposure to the effects of wind, current, wave and sunlight action results.

At this point, evaporation is a predominant means of dispersion, and as much as 50 percent of the hydrocarbons in an average crude oil can be removed from the ocean's surface by this process.[13] If the spill occurs in the open sea, evaporation could be complete before the material reaches a shoreline. Rough seas tend to increase evaporation rates, since wave-produced sea spray and bursting bubbles eject both volatile and non-volatile components together into the marine atmosphere. Transfer into the atmosphere will depend on wind speed, sea state, and the extent to which wave-breaking and whitecap formation are suppressed by oil films. Fall-out of this oily mist usually returns to the sea downwind from and outside of the main body of the spill. If the slick is occurring in coastal waters, it may fall out on nearby land.

The most important means of dispersion is the formation of emulsions, which may be influenced by naturally-occurring surfactants in the petroleum or by dispersants added to control the spilled oil. Oil-in-water emulsions are spread easily by currents and turbulence at the surface, particularly in rough seas. Studies indicate that the eventual fate of these fine particles of oil is dissolution in the water column or association with solid particulate matter or detritus, with eventual biodegradation or incorporation into sediments.

Water-in-oil emulsions also can form from most crudes, residual oils, and tank washing residues. These tend to be thicker and more viscous than the original crude and often are referred to as "chocolate mousse". They are attributed as the source of beach tar.

Further reduction of the slick now is assumed by photochemical and biological degradation. More soluble compounds, spread into thin layers initially, will dissolve into the underlying water, although dissolution is slow for most of the compounds in petroleum.

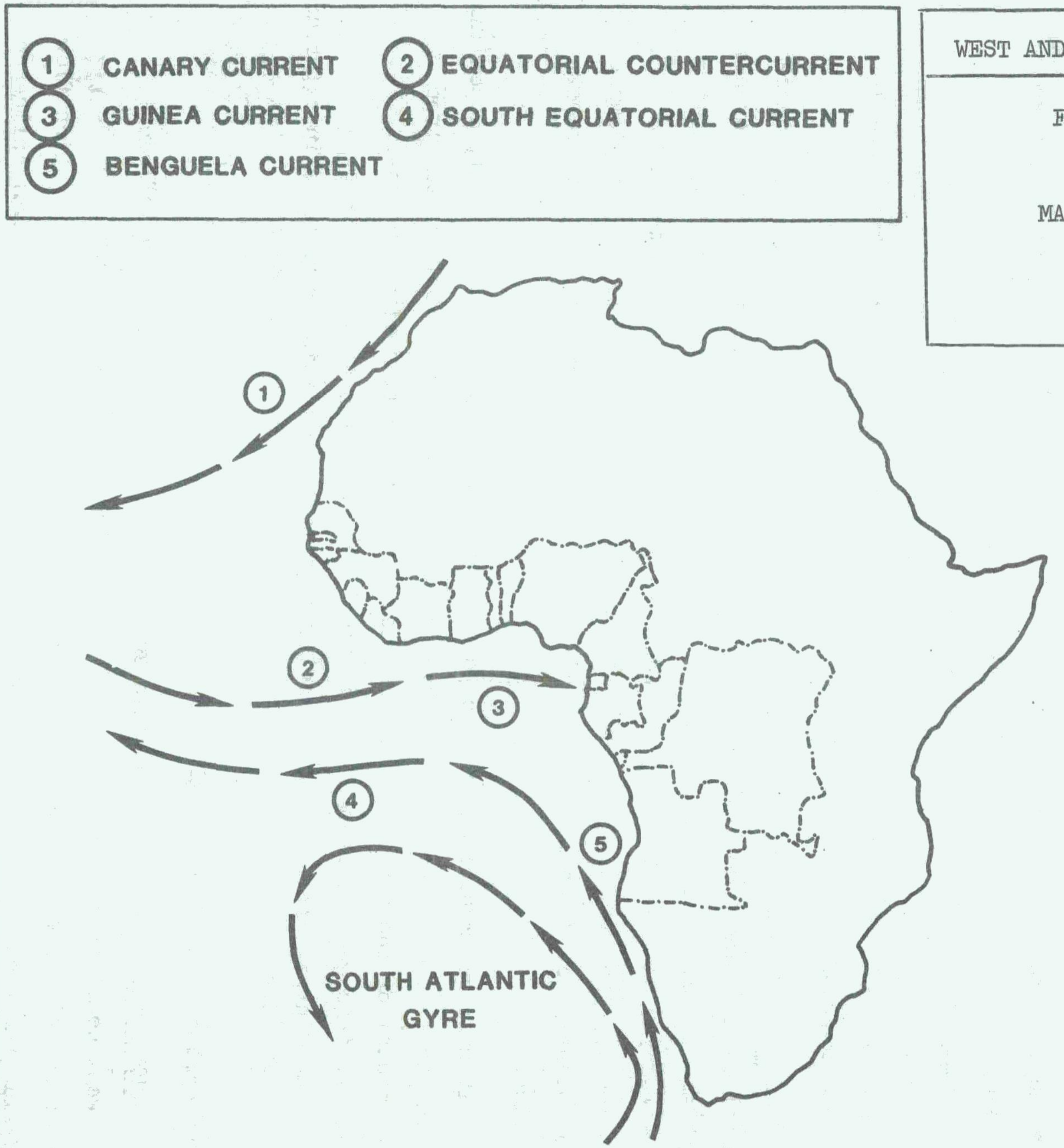
The lighter components of the oil thus removed by evaporation and dissolution, the remainder will polymerize and oxidize to form a variety of viscous, tarry, semi-solid or solid residual products. Further degradation, weathering and interaction with the environment is extremely slow since the surface-to-volume ratio of unspread tar is small, and most dispersive reactions occur at interfaces. Microbial degradation becomes important as populations of hydrocarbon-adapted bacteria develop.

Oil slicks bound for a coastline may be carried ashore by local tidal currents, normal oceanographic conditions such as breaking waves, or unusual weather events such as storms. Their dispersion along the shoreline and their ultimate impact rest heavily on the topography of the immediate area (discussed in detail in Section 5), the amount of wave-washing or tidal flooding that occurs, the temperature and intensity of the sun's heat, and, of course, the efforts of people to remove residue.

It must be emphasized at this point that each pollution is different, depending on the type of oil, the oceanographic and meteorologic circumstances, the type of accident or incident, the time of year, and the location along the coast. However, this general sketch should permit the following specific data about West and Central African coastal environments to be put into perspective in reference to oil pollution.

Oceanographic and Meteorologic Features

CURRENTS. A number of oceanic currents directly or indirectly influence the west coast of Africa. Those which flow directly along the coast are the Benguela and Guinea Currents and the Equatorial Countercurrent. Those which flow outside the West and Central African region but which nonetheless might influence the direction and flow of an oil spill are the Canary and South Atlantic Equatorial Currents. The locations and directions of these moving masses of water are shown in Figure II-1.



WEST AND CENTRAL AFRICA

FIGURE II-1

MAJOR SURFACE CURRENTS

Bearing south-southwest from around Gibraltar, the Canary Current brings cold water as far south as Cape Verde before being deflected seaward into the North Atlantic Equatorial Current. It causes fog and cool temperatures along the northern West African coast and influences the species of fish available to local fishermen. The mean speed of these two currents, which are very sensitive to prevailing winds, is about 0.5 to 1.0 knots.

Their counterparts in the Southern Hemisphere are the Benguela and South Atlantic Equatorial Currents. Cold water from the former cools sea and air temperatures and causes dry weather by restricting convection conditions. Flowing northwesterly from Angola to Cameroon at an average 0.5 knots, the Benguela Current ultimately veers seaward toward the westerly-moving South Atlantic Equatorial Current, where water masses increase in speed to 1.0 to 2.0 knots.

The Guinea Current flows at 1.0 to 3.0 knots between the shore and the South Atlantic Equatorial Current in a southeasterly direction, bringing warm water to countries between Liberia and Cameroon. The convergence in the Gulf of Guinea of the various west coast flows creates a turbulence and eddying effect which is called the Equatorial Countercurrent. During the summer, the countercurrent is vigorous, with speeds of 1.0 to 1.7 knots; during winter months, the flow rate diminishes to 0.7 to 1.1 knots. Figures II-2 to II-5 show average current speeds in knots during three-month intervals.

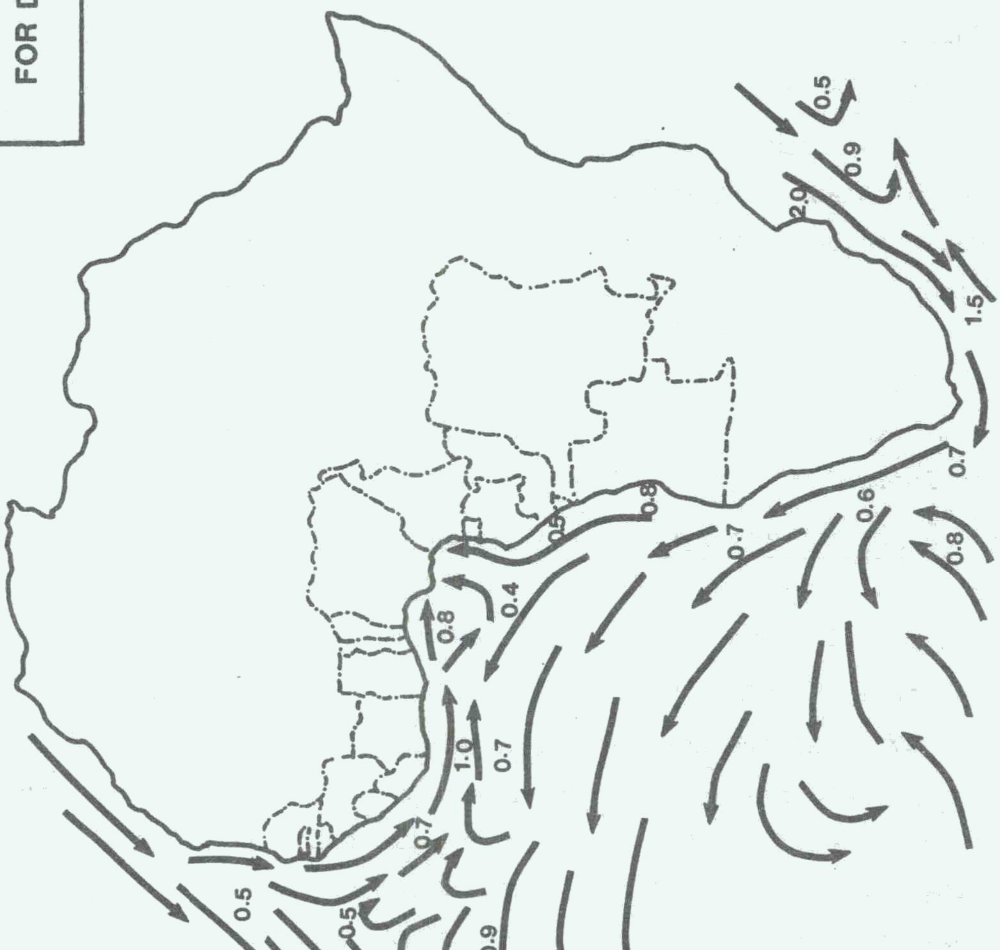
SEA SURFACE WINDS. The direction and velocity of winds moving across the surface of the sea influence the movement of currents and the height of waves. The relationship between these factors is summarized in Table II-1 and can be extrapolated as effects on the spreading or evaporation of an oil spill.

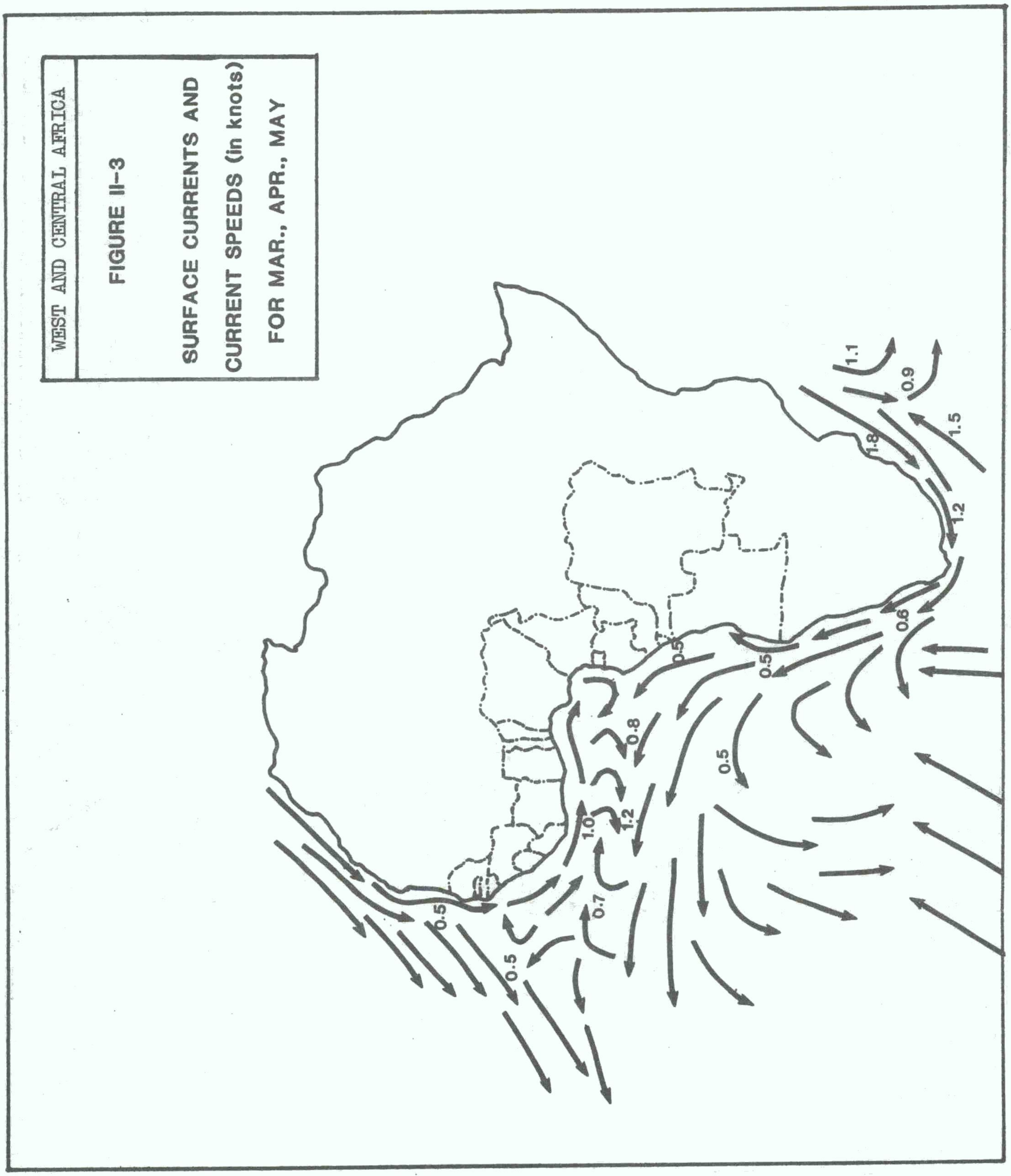
West Africa has several major wind and front systems, depending on local topographic features, although the prevailing trends are out of the northeast or southwest. This is true of the two seasonal winds along the coast. Wind rose diagrams, showing relative wind direction and speed frequency for the northern portion of the region over three-month intervals, are presented in Figures II-6 and II-7.

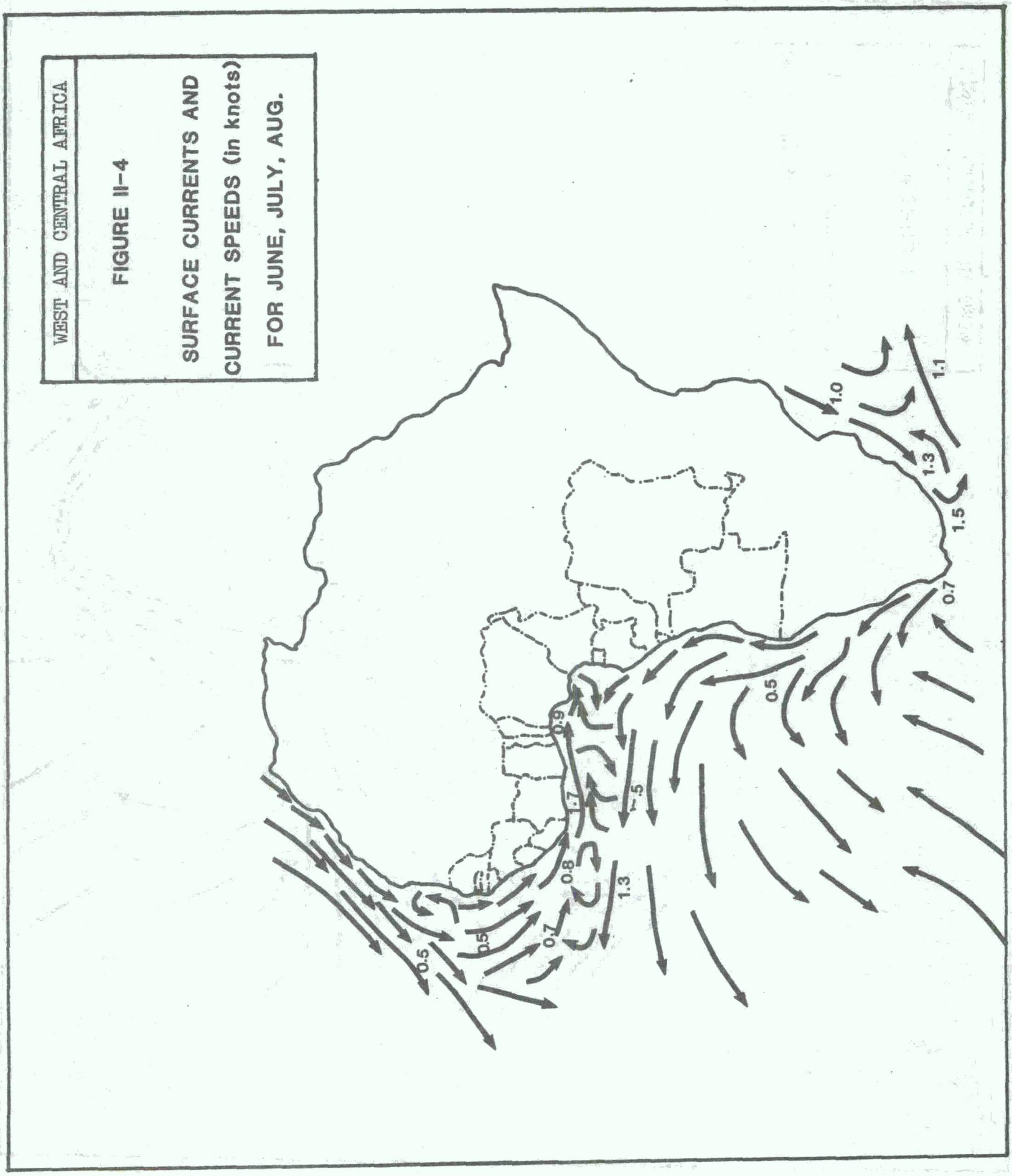
WEST AND CENTRAL AFRICA

FIGURE II-2

SURFACE CURRENTS AND CURRENT SPEEDS (in knots) FOR DEC., JAN., FEB.



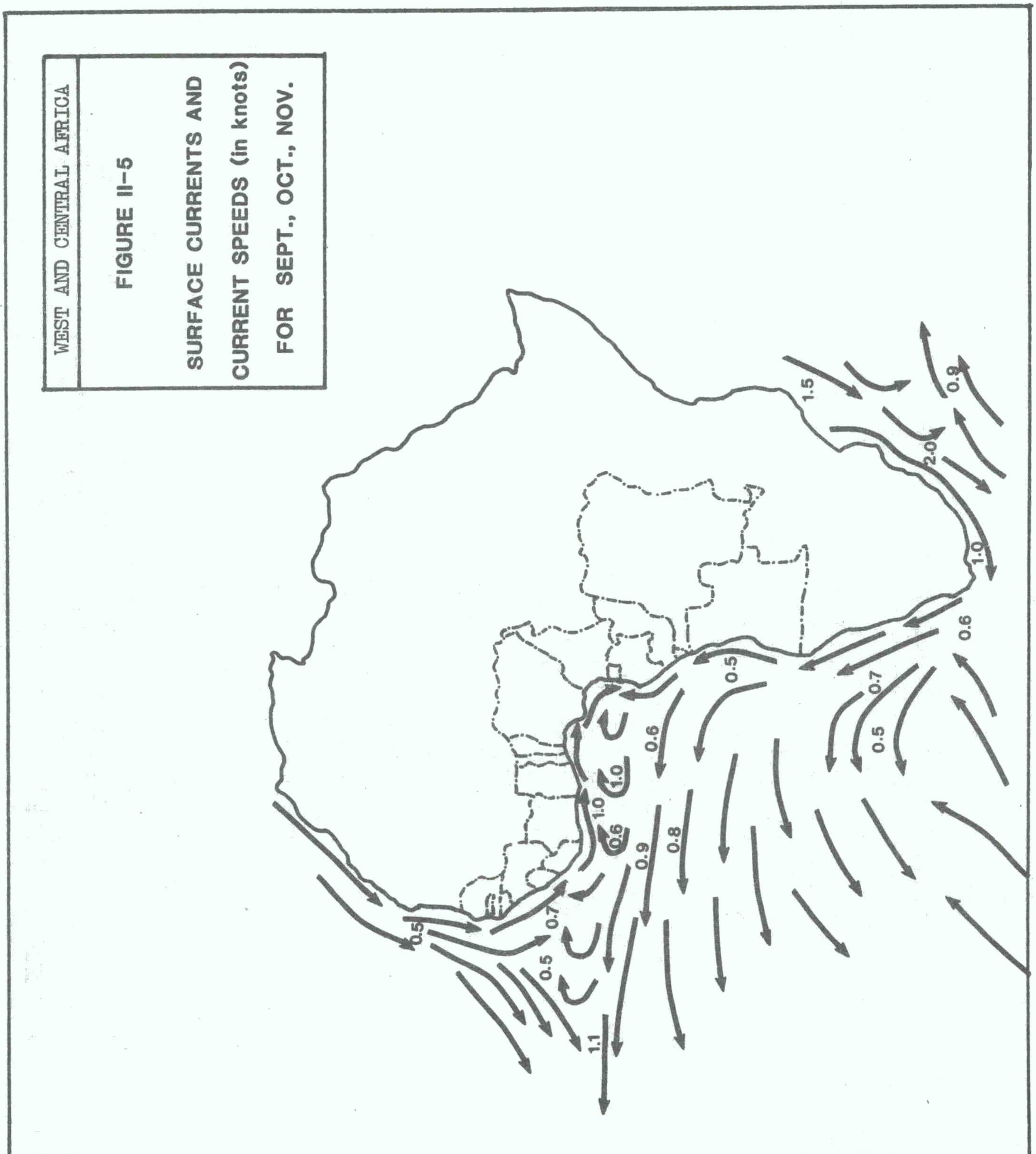

WEST AND CENTRAL AFRICA
FIGURE II-3
SURFACE CURRENTS AND CURRENT SPEEDS (in knots) FOR MAR., APR., MAY
1.1
0.9
1.5
1.8
1.2
0.6
0.5
0.5
0.5
0.8
0.5
1.0
1.2
0.7
0.5
0.5



WEST AND CENTRAL AFRICA

FIGURE II-4

SURFACE CURRENTS AND CURRENT SPEEDS (in knots) FOR JUNE, JULY, AUG.



WEST AND CENTRAL AFRICA

FIGURE II-5

SURFACE CURRENTS AND CURRENT SPEEDS (in knots) FOR SEPT., OCT., NOV.

TABLE II-1: WIND SCALES AND SEA DESCRIPTIONS

Beaufort Scales	Velocity in knots	meters/ seconds	Description	Wave Ht. in feet	Meters	State of Sea Code
1	1-3	0.6	Light air; ripples - no foam crests.	0	0	0
2	5	1.5	Lt. breeze; small wavelets, crests have glassy appearance and do not break.	0-1	0-0.3	1
3	10	3.1	Gentle breeze; large wavelets, crests begin to break. Scattered whitecaps.	1-2	0.3-0.6	2
4	15	4.6	Moderate breeze; small waves becoming longer. Frequent whitecaps.	2-4	0.6-1.2	3
5	20	6.1	Fresh breeze; moderate waves taking a more pronounced long form; mainly whitecaps, some spray.	4-8	1.2-2.4	4
6	25	7.7	Strong breeze; large waves begin to form extensive whitecaps everywhere, some spray.	8-13	2.4-4.0	5
7	30	9.0	Moderate gale; sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind	13-16	4-5	5 1/2
8	40	12	Fresh gale; edges of crests break into spindrift. Foam is blown in well-marked streaks along direction of the wind	16-18	5-6	6
9	45		High waves, sea begins to roll; dense streaks to foam; spray reduces visibility	18-20		6 1/2
10	50	15	Whole gale. Sea surface is white. Rolling of the sea is heavy	20-30	6-9	7

SOURCE: Seadock Environmental Report (Houston: Seadock, Inc., 1974).

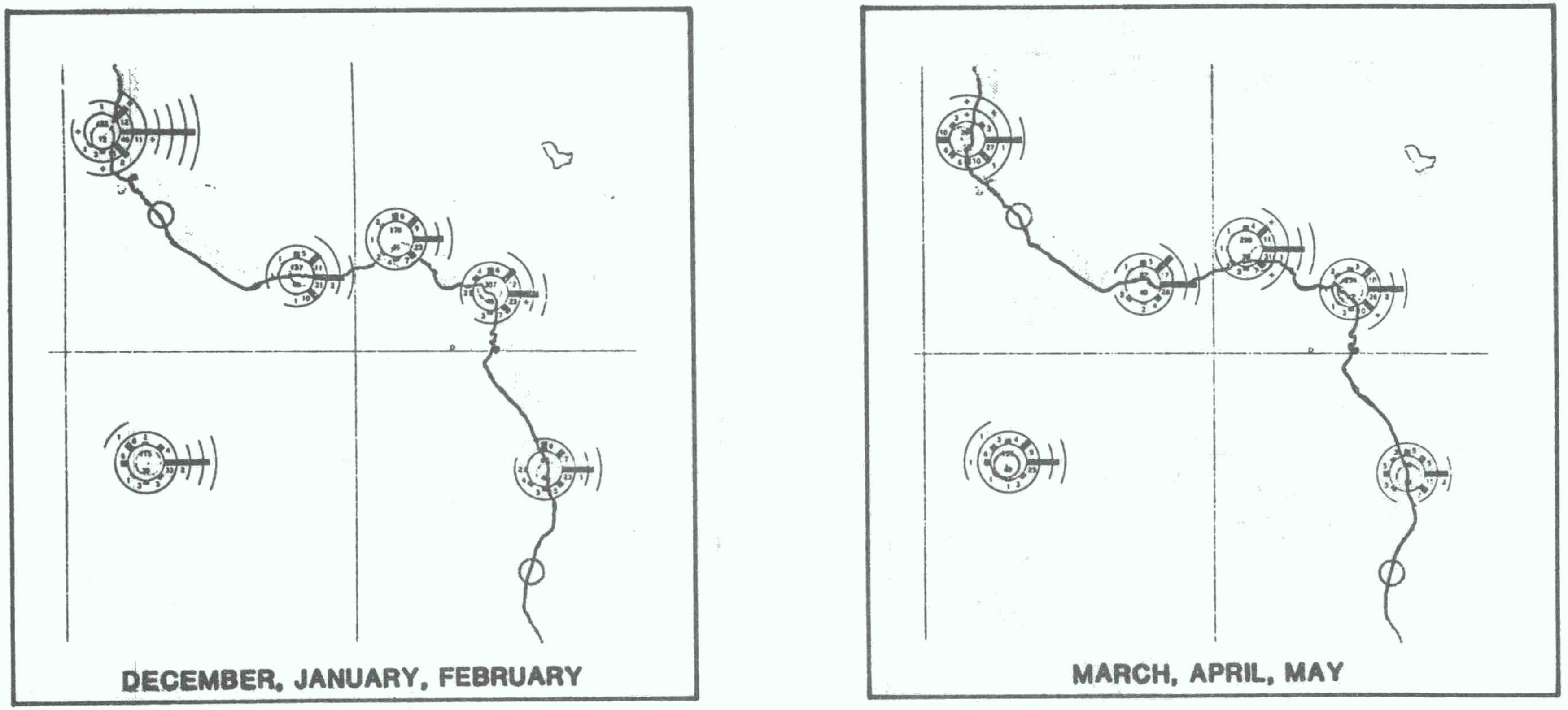


FIGURE II-6: WIND ROSE DIAGRAMS FOR DECEMBER THROUGH MAY

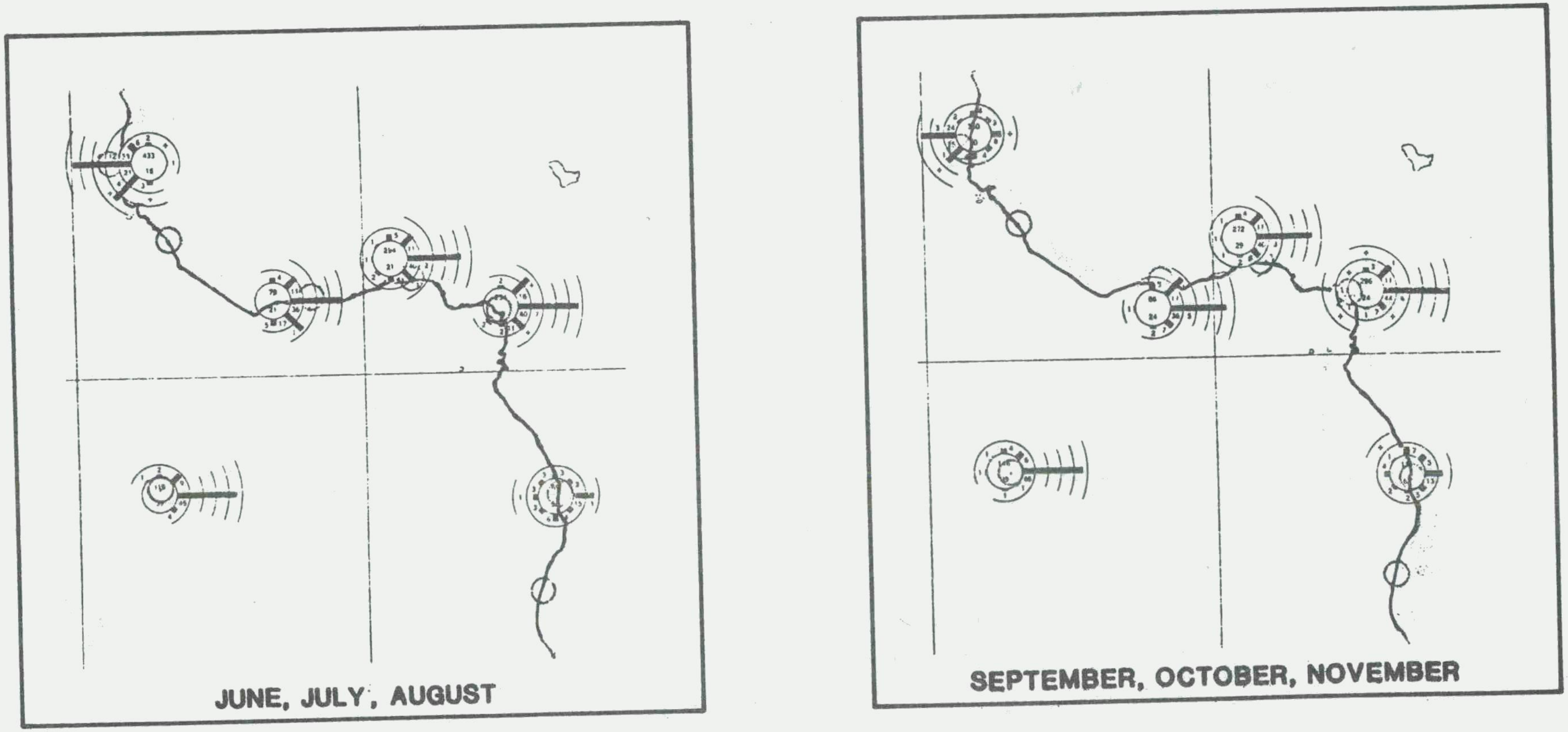


FIGURE II-7: WIND ROSE DIAGRAMS FOR JUNE THROUGH NOVEMBER

Along the entire West and Central African coastline to about 16 km. (10 mi.) inland, sea and land breezes are prevalent and important. In the late-day, an onshore breeze results from the relative overheating of the land compared to the temperature of the sea. At night, the trend is reversed, and winds blow away from the shore. Except in areas where the coastline descends sharply to the sea, the onshore breeze usually is the stronger.

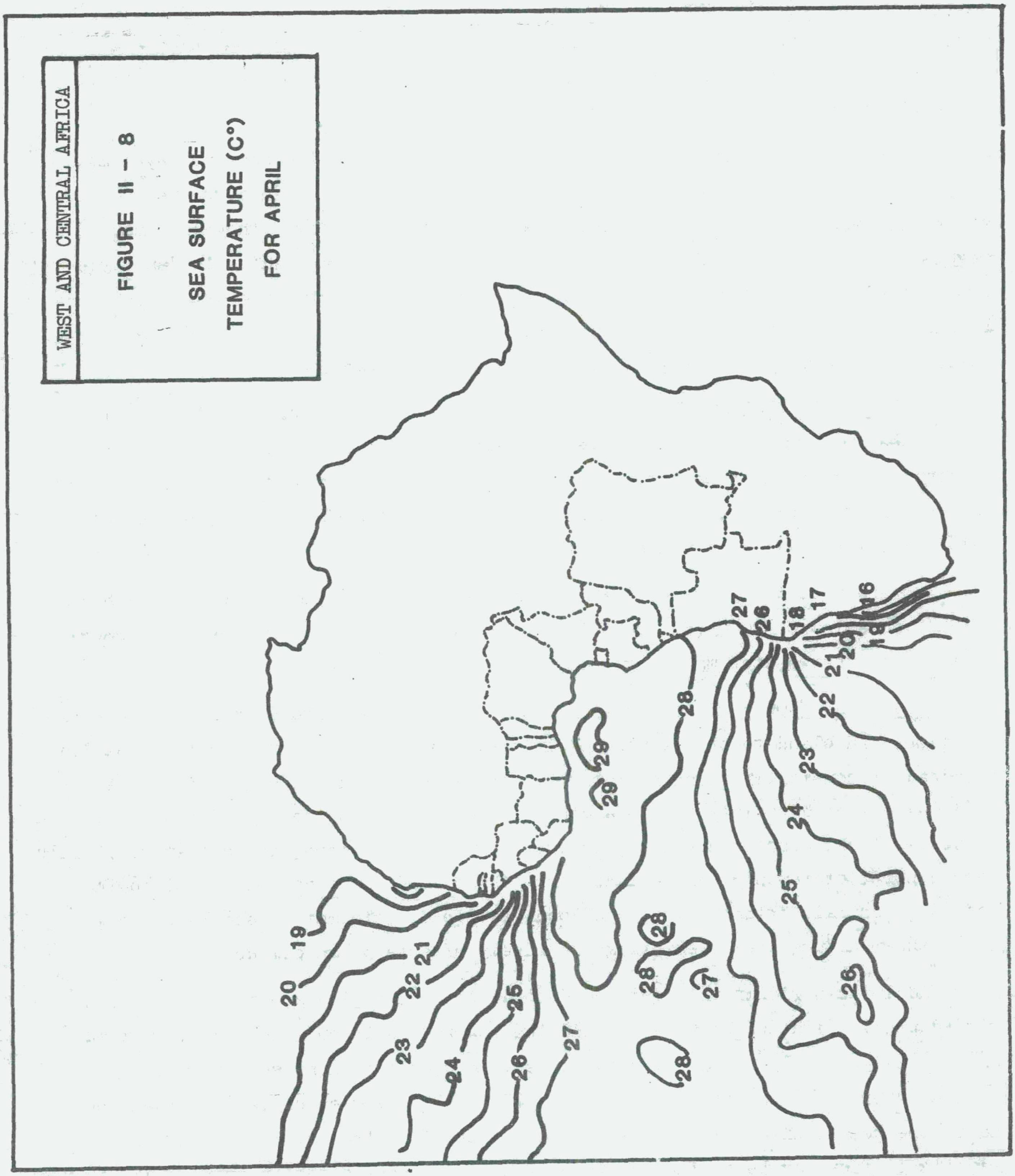
These two light air systems exert varying effects on the seasonal systems. They may divert the prevailing wind, as in Senegal and Mauritania, where north-northwest marine trade winds are common during the day. They also may reverse the normal wind flow, as in Guinea or Guinea-Bissau, where in January a westerly wind frequently replaces the northeast trades during the afternoon. Finally, in some areas they may replace the usual wind, as along the Guinea coast, where southwesterlies are especially strong in the afternoon.

LAND AND SEA TEMPERATURES. The evaporation, spreading and solubility of oil at sea increases as surface water and air temperatures increase. The sea surface temperatures in West and Central Africa vary an average of 1° to $2^{\circ}C$ between the summer and winter months, as indicated in Figures II-8 to II-12, which show values for five different months of the year.

Temperatures along the West and Central African coast may range from a high of $28^{\circ}C$ to a low of $20^{\circ}C$ (82° to $68^{\circ}F$) in the winter months. During the summer months, the thermometer may range between $28^{\circ}C$ and $18^{\circ}C$ ($82-64^{\circ}F$).

LOCAL CONDITIONS. Local oceanographic, meteorologic and topographic conditions sometimes can blend to create unique circumstances within an area that are basically atypical or constantly changing, or which serve to make a transition from one regional set of circumstances to another. Among these influential factors are tidal currents, local countercurrents, and unique geologic or topographic features. Only very general statements can be made about these conditions as they exist on the West and Central African coast, and local advice or information should be sought as to their nature when predicting the likely effects on an oil spill.

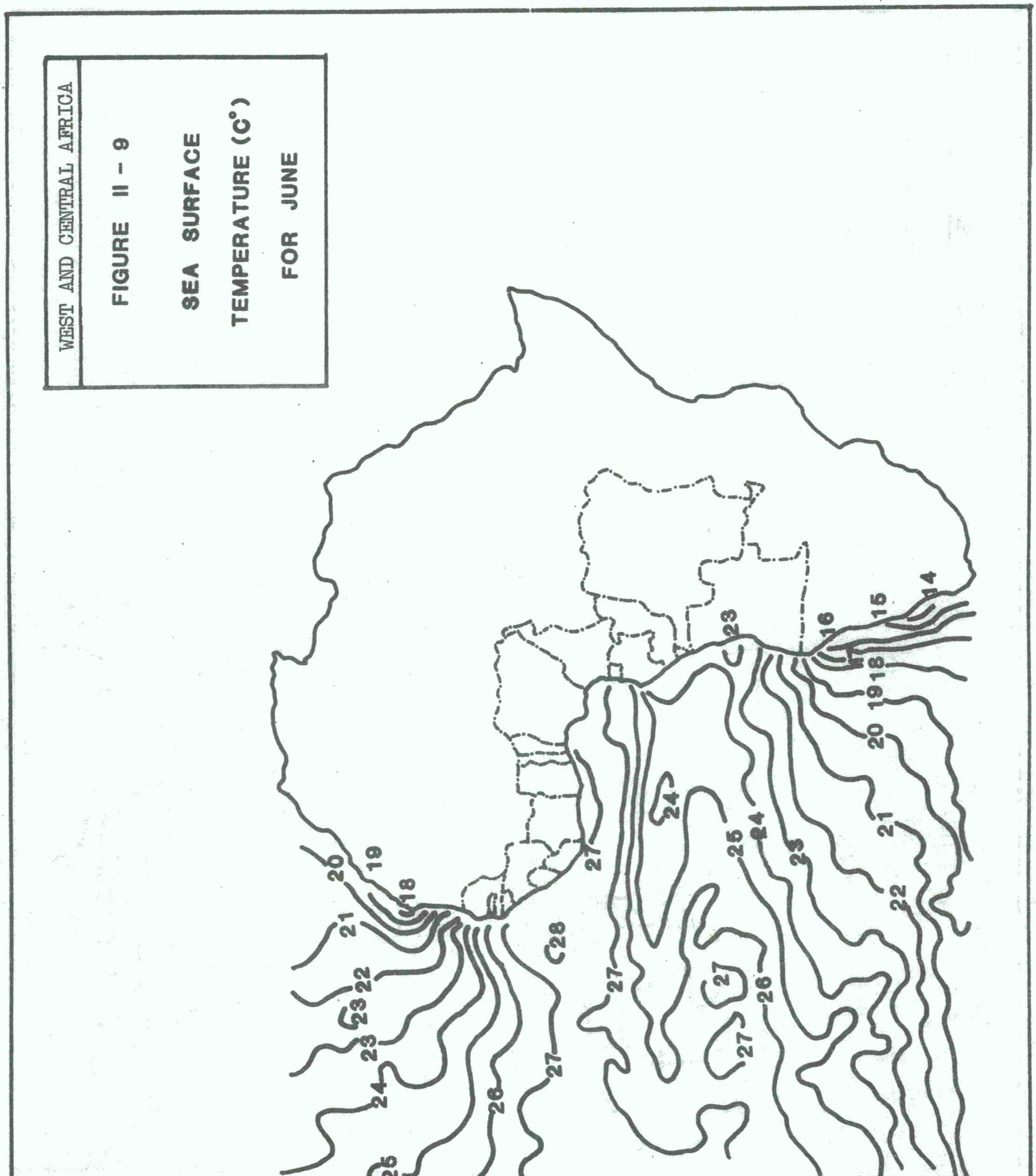
Tidal flows within the West and Central African region are predominantly semi-diurnal, with two high waters and two low waters in one lunar day. Maximum amplitudes generally are about 2 m., except in some locations such as Conakry, Guinea, where maximum amplitude reaches 3.5 m. In river estuaries, on the other hand, the behaviour of tidal flows tends to vary to extremes. In some areas, a river's outflow may be sufficient to balance and suppress the incoming tidal current during rainy seasons. In other areas, tidal range may exceed 4 m. and actually be larger upstream than at the mouth of the river.



WEST AND CENTRAL AFRICA

FIGURE II - 8

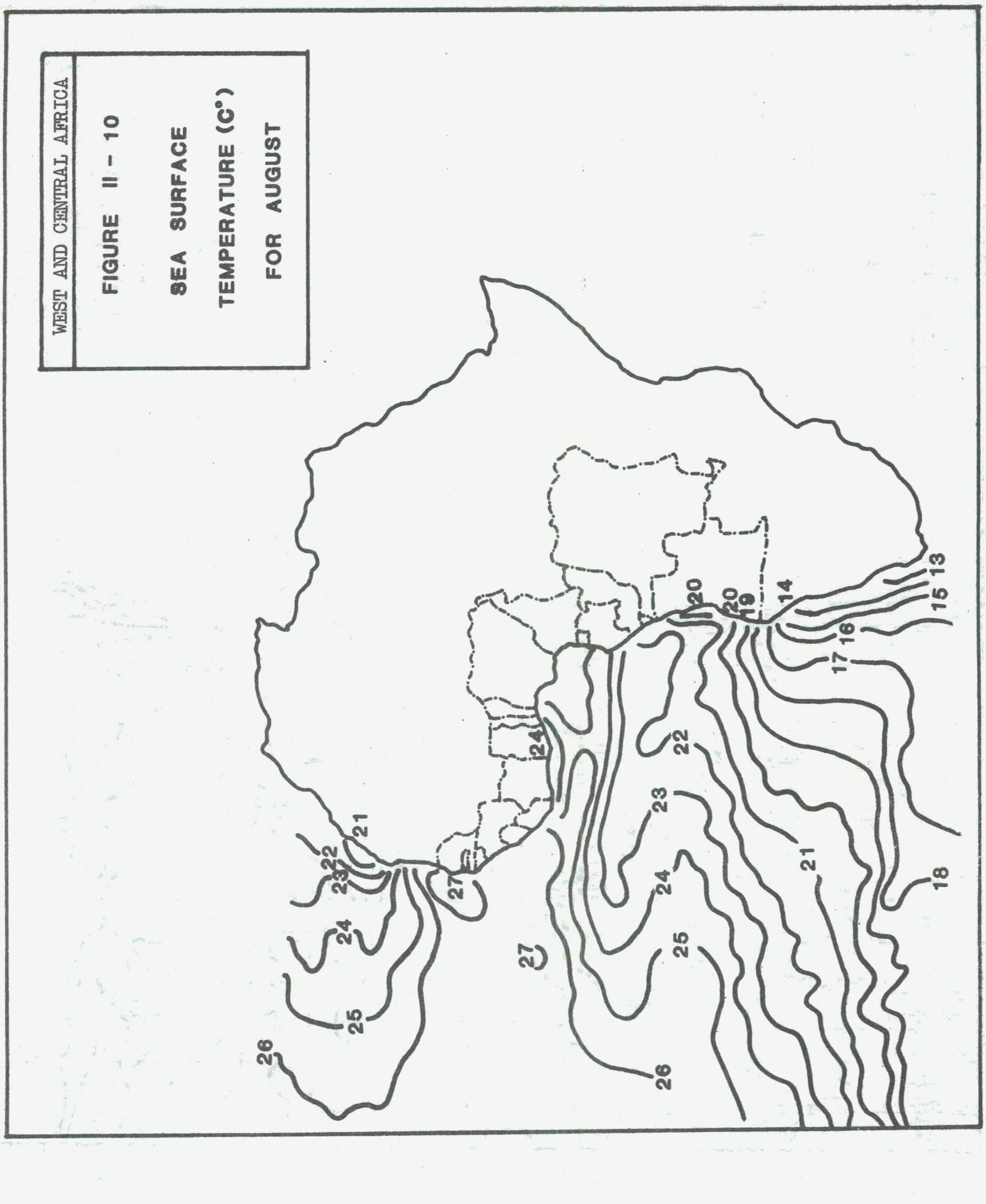
SEA SURFACE TEMPERATURE (C°) FOR APRIL



WEST AND CENTRAL AFRICA

FIGURE II - 9

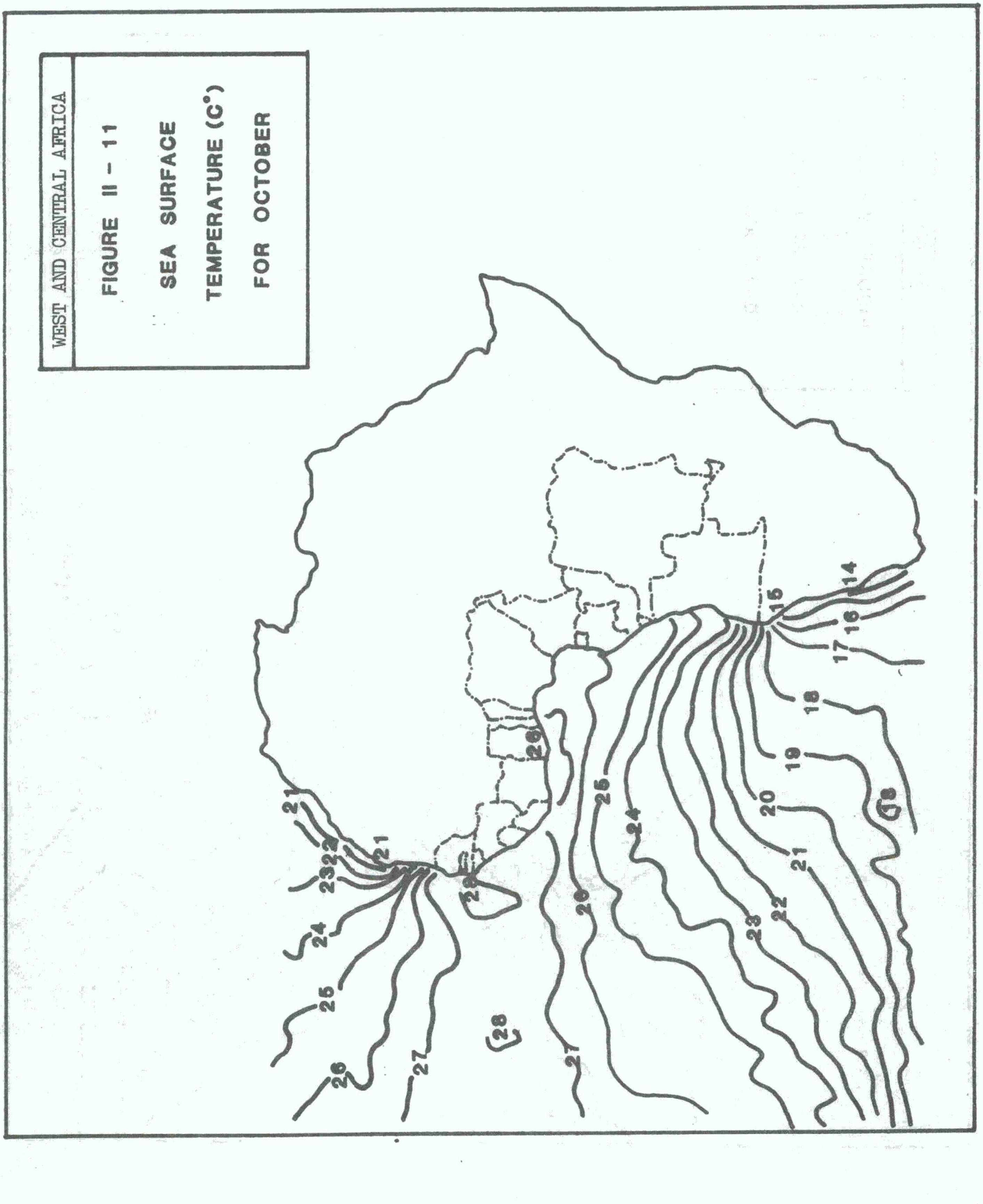
SEA SURFACE TEMPERATURE (C°) FOR JUNE



WEST AND CENTRAL AFRICA

FIGURE II - 10

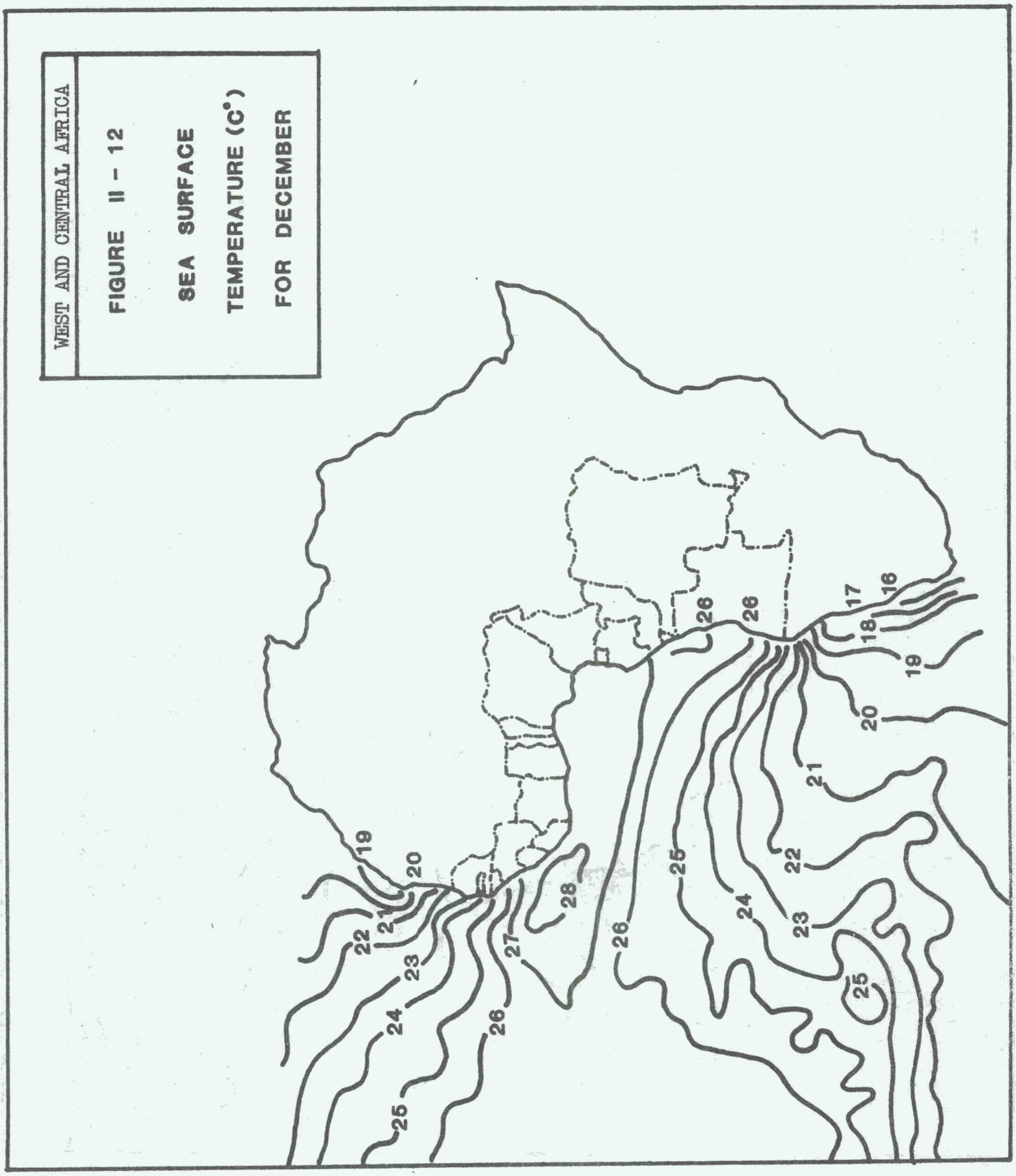
SEA SURFACE TEMPERATURE (C°) FOR AUGUST



WEST AND CENTRAL AFRICA

FIGURE II - 11

SEA SURFACE TEMPERATURE (C°) FOR OCTOBER


WEST AND CENTRAL AFRICA
FIGURE II - 12
SEA SURFACE
TEMPERATURE (C°)
FOR DECEMBER

Capes and promontories can modify the general pattern of currents and create countercurrents, such as in the Bay of Dakar. The large and impressive River Congo has created a permanent current that bears west, then deviates to the north; this may be compared to oceanic circulation currents, both by its speed and the range of its influence.

Seasonal winds, combined with the trend of the coast and the degree of slope on the foreshore, account for the moderate swell and vigorous surf which are found in all areas of the West and Central African coast. Swell along the Mauritanian shoreline comes from the north; along the Senegalese shoreline, it comes from a southerly direction in the months of June to September. On all other coasts, it is generally from the south and southwest. This phenomenon is of value in the matter of oil pollution, for if swell breaks directly onshore, it may aid in cleaning up rocky or sandy shorelines. On the other hand, swell breaking on offshore reefs may aid in oil emulsification and thus make clean-up more difficult.

Surf tends to be severe on most coasts, contributing to the creation of sandbars and hindering the establishment of ports.

The Coasts of West and Central Africa

While the geology of a coastline depends primarily on the types and deposition of rocks, earth movements, relief, drainage and climate, the morphology of a shoreline is affected by waves, winds, tides and longshore drift. West and Central African coasts are mainly low, sandy and lacking natural harbours, except where a river or tidal range has maintained an opening.

West and Central Africa's seaward border is characterized by four types of coastline: ria or drowned coast, sandbar or lagoon coast, deltas, and coasts with spits formed by drifts. Figure II-13 shows the distribution of these types between Senegal and Angola.

Ria coasts extend in a 630-mile long strip between Guinea-Bissau and Sierra Leone. Composed of a jigsaw pattern of deep inlets and small islands, they have been formed by the submergence of lowland and river valleys. One of the finest examples of a ria coast is the Sierra Leone estuary, which has sheer mountains rising nearly 3,000 feet out of the sea.

A transition from ria coast to the sandbar and lagoon types is made between Liberia and the Ivory Coast, continuing to an area just east of Lagos, Nigeria. Shallow waters offshore break the rotational motion of approaching waves, which then deposit long lines of sand close to shore to form bars backed by shallow lagoons.

Figure II-13:

WEST AND CENTRAL AFRICAN COASTAL TYPES

1. Ria or Drowned
2. Sandbar or Lagoon
3. Deltas
4. Coasts with Spits

SOURCE: J.M. Pritchard, Africa: The Geography of a Changing Continent, p. 16.

These natural inland waterways generally are navigable by shallow-draft vessels, but cannot accommodate ocean-going craft. Usually, the lagoons are comprised of a system of sandy islands and water channels. This complex necessitates constant dredging in port channels and has precipitated construction of artificial harbours. Many lagoons slowly are being filled in and eventually may become marshy strips. Thus, this system is always changing, due to the addition or movement of sediments.

While West and Central Africa has a lack of true river estuaries, it has instead deltas as the natural feature at the mouths of rivers. Often formed by the confluence of longshore currents and river tributaries, access into deltas varies depending on the drifting deposition of sand and the diligence of local dredging efforts. Associated features include mangrove swamps, marshes and man-made levees or breakwaters.

The accumulation of sand in bays and the subsequent development of sandspits is the result of longshore drift caused by strong currents and winds. Most examples of this are found on the western and eastern sides of South Africa, although the northwestern boundary falls well into Angola.

SECTION III

OIL PRODUCTION AND REFINING IN WEST AND CENTRAL AFRICA

The ways in which most people come into contact with petroleum are quite remote from the thick, dark fluid that comes out of the ground. To them it is fuel that powers buildings, vehicles or equipment; products of all textures and uses; or perhaps just the access to benefits financed by the sale of oil. A worldwide dependence on petroleum to provide such things has prompted energetic efforts to find and extract it out of the earth and to make it usable for myriad purposes. Some idea of how much the demand for refined products has increased in the world in the last 20 years is shown in Table A2-2 in Appendix 2. In Africa, petroleum and by-product consumption more than tripled during this period, and Africans today make use of all types of refined products, as shown in Table A2-3.

Since their discovery, the promising reserves in West and Central Africa have been pursued with unfailing zeal. This section analyses the success of those efforts by presenting data about production and refining levels in the region. Basic information of this type can be used to compute the potential for and probable extent of oil pollution, as well as the types, for an area. Of equal value is knowledge about the geology and chemistry of petroleum, which not only helps to predict its behaviour, but also to predict its location. Oil-seeking theory and technology have continued to expand to meet the demand and challenge to find new sources, although certain unchanging facts still underlie most decisions about where and how extensively to look.

It is now generally held that petroleum of varying densities and mixtures is formed by the decomposition of organic materials, such as marine plankton, in sedimentary rocks. This process still takes place, and oil has been found in formations of all geological periods from Cambrian (± 620 million years B.P.) onward, although more than half of the world supply is obtained from Tertiary (± 70 million years B.P.) deposits.

Once oil forms, it migrates along with natural gas produced at the same time through porous, permeable sedimentary rocks, such as sandstone and limestone, until it is trapped by an impermeable layer - a cap rock, likely composed of shale or anhydrite. The components may accumulate there, but to pool and hold the migrating oil in a reservoir, the sedimentary layers must contain an impervious trap-structure, such as a fault, anticline or salt dome. Thus held, oil and gas accumulate in the upper portions of the formation, and it is these structures which have been sought and found by oil exploration teams on all continents of the world.

In the oceans, the continental shelf and, to some extent, the continental slope, have proved to be sodden with oil; indeed, in the view of some, they are more promising than the land. Continental shelves occupy only about ten million square miles, but more than half of that - 5.8 million square miles - consists of the sedimentary basins so implicit in oil formation. Only one-third of the total land area of the world is composed of these oil-producing layers. One-fifth of all the oil discovered has been found offshore, and offshore exploitation in 1975 accounted for 15 percent of the total world production.[14] These figures undoubtedly will increase in the future as onshore areas pass their peak, and the offshore search is intensified.

Crude oils, from which petroleum is derived, consist of a complex of hydrocarbons that are separated from oils by distillation during the refining process. They have been categorized and described according to their components, and three major types of crudes are distinguished by their varying yields of gasoline after a certain type of distillation. Paraffin-based crude oils have the highest yields; asphalt-based crudes have the lowest, some producing no gasoline at all; and naphthenic-based crudes are in the middle. Most reserves, however, prove to be a combination of all three. It should be noted that as the technology of oil manipulation and chemical transformation improves, the original character of the crude loses some of its importance as a determinant of yields of specific products.

Petroleum is the leading raw material in world trade and accounted for 46 percent of the world's consumption of primary energy in 1977 and 1978.[15] World crude oil production in 1978 was calculated at 22.1 billion barrels; of that, 2.2 billion barrels (10.08 percent) were produced in Africa. A comparison of these figures with other world totals can be seen in Table III-1. A breakdown by percentage is given in Table III-2.

Oil Production in West and Central Africa

The shape of West and Central Africa's oil production map changes annually as new onshore and offshore strikes occur. To date, petroleum reserves have been found on land in Angola, the Congo, Gabon, Ghana, Nigeria and Zaire. Offshore resources have been located in Angola/Cabinda, Benin, Cameroon, the Congo, Gabon, Ghana,

TABLE III - 1

WORLD CRUDE PRODUCTION

(thousands of barrels)

Year	Africa	Asia Middle and Far East	Europe (Incl. USSR)	North America	South America	World Total (1)
1918	1,942	32,534	42,598	420,061	6,355	503,515
1919	1,522	37,217	45,150	465,681	6,285	555,875
1920	1,046	41,375	39,181	600,194	7,068	688,884
1921	1,258	46,009	43,297	665,769	9,649	766,002
1922	1,197	52,746	51,736	739,988	13,209	858,898
1923	1,063	59,250	56,374	882,162	16,863	1,015,736
1924	1,133	67,239	64,481	853,779	26,662	1,014,318
1925	1,238	70,906	76,367	879,590	40,809	1,068,933
1926	1,197	71,823	94,974	861,659	67,153	1,096,823
1927	1,275	82,249	110,496	965,727	102,822	1,262,582
1928	1,850	92,200	122,970	952,249	155,490	1,324,774
1929	1,888	98,282	141,764	1,053,128	190,767	1,485,867
1930	2,012	103,619	175,809	939,063	189,494	1,410,037
1931	2,038	94,849	221,749	885,663	168,179	1,372,532
1932	1,902	103,328	217,624	819,008	167,760	1,309,677
1933	1,670	112,342	218,126	940,825	169,119	1,442,146
1934	1,552	130,310	246,175	947,682	196,472	1,522,288
1935	1,305	150,131	253,929	1,038,331	210,783	1,654,495
1936	1,282	165,029	261,058	1,142,277	221,885	1,791,540
1937	1,218	192,698	257,836	1,329,044	258,427	2,039,231
1938	1,608	196,576	267,064	1,259,905	262,880	1,988,041
1939	4,693	202,507	278,897	1,315,810	284,246	2,086,160
1940	6,532	184,431	284,094	1,405,983	286,764	2,149,821
1941	8,573	147,838	300,443	1,454,708	309,092	2,220,657
1942	8,316	137,085	295,536	1,431,976	220,185	2,093,100
1943	8,992	169,641	269,723	1,550,935	257,344	2,256,637
1944	9,452	181,436	331,649	1,726,315	343,435	2,592,289
1945	9,434	209,088	203,888	1,765,834	406,450	2,594,697
1946	9,091	264,599	214,046	1,791,029	466,663	2,745,430
1947	8,649	331,260	243,379	1,921,263	517,586	3,022,139
1948	13,499	473,191	280,504	2,091,139	574,892	3,433,225
1949	16,135	586,755	303,447	1,924,361	573,444	3,404,142
1950	16,702	728,527	338,493	2,075,217	644,056	3,802,995
1951	16,947	802,761	363,542	2,372,766	726,714	4,282,730
1952	17,561	870,580	421,972	2,428,384	766,211	4,504,708
1953	17,900	1,007,616	505,766	2,510,438	756,335	4,798,055
1954	15,225	1,129,569	567,578	2,494,746	809,725	5,016,843
1955	13,837	1,327,701	670,046	2,703,649	910,650	5,625,883
1956	13,224	1,413,751	780,512	2,880,467	1,036,722	6,124,676
1957	18,102	1,467,015	897,269	2,887,410	1,168,648	6,438,444
1958	31,713	1,736,030	1,010,975	2,708,389	1,120,643	6,607,750
1959	41,943	1,892,819	1,138,186	2,855,953	1,204,337	7,133,238
1960	105,308	2,149,086	1,290,005	2,863,624	1,266,437	7,674,460
1961	178,613	2,304,846	1,434,717	2,949,483	1,318,554	8,186,213
1962	293,384	2,524,783	1,592,874	3,032,245	1,438,572	8,881,858
1963	434,311	2,761,678	1,748,886	3,125,468	1,468,003	9,538,346
1964	623,586	3,076,709	1,902,734	3,178,026	1,528,589	10,309,644
1965	811,692	3,372,326	2,051,050	3,263,734	1,563,713	11,062,515
1966	1,029,674	3,759,992	2,213,575	3,469,639	1,548,906	12,021,786
1967	1,137,566	4,063,770	2,362,244	3,700,827	1,649,933	12,914,340
1968	1,460,968	4,563,446	2,521,902	3,908,267	1,691,735	14,146,318
1969	1,849,123	5,067,239	2,658,336	3,951,765	1,696,048	15,222,511
1970	2,215,237	5,788,192	2,820,464	4,157,011	1,737,804	16,718,708
1971	2,060,359	6,746,446	3,043,437	4,123,819	1,688,732	17,662,793
1972	2,085,873	7,537,595	3,173,015	4,201,847	1,602,171	18,600,501
1973	2,161,473	8,925,778	3,376,764	4,201,508	1,702,458	20,367,981
1974	1,989,898	9,277,361	3,662,661	4,058,163	1,549,644	20,537,727
1975	1,826,255	7,967,322	4,527,980	3,867,743	1,308,304	19,497,604
1976	2,134,861	9,038,526	4,928,224	3,792,145	1,297,784	21,191,154
1977	2,276,007	9,857,445	4,628,595	3,850,151	1,288,497	21,900,695
1978	2,233,791	9,654,272	4,874,574	4,100,517	1,295,097	22,158,251

(1) World total includes minor production of remote areas.

SOURCE: Twentieth Century Petroleum Statistics 1979 (Dallas: DeGolyer and MacNaughton, 1979), p. 4. This source cites the U.S. Department of Energy.

TABLE III - 2

PERCENTAGE OF WORLD CRUDE OIL PRODUCTION BY COUNTRIES

(thousands of barrels per day)

CONTINENT AND COUNTRY	1938	1950	1955	1960	1965	1970	1975	1976	1977	1978
NORTH AMERICA	63.38	54.56	48.06	37.24	29.47	24.86	19.83	17.89	17.58	18.50
Canada	0.36	0.76	2.30	2.46	2.64	2.76	2.67	2.31	2.20	2.18
Cuba	...	...	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mexico	1.94	1.90	1.59	1.29	1.07	1.06	1.51	1.54	1.64	1.99
United States	61.08	51.90	44.16	33.49	25.76	21.04	15.65	14.04	13.74	14.33
SOUTH AMERICA	13.22	16.94	16.18	16.47	14.15	10.40	6.70	6.12	5.89	5.83
Argentina	0.86	0.61	0.54	0.83	0.89	0.86	0.74	0.69	0.72	0.74
Bolivia	0.01	0.02	0.05	0.04	0.03	0.05	0.08	0.07	0.06	0.05
Brazil	...	0.01	0.03	0.39	0.31	0.36	0.32	0.29	0.27	0.26
Colombia	1.09	0.90	0.71	0.73	0.66	0.48	0.29	0.25	0.23	0.22
Ecuador	0.11	0.07	0.06	0.04	0.03	0.01	0.30	0.32	0.31	0.33
Peru	0.80	0.39	0.31	0.25	0.21	0.16	0.13	0.13	0.15	0.25
Trinidad and Tobago	0.89	0.54	0.44	0.55	0.44	0.30	0.40	0.37	0.38	0.38
Venezuela	9.46	14.38	14.00	13.55	11.46	8.10	4.39	3.96	3.73	3.57
Other South America	...	0.02	0.04	0.09	0.12	0.08	0.05	0.04	0.04	0.03
EUROPE	13.24	8.72	11.91	16.75	18.54	16.87	20.30	20.21	21.13	22.01
Austria	0.02	0.27	0.44	0.22	0.18	0.12	0.07	0.06	0.06	0.06
France	0.02	0.02	0.11	0.18	0.20	0.10	0.04	0.04	0.03	0.03
Germany, West	0.19	0.22	0.40	0.52	0.51	0.32	0.21	0.19	0.18	0.17
Italy	0.01	...	0.03	0.18	0.14	0.06	0.03	0.04	0.04	0.05
Netherlands	...	0.13	0.13	0.17	0.15	0.08	0.05	0.05	0.04	0.05
Norway	...	...	...	...	...	...	0.35	0.48	0.47	0.59
Rumania	2.44	0.84	1.40	1.11	0.85	0.61	0.56	0.52	0.50	0.45
U.S.S.R.	10.31	7.00	9.06	14.04	16.15	15.25	18.51	18.04	18.22	18.47
United Kingdom	...	0.01	0.01	0.01	0.00	0.00	0.04	0.42	1.24	1.78
Yugoslavia	...	0.02	0.03	0.09	0.14	0.13	0.15	0.14	0.13	0.14
Other Europe	0.25	0.21	0.30	0.23	0.22	0.20	0.29	0.23	0.22	0.22
AFRICA	0.08	0.44	0.25	1.37	7.34	13.25	9.37	10.08	10.39	10.08
Algeria	...	0.01	0.02	0.89	1.87	2.25	1.80	1.81	1.87	2.02
Angola	...	...	...	0.01	0.04	0.24	0.30	0.17	0.28	0.22
Egypt	0.08	0.43	0.23	0.31	0.41	0.71	0.43	0.57	0.69	0.76
Gabon	...	...	...	0.07	0.08	0.24	0.42	0.39	0.37	0.37
Libya	...	...	...	...	4.03	7.23	2.83	3.32	3.44	3.28
Nigeria	...	...	...	0.09	0.90	2.37	3.34	3.57	3.50	3.15
Other Africa	...	...	...	...	0.01	0.21	0.25	0.25	0.24	0.28
ASIA, MIDDLE EAST	10.08	19.34	23.60	28.17	30.48	34.23	43.02	44.96	44.27	42.85
Bahrain	0.42	0.29	0.19	0.22	0.19	0.17	0.11	0.10	0.10	0.09
Brunei and Malaysia	0.35	0.82	0.71	0.44	0.27	0.34	0.52	0.64	0.66	0.75
China	...	0.02	0.06	0.52	0.66	0.87	2.93	3.05	2.98	3.30
India	0.13	0.08	0.08	0.08	0.24	0.31	0.32	0.30	0.35	0.42
Indonesia	2.88	1.27	1.55	1.99	1.61	1.86	2.45	2.60	2.81	2.70
Iran	3.94	6.38	2.14	5.02	6.22	8.36	10.01	10.23	9.50	8.58
Iraq	1.64	1.31	4.47	4.60	4.36	3.40	4.23	4.17	4.15	4.33
Kuwait	...	3.31	7.08	7.73	7.16	5.97	3.44	3.30	2.97	3.07
Neutral Zone	...	...	0.16	0.65	1.20	1.10	0.93	0.81	0.62	0.77
Oman	...	...	...	...	...	0.72	0.64	0.63	0.57	0.52
Qatar	...	0.32	0.75	0.82	0.76	0.79	0.82	0.86	0.74	0.80
Saudi Arabia	0.02	5.25	6.26	5.94	6.68	7.75	12.78	14.41	15.02	14.05
Syria	...	...	...	...	...	0.18	0.34	0.33	0.29	0.28
United Arab Emirates	...	...	...	...	0.93	1.70	3.17	3.36	3.33	3.02
Other Asia and Middle East	0.70	0.29	0.15	0.16	0.20	0.71	0.33	0.17	0.18	0.17
AUSTRALIA-NEW ZEALAND	...	...	...	...	0.02	0.39	0.78	0.74	0.74	0.73
TOTAL WORLD PRODUCTION	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

SOURCE: Twentieth Century Petroleum Statistics 1979 (Dallas: DeGolyer and MacNaughton, 1979), p. 3. This source cites the U.S. Dept. of Energy.

Ivory Coast, Nigeria, Senegal and Zaire. Nearly every other country in the region has initiated some type of exploratory survey in the hope that their coastal substrates are a link in the oil-bearing chain that seems to parallel the entire west coast. Individual discussions of the development of oil exploration and exploitation in the nations of the region are found in Appendix 2, however, a summary of production between 1918 and 1978 in more lucrative countries is included in Table III-3. Statistics from other African oil-producing countries provide a comparative index for the continent. Information about some of the fields in operation, including such data as discovery date, number and type of wells, flow rate and cumulative flow, and type of oil, is outlined in Table III-4. Although not entirely current - not all fields within each country are listed, and data is for 1979 - the table allows typical comparisons to be made between on- and offshore production, and it also allows lucrative areas within some countries to be identified. Four additional figures, III-1 to III-4, are maps which show the locations of various fields in the countries of Nigeria, Gabon, the Congo and Angola/Cabinda for the year 1979.

Major oil-producing countries in West and Central Africa yield about 21 million barrels per day, and the distribution of onshore and offshore yields for 1978 is illustrated in Figure III-5. Production solely from offshore sites in the same year is shown in Figure III-6.

Oil Refining in West and Central Africa

The increased availability of oil in West Africa for export and domestic use has been accompanied by a burgeoning development of ancillary industries, in particular, the refining industry. Most frequently located in coastal areas near the sites of production, new refineries are not only a response to the increased flow of oil through any given area, but they also are often the result of petroleum production in that their establishment is part of an industrial stimulation programme within a nation that has been financed by oil revenues. Table III-5 charts the increase in refining capacity in five West and Central African nations - Angola, Ghana, Ivory Coast, Nigeria and Senegal - between 1960, when capacity was 2,000 b/d, and 1979, when it had reached 276,000 b/d, or 13.9 million tons per year. A more general view of the 20-year increase is shown in Table III-6, which gives world refinery capacities between 1940 and 1979. A map of major refinery locations in Africa appears in Figure III-7. Table III-7 provides a survey of major plants in nine West and Central African countries, as of 1978.

TABLE III - 3

WORLD CRUDE PRODUCTION - AFRICA

(thousands of barrels)

Year	Algeria	Angola	Cameroon	Congo	Egypt	Gabon	Libya	Morroco	Nigeria	Tunisia	Zaire	Total Africa
1918	7	...	...	...	1,935	...	...	...	...	...	...	1,942
1919	5	...	...	...	1,517	...	...	...	...	...	...	1,522
1920	4	...	...	...	1,042	...	...	...	...	...	...	1,046
1921	3	...	...	...	1,255	...	...	...	...	...	...	1,258
1922	9	...	...	...	1,188	...	...	...	...	...	...	1,197
1923	9	...	...	...	1,054	...	...	...	...	...	...	1,063
1924	11	...	...	...	1,122	...	...	...	...	...	...	1,133
1925	12	...	...	...	1,226	...	...	...	...	...	...	1,238
1926	9	...	...	...	1,188	...	...	...	...	...	...	1,197
1927	8	...	...	...	1,267	...	...	...	...	...	...	1,275
1928	8	...	...	...	1,842	...	...	...	...	...	...	1,850
1929	20	...	...	...	1,868	...	...	...	...	...	...	1,888
1930	16	...	...	...	1,996	...	...	...	...	...	...	2,012
1931	(1)	...	...	...	2,038	...	...	...	...	...	...	2,038
1932	(1)	...	...	...	1,895	...	...	7	...	...	...	1,902
1933	(1)	...	...	...	1,663	...	...	7	...	...	...	1,670
1934	(1)	...	...	...	1,546	...	...	6	...	...	...	1,552
1935	(1)	...	...	...	1,301	...	...	4	...	...	...	1,305
1936	(1)	...	...	...	1,278	...	...	4	...	...	...	1,282
1937	(1)	...	...	...	1,196	...	...	22	...	...	...	1,218
1938	(1)	...	...	...	1,581	...	...	27	...	...	...	1,608
1939	(1)	...	...	...	4,666	...	...	27	...	...	...	4,693
1940	(1)	...	...	...	6,505	...	...	27	...	...	...	6,532
1941	(1)	...	...	...	8,546	...	...	27	...	...	...	8,573
1942	(1)	...	...	...	8,275	...	...	41	...	...	...	8,316
1943	(1)	...	...	...	8,953	...	...	39	...	...	...	8,992
1944	4	...	...	...	9,416	...	...	32	...	...	...	9,452
1945	2	...	...	...	9,406	...	...	26	...	...	...	9,434
1946	1	...	...	...	9,070	...	...	20	...	...	...	9,091
1947	1	...	...	...	8,627	...	...	21	...	...	...	8,649
1948	1	...	...	...	13,398	...	...	100	...	...	...	13,499
1949	2	...	...	...	15,997	...	...	136	...	...	...	16,135
1950	24	...	...	...	16,373	...	...	305	...	...	...	16,702
1951	49	...	...	...	16,311	...	...	587	...	...	...	16,947
1952	348	...	...	...	16,464	...	...	749	...	...	...	17,561
1953	638	...	...	...	16,501	...	...	761	...	...	...	17,900
1954	570	...	...	...	13,774	...	...	881	...	...	...	15,225
1955	438	...	...	...	12,634	...	...	765	...	...	...	13,837
1956	253	52	...	...	12,185	...	...	734	...	...	...	13,224
1957	101	71	...	...	16,157	1,207	...	566	...	...	...	18,102
1958	3,315	358	...	...	21,960	3,550	...	560	1,970	...	...	31,713
1959	10,205	361	...	...	21,303	5,295	...	712	4,067	...	...	41,943
1960	67,613	477	...	377	23,968	5,626	...	695	6,552	...	...	105,308
1961	121,494	757	...	740	26,129	5,446	6,642	603	16,802	...	...	178,613
1962	158,094	3,404	...	929	32,321	5,992	67,052	968	24,624	...	...	293,384
1963	184,311	5,776	...	820	38,760	6,446	169,414	1,140	27,644	...	...	434,311
1964	204,300	6,535	...	619	43,915	7,668	315,642	910	43,997	...	...	623,586
1965	206,258	4,734	...	534	45,556	9,100	445,374	782	99.354	...	...	811.692
1966	262,377	4,549	...	467	44,070	10,440	550,186	755	152,428	4,402	...	1,029.674
1967	297,715	3,885	...	376	39,552	25,203	636,504	738	116,525	17,068	...	1,137,566
1968	330,922	5,401	...	342	62,208	33,630	951,345	674	51,907	24,539	...	1,460.968
1969	345,436	17,456	...	173	89,601	36,421	1,135,684	438	197,204	27,942	...	1,850,355
1970	376,024	40,838	...	137	119,165	39,292	1,209,314	335	395,836	34,296	...	2,215,237
1971	279,627	33,922	...	130	106,993	41,911	1,007,687	172	558,375	31,542	...	2,060,359
1972	384,858	51,405	...	2,522	84,693	45,671	819,619	216	665,282	31,607	...	2,085,873
1973	400.515	58,910	...	12,713	60.483	55,045	793.839	320	749,820	29,828	...	2,161,473
1974	368,139	61,392	...	22,434	53,715	73,548	555,291	191	823,347	31,841	...	1,989,898
1975	350,753	57,943	...	13,460	84,348	81,948	551,150	171	651,890	34,567	25	1,826,255
1976	383,816	36,764	...	14,274	120,180	82,042	704,011	35	756,064	28,600	9,075	2,134,861
1977	409,864	62,437	...	12,045	150,925	81,144	753,178	167	765,473	32,519	8,255	2,276,007
1978	447.125	47,815	3,650	14,956	169,360	82,125	727,445	365	697,150	36,500	7,300	2,233,791

(1) Not available.

SOURCE: Twentieth Century Petroleum Statistics 1979 (Dallas: DeGolyer and MacNaughton, 1979), p. 10. This source cites the U.S. Dept. of Energy.

TABLE III - 4

WEST AND CENTRAL AFRICAN OILFIELDS IN OPERATION

• Offshore (e) Estimated (c) Condensate (NA) Not available

	WORLDWIDE PRODUCTION	Name of field, discovery date	Depth, feet	No. of wells: Flow	No. of wells: Pump	No. of wells: Gas lift	No. of wells: Shut in	B/d average, first 6 mo. 1978	Cumulative, bbl 7-1-78	°API gravity
ANGOLA		Bento, 1972	7,500	2	...	...	1	740	3,356,503	26.0
		N'Zombo, 1973	6,100- 6,300	17				19,530	28,089,850	34.0
		Quenguela N., 1968	4,900- 6,200		2	22	20	2,814	27,515,994	31.0
		Quinfuquena, 1975	6,800- 7,050	5				5,974	4,405,431	33.0
		Quinguila, 1972	4,700	1	8	...	4	6,257	6,881,393	36.0
		Other	2,100- 9,900	4	8	...	18	1,575	39,791,376	29.0
	CABINDA	• Malongo, N., 1966	1,500- 8,500	11	...	43	5			25.5-33.8
		• Malongo, S., 1966	1,300- 1,600	4	...	24	2			24.5
		• Malongo, W., 1969	1,800- 8,750	19	...	11	15			20.5-31.5
		• 95-03, 1969	10,650	1	...	0	0	94,625	377,421,392	36.0
		• 121-02, 1971	11,100	0	...	0	1			36.0
		Total Angola		**64**	**18**	**100**	**66**	**131,515**	**487,461,939**	
CAMEROON	ELF	• Kolé, 1974	5,500	13				10,000	1,800,000	31.0
CONGO		• Emeraude, 1969	1,000		85		27	27,440	75,474,130	23.6
		• Loango, 1972	3,000			20		N.A.	N.A.	27.0
		Pointe Indienne, 1957	5,000	2			17	240	6,303,450	36.9
		Total Congo		**2**	**85**	**20**	**44**	**27,680**	**81,777,580**	
GABON	ELF-GABON	Clairette, 1956	8,200	...	...	...	...	878	27,659,000	30.8
		Tchengue, 1958	8,200	...	...	...	...	2,164	25,190,000	30.4
		• Tchengue Ocean, 1962	8,200	...	...	...	...	750	6,672,000	31.9
		• Anguille, 1962	9,514	...	...	...	...	14,591	74,278,000	31.9
		• Anguille NE, 1968	8,200	...	...	...	...	5,754	37,127,000	31.0
		• Anguille SW, 1968	7,385	130	...	20	80	1,147	5,070,000	31.0
		• Port Gentil Ocean, 1964	8,200	...	...	...	...	2,671	14,938,000	33.6
		• Torpille, 1968	10,000	...	...	...	...	16,087	40,898,000	36.8
		• P.G.S. Marine	9,185	...	...	...	...	2,796	1,020,000	30.0
		• Barbier, 1973	7,710	...	...	...	...	24,431	111,340,000	30.0
		• Mandaros, 1972	6,400	...	...	...	...	19,908	30,924,000	22.1
		• Girelle, 1971	11,975	...	...	...	...	8,894	9,813,000	30.5
		• Gonelle, 1972	5,700	...	...	...	...	9,167	4,914,000	25.7
		• Doree, 1972	8,890	...	...	...	...	8,890	1,325,000	18.1
		• Batanga, 1960	529	...	...	...	...	529	6,493,000	43.0
		Other	....	...	...	...	...	11,830	28,107,000	
	SHELL-ELF	Gamba, 1963	3,000	32			13	12,002	124,923,517	...
		Ivinga, 1967	3,100	23	...	...	6	16,971	69,296,285	
	SHELL/GULF/ELF	• Lucina-Marine, 1971	....	6	...	...	...	7,405	13,238,644	
		Total Gaben		**191**	...	**20**	**99**	**166,865**	**663,226,446**	

SOURCE: <u>International Petroleum Encyclopedia 1979</u> (Tulsa: Petroleum Publishing Company, 1980).

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TABLE III - 4 (Con't)

WORLDWIDE PRODUCTION	Name of field, discovery date	Depth, feet	No. of wells Flow	Pump	Gas lift	Shut in	B/d average, first 6 mo. 1978	Cumulative, bbl 7-1-78	°API gravity
NIGERIA ELF	Aghigho, 1972	6,000- 8,500	1		7	2	4,600	7,432,000	24.6
	Okpoko, 1967	6,000- 7,500	2		3		4,660	7,345,000	19.0
	Obodo-Jatumi, 1966	6,000-11,000	10				14,050	17,331,000	29.0
	Upomami, 1965	6,000- 7,000			7	1	3,720	5,126,000	17.5
	Obagi, 1964	6,000-10,000	25		6		51,640	153,922,000	24.0
	Erema, 1972	9,800	1				1,030	1,802,000	30.0
GULF	Abiteye, 1970	5,750- 9,400	7			3	5,939	15,296,513	37.8
	• Delta, 1965	5,600- 9,580	24			3	17,936	86,026,965	36.7
	• Delta South, 1965	7,100-10,179	21			3	27,669	162,880,022	38.9
	• Isan, 1970	5,900- 9,000	8			3	8,735	26,953,031	40.7
	Makaraba, 1973	7,100-12,005	13			2	11,194	14,432,875	32.2
	• Malu, 1969	4,800- 6,300	12			3	7,135	42,599,316	40.7
	• Mefa, 1965	5,300- 9,300	5			0	2,995	3,096,673	37.7
	• Meji, 1965	5,200-10,900	19			2	21,565	72,644,408	32.0
	• Meren, 1965	5,000- 7,500	41			9	48,205	287,574,310	31.1
	• Okan, 1964	5,500- 9,245	45			10	32,820	269,268,448	36.3
	• Parabe/EKO, 1968	4,500- 8,200	19			6	11,869	65,141,305	38.3
	Utonana, 1971	7,400- 9,165	2			2	2,943	2,864,508	35.1
	• West Isan, 1971	7,825-10,229	9			0	6,734	10,221,902	38.9
	• Yorla South, 1973	9,980-11,400	1			1	1,418	256,717	41.4
MOBIL	• Asabo, 1966	5,600	6			7	19,251	96,221,490	34.5
	• Adua, 1968	4,500	8			2	12,730	5,899,757	34.4
	• Ekpe, 1966	7,650	10			6	19,178	124,022,838	34.4
	• Eku, 1966	5,420	5			1	3,558	4,261,807	39.1
	• Enang, 1968	5,600	21			2	22,618	34,339,377	32.2
	• Etim, 1968	6,200	6			2	14,380	51,264,272	38.7
	• Idoho, 1966	8,536	3			2	2,373	21,908,462	39.1
	• Inim, 1966	6,650	7			1	16,339	73,293,314	36.4
	• Mfem, 1968	5,175	3				6,436	6,922,305	36.0
	• Ubit, 1968	4,842	34			10	23,345	76,138,289	36.0
	• Unam, 1968	5,150	3			1	7,450	13,773,822	36.0
	• Utue, 1966	5,700	4			2	8,269	36,732,045	38.4
PAN OCEAN (MARATHON)	Ogharefe, 1973	9,900	13			2	10,310	7,193,494	47.4
ASHLAND	Izombe, 1974	9,500±	9				7,900	9,492,908	43.2
	Ossu, 1974	9,000±	2			2	845	507,787	44.0
AGIP-PHILLIPS	Ebocha, 1965	8,000-10,900	12			5	19,466	72,059,354	42.3
	Mbede, 1966	7,300- 9,400	13			1	26,910	100,810,503	43.2
	Akri, 1973	9,600-10,600	7			4	18,970	22,623,273	44.4
	Odugri, 1972	12,500	2				2,437	2,060,399	44.8
	Obiafu, 1973	9,300-12,200	11			1	23,546	30,647,222	44.5
	Obrikom, 1973	8,000-10,000	8			2	13,060	32,085,752	44.5
	Idu, 1973	7,750-10,700	3			5	5,889	16,901,114	30.9
	Oshi, 1974	9,600-11,300	7			2	13,535	20,959,599	40.8
	Obama, 1975	11,600-14,300	7				26,815	19,834,993	44.0
	Tebidaba, 1975	10,300-13,300	8			1	38,926	36,253,054	38.6
	Omoku West, 1975	11,500	1				2,412	1,456,814	32.9
	Akri West, 1975	9,900-10,200	1			1	847	205,196	31.4
	Ogbogene, 1976	11,500-12,500	2				1,912	1,651,945	42.2
	Ebegoro, 1976	11,500-12,000	8				25,425	13,543,863	36.1
TEXACO-CHEVRON	• Pennington, 1965	5,000- 7,000	4			7	3,867	17,153,041	39.6
	• Middleton, 1972	5,000- 7,000	2			4	3,639	6,534,751	37.7
	• North Apoi, 1973	4,000- 7,500	12			3	33,857	30,915,498	36.7
SHELL-BP (Midwest)	Ugh-Ogini, 1964	5,860	7			2	4,463	11,773,191	17.5
	Ugh-Uzere E., 1960	8,500	13				12,333	62,657,243	22.6
	Ugh-Uzere W., 1960	8,500	11				10,457	77,300,274	27.7
	Ugh-Olomoro, 1963	7,000-10,000	25			6	19,043	202,921,264	22.3
	Ugh-Oweh, 1964	12,300	10			1	5,769	76,301,010	26.8
	Ugh-Kokori, 1961	8,000- 9,800	17			7	35,332	229,783,592	44.9
	Ugh-Afiersere, 1966	8,000- 9,000	31			1	33,837	60,274,552	23.8
	Ugh-Eriemu, 1961	12,500	12			1	9,451	19,075,869	29.9
	Ugh-Ughelli E., 1959	11,800	8				8,882	71,720,513	33.6
	Ugh-Ughelli W., 1959	7,400-10,200	6				3,842	20,300,775	20.6
	Ugh-Utorogu, 1964	9,000	18			1	15,405	99,834,889	25.0
	Ugh-Oroni, 1964	12,000	5			2	4,777	18,350,298	19.0
	Ugh-Warri R., 1961	12,264	3				3,500	9,960,709	30.8

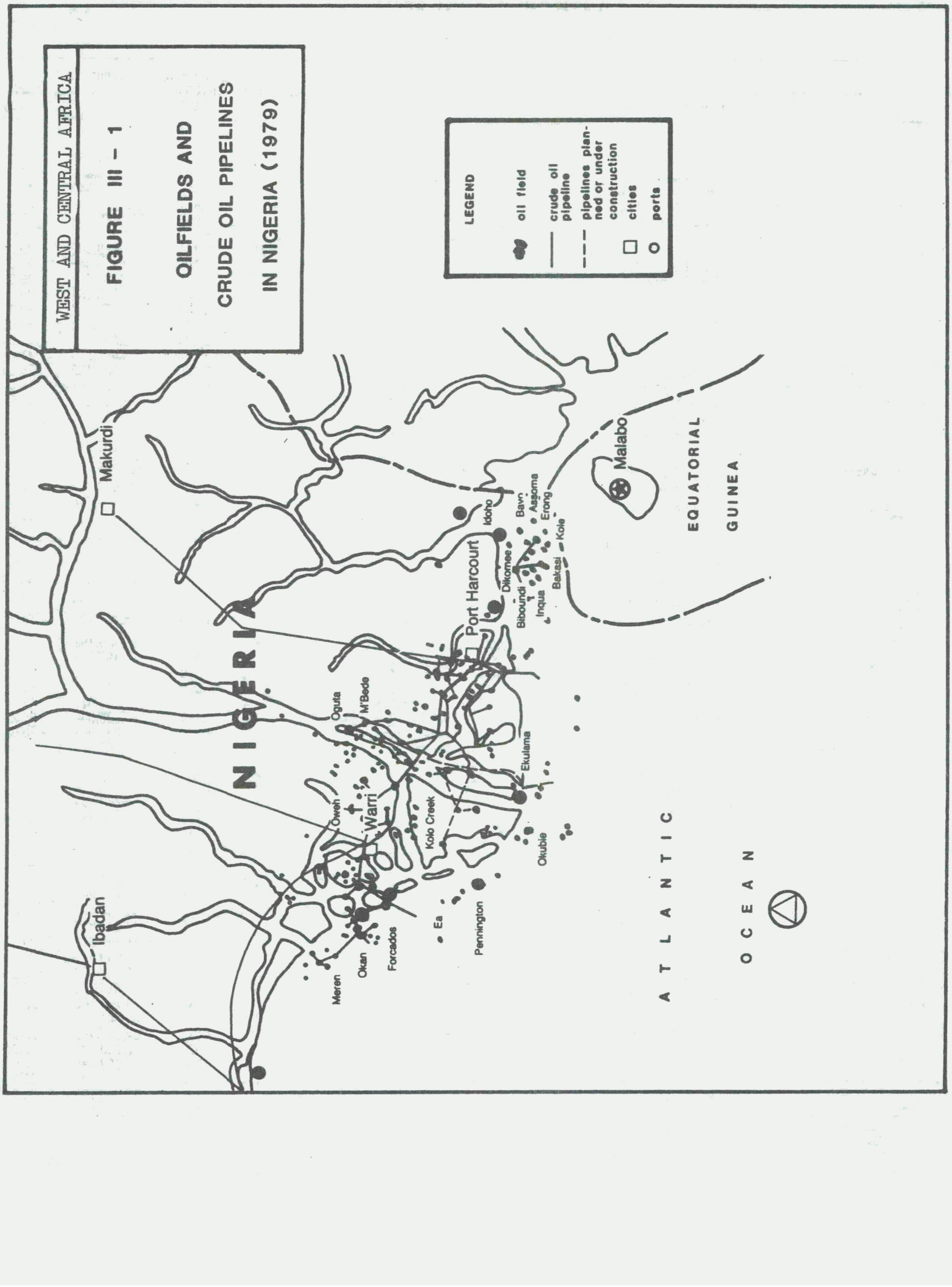
TABLE III - 4 (Con't)

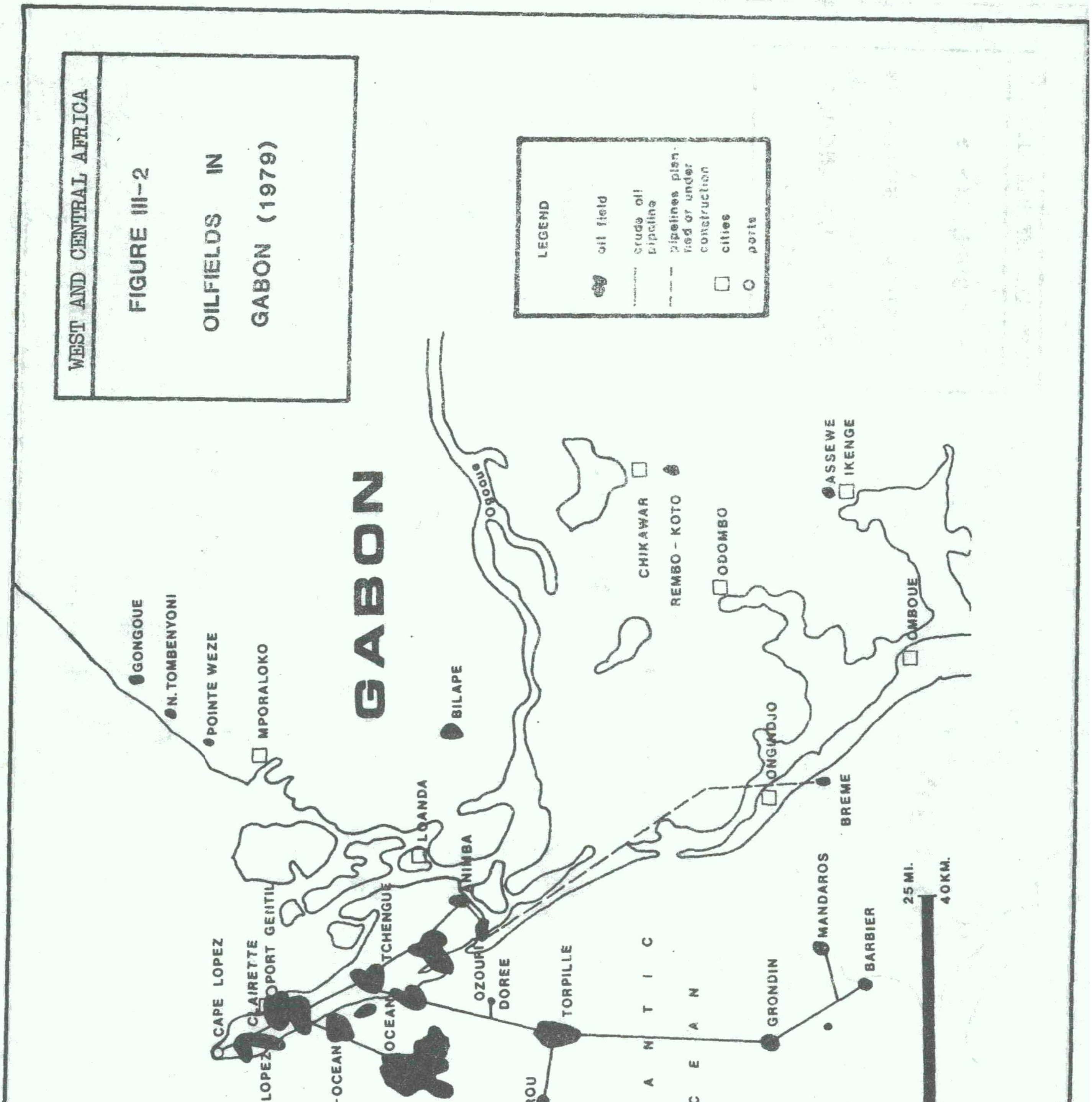
WORLDWIDE PRODUCTION	Name of field, discovery date	Depth, feet	No. of wells: Flow	Pump	Gas lift	Shut in	B/d average, first 6 mo. 1978	Cumulative, bbl 7-1-78	°API gravity
	Ugh-Evwreni, 1967	10,900	4			5	3,378	27,981,188	25.0
	Ugh-Rapele, 1965	12,934	3				3,893	17,193,603	25.0
	Ugh-Osioka, 1967	12,885	2				1,167	5,316,549	30.0
	Forc-Odidi, 1967	10,980	18			2	32,971	112,880,928	30.0
	Forc-Jones Cr., 1967	7,000- 9,000	26			3	68,912	288,425,051	25.0
	Forc-Egwa, 1967	9,350	17			4	24,818	82,969,111	37.0
	Forc-Forc/Yorkri, 1971	10,859	70			13	95,744	281,519,149	25.0
	Forc-Batan, 1968	11,000	7				13,109	33,893,345	21.0
	Forc-Escravos Beach, 1969	9,931	7			1	12,825	30,525,477	36.0
	Forc-Otumara, 1970	8,176	20				21,842	65,138,188	30.0
	Forc-Saghara, 1970	8,590	3			1	6,434	13,472,507	30.0
	Forc-Ajuju, 1970	13,324	1				2,127	6,521,254	30.0
	Node-Sapele, 1970	12,788	11			5	20,884	53,894,575	41.0
	Node-Amukpe, 1970	12,378	2				1,406	8,463,370	41.0
	Ugh-Isoko, 1960	....	2				2,395	1,629,450	25.0
	Forc-Opukushi, 1963	....	9				15,177	15,479,701	25.0
	Node-Oben, 1972	12,036	15				18,680	28,361,397	30.0
	Forc-Opuama, 1973	....	4				7,307	10,053,438	30.0
	Forc-Benisede, 1973	....	10				10,499	8,782,301	...
	Other	....	...				....	261,570	...
SHELL-BP (Eastern)	Phl-Bomu, 1968	6,700- 7,500	19			13	23,954	284,184,404	33.2
	Phl-Imo R., 1959	5,800-10,000	36			4	45,132	332,684,430	30.0
	Phl-Onne, 1965	10,384	3				1,420	4,668,376	30.0
	Phl-Nkali, 1963	12,000	3			4	2,807	19,635,679	41.0
	Phl-Obigbo N., 1963	....	18			4	19,832	109,039,628	24.2
	Phl-Ajokpori	....	2				1,114	1,850,497	30.0
	Phl-Elelenwa, 1959	11,000	5			2	4,420	18,875,504	38.0
	Phl-Agbada, 1960	8,000-12,000	27			3	15,127	100,723,360	32.1
	Phl-Otamini, 1973	....	3			1	2,434	6,274,138	30.0
	Phl-Umuechem, 1959	5,800-10,700	11			8	11,598	118,309,762	37.6
	Phl-Tai, 1965	....	2				986	2,483,311	30.0
	Phl-Apara, 1960	9,000	5			2	4,900	11,600,621	34.0
	Phl-Akuba, 1967	....	1				619	2,091,993	30.0
	Phl-Afam, 1956	6,000	13			1	11,336	35,815,614	45.0
	Phl-Korokoro, 1969	8,000- 9,800	7			1	6,389	71,395,358	35.2
	Phl-Yorla, 1970	11,917	10			3	7,842	37,031,008	30.0
	Phs-Bonny, 1959	12,254	13			2	12,118	45,543,999	30.4
	Phs-Alakiri, 1962	10,000	8			7	2,718	51,250,722	32.5
	Phs-Cawth, Channel, 1963	11,000	13			4	14,201	142,403,971	39.0
	Phs-Krakama, 1958	11,530	5			2	3,666	10,170,642	38.0
	Phs-Soku, 1958	11,500	19			4	14,086	65,922,524	35.0
	Egb-Oguta, 1965	10,300	12			4	22,189	73,399,498	30.0
	Egb-Ahia, 1965	11,500	9			3	11,690	64,438,837	35.5
	Cesw-Nun R., 1974	....	5				7,893	15,805,636	37.0
	Cesw-Enwhe	....	2				837	1,752,017	30.0
	Cesw-Adibawa, 1966	11,950	17			1	7,873	29,037,739	30.0
	Cesw-Adibawa, NE	....	3				2,824	4,784,843	30.0
	Cesw-Etelebou, 1971	12,000	8				28,203	53,454,487	30.0
	Cesw-Kolo Cr., 1974	12,000	18			6	11,257	48,857,958	30.0
	Cesw-Diebu Cr., 1974	....	12				25,453	51,342,379	30.0
	Cesw-Ubie, 1961	14,380	4				4,805	12,949,479	30.0
	Phl-Isimiri, 1964	5,900-11,000	6				5,412	25,769,567	28.8
	Phl-Ebubu, 1958	8,200	4			3	1,245	16,414,274	26.0
	Phl-Obele, 1964	10,000	4			1	986	3,154,168	22.0
	Phl-Bodo W., 1962	9,700	9			2	8,448	60,741,737	22.5
	Phs-Ekulama, 1958	10,483	27			2	29,035	64,117,442	20.2
	Phs-Obeakpu, 1975	....	2				6,072	2,210,701	30.0
	Egb-Assa, 1961	11,300	2				1,266	2,958,786	17.5
	Egb-Egbema, 1960	10,470	4			1	7,725	36,470,609	28.0
	Egb-Egbema W.	....	14			1	25,207	32,040,199	28.0
	Phs-Orubiri, 1971	...	3			3	1,841	4,855,860	35.0
	Other		7			32	997	47,396,170	
	Total Nigeria		**1,289**		**23**	**305**	**1,671,968**	**6,416,807,589**	

WEST AND CENTRAL AFRICA

FIGURE III - 1

OILFIELDS AND CRUDE OIL PIPELINES IN NIGERIA (1979)




WEST AND CENTRAL AFRICA
FIGURE III-2
OILFIELDS IN
GABON (1979)
LEGEND
oil field
crude oil pipeline
pipelines planned or under construction
cities
ports
GABON
GONGOUE
N. TOMBENYONI
POINTE WEZE
MPORALOKO
BILAPE
Ogooue
CHIKAWAR
REMBO - KOTO
ODOMBO
ASSEWE
IKENGE
OMBOUE
BREME
LOANDA
ANIMBA
TCHENGUE
CAPE LOPEZ
CLAIRETTE
PORT GENTIL
CAPE LOPEZ
PORT GENTIL-OCEAN
OCEAN
ANGUILLE
OZOURI
DOREE
TORPILLE
MEROU
GIRELLE
GRONDIN
MANDAROS
BARBIER
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40 KM.
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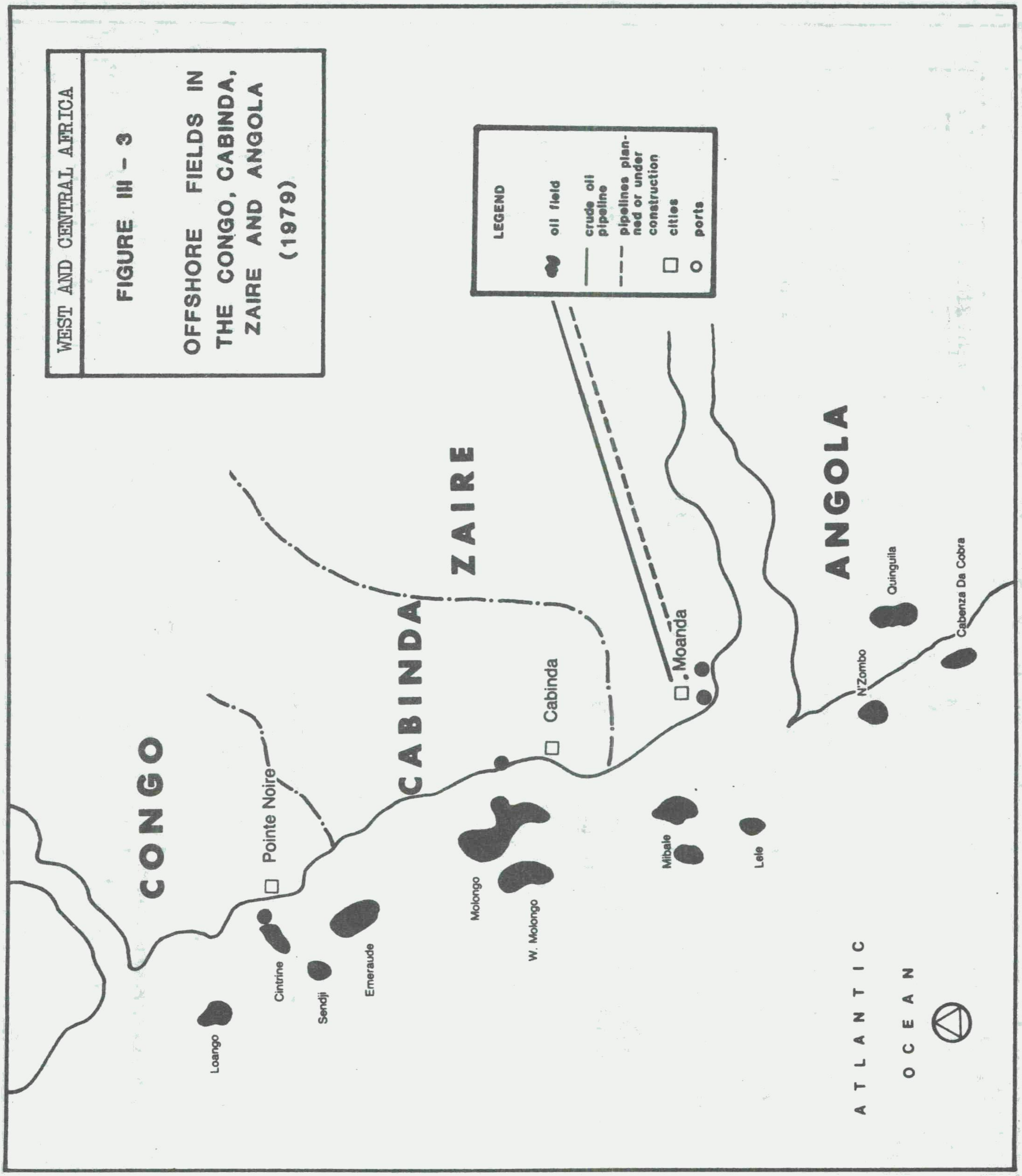
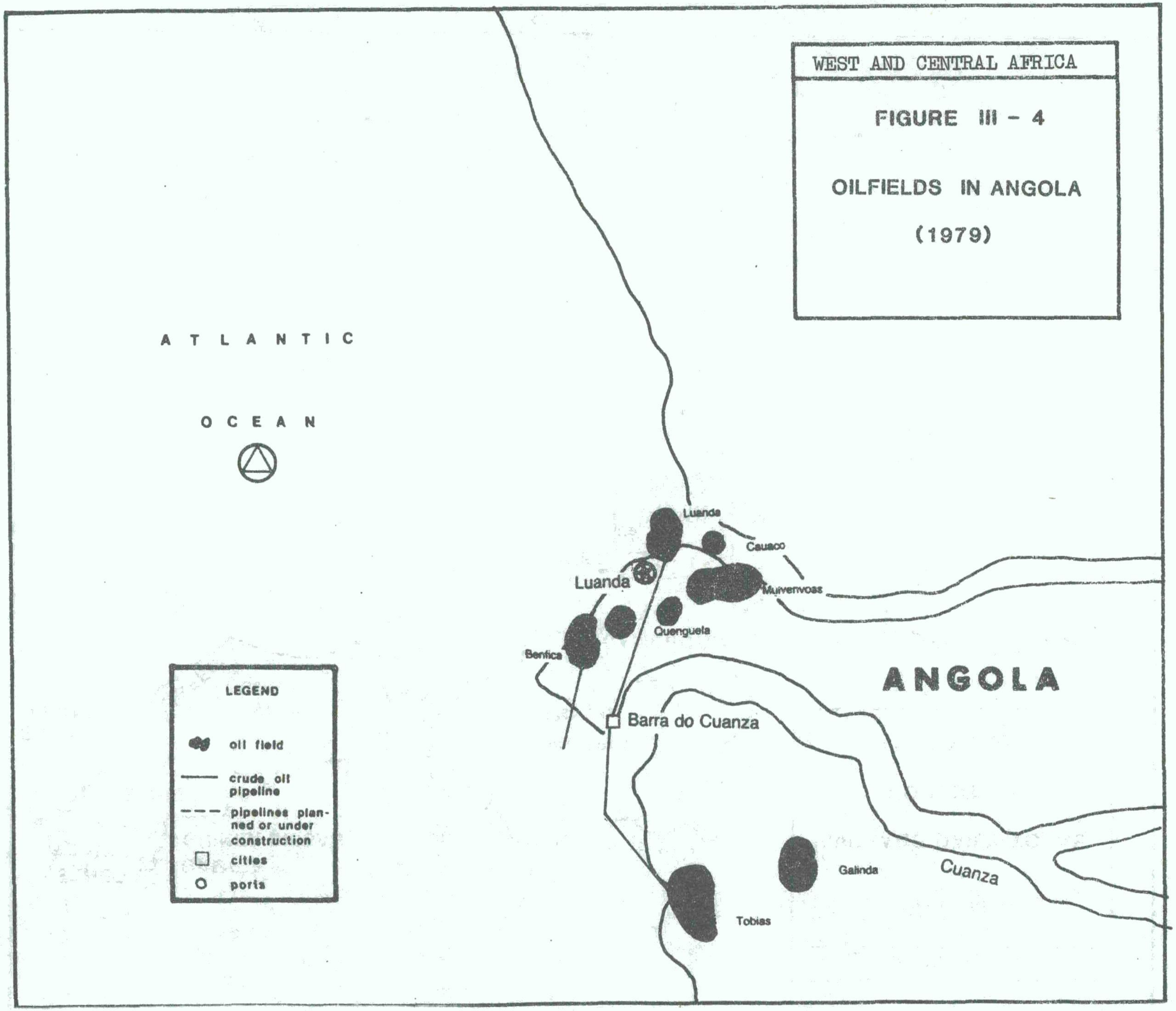


WEST AND CENTRAL AFRICA

FIGURE III - 3

OFFSHORE FIELDS IN THE CONGO, CABINDA, ZAIRE AND ANGOLA (1979)

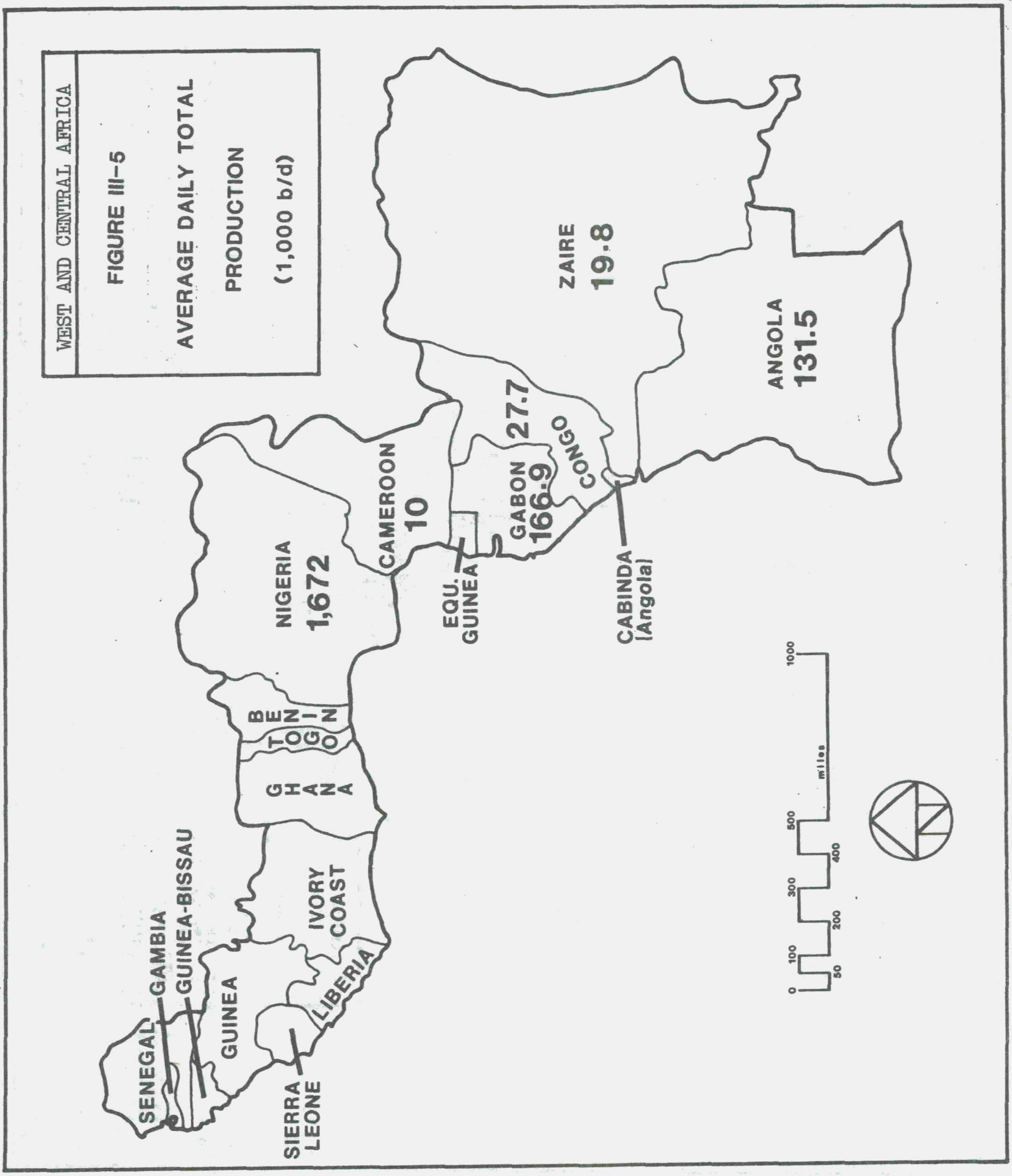


WEST AND CENTRAL AFRICA

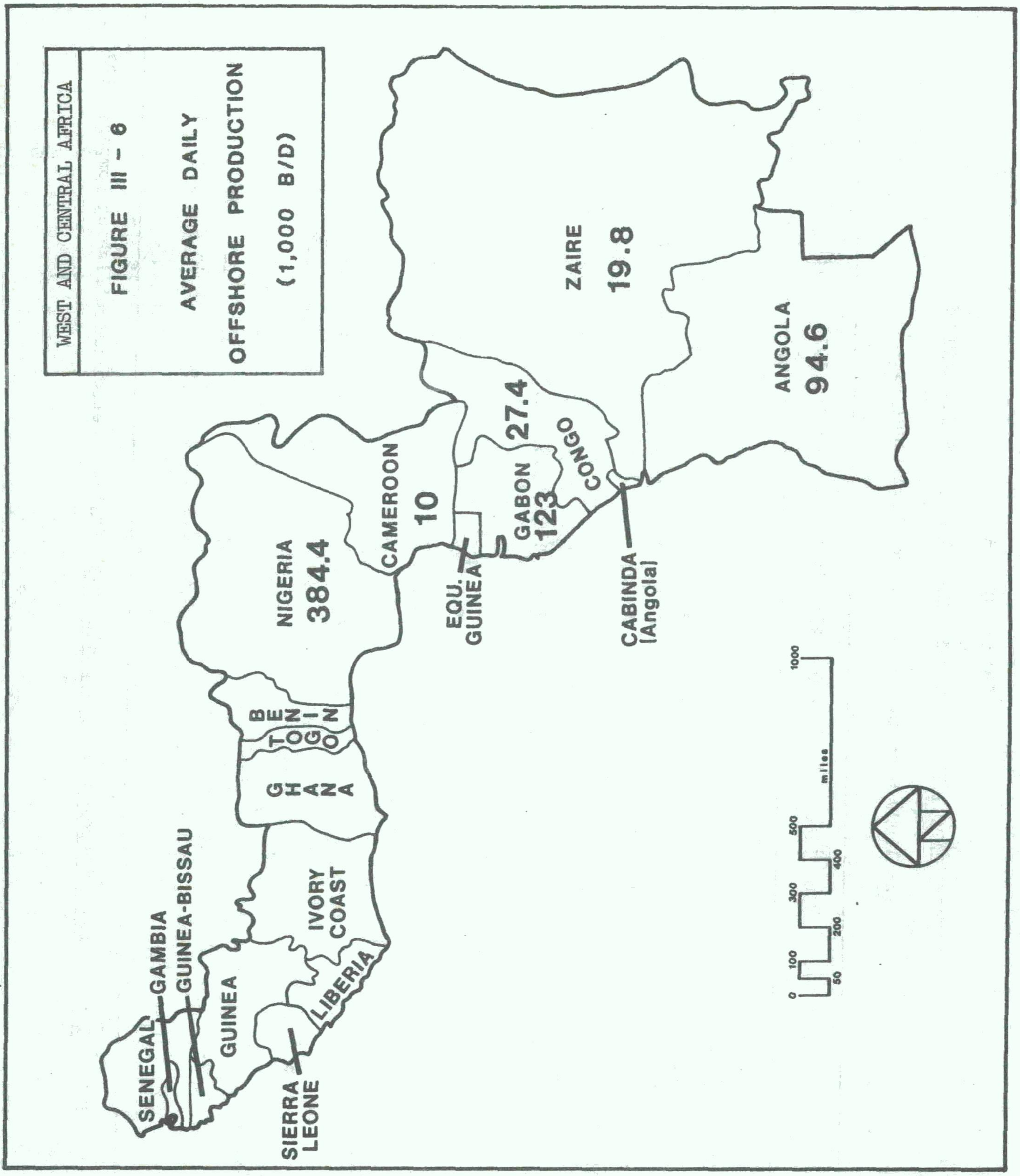
FIGURE III - 4

OILFIELDS IN ANGOLA

(1979)



WEST AND CENTRAL AFRICA
FIGURE III-5
AVERAGE DAILY TOTAL
PRODUCTION
(1,000 b/d)
ZAIRE
19.8
ANGOLA
131.5
27.7
CONGO
GABON
166.9
CAMEROON
10
NIGERIA
1,672
EQU. GUINEA
CABINDA
(Angola)
BENIN
TOGO
GHANA
IVORY COAST
LIBERIA
GUINEA
SIERRA LEONE
SENEGAL
GAMBIA
GUINEA-BISSAU
0
50
100
200
300
400
500
miles
1000



WEST AND CENTRAL AFRICA

FIGURE III - 6

AVERAGE DAILY OFFSHORE PRODUCTION (1,000 B/D)

TABLE III - 5

REFINING CAPACITY IN FIVE WEST AND CENTRAL AFRICAN NATIONS

(a: 1,000 barrels/day - b: million tons/year)

	1940	1950	1960	1965	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
ANGOLA/CABINDA														
a.			2	12	20	14	14	16	25	36	35	32	32	32
b.			0.1	0.6	1.0	0.7	0.7	0.8	1.2	1.8	1.7	1.7	1.7	1.7
GHANA														
a.				27	29	29	28	27	25	28	28	26	26	26
b.				1.3	1.4	1.4	1.4	1.3	1.2	1.4	1.4	1.4	1.4	1.4
IVORY COAST														
a.					19	19	22	24	44	44	40	41	39	39
b.					0.9	0.9	1.1	1.2	2.2	2.2	1.8	2.0	1.8	1.8
NIGERIA														
a.					40	46	55	60	60	60	57	50	60	159
b.					2.0	2.3	2.7	3.0	3.0	3.0	2.8	3.0	3.0	7.9
SENEGAL														
a.				23	13	13	12	12	18	15	12	19	20	20
b.				1.1	0.6	0.6	0.6	0.6	0.9	0.7	0.6	1.0	1.1	1.1

SOURCE: International Petroleum Encyclopedia 1979 (Tulsa: Petroleum Publishing Company, 1980).

TABLE III - 6

WORLD REFINING CAPACITY AS OF DECEMBER 31

(thousands of barrels per day)

	1940	1950	1960	1970	1977	1978	Percent of World Total at 12/31/78
NORTH AMERICA, TOTAL	4,783	7,040	11,795	15,391	20,587	20,870	26.6
Canada	222	340	1,002	1,604	2,126	2,225	2.8
Mexico	100	160	393	494	1,384	1,244	1.6
United States(1)	4,461	6,540	10,400	13,293	17,077	17,401	22.2
SOUTH AMERICA, TOTAL	806	1,263	2,706	4,986	7,045	7,082	9.0
Argentina	94	152	238	456	655	655	0.8
Brazil	7	7	208	504	1,161	1,209	1.5
Netherlands Antilles	505	624	680	790	842	842	1.1
Trinidad and Tobago	79	100	295	438	461	461	0.6
Venezuela	76	285	962	1,526	1,446	1,446	1.9
Others	45	95	323	1,272	2,480	2,469	3.1
WESTERN EUROPE, TOTAL	480	1,034	4,476	15,359	20,278	20,329	25.9
France	152	363	843	2,527	3,456	3,469	4.4
Germany, West	69	112	846	2,495	3,081	3,103	4.0
Italy	57	102	819	3,359	4,241	4,197	5.3
Netherlands	15	98	459	1,604	1,869	1,857	2.4
United Kingdom	144	252	949	2,456	2,911	2,527	3.2
Others	43	107	560	2,918	5,170	5,176	6.6
AFRICA, TOTAL	18	41	122	856	1,467	1,667	2.1
Algeria	0	0	0	48	122	122	0.1
Egypt	17	41	93	175	234	251	0.3
Libya	0	0	0	9	135	137	0.2
Nigeria	0	0	0	46	60	159	0.2
Union of South Africa	1	0	25	239	446	478	0.6
Others	0	0	4	339	470	520	0.7
MIDDLE EAST, TOTAL	410	924	1,483	2,592	3,506	3,546	4.5
Iran	333	500	495	645	910	921	1.2
Kuwait	0	25	220	489	712	712	0.9
Saudi Arabia	0	140	189	395	586	487	0.6
Turkey	0	1	7	286	326	338	0.4
Others	77	258	572	777	972	1,088	1.4
FAR EAST AND OCEANIA, TOTAL	274	300	1,431	6,242	10,177	10,285	13.1
Australia and New Zealand	4	19	241	706	709	782	1.0
Brunei, Malaysia, and Singapore	10	10	46	505	1,086	1,058	1.3
Indonesia	180	206	320	268	528	528	0.7
Japan	53	48	684	3,437	5,467	5,480	7.0
Others	27	17	140	1,326	2,387	2,437	3.1
SINO-SOVIET COUNTRIES (2)	904	1,141	3,409	7,953	13,889	14,748	18.8
TOTAL WORLD	7,675	11,743	25,422	53,379	77,399	78,527	100.0

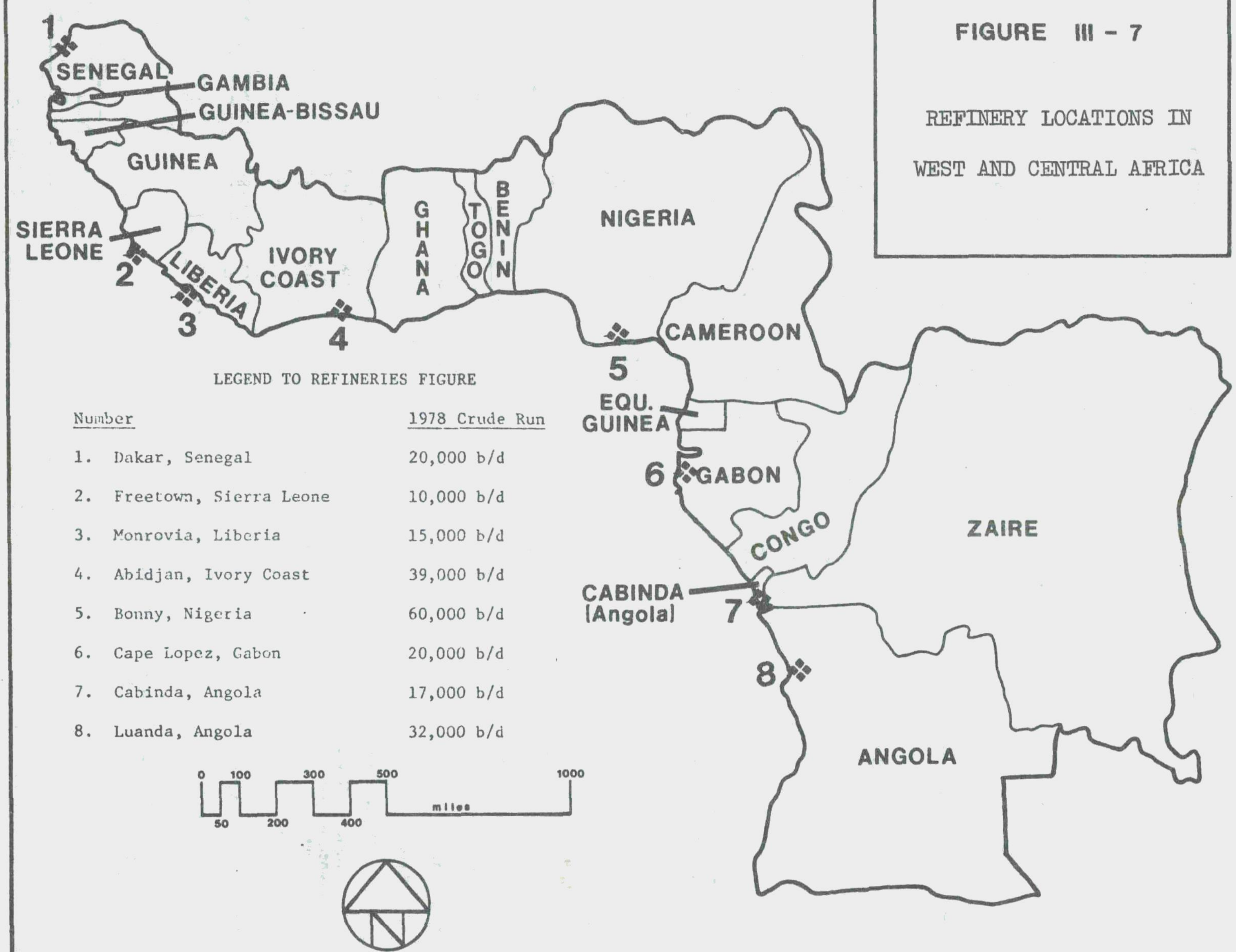
(1) Excludes shutdown refining capacity.
(2) Includes Eastern Europe and Cuba.

SOURCE: Twentieth Century Petroleum Statistics 1979 (Dallas: DeGolyer and MacNaughton, 1979), p. 19. This source cites the U.S. Dept. of Energy and "Oil and Gas Journal".

WEST AND CENTRAL AFRICA

FIGURE III - 7

REFINERY LOCATIONS IN WEST AND CENTRAL AFRICA



LEGEND TO REFINERIES FIGURE

Number		1978 Crude Run
1.	Dakar, Senegal	20,000 b/d
2.	Freetown, Sierra Leone	10,000 b/d
3.	Monrovia, Liberia	15,000 b/d
4.	Abidjan, Ivory Coast	39,000 b/d
5.	Bonny, Nigeria	60,000 b/d
6.	Cape Lopez, Gabon	20,000 b/d
7.	Cabinda, Angola	17,000 b/d
8.	Luanda, Angola	32,000 b/d

TABLE III - 7

REFINING SURVEY OF NINE WEST AND CENTRAL AFRICAN NATIONS

(All figures are barrels/calendar day)

Company and Refinery Location	Crude	Catalytic Cracking	Catalytic Reforming
ANGOLA:			
Companhia de Petróleos de Angola, Luanda	32,100	---	1,900
GABON:			
Société Gabonaise de Raffinage, Port Gentil	20,000	---	1,400
GHANA:			
Ghanaian Italian Petroleum Co., Tema	26,000	---	4,750
IVORY COAST:			
Société Ivoirienne de Raffinage, Abidjan	39,000	---	5,900
NIGERIA:			
Nigerian Petroleum Refining Co., Ltd.			
Alesa-Eleme	59,000	---	6,000
Warri	100,000	26,000F	---
Total	159,000	26,000	6,000

Company and Refinery Location	Crude	Catalytic Cracking	Catalytic Reforming
SENEGAL:			
Société Africaine de Raffinage, M'Bao (Dakar)	20,138	---	2,114
SIERRA LEONE:			
Sierra Leone Petroleum Refining Co., Ltd. Freetown	10,000	---	---
TOGO:			
Ste. Togolaise des Hydrocarbures, Lome	20,000	---	3,020
ZAIRE:			
Sozir - Société Zairo-Italienne de Raffinage, Muanda	17,000	---	3,000

SOURCE: International Petroleum Encyclopedia 1979 (Tulsa: Petroleum Publishing Co., 1980).

Oil Pollution from Production and Refining

Oil pollution from production can come from a number of sources. These include dramatic spillages that are a short-lived phenomenon, such as platform fires, blowouts, collection pipeline accidents, and spillages associated with natural occurrences such as hurricanes. There are also chronic production-related causes in the form of drilling muds, deck drainage from platforms, and oil contained in produced formation water which is discharged into the sea. In reference to the latter type, J.E. Portmann, in his 1978 report on pollution in the Gulf of Guinea prepared for the FAO/UNEP, noted that at least 12 nations in the area either had or were building their own oil refineries. However, he also noted that only two of these have any form of treatment of the effluents before they are discharged into the ocean. Thus, oil pollution of the coastal waters by oily water discharges is inevitable and where the discharges are near to lagoons, the problem is particularly serious.[16]

That the matter of production- and refining-related oil pollution has become more critical is evidenced by the fact that in 1979 ten oil spills occurred that were related to these causes. The incidents involved a loss of 652,381 barrels of oils.

Analysis of the Probability of a Major Spill
Due to Offshore Production

Predicting potential production-related spillage is difficult, however, it is somewhat easier to do than for shipping-related spills, since likely locations are better defined. A recent analysis by the United States Coast Guard using U.S. spill data predicted that major production spills of 1,200 barrels or more per year could be calculated by the formula (No. Spills = .027V), where V is the total production in million tons per year.[17] Applying this formula to West and Central African production, experience would yield the rates listed in Table III-8 for each West African offshore producing country.

TABLE III-8

PROJECTED SPILL RATE

Country	Million Tons/Year	Accidents/Year
Angola	4.9	0.13
Cameroon	0.5	0.01
Congo	1.4	0.04
Gabon	6.4	0.17
Nigeria	20.0	0.54
Zaire	1.0	0.03
Total	34.2	0.92

This would indicate that one major production-related spill of over 1,000 barrels would occur in the West and Central African region each year. This would correspond to the actual number of spills reported in 1979; that is, there was only one major spill due to offshore production reported by any West and Central African nation to the Oil Spill Intelligence Report. The spill was the SBM-2 Bonny offshore spill on June 20, 1979.

Since the preceding is based on the prediction of large spills, it is most important to consider the number of lesser spills which might be anticipated. Based on U.S. experience, a figure of 486 spills per year from offshore production in this region would seem reasonable.[18] It is, however, doubtful that U.S. data is directly transferable to West and Central Africa. In areas of the world where monitoring of production is not similar, a different ratio of production volume to number of spills might be anticipated.

Data is not readily available to confirm whether a higher (or lower) rate should be applied for countries in West and Central Africa based on local production practices. Of course, the frequency of major oil spills is predicated on the oil spill technological base, training, and capability of rapid response for a spill within each individual country. Thus, those countries with an advance technology centre, training programme and rapid response capability will reduce the probability of a major oil spill occurring.

SECTION IV

OIL TRANSPORTATION IN WEST AND CENTRAL AFRICA

Based on tonnage, petroleum and natural gas dominate all trade flows in the world, through four common means of conveyance: via pipelines, tank trucks, railway tank cars, and tankers and barges. The size and capacities of these modes of oil transport have changed considerably as the demand for and cost of petroleum have increased. Of particular interest is the evolution of the oil-transporting tanker, which had humble beginnings in the 249 dwt, steam-powered Zoroaster built in 1878. One hundred years of development have added as much as 600,000 tons to the modern design, such that the largest super tankers cannot enter most of the ports of the world. While they are operationally economic for long-distance runs, they still must wait offshore to deliver their cargoes onto vessels of a shallower draft, or through offshore buoy systems and pipelines to shore.

The appearance of large tankers on the horizon has been linked to the increased appearance of small floating slicks of oil in the open ocean and to the increased deposition of tar and petroleum sludge on the shorelines of nearly all countries of the world. These result from the pumping of tank cleaning residue during return voyages. However, oil also can be introduced into the marine environment during the offshore or in-port transfer of petroleum from the transporting vessels.

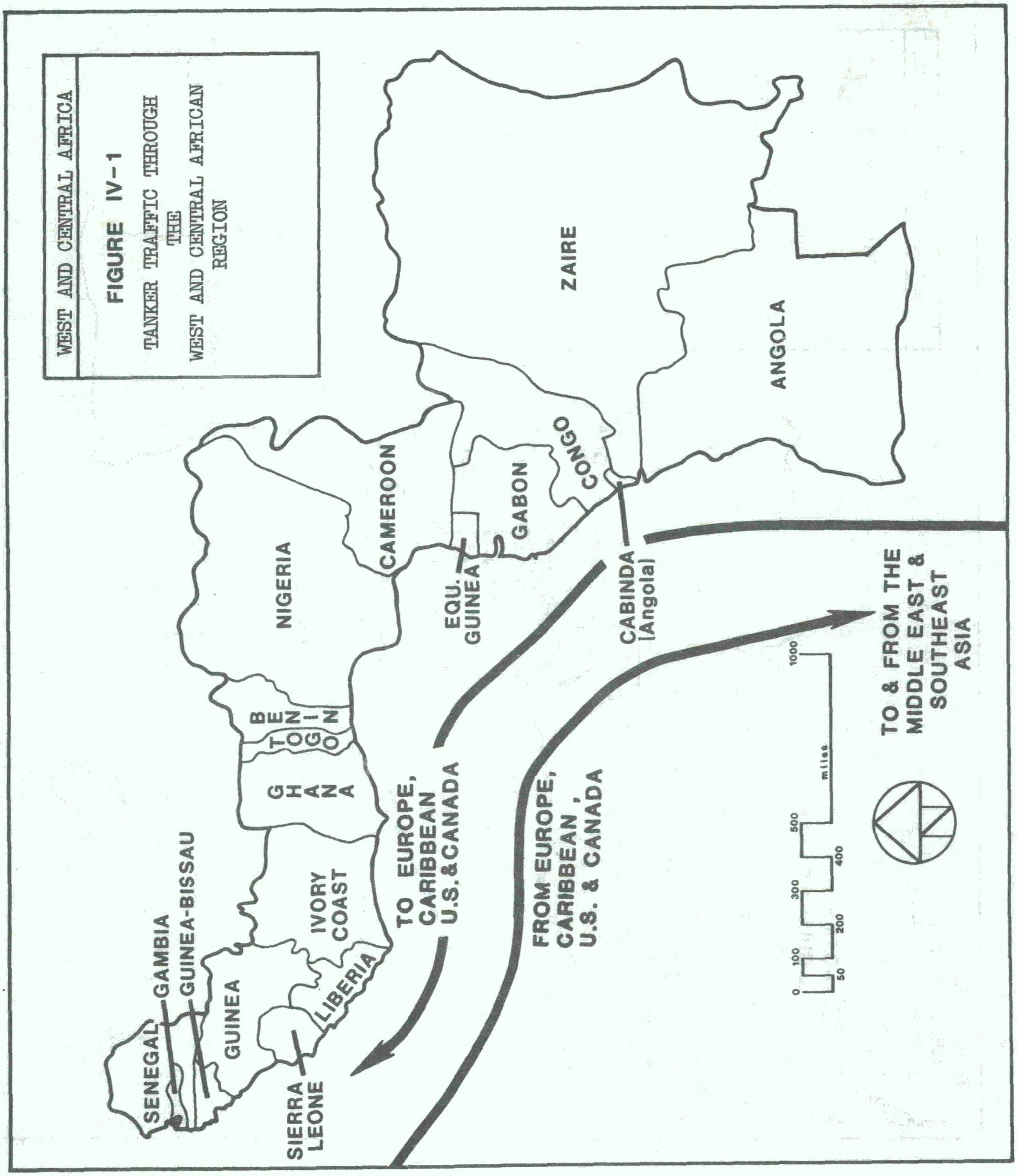
In her new role as an oil-bearing region, it is inevitable that West and Central Africa should begin to see some of these problems in the region, particularly due to the two transport-related conduits she provides. The region is a pathway for the shipment of crude oil coming out of the Middle East and bound for the United States, Europe and South America. In 1976, Western Europe imported 466.5 million tons of crude oil from the Middle East, and it has been estimated that 90 percent was transported via the Cape route.[19] Tankers travelling this way often make stops in the region to leave oil for refining. In addition, domestically produced and refined petroleum has become a regular export item for West and Central Africa; 111.5 million tons left the area in 1976 for European and American ports, and thus the levels of coastal shipping activity also have increased. Figures IV-1 and IV-2 show primary routes of tanker traffic through the area.

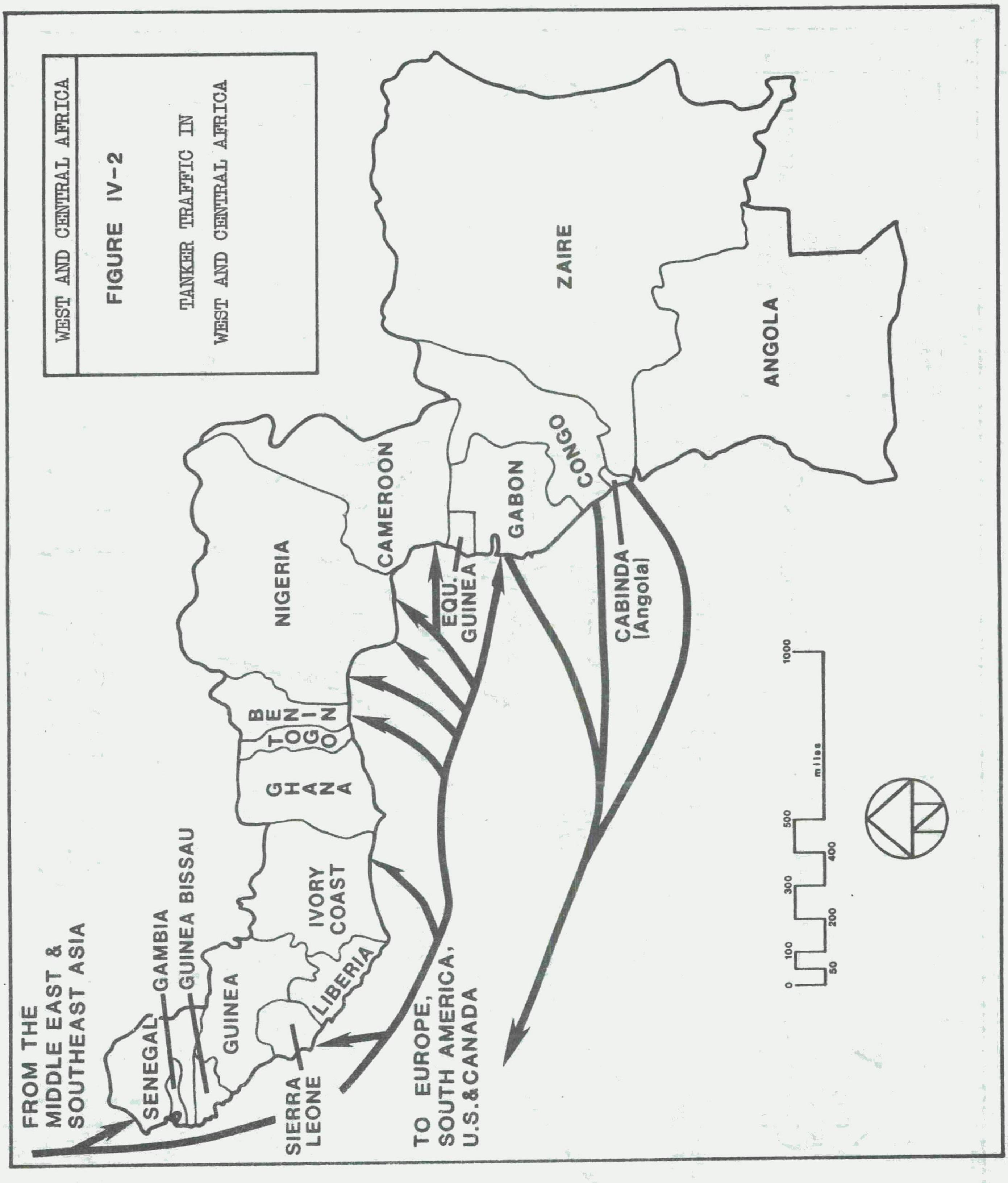
The extent to which West and Central Africa has experienced marine oil pollution problems as a result of on- and offshore shipping has been summarized by J.E. Portmann in a report on the status of oil pollution in the Gulf of Guinea.[20] After studying

WEST AND CENTRAL AFRICA

FIGURE IV-1

TANKER TRAFFIC THROUGH
THE
WEST AND CENTRAL AFRICAN
REGION





WEST AND CENTRAL AFRICA

FIGURE IV-2

TANKER TRAFFIC IN
WEST AND CENTRAL AFRICA

the problem for 14 West and Central African countries, Portmann reported that nearly three-quarters of the nations have "common" to "serious" levels of oil pollution on their beaches.

> . . . In most cases the countries visited attributed their oil pollution problems to the offshore tanker traffic moving around the Cape between Europe and the Middle East. Undoubtedly, this is the cause of some of the problem, e.g., in Senegal and in the Gulf of Guinea proper and Bight of Benin, where any surface oil would be expected to move under the influence of the prevailing currents and wind to be stranded on the beaches . . .[21]

However, he notes that the worst problems with oil pollution occur in and around the areas with ports, especially those handling oil exports and imports, which suggests that "part of the problem is caused by inadequate facilities to contain oil spillages and failure to provide proper reception facilities for tank washings."

Naturally, the seriousness of oil pollution problems in West and Central Africa will depend on the extent of traffic passing by offshore or traffic entering into coastal ports. In the following pages, the specific factors within this region will be reviewed in a series of charts, tables and figures. Included in the discussion will be the locations and activity of ports, transshipping terminals and lightering points in West and Central Africa; and additional comment on oil pollution resulting from collisions, groundings, loading and unloading, tank washings, and other related causes.

West and Central African Tanker Traffic

With the exception of Liberia, the countries of this region have virtually no registered fleets of tank ships, as indicated in Table IV-1, which lists world tank ship fleets by flag of registry. Nonetheless, the coastline is studded with ports which can accommodate and regularly receive tankers of many sizes. Figure IV-3 illustrates the locations of major ports in each country. Tables IV-2 and IV-3 augment this information by giving the vessel capacity by size for ports in Angola, the Congo, Gabon, Ivory Coast, Nigeria, Senegal, Sierra Leone, Togo and Zaire, as well as the channel depths for major ports on the coast.

VLCC Traffic in West and Central Africa

The emergence of the Very Large Crude Carrier (VLCC) tanker has been motivated largely by economics. The expanding demand for petroleum products since World War II has caused the distance between producers and consumers to become an important factor. The savings in transporting oil by a VLCC over these long distances, compared to a smaller tanker, is substantial.

TABLE IV - 1

WORLD TANK SHIP FLEET BY FLAG OF REGISTRY

OCEAN-GOING VESSELS 2,000 GROSS TONS AND OVER

(as of December 31, 1977)

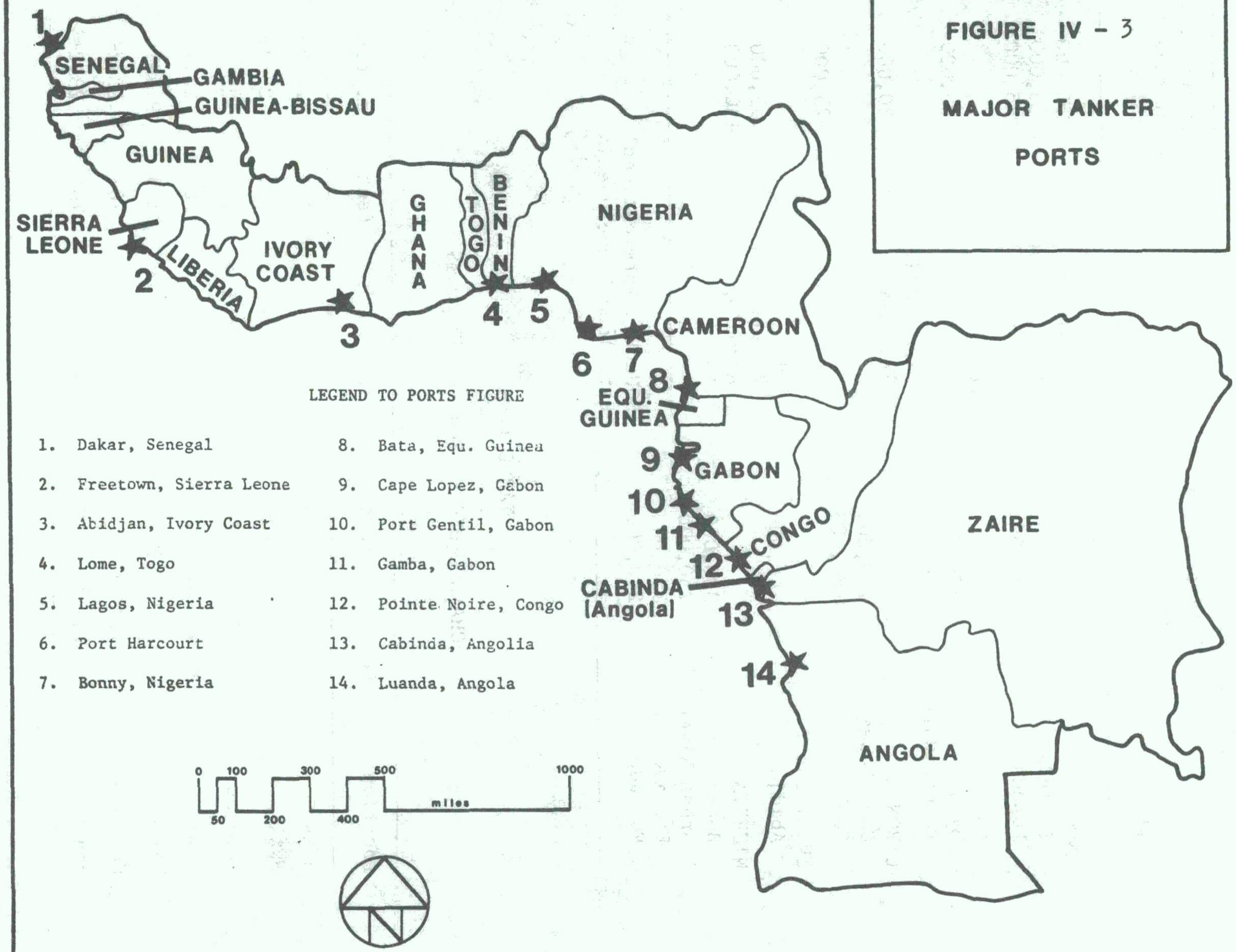
Flag of Registry	Number	Gross Tons (000's)	D.W.T. (000's)	Average D.W.T.	T2-SE-A1 Equivalents Number	T2-SE-A1 Equivalents Percent of World
NORTH AMERICA, TOTAL	354	7,678	13,924	39,000	927.9	3.7
Canada	27	187	282	10,400	16.2	0.1
Mexico	29	363	587	20,200	36.3	0.1
United States	298	7,128	13,055	43,800	875.4	3.5
SOUTH AMERICA, TOTAL	347	9,965	18,623	54,000	1,204.9	4.5
Argentina	46	585	887	19,300	55.5	0.2
Brazil	56	1,971	3,531	63,000	229.7	0.9
Panama	212	6,842	13,002	61,300	843.3	3.3
Venezuela	14	262	386	27,600	24.4	0.1
Others	19	305	817	43,000	52.0	0.0
WESTERN EUROPE, TOTAL	1,877	86.149	160,637	85,600	10,391.6	41.5
Denmark	51	2,499	4,765	93,400	305.6	1.2
France	129	8,541	16,232	125,800	1,056.2	4.2
Germany, West	67	3,625	6,941	103,600	446.9	1.8
Greece	354	10,949	20,181	57,000	1,304.5	5.2
Italy	178	6,758	12,450	69,900	823.7	3.3
Netherlands	61	2,364	4,336	71,000	278.7	1.1
Norway	355	19,295	36,339	102,300	2,355.2	9.3
Spain	102	4,434	8,203	80,400	523.7	2.1
Sweden	78	4,809	9,355	119,900	605.2	2.4
United Kingdom	374	19,284	35,408	94,700	2,275.5	9.0
Others	128	3,591	6,427	35,100	416.4	1.9
AFRICA, TOTAL	1.186	62,986	125,804	106,000	8,168.1	32.4
Algeria	17	748	1,223	71,900	81.6	0.4
Egypt	7	149	278	39,700	17.2	0.1
Liberia	1,112	59,909	120,347	108,200	7,813.2	30.9
Others	50	2,180	3,956	79,500	256.1	1.0
MIDDLE EAST, TOTAL	61	3,041	5,534	90,700	354.6	1.3
Iran	10	573	1,091	109,000	69.9	0.3
Iraq	18	905	1,720	95,500	111.7	0.4
Kuwait	12	1,215	2,148	179,000	136.8	0.5
Turkey	21	348	575	27,400	36.2	0.1
Others	-	-	-	-	-	-
FAR EAST AND OCEANIA, TOTAL	659	29,214	54,031	82,000	3,462.7	13.8
Australia	13	333	568	43,700	36.4	0.1
India	50	1,918	3,406	68,100	221.3	0.9
Indonesia	15	75	116	7,700	6.6	0.0
Japan	403	21,706	40,439	100,300	2,596.1	10.3
South Korea	29	774	1,425	49,100	87.7	0.4
Singapore	90	3,252	6,147	68,300	394.7	1.6
Others	59	1,156	1,930	33,700	119.9	0.5
SINO-SOVIET COUNTRIES, TOTAL	529	7,316	11,612	21,900	724.5	2.8
China	53	964	1,664	31,400	106.2	0.4
Cuba	6	52	79	13,200	5.1	0.0
U.S.S.R.	408	4,692	7,084	17,400	450.3	1.8
Eastern Europe (excluding U.S.S.R.)	57	1,519	2,629	46,100	152.7	0.6
North Korea	5	89	156	31,200	10.2	0.0
TOTAL WORLD	5,013	206,349	390,165	77,800	24,233.9	100.0

SOURCE: Twentieth Century Petroleum Statistics 1979 (Dallas: DeGolyer and MacNaughton, 1979), p. 20. This source cites "Analysis of World Tank Ship Fleet", Sun Oil Company, Sun Shipbuilding and Dry Dock Company, and Bulk Cargo Ship Product Group.

WEST AND CENTRAL AFRICA

FIGURE IV - 3

MAJOR TANKER PORTS



LEGEND TO PORTS FIGURE

1. Dakar, Senegal
2. Freetown, Sierra Leone
3. Abidjan, Ivory Coast
4. Lome, Togo
5. Lagos, Nigeria
6. Port Harcourt
7. Bonny, Nigeria
8. Bata, Equ. Guinea
9. Cape Lopez, Gabon
10. Port Gentil, Gabon
11. Gamba, Gabon
12. Pointe Noire, Congo
13. Cabinda, Angolia
14. Luanda, Angola

TABLE IV-2

TANKER PORTS

Port	Estimated max. vessel size in DWT current
ANGOLA	
Cabinda	100,000
Luanda	50,000
CONGO	
Djeno	120,000
Pointe Noire	20,000
GABON	
Cape Lopez	250,000
Gamba	80,000
IVORY COAST	
Abidjan	40,000
NIGERIA	
Bonny	300,000
Brass River	250,000
Escravos	350,000
Forcados	250,000
Pennington	250,000
Port Harcourt	33,000
Qua Iboe	255,000
SENEGAL	
Dakar	35,000
SIERRA LEONE	
Freetown	30,000
TOGO	
Lome	25,000
ZAIRE	
Banana	55,000
Ango Ango	±30,000

SOURCE: International Petroleum Encyclopedia

TABLE IV-3

CHANNEL DEPTHS FOR TANKER PORTS

Location	feet	meters	Location	feet	meters
Dakar	6-10	1.8- 3.0	Bata	76+	23.2+
Freetown	31-35	9.4-10.7	Cape Lopez	76+	23.2+
Abidjan	31-35	9.4-10.7	Port Gentil	76+	23.2+
Lome	41-45	12.5-13.7	Gamba	76+	23.2+
Lagos	26-30	7.9- 9.1	Pointe Noire	31-35	9.4-10.7
Pt. Harcourt	26-30	7.9- 9.1	Cabinda	76+	23.2+
Bonny	36-40	11.0-12.2	Luanda	76+	23.2+

One of the several cost-saving aspects concerns the size of the crew and their living and working quarters; these are not much greater on a VLCC than on a mid-sized tanker, therefore the cost of manning the larger vessel in relation to the amount of oil carried is less. Another factor is that overall surface area does not increase in proportion to volume when constructing a VLCC. In addition, the size of a ship's engine does not increase in proportion to the ship's size, because of the hydrodynamic efficiencies of a larger vessel.

Approximately 586 million tons of oil per year are being transported around the Cape of Good Hope from the Middle East to destinations in the United States, Western Europe, Canada and other countries in the Western Hemisphere. With the addition of 120 million tons of oil per year being exported by West and Central African countries, the total volume of oil passing along the West and Central African coast annually is about 706 million tons. These figures include each oil shipment once; e.g., oil shipped to a transshipping terminal and then reshipped to its final destination is considered to be one overall shipment through the area.

At the present time, it is believed that approximately half of this oil is transported on VLCCs (super tankers) averaging 200,000 tons and the other half in mid-sized or handy-sized ships averaging 60,000 tons. Thus, there would be 1,765 super tanker passages per year and 5,883 mid-sized voyages per year along the West and Central African region. This would average five super tankers and 16 mid-sized tankers entering and leaving the region each day. Assuming each tanker traverses 2,500 nautical miles along the coast at an average of 200 nautical miles a day, the approximate time spent in the region would be 12.5 days for a one-way voyage.

Thus, at any one time there could be as many as 63 loaded VLCCs and 63 returning VLCCs; in the mid-sized range, 200 loaded and 200 returning ships might be traversing the coast. This computation does not take into account the extra numbers of smaller tankers utilized in transshipping and lightering service.

Tanker Related Accidental Spills

Table IV-4 lists the reported transportation-related oil spills in the West and Central African region for 1975 to 1980. Factors which influence the occurrence of accidental pollution incidents from tankers are: traffic density, crossing traffic, width of navigable area, varying visibility and weather, navigational constraints (i.e., shoals, rocks, islands), routeing systems and traffic advisory systems, rounding of headlands, navigational aids, navigational data, hydrographic data, and the nature of the bottom terrain. The positive factors for West and Central Africa are low traffic, large sea room, and parallel traffic. Conversely, the negative factor

TABLE IV-4

OIL SPILL INCIDENTS IN WEST AND CENTRAL AFRICA, 1975-1980

SHIP NAME	DATE	LOCATION	NATURE OF INCIDENT	POLLUTION
MOBIL REFINER	12/17/75	Douala, Cameroon	Collision	45 tons bunker fuel
UNIVERSE DEFIANCE	4/16/77	Off Senegal	Explosion in engine room	Bunker fuel - unknown quantity
UNILUCK (not tanker)	10/26/77	4 miles from Fouche Island, Nigeria	Grounding	Fuel oil - unknown quantity
ARZEN	11/01/77	Cotonou (Dahomey)	Fire while discharging	50-5,000 BBL white product
COSTATHINA (not tanker)	7/17/78	1.25 miles north Cape Vert, Senegal	Grounding	Fuel oil - quantity unknown
PETRO BOUSCAT	6/21/79	20 miles south of Douala, Cameroon	Grounding	Fuel oil - quantity unknown
IOANNIS ANGELI COUSSIS	8/16/79	Louanda, Angola ($6^{o}16'S$, $11^{o}33'E$)	Explosion and sinking	Ship discharging crude unknown quantity
SALEM	1/16/80	off Senegal ($12^{o}38'N$, $18^{o}34'W$)	Explosion and sinking	"Theoretically" loaded with 200,000 tons of Kuwait crude
MARIA ALEJANDRA	3/11/80	Off Mauritania ($20^{o}32'N$, $18^{o}13'W$)	Explosion and sinking	Ship in ballast - unknown quantity
MYCENE	4/03/80	off the Ivory Coast	Explosion and sinking	Ship in ballast - unknown quantity

areas are navigational aids and marks, variable visibility, hydrographic data, and shallow water depths. Weighing both sets of factors, the degree of risk for West and Central Africa, compared to other areas around the world, is low.

A rough calculation of the potential for a tanker-related spill within 50 miles of land can be calculated. Tables IV-5 to IV-7 present analyses of worldwide tanker accidents for the period of 1969 to 1972. These charts examine accidents by type, location and size of ship, as well as provide a method for calculating expected spill volumes and frequency, based on the number of port calls, volume of cargo, and number of vessel years.

These statistics have been used with crude oil throughput for the West and Central African region; the results are presented in Table IV-8. This analysis indicates a likelihood of 1.15 spills per year, averaging 1,000 metric tons, within 50 miles of land. This also projects 0.26 spills per year, averaging 3,338 metric tons of oil, outside of 50 miles from land.

Predicting future spills from present and planned oil transportation operations is important in developing oil spill prevention and control methods, contingency planning, and predicting environmental impact from these spills. When estimating the potential of tanker-related spills, a selection of appropriate exposure variables is necessary. The most common variables used are the volume of cargo transported, number of tanker port calls, and the time that tankers are at risk in a particular area. Since there is no one best variable which can be used, the selection process dictates weighing all factors and selecting the best for each individual case. When weighing these factors, historical data should be functionally compatible with the selected variable.

From international data compiled during 1969 to 1972, Beyer and Painter developed parameters to find the mean spill frequency and mean spill size.[20] These parameters are listed in Table IV-8 and constitute one method of predicting tanker casualty spills. When comparing this example to those developed by the U.S. Coast Guard (1979), certain variations are noted. Beyer and Painter found that spills would occur 0.92 times per 1,000 port calls, or 0.020 times per vessel-year. The U.S. Coast Guard found a spill rate of 0.050 per vessel-year from U.S. historical spill records.

TABLE IV-5

LOCATIONS AND CAUSES OF WORLDWIDE TANKER CASUALTY SPILLS, 1969-1972

	Breakdowns	Collisions	Explosions	Fires	Groundings	Rammings	Structural Failures	Others	Total
Spills in Coastal Waters (<50 miles from land):									
Number	10	171	32	48	171	43	36	11	522
Bbl. Spilled	457	1,394,347	285,630	43,402	1,379,580	64,095	383,925	167,213	3,718,649
Av. Size, Bbl.	46	8,154	8.926	904	8,068	1,491	10,665	15,201	7,124
Spills at Sea (>50 Mi. from land):									
Number	8	8	14	5	0	2	79	4	120
Bbl. Spilled	122,678	3,518	409.695	1,523	0	1,020	2,010,368	255,855	2,804,657
Av. Size, Bbl.	15,355	440	29,264	305	-	510	25,448	63,964	23,372
All Spills:									
Number	18	179	46	53	171	45	115	15	642
Bbl. Spilled	123,135	1,397,865	695,325	44,925	1,379,580	65,115	2,394,292	423,068	6,523,306
Av. Size, Bbl.	6,841	7,809	15,116	848	8,068	1,447	20,820	28,205	10,161

TABLE IV-6

WORLDWIDE TANKER CASUALTY SPILLS VS. VESSEL SIZE, 1969-1972

Vessel Size (dwt)	Average No. of Vessels	No. of Spills	Spills per Vessel/yr.	Volume Spilled (bbl.)	Bbl. Spilled per vessel per year	Average Spill Size (bbl.)
<10,000	2,885	148	0.013	159,435	13.5	1,058
10,000 - 19,999	1,119	155	0.035	1,715,040	383.3	11,078
20,000 - 29,999	638	104	0.041	760,170	297.8	7,298
30,000 - 39,999	450	68	0.038	1,462,583	812.3	21,488
40,000 - 49,999	298	37	0.031	768,075	644.3	20,783
50,000 - 59,999	209	26	0.031	199,058	237.8	7,643
60,000 - 69,999	153	21	0.034	71,145	116.3	3,390
70,000 - 79,999	150	15	0.025	108,255	180.8	7,230
80,000 - 89,999	95	17	0.045	59,055	155.3	3,473
90,000 - 99,999	91	8	0.022	97,665	268.5	12,203
100,000 - 149,999	128	14	0.028	1,004,700	1,960.5	71,813
150,000 - 199,999	35	3	0.021	1,223	9.0	420
≥200,000	121	26	0.054	116,903	241.5	4,455
All Vessels	6,368	642	0.025	6,523,305	255.8	10,148

SOURCE: A.H. Beyer and L.J. Painter, "Estimating the Potential for Future Oil Spills from Tankers Offshore Development and Onshore Pipelines," in Proceedings of the 1977 Oil Spill Conference (New Orleans: n.p. 1977).

TABLE IV-7

HISTORICAL PARAMETERS FOR PREDICTING

TANKER CASUALTY SPILLS WITHIN 50 MILES OF LAND

	Spill Frequency		Spill Size		Generally Suitable for use when:
Exposure Variable	Mean	Basis	Mean (bbl)	Basis	
Number of Port-Calls	0.92 spills/10^3 port-calls	1969-1970 worldwide spills <50 mi from land and 1969-1972 spills at 7 major U.S. ports	7,100	1969-1972 worldwide spills <50 miles from land.	The tanker fleet, total volume of cargo, and trade routes are known.
Volume of Cargo Transported	12 spills/10^9 bbl. transported.	1969-1972 worldwide spills <50 mi. from land.	7,100	same as above	Total volume of cargo is known, but tanker fleet and trade routes are uncertain.
Number of Vessel-Years	20 spills/10^3 vessel-years	1969-1972 world-spills <50 mi. from land.	7,100	same as above	Tanker fleet is known, but the total volume of cargo and trade routes are uncertain.

TABLE IV-8

POTENTIAL TANKER-RELATED SPILLS WITHIN 50 MILES OF LAND

(Based on volume of cargo transported)

Volume = 0.96×10^9 bbl/year

Spill Rate Experience

< 50 miles from land	12 spills/10^9 bbl
> 50 miles from land	2.76 spills/ 10^9 bbl

and

Expected Rate

< 50 miles from land	$0.96 \times 12 = 1.15$ spills/year
> 50 miles from land	$0.96 \times 2.76 = 0.26$ spills/year

Average Size of Spill

< 50 miles from land = 7,100 bbl or 1,000 metric tons

> 50 miles from land = 23,372 bbl or 3,338 metric tons

Operational Discharges

Of great importance to the West and Central African region are the discharges of tank washings into the Atlantic Ocean. These discharges amount to the greatest tanker-related dose of oil pollution into the marine environment.

Between 0.35 and 0.5 percent of a tanker's cargo may settle-out during long sea voyages. Due to the practice of discharging this residue into the sea - against the law in many countries - approximately 1,000 tons or 7,119 barrels on a single voyage of a 200,000-ton tanker could be discharged into the sea with tank wash water.

Newer techniques, such as load-on-top (LOT), crude oil washing, and segregated ballast can greatly reduce these operational discharges. It is in the best interests of West and Central African nations to support international efforts to reduce operational discharges.

SECTION V

VULNERABLE ENVIRONMENTAL SYSTEMS IN WEST AND CENTRAL AFRICA

In this section of the report, the various types of environmental systems in West and Central Africa will be discussed, along with their susceptibility to oil impact. A detailed evaluation of the environmental systems of each country is not possible due to the scope of this study, as well as the lack of available resources, however, primary components will be discussed.

The effects of oil spills and their ecological impact will be influenced by a number of factors, including: (a) oil dosage, i.e., the amount of oil impacting an area; (b) the type of oil; (c) meteorological conditions; (d) oceanographic conditions; (e) physical geography of the area; (f) turbidity of the water; (g) season; (h) the presence of other pollutants; (i) biota types; and (j) the treatment of the spill.

Little was located about the toxicity levels of the various crudes and petroleum products in relation to the species of biological life in West and Central Africa. The information on areas of likely oil spills resulting from production and transportation related activities are analysed in this section in light of the general meteorological and oceanographic trends in order to discern the environmental systems most likely to be impacted by future spills.

Biological Systems Vulnerable to Oil Impact

The biological systems vulnerable to impact by oil include mammals, birds, reptiles, fish, crustaceans, molluscs, polychaetes, zooplankton, and phytoplankton.

Oil pollution, whether it is due to a spill or the discharge of a crude oil or refined product, may damage the marine environment in many different ways:

(a) direct kill of organisms through coating and asphyxiation;
(b) direct kill through contact poisoning of organisms;
(c) direct kill through exposure to water-soluble toxic components of oil at some distance in space and time from the accident;
(d) destruction of the generally more sensitive juvenile forms of organisms;
(e) destruction of the food sources of higher species;
(f) incorporation of sub-lethal amounts of oil and oil products into organisms, resulting in reduced resistance to infection and other stresses (e.g., the principal cause of death in birds surviving the immediate exposure to oil);

(g) destruction of food values through the incorporation of oil and oil products into the marine environment;

(h) incorporation of carcinogens into the marine food chain and human food sources; and

(i) low level effects that may interrupt any of the numerous events necessary for the propagation of marine species and for the survival of those species which stand higher in the marine food chain.

In general, the biological communities most affected by oil spills exist in three distinct coastal habitats or zones. These zones are called supratidal, intertidal and subtidal; Figure V-1 shows this zonation in the marine environment. Mammals, reptiles, and waterfowl are found in the supratidal zone and will be discussed separately.

The intertidal zone is onshore between spring high water and spring low watermark and extends out to sea to include bottom sediments and the ocean water above, leading into the benthic zone. The subtidal and benthic zones are always submerged and will be discussed together.

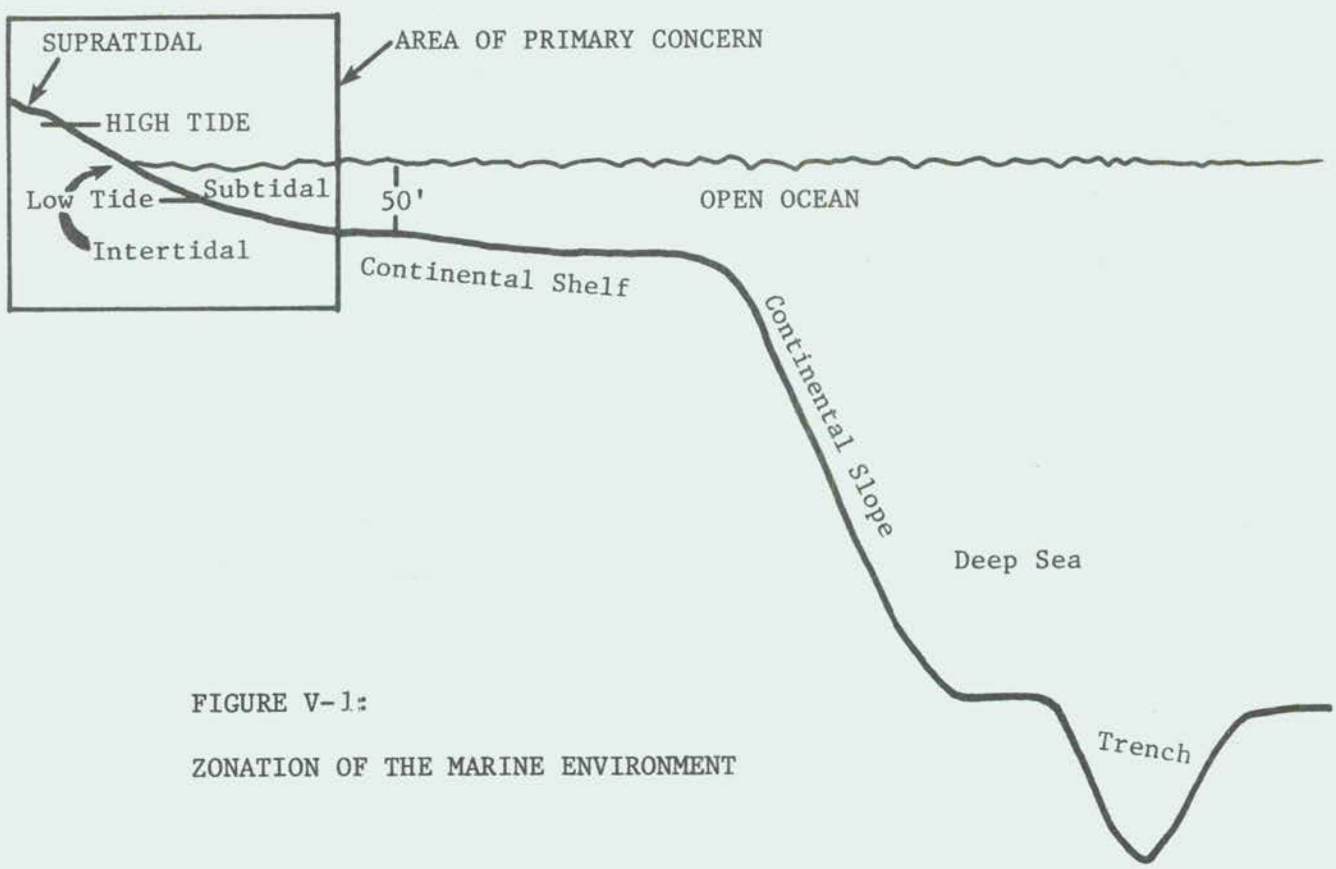


FIGURE V-1:

ZONATION OF THE MARINE ENVIRONMENT

Environmental Systems Vulnerable to Oil Impact

The environmental systems are made up of three interrelated groups: coastal systems, aquatic systems, and biological systems. Subgroups within each include:

COASTAL SYSTEMS: rocky beach, sheltered rocky coast, flat and fine-grained sandy beaches, steep and medium-to-coarse grained sandy beaches, gravel beaches, estuaries, mangroves, salt marshes, and intertidal zone.

AQUATIC SYSTEMS: bays and lagoons, open seas, benthic/subtidal zone, surf zone, and coral zone.

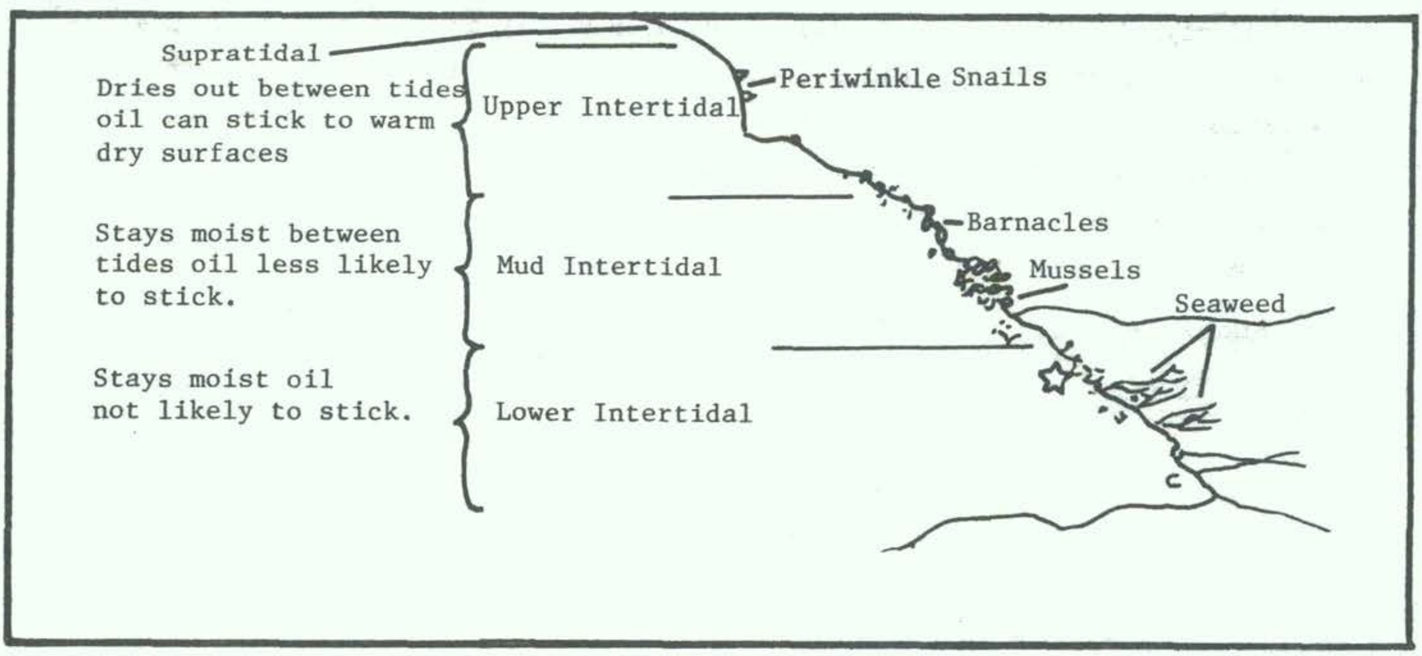
BIOLOGICAL SYSTEMS: mammals, water fowl, reptiles, fisheries, phytoplankton and zooplankton.

The coastal and aquatic systems comprise the habitats for the biological systems, and thus will be considered as ecological units.

1. Rocky Beach. The rocky coast is an ecological zone containing crevices in which many animals and plants make their homes, thus protecting themselves from the full force of the surf. The extent to which these areas are colonized depends on the tides, substrates, and degree of protection from the surf. The intertidal rocks provide a hard substrate for barnacles and mussels to attach to. Figure V-2 shows zonation of organisms on rocky shores.

These shores exist where the effect of the waves on the coastline is mainly erosive. It is a high energy zone with heavy wave action, so oil will be kept off the rocks. This creates a natural clean-up mechanism and additional control usually is not necessary.

FIGURE V-2: ZONATION OF ORGANISMS ON ROCKY SHORES



2. Sheltered Rocky Coasts. These types of shorelines have numerous coves and protected embayments along the rocky coastline. Wave activity in the areas ranges from low to moderate, depending on the degree of protection. In some areas, oil will degrade fairly rapidly, whereas in others the oil can remain for years. The biological community in this type of environment includes algae, molluscs, crustaceans, and infaunas. These and other communities occur extensively and are vulnerable to oil spill damage.

3. Flat, Fine-Grained Sandy Beaches. These types of beaches usually have a flat profile and are hard-packed, allowing traffic (i.e., vehicles) to move over the beach. Grain size is from 0.0625 mm to 0.25 mm. Since beach sands present an evershifting substrate, they are relatively free of larger organisms. Smaller burrowing organisms may be present, such as amphipods and surf clams.

The fine-grained sand limits the penetration of oils to a few centimetres below the surface. In removing oil, caution must be taken to wait until the oil is on the beach, to avoid repeatedly driving over the beach (which may further grind it beneath the surface), and to remove minimal amounts of sand to minimize beach erosion. Sand should be replaced if necessary to prevent erosion of the impacted beach.

4. Steeper, Medium-to-Coarse Grained Sandy Beaches. These types of beaches have a grain size of from 0.25 mm to 2.0 mm. They are present in many coastal environments, including those of low energy and high energy beaches. The surface of a sandy beach is vulnerable to wind and wave disturbance and therefore provides no firm anchorage for superficially attached plants and animals. Typically, biological activity is relatively low with the possible existence of a microscopic vegetation of diatoms and flagellates between the superficial sand grains.

Oil may sink 15 to 25 cm. into the sand, possibly being buried by natural processes at greater depths. Oil spill clean-up is difficult because of poor tracking across the loosely-packed sand. High energy beaches also can remove oil through natural cleaning mechanisms. Oil deposited due to above-normal wave action during storm surges and high spring tides should be removed. Removal also should take place on the beaches of low energy, where wave-action is at a minimum.

Figure V-3 shows the zonation of organisms on sandy beaches.

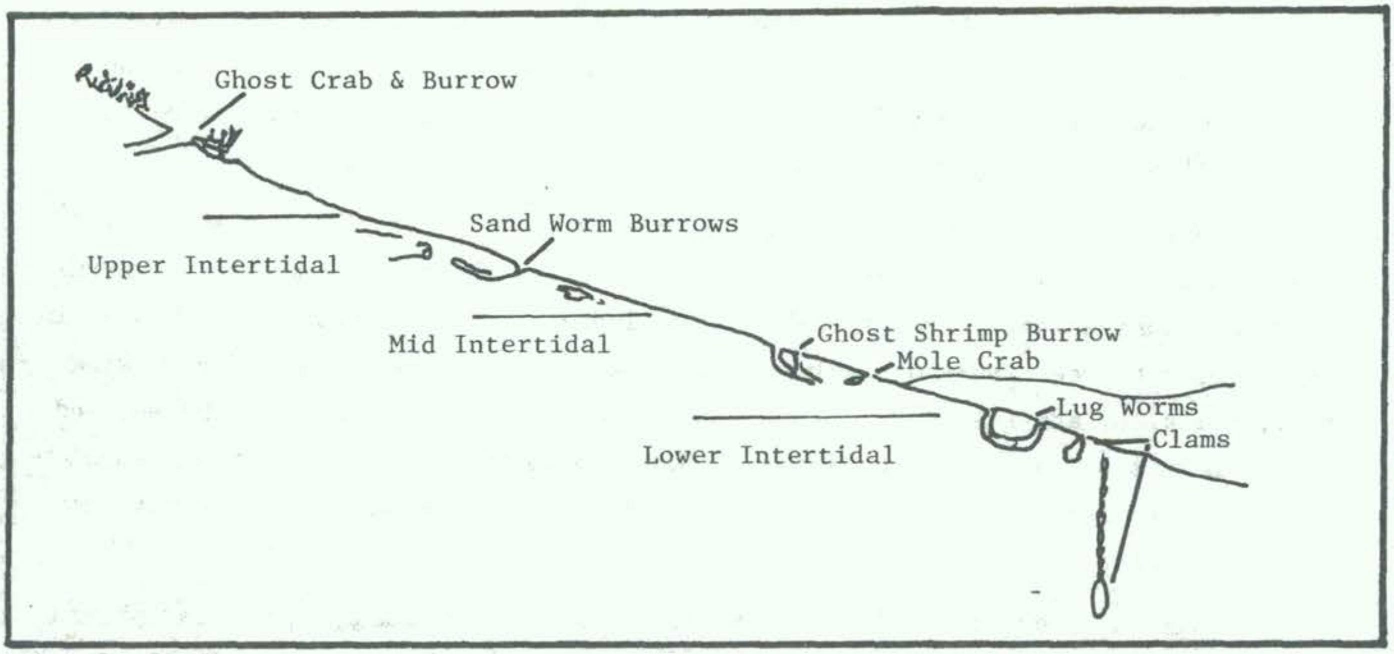


FIGURE V-3: ZONATION OF ORGANISMS ON SANDY BEACHES

5. Gravel Beaches. Gravel beach grain size is greater than 2 mm. Oil penetration into fine gravel beaches has been reported at 60 to 80 cm. Cleaning beaches of this type is hard to do without removals of large amounts of material, moderately to heavily oiled. Removal of excessive material may cause adverse effects on the long-term stability of the beach. Biological activity often is extensive and diverse in the sublittoral zone. Sinking and penetration of oil can be highly damaging to biological activity.

6. Estuaries (Sheltered Estuarine Tidal Flats). An estuary is where fresh inland water meets saline, open sea water. It is a semi-enclosed coastal body of water which has a free connection with the ocean and therefore is strongly affected by tidal action.

Estuaries are often important spawning and nursery areas for many marine organisms. Several species of commercially important organisms, such as oysters, crabs and shrimp, live and spawn as adults offshore and come into estuaries to live out the larval stage.

Oil spilled in an estuarine habitat could have far-reaching effects if spawning and nursery functions become affected. Oil should be prevented from entering these areas by closing off the estuary entrances through the use of diversion booms or by other effective means.

7. Mangroves. Mangroves are tidal, forming an interface between sea and land. A mangrove community develops on mud flats which are exposed at low tide. It has

an elaborate root system which reduces the tidal currents and causes extensive deposition of mud and silt. The mangrove forest tends to increase in extent, forming broad flat areas of swamp cut by drainage channels through which the sea flows with the rise and fall of the tide. Mangroves are important in extending the coastline, as well as protecting the coast from excessive erosion.

Mangroves harbour a large animal community. The roots of the trees provide a substrate for a variety of attached organisms, e.g., barnacles, bivalves, serpulid worms, and tunicaetes. Fish, free-living molluscs, and crustaceans find shelter in the crannies between the roots. In the mud are found a large number of burrowing crabs, molluscs, and fish. In the tree branches are insects, lizards, snakes, and birds. Detritus from mangroves has been shown to contribute a major energy input into the fisheries. Degradation of the detritus releases nutrients which may then pass to offshore waters.

Mangrove areas are vulnerable to oil spills because mangrove pneumatophores (the plant's breathing organs) and root systems are close to shore and easily clogged by oil. Oil can be toxic to the organisms inhabiting mangroves and can possibly damage the trees themselves. Removal of oil from mangroves is difficult, so their protection from oil spills should be given high priority.

8. Salt Marsh. A salt marsh is a rich nursery for many kinds of animals which grow to adulthood there and then leave for open coastal waters. The protected marsh area is supplied with large amounts of plants that help to support the animal life. Well-defined parallel zones of vegetation types are found in tidal marshes. The mud flats within the marsh are rich with microscopic plants and animals. Figure V-4 shows typical members of a marsh ecosystem.

Because of their sensitivity to oil pollution, great care should be given to the protection and clean-up of these marshes. Those which recover from a single oil pollution incident are less tolerant to repeated oilings.

9. Intertidal Zone. The intertidal zone is the area between the high water and low water marks. Organisms in this zone contend with alternating periods of immersion and exposure, sudden infusions of fresh water and greatly elevated salinities due to evaporation of sea water.

Exposure of stranded oil to the aerial environment accelerates the evaporation of the shorter chain hydrocarbons and reduces toxicity. As a result of the loss of the shorter chain components, the oil becomes tarry and coats the intertidal surfaces. This makes organisms vulnerable to oil which can coat and smother them.

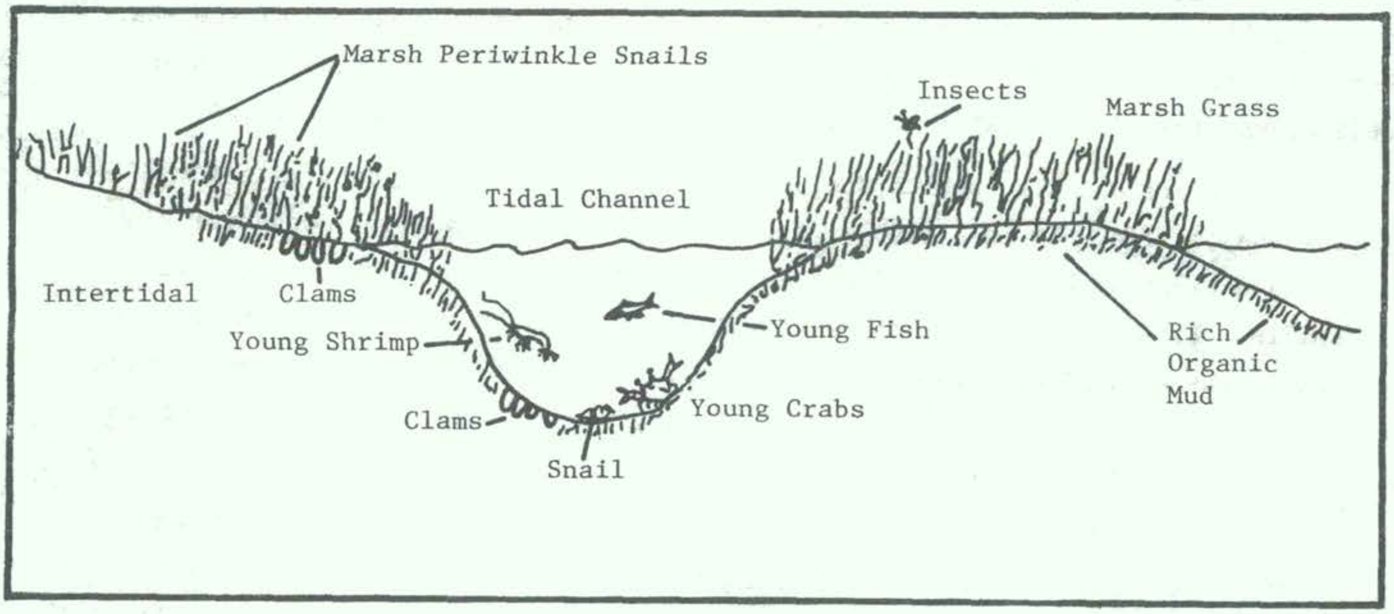


FIGURE V-4: TYPICAL MEMBERS OF A MARSH ECOSYSTEM

10. Benthic and Subtidal Zone. The benthic or subtidal zone of the coastal and deep ocean system includes those organisms living on the bottom, from the sub-littoral to the deep ocean. Benthic marine communities include organisms such as lobsters, oysters, scallops and clams, all of which are important commercial fisheries resources.

Usually, oil floats on the surface, but several mechanisms can sink it, thus exposing benthic/subtidal communities. Oil-burdened sediments can be toxic to rocky-bottom and sedentary organisms. Many of the organisms are filter feeders, extrac ing oil from fine particulate matter as well as from fractions dissolved in the water column. They also are susceptible to oil which can coat and smother them. This is especially true of sedentary or immobile organisms which cannot escape. Figure V-5 shows the organisms of the subtidal zone.

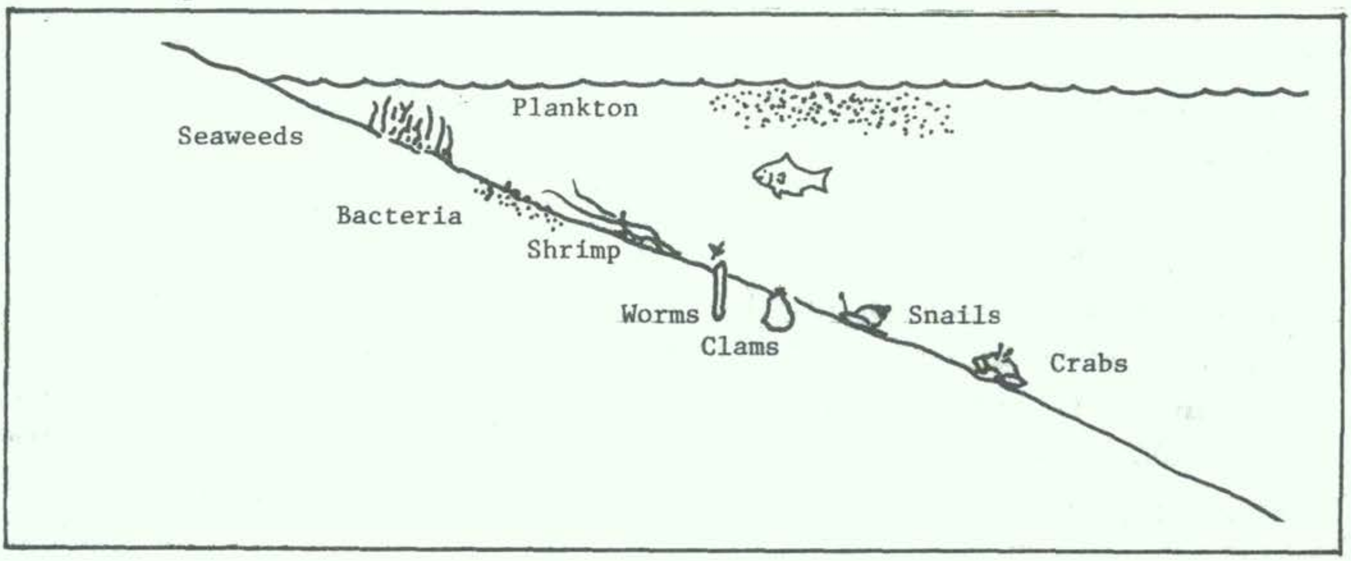


FIGURE V-5: ORGANISMS OF THE SUBTIDAL ZONE

11. Coral Zone. The coray systems serve a valuable role in protecting island systems, as well as the coastal region, from the eroding forces of the sea. There are three types of coral systems: barrier reefs along continents, fringing reefs around islands, and atolls, which are horseshoe-shaped ridges of rocks.

Corals are animals (phylum Coelenterata) and are a living substrate for other forms of life. It is a stable, species-diverse, well-adapted ecosystem with an intimate exchange between plant and animal, but not immune to the effects of oil spills. Little is known of their actual susceptibility to damage from oil, but due to the ecological balance in existence, oil should be prevented from coming into contact with the community. Corals probably will sustain less impact from an oil spill as long as they remain submerged.

12. Bays and Lagoons. Bays and lagoons are semi-enclosed bodies of water experiencing currents due to meteorological and tidal influences. These systems are directly or indirectly joined to marine waters. The areas are usually biologically productive and sensitive to the adverse effects of oil pollution.

Bays and lagoons are found throughout the West and Central African region. Due to the importance of these areas as shellfish, sport and commercial fisheries, spawning and nursery areas, and as generators of primary and secondary productivity organisms which feed the marine chain, spilled oil coming into contact with this type of system can be devastating. The shallow water brings the oil into close proximity with the organisms and thus these areas are especially sensitive to oil spill damage. In addition, wildlife, waterfowl, mammals and reptiles are sensitive to oil in bays and lagoons.

Oil movement in the bay and lagoon systems is primarily dependent on meteorological conditions. The deposition of oil will depend on the relief and slope of the shoreline and tidewater elevation.

13. Harbours. The size and vessel capacity of harbours vary. Within harbours, three problem areas exist with regard to the amount of oil present in the harbour aquatic system. These problem areas are: shipping operation sites, harbour operation sites, and harbour approaches.

Shipping operations within a harbour account for some of the oily water usually present. Oily wastes usually are due to petroleum-product, transfer operation-related accidents; oily ballast waste discharges; and accidental oil spills. In addition, port operation problems that exist include oily waste water and storm runoff control for large operations. Oil pollution may occur indirectly as a result of the failure to remove oil in ballast water by treatment. The untreated ballast or poorly-treated waste water is usually discharged into the harbour.

Harbours are often natural catch basins for oil spills because of their relative quiescent nature. The uncontrolled movement of large amounts of oil within these facilities may cause damage to docked vessels, and removal of oil from these vessels is expensive and laborious. Under most conditions, large amounts of oil will remain in the harbour until removed.

14. Open Seas. The pelagic, referring to the waters of the world oceans, is divided into the neritic province, or water overlying the continental shelf; and the oceanic province, or the rest of the water seaward off the continental shelf.

There are some very basic differences between the environmental conditions of the neritic and oceanic provinces, even though they tend to overlap. In the open ocean, the physical conditions do not vary a great deal. The surface salinity remains constant at approximately 35 gm/kg, and the major sources of variation are rain, which lowers the salinity, and evaporation, which causes an increase in the salinity of the surface water.

One of the important properties of seawater that is of interest in an oil spill is the density of the water. Seawater has a density of 1.02 to 1.03, and in the ocean, the density is dependent on the temperature and salinity. Therefore, as the salinity increases and/or the temperature decreases, the density of the seawater increases, and vice versa.

The waters of the neritic province are 200 metres or less in depth, and thus this region is much more diversified than the open ocean region due to the shallowness of depth, the influx of fresh water from river runoff, and a higher loading of suspended sediments. The influx of fresh water with its high level of nutrients makes the neritic province the more productive of the two pelagic regions.

The upper 200 metres of the ocean is the zone most affected by an oil spill. For the most part, catastrophic effects from an oil spill are not expected in the open ocean environment, primarily as a result of the rapid dispersion and degradation of the oil and the general low vulnerability of open ocean organisms to contact with oil. For example, damages to small populations of phyto- and zooplankton depend mostly on the chance event of encountering a floating slick; however, once contact occurs and organisms are killed, numbers are generally quickly restored as a result of fast rates of reproduction and migration.

The term "neuston" refers to those organisms which live at or near the surface of the water. Due to their habitat, they are quite vulnerable to impact from an oil slick. Of particular importance are the larval and post-larval stages of shrimp and other organisms that float to the surface during part of the developmental cycle and thus are particularly sensitive to oil.

The term "nekton" refers to that community of animals which are capable of moving themselves vertically and horizontally within the water column. It is now documented that oil can be carried to considerable depths in the water column, deposited in sediments and redispersed in the column, affecting bottom organisms as much as 20 metres below the surface.

15. Surf Zone. Surf zone is more of an engineering term used to refer to the intertidal area and the shallow supratidal area where the wave action against the sand or rock mixes the oil and sand together. The oil-sand combination then sinks in this area, disturbing those marine organisms living in the area.

Supratidal Zone: Mammals. An aquatic mammal population of any consequence does not exist in West and Central Africa. Species of dolphins live off the coast of Europe and may migrate to African waters in the winter. These probably would not venture below the northwest African coast. There are two families of manatees (sea cows) to be found on the West and Central African coast; they are found between 10° north and 10° south latitudes in the estuaries of the Senegal, Niger and Congo Rivers. These mammals are nearly extinct, so contact with oil pollution could be especially injurious.

Marine Birds. Marine birds can suffer major damage from oil spilled in the near-shore areas. Diving birds are the most affected, living on the surface of the sea and diving for food. If they dive into floating oil or surface through it, they become completely covered by the substance. Some seabird species can be treated to remove oil and minimize mortality.

In oil-matted plumage, air is replaced by water, causing decreased insulation (body heat) and buoyancy. Migratory birds may avoid exposure due to absence at the time of a spill, but non-migratory birds are hard-hit, with the possibility of eliminating an entire colony.

Special efforts should be made to keep birds away from a spill area such as through the use of alarm devices or explosive noise-makers.

Reptiles. Reptiles subject to damage are tortoises and crocodiles. Turtle eggs are buried and hatched on the beaches, and oil in or on the sand may damage the eggs and/or kill newly-hatched tortoises.

Fisheries. Danger to fish is probably limited to harm to eggs, larvae, or juveniles, since the adults are able to move away from endangered areas. Fish do not suffer directly from sinking oil, but may acquire a bad flavour by feeding on benthic organisms carrying oil droplets. Indirectly, they may be affected if oil infects and/or destroys their spawning grounds.

Shellfish, including molluscs such as clams, oysters and scallops as well as crabs, lobsters and shrimp, appear to be the segment of marine life that is most affected by oil spillage in the coastal zone. Most of these types will survive contamination by heavy oil alone, however, the flavour of the fish will be tainted. Lighter petroleum fractions such as diesel or gasoline appear to be more fatal, and some species such as clams may experience significant mortalities. Fortunately, in most spill incidents, the effects on shellfish appear to be fairly temporary, and even in those situations where high mortalities were observed at the time of the incident, recovery appears to have taken place within a period of six months to two years.

Phytoplankton and Zooplankton. Phytoplankton are responsible for the fixation of energy in the marine environment in that they produce food and oxygen. These small organisms use sunlight to convert chemicals in the water to living plant material, releasing oxygen in the process. Phytoplankton communities are found offshore throughout the West and Central African region and represent an important link in the food chain. Phytoplankton move with wave motion and induced currents, and therefore cannot escape contamination by their own propulsion.

Zooplankton are small animals that feed on living and dead phytoplankton. They in turn are eaten by other organisms.

The existence of both phytoplankton and zooplankton is seasonal and depends on available sunlight as well as nutrient supply. Oil spills may cut off sunlight, thus killing this important link in the food chain.

Evalution of Environmental Susceptibility to Oil Pollution

The evaluation of environmental systems and their relative susceptibility to oil contamination is an important part of site-specific oil contingency planning. Because the resources to deal with oil spills within a region are limited, priorities for protecting and cleaning environmental systems must be set. For example, where boom or barrier resources are limited, the most valuable environmental resources should be protected with whatever equipment is available.

Tables V-1 to V-5 show a series of four rating systems which rate the value of different environmental systems from various viewpoints, and Table V-3, which rates the relative ease of removing oil from the different systems.

The first rating system, developed by Hann, orders the relative biological value of different ecosystems. The ranking is arbitrary and may vary in different parts of the world where different values are placed on different systems.

The second index is the geomorphologically-oriented vulnerability index developed by Grundlach and Hayes. This index takes into account beach mechanics, wave energy and related self-cleaning properties to rate the recovery rate and potential of various ecosystems without clean-up activities.

The third index, the spilled oil removability index, rates environmental systems as to the ease of removing spilled oil from them. Both the biological index and oil removability index were conceived by Hann to compensate for the fact that the Grundlach and Hayes geomorphological vulnerability index does not seem to give adequate consideration to the potential impact of oil on the biological systems. It also does not consider that some systems, although self-cleaning in themselves, were the only places where the oil could be rapidly recovered through mechanical means and thus prevented from causing damage to other more vulnerable biological or geomorphological systems. Self-cleaning beaches do not get rid of the problem oil; they merely pass it on to another system, i.e., water, from where it can pass to other susceptible systems.

To complement the three indices above, two additional indices were developed to rank the various environmental systems with regard to their commercial and recreational/tourism value. Table V-6, a summary of the coastal morphology of West and Central African nations, has been included so that the data provided in the previous five tables can be extrapolated to the region.

TABLE V-1

BIOLOGICAL SYSTEMS RANKED

IN ORDER OF DECREASING VALUE

1. Coral Reefs
2. Shallow Estuarine Intertidal Zone
3. Estuarine Marshes
4. Mangroves
5. Rocky Intertidal Zone, Jetties, etc.
6. Shallow Subtidal Beach
7. Intertidal Beach
8. Mud Flats
9. Deeper Subtidal Bottoms
10. upratidal Beach

TABLE V-2

SUMMARY OF COASTAL SHORELINE SYSTEMS
IN ORDER OF INCREASING VULNERABILITY TO OIL SPILL DAMAGE

Vulnerability Index	Shoreline Type	Comments
1	Exposed rocky headlands	Wave reflection keeps most of the oil offshore.
2	Eroding wave-cut platforms	Wave swept. Most oil removed by natural processes within weeks.
3	Fine-grained sand beaches	Oil does not penetrate into the sediment. Otherwise, oil may persist several months.
4	Coarse-grained sand beaches	Oil does not sink in and/or become buried rapidly. Under moderate to high energy conditions oil will be removed naturally within months from most of the beach face.
5	Exposed, compacted tidal flats	Most oil will not adhere to, or penetrate into, the compacted tidal flat.
6	Mixed sand and gravel beaches	Oil may undergo rapid penetration and burial. Under moderate to low energy conditions, oil may persist for years, unless physically removed.
7	Gravel beaches	Same as above. Cleanup should concentrate on the high-tide swash area. A solid asphalt pavement may form under heavy oil accumulations.
8	Sheltered rocky coasts	Areas of reduced wave action. Oil may persist for many years if not physically removed.
9	Sheltered tidal	Areas of great biologic activity and low wave energy. Oil persist for years if not physically removed.
10	Salt marshes	Most productive of aquatic environments. Oil may persist for years if not physically removed.

SOURCE: Vulnerability of Coastal Environments to Oil Spill Impacts.

TABLE V-3

SPILLED OIL REMOVABILITY INDEX

(Lowest Number = Best Removal)

1. Oil or mousse trapped in quiescent areas where it is consolidated by current, wind or booms where it can be removed by vacuum trucks or shore operated skimmers from a water surface.

2. Mousse on the surface of gently sloping hard-packed beaches.

3. Consolidated oil or mousse removed by vessel-operated or dynamic skimmers.

4. Oil on the surface or uniformly soaked into the surface of gently-sloping hard-packed beaches.

5. Oil trapped in pools in marshes or rocks accessible by externally-located vacuum systems.

6. Heavy oil concentrations floating loose on the water and removed by skimmer systems.

7. Oil or mousse on the surface of irregular or low-load bearing capacity beaches which must be removed by manual or semi-manual method.

8. Oil or mousse in marsh or mangrove areas where water-flushing to collection point is possible and water access for logistical support is available.

9. Oil or mousse in inaccessible marsh or rocky areas where logistics are expensive and removal is by hand method, such as dipping or absorbents.

10. Removal of buried oil on beaches where clean overburden material must be removed by hand to get to the heavily-oiled layers of sand and mousse.

11. Oil or mousse in vegetation where removal of oil requires removal of the vegetation, such as seaweed, marsh grass, trash, etc.

12. Light concentrations of oil on the water surface.

13. Removal of the oil contaminated layer on mud flats or marshes by scraping, skimming off the contaminated layer or dredging.

TABLE V-4

COMMERCIAL FISHING IMPORTANCE

RATED ACCORDING TO DECREASING VALUE

1. Marshes
2. Mangroves
3. Mud Flats
4. Shallow Intertidal Zone
5. Coral Reefs
6. Rocky Intertidal Zone
7. Estuarine Subtidal Zone
8. Offshore Subtidal Zone
9. Beach Intertidal Zone
10. Beach Supratidal Zone

TABLE V-5

RECREATIONAL IMPORTANCE

RATED ACCORDING TO DECREASING VALUE

1. Open Sandy Beach
2. Coral Reef
3. Cobble Beach
4. Fishing Jetty, Causeway, etc.
5. Open Shallow Waters, Bays
6. Offshore Waters, Offshore Banks, Oil Platforms
7. Sheltered Coves and Bays
8. Rocky Shoreline
9. Mangroves, Marshes
10. Mud Flats

TABLE V-6

COASTAL MORPHOLOGY OF WEST AND CENTRAL AFRICAN NATIONS

Country	DESCRIPTION
ANGOLA	Shoreline lined with beaches or cliffs, before a generally high hinterland. Sea breaks violently, either onshore or on offshore shoals.
BENIN	Sandy shoreline with lagoons communicating with open sea through narrow channels. Strong swell surfing onshore.
CABINDA (Angola)	Shoreline generally sandy and lined by reefs where sea breaks regularly.
CAMEROON	Shoreline varied, including sandy, rocky and estuarine features, with strong swell in most areas.
CONGO	Generally low and sandy shore, lined by rocky reefs on which swell breaks in inclimate weather.
EQUATORIAL GUINEA	Generally rocky shoreline with reefs where sea breaks violently. Strong tidal current.
GABON	Shoreline varied with rocky, sandy or estuarine features. Strong swell in many areas.
THE GAMBIA	Low, sandy shore lined with lagoons that sometimes communicate with open sea at high tides.
GHANA	Rocky and sandy shoreline.
GUINEA	Low and mostly marshy shoreline, except on Iles de Los and near Conakry.
GUINEA-BISSAU	Generally low and sandy shoreline except around offshore archipelago.
IVORY COAST	Shoreline varied, including rocky, sandy or estuarine features. Low tidal range.
LIBERIA	Low and sandy, with strong swell surfing on sand shoals.
NIGERIA	Shoreline varied, with sandy or estuarine features and varying tidal currents.
SENEGAL	Low, sandy shoreline lined with lagoons that sometimes communicate with open sea at high tides.

TABLE V-6 (Con't)

Country	Description
SIERRA LEONE	Low, straight, sandy shoreline with many estuaries. Islands marshy; rocky shore near Cape Sierra Leone.
TOGO	Sandy shoreline.
ZAIRE	Congo estuary has strong outflowing current which creates coastal current bearing west thus protecting estuary.

SOURCE: Massart, Georges and Cabaniols, Lucien, "Survey of Natural Conditions on Oil Pollution Impact." Brest:1980. (Mimeographed).

Potential Zones of Impact

Oil pollution occurs in four types of risk areas in West and Central Africa. The probability of the occurrence of oil spills is greater in the areas which include offshore production accident risk zones; through shipping risk zones; terminal, refining and transshipping risk zones; tank washing and oily ballast discharge risk zones; and harbour approach risk zones. These zones are considered to be high risk areas and, with the exception of harbour approach risk zones, are listed for West and Central Africa in Table V-7. The likely points of impact represent areas to which spilled oil will move, based on information provided in previous sections.

Figures V-6 to V-9 illustrate the high risk zones for oil spill impact along the West and Central African coast based on four major causes: (a) offshore production accidents (Figure V-6); (b) through shipping (Figure V-7); (c) port approaches (Figure V-8); and (d) tank washing and oily ballast discharge (Figure V-9).

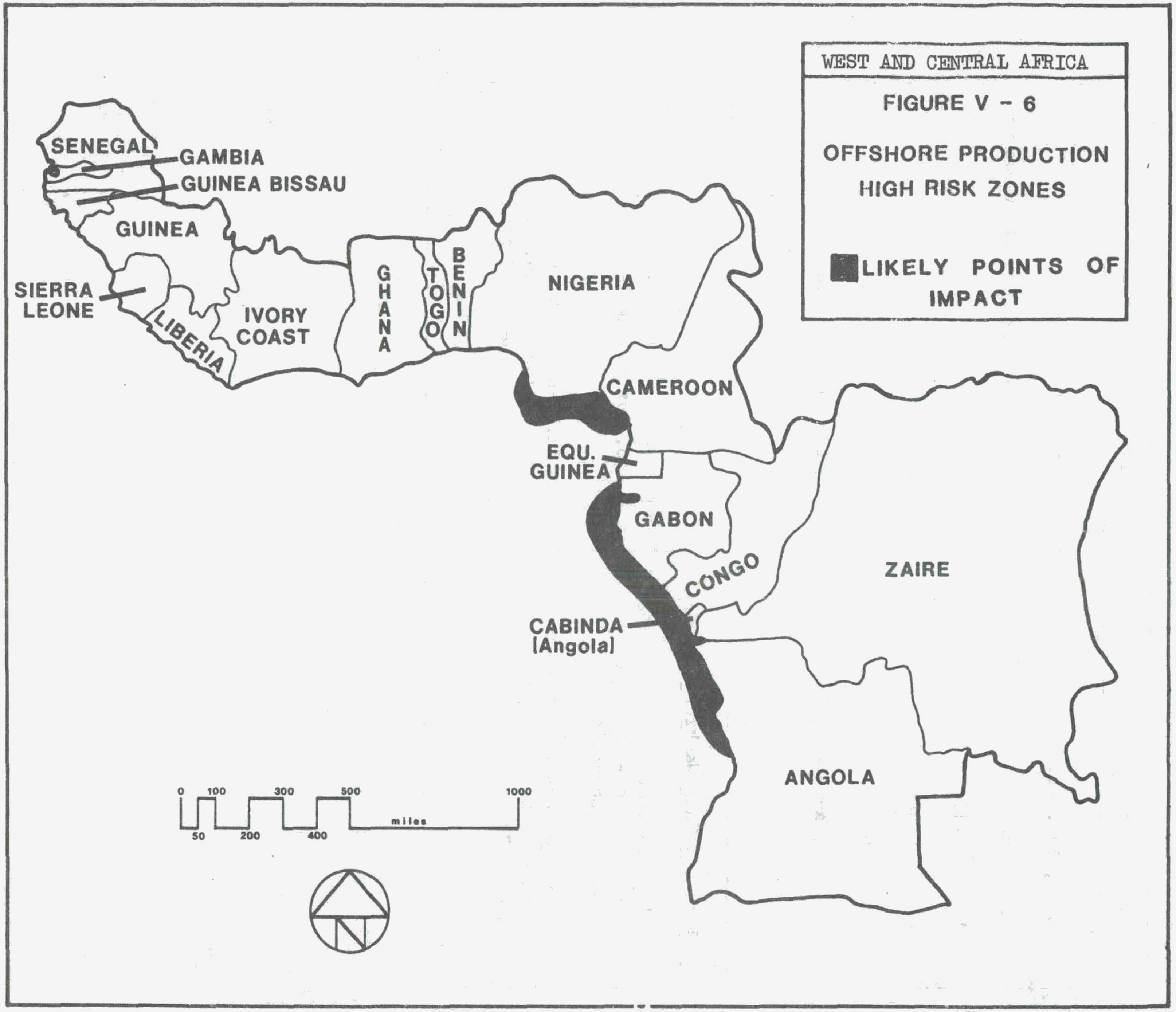
TABLE V-7

ZONES OF HIGH RISK TO OIL SPILLS AND LIKELY POINTS OF IMPACT

High Risk Zone	Likely Point of Impact
Offshore Production Accidents	
Nigeria	Nigeria, Republic of Benin, Togo, Cameroon
Gabon	Gabon, Equatorial Guinea, Cameroon
Congo	Congo, Gabon
Zaire	Zaire
Cameroon	Cameroon
Angola	Angola, Congo, Gabon
Through Shipping	
South Atlantic Ocean	Angola, Congo, Gabon
Middle Atlantic Ocean	Gulf of Guinea, Senegal, Gambia, Guinea, Sierra Leone, Liberia, Ivory Coast, Ghana, Togo, Benin, and Nigeria
Port Approaches	
(refer to Figure IV-5 for numbered locations)	
Dakar, Senegal (1)	Senegal, Guinea-Bissau
Freetown, Sierra Leone (2)	Sierra Leone, Liberia
Abidjan, Ivory Coast (3)	Ivory Coast, Ghana
Lome, Togo (4)	Togo, Benin
Lagos, Nigeria (5)	Nigeria
Port Harcourt, Nigeria (6)	Nigeria
Bonny, Nigeria (7)	Nigeria

TABLE V-7 (Con't)

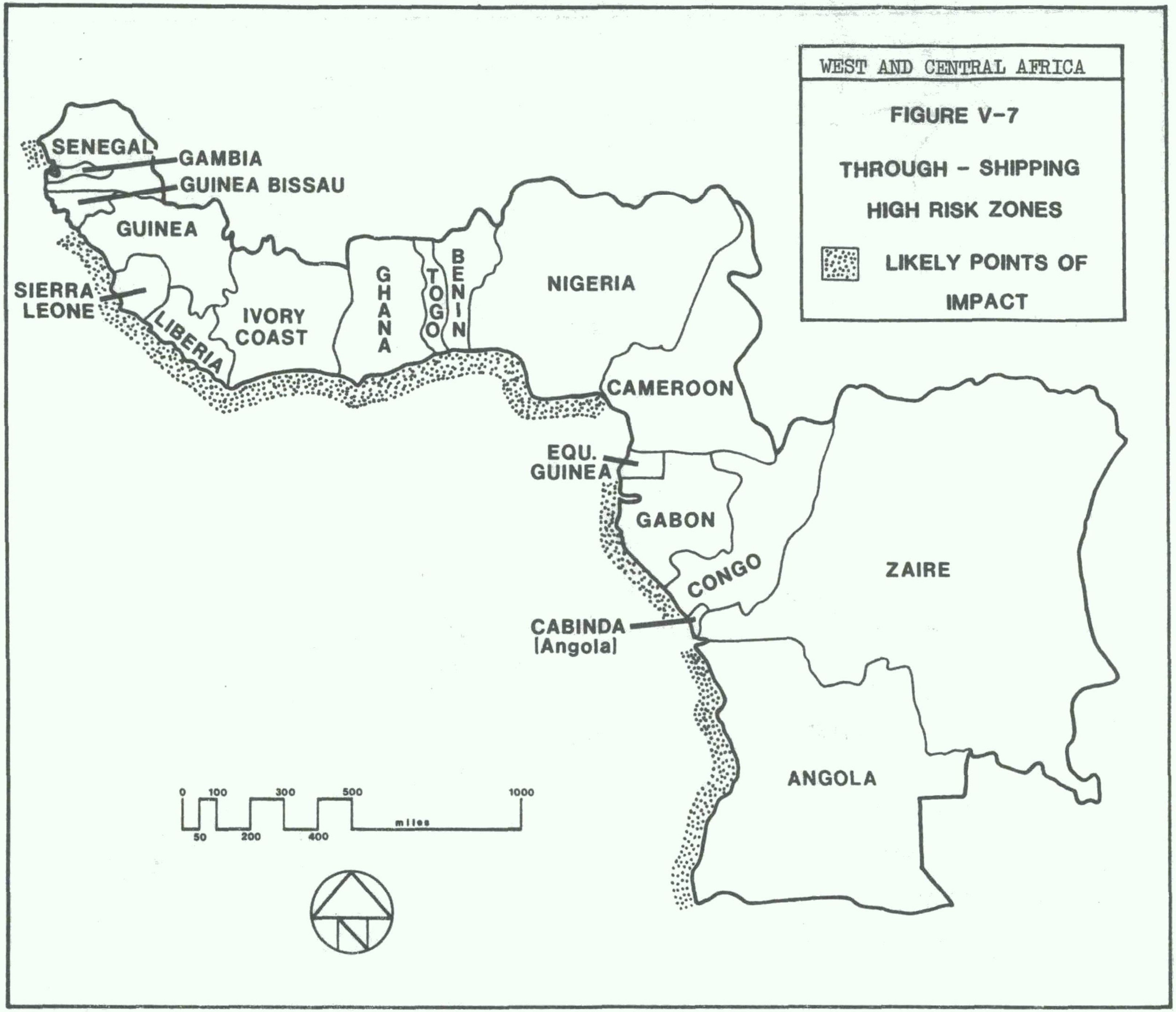
High Risk Zone	Likely Point of Impact
Bata, Equ. Guinea (8)	Equatorial Guinea
Cape Lopez, Gabon (9)	Gabon, Equatorial Guinea, Cameroon
Port Gentil (10)	Gabon
Gamba, Gabon (11)	Gabon
Pointe Noire (12)	Congo, Gabon
Cabinda, Angola (13)	Angola, Congo, Gabon
Luanda, Angola (14)	Angola
<u>Ballast and Tank Washings</u>	
Dirty Ballast from tankers returning to Africa from importing countries	Ivory Coast, Togo, Benin, Nigeria, Congo, Zaire, Angola
Tank washings from tankers returning from Europe to Middle East	Gambia, Senegal, Sierra Leone, Guinea, Guinea-Bissau, Liberia Ivory Coast, Benin, Nigeria and Togo



WEST AND CENTRAL AFRICA

FIGURE V - 6

OFFSHORE PRODUCTION HIGH RISK ZONES

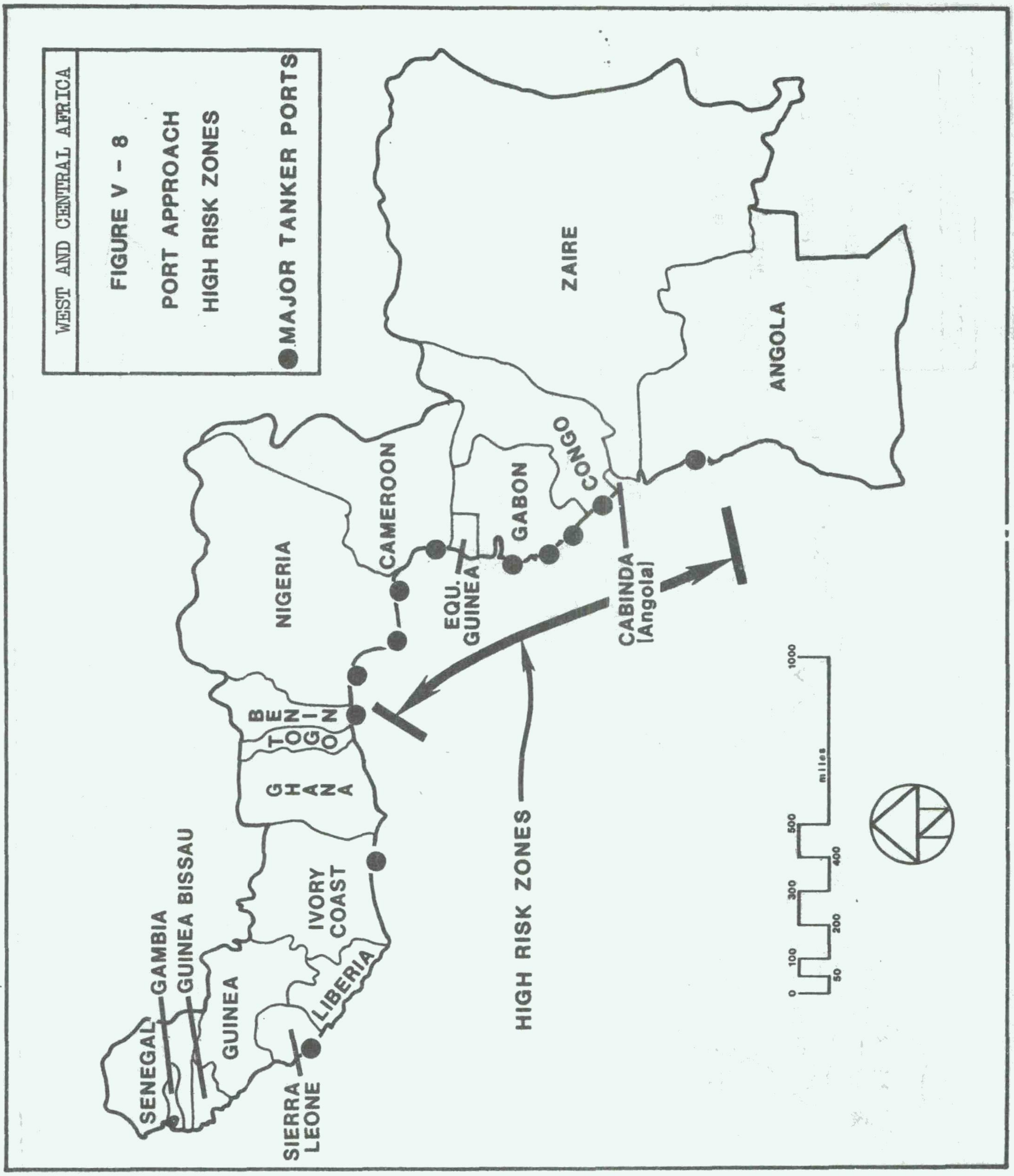


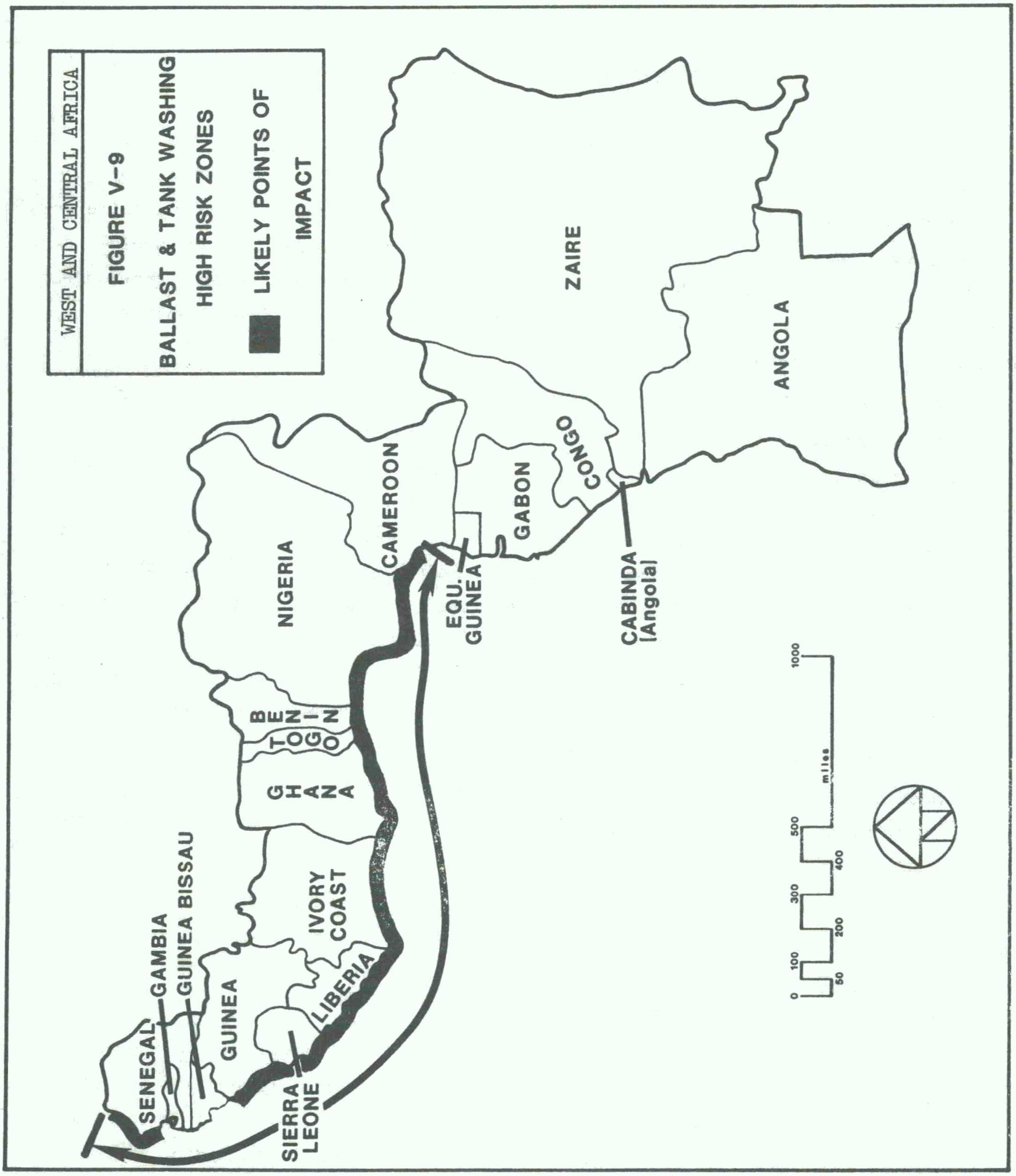
WEST AND CENTRAL AFRICA

FIGURE V-7

THROUGH - SHIPPING HIGH RISK ZONES

LIKELY POINTS OF IMPACT


WEST AND CENTRAL AFRICA
FIGURE V - 8
PORT APPROACH
HIGH RISK ZONES
MAJOR TANKER PORTS
SENEGAL
GAMBIA
GUINEA BISSAU
GUINEA
SIERRA LEONE
LIBERIA
IVORY COAST
GHANA
TOGO
BENIN
NIGERIA
CAMEROON
EQU. GUINEA
GABON
CONGO
ZAIRE
ANGOLA
CABINDA (Angola)
HIGH RISK ZONES
0
100
300
500
1000
50
200
400
miles


WEST AND CENTRAL AFRICA
FIGURE V-9
BALLAST & TANK WASHING
HIGH RISK ZONES
LIKELY POINTS OF
IMPACT
SENEGAL
GAMBIA
GUINEA BISSAU
GUINEA
SIERRA LEONE
LIBERIA
IVORY COAST
GHANA
TOGO
BENIN
NIGERIA
CAMEROON
EQU. GUINEA
GABON
CONGO
CABINDA (Angola)
ZAIRE
ANGOLA
0
50
100
200
300
400
500
1000
miles

SECTION VI

THE STATUS OF OIL POLLUTION CONTROL IN THE WEST AND CENTRAL AFRICAN REGION

In this section, the existing status of oil pollution control in the West and Central African region is explored. This evaluation is based on a visit by the consultants to four oil-producing countries - Nigeria, Gabon, Congo and Zaire - in 1980, and a visit by two of the consultants to Cameroon in 1977. Review of reports by other consultants who have travelled to the region and general knowledge extrapolated from various publications and newsletters have also been invaluable in formulating the text in this section.

The general status of oil pollution in each country of the region and the existing status of control are discussed in the following paragraphs. Each country is examined in terms of: (a) its identified and potential oil pollution problems; (b) applicable laws and legislation; (c) existing responsible agencies, such as port authorities, environmental agencies, other governmental agencies, military organizations, nationalized industry or private industry; (d) an assessment of the existing oil pollution control capability in terms of designated manpower, specialized oil pollution control equipment and supplies; (e) training to deal with oil pollution; (f) the organizational structure for oil pollution control; (g) the status or sophistication of the planning programme to prevent or deal with spills; and (h) the history of any known responses.

Much of the information presented has been derived from reports previously prepared by experts. Detail on each reference is shown in the sources list following the appendices.

This country-by-country approach is followed by a general summary of the capability of the region, including a focus on non-petroleum producing/product importing countries, emerging petroleum producing and exporting countries, and established petroleum producing and exporting countries.

A summary of various resources which may be available from outside the region, such as the United Nations and other consultants, contractors, government assistance teams, United Nations programmes, and international conventions and agreements, is presented so the reader will be aware of resources available for building an oil pollution control programme within a country.

Development of Oil Pollution Control Legislation in the Region

A. Piquemal and M. Savini, in their report entitled Legal Aspects of Marine Environmental Protection in the Gulf of Guinea and Adjacent Coastal Areas, effectively evaluated pollution control legislation in general and oil pollution control legislation in particular.

As noted in their report and elsewhere, oil pollution control legislation follows a general pathway of development from simple common law to sophisticated specialized legislation. This pattern of development is shown in Figure VI-1. The first step is the general body of English, French or other common law, which generally says "do good, not bad". In English common law, this notion expands to the Riparian doctrine, which states that the owner of land along a body of water has the right to use it as long as it is not diminished in quality or quantity.

The next progression is to general nuisance and public health law, followed by water supply, water pollution and public works laws. The agencies called for by these laws generally have had a very large area with great human need to focus on, and thus they have not been able to develop each particular area such as oil spill control to its fullest. Generally, their authority and ability to act in specialized areas has been or is limited.

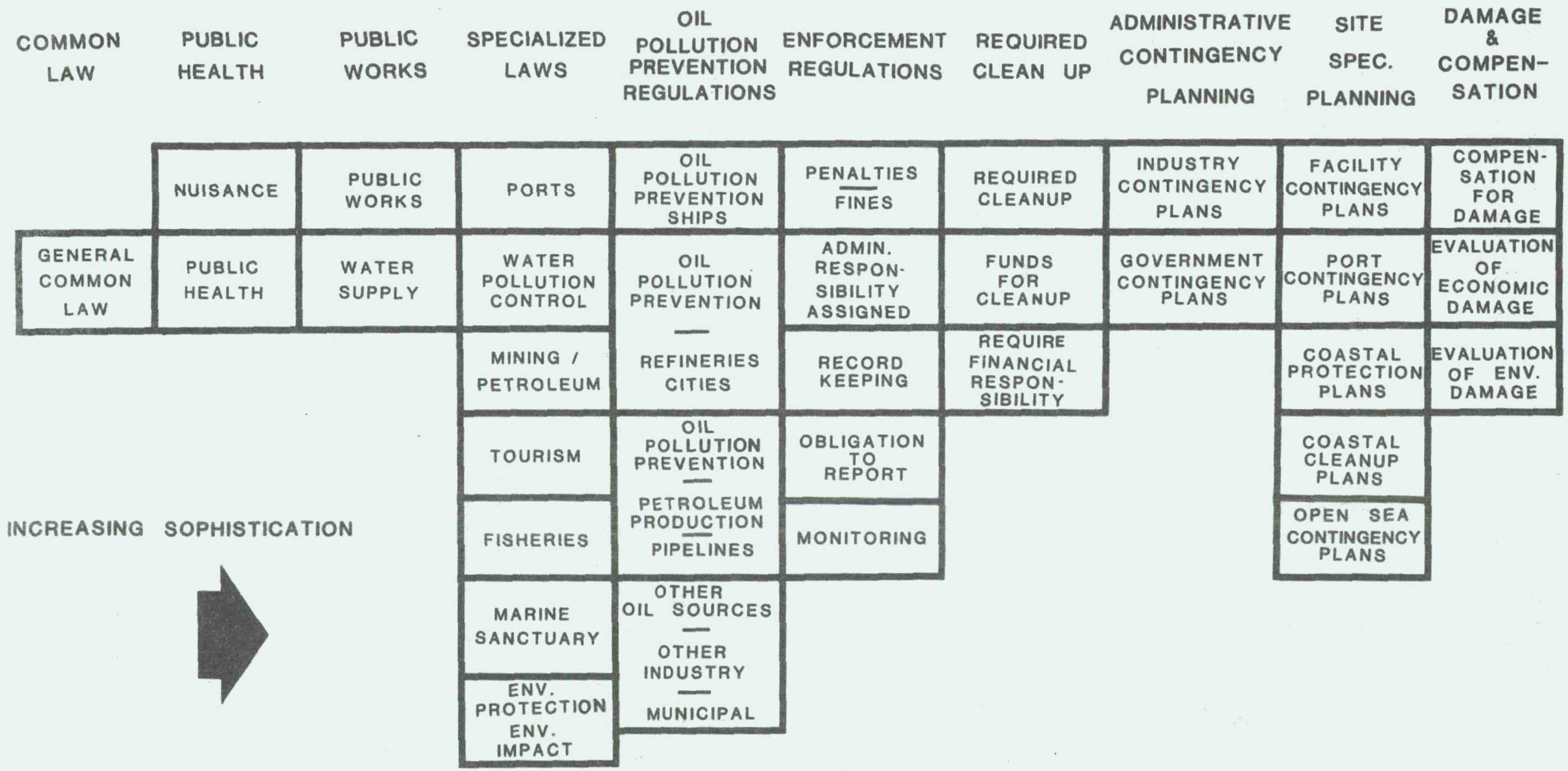
Specialty laws relating to ports, mining, petroleum development, fisheries and tourism then emerge, of which many can be applied to spilled oil as a general pollutant or by-product of development.

Specialized oil pollution legislation then begins to emerge, with initial emphasis on laws stating that oil shall not be spilled. Many of the earlier oil pollution laws closely follow the 1954 IMCO Convention and its subsequent amendments. These laws often prove ineffective without companion legislation to assign responsibility and supervision and to provide penalties for spillage.

It is easy to realize, however, that fines do not pay clean-up costs, and they do not compensate those who are damaged. Thus, new legislation requires clean-up by the spiller and/or by government and requires financial resources for the clean-up. Subsequent steps provide for more efficient prevention and response capability to be demonstrated to government by specifying levels of contingency planning as a requirement for doing business, and they ultimately provide for calculation of spill damage and corresponding payment for damages.

A major role of the later stages of this legislation process is the development of laws to implement international conventions such as the Civil Liability Convention (CLC) and the Fund Convention, which call for payment of clean-up costs

FIGURE VI-1
OIL POLLUTION/ENVIRONMENTAL POLLUTION
LAW PROGRESSION



and damage but require national laws to be in place for implementation. These two conventions are discussed later in this section.

Figure VI-2 is a composite analysis of the laws referenced by Piquemal and Savini. It may be noted that most countries in West and Central Africa have laws which correspond to the first three steps, and about half of the countries have specialized statutes and oil pollution prohibition laws. However, few laws in West and Central Africa have yet proceeded past this stage. A major opportunity exists for a regional programme to stimulate the development of harmonized laws and particularly to assure that developed laws permit the benefits of the CLC and Fund Convention to accrue to nations of the region.

LEGISLATION / COUNTRY	ENVIRONMENT GENERAL NUISANCE PUBLIC HEALTH WATER SUPPLY	FORBIDS OIL POLLUTION: SHIPS/ PORTS	FORBIDS OIL POLLUTION: PRODUCTION	FORBIDS OIL POLLUTION: PIPELINES / OTHER	PENALTIES FOR OIL POLLUTION	REQUIRES CLEAN UP BY SPILLER	REQUIRES COMPENSATION FOR DAMAGE	ASSIGN REGULATOR AUTHORITY (TO WHOM)	REQUIRES CONTINGENCY PLANNING	AUTHORIZES GOVERNMENT CLEAN UP	AUTHORIZE FUNDS FOR CLEAN UP
SENEGAL		DRAFT ENV. CODE P&S 39									
GAMBIA	GAMBIA UTILITY CORP. ACT - WATER HEALTH ACT P 2541	CONTINENTAL SHELF ACT CHAPTER 32 PORT ACT P&S 36,40	MINING ACT (MINERAL OIL) CHAPTER 122 SECTION 18 P&S 35	CONTINENTAL SHELF ACT — PETROLEUM ACT P&S 36							
GUINEA-BISSAU											
GUINEA											
SIERRA LEONE	WILDLIFE CONSERVATION ACT	PORTS ACT 1964 P&S 39									
LIBERIA		LIBERIAN MARINE REGULATION 1974 2.83 P&S 23			500-2500 FINES LMR 1974 P&S 29						
IVORY COAST	MINISTRY OF PUBLIC WORKS DECREE 77-694 NATIONAL COMMISSION	ORDER 819TP.MM P&S 23	→ SAME	→ SAME							
GHANA	ENVIRONMENTAL PROTECTION COUNCIL	OIL IN NAVIGABLE WATER ACT 1964 — PORT AUTHORITY DECREE P&S 23	SAME → MINERALS ACT &REGULATIONS P&S 36,37	SAME → → SAME	FINES-OIL IN NAVIGABLE WATER ACT P&S 29						
TOGO	LAW 63-22 NATIONAL WATER SER. P&S 40										
BENIN	NATIONAL COMMISSION ON	ORDINANCE 74-3P (RE: PORTS) P&S 39	ARTICLE 1 ORDINANCE 73-31 MINING CODE & PETROLEUM CODE P&S 34	PETROLEUM CODE							
NIGERIA	DEPARTMENT OF HOUSING AND ENVIRONMENT	OIL & NAVIGABLE WATER DECREE 1968 PORT REG. 1968 P&S 23	SAME → NNPC DEGREE & QUARRIES DEC. P&S 37	OIL PIPELINES ACT 1956 → SAME NIGERIAN NATL PETROLEUM CO. DECREE P&S	FINES-OIL & NAVIGABLE WATER DECREE P&S 29						
CAMEROON	FRENCH COLONIAL WATER LAW TOURISM LAW P&S 40,42	DECREE 62-DF-215 6/25/62 76/372 P&S 35,38	→ SAME	→ SAME							
EQUATORIAL GUINEA	FRENCH COLONIAL WATER LAW										
GABON	F.C. WATER LAW WATER POLL. LAW URBAN SERVICE OF HYGENE P&S 41		MERCHANT MARINE CODE P&S 38	→ SAME				NATIONAL ANTI POLL. CENTER MERCHANT MARINE P&S 51 HANN			
CONGO	F.C. WATER LAW ENV. COMMISSION P&S 40	ORDINANCE 22-70 P&S 23	LAW 29-62 6/16/62 MINING CODE P&S 35		100,000 TO 1,000,000 CFA FINE & ORDINANCE 21-70 P&S 29,35						
ZAIRE			ARTICLE 54 (1) LEGISLATIVE ORDINANCE 67-231- MINES P&S 35								
ANGOLA											

FIGURE VI-2: ANALYSIS OF LAWS REFERENCED BY PIQUEMAL & SAVINI

THE STATUS OF OIL POLLUTION PROBLEMS IN SENEGAL

While Senegal presently is not engaged in either on- or offshore oil production, it is not without incidents of oil pollution in or around its waters. Current or potential oil spill problems in the country consist of: (a) oil/tar balls on beaches caused by tank washing residues or similar discharges from tankers passing offshore; (b) oil on beaches and structures in the vicinity of port oil transfer facilities; and (c) oily wastes from refinery operations. Additional problems may arise in the future with the development of oil production.

Perhaps because of the rather local or low-key nature of its oil pollution incidents, Senegal has no known history of organized response to specific oil spills. Documents indicate that the country does not have a specifically-identified capability for responding to oil spills, except for the use of public works and port equipment, agricultural equipment, and labour intensive methods on the shoreline. Similarly, there is no known documented governmental oil spill contingency plan on either the administrative or site-specific level. Industrial sources also have not identified an oil spill contingency plan on either the administrative or site-specific level.

The main government leadership in oil pollution control in Senegal appears to be vested in the port authority and the Environmental Department.

THE STATUS OF OIL POLLUTION PROBLEMS IN THE GAMBIA

The circumstances within the Gambia are nearly identical to those of Senegal. There currently is neither onshore nor offshore oil production, and there is no known history of an organized response to specific oil spills. Current oil spill problems in the Gambia consist solely of oil/tar balls on beaches caused by tank washing residues or similar discharges from tankers passing offshore. However, if ancillary industries develop in the future, the unfortunate ramifications might include oily wastes from refinery operations or potential major releases from production facilities, pipelines, or loading facilities.

If oil production or refining operations were to be developed, the Gambia likely would be unprepared to handle a major oil spill based on current levels of preparedness. The country has no specific, identifiable capability for responding to oil disasters except for the use of public works and port equipment, agricultural equipment, and labour intensive methods on the shoreline. In addition, neither government nor industry has a documented or publicised oil spill contingency plan on either the administrative or site-specific level. The main government leadership in oil pollution control has not been determined by researchers of this report.

THE STATUS OF OIL POLLUTION PROBLEMS IN GUINEA-BISSAU

Guinea-Bissau is fortunate in that the nation currently does not have any notable oil spill problems. That does not mean they could not develop. Potential future problems could include oily wastes from refinery operations and a chronic release of produced water, deck drainages and occasional small spills from production platforms. The latter hazard, of course, is incumbent on the development of on- or offshore oil production, neither of which currently exists in Guinea-Bissau.

The country shares with many West and Central African nations the fact that only basic resources are available to confront an oil pollution disaster. These include the possible use of public works and port equipment, agricultural equipment, and labour intensive methods on the shoreline. While there is no known history of an organized response to specific oil spills, there also is no identifiable, specific capability for responding, except for the resources mentioned above.

The main government leadership in oil pollution control has not been determined. In addition, report researchers could not locate documentation of either governmental or industrial oil spill contingency plans on the administrative or site-specific levels.

THE STATUS OF OIL POLLUTION PROBLEMS IN GUINEA

In addition to sharing one border, Guinea and Guinea-Bissau share virtually the same circumstances concerning oil pollution.

There is no current onshore or offshore oil production in Guinea, and there are no apparent oil spill problems. Similarly, there is no known history of organized response to specific oil spills. Potential problems in the future might include oily wastes from refinery operations or the chronic release of produced water, deck drainages, and occasional small spills from production platforms.

Report research was unable to identify a specific capability for responding to oil spills, except for the resources mentioned in previous pages; that is, the use of public works or port equipment, agricultural equipment, and labour intensive methods on the shoreline.

There is no known, documented governmental or industrial oil spill contingency plan on either the administrative or site-specific level in Guinea. The main government leadership in oil pollution control has not been determined.

THE STATUS OF OIL POLLUTION PROBLEMS IN SIERRA LEONE

Current or potential oil spill problems in Sierra Leone consist solely of oil/tar balls on beaches from tank washing residues or similar discharges from tankers passing offshore. The primary problem which could develop in the future is the production of oily waste products associated with refining operations. While there currently is no offshore oil production in the country, at least one firm, the Sierra Leone Petroleum Refining Co., Ltd., is operating in coastal areas.

In the event of a major oil spill in its waters, Sierra Leone has at hand only basic resources to combat the disaster. These include the availability of public works and port equipment, agricultural equipment, and labour intensive methods on the shoreline. No other specific capability is known to exist.

Two governmental agencies have been identified as having the primary leadership role in oil pollution control: the acting general manager of the Port Authority and the Ministry of Transport and Communication. However, there is no known, documented governmental or industrial oil spill contingency plan on either the administrative or site-specific level.

Sierra Leone also has no history of an organized response to specific oil spills.

THE STATUS OF OIL POLLUTION PROBLEMS IN LIBERIA

Liberia, a country with neither onshore nor offshore oil production, is confronted with two oil spill problems which are common to many of the nations of West and Central Africa. These are: (a) oil/tar balls on beaches - the result of tank washing residues or similar discharges from tankers passing offshore; and (b) oily wastes from refinery operations. Additional problems naturally could be expected with any future oil production development.

Another circumstance which Liberia shares with regional neighbours is the absence of an identifiable oil spill contingency plan set forth either through government or industry on an administrative or site-specific level. The main governmental leadership in oil pollution control appears not to be vested in any one particular agency.

While there is no known history of an organized response to specific oil spills, Liberia also seems not to have a recognized or publicized capability for responding, except, of course, for the availability of public works and port equipment, agricultural equipment, and labour intensive methods on the shoreline.

THE STATUS OF OIL POLLUTION PROBLEMS IN THE IVORY COAST

At least three companies are currently operating in coastal areas of the Ivory Coast to exploit or refine the country's offshore oil resources. These include Phillips Petroleum Company - Ivory Coast and Société Nationale d'Opérations Pétrolières de Côte d'Ivoire, both of which have offshore operations; and Société Ivoirienne de Raffinage, a refining firm established on the coast.

The Ministère de la Protection de la Nature appears to have the primary governmental role in oil pollution control in Ivory Coast. However, the Government does not have any evident oil spill contingency plan on either the administrative or site-specific level. The same can be said about industry. Similarly, the country has no specific, identifiable capability for responding to oil spills, except for the availability of public works and port equipment, agricultural equipment, and labour intensive methods on the shoreline. Fortunately, pollution problems in the Ivory Coast are common, but not considerable. They consist primarily of oil/tar balls on beaches caused by tank washing residues or similar discharges from tankers passing offshore; and oily wastes from refinery operations. An increase in the levels of production and refining, however, possibly could result in additional problems: the chronic release of produced water, deck drainages, or occasional small spills from production platforms.

THE STATUS OF OIL POLLUTION PROBLEMS IN GHANA

Oil and tar balls on its beaches constitutes Ghana's primary, ongoing problem of oil pollution. Caused by tank washing residues or similar discharges from tankers passing offshore, the incidence is unrelated to the country's current coastal land oil production development. Petroleum companies operating inshore include Ghanaian Italian Petroleum Company Ltd.; there presently are no offshore oil production operations. Expansion of current exploitation or refining activities, or the development of new oil-related activities, in the future could possibly yield such additional pollution problems as the presence of oily wastes from refinery operations or the chronic release of produced water, deck drainages, or occasional small spills from production platforms.

Ghana is among the West and Central African nations which do not have a well-defined programme for dealing with oil pollution in the marine environment. Although the main government leadership appears to be vested in the Environment Protection Council, the country has no specific, identifiable capability for responding to oil spills, except for the availability of standard port, public works, and agricultural equipment, or the use of labour intensive methods on the shoreline. There is no known, documented governmental or industrial contingency plan on either the administrative or site-specific level. Ghana has no recorded history of an organized response to specific oil spills.

THE STATUS OF OIL POLLUTION PROBLEMS IN TOGO

Current or potential oil spill problems in Togo consist solely of oil/tar balls on beaches, which are the result of tank washing residues or similar discharges from tankers passing offshore. While there presently are no petroleum companies operating offshore or in coastal land areas, any future development of oil production could yield associated pollution problems. Expansion of refining capabilities possibly could present the problem of oily wastes from refinery operations in the future.

Togo has no recorded history of organized response to specific oil spills. In the event of a major disaster, only basic resources currently are available to respond. These include the use of port, public works and agricultural equipment, or the use of labour intensive methods on the shoreline.

While government leadership in oil pollution control appears to be vested in an emerging Environmental Committee, the government does not have a documented contingency plan on either the administrative or site-specific level. This same status exists within industry.

THE STATUS OF OIL POLLUTION PROBLEMS IN BENIN

Currently in the West and Central African nation of Benin, there are no offshore or onshore oil production operations. A problem of oil/tar balls on beaches nonetheless exists, caused by tank washing residues or similar discharges from tankers passing offshore. In the event of future oil production development, the nation likely could expect to see an increase in the number or types of associated pollution and pollution control problems.

It appears that neither government nor industry has developed an oil spill contingency plan on the administrative or site-specific level. The main government leadership in oil pollution control evidently is vested in the Commission Nationale pour l'Environnement. However, Benin has no specific, identifiable capability for responding to a spill, except for the availability of port, public works, and agricultural equipment, or the use of labour intensive methods on the shoreline. There is no known history of organized response to specific oil spills in Benin.

THE STATUS OF OIL POLLUTION PROBLEMS IN NIGERIA

As one of the primary oil-producing nations of West and Central Africa, it is not surprising that Nigeria is experiencing a wide range of oil pollution problems. Among these are: (a) oil/tar balls on beaches, due to tank washing residues or similar discharges from tankers passing offshore; (b) oil on beaches and structures in the vicinity of port oil transfer facilities; (c) oily wastes from refinery operations; (d) the chronic release of produced water, deck drainages, and occasional small spills from production platforms; (e) the possibility of major releases of oil from production facilities, pipelines and loading facilities; and (f) modification of the environment from oil production-related development, such as deforestation or the cutting of channels onshore.

At this time, the country has no specific, identifiable governmental capability for responding to oil spills, except for the availability of public works and agricultural equipment, or labour intensive methods on the shoreline. The Port Authority in Lagos has submitted a budget request for its first pollution control vessel. Nonetheless, Nigeria's oil spill control capability appears to be the undetermined resources of oil companies operating under the direction of the Nigerian National Petroleum Company.

While there currently is no known, documented governmental oil spill contingency plan on either the administrative or site-specific level, Mr. Raimi Ojikutu, Director of the Environment, informed the consultants in July 1980 that the implementation of a plan had recently been approved.

Industry also appears to be currently without a documented oil spill contingency plan on either the administrative or site-specific level. In fact, these may exist, however, information about them was not made available to the authors. The Shell-BP Oil Company provides the only recorded history about an organized response to a specific oil spill, in its recovery of oil from the Otamiri-1 Flowline in November 1979.

The main government leadership for oil pollution control in Nigeria appears to be vested in three separate agencies, the Secretary of Transport and its Nigerian Port Authority, the Department of Housing and Environment, and the Nigerian National Petroleum Company and its directorate division. Overall co-ordination is conducted through an Interministry Committee. In general, the nation relies on oil pollution clean-up resources within industry; for example, in the Funiwa 5 incident, full responsibility for response was placed on the operator, Texaco-Chevron.

Because of the extensive oil production operations in Nigeria, a number of companies currently are working in offshore or coastal land areas. These include: (offshore) Mobil, Gulf, Texaco-Chevron, and Shell-BP, all in co-operation with the Nigerian National Petroleum Company; and (onshore) Shell-BP (Midwest and Eastern divisions), AGIP-Phillips, Gulf, ELF, Ashland, and Pan Ocean (Marathon). These firms also conduct their operations in co-operation with the Nigerian National Petroleum Company.

Comments on Nigerian Oil Pollution Control

The existence of Nigeria's oil pollution problems is better documented than in most West and Central African nations. Examples of this documentation include a report by Odoliyi Lolomari and O.A. Awobajo in the Oil Spill Intelligence Report and a publication by R. Arekaya of the Nigerian Institute of Oceanography and Marine Research.

Cornelius Wenninck prepared an undated report, entitled On the Evaluation and Quantification Related to the "International Conference on Marine Pollution - 1973" as It Applies to Marine Operations and Environment of the Federation of Nigeria for IMCO and the Ministry of Transport of the Federal Government of Nigeria. His excellent document discussed many facets of oil pollution control in the country at that time, showing that Nigeria was well exposed to the concepts of oil spill control management. Included were recommendations for port facilities and offshore transfer facilities, Nigerian flag ships and special training, as well as comment on concepts for a national contingency plan and cost estimates for providing these capabilities.

The Funiwa 5 blowout, in which thousands of tons of oil escaped from an offshore platform and adversely impacted coastal ecosystems and the people utilizing them, undoubtedly has focused attention on the problems. These circumstances also no doubt have stimulated the reporting of incidences and the creation of more governmental involvement and development on some level of oil spill contingency planning.

It should be noted that there appears to be no programme requiring clean-up or payment of clean-up costs or damages to individuals, as pointed out by examples in the report by Piquemal and Savini.

Between January 1, 1978 and August 1, 1979, 18 oil spills greater than 476 barrels each took place in Nigeria. The spills together totalled more than 738,095 barrels, and three spills involved more than 59,523 barrels each, including one of almost 571,429 barrels. In total, about 90,000 barrels of oil were spilled in ten spills greater than 476 barrels during 1978, and about 650,000 barrels in ten spills greater than 476 barrels in 1979 from January 1 to July 31. An additional 5,952 barrels were spilled during the remainder of 1979. In all cases, the oil lost was light Nigerian Crude.

THE STATUS OF OIL POLLUTION PROBLEMS IN CAMEROON

Two current or potential oil spill problems have been identified in Cameroon. These are the presence of oil/tar balls on beaches due to tank washing residues or similar discharges from tankers passing offshore or from Nigerian offshore production; and the chronic release of produced water, deck drainages, and occasional small spills from production platforms. At the present time, only offshore oil operations exist in Cameroon, and future escalation of these activities may create the potential of major releases from production facilities, pipelines and loading facilities. Additional future pollution problems may consist of oil on beaches and structures in the vicinity of port oil transfer facilities, oily wastes from refinery operations, and continued release of produced water, deck drainages and occasional small spills from production platforms in Cameroon and Nigeria.

Among the companies operating in the offshore area are ELF-Serepca, Gulf Oil Company, and Mobil Oil Cameroon. Despite this level of involvement on the part of industry, there is no known, documented industrial oil spill contingency plan on either the administrative or site-specific level.

The same statement may be made concerning government. Report research did not reveal a government contingency plan on either level, nor did it identify a specific oil spill response capability other than the availability of basic equipment or labour intensive techniques for shore clean-up. Information also was not readily available to identify the main leadership agency in government. Research did determine, however, that Cameroon has no recorded history of organized response to specific oil spills.

THE STATUS OF OIL POLLUTION PROBLEMS IN EQUATORIAL GUINEA

The status of oil pollution problems in Equatorial Guinea is a relatively straightforward situation. No current or potential spill problems have been determined to exist, and potential future problems may arise in the form of major releases of oil from production facilities, pipelines and loading facilities. At this time, however, there is neither onshore nor offshore oil production activity in the country.

Aside from the availability of basic port, public works and agricultural equipment or the use of labour intensive methods for shore clean-up, Equatorial Guinea has no specific, identifiable capability for responding to oil spills. There is no known, documented governmental or industrial oil spill contingency plan on either the administrative or site-specific level, and the main government leadership in oil pollution control has not been determined.

THE STATUS OF OIL POLLUTION PROBLEMS IN GABON

As another of West and Central Africa's leading oil-producing nations, Gabon is experiencing a number of oil pollution problems on a real or potential basis. These include: (a) oil on beaches and structures in the vicinity of port oil transfer facilities; (b) oily wastes from refinery operations; (c) chronic releases of produced water, deck drainages, and occasional small spills from production platforms; and (d) the potential of major releases of oil from production facilities, pipelines and loading facilities. Potential, additional future problems may be associated with ongoing oil development.

Currently, petroleum companies operating in the offshore area include ELF-Gabon and Royal Dutch/Shell. Companies operating in the coastal land area have not been identified.

Gabon has two identified oil spill control capabilities: boom and dispersant at the ELF-Gabon Cape Lopez Terminal. However, there is no known, documented governmental or industrial oil spill contingency plan on either the administrative or site-specific level. There is a history of organized response to one small oil spill which impacted the coast, but which was washed away within several days.

The main government leadership in oil pollution control appears to be vested in a number of agencies. These include: the Gabon Anti-Pollution Agency (CENAP) of the Ministry of Universities, Research and Environment; the Ministry of Mines; the Merchant Marine of the Ministry of Transport; and some supporting capability was noted from the Navy, Army (Firemen) and the National Forest Service.

In general, Gabon relies on industry clean-up resources. ELF-Gabon reports that they deal with pollution when it occurs. No reporting is required.

Comments on Gabonese Oil Pollution Control

The Gabon administrative agencies had a better awareness and documentation of their oil pollution situation than any of the other countries visited by the authors. The background information and reports presented to the consultants were outstanding. For the most part, the problems mentioned above are minimal because of the government's awareness and the high level of industrial responsibility evidenced by some industries.

Oil transfer and storage facilities near Port Gentil were visited by the consultants. ELF-Gabon operates an ultra-modern VLCC transfer and storage facility at Cape Lopez. The terminal had its beginning in 1957, with the construction of the first four tanks. Since that time, it has had three additional expansions and probably is at its final size. The terminal is highly instrumented. Four crude oil lines come into the terminal from offshore production and from production areas to the south. A group of tanks is used to store ballast water from tankers that dock at the terminal. These are being used less frequently, however, because of the greater number of tankers using segregated ballast.

Crude oil arriving by pipeline goes through a heat processing system and separation and then to storage tanks for delivery to the crude tankers. There also are two tanks which store oil going to the local refinery. Part of this crude is purchased and used by the refinery, and part of it is refined under contract for ELF. Refined products produced for ELF return through a pipeline and are stored in the terminal. These products include naphtha, gas oil (diesel) and fuel oil.

A capability is maintained in the plant for injecting naphtha into their product line. The primary crude from the northern part of the country is around a 29 API gravity. By injecting a fraction of naphtha to keep the API density above a certain point, they gain a marketing advantage.

Pumping to tankers has a potential rate of 12,000 metric tons per hour, although most loading takes place at 6,000 to 9,000 metric tons per hour. The pipeline system going to the ship consists of about six pipelines, the largest of which is the 42-inch main crude line. The crude oil, bunker fuel, gas oil (diesel) and naphtha can be piped to the loading system, and deballast water and perhaps product return are taken away from the loading dock.

The loading dock system is an extremely modern structure located only a short distance from the shoreline, but able to berth tankers of 65 feet (20 m.) in depth. They can accommodate a super tanker of 150,000 dwt. The loading system is quite modern with mechanical loading arms, automated fire fighting equipment, and a tower for access to the supertanker deck as the tanker arrives empty and leaves loaded. The operation was maintained in spotless condition and was an exceptional example of a loading terminal.

The ballast water and the produced water from offshore are delivered to an oil separation unit.

Two long pieces of Balear boom are maintained at the facility. This boom system is taken out and tested once a year. There are no skimming devices available at the facility. A modest amount of dispersant, reported to be 20 drums, is stored at the site. No specialized dispersant spreading equipment was observed. The terminal is protected by dykes around each tank. A fire-fighting system consisting of fresh water intake going into a major foam mixing plant and then fresh water and foam lines are circulated around each tank.

The SOGAR-COGAR refinery in Port Gentil was visited and found to be not as well equipped. This refinery produces gasoline, diesel, naphtha and fuel oil. The effluent from the plant goes through a simple API separator and then into the bay.

The loading dock at this facility was visited during a transfer of product to a tanker. The dock was made of treated timbers with gaps between the planks so that any oil spilled would drain through into the water. The consultants were able to see oil spilled as a result of this operation. Blind flanges were in place on a few of the lines, and there were a few buckets around for containment under connections.

The tanker that was loading had a very fine fixed catchment under the piping manifold, but a drain hose leaving away from the catchment went overboard to ensure that any oil spilled, instead of spilling on the dock, would be discharged directly overboard. There were a couple of small fire extinguishers on the dock, but no major fire-fighting equipment on the dock itself. The communications system consisted of a telephone on the shore end of the dock, thus on any overfillage of the tank it would be necessary for the operator to run ashore and call to the pump house to turn off the pumps. Previous oil spillage was evident on logs which were beached along the shoreline adjoining the facility.

Several ocean beaches were visited near Port Gentil, but no tarballs or fresh oil were observed at that time. A beach and an estuarine area at Libreville were also visited and found to be free of oil pollution.

THE STATUS OF OIL POLLUTION PROBLEMS IN THE CONGO

Six current or potential oil pollution problems have been identified as existing in the Congo. These include: (a) oil/tar balls on beaches, caused by tank washing residues or similar discharges from tankers passing offshore; (b) oil on beaches and structures in the vicinity of port oil transfer facilities, Point Noire and from the offshore terminal at Djeno; (c) the chronic release of produced water, deck drainages and occasional small spills from production platforms, with the potential at Emeraude and Luango being low due to a northerly current; (d) potential major releases from production facilities; (e) public utilities and railway waste oil disposal at Point Noire; and (f) spillage in waters to the south, possibly in Cabinda or Zaire and carried northward by the strong current.

Potential future problems in the Congo have been identified as being oily wastes from refinery operations when the Point Noire refinery becomes operational; and damage to coastal fishing and environmental resources along the coastline if the repeated heavy oilings which Point Noire is now experiencing continue.

The Congo has no specific, identifiable capability for responding to oil spills except for the use of public works, port and agricultural equipment or labour intensive methods on the shoreline. In addition, there is no known, documented governmental or industrial oil spill contingency plan on either the administrative or site-specific level. There is, however, a history of an organized response to a pipeline leak. The line was depressurized and the leak controlled until the pipe could be replaced. An oil tanker stood by to receive oil from production wells if the leak could not be controlled. Bacterial seeding of the oil flowing through the pipeline was attempted, however, it was not successful.

The main government leadership in oil pollution control appears to be vested in the Directeur de l'Environnement of the Ministère de l'Aménagement du Territoire. A general law exists governing the territorial sea, water pollution, fishing and exploitation of the sea: Ordonnance No. 22/70/70 du 14/7/70 sur la mer territoriale, la pollution des eaux de la mer, l'exercice de la pêche maritime, l'exploitation des produits de la mer. Article 3 of this law specifically refers to pollution of the sea by oil. It endorses the 1954 MARPOL and prohibits the discharge of oil or oily mixtures into Congo's waters. Specific penalties for the pollution of the sea are provided by this law.

The country generally relies on industry clean-up resources. Companies operating in the offshore area include ELF Congo and AGIP Recherches Congo. Firms which have onshore operations include Hydro Congo, which is involved in the distribution of oil and the importation of refined products.

Comments on Congolese Oil Pollution Control

Reports were received from scientific personnel from the Congo's oceanographic institute at Pt. Noire (ORSTROM) and from casual beachgoers of frequent oilings and tarballings of Point Noire's beaches. These oilings occur on the order of once a month and render the beach unusable for about one week. The oil comes ashore in two forms, as viscous mousse and as scattered tarballs. These two types of oilings are reported to occur independently of each other.

The beaches north of Point Noire near the river also have been oiled. A sample of oiled sand from one of these beaches, taken in December 1979, was given to the team. This same beach was visited in July 1980 and found to be oil-free. The team also visited the beaches at Point Noire and found traces of oily debris.

Potential sources for these incidents are the Djeno terminal, offshore production and production to the south in Cabinda or Zaire.

The Djeno terminal consists of a single point mooring about 3,800 metres offshore and onshore tankage. Three to six transfers occur per month.

Two offshore platforms operated by ELF and AGIP were visited and found to be well maintained. A small amount of very light sheen was observed coming from these platforms as a major washdown was underway at the time of the visit. However, these platforms appeared to be clean in all other respects. A strong current was evident from the movement of water past the platform legs from the south to the north.

The sheltered beaches inside Point Noire were examined for oil and found to be oil-free.

The co-operation of ELF and AGIP in allowing their platforms to be set up with oceanographic equipment is a definite benefit to this effort. An awareness of the oil pollution problem, its sources and impact on the Congo were demonstrated through numerous conversations and in a report prepared by M. Issanga, entitled "La Pollution marine par les Hydrocarbures Pétroliers dans la Région Maritime Congolaise".

THE STATUS OF OIL POLLUTION PROBLEMS IN ZAIRE

Many of the oil pollution problems characteristic of major West and Central African producers also exist in Zaire. Among these current or potential hazards are: (a) the presence of oil on beaches and structures in the vicinity of port oil transfer facilities; (b) oily wastes from refinery operations; (c) chronic releases of produced water, deck drainages, and occasional small spills from production platforms; and (d) potential major releases from production facilities, pipelines and loading facilities.

While there is no recorded history of organized response to specific oil spills in Zaire, there also is no identifiable, definite capability for responding to oil spills, except for the use of public works, port and agricultural equipment, or the use of labour intensive methods on the shoreline. In addition, there is no known, documented governmental or industrial oil spill contingency plan on either the administrative or site-specific level.

The main government leadership in oil pollution control appears to be vested in the Ministry of Environment, Conservation and Tourism. The Ministry of Transport is responsible for navigation, and ports are run by a State-owned corporation, l'Onatra (l'Office Nationale des Transports), which is in charge of all port activities except petroleum. Port regulations exist regarding the discharge of ballast water, throwing refuse into the water, and other similar pollutions. In general, Zaire relies on industry for clean-up responses.

A number of petroleum companies are operating in Zaire. Among those with offshore production facilities are Zaire Gulf, which manages offshore production and operates two producing fields, Mibale and Mwambe, near Moanda, as well as an offshore terminal. Those which have onshore activities are Zairep, an exploration and production co-operative which is comprised of Petrofina (35 percent), Amoco (40 percent and Shell (25 percent), and which is developing two onshore fields, Mibale and Kinkali near Moanda; and Zaire SEP (Service of Enterprise Petroleum), which handles all hydrocarbons. This latter firm also is a kind of co-operative among all the oil companies, including common tankage, methods of transport, and so forth.

Comments on Oil Pollution Problems in Zaire

No ongoing pollution incidents were observed in Zaire. The terminals at Matadi, Banana and Ango Ango were not visited. The waterfront area of the Congo River in Kinshasa showed evidence (rainbow sheen and smell of oil) of oil pollution, most probably from the numerous river craft moored near the ferry landing. Urban runoff also could have contributed to this oil sheen.

The offshore terminal operated by Zaire Gulf was visited. It consists of a 72,000 dwt (about 540,000 bbl. capacity) tanker, the S.S. Solon (U.K.) and two SPM buoys. The tanker is permanently moored to one buoy and receives oil from both offshore and onshore production via an undersea pipeline. The second monobuoy is utilized by the receiving tanker. The S.S. Solon is maintained in a ready-to-sail condition, has permanent ballast and was spotless when visited. Both crew and Zaire Gulf personnel advised that there had been no spillage during the operation of the facility. They further advised that most of the tankers now arriving for cargo had segregated ballast.

Two of Zaire Gulf's offshore platforms also were visited. They, too, were spotless and fully scuppered. Low field pressures as evidenced by the use of both water injection and gas life greatly reduce the possibility of a serious production pollution incident.

Zairep, a petroleum exploration and production co-operative made up of Amoco, Shell and Petrofina, is developing two onshore production areas near Moanda. Al of Zairep's sites were clean and well organized. A pumping station is located at Mibale. A 16-inch line connects Zairep's onshore production with Zaire Gulf's offshore production and the S.S. Solon.

Crude oil and refined products are imported at Banana and Ango Ango (up the Congo River near Matadi). Refined product tankers are lightered by barges near Banana and off-loaded at Ango Ango. A small refinery in Banana uses a mixture of imported and domestic crudes.

The offshore areas in which oil is produced lie within a high current area (flowing northerly) reportedly at two to six knots. A daily operation sheet received from Gulf indicated a two-knot current, and visual observation of the flow of water around the legs of the platform verified the high current. Oil containment would be impossible offshore in these conditions. The oil would soon enter Angola (Cabinda) waters.

The beaches are sandy, medium-grained from Banana to Moanda, with a small estuary at Moanda. They are littered with debris, and the water is turbid from the outflow of the Congo River. Sandy beaches were also observed at Vista. These observations cover a majority of Zaire's short coastline. Mangroves were observed and photographed in estuaries at Moanda and Banana. Oil pollution was not noted in beach or mangrove areas.

THE STATUS OF OIL POLLUTION PROBLEMS IN ANGOLA

The mission was unable to visit Angola. However, document research has revealed that Angola is confronted by one major oil spill problem, the potential release of oil from production facilities, pipelines and loading facilities. No direct information was available, but conversations with individuals who have observed oil coming from Angolan waters suggest a major problem may concern oil on beaches from offshore production.

Potential future problems may be oil on beaches and structures in the vicinity of port oil transfer facilities, and the potential for major releases from production, piping and loading activities. Currently, only offshore operations could be identified; those are being carried out by Gulf Cabinda.

There is no known history of organized response to specific oil spills. The capability to deal with a petroleum disaster seems to consist only of basic equipment available from public works, port and agricultural sources, and through labour intensive methods used on the shoreline. Neither government nor industry seem to have developed an identifiable oil spill contingency plan on either the administrative or site-specific level. The main government leadership in oil pollution control was not determined.

Overview

The overview is divided into three components dealing with those countries with extensive petroleum production and exportation (Nigeria, Gabon, Congo, Zaire and Angola); emerging oil producers (Ivory Coast, Cameroon, Ghana, Senegal, Guinea and Benin); and non-oil producing nations (the Gambia, Guinea-Bissau, Togo and Equatorial Guinea).

Oil-Producing Countries

In the oil-producing countries, considerable variation in philosophy seems to prevail. Industry, particularly government-owned petroleum and shipping firms, appears to operate under two divergent philosophies. One is that in the absence of regulation from government, industries will emulate high standards. The other view is that in the absence of regulation, they will do only what they consider to be necessary.

This divergent philosophy is dramatically exemplified in Gabon. In one location, an ELF-Gabon terminal was designed and is operated to the highest standards; in another location nearby, a refinery terminal is decidedly behind current safety and oil pollution technology, with the tanker at the dock carelessly piped and the catchment area oil drainage going directly over the side.

This is not atypical of the status of oil pollution control, that is, emerging but having limited governmental regulation and supervision, little (if any) co-ordinated contingency planning, general reliance on industry to address its own its own problems, and no programme to handle problems if they get out of hand.

Although problems generally are not considerable in the overall region, the continued expansion of petroleum development and shipping, particularly in Nigeria, makes the development of trained specialists, effective plans, and supporting resources necessary. The Funiwa 5 spill may serve the role in West and Central Africa which the <u>Torrey Canyon</u> disaster did in England, the <u>AMOCO-Cadiz</u> in France, and the <u>Argo Merchant</u> in the United States by shocking governments into more effective prevention of spills and proper management of spills when they occur.

Non-Petroleum Producers

A number of West and Central African nations are not now oil producers. Typically, they import a limited amount of crude to a small refinery or merely import refined products. For these nations, the internally generated oil pollution problem is relatively small and consists primarily of transfer accidents and refinery discharges. The local port authority usually is the agency most concerned with oil spills. These nations are often impacted by tar balls from the international tanker traffic and subjected to the rick of impact from offshore collision, grounding or explosion. These nations generally have limited oil pollution laws and limited, if any, response capability in either the industrial or governmental sector. If impacted by a major spill from without, they would be ill-equipped to handle it. Furthermore, their existing internal laws do not consider the Civil Liability Convention or Fund Convention; generally, they have not ratified the conventions. Thus, they would have to rely on outside response capability by the spiller and be dependent on the TOVALOP or CRISTAL programmes for funding either internal or external spill response.

Emerging Oil-Producing Nations

These are nations just beginning down the pathway from the "simple" life of the non-producer to that of major petroleum producer. How they fare on this pathway depends on how they chart their course in terms of legislation, supervision and planning, and on the terms or requirements built in the operating permits of the operating companies hired or authorized to work in the country.

Resources Available for Response

For those people responsible for oil spill control in their country or company, there are many resources available to help with the tasks of developing a programme, preventing spills from occurring, and dealing with them.

INTERNATIONAL CONVENTIONS. Over the last 25 years, a series of international conventions have been developed which serve to help prevent marine pollution. However, these conventions will only have effect when ratified and enforced by nations. The list of the Inter-Governmental Maritime Consultative Organization conventions includes:

1. Operational Pollution Related

   1969 AMENDMENTS

   1973 MARPOL - International Convention for Prevention of Pollution from Ships

   1978 MARPOL PROTOCOL

2. Accident and Safety Related

    1960 SOLAS - International Convention for Safety of Life at Sea

    1960 COLREG - International Regulations for Preventing Collisions at Sea

    1966 LOAD LINES - International Convention on Load Lines

    1972 INTERVENTION - International Convention Relating to Intervention on the High Seas in Case of Oil Pollution Casualties

    1974 SOLAS

    1978 TRAINING/CERTIFICATION - Conference planned to develop a Convention on Maritime Training

3. Compensation and Liability Related

    1969 CIVIL LIABILITY - International Convention on Civil Liability from Oil Pollution Damage

    1971 FUND - International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage

The provisions of the 1969 amendments to the 1954 Convention are extremely important to the West and Central African area in that they require the equivalent of the load on top (LOT) tank washing and ballast water management system and limit oil discharge to 1/1,5000 of the cargo and 60 litres of oil discharged per mile. This discharge level is 1/75 of the amount of oil discharged by straight tank washing and discharge. For a 200,000-ton tanker, this reduces the discharge of oil from 1,000 tons, or 7,000 barrels per voyage, to 26.7 tons, or 93.3 barrels per voyage.

The 1973 Convention and the 1978 Protocol go even farther in limiting discharge to 1/30,000 of the cargo. The Conventions can be roughly divided into three areas: conventions to limit chronic pollution discharges, such as ballast water and tank washings; conventions to increase safety and reduce accidents at sea; and conventions to compensate for oil spill clean-up costs and damages. Table VI-1 gives the provisions of the basic 1954 Convention and the subsequent 1973 Convention, which comprise the first group.

The second group of conventions aim at preventing tanker accidents. The pending 1978 Safety of Life at Sea (SOLAS) protocol requires duplicate systems of key tanker components, such as steering mechanisms and navigation systems. These two groups are discussed further in the next section of the report.

TABLE VI-1

PROVISIONS OF THE 1954 AND 1973 CONVENTIONS

Topic	1954 Convention (as amended in 1962)	1973 Convention
Applicability as regards carriage of oil	1. Seagoing tankers over 150 gross tons 2. Other seagoing ships over 500 gross tons	1. All tankers over 150 gross tons. 2. All other ships over 400 gross tons including novel craft and fixed and floating platforms.
Dispute settlement	Referred to International Court of Justice unless all parties agree to arbitration.	Compulsory arbitration by specially formed tribunals upon application of any party to dispute.
Amendment procedure	Effective only upon specific acceptance via IMCO assembly and contracting States.	Speedier method for annexes and appendices via IMCO Committee and tacit acceptance procedures.
Survey and certification	No comparable provision	1. Survey at 5-year intervals and at intermediate intervals. 2. Equipment must be approved by Administration (monitors, filters, separators, interface detectors). 3. Administration issues certificate attesting to compliance by its ships. Certificate shall be accepted except when there are clear grounds to believe the ship is not in compliance.
Definition of oil	1. Limited to crude, fuel, heavy diesel and lubricating oils 2. Does not include bilge slops and fuel and lube oil purification residues.	Includes all petroleum oils except petrochemicals (which are regulated by annex II).
Discharge criteria in prohibited zones (this term does not appear in the 1973 Convention which uses a distance from land criterion).	1. Prohibits discharges by all ships in concentrations in excess of 100 parts per million within the prohibited zones. 2. Prohibited zone generally 50 miles or greater from nearest land for tankers. Prohibited zone applies to other ships unless proceeding to a port not provided with adequate reception facilities.	1. Prohibits discharges which leave visible traces unless it can be established by installed instruments that the concentration discharged was less than 15 parts per million. 2. For tanker cargo slops, discharge is prohibited within 50 miles from nearest land. For other ships slops, and other tanker slops, discharge is prohibited within 12 miles from the nearest land.
Discharge criteria outside of the prohibited zones.	No restriction on discharges from a ship less than 20,000 gross tons. Vessels over 20,000 gross tons are limited to discharges whose concentrations are 100 parts per million or less, unless when in the opinion of the master, circumstances make it unreasonable or impractical to retain the higher concentrated slops on board.	1. Tankers must meet all the following conditions: a. Ship is proceeding enroute. b. Discharge is limited to 60 liters per mile instantaneous rate. c. Total quantity discharged is limited to 1/15,000 of cargo last carried for existing tankers and 1/30,000 of cargo last carried for new tankers. d. Tanker bilges, except pump rooms, shall be treated same as other ships. 2. Other ships must meet all of the following conditions: a. Ship is proceeding enroute. b. Oil content of the effluent must not exceed 100 parts per million.
Enforcement mechanism	No comparable provision	Requires that the monitoring and control system be in operation and a permanent record made anytime oily effluent is being discharged, except for clean or segregated ballast.
Construction and equipment requirements to control operational discharges of oily mixtures.	No comparable provision	1. Segregated ballast is mandatory for new tankers of 70,000 deadweight tons and greater, and is optional for tankers of less than 70,000 deadweight tons. Note that "new" tankers are defined by calendar dates and are therefore not dependent upon entry into force of this Convention. 2. Retention of oil on board (LOT) is mandatory for all tankers. 3. Mandatory installation of effluent monitor and control system, provision of slop tanks, and provision of oil/water interface detectors. Effluent must comply with discharge criteria or be transferred to reception facility. 4. Other ships require sludge tank installations, oil water separator and/or filters dependent upon ship size.
Reception facilities.	Provision to promote according to need of ships using ports.	Expanded provision to undertake to insure availability and adequacy at oil loading ports, repair ports and at other ports according to the needs of ships.
Oil record book	Establishes basic requirement to provide oil record book and requires entries for specific operations.	Expands requirements to provide entries for more specific operations and in greater detail to aid in enforcement.
Construction requirements to limit the amount of oil discharge in case of accidents.	No comparable provision	1. Establishes damage assumptions and methods of calculation of the amount of hypothetical oil outflow for tankers. 2. Establishes tank arrangement and size limitations for the cargo tanks of tankers. 3. Establishes subdivision and damage stability criteria to be applied to tankers to increase survivability in the event of accident.
Additional annexes for substances other than oil. Annex II is mandatory and annexes III, IV and V may be adopted at the motion of contracting States.	No comparable provision	1. Annex II details mandatory requirements for construction of chemical tankers and discharge criteria for liquid noxious substances in bulk. 2. Annex III contains regulations for the prevention of pollution by harmful substances carried at sea in packaged form, or in freight containers, portable tanks of road and rail tank cars. 3. Annex IV contains regulations for the prevention of pollution by sewage from ships. 4. Annex V contains regulations for the prevention of pollution by garbage from ships.

The third group of conventions deals with compensation for clean-up costs and pollution damage. There is a planned phase-out of the voluntary insurance schemes (TOVALOP and CRISTAL) as the new CLC and Fund Conventions become established. Tables VI-2 and VI-3 provide further information on these programmes.

Shift in Oil Clean-up Responsibility from the Shipowners and Cargo Owners to Governments

Following the Torrey Canyon spill in 1967, shipowners created the TOVALOP Insurance System and the cargo owners created the CRISTAL Insurance System as interim programmes to compensate for oil spill clean-up costs (and later third party damages) until international conventions could be created to replace them.

This replacement took the form of the Civil Liability Convention and the International Fund Convention which recently have come into force.

What is generally unrecognized is that the shift to the new conventions and the pending dissolution of the TOVALOP and CRISTAL programmes shifts to a greater degree the role of oil pollution control.

To partake of the benefits of these new conventions, governments must do the following:

1. Ratify the conventions, which only apply when the flag state of the ship and damaged state are both parties to the convention.

2. Pass national laws under which to have access to the benefits of the convention. Recovery of clean-up costs and third party damages are through the internal laws of the damaged country.

3. Be prepared to mount a "reasonable" clean-up effort.

4. Be prepared to determine accurately third party damage to fisheries, tourism and industry.

The government should also be aware that the maximum limits under the conventions are not adequate to cover all of the costs incurred in a really large spill such as that of the AMOCO Cadiz, which spilled 220,000 metric tons of oil on the coast of France and generated damages ranging upward of ten times the limit provided by the CLC and CRISTAL programmes in force at the time of the spill.

It is, however, noted that these conventions and programmes pay only for "after the fact" costs of response and do not pay funds to government for preparing to deal with spills.

TABLE VI-2

PROVISIONS OF CIVIL LIABILITY CONVENTION AND TOVALOP

	Civil Liability Convention	TOVALOP
PURPOSE	• Establishes uniform worldwide limit on liability for oil pollution damage and cleanup costs.	• Assure reimbursement of national governments for actions taken to avoid or mitigate damage from oil pollution, and encourage tanker owners to cleanup on their own account.
STATUS	• International treaty—In force since 6/19/75 (25 nations as of 7/30/76).	• Agreement among tanker owners—in operation since 1969.
SCOPE	• Seagoing vessels carrying oil in bulk as cargo. • Covers pollution damage to contracting nations' territory and seas, although spill can have originated elsewhere.	• 95% of free-world tanker tonnage (99% of those operating). • Seagoing tank vessels, including barges.
OILS	• Persistent oils (cargo or bunkers) if cargo being carried at time of spill (does not cover vessels in ballast).	• Persistent oils (cargo or tankers) or both loaded and ballast vessels.
DAMAGES	• Loss or damage by oil contamination, including cleanup costs. • Costs of preventive measures. • Further loss caused by preventive measures.	• Government oil removal costs (coastlines). • Tank vessel owners' cleanup costs. • Government or tank vessel owners' measures to avoid serious threat of pollution.
LIABILITY LIMITS	• $160/convention ton—not to exceed $16.8 million per incident.	• $160/gross ton. Maximum $16.8 million per incident per tank vessel.
DEFENSES	• War, hostilities. • Exceptional natural phenomenon (Act of God). • Act with damage intent by third party. • Negligence or wrongdoing by any government (mis-maintenance of lights/navigational aids, etc.).	• Proof of no fault on part of vessel.
ADMINISTRATION	• Government agencies of contracting nations.	• International Tanker Owners Pollution Federation Limited.
FINANCIAL RESPONSIBILITY	• Vessel must be certified by a contracting nation as having sufficient financial coverage for convention liability.	• Must be established through P&I club, insurance company or ITIA (a specially formed company providing TOVALOP coverage).
CLAIMS PROCEDURE	• Actions brought in courts of contracting nations. Court determines apportionment and distribution of award.	• Claim registered with tank vessel owner who passes it on to insurer. • If claim disputed, arbitrated by International Chamber of Commerce.

Civil Liability

Recognizing the need for the legal machinery to deal with oil spills, the Inter-Governmental Maritime Consultative Organization in 1969 sponsored the adoption of the International Convention on Civil Liability for Oil Pollution Damage, which represented a significant step in the development of legal remedies for persons or nations affected by oil spills. It standardized criteria of financial responsibility for pollution clean-up and damage liability within the international marine community. The Convention has been ratified by 42 IMCO member and non-member nations as of 8 April 1980. Table VI-2 describes the Civil Liability Convention and industrial TOVALOP programme it ultimately may replace.

The Civil Liability Convention covers pollution damage to a contracting State's territory or territorial seas resulting from a spill of persistent oil carried by seagoing vessels. The spill may have originated on the high seas, but only the resulting damage within the territorial waters is covered. Bunkers also are covered if the vessel was carrying oil cargo. The Convention places the primary responsibility for oil pollution damage on the shipowners. Vessels covered by the Convention must have proof on board that they are covered by insurance sufficient to meet the requirements of the Convention.

Under the Convention, injured parties may collect up to $160 per ton of the ship's tonnage (defined as net tonnage plus tonnage of engine room space) with a maximum of $16.8 million per incident for costs of loss due to oil pollution including clean-up costs. The Convention also provides for compensation for preventive measures, such as the use of skimmers or protection booms, which are taken to protect endangered coastlines and other resources.

There are some circumstances under which a shipowner is not liable for the costs of clean-up, damage or loss due to oil pollution under this Convention. These include "acts of God" (i.e., lightning), acts of war or hostility, negligence by governments (failure to maintain navigational aids), or action of a third party claimant with intent to do damage (sabotage).

The injured party suffering damage or loss, or the party incurring clean-up costs, makes a claim against the tanker owner. If the owner does not have a defence under the Convention, he may settle out of court with the claimant. Otherwise, the claim is heard in the court of the contracting State where the damage occurred: liabilities of the owner are determined, and payment is made by the owner's insurers. If a shipowner is able to use one of the defences, or if the costs exceed Civil Liability Convention limits, the injured party could then turn to the Fund Convention.

TABLE VI-3

PROVISIONS OF IMCO CONVENTIONS

	Fund Convention	CRISTAL
PURPOSE	• Supplements Civil Liability Convention funds to assure compensation to parties suffering pollution damage or loss. Also would reimburse tanker owners for portion of their liability under the Civil Liability Convention.	• Increases the compensation available to persons sustaining pollution damage, supplementing TOVALOP or the Civil Liability Convention. Also reimburses shipowners for portion of "excess" cleanup costs.
STATUS	• International treaty; pending sufficient ratifications.	• Agreement among cargo owners, in effect since 1971. • Originally intended as interim substitute for Fund Convention.
SCOPE	• Contracting nation's territory and territorial seas, although spill can have originated elsewhere. • Vessels of nations which are party to the Civil Liability Convention.	• Any seagoing vessel or craft carrying bulk oil cargo (estimated to cover 90% of crude & fuel oil shipped by sea). • Seas, waters entered by seagoing vessels.
OILS	• Persistent hydrocarbon mineral oils.	• Persistent oils (cargo or bunkers).
CONDITIONS	• Contracting states must be party to the Civil Liability Convention. • Flag state must be party to the Civil Liability Convention in order for shipowner to receive compensation.	• Oil owned or "deemed" owned by party to CRISTAL • Tanker involved enrolled in TOVALOP, or Civil Liability Convention applicable to incident. • Circumstances such that Civil Liability Convention imposes liability on tanker owner.
DAMAGES	• Pollution damage to persons not adequately compensated under the Civil Liability Convention because of: —no Civil Liability Convention liability —financial incapability of vessel owner —damages exceed Civil Liability Convention liability	• Vessel owner's cleanup costs in excess of deductions (see below). • Pollution damages in excess of deductions.
FUND SIZE	• $36 million (can be increased to, $72 million).	• $30 million guaranteed ($5 million actually being held).
METHOD OF FUNDING	• Contributions by cargo owners of participating nations proportional to volumes of oil received by participating nations.	• Contributions of cargo owners, proportional to volumes of oil transported by sea.
FUND LIABILITY	• Maximum $36 million, aggregate with Civil Liability Convention compensation. • Can be increased to $72 million by agreement of Assembly of Fund. • Compensates owner for Civil Liability Convention liability over $120/ton or $10 million, whichever is less, but not in excess of $160/ton or $16.8 million, whichever is less.	• Owner's cleanup costs less TOVALOP coverage. • Pollution damage to maximum of $3 million, less deductions for: —owner's cleanup costs in excess of $125/grt or $10 million, whichever is less, but not more than $30 million. —Liability to governments. —Any other liability of tanker owner or anyone else to the claimant as a result of a spill.
DEFENSES OF FUND	• War, hostilities. • No proof of ship-source spillage. • Intentional or negligent act of claimant.	• War, hostilities. • Third party act. • Government negligence.
ADMINISTRATION	• Fund Convention Secretariat, Executive Committee, and Assembly (latter comprising representatives of all contracting nations).	• Oil Companies Institute for Marine Pollution Compensation Ltd./Directors.
CLAIMS PROCEDURE	• Brought against the Fund Convention in court of contracting nation in which damage occurred.	• Direct application to the Institute.

Fund Convention

Due to the limitations in the compensation available to the damaged party under the Civil Liability Convention, another Convention was adopted under IMCO sponsorship in 1971 to supplement the Civil Liability Convention. The International Convention on the Establishment of an International Fund for Compensation of Oil Pollution Damage created a fund financed by mandatory contribution from contracting States which receive oil shipped by sea. This Convention applies only to those situations and vessels already covered by the Civil Liability Convention.

The Fund Convention more than doubles the maximum amount of compensation available under the Civil Liability Convention, from $16.8 million to $36 million per incident (1975 rates). The upper limit of the Fund Convention could be increased to $75 million, if necessary, by a decision of the governing body of the International Fund. Furthermore, a shipowner who is shown to be liable for costs over $120 per ton or $10 million, whichever is less, under the Civil Liability Convention will be able to apply to the Fund for reimbursement of the portion of his liability exceeding these figures, up to a maximum of $160 per ton and $16.8 million, whichever is less. Thus, the owner's insurer would be relieved of part of the burden under the CLC. The Fund Convention and CRISTAL are described in Table VI-3.

Parties damaged by oil pollution that might not be able to obtain compensation under the Civil Liability Convention could sue the International Fund. This includes incidents in which: (a) a shipowner is not liable because he has a defence under the Civil Liability Convention; (b) damages exceed the limitation of liability under the CLC; and (c) the shipowner and his guarantor are financially unable to meet their obligations under the CLC.

Other Resources

There are a large number of other resources available to assist in spill planning and response activities by governments. UNEP and IMCO have in many cases provided consultants and advisers to help governments with regard to oil pollution problems.

The availability of other support entities is shown in Table VI-4. Although not applicable in all countries, the depth of available supporting entities is demonstrated.

Source		Oil Spill Cleanup: Organized Manpower	Oil Spill Cleanup: Oil Spill Equipment	Oil Spill Cleanup: Oil Spill Supplies	Oil Spill Cleanup: Contingency Public Works Equipment	Oil Spill Cleanup: Vacuum Trucks & Tank Trucks	Oil Spill Cleanup: Vessels	Oil Spill Cleanup: Aircraft/ Helicopters	Oil Spill Cleanup: Manpower Logistics	Oil Spill Cleanup: Other	Technical Assistance/ Documentation: Oil Spill Specialists	Technical Assistance/ Documentation: Engineering Manpower	Technical Assistance/ Documentation: Scientific Manpower	Technical Assistance/ Documentation: Legal Manpower	Technical Assistance/ Documentation: Financial Management	Technical Assistance/ Documentation: Photo/ Documentation
Industry	Company Resources	x	x	x					x	x	x	x	x	x	x	x
Industry	Cooperative Resources	x	x	x		x	x			x	x					
Contractors & Suppliers	Oil Spill Contractors	x	x	x		x	x			x	x					
Contractors & Suppliers	Construction Contractors	x			x											
Contractors & Suppliers	Oil Industry Service Contr.	x			x	x	x	x	x							
Contractors & Suppliers	Oil Spill Suppliers		x	x												
Consultants & Academic Organizations	Oil Spill Consultants										x	x		x		
Consultants & Academic Organizations	Environmental Consultants												x			
Consultants & Academic Organizations	Universities										x		x			x
Consultants & Academic Organizations	Research Organizations										x	x	x			x
Local/State Government	Public Works Transportation	x			x			x								
Local/State Government	Fire/Police	x														
Local/State Government	Port Authorities						x									
National Government	Navy/Coast Guard	x	x				x	x	x		x					
National Government	Army	x			x			x	x							
National Government	Air Force	x						x	x							x
National Government	Public Works	x			x				x							

TABLE VI-4

SUPPORT ENTITY DIAGRAM

A wide variety of resources are utilized in a given spill control situation. For small spills of a few barrels, local industry resources may be sufficient to handle the situation. However, as spill size and complexity increase, successively higher levels of supplemental resources are needed both for the clean-up operation and to document the spill situation, the response to the spill situation, and the impact of the spill. This hierarchy normally goes from local and/or co-operative industry resources through contractor resources to governmental resources as the spill size and complexity increase, unless national governments pre-empt the process and take over the response at some stage.

As the spill size and complexity increase, the administrative role often shifts from that of actual hands-on clean-up response to a more managerial role of obtaining outside resources; monitoring both performance and costs of contractors, consultants and suppliers; ensuring that adequate engineering and scientific input is included in the clean-up decision process; and ensuring that adequate documentation for reimbursement and future litigation is achieved.

Consultants and Academic Organizations

Consultants, either from consulting organizations or from academia, can play an important role in the spill response and the activities thereafter. Consultants can serve three major roles during the period of the spill. The first is to provide scientific input in the form of oceanography, meteorology, and environmental systems characteristics which are necessary inputs for the response activity. Secondly, they can provide technical information with regard to clean-up technology, sources of supply, and knowledge of effective spill equipment and supplies under different circumstances. Finally, the consultants can carry a major role in documenting the spill.

The value of the consultant is extremely valuable both at spill time and for ultimate litigation activities. Often those directly involved with the spill response are too busy to sit back and make an objective evaluation of the response itself and the resulting impact. Those who have provided technical advice and carried out documentation activities on other spills are as equally skilled in this area as support contractors in other areas. Only now is the need for a highly documented evaluation of the spill and its impact from the AMOCO Cadiz truly being realized, and funds are being expended to try to recreate much of the knowledge base which could have been generated much more easily and economically at the time of the spill.

If a spill ultimately goes to court for a decision on clean-up costs, third party damages and environmental damages, the value of consultants is magnified. If their reports of other spills have been objective, then they bring a high level of credibility into the courtroom. In addition, their participation on other spills makes it possible for them to make comparisons that a person involved only with a single spill would not be able to do, and, as a result of their training, they usually are skilled at report synthesis and writing.

The value of technical assistance at the time of the spill is demonstrated by the attached diagrams. Figure VI-3 demonstrates the major effects of delaying or miscalculating spill response. An important factor in avoiding the problems of delay in response is to assess correctly the technology required and the magnitude of manpower and equipment resources needed for response.

Table VI-5 shows typical response priorities and Figure VI-4 demonstrates technology selection of different unit processes which may be further refined to individual unit operations suitable for the technology of individual countries. Figure VI-5 demonstrates the extent of manpower resources required for coastal spill clean-up. Figure VI-6 shows how required equipment resources can be calculated.

Figure VI-7 provides a logistical flow diagram for use in designing the required logistical network.

Resources in West and Central Africa

Institutes in West and Central Africa which may be able to serve a role in response, training and scientific studies are presented below.

SENEGAL

Centre de Recherches Océanographiques de Dakar Thiaroye, Dakar, aided by ORSTOM (Office de la Recherche Scientifique et Technique d'Outre Mer)

Institut Sénégalais de Recherches Agronomiques, Dakar

Centre National de Recherches Agronomiques de Bombaya, Bombaya

Centre ORSTOM de Hann, operated by France in co-operation with Senegal

SIERRA LEONE

Department of Chemistry and Institute of Marine Biology and Oceanography, Fourah Bay College, Freetown

EFFECT OF DELAYED CLEANUP RESPONSE

FIGURE VI-3

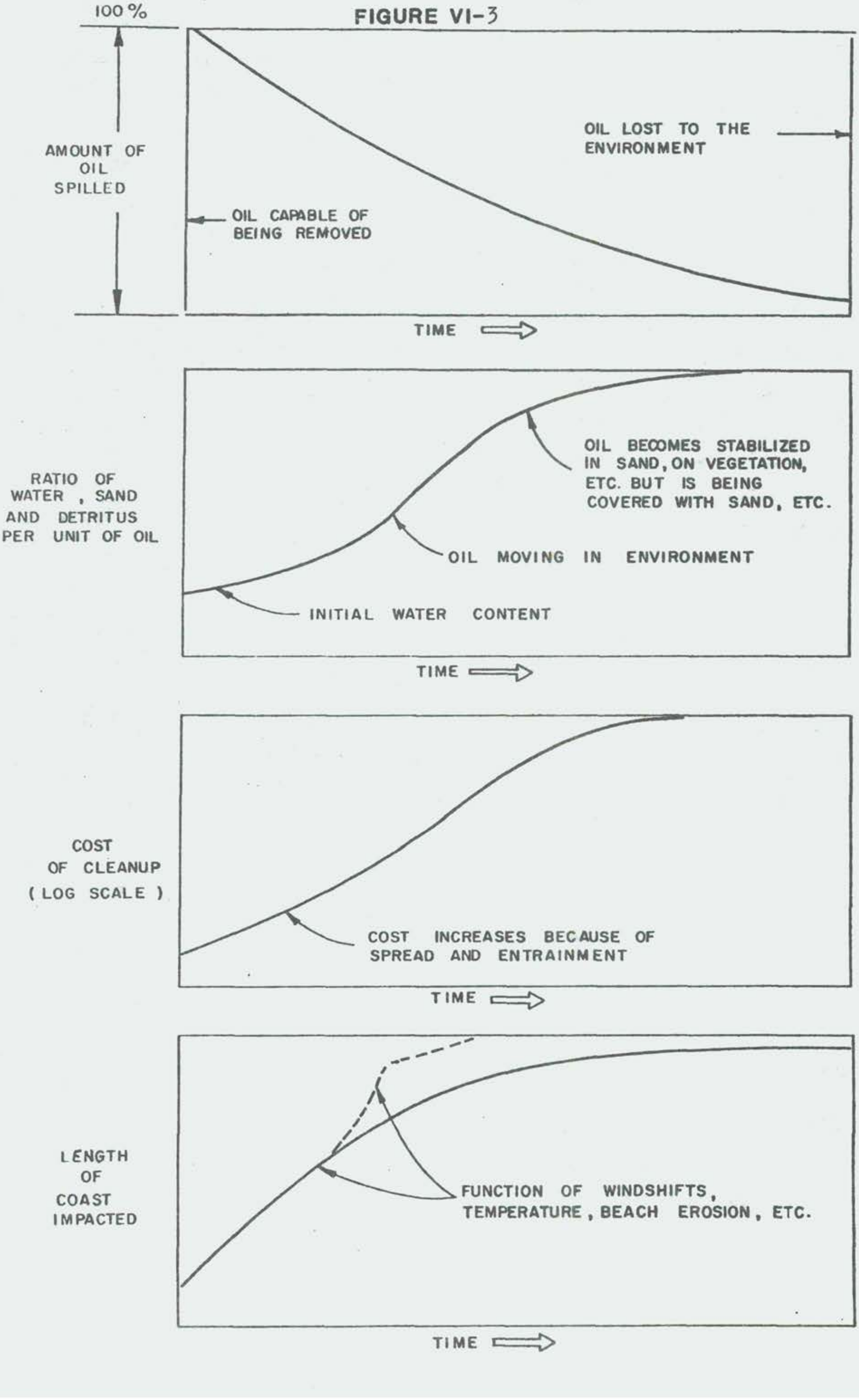


TABLE VI-5

TYPICAL PRIORITY OF RESPONSE OPERATIONS

1. Stop the discharge of the oil.
2. Protect endangered environmental systems of greatest value.
3. Contain and remove the oil or otherwise prevent it from coming ashore.
4. Remove floating oil and mousse from the water where possible and transport to interim liquid storage.
5. Remove stranded oil from beach faces to interim liquid storage.
6. Remove stranded oil from marshes to interim liquid storage.
7. Remove oiled sand, kelp, marsh vegetation and detritus and transport to interim dry storage.
8. "Polish" cleanup by cleaning rockfaces, ramps, breakwaters, etc.
9. Move materials from interim storage to final disposal sites.
10. Restore environmental systems damaged by the oil or by the protection and cleanup operations.
11. Reclaim or dispose of residual materials.

OIL SPILL COASTAL CLEANUP

INTERRELATIONSHIP OF UNIT PROCESSES

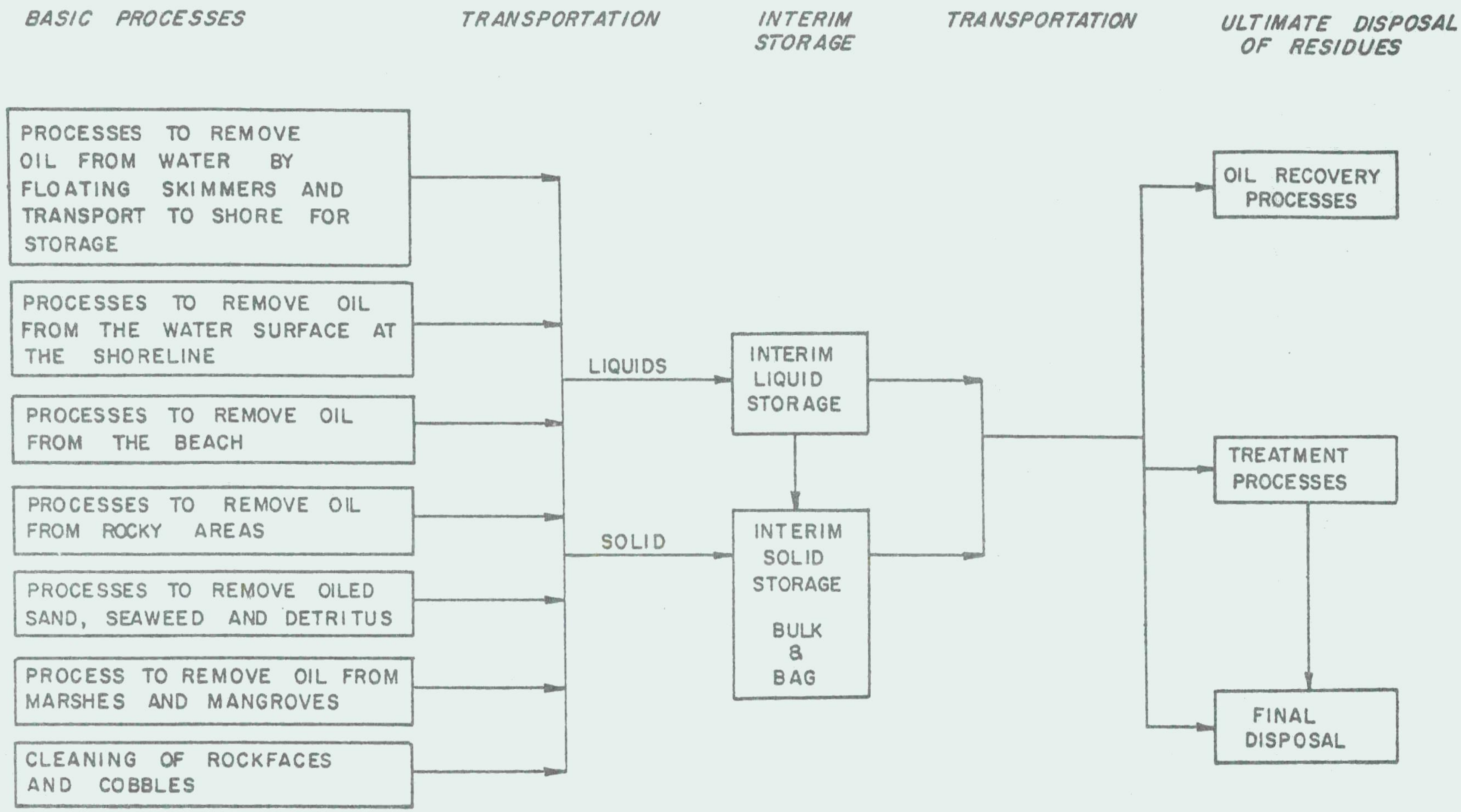


FIGURE VI-4

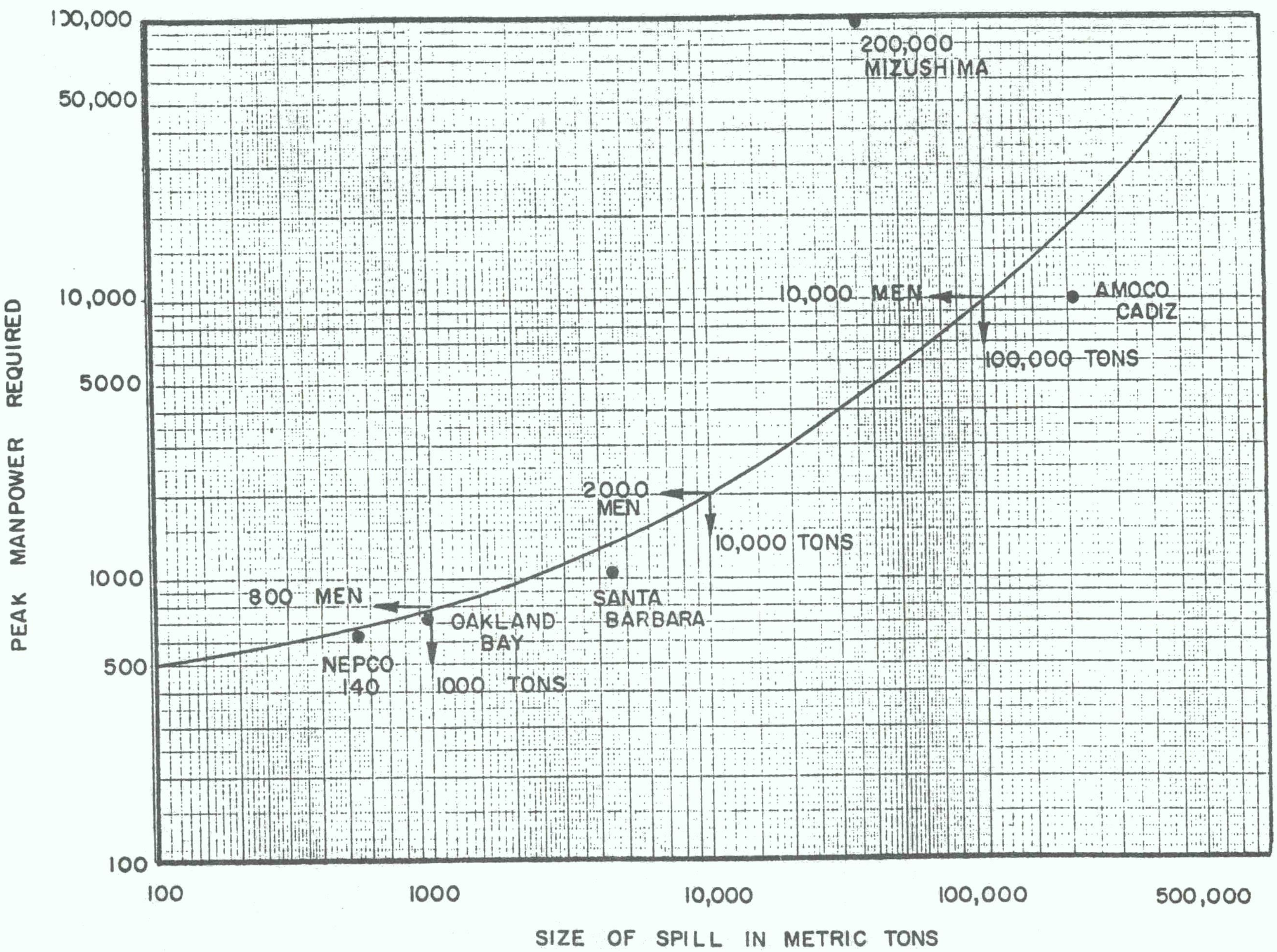


FIGURE VI-5

PEAK MANPOWER vs. AMOUNT SPILLED

SPILLS WHICH IMPACT A COASTLINE

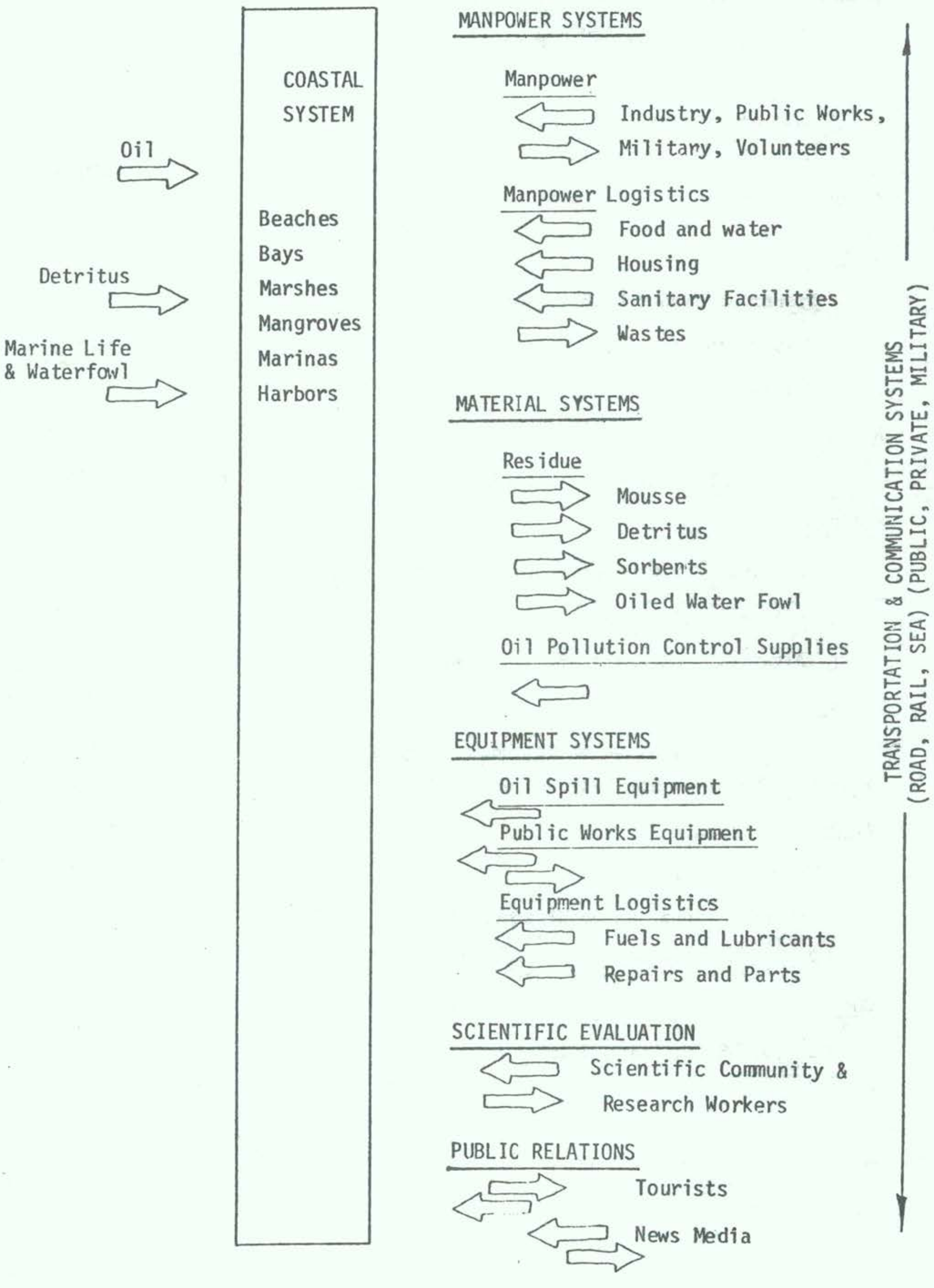
FIGURE VI-6

2,000 AND 10,000 TON SCENARIOS FOR LIGHT NIGERIAN CRUDE

	2,000 Ton Spill	10,000 Ton Spill
Metric Tons Spilled	2,000	10,000
Evaporation (metric tons)	800	4,000
Loss to Environment	None	None
Remaining Tons Oil to be Cleaned Up	1,200	6,000
Tons Mousse to be Cleaned Up (*3.5)	4,200	21,000
Fraction Skimmed from Water (A)	50%	50%
Fraction Skimmed from Beach (B)	20%	20%
Fraction Mixed in Sand, etc. (C)	30%	30%
Liquid Material:		
Skimmed from Water (A)		
liquid mass (tons mousse* .50)	2,100	10,500
Skimmed from Beach (B)		
liquid mass (tons mousse* .20)	840	4,200
Total Liquid Mass to be Handled	2,940	14,700
Vacuum Truck Loads @ 6 tons (m)/load	490	2,450
Loads/day (5 day cleanup)	98	490
Vacuum Trucks (4 loads/day)	25	123
Vacuum Trucks (2 loads/day)	49	245
Mass Oil Mixed with Solids	1,260	6,300
Solid Material:		
With Skimmings from Beach (B)		
solid mass (tons mousse* .2)	840	4,200
Bulk Oiled Solid Waste (C)		
solid mass (tons mousse* .3*15)	18,900	94,500
Total Oiled Solids (metric tons)	19,740	98,700
Dump Truck Loads @ 9 tons (m) each	2,193	10,966
Loads/day (21 days)	104	522
Avg. Number of trucks (5 loads/day)	21	104
Avg. Number of front end loaders (1 per 4 trucks)	5	26
Avg. Number of graders (1 per 4 trucks)	5	26

FIGURE VI-7

LOGISTICS FLOW DIAGRAM
COASTAL CLEANUP



IVORY COAST

Centre de Recherches Océanographiques, Abidjan, under the Ministry of Scientific Research and managed by ORSTOM

Institut National de la Santé Publique, a laboratory for sewage effluents

Laboratory for Industrial Waste Waters at Sodemi

Faculty of Sciences, University of Abidjan, training in oceanographic sciences

GHANA

Fisheries Research Unit, Tema

University of Ghana, Legon

University of Cape Coast

BENIN

Institut National pour l'Environnement, planning phase only

NIGERIA

Institute for Oceanography and Marine Research, Lagos

University of Lagos

University College of Port Harcourt

CAMEROON

Research Instiutute on Sea Technology, Douala, planning phase only (will come under Office National de la Recherche Scientifique et Technique)

GABON

University of Gabon

Centre National antipollution, Libreville, planning phase only

Ministry of Mines Laboratory

CONGO

Centre ORSTOM, Point Noire

SECTION VII

THE BACKGROUND SITUATION FOR FUTURE PLANS, OPTIONAL PATHWAYS FOR THE FUTURE, AND RECOMMENDATIONS

Previous sections of this report have dealt with the physical and environmental systems of the West and Central African area, oil spill potential from production and tanker traffic, and the environmental systems that can be impacted to various degrees by an oil spill. In addition, predictions have been made of various high risk areas within the region, as well as identification of the most likely points of impact of spills from these risk areas. In Section VI, a summary was presented with limited information about specialized spill control equipment resources available within the West and Central African area, pointing out the additional information contained in the various appendices of this report.

It is now possible to look at a few background conditions from which future planning should be directed.

(1) It is to be expected that oil shipments within and through the West and Central African area will remain on the same order of magnitude as current levels in the foreseeable future, with some continued expansion of exports of crude and refined products as exploration, development and refining capacity increase.

(2) Increased offshore oil development will evolve and be pushed into deeper water.

(3) Almost no governmental oil spill response capability exists for dealing with port or terminal oil spills in the West and Central African area. This deficiency is supplemented, however, by modest industrial capabilities depending on the in-house

(4) Few of the governments in West and Central Africa maintain oil spill contingency plans capable of dealing with major spills. They also currently do not have the specialized oil pollution control equipment, supply resources, or trained personnel to execute such plans.

(5) Some specialized oil pollution control laws exist within West and Central Africa, however, revision and expansion are likely.

(6) Regional activities to stimulate pollution control are in a nascent stage; strong guidance and support are needed to make them effective.

(7) Most current oil pollution impact on West and Central African beaches is caused by passing traffic rather than from internally-generated activity.

(8) A shift is occurring from TOVALOP (Tanker Owners Voluntary Agreement Concerning Liability for Oil Pollution) and CRISTAL (the Cargo Owner's Contract Regarding an Interim Supplement to Tanker Liability for Oil Pollution) to the IMCO Civil Liability Convention (CLC) and IMCO International Convention on the Establishment of an International Fund for Oil Pollution Damage (Fund Convention). This requires governments to ratify the conventions and to become more active in oil spill response in order to benefit from the conventions. It also requires governments to be sure their internal laws provide methods for recovering clean-up costs under the CLC and Fund Conventions in the event of an accident.

Oil Pollution Control Options

There are several options that nations can follow in dealing with oil pollution. They range from a "do-nothing" approach, which allows spills to occur without control or clean-up, to highly sophisticated and costly programmes with large numbers of persons assigned specifically to oil pollution control. With the former, the environment almost always suffers because there is no incentive to minimize pollution, whereas the latter competes for funds needed by other programmes in the nation. Most nations choose a path between the two extremes, which provides a reasonable degree of protection for its environmental systems while discouraging damaging discharges through prevention programmes, contingency planning, and reasonable clean-up activities and charges. Several basic options are discussed in the following sections.

Organizational Structure: Within a Country

Several alternative organizational structures are possible within a country depending on the desires of the national government and its interaction with private enterprise in the form of oil production, refining and shipping organizations. In a country that has a large, strong private sector capable of executing preventive and clean-up measures, the government has the alternative of acting in a regulating, supervising and enforcing role to ensure that private industry organizes and builds a capable response programme. In countries where the oil production, refining and shipping interests are not strong, where these entities are nationalized industries or where pollution is likely from passing ships or nearby foreign production facilities - it may be necessary for the national government to play a more active role.

In some cases it is possible to combine the governmental and industrial efforts into a unified programme. The use of co-operative programmes, where industries or industries and government agencies agree to pool resources to manage the response effort, have been effective in several countries. It is necessary for the national government to evaluate carefully its situation and purposefully to design the appropriate arrangement for its country.

Organizational Structure: Regional

Similar choices exist in the regional arena. The role of pollution prevention and control may be left to industry either with or without governmental control or participation. The industrial response may either be on the part of each producing, refining or shipping company, or the industries may organize a regional oil spill co-operative. A noticeable example of a regional co-operative is the Clean Caribbean Co-operative, which is an organization of most of the companies and governments which ship oil to, from, or within the Caribbean Sea area.

Wherever government chooses to exercise leadership in a regional arena, considerable benefits can accrue as a result of co-operation in the area. The regional concept can pool technical expertise, build common stockpiles of supplies and equipment, economize on training activities, and otherwise benefit the participating countries. Dual regional participation by both government and industry is possible when the nature of the government and industry so permit.

In West and Central Africa, the general trend to nationalized petroleum and other industries rules out classical industry-only programmes. Thus, government participation and regional co-operation are essential.

Financing Pollution Response

A major issue in oil pollution response is the appropriate expenditure of funds prior to the spill to purchase and stockpile equipment, for training, and for contingency planning, as opposed to paying for response only after the spill occurs. Significantly, major compensation programmes like TOVALOP, CRISTAL, the CLC, and the Fund Convention pay only after the spill. The cost of developing the response organization and its capability is expected to be borne by the local governments or industries.

In another arena, this is similar to saying that a fire insurance company will pay for the fire brigade after the burning starts, but it will not participate in organizing and training the people or obtaining the equipment to staff the brigade.

Those responsible for oil spill compensation, like the hypothetical fire insurance company, know quite well that if there is no response organization in place, there can be no cost for mobilizing it.

Thus, governments should understand that they either must use their own resources, or outside assistance, if available, and perhaps permit requirements, standards and equipment pool charges to build their response programme. The Japanese use of requirements for pollution control equipment on ships in their waters or the alternate payment of a stockpiling fee is a noteworthy example to be explored.

Once the response capability has been established, the government can look to the spiller and insurance programmes for compensation for clean-up to prescribed limits when the spiller is known and/or covered. When the spiller is unknown, uncovered by insurance, or when the liability limits are exceeded, a government again must turn to its own resources to finance a response.

Prevention Plan Cycle

The most cost-effective programme for a nation which cannot afford costly oil spill clean-up response is directed toward preventing the spills from occurring. Figure VII-1 shows a classic prevention plan diagram that emphasizes design, operating procedures, training, supervision and enforcement as the key elements. Both national laws and international conventions may follow the steps shown in developing an effective prevention programme.

Figure VII-2 shows how many of the IMCO conventions track the Prevention Plan Cycle. Thus, by supporting the international conventions through ratification, enforcement, and the creation of parallel national laws, an effective prevention programme may be initiated. Figure VII-3 displays the current status of the ratification of IMCO conventions by West and Central African nations.

Contingency Planning Cycle

A key part of oil spill control is documented by the contingency planning process shown in Figure VII-4. Much of the planning as it is carried out today stops with the development of the administrative contingency plan which may be as simple as a list of agencies called together to handle a problem. The authors submit that the completion of the entire contingency process is essential for a well planned programme.

FIGURE VII - 1

PREVENTION PLAN CYCLE

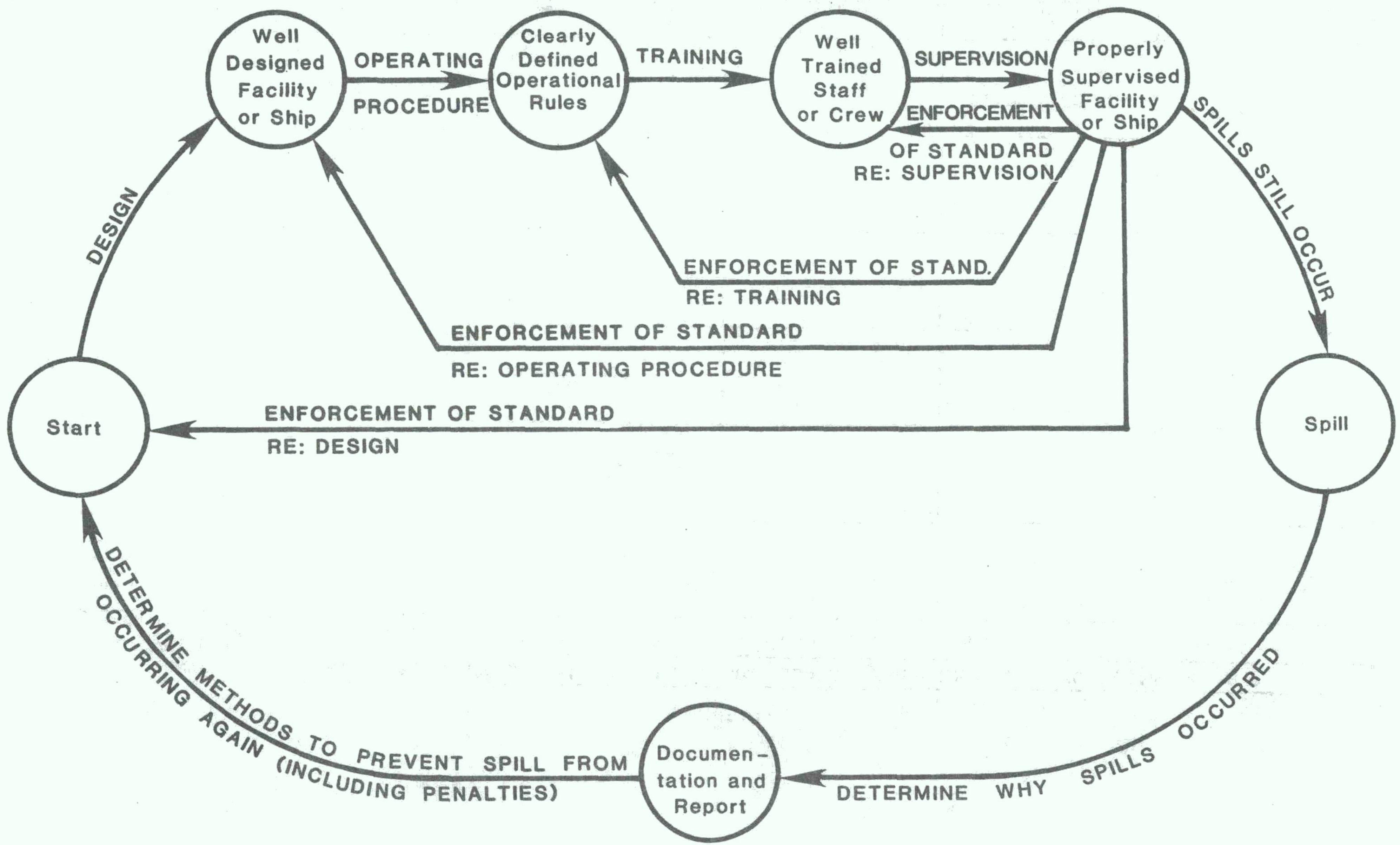


FIGURE VII-2

INTERRELATIONSHIP BETWEEN IMCO CONVENTIONS AND OIL SPILL CONTROL PREVENTION PLAN CYCLE COMPONENTS

	IMCO CONVENTION / PREVENTION COMPONENT	DESIGN	OPERATING PROCEDURE	TRAINING	SUPERVISION	ENFORCEMENT
1	INTERNATIONAL CONVENTION FOR THE PREVENTION OF POLLUTION OF THE SEA BY OIL (OILPOL, 1954). INC. 1962 AMENDMENTS (IN FORCE)	PROVIDES FOR DESIGN OF VESSEL TO AVOID ESCAPE OF FUEL OR DIESEL OIL INTO BILGES.	ESTABLISHES PROCEDURES FOR THE DISCHARGE OF OIL MIXTURES (PERSISTENT OILS ONLY), INCLUDING DEFINITIONS OF: 1. DISCHARGE QUANTITIES 2. PROHIBITED ZONES 3. OIL RECORD BOOKS 4. GUIDELINES ON BILGE PUMPING			PROVIDES FOR INSPECTION BY CONTRACTING STATES; ACTION BY FLAG STATES AGAINST OWNER OR MASTER OF SHIPS.
2	1969 AMENDMENTS TO 1954 CONVENTION (IN FORCE)		UPGRADES PROCEDURES CONCERNING DISCHARGE OF OILY MIXTURES INCLUDING: 1. LIMITING QUANTITIES 2. LIMITING DISCHARGE RATES FOR VESSELS WITHIN 50 MILES OF SHORE TO 15 PPM 3. UPGRADING THE OIL RECORD BOOK			
3	1971 AMENDMENTS TO THE 1954 CONVENTION (GREAT BARRIER REEF) (NOT YET IN FORCE)		PROVIDES FOR PROTECTION OF AUSTRALIA'S GREAT BARRIER REEF FROM DISCHARGE OF OIL OR OILY MIXTURES BY EXTENDING DEFINITION OF PROHIBITED ZONES.			
4	1971 AMENDMENTS TO 1954 CONVENTION (TANKS) (NOT IN FORCE)	PROVIDES FOR CARGO TANK ARRANGEMENT AND SIZE LIMITATIONS.				
5	INTERNATIONAL CONVENTION FOR THE PREVENTION OF POLLUTION FROM SHIPS, 1973 (MARPOL) (NOT YET IN FORCE)	PROVIDES FOR TANK ARRANGEMENT AND SIZE LIMITS, SUBDIVISIONAL BALLAST AND STABILITY REQUIREMENTS; RECEPTION FACILITIES; SEGREGATED BALLAST; OIL DISCHARGE MONITORING DEVICES, SPECIAL PIPING, SLOP TANKS.	UPGRADES THE 1954 CONVENTION AND ITS AMENDMENTS, PROVIDES FOR WASTE DISCHARGES, INCLUDING OPERATIONAL DISCHARGES, NOXIOUS SUBSTANCES OTHER THAN OIL, NON-PERSISTENT OILS, SEWAGE AND GARBAGE. PROHIBITS THE DISCHARGE OF PLASTICS.			BY COUNTRY IN WHICH VIOLATION OCCURS. INSPECTION BY PORT PERSONNEL.
	" "	CODE OF CONSTRUCTION FOR CHEMICAL AND OIL TANKERS; PORTABLE AND PACKAGE CHEMICAL AND HAZARDOUS MATERIAL REGULATIONS; OIL/WATER SEPARATORS.	" "		CERTIFICATE ISSUED BY FLAG STATES AFTER INSPECTION OF VESSEL; INSPECTION REQUIRED EVERY FIVE YEARS.	INSPECTION OF CERTIFICATES AND OIL RECORD BOOKS BY PORT AUTHORITIES; CONTRACTING STATES MAY IMPOSE SANCTIONS IN THEIR WATERS; LEGAL PROCEEDINGS BY FLAG STATES.
6	1978 PROTOCOL TO 1973 CONVENTION (MARPOL) (NOT YET IN FORCE)	REQUIRES SEGREGATED BALLAST OR SUBSTITUTION OF CRUDE OIL WASHING FOR CLEAN BALLAST TANKS/SEGREGATED BALLAST TANKS BASED ON A TIMETABLE AND SIZE OF SHIP; REQUIRES PROTECTIVE BALLAST TANK LOCATIONS.	UPGRADES REGULATIONS FOR OIL RECORD BOOK AND ESTABLISHES OPERATING PROCEDURES FOR CRUDE OIL WASHING.	ASSISTANCE TO REQUESTING STATES THROUGH THE MARINE SAFETY CORPS: ENCOURAGES TRAINING AND CERTIFICATION OF CREWS ON TANKERS.	PROVIDES GUIDELINES FOR IN-PORT INSPECTION OF CRUDE OIL WASHING.	PROVIDES FOR: "PENALTIES UNDER THE LAW OF A PARTY . . . SHALL BE ADEQUATE IN SEVERITY . . .(and) SHALL BE EQUALLY SEVER IRRESPECTIVE OF WHERE THE VIOLATIONS OCCUR."

FIGURE VII-2 (CON'T)

INTERRELATIONSHIP BETWEEN IMCO CONVENTIONS AND OIL SPILL CONTROL PREVENTION PLAN CYCLE COMPONENTS

	IMCO CONVENTION / PREVENTION COMPONENT	DESIGN	OPERATING PROCEDURE	TRAINING	SUPERVISION	ENFORCEMENT
7	INTERNATIONAL CONVENTION RELATING TO INTERVENTION ON THE HIGH SEAS IN CASES OF OIL POLLUTION CASUALTIES, 1969 (INTERVENTION CONVENTION) (IN FORCE)		ALLOWS A COASTAL STATE TO TAKE ACTION AGAINST A VESSEL WHICH POSES AN OIL POLLUTION THREAT TO ITS COASTLINE: PROVIDES NOTIFICATION AND CONSULTATION PROCEDURES.			PROVIDES FOR COMPULSORY ARBITRATION OF DISPUTES.
8	INTERNATIONAL CONVENTION RELATING TO INTERVENTION ON THE HIGH SEAS IN CASES OF MARINE POLLUTION BY SUBSTANCES OTHER THAN OIL, 1973 (INTERVENTION PROT. 1973) (NOT IN FORCE)		ALLOWS A COASTAL STATE TO TAKE ACTION AGAINST A VESSEL WHICH POSES A POLLUTION THREAT TO ITS COASTLINE.			SIMILAR TO INTERVENTION CONVENTION.
9	THE CONVENTION ON THE PREVENTION OF MARINE POLLUTION BY WASTES AND OTHER MATTER, 1972. (THE LONDON DUMPING CONVENTION) (IN FORCE)		PROVIDES FOR CONTROL OF DELIBERATE DISPOSAL AT SEA OF WASTE AND OTHER MATTER FROM ALL MANNER OF TRANSPORTATION AND STRUCTURES. EXCLUSION: EXPLORATION RELATED AND OPERATIONAL POLLUTION.			
10	1978 AMENDMENTS TO THE LONDON DUMPING CONVENTION. (DISPUTES) (NOT IN FORCE)		PROVIDES PROCEDURES FOR SETTLING DISPUTES TO THE LONDON DUMPING CONVENTION.			
11	1978 AMENDMENTS TO THE ANNEX TO THE LONDON DUMPING CONVENTION. (INCINERATION) (IN FORCE)		PROVIDES SPECIFIC PROCEDURES TO CONTROL INCINERATION OF WASTE AT SEA.			
12	1958 CONVENTION ON THE HIGH SEAS. (IN FORCE)		PROVIDES FOR THE AVOIDANCE OF POLLUTION OF THE SEA BY OIL FROM SHIPS AND PIPELINES OR RESULTING FROM EXPLORATION AND EXPLOITATION OF THE SEABED AND ITS SUBSOIL.			
13	1958 CONVENTION ON THE CONTINENTAL SHELF. (IN FORCE)		DEFINES CONTINENTAL SHELF. PROHIBITS INTERFERENCE WITH NAVIGATION. PROTECTS LIVING RESOURCES FROM HARMFUL AGENTS. PROVIDES FOR NOTICE OF CONSTRUCTION OF STRUCTURES. PROVIDES FOR REMOVAL OF ABANDONED STRUCTURES			

FIGURE VII-2 (CON'T)

INTERRELATIONSHIP BETWEEN IMCO CONVENTIONS AND OIL SPILL CONTROL PREVENTION PLAN CYCLE COMPONENTS

	IMCO CONVENTION / PREVENTION COMPONENT	DESIGN	OPERATING PROCEDURE	TRAINING	SUPERVISION	ENFORCEMENT
14	1958 CONVENTION ON THE HIGH SEAS. (IN FORCE)		PROVIDES FOR THE PREVENTION OF POLLUTION FROM DUMPING RADIO-ACTIVE WASTES. PREVENTS POLLUTION OF SEAS AND AIR SPACE ABOVE FROM ACTIVITIES USING RADIO-ACTIVE MATERIALS.			
15	SAFETY OF LIFE AT SEA--1974. (SOLAS) (IN FORCE, REPLACES SOLAS--1960)	SUBDIVISIONAL AND STABILITY REQUIREMENTS FOR MACHINERY, ELECTRICAL INSTALLATIONS, FIRE SAFETY SYSTEMS, LIFE SAVING EQUIPMENT, NAVIGATION EQUIPMENT AND COMMUNICATIONS EQUIPMENT.	PROVIDES FOR "TACIT ACCEPTANCE" PROCEDURE OF NEW AMENDMENTS. RULES ON CARRIAGE OF GRAIN MANDATES USE OF THE BULK CHEMICAL CODE AND GAS CARRIER CODE.		INSPECTION OF VESSEL FOR ISSUANCE OF CERTIFICATE.	SURVEYS - CERTIFICATES OF COMPLIANCE.
16	1978 PROTOCOL TO SOLAS--1974.	PROVIDES FOR SURVEYS AND CERTIFICATES OF REQUIRED EQUIPMENT, DUPLICATE STEERING SYSTEMS, HULL AND MACHINERY STANDARDS, FIRE SAFETY EQUIPMENT AND RADAR STANDARDS. INERT GAS SYSTEM			INSPECTION OF VESSELS FOR ISSUANCE OF CERTIFICATE - REQUIREMENTS STRENGTHENED UNDER '78 PROTOCOL.	INSPECTION OF SOLAS CERTIFICATES OF COMPLIANCE - COASTAL STATE CAN DETAIN VESSEL IF VESSEL DOES NOT MEET REQUIREMENTS.
17	INTERNATIONAL CONVENTION ON STANDARDS OF TRAINING, CERTIFICATION AND WATCH-KEEPING FOR SEAFARERS, 1978. (STCW 1978) (IN FORCE)			PROVIDES FOR MINIMUM TRAINING STANDARDS FOR WATCHKEEPING AND REQUIRES SPECIAL TRAINING FOR TANKER PERSONNEL.		PORT INSPECTION OF CREW'S CERTIFICATE TO INSURE PROPERLY TRAINED CREWS.
18	INTERNATIONAL CONVENTION ON LOAD LINES, 1966. (LL 1966) (IN FORCE)	LOAD LINES ARE PROVIDED TO INSURE STABILITY OF VESSEL.	OBSERVING LOAD LINES OR "PLIMSOLL MARKS" TO PREVENT OVERLOADING.		BY PORT AUTHORITIES AND VESSEL PERSONNEL.	PORT AUTHORITY MAY INSPECT CERTIFICATE ON OBSERVED VESSEL FOR SUBMERGED LOAD LINE.
19	INTERNATIONAL CONVENTION ON MARINE SEARCH AND RESCUE. (SAR 1979) (NOT IN FORCE)		FACILITATES COOPERATION BETWEEN NATIONS IN SEARCH AND RESCUE ACTIVITIES.			
20	INTERNATIONAL CONVENTION FOR THE SAFETY OF THE SEA. (SOLAS - 1960) (IN FORCE)	BASIC VESSEL CONSTRUCTION, EQUIPMENT, AND SAFETY STANDARDS ARE SPECIFIED.	BASIC OPERATING PROCEDURES FOR VESSELS ARE SPECIFIED.		SHIPS ARE INSPECTED TO INSURE PRESCRIBED EQUIPMENT IS ON BOARD BEFORE ISSUING CERTIFICATE.	INSPECTION OF CERTIFICATE BY PORT STATE.
21	THE INTERNATIONAL REGULATION FOR THE PREVENTION OF COLLISIONS AT SEA. (COLREG 1972) (IN FORCE)		PROVIDES FOR OBLIGATORY TRAFFIC SEPARATION SCHEMES. INTERNATIONAL REGULATIONS FOR PREVENTING COLLISIONS AT SEA (NAUTICAL RULES OF THE ROAD) ARE PRESCRIBED.			
22	INTERNATIONAL MARITIME SATELLITE SATELLITE ORGANIZATION. (INMARSAT) (IN FORCE)		PROVIDES FOR THE USE OF SPACE SATELLITES TO IMPROVE COMMUNICATIONS BETWEEN PLANES AND SHIPS.			

RATIFICATION OF IMCO CONVENTIONS BY WEST AND CENTRAL AFRICAN NATIONS

(By July 1980)

	1954 CONV	1971 AMEND	1973 MARPOL	1969 INTERV.	1973 INTERV.	CLC	FUND	1972 DUMP	1958 HIGH SEAS	1958 CONT. SHELF	1957 LIABILITY	TERRITORIAL SEA LIMIT
Angola												12/200
Benin												200
Cameroon												50
Congo	*								*REQUIRES MASTERS TO COMPLY			200
Equatorial Guinea												12
Gabon												100
Gambia												12
Ghana	X										X	200
Guinea												200
Guinea-Bissau												150
Ivory Coast	X	X				X						12/200
Liberia	X	X		X		X	X					200
Nigeria	X							X	X	X		30
Senegal	X			X		X			X	X		150
Sierra Leone									X	X		200
Togo												200
Zaire								X			X	12

FIGURE VII-3

FIGURE VII-4

CONTINGENCY PLANNING CYCLE

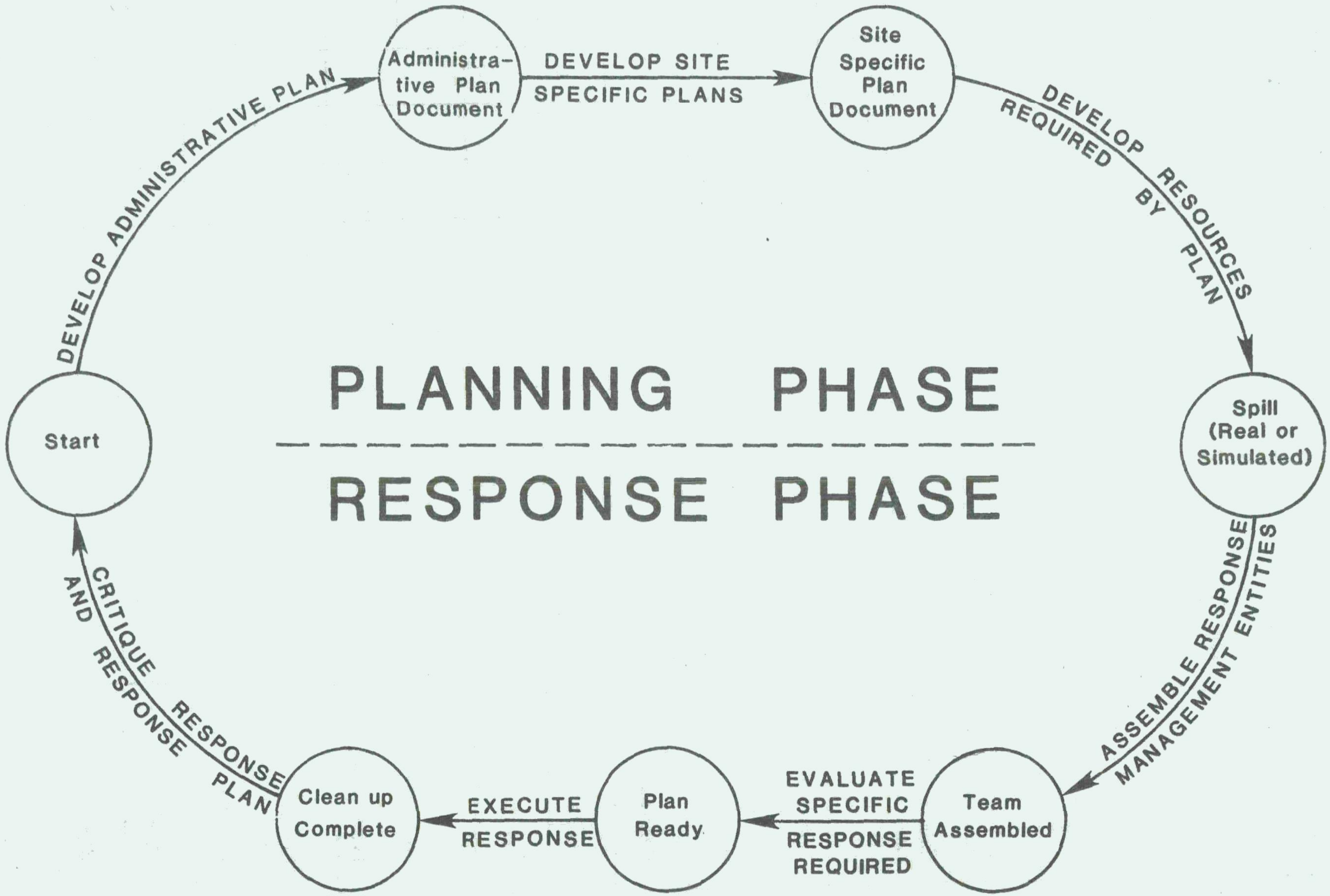


Table VII-1 describes in detail some of the sub-components of the different steps in Figure VII-4. It should be noted that the top half of the diagram is the planning phase, and the bottom half is the response phase. The diagram is equally valid for an international region or for a single port or facility. Indeed, it is also important to realize that a regional plan could have an overall administrative plan, several zones at sea for site-specific plans, a dozen or more country site-specific plans for coastal protection and clean-up, and hundreds of individual port or industrial site-specific plans.

Problem Solution Analyses

The authors have included 12 problem solution analyses in this report. Each analysis states the problem, the group of countries faced with the problem, potential methods to prevent the problem, potential methods of dealing with the problem if it occurs, and needed background information. These analyses are shown in Tables VII-2 through VII-13 on the following pages. Figure VII-5 indicates the countries having or suspected of having the individual problems.

The purpose of the problem solution analyses is to demonstrate that the solutions to the problems take different forms as the problem level shifts from local to international. It also demonstrates that a logical approach may be taken to identify the steps needed to achieve the solution.

TABLE VII-1

SUB-COMPONENTS OF THE CONTINGENCY PLANNING PROCESS

I. Components of Administrative Contingency Plans:

1. Define authority, purpose and objectives;
2. Establish policy;
3. Delegate authority;
4. Provide financial resources;
5. Designate institutional, personnel and material resources to be used in response;
6. Establish the role of the spiller, industry and/or government(s); and
7. Establish common or core resources for use of sub-entity plans (i.e., equipment, supplies and training programs).

II. Components of Site-Specific Contingency Plans:

1. Develop local site version of administrative plan components;
2. Evaluate resources to be protected, such as
   a. environmental systems (estuaries, marshes, breeding grounds),
   b. economic systems (beaches, aquaculture, resort areas, fisheries, marinas);
3. Develop the response goals and priority of action consistent with the value of resources and likelihood of impact;
4. Determine mechanism for initiating action;
5. Develop the framework of authority, responsibility and hierarchy of response to be followed in the area (i.e., spiller, industry group, government, contractor);
6. Inventory the various resources available to deal with the expected problem, such as
   a. laws
   b. agreements
   c. management structure
   d. communications
   e. specialized equipment and supplies
   f. traditional equipment and supplies
   g. money
   h. land
   i. engineering plan
   j. response personnel
   k. technical assistance personnel
   l. construction
   m. background studies (i.e., environmental)
   n. logistical support;

TABLE VII-1 (Con't)

7. Develop the detailed response strategy for control, including equipment placement, protective booming containment and removal locations, removal devices, and chemical application devices, for the expected problem;

8. Develop the detailed technical response strategy, such as to

   a. provide technical input to the design process,
   b. provide needed technical information,
   c. document the behavior and impact of spills,
   d. assess the damage caused by spill and response;

9. Evaluate needed resources in excess of those already available (see item 6);

10. Develop a plan for acquisition of the needed resources;

11. Develop detailed job descriptions for people who will staff a response team;

12. Develop procedures to test the readiness of the plan or its components; and

13. Publish the plan for the use of those involved and for outside review and suggestions for improvement.

III. Development of Resources Required by Administrative and Site-Specific Plans:

1. Acquire specialized equipment and supply resources;

2. Develop institutional arrangements;

3. Train personnel;

4. Carry out background engineering and scientific studies; and

5. Build specialized defenses, such as

   a. storage
   b. deployment
   c. anchorages
   d. pooling areas
   e. disposal areas.

6. Develop the response team

IV. Post-Spill Activity - Assemble Response Management Entities:

1. Assemble cleanup line management staff; and

2. Assemble technical assistance staff.

V. Post-Spill Activity - Evaluate Specific Response Required:

1. Evaluate nature, size and potential impact;

2. Evaluate response plan methods to be used and when (i.e., priority of operations);

TABLE VII-1 (Con't)

3. Evaluate resource levels needed;
4. Evaluate source of resources to be used (hierarchy of response levels to be used) for cleanup;
5. Evaluate additional technical response resources.

VI. Post-Spill Activity - Carry Out Response:

1. Carry out containment, removal, disposal and/or dispersion in accordance to plans;
2. Carry out documentation of spill according to technical assistance plan; and
3. Carry out damage assessment according to technical assistance plan.

VII. Post-Spill Activity - Document and Critique Response and Plan:

1. Evaluate the effectiveness of the spill control response;
2. Evaluate the effectiveness of the technical response;
3. Evaluate the effectiveness of previous contingency plan; and
4. Make recommendations for future plan revisions and responses.

TABLE VII-2

WEST AND CENTRAL AFRICAN OIL POLLUTION PROBLEM SOLUTION ANALYSIS

A. Statement of the Problem:

The threat of major oil spills resulting from collision, grounding, explosion or structural failure.

B. West and Central African Countries Experiencing the Problem:

All to a varying degree, depending on the proximity to shipping lanes and prevailing wind and currents.

C. Potential Preventive Solution:

1. INTERNATIONAL. Support International IMCO conventions for vessel safety, protective design and pollution compensation.

2. REGIONAL or NATIONAL. Establish traffic lanes and/or establish survey lane and tracking systems and communications systems in high risk areas. Require minimum distance offshore for vessels travelling through the region.

3. NATIONAL. Prohibit entry into national waters of ships not conforming to acceptable standards.

D. Potential Remedial Solution:

1. REGIONAL. Develop a regional plan of mutual assistance to share resources of personnel, equipment and supplies in the event of a major spill threat or impact.

2. NATIONAL or LOCAL. Assure that appropriate administrative and site-specific contingency plans are developed to deal with spills of various sizes.

E. What Needs to be Known to Initiate Activity:

Levels of effort required to deal with spills of various sizes.

TABLE VII-3

WEST AND CENTRAL AFRICAN OIL POLLUTION PROBLEM SOLUTION ANALYSIS

A. Statement of the Problem:

Threat of oil spills of fuels and lubricants from collisions, grounding, and sinking of ships other than cargo carrying tankers which are not covered by IMCO pollution conventions, TOVALOP, or other oil spill programs.

B. West and Central African Countries Experiencing the Problem:

All to a varying degree, depending on proximity to non-tanker shipping routes.

C. Potential Preventive Solution:

1. INTERNATIONAL. Seek international conventions and/or insurance programs for ships other than those carrying oil as cargo.

2. REGIONAL or NATIONAL. Establish a program under national law to prohibit unsafe ships in local ports, to require appropriate insurance for ships, other cargo carrier tankers, and to establish responsibility for cleanup.

3. NATIONAL. Establishment of appropriate national laws requiring proof of financial ability to cover potential spill cleanup cost and damage.

D. Potential Remedial Solution:

1. LOCAL and NATIONAL. Develop an effective oil spill contingency plan on both the administrative and site-specific levels.

2. NATIONAL. Develop appropriate contingency funds to deal with such spills in the absence of effective international programs.

E. What Needs to be Known to Initiate Activity:

Status of insurance coverage traditionally carried by ships in the region.

TABLE VII-4

WEST AND CENTRAL AFRICAN OIL POLLUTION PROBLEM SOLUTION ANALYSIS

A. Statement of the Problem:

Tar spots and tar balls carried to West and Central African beaches as a result of discharge of washings, dirty ballast and bilge water in the Atlantic Ocean and Gulf of Guinea.

B. West and Central African Countries Experiencing the Problem:

All coasts from Cameroon northward to varying degrees.

C. Potential Preventive Solution:

1. INTERNATIONAL. Ratify IMCO conventions which limit or eliminate routine oil discharge at sea and which require segregated ballast or crude oil washing.

2. NATIONAL. Forbid entry of tankers not using techniques called for under IMCO 1969 Amendments and/or 1973 Conventions. Require submission of binding tank washing plan before allowing tankers to depart from harbor.

3. NATIONAL and INTERNATIONAL. Develop receiving stations for tank washings, bilge water and dirty ballast.

D. Potential Remedial Solution:

1. LOCAL. Beach cleaning of oil and oil/sand pellets.

E. What Needs to be Known to Initiate Activity:

Obtain up-to-date information on the tank cleaning and ballast water management on the tankers involved in the Middle East and West and Central African tanker routes to Europe and the United States.

TABLE VII-5

WEST AND CENTRAL AFRICAN OIL POLLUTION PROBLEM SOLUTION ANALYSIS

A. Statement of the Problem:

Threat of destruction of a valuable environmental system uniquely important to a nation, such as protective mangrove coastlines and coral reef systems.

B. West and Central African Countries Experiencing the Problem:

Nations with similar important systems.

C. Potential Preventive Solution:

1. INTERNATIONAL. Seek prohibition of shipping of cargos with the volume and toxicity to cause damage in zones from which contamination could occur.

D. Potential Remedial Solution:

1. NATIONAL. Develop extensive plan to divert, disperse or remove spilled oil before contact.

2. LOCAL. Cleanup to the degree possible when impacted, via a predetermined contingency plan.

D. What Needs to be Known to Initiate Activity:

Environmental systems deemed to be of such great important need to be specified and studied.

TABLE VII-6

WEST AND CENTRAL AFRICAN OIL POLLUTION PROBLEM SOLUTION ANALYSIS

A. Statement of the Problem:

Discharge of oily ballast prior to entering loading areas.

B. West and Central African Countries Experiencing the Problem:

All crude oil exporting countries.

C. Potential Preventive Solution:

1. LOCAL and NATIONAL. Monitor discharge, provide shore or floating ballast receiving systems, and require segregated ballast or crude oil washing.

2. REGIONAL. Same as above.

3. INTERNATIONAL. Support and ratify the international convention requiring the use of segregated or clean ballast or crude oil washing.

D. Potential Remedial Solution:

None.

TABLE VII-7

WEST AND CENTRAL AFRICAN OIL POLLUTION PROBLEM SOLUTION ANALYSIS

A. Statement of the Problem:

Potential impact of oil spilled in a neighboring country from a collision, grounding, explosion, loading or lightering accident, or other forms of oil discharge such as production and refining.

B. West and Central African Countries Experiencing the Problem:

Primarily those between Nigeria and Angola, but all to a varying degree depending on the proximity to other countries, level of oil-related activity in adjacent countries, prevailing winds and currents.

C. Potential Preventive Solution:

1. LOCAL and NATIONAL. Establish national programs of spill prevention and control planning and/or associated program of facility inspection within the region. Establish national laws to compliment international programs of compensation.

2. REGIONAL. Establish regional insurance programs to pay response and damage costs for spills not covered under CLC, TOVALOP, Fund Convention or CRISTAL.

3. INTERNATIONAL. Support international IMCO conventions for pollution compensation.

D. Potential Remedial Solution:

1. REGIONAL. Develop a plan of mutual assistance to share resources of personnel, equipment and supplies in the event of a major spill threat or impact.

2. NATIONAL or LOCAL. Assure that appropriate administrative site-specific contingency plans are developed to deal with spill of various sizes.

TABLE VII-8

WEST AND CENTRAL AFRICAN OIL POLLUTION PROBLEM SOLUTION ANALYSIS

A. Statement of the Problem:

Potential local impact from loading and unloading accidents in harbors, at buoys, and lightering operations.

B. West and Central African Countries Experiencing the Problem:

All with varying risk depending on petroleum throughput or port facilities.

C. Potential Preventive Solution:

1. LOCAL and NATIONAL. Establish national program of spill prevention and control and associated program of facility inspection.

2. NATIONAL. Require facilities in country to require or have appropriate insurance to pay cost of spill cleanup and damage. Forbid entry of ship with substandard oil pollution prevention methods.

D. Potential Remedial Solution:

1. LOCAL. Require preventive booming and facility design (i.e., to contain spilled oil and prevent release into environment.)

2. LOCAL and NATIONAL. Assure that appropriate administrative and site-specific contingency plans are developed to deal with spills of various sizes.

E. What Needs to be Known to Initiate Activity:

Inventory of loading facilities and current status of local prevention and spill contingency plan programs.

TABLE VII-9

WEST AND CENTRAL AFRICAN OIL POLLUTION PROBLEM SOLUTION ANALYSIS

A. Statement of the Problem:

Potential for major offshore production-related spills from blowouts, platform explosions, pipeline failure, natural phenomena and sabotage.

B. West and Central African Countries Experiencing the Problem:

Nigeria, Gabon, Cameroon, Congo, Zaire, Angola and others with coastal and offshore oil development potential.

C. Potential Preventive Solution:

1. NATIONAL. Assure that offshore operations are carried out with proper spill prevention technology including blowout prevention, storage and pipeline construction methods.

2. REGIONAL. Develop regional insurance program to insure payment of cleanup and damage costs not only in originating country but also in impacted countries.

D. Potential Remedial Solution:

1. LOCAL and NATIONAL. Assure that appropriate administrative and site-specific contingency plans are developed to deal with spills of various sizes.

2. REGIONAL. Develop a regional plan of mutual assistance to share resources of equipment, personnel and supplies in the event of a major spill threat or impact.

TABLE VII-10

WEST AND CENTRAL AFRICAN OIL POLLUTION PROBLEM SOLUTION ANALYSIS

A. Statement of the Problem:

Discharge of oil contaminated produced water, drilling mud, lubricating oil and deck drainage from offshore platforms.

B. West and Central African Countries Experiencing the Problem:

Nigeria, Cameroon, Gabon, Congo, Zaire and Angola.

C. Potential Preventive Solution:

1. NATIONAL. Establish and enforce national standards for type of drilling muds allowed and require treatment levels on produced water and other discharges.

2. LOCAL. Inspect local facilities to insure compliance.

D. Potential Remedial Solution:

Usually none feasible.

E. What Needs to be Known to Initiate Activity:

Experience of discharges in a given country, and the achievable discharge values with current technology.

TABLE VII-11

WEST AND CENTRAL AFRICAN OIL POLLUTION PROBLEM SOLUTION ANALYSIS

A. Statement of the Problem:

Potential impact of refinery discharges on the environment.

B. West and Central African Countries Experiencing the Problem:

All with refineries.

C. Potential Preventive Solution:

1. NATIONAL. Establish and enforce national standards for oil spill prevention and effluent requirements for refinery discharges. In addition, assure that refinery effluents coupled with other pollution stress (i.e., domestic, industrial and agricultural wastes) do not overload the system.

2. LOCAL. Inspect local facilities to insure compliance.

D. Potential Remedial Solution:

1. NATIONAL and LOCAL. Assure that appropriate administrative and site-specific contingency plans are developed to deal with spills of various sizes.

2. LOCAL. Retrofit with refinery waste treatment systems and other pollution prevention equipment.

E. What Needs to be Known to Initiate Activity:

Background waste loadings from other sources in impacted system.

TABLE VII-12

WEST AND CENTRAL AFRICAN OIL POLLUTION PROBLEM SOLUTION ANALYSIS

A. Statement of the Problem:

Different standards of oil spill prevention and spill response capability by different private and nationalized companies operating in the individual countries and the region.

B. West and Central African Countries Experiencing the Problem:

Nigeria, Gabon, Congo and Zaire.

C. Potential Preventive Solution:

1. LOCAL and REGIONAL. Develop program of supervision and enforcement to assure that minimum standards of design, operating procedures, training, supervision and enforcement are met.

2. REGIONAL. a) Develop model standards for production, refining, and transportation facilities in the region; b) Train personnel from individual countries to recognize poorly designed and maintained facilities and be able to recommend proper design and operating procedure; c) Determine which entities in different countries operate to high standards as demonstration facilities.

D. Potential Remedial Solution:

1. LOCAL and REGIONAL. Develop a program of supervision of facilities to insure that minimum response capability is in place and that equipment and personnel are in a state of readiness.

E. What Needs to be Known to Initiate Activity:

Inspection of facilities and their operation and examination of contingency plans and their readiness.

TABLE VII-13

WEST AND CENTRAL AFRICAN OIL POLLUTION PROBLEM SOLUTION ANALYSIS

A. Statement of the Problem:

Environmental modification of coastal delta systems including mangrove areas by physical environmental modification through channelization and deforestation, and the resultant impact on local marine resources, ground water intrusion and mangrove communities.

B. West and Central African Countries Experiencing the Problem:

Nigeria

C. Potential Preventive Solution:

1. LOCAL and NATIONAL. Adequately assess the degree of modification needed for petroleum development and determine the impact on local communities and sustenance fishing. Develop the appropriate national standards and enforcement policy.

2. REGIONAL. Communicate national knowledge to others who may face similar problems.

D. Potential Remedial Solution:

None.

E. What Needs to be Known to Initiate Activity:

Examination of the status of environmental modification and its impact in Nigeria, Louisiana (USA) and similar delta ecosystems.

WEST AND CENTRAL AFRICAN OIL POLLUTION PROBLEM MATRIX

	LOADING AND SHIPPING					PRODUCTION & REFINING			MISCELLANEOUS PROBLEMS		
	Threat of Spill From Collision Grounding and Explosion of Tankers	Threat of Spills of Fuels & Lubricants from Collision, Grounding and Explosion from ships other than Tankers	Tar Spots and Tar Balls From Tank Washing Residues, Ballast Water,etc.	Discharge of Oily Ballast Prior to Loading	Impact from Loading and Unloading	Potential for Major Production Related Spills	Discharge of Oil Contaminated Platform Discharges	Impact of Refinery Discharge	Different Standards of Prevention and Response	Potential Impact from Spills in Adjacent Country	Threat of Destruction of Valuable Ecosystem Through Oil Impact or Environmental Modification
	Table 7-2	Table 7-3	Table 7-4	Table 7-6	Table 7-8	Table 7-9	Table 7-10	Table 7-11	Table 7-12	Table 7-7	Table 7-5
SENEGAL	E	E	E		E			E			
GAMBIA	E	E	E		E						
GUINEA-BISSAU	E	E		P	E	P	P	P			
GUINEA	E	E			E			P			
SIERRA LEONE	E	E	E		E			P			
LIBERIA	E	E	E		E			E			
IVORY COAST	E	E	E	P	E	P	P	E			
GHANA	E	E	E		E	P	P	E			
TOGO	E	E	E		E			P			
BENIN	E	E	E		E						
NIGERIA	E	E	E	E	E	E	E	E	E		E
CAMEROON	E	E	E	E	E	E	E	E		E	E
EQUITORIAL GUINEA	E	E	NI		E					E	
GABON	E	E			E	E	E	E	E	E	E
CONGO	E	E	E	E	E	E	E			E	
ZAIRE	E	E		E	E	E	E			E	
ANGOLA	E	E	NI	E	E	E	E	NI			

E Existing Problem   P Potential Problem   Blank no Problem   NI No Inform.

FIGURE VII-5

Regional Programmes and Centres

Considerable discussion in this report has been addressed toward the concept of regional programmes. The concept of a regional centre to co-ordinate regional activity and to administer selected components is often advanced. In the event that a regional or sub-regional centre or centres are established in West and Central Africa, it is suggested that appropriate activities of the centre would include but not be limited to the following:

1. The stimulation and development of programmes relating to oil spill prevention and control in the nations and the region.

2. Documenting occurrences of spills and response activities.

3. Serving as a communications centre to advise of international spills and to facilitate outside support for response.

4. Training programme leaders for prevention and response organizations in the member countries.

5. Training workers to be involved in actual response to spills.

6. Arranging outside training in oil spill programme management for those capable of obtaining it outside of the region.

7. Evaluating the appropriate oil spill control technology for the region.

8. Developing model oil spill legislation and promoting its adoption.

9. Developing model site-specific and administrative oil spill control contingency plans as examples to be used in plan development and training.

10. Assisting in the development of administrative and site-specific contingency plans for the member countries.

11. Providing technical assistance in the form of consultation and training in the event of major spills.

12. Maintaining lists of worldwide suppliers, contractors and consultants available to help in spill response.

13. Assisting in the arrangements for the stockpiling of supplies or equipment to be acquired on a regional basis.

14. Arranging for the maintenance of regional supplies and equipment.

15. Promoting the development of laws to facilitate entry of pollution control equipment and supplies into countries impacted by spills.

16. Arranging for the transportation of regionally stockpiled equipment to a spill scene.

17. Examining and recommending methods of funding for regional capabilities and national programmes.

It is furthermore suggested that the following criteria be considered in selecting the location of such centres:

1. Interest of the host nation in sponsoring the centre.

2. Language of the host nation in relationship to the languages of the other countries in the region.

3. Safety of staff and trainees in the host city.

4. Physical facilities available:

   a. offices
   b. classroom facilities
   c. field training facilities
   d. research laboratories
   e. case study problems
   f. housing for staff and students
   g. oil spill control equipment

5. Cost of housing, goods and services.

6. Transportation and communication to and within the country.

7. Existing pollution control programmes to serve as demonstration activities.

8. Ability to interface with other regional organizations to share logistical, communication and other resources.

9. Local customs, currency requirements, entry requirements and tolerance of visitors from other countries.

It is important that a centre be given a good start in terms of initial programme activities. Some suggested programme activities for the first year include:

1. Delivery of a substantial technical library resource.

2. Initial training course or courses.

3. Train the centre staff through an intensive overseas training programme (i.e., three months' duration).

4. Develop a package of model laws for the countries in the region.

5. Collect and deliver training aid equipment (i.e., movies, visual aids, projectors, colour TV camera and editing equipment and teletype).

6. Provide pilot oil spill control equipment for hands-on training.

Summary Suggestions

In view of the information presented in this report and the current status of pollution control in this area and the various options open to the countries, the following suggestions are made:

PREVENTION:

1. The countries of West and Central Africa should ensure that adequate spill prevention and control plans are developed for the potential oil spill sources within each country such as refineries and loading docks, following the concept of the prevention plan diagram (Figure VII-2).

2. The countries of West and Central Africa should proceed as rapidly as possible to ratify and enforce the appropriate international conventions which lead to the reduction of tank washings, discharges into the Atlantic Ocean and Gulf of Guinea and other contiguous seas and which call for proper equipment and safe operating practices on the part of tankers.

3. The West and Central African governments should initiate a programme to monitor tanker washing discharges including:

(a) the identification of tankers which do not use load-on-top crude oil washing, segregated ballast tanks or dedicated clean ballast tank methods or which do not discharge tank washings into shore receiving stations; and

(b) the evaluation of the rate of change in tank washings to the areas likely to impact West and Central Africa.

CONTROL OF MAJOR ACCIDENTAL SPILLS:

1. A programme of mutual assistance should be developed within West and Central Africa that involves governmental resources as well as the industrial resources.

2. The governments of West and Central Africa should investigate the capabilities of the response to the major spills which could be carried out by those companies operating in the area and should determine what supplemental governmental capability is needed.

3. The governments of West and Central Africa should develop their response capabilities in areas that will be complementary to, rather than duplicative of, existing industry programmes. Of particular importance would be programmes utilizing public resources for beach clean-up, programmes to protect particularly valuable environmental or economic resources and programmes to ensure that both site-specific and general contingency plans are available.

4. The governments of West and Central Africa should carefully evaluate the industrial response available for each production facility, refinery or port facility within their jurisdiction and if deficiencies are found, they should require adequate response capability as a condition of doing business in that country.

5. The governments of West and Central Africa should stimulate the improvement of both administrative and site-specific contingency planning in accordance with the contingency planning cycle.

6. The governments of West and Central Africa should formulate a programme of financing contingency planning, equipment and supply acquisition, stockpiling and maintenance, and response training. This programme should pay advance costs.

7. The governments of West and Central Africa should address the problem of compensation for spills (clean-up costs and damages) where the spill impacts several countries.

CONTROL OF CHRONIC OIL SPILLS:

1. The governments of West and Central Africa should measure carefully the chronic spill levels from production facilities and refineries, and where spill discharges do not conform with acceptable worldwide standards for the industries, suitable remedies should be sought.

2. The governments of West and Central Africa should establish an appropriate data base for the area to record small spills as well as large ones, so that the predictions about spill rates may be based on real data for West and Central Africa.

ENVIRONMENTAL DATA:

1. The governments of West and Central Africa should establish a programme to require the reporting of environmental data such as wind and current speed and direction by offshore operators of petroleum-producing platforms to enhance the knowledge base of winds and currents in the region and to report winds and currents at the time spills occur.

2. The governments of West and Central Africa should establish a system to record the incidence of oil spillages in the region.

3. The governments of West and Central Africa should carefully study the environmental impact of actual and proposed petroleum-producing refinery and transportation facilities.

It is believed that an effective programme based on these principles and expanded as needed can significantly reduce spillages and lead to a better response to those that occur.

APPENDIX 1

Oil Production Profiles for West and Central African Nations

Comparative International Petroleum Charts

OIL PRODUCTION PROFILES FOR WEST AND CENTRAL AFRICAN NATIONS

ANGOLA

A Belgian-owned company, Petrofina, struck oil in 1955 near Luanda. Subsequent financial transactions brought about the creation of Petrangol, jointly owned by the Province of Angola and Petrofina interests, which constructed a 1,000,000-ton refinery in the suburbs of Luanda. The Angol and Texaco Companies also have prospected and drilled offshore near the Congo and Cuanza Rivers, but the greatest impetus to expansion came from the Cabinda Gulf Oil Company, which struck oil offshore in Cabinda in 1966. Reserves of crude oil are estimated to be at least 300 million tons. In 1974, production was 160,000 b/d. Further south, other French, Portuguese, American and South African interests were prospecting or investing in oil before 1975. It is certain that Angola has some of the most promising oil prospects in Southern Africa. In 1974, exports were 7,377,264 tons, worth 14.9 billion escudos. In 1972, the value of oil refining reached 515 million escudos, and a new Petrangol oilfield near the Congo mouth came into operation. Following the price increase of Arab oil, Angola was regarded as a new, big potential producer, and U.S. interests intensified their explorations. In 1975, Cabinda Gulf Co. suspended operations in Cabinda and production fell sharply. Production was resumed in April 1976, following the release of about U.S. $120 million in royalties and tax payments to the Angolan Government by Cabinda Gulf Oil Co. Since then, production has surpassed its former averages, producing 8,027,000 tons of crude oil in 1975. Cabindan oil provides Angola with over $600 million a year. Including the production of mainland Angola - 30,000 b/d - oil production, refining and distribution constitute Angola's most important economic activity. In May 1976, a national oil company, SONANGOL, was set up with a view to undertaking all fuel production and distribution. The bulk of the oil is exported to the U.S.A., Portugal and Canada in its crude form, but Angola currently refines half of her own needs and exports bearing oil, bunkering oils and heavy fuels. Production of about 20 million tons is envisioned by 1984. As of 1979, 12 concessions had been granted to Gulf Oil, Texaco, Petrangol, Total and Elf. [Source: Africa South of the Sahara 1980-1981 (London: Europa Publications, Ltd., 1980), p. 149.]

BENIN

Petroleum exploration began in Benin with the signing in December 1964 of an agreement between the government and the Western Geophysical Company. A subsidiary of Union Oil Company of California, Western agreed to invest 400 million CFA francs in a five-year search for oil in the Cotonou Lagoon, beginning 1965. In 1968, the Seme Field was located 15 km. offshore from Cotonou, but at the time, exploitation was not considered to be commercially viable. This picture has changed with the high cost of oil, and in February 1980, a Norwegian firm, Saga Petroleum, was scheduled to sign an agreement to develop the Seme Oilfield. Recoverable reserves were estimated at 22 million barrels. Production is due to begin in 1981, at a rate of 15,000 b/d. This amount is about three times greater than Benin's current consumption level, thus, exploitation of the field will yield foreign income.

CAMEROON

Although petroleum actually was discovered in 1973, it was not until 1976 that Elf of France finally proved a commercial oilfield in shallow water, 90 km. northwest of Victoria, near the Nigerian border. Initial production began in 1978 with a target output by 1980 of 1.5 million metric tons per year, which is about three times the level of local consumption. The first consignment of 63,000 metric tons was exported in February 1978. Over $50 million have been spent by at least six multinational companies in offshore oil exploration, and their efforts have not been in vain. In 1979 and 1980, new offshore strikes of gas and good quality light crude were found in deep water near the Nigerian border in new areas of the Warri estuary and off Kribi. Oil output reached 1.7 million tons in 1979 - exceeding earlier projections - and annual output levels of 5 million tons are expected to be achieved by 1982-83. The Sonoro oil refinery at Victoria processes 150,000 tons of petroleum products annually. Exploratory drillings suggest that Cameroon's reserves may be as large as those of Gabon, although at this time she is still on the development side of exploitation and production.

CONGO

Prospecting for petroleum in Moyen-Congo dates back to 1928, when traces were found in the Mayombé massif. A systematic search begun in 1931 by the French Syndicat d'Etudes et de Recherches Pétrolières brought no results and ceased in 1934. Five years later, the Syndicat was transformed into a company called the SPAFE, which received permission to prospect in both Congo and Gabon. It did not resume work in the former territory until 1951, when it was granted a new permit covering 8,000 sq. km. In 1957, the SPAFE struck oil at Pointe Indienne, 20 km. from Pointe Noire, but the deposit was small and production did not begin until 1960. During the following decade, a total of 700,000 tons of oil was produced. Deposits at Pointe Indienne were almost exhausted by 1971 (production was only 15,000 tons compared with 123,000 tons in 1962) when new offshore fields were discovered. "Emeraude Marine" went into production in 1972; output was 2,071,000 tons in 1973 and 2,455,000 tons in 1974. The field was then found to have attained its peak production, and output, which declined to 1.4 million tons in 1977, is expected to be worked out by 1982. The development of the Loanga concession, the other major new field, was delayed for technical reasons, and the first platforms were not producing until fall 1977. This field is being worked by Agip of Italy and Elf Congo, and maximum production of 2 million tons annually is expected by 1982. A more recently discovered field, Likouala, began production in 1980, and two further offshore fields, Sendji-Marine and Yanga, are due to enter production in the next two years. Output of crude rose to 2.7 million tons in 1979, and Likouala Field is expected to add a further 600,000 tons in its first year. Oil provided 25.7 percent of the Congo's export receipts in 1973, but with greatly increased prices, the proportion rose to 62.4 percent in 1974 and remained at about 60 percent in the three subsequent years. The refinery at Pointe Noire was expected to go into production at the end of 1975 with a capacity of one million tons per annum, but it was not actually operational until October 1976. [Sources: Africa South of the Sahara 1980-1981 (London: Europa Publications Ltd., 1980), p. 324; and Virginia Thompson and Richard Adloff, Historic Dictionary of the People's Republic of the Congo (Metuchen, N.J.: Scarecrow Press, 1974), pp. 94-95.]

EQUATORIAL GUINEA

Oil prospecting in the region started in Gabon in 1931 and later in Nigeria with the Gulf Oil Co., and it was Gulf Oil Spain that started prospecting in (then) Spanish Guinea. From 1966 until the present, the following companies have prospected in Equatorial Guinea: Gulf, associated with Minas de Rio Tinto; Mobil Oil Co., associated with the Spanish firm CIPSA and the Banco de Bilbao; and also Chevron Oil and Continental Oil. Royalties yielded about $15 million (one billion pesetas) between 1960 and 1970 to the country and more between 1971 and 1976 (350 million pesetas). Since 1976, the Continental Oil Group, Gulf Oil and CIPSA have considered investing a further $4 million in prospecting in Equatorial Guinea, and interest also has been expressed by a number of other firms. Despite all this activity, drillings to date have revealed no exploitable oil fields. [Source: Max Liniger-Gonmaz, Historical Dictionary of Equatorial Guinea (Metuchen, N.J.: Scarecrow Press, 1979), pp. 125-126.]

GABON

Gabon is the twenty-first largest producer of petroleum in the world, and oil is the foundation of the Gabonese economy. The country's reserves are estimated at 108 million metric tons, of which four-fifths are offshore deposits. Exploitation commenced in 1957 but began its spectacular growth only after 1967 with the coming into production of the Gamba-Ivinga deposits in the northwest and the exploitation of the offshore Anguille deposit. Production has risen from 1.4 million tons in 1963 to about 11.3 million tons in 1976. Production dropped slightly to 11 million tons in 1977, but 66 million cubic metres of gas were also produced. Although production has continued to decrease gradually since then, improved world prices have again generated higher revenues. Total oil exports earned 221,000 million CFA francs in 1977, but government revenues from oil alone in the 1980 budget were estimated at 163,700 million CFA francs, compared to 129,000 million in the 1979 budget. Of the 22 companies operating oil concessions in Gabon, three account for 97 percent of the production: these are Elf-Gabon, Shell-Gabon and the Gulf Oil Company of Gabon. The State holds a 25 percent interest in all these companies. Eighty-five percent of crude oil production is exported. At the present rate of extraction, known reserves are estimated to be exhausted by the end of the 1980s, despite some recent finds, such as the Mayumba Field. The companies were expected to invest over 100,000 million CFA francs in prospecting during the later part of the seventies. The petroleum output at the refinery at Port Gentil has a maximum capacity of 1 million tons per year. A second refinery came into production in July 1976 at Pointe Clairette, and new tanker facilities to take vessels up to 250,000 tons have been opened at Cap Lopez. [Sources: Africa South of the Sahara 1980-1981 (London: Europa Publications Ltd., 1980), p. 393; and George Kurian, Encyclopaedia of the Third World (New York: Facts on File, 1978) vol. 1, p. 507.]

THE GAMBIA

Magnetic and seismic surveys have been carried out to discover whether workable reserves of oil are present in the Gambia, and test wells are being sunk. No details are available to indicate their success.

GHANA

Licenses for oil exploration were first issued in 1971, and deposits were discovered at Atiavi, Angola and Avenofeme in the Volta Basin. In January 1979, an American company began producing oil from the continental shelf at Saltpond Oilfield, 15 km. offshore, producing 4,500 b/d. In full production, the oilfield is expected to produce 5,000 b/d, rising to 10,000 barrels when three more wells are dug. Petroleum products have been refined at Tema from imported crude since 1963. The plant has a capacity of 1,250,000 tons per year.

GUINEA

One of Guinea's major import needs is for petroleum products, as the nation has no known deposits of petroleum or natural gas. The country does have a broad continental shelf, part of which extends over 100 miles out to sea, and there remains some possibility that oil deposits may still be found there. Guinea has signed an agreement with the American company, Union Texas Petroleum, creating the Guinean Hydrocarbon Company. The aim is to relaunch offshore petrol exploration in two phases: seismic tests were scheduled to take place in 1980 and drilling is expected to begin in 1981 [Sources: Thomas E. O'Toole, Historical Dictionary of Guinea (Metuchen, N.J.: Scarecrow Press, 1978), p. 56; and "Guinea's Oil Search Plans," West Africa Magazine, March 1980.]

GUINEA-BISSAU

In March 1958, Esso Exploration of Guinea was established in Guinea-Bissau and was given exclusive oil prospecting rights at the cost of a quarter of a million dollars (U.S.) per year. An additional $14 to $60 were paid for each square kilometre where prospecting actually took place. Beyond this, there was a 12.5 percent tax on production and a 50 percent tax on profits. In 1966 and 1973, the contract between the Portuguese colonial government and Esso Exploration was renewed and expanded to include other minerals. The onshore and offshore results of the prospecting were not conclusive but there are appropriate conditions for potentially oil-yielding strata. Since independence, the contract with Esso has been suspended, and a new contract has been written with the Italian petroleum company, Agip. [Source: Richard Lobban, Historical Dictionary of the Republics of Guinea-Bissau and Cape Verde (Metuchen, N.J.: Scarecrow Press, n.d.), p. 50.]

IVORY COAST

In 1977, small-scale reserves of offshore petroleum were discovered by Exxon-Shell. It is estimated that production, which began in 1980, should eventually reach 400,000 tons per year. Total reserves of the Belier Field, located 15 km. south of Grand Bassam, are estimated to be 75 million tons. The Ivory Coast imported 1.8 million tons in 1978 and exported 500,000 million tons of refined products to her neighbours. It has been suggested that the country could be self-sufficient in petroleum by 1982, thus reducing imports and stimulating internal industries.

LIBERIA

Data from a recent airborne geophysical survey of Liberia have indicated the presence of offshore sedimentary basins which may contain petroleum. Liberia's coastline is one of the missing links in West Africa's offshore oil chain. Government has, in this regard, spared no effort in granting concession rights to several foreign oil companies for detailed exploration of certain areas of the continental shelf. [Source: Alan Rake, "The Struggle for the Oil Wealth," in Africa 1971, ed. Bechir Ben Yahmed (New York: Africana Publishing Corp., 1972), p. 149.]

NIGERIA

The production of crude petroleum, which was first discovered in Nigeria in 1956, increased very rapidly from 13.3 million tons in 1965 to 111.6 million tons in 1974. However, there has since been a levelling-off in production of crude, which in 1975 dropped to 88.4 million tons; in 1978, it was 94.9 million tons. Average liftings in terms of barrels per day, which had reached a peak of 2.25 million b/d by the second half of 1974, fell sharply to 1.56 million b/d in the first half of 1975, due to slack demand on the world market. However, after mid-1978, output steadily increased to 2.2 million b/d. During 1979 and in the early part of 1980, Nigeria increased the price of her oil several times, in line with OPEC policy and by February 1980, the price of Bonny light was U.S. $34.20 per barrel, putting it at the top of the OPEC scale.

Crude petroleum is the country's principal earner of foreign exchange (over 90 percent of the total). In 1974, with 95.6 million tons exported, Nigeria earned 5,317.6 million niaras. In 1978, lower output meant a fall in revenue to about 5,600 million, but they recovered in 1979, particularly as a result of greatly increased prices. They are expected to stand at a level at least one-third higher than the 1979 revenue of 6,880 million niara.

Exploration and production is carried out mainly in the southern part of the country: in the Rivers, Cross River, Anambra, Imo, Bendel and Lagos States, and on offshore fields. In 1971, the State-owned Nigerian National Oil Corporation (NNOC) was set up to take a stake in the main oil firms and to carry out joint exploration with others. The NNOC was merged during 1977 with the Federal Ministry for Petroleum Resources to form a new body, the Nigerian National Petroleum Corporation (NNPC). The NNPC increased its equity stake in oil operations from 55 to 60 percent in July 1979 and in August, it nationalized BP's interests in Nigeria. BP's Nigerian operations accounted for about 300,000 b/d or one-eighth of her total supplies. Prior to nationalization, Shell-BP had accounted for 57 percent of Nigeria's total output. The other main producers are Gulf (14 percent), Mobil (11 percent), Agip/Phillips (11 percent), and Elf-Aquitaine, Texaco and Pan Ocean (with about 7 percent collectively). Among other companies involved in exploration or production on a small scale are Delta Oil and Henry Stephens (both Nigerian firms) and Ashland.

Production costs for Nigerian oil are three to seven times as much as in the Middle East, but it has an exceptionally low sulphur content. Nigeria is now the ninth largest producer of crude oil in the world, the largest in Africa, and accounts for about 3.1 percent of total world production. Her proven reserves amount to some 20,000 million barrels, which could last about 20 years at the current rate of lifting, but new finds could raise total reserves as much as 50,000 million barrels. The U.S.A. is the main customer for Nigeria's oil, taking more than one-third of exports. The Netherlands and France are also important customers. In 1972, Nigeria became a member of the Organization of Petroleum Exporting Countries (OPEC).

Until 1964, the entire output of Nigeria's crude oil was exported. With the completion and operation of the 60,000 barrels-per-day oil refinery at Port Harcourt in 1965, a small proportion of the crude oil production started to be refined in the country. A second oil refinery, built by a subsidiary of the Italian State Oil Company (ENI) at Warri in Bendel State, went on stream in September 1978, and now produces 100,000 barrels per day. It is wholly owned by the NNPC. A third refinery with a daily capacity of 100,000 b/d is being built at Kaduna and was due to be commissioned in 1980. Nigeria suffers severe shortages of refined products but should be almost self-sufficient when all three refineries are operating. A network of pipelines is being built for transporting refined products from Warri for distribution in the north, and for transporting crude from the coast to the refinery at Kaduna. The first section, from Warri to Kaduna, was completed in 1978. [Source: Africa South of the Sahara 1980-1981 (London: Europa Publications, Ltd., 1980), p. 765.]

SENEGAL

Exploitation of Senegal's offshore oil deposits was scheduled to begin in 1980. The oil field, 50 km. (30 mi.) off the coast of Casamance, has an estimated reserve of 100 million tons. Senegal previously had refrained from exploiting the field because of the expense of extracting the heavy oil. However, experts have estimated that with the rising cost of oil, it has become worthwhile to exploit the Casamance deposits.

SIERRA LEONE

A seismic exploration vessel was scheduled to begin offshore tests for oil in April 1980 as the second part of Arracca Petroleum Corporation's search for oil off Sierra Leone. An oil refinery using Nigerian crude has been operating since 1969, producing about 8,000 barrels per day.

TOGO

Petroleum exploration is underway, but no reserves have yet been located. A one million-ton capacity oil refinery began operation in 1977.

ZAIRE

The search for petroleum has been going on since 1958 in Zaire. A new oil agreement was made in October 1969 between SOREPZA (controlled 50 percent by Fina, 25 percent by Mobil Exploration, and 25 percent by Shell) to prospect over 4,700 square kilometres on a strip of land parallel to the coast. First traces of oil had been found at Lindu in 1963; a further show was found in May 1972 on the third hole drilled.

The Gulf Oil Company began drilling offshore in December 1970 and announced that it had struck oil in its first well near Moanda, but further holes drilled were dry. The first barrel of offshore oil was pumped into a tanker at Moanda in November 1975. The oil is being produced by the Gulf Oil Company in partnership with Japan's Teikoku Oil Company (33 percent) and Belgium's Cometra (17 percent). The Zaire Government also has a 15 percent stake. The consortium had spent $25 million on exploration and drilling by the time production came on stream. Production should reach 25,000 b/d at its peak, enough to meet all of Zaire's consumption needs. A pipeline takes the Zaire crude to the Moanda coastal refinery run by SOZIR (Société Zairo-Italienne de Raffinage, owned 50 percent by the Zaire Government and 50 percent by Italy's ENI). [Source: Africa South of the Sahara, 79-80, pp. 1103.]

TABLE A1-1

ESTIMATES OF PETROLEUM RESERVES IN PRINCIPAL PRODUCING COUNTRIES AND CRUDE OIL PRODUCTION IN 1978

(THOUSANDS OF BARRELS)

Continent and Country	Estimated Reserves at 1/1/78	Estimated Reserves at 1/1/79	Percent World Reserves at 1/1/79	Crude Oil Production 1978	Reserve Production Ratio (3)
NORTH AMERICA, TOTAL	45,885,251	61,994,478	10.90	4,100,517	13.15
Canada	5,970,872	5,784,194	1.02	483,260	12.16
Cuba *	(1)	(1)	...	775	...
Mexico	10,427,977	28,406,524	4.99	440,555	44.07
United States	29,486,402	27,803,760	4.89	3,175,927	9.01
SOUTH AMERICA, TOTAL	25,794,132	26,234,452	4.61	1,295,097	20.09
Argentina	2,317,105	2,424,531	0.43	165,195	14.35
Bolivia	129,990	135,109	0.02	12,045	11.00
Brazil	1,094,089	1,125,753	0.20	58,527	18.96
Chile	514,938	578,007	0.10	6,570	83.18
Colombia	779,000	850,000	0.15	47,815	17.03
Ecuador**	1,500,000	1,450,000	0.25	73,730	20.01
Peru	750,000	774,122	0.14	55,845	13.65
Trinidad and Tobago	650,000	650,000	0.11	84,680	7.68
Venezuela**	18,043,000	18,228,000	3.21	790,418	22.94
Other South America	16,010(2)	18,930(2)	0.00	272	64.23
EUROPE, TOTAL	77,641,155(5)	76,559,585(5)	13.47	4,874,574	15.82
Albania *	130,116	126,771	0.02	15,000	8.56
Austria	137,275	137,536	0.02	12,486	11.00
Bulgaria *	15,208	17,267	0.00	730	22.24
Czechoslavakia *	14,617	13,705	0.00	730	19.40
Denmark	50,781	207,612	0.04	3,650	35.40
France	55,381	59,753	0.01	7,300	7.89
Germany, East	22,478	22,113	0.00	2,500	8.92
Germany, West	309,209	305,013	0.06	37,230	8.25
Greece	136,875	136,875	0.03	...	...
Hungary *	193,288	213,640	0.04	15,695	12.96
Italy (Incl. Sicily)	320,211	327,024	0.06	9,902	32.68
Netherlands	70,818	61,260	0.01	10,950	6.03
Norway	4,764,160	4,094,200	0.72	129,940	34.09
Poland *	24,344	21,686	0.00	3,285	7.01
Rumania *	1,667,000	1,565,000	0.28	100,010	16.16
Spain	303,384	296,251	0.05	6,570	45.63
United Kingdom	10,070,338	10,190,600	1.79	394,930	25.65
U.S.S.R. *	59,000,000	58,438,000	10.28	4,093,475	14.34
Yugoslavia	355,302	324,933	0.06	30,191	11.26
AFRICA, TOTAL	54,616,954	56,257,082	9.89	2,233,791	24.82
Algeria **	10,000,000	9,575,140	1.68	447,125	21.89
Angola (Incl. Cabinda)	1,413,930	1,365,144	0.24	47,815	29.06
Egypt	2,081,475	2,132,527	0.38	169,360	12.44
Gabon **	543,375	466,577	0.08	82,125	6.15
Libya **	25,327,435	27,203,797	4.78	727,445	26.11
Nigeria **	12,243,358	12,273,400	2.16	697,150	17.58
Tunisia	2,262,941	2,225,346	0.39	36,500	61.48
Other Africa	744,440	1,015,151	0.18	26,271	33.49
ASIA, MIDDLE EAST TOTAL	338,118,768(5)	344,437,191(5)	60.58	9,491,741	35.96
Bahrain	289,673	269,482	0.05	19,345	14.45
Brunei-Malaysia	2,430,685	2,426,020	0.44	166,164	14.61
Burma	67,921	57,931	0.01	8,960	7.02
China *	18,026,000	20,025,240	3.53	731,825	26.00
India	2,260,000	2,310,000	0.41	92,812	24.62
Indonesia **	8,297,084	7,824,069	1.39	597,505	13.49
Iran **	46,863,000	44,965,650	7.91	1,900,555	24.16
Iraq **	35,338,465	34,392,020	6.06	959,585	36.33
Israel	1,021	808	0.00	365	2.50
Japan	26,493	22,530	0.00	3,963	6.18
Kuwait **	72,000,000	71,400,000	12.56	680,725	105.33
Neutral Zone	6,343,000	6,171,500	1.10	170,090	36.79
Oman	3,086,136	3,271,404	0.58	115,300	27.57
Pakistan	282,340	278,358	0.05	3,650	76.81
Qatar **	3,942,000	3,765,340	0.67	176,537	21.83
Saudia Arabia **	110,400,000	113,284,000	19.92	3,113,470	35.92
Syria	1,777,000	1,735,000	0.31	62,050	28.30
Taiwan	16,218	14,649	0.00	1,825	8.46
Thailand	323	323	0.00	110	2.94
Turkey	243,513	223,989	0.04	18,225	12.83
United Arab Emirates	26,009,639	31,583,651	5.55	668,680	43.06
AUSTRALIA-NEW ZEALAND	2,774,183	3,098,805	0.55	162,531	18.07
TOTAL WORLD	544,830,443	568,581,593	100.00	22,158,251	25.66
Sino-Soviet Countries	79,070,573	80,421,309	14.15	4,961,525	16.07
OPEC Countries (4)	350,840,717	350,999,493	61.73	10,246,370	34.10
Rest of World	114,919,153	137,160,791	24.12	6,950,356	18.13

* Communist controlled countries. ** Organization of Petroleum Exporting Countries (OPEC).

(1) Not available.
(2) Includes Central America, 14,500 at 1/1/78 and 17,730 at 1/1/79.
(3) Reserve production ratio based on average of estimated reserves 1/1/78 and 1/1/79.
(4) Includes Neutral Zone.
(5) Total includes amounts from countries not identified.

SOURCE: Twentieth Century Petroleum Statistics 1979 (Dallas: DeGolyer and MacNaughton, 1979), p. 1. This work sites the U.S. Dept. of Energy, "World Oil", American Petroleum Institute, and Canadian Petroleum Association.

TABLE A1-2

WORLD DEMAND FOR REFINED PRODUCTS

(THOUSANDS OF BARRELS)

CONTINENT AND COUNTRY	1960	1965	1970	1975	1976	1977
NORTH AMERICA	3,951,396	4,668,535	6,093,264	6,848,264	7,324,067	7,676,440
Canada	306,865	416,873	542,386	618,363	638,081	639,167
Mexico	108,726	124,293	183,658	268,389	291,273	306,791
United States	3,535,805	4,125,867	5,364,473	5,957,515	6,390,750	6,727,468
Others	...	1,502	2,747	3,997	3,963	3,014
CENTRAL AND SOUTH AMERICA	472,566	640,822	792,017	1,021,967	1,079,783	1,116,791
Argentina	89,007	139,014	154,239	165,913	165,170	169,563
Brazil	99,819	119,534	185,365	316,385	354,946	368,433
Colombia	19,567	24,994	35,069	50,944	53,040	55,182
Netherlands Antilles	55,441	52,484	26,606	40,856	50,352	58,383
Peru	18,130	27,901	35,406	42,489	43,214	39,900
Puerto Rico	21,130	36,126	56,868	59,101	65,159	76,010
Venezuela	56,593	64,875	73,141	89,717	89,484	100,805
Others	112,879	175,894	225,323	256,562	258,418	248,515
TOTAL WESTERN HEMISPHERE	4,423,962	5,309,357	6,885,281	7,870,231	8,403,850	8,793,231
WESTERN EUROPE	1,407,121	2,746,529	4,512,974	4,599,943	4,922,309	5,035,011
Austria	20,890	39,148	65,586	78,327	88,375	81,524
Belgium and Luxenbourg	52,946	106,858	206,084	194,486	198,137	202,891
Denmark	37,468	74,750	133,714	120,664	122,215	124,752
France	204,177	397,252	689,136	779,738	834,337	815,604
Germany, West	229,288	586,531	888,170	917,939	991,269	1,035,475
Greece	18,928	30,702	44,795	69,653	75,611	76,031
Italy	162,628	357,946	669,694	319,024	659,285	720,239
Netherlands	91,900	182,587	274,015	257,108	249,776	272,774
Norway	27,450	36,665	60,191	60,045	63,209	71,572
Spain (1)	34,987	83,158	205,670	305,994	358,787	340,354
Sweden	96,877	137,968	216,207	203,532	216,601	207,577
Switzerland	29,206	60,483	95,051	96,208	105,771	98,420
United Kingdom	344,238	545,170	761,883	683,249	679,362	686,121
Others	56,138	107,311	202,778	513,976	279,574	301,677
MIDDLE EAST	209,473	285,132	390,398	586,502	619,677	679,657
Iran	53,878	68,044	101,824	175,674	166,052	187,609
Kuwait	32,645	27,830	46,442	41,176	37,986	37,594
Saudi Arabia	24,900	32,610	59,032	97,175	129,292	128,446
Turkey	12,054	29,357	55,685	99,603	109,307	127,868
Others	85,996	127,291	127,415	172,874	177,040	198,140
AFRICA	129,494	205,891	260,538	374,996	393,495	404,914
Algeria	11,562	11,633	15,824	28,929	28,424	30,850
Egypt	34,288	46,816	41,423	53,052	71,375	67,535
Libya	1,588	3,290	6,603	18,076	20,540	24,336
Nigeria	5,813	9,251	11,184	24,495	22,896	18,815
South Africa, Republic of	29,405	46,508	70,982	116,483	106,506	106,770
Others	46,838	88,393	114,522	133,961	143,754	156,608
FAR EAST AND OCEANIA	540,687	1,114,940	2,258,789	2,679,861	2,920,933	3,104,274
Australia	80,965	127,778	187,424	204,685	226,727	239,303
India	60,120	90,755	133,853	182,085	188,059	200,594
Indonesia	35,274	57,585	50,947	82,497	90,463	109,111
Japan	242,358	636,197	1,404,140	1,643,235	1,746,246	1,874,583
Korea, South	5,113	11,511	72,639	113,565	130,606	153,946
Philippines	19,587	35,404	61,602	68,620	73,232	80,067
Others	97,270	155,710	348,184	385,174	465,600	446,670
SINO-SOVIET AREA (2)	1,058,000	1,647,203	2,373,670	3,231,831	3,915,572	4,225,188
TOTAL EASTERN HEMISPHERE	3,344,775	5,999,695	9,796,369	11,473,133	12,771,986	9,223,856
TOTAL WORLD (3)	7,793,889	11,317,562	16,681,650	19,343,364	21,175,836	22,242,275

(1) Includes Canary Islands.
(2) Cuba excluded.
(3) From 1959-1966, the World Total includes small amount of demand from other countries not separately listed by Bureau of Mines.

SOURCE: Twentieth Century Petroleum Statistics 1979 (Dallas: DeGolyer and MacNaughton, 1979), p. 18.

TABLE A1-3

ESTIMATED PROVED WORLD RESERVES OF NATURAL GAS BY COUNTRY

(BILLIONS OF CUBIC FEET)

CONTINENT AND COUNTRY	Estimated Reserves at 1/1/78	Estimated Reserves at 1/1/79	Percent World Reserves at 1/1/79	1977 Production Vented and Flared	1977 Production Marketed Production
NORTH AMERICA, TOTAL	296,218	321,934	13.59	328	23,787
Canada	59,472	62,697	2.65	47	3,161
Mexico	27,868	58,935	2.49	144	600
United States	208,878	200,302	8.45	137	20,026
SOUTH AMERICA, TOTAL	80,612 (2)	81,034 (2)	3.42	399	1,238
Argentina	16,000	15,255	0.64	98	304
Bolivia	5,372	5,217	0.22	19	59
Brazil	1,393	1,567	0.07	36	28
Chile	3,500	4,700	0.20	(1)	134
Colombia	4,861	4,500	0.19	26	74
Ecuador	296	296	0.01	11	1
Peru	1,328	1,352	0.06	30	43
Trinidad and Tobago	6,000	6,000	0.25	79	71
Venezuela	41,853	42,138	1.78	100	524
EUROPE, TOTAL	931,588	960,076	40.52	1,097	20,680
Albania*	445	390	0.02	(1)	7
Austria	489	489	0.02	3	81
Bulgaria*	468	465	0.02	(1)	1
Czechoslovakia*	467	467	0.02	(1)	36
Denmark	5,500	5,500	0.23	4	(1)
France	2,910	2,478	0.10	86	272
Germany, East*	3,190	2,843	0.12	(1)	317
Germany, West	6,523	6,259	0.26	41	638
Greece	48	48	0.00	0	0
Hungary*	4,203	4,000	0.17	(1)	228
Ireland	1,000	1,000	0.04	(1)	(1)
Italy (Incl. Sicily)	6,710	6,354	0.27	(1)	485
Netherlands	60,363	58,231	2.46	0	3,422
Norway	17,049	14,331	0.60	34	124
Poland*	4,711	4,474	0.19	(1)	242
Rumania*	12,199	12,286	0.52	142	1,104
Spain	401	447	0.02	(1)	0
United Kingdom	28,558	24,710	1.04	122	1,437
U.S.S.R. *	774,900	813,645	34.35	665	12,219
Yugoslavia	1,454	1,659	0.07	(1)	67
AFRICA, TOTAL	214,141	216,430	9.14	1,443	959
Algeria	122,500	122,002	5.15	414	305
Egypt	2,167	2,884	0.12	20	58
Gabon	35	33	0.00	55	6
Libya	28,500	30,568	1.29	150	556
Nigeria	51,649	51,775	2.19	740	18
Tunisia	6,519	6,412	0.27	16	10
Other Africa	2,771	2,756	0.12	48	6
MIDDLE EAST, TOTAL	616,197	616,302	26.02	3,578 (2)	1,464
Abu Dhabi	18,187	18,737	0.79	430	112
Bahrain	9,308	9,177	0.39	(1)	83
Dubai	1,925	1,912	0.08	109	20
Iran	373,400	371,955	15.70	985	748
Iraq	27,394	26,660	1.13	315	56
Israel	13	11	0.00	(1)	2
Kuwait	37,267	37,262	1.57	120	211
Neutral Zone	19,000	19,000	0.80	(3)	(3)
Oman	2,480	2,630	0.11	131	5
Qatar	58,737	58,499	2.47	95	57
Saudi Arabia	65,700	67,700	2.86	1,321 (3)	159
Syria	1,768	1,765	0.08	57	8
Turkey	30	29	0.00	3	3
Other Middle East	988	965	0.04	(1)	0
FAR EAST, TOTAL	108,611	138,513	5.85	702	2,979
Afghanistan	...	...	...	5	85
Brunei-Malaysia	16,521	36,036	1.52	95	347
Burma	194	164	0.01	6	10
China *	25,000	26,000	1.10	300	1,900
India	8,140	8,430	0.35	34	58
Indonesia	24,607	24,186	1.02	260	200
Japan	796	659	0.03	2	98
Pakistan	14,690	22,000	0.93	(1)	180
Taiwan	917	921	0.04	(1)	69
Other Far East	17,746	20,117	0.85	(1)	32
AUSTRALIA-NEW ZEALAND	34,475	34,512	1.46	7	287
TOTAL WORLD	2,281,842	2,368,801	100.00	7,554	51,394
Sino-Soviet Area *	825,583	864,570	36.50	1,107	16,054
TOTAL FREE WORLD	1,456,259	1,504,231	63.50	6,447	35,340

* Sino-Soviet countries.

(1) Not available.
(2) Total includes amounts from countries not identified.
(3) One half of Neutral Zone's gas flared or vented included with Kuwait and the other half with Saudi Arabia.

SOURCE: Twentieth Century Petroleum Statistics, 1979, p. 16. This work cites U.S. Dept. of Energy and Others.

APPENDIX 2

Conversion Charts

TABLE A2-1

GRAVITY, WEIGHT AND VOLUME CONVERSIONS FOR PETROLEUM PRODUCTS

(All measurements at 60°F)

Gravity, Degrees API	Specific Gravity	Gallons per Pound	Pounds per Gallon	Pounds per Barrel	Barrels per Short Ton	Barrels per Metric Ton	Barrels per Long Ton
0	1.0760	0.1116	8.962	376.40	5.31	5.86	5.95
10	1.0000	0.1201	8.328	349.78	5.72	6.30	6.40
15	0.9659	0.1243	8.044	337.85	5.92	6.52	6.63
18	0.9465	0.1269	7.882	331.04	6.04	6.66	6.77
20	0.9340	0.1286	7.778	326.68	6.12	6.75	6.86
22	0.9218	0.1303	7.676	322.39	6.20	6.84	6.95
24	0.9100	0.1320	7.578	318.28	6.28	6.93	7.04
26	0.8984	0.1337	7.481	314.20	6.36	7.02	7.13
28	0.8871	1.1354	7.387	310.25	6.45	7.10	7.22
30	0.8762	0.1371	7.296	306.43	6.53	7.19	7.31
32	0.8654	0.1388	7.206	302.65	6.61	7.28	7.40
34	0.8550	0.1405	7.119	299.00	6.69	7.37	7.49
36	0.8448	0.1422	7.034	295.43	6.77	7.46	7.58
38	0.8348	0.1439	6.951	291.94	6.85	7.55	7.67
40	0.8251	0.1456	6.870	288.54	6.93	7.64	7.76
42	0.8156	0.1473	6.790	285.18	7.01	7.73	7.85
44	0.8063	0.1490	6.713	281.95	7.09	7.82	7.94
46	0.7972	0.1507	6.637	278.75	7.17	7.91	8.04
48	0.7883	0.1524	6.563	275.65	7.26	8.00	8.13
50	0.7796	0.1541	6.491	272.62	7.34	8.09	8.22
55	0.7587	0.1583	6.316	265.27	7.54	8.31	8.44
60	0.7389	0.1626	6.151	258.34	7.74	8.53	8.67
65	0.7201	0.1668	5.994	251.75	7.94	8.76	8.90
70	0.7022	0.1711	5.845	245.49	8.15	8.98	9.12
75	0.6852	0.1753	5.704	239.57	8.35	9.20	9.35
80	0.6690	0.1796	5.569	233.90	8.55	9.43	9.58
85	0.6536	0.1838	5.440	228.48	8.75	9.65	9.80
90	0.6388	0.1881	5.317	223.31	8.96	9.87	10.13
95	0.6247	0.1923	5.190	218.36	9.16	10.10	10.26
100	0.6112	0.1966	5.087	213.65	9.36	10.32	10.48

TABLE A2-2

REPRESENTATIVE WEIGHTS OF CRUDE OIL IN INTERNATIONAL TRADE

BY COUNTRIES OF PRODUCTION

Country	Pounds Per Gallon	Pounds Per Barrel	Barrels Per Short Ton	Barrels Per Metric Ton
Albania	7.87	330.4	6.053	6.672
Algeria	6.79	285.2	7.013	7.731
Argentina	7.51	315.3	6.343	6.992
Austria	7.62	319.9	6.252	6.892
Bahrain	7.16	300.6	6.653	7.335
Bolivia	6.46	271.4	7.369	8.123
Brazil	7.18	301.4	6.636	7.315
Borneo	6.99	293.6	6.812	7.508
Burma	7.03	295.4	6.770	7.464
Canada	7.07	296.8	6.738	7.428
Chile	6.73	282.6	7.077	7.802
Columbia	7.45	312.8	6.394	7.049
Czechoslovakia	7.74	325.1	6.152	6.782
Equador	7.06	296.6	6.743	7.432
Egypt	7.58	318.4	6.281	6.923
Formosa	6.90	289.7	6.904	7.610
France	7.29	306.2	6.532	7.201
Germany	7.24	304.2	6.575	7.247
Hungary	6.83	288.9	6.923	7.630
India	7.03	295.4	6.770	7.464
Indonesia	7.12	299.2	6.684	7.369
Iran	7.10	298.1	6.709	7.395
Iraq	7.08	297.5	6.723	7.411
Israel	7.20	302.6	6.609	7.286
Italy	7.70	323.6	6.180	6.813
Japan	7.35	308.8	6.477	7.138
Kuwait	7.24	303.0	6.581	7.254
Mexico	7.39	310.3	6.445	7.104
Morocco	6.97	292.7	6.833	7.532
Netherlands	7.53	316.1	6.327	6.975
Neutral Zone	7.67	322.3	6.205	6.840
New Guinea	7.03	295.2	6.775	7.468
Pakistan	7.38	310.2	6.447	7.107
Peru	6.98	293.3	6.819	7.517
Poland	7.08	297.2	6.729	7.419
Qatar	6.83	286.8	6.974	7.686
Rumania	7.04	295.8	6.761	7.453
Saudi Arabia	7.10	298.3	6.705	7.390
Trinidad	7.51	315.4	6.341	6.989
Turkey	7.25	304.5	6.568	7.240

(continued)

TABLE A2-2 (Cont'd.)

Country	Pounds Per Gallon	Pounds Per Barrel	Barrels Per Short Ton	Barrels Per Metric Ton
United Kingdom	7.21	302.9	6.603	7.279
United States	7.08	297.2	6.729	7.418
Venezuela	7.64	320.8	6.234	6.871
Yugoslavia	7.42	311.8	6.414	7.070

SOURCES: U.S. Bureau of Mines; American Petroleum Institute.

TABLE A2-3

REPRESENTATIVE WEIGHTS OF PETROLEUM PRODUCTS

Product	Gallons Per Pound	Pounds Per Gallon	Pounds Per Barrel	Barrels Per Short Ton	Barrels Per Metric Ton
Aviation gasoline	0.169	5.90	248	8.07	8.90
Motor gasoline	0.162	6.17	259	7.72	8.50
Natural gasoline	0.162	6.17	259	7.72	8.50
Kerosine	0.148	6.76	284	7.04	7.75
Gas oil, diesel oil, distillate fuels	0.142	7.05	296	6.76	7.46
Residual fuel oils	0.127	7.88	331	6.04	6.66
Lubricating oils	0.133	7.50	315	6.35	7.00
Unspecified oils	0.133	7.50	315	6.35	7.00
Benzol	0.136	7.36	309	6.47	7.14
Mineral spirits	0.164	6.10	256	7.81	8.62
Liquefied petroleum gas	0.221	4.52	190	10.53	11.60
Paraffin wax	0.150	6.67	280	7.14	7.87
Petrolatum	0.150	6.67	280	7.14	7.87
Grease	0.120	8.33	350	5.71	6.30
Asphalt, road oil	0.115	8.67	364	5.50	6.06
Petroleum coke	0.105	9.55	401	4.99	5.50

SOURCES: U.S. Bureau of Mines; American Petroleum Institute.

GENERAL CONVERSIONS

2,000 pounds = short ton
2,220 pounds = metric ton
2,240 pounds = long ton

Notes

[1]See: Michel P. Angot and Donald Kaniaru, Exploratory Mission on Marine Pollution Problems of the West African Coastal Countries of the Gulf of Guinea (New York: United Nations Environment Program, 1976).

[2]See: A. Piquemal and M. Savini, Legal Aspects of Marine Environment Protection in the Gulf of Guinea and Adjacent Coastal Areas (Rome: United Nations Food and Agriculture Organization, 1979).

[3]See: J.E. Portmann, The Gulf of Guinea: Pollution and the Need for Control and Possible Mechanisms Thereof (Rome: United Nations Food and Agriculture Organization, 1978).

[4]See: United Nations Environment Program (UNEP), Report of the Workshop on Causes and Possible Solutions to Coastal Erosion in Benin and Togo (New York: United Nations Environment Program, 1979).

[5]Program coordinators included Dr. Roy W. Hann, Jr., head of the Texas A&M University Oil Spill Technical Assistance Program and the Environmental Engineering Division of the Department of Civil Engineering; and Harry N. Young, Jr., research associate and oil spill control expert from the Oil Spill Technical Assistance Program, College Station, Texas.

[6]Nicolas Sarkis, "Petroleum and Gas Industries in Africa," in Africa 1968, ed. Bechir Ben Yahmed (New York: Africana Publishing Corp., 1968), p. 53.

[7]Petroleum Outlook Vol. 33, No. 6, (June 1980): 42.

[8]Alan Rake, "The Struggle for the Oil Wealth," in Africa 1971, ed. Bechir Ben Yahmed (New York: Africanan Publishing Corp., 1971), p. 137.

[9]Ibid., p. 139.

[10]There is some historic evidence to this, as noted by Rake in "The Struggle for the Oil Wealth", p. 139. He notes that during the Nigerian civil war, multinational companies with offshore concessions were able to continue production much longer than those working onshore.

[11]Exxon Company figures extracted from the (unpublished) manual for the Texas A&M University Oil Spill Technical Assistance Training Program, entitled "Prevention, Abatement and Control of Pollution of Ships", prepared by Roy W. Hann, Jr.

[12]National Academy of Sciences, Petroleum in the Marine Environment (Washington, D.C.: National Academy of Sciences, 1975), p. 51.

[13]Ibid., p. 45.

[14]Rand McNally & Company, Atlas of the Oceans (New York: Rand McNally & Company, 1979), p. 108.

[15] Africa South of the Sahara 1979-1980 (London: Europa Publications, Ltd., 1980), p. 1355.

[16] Portmann, The Gulf of Guinea, p. 25.

[17] U.S. Coast Guard Publication #CG-296.

[18] Oil Spill Intelligence Report Vol. III, No. 32 (August 1980):2.

[19] Portmann, The Gulf of Guinea.

[20] Ibid., p. 26.

[21] Ibid.

[22] A.H. Beyer and L.J. Painter, "Estimating the Potential for Future Oil Spills from Tankers, Offshore Development and Onshore Pipeline," in Proceedings of the 1977 Oil Spill Conference (New Orleans, n.p., 1979), p. 21.

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