REGIONAL SEAS

UNITED NATIONS ENVIRONMENT PROGRAMME

Environmental management problems in resource utilization and survey of resources in the West and Central African Region

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PREFACE

Ten years ago the United Nations Conference on the Human Environment (Stockholm, 5-16 June 1972) adopted the Action Plan for the Human Environment, including the General Principles for Assessment and Control of Marine Pollution. In the light of the results of the Stockholm Conference, the United Nations General Assembly decided to establish the United Nations Environment Programme (UNEP) to "serve as a focal point for environmental action and co-ordination within the United Nations system" (General Assembly resolution (XXVII) of 15 December 1972). The organizations of the United Nations system were invited "to adopt the measures that may be required to undertake concerted and co-ordinated programmes with regard to international environmental problems", and the "intergovernmental and non-governmental organizations that have an interest in the field of the environment" were also invited "to lend their full support and collaboration to the United Nations with a view to achieving the largest possible degree of co-operation and co-ordination". Subsequently, the Governing Council of UNEP chose "Oceans" as one of the priority areas in which it would focus efforts to fulfil its catalytic and co-ordinating role.

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 eleven regions [1/] 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[2/].

At the third session of UNEP's Governing Council (1975), a number of West and Central African States requested UNEP to study the problems of marine and coastal pollution of their region. As a result of that request, UNEP's exploratory mission visited fourteen States of the region during 1976. The mission's report identified the major environmental problems of the region and recommended the development of a regional action plan for the protection and development of the marine environment and coastal areas of the region.

After considering the report of the mission, the fifth session of the Governing Council (1977) decided that "steps should be undertaken for the development of an action plan and a regional agreement to prevent and abate pollution" in the West and Central African region.

1/ Mediterranean Region, Kuwait Action Plan Region, West and Central African Region, Wider Caribbean Region, East Asian Seas Region, South-East Pacific Region, South Pacific Region, Red Sea and Gulf of Aden Region, East African Region, South-West Atlantic Region and South Asian Region.

2/ Achievements and planned development of UNEP's Regional Seas Programme and comparable programmes sponsored by other bodies. UNEP Regional Seas Reports and Studies No. 1. UNEP, 1982.

The preparatory work on the development of the action plan and the regional agreement included several expert group meetings, missions and surveys[3/] leading to 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 (UNEP/IG.22/7) convened by UNEP in Abidjan, 16 - 23 March 1981 as the final stage of the preparatory work leading to the adoption of the (a) Action Plan for the protection and development of the marine environment and coastal areas of the West and Central African Region, (b) Convention for the Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region, (c) Protocol concerning co-operation in combating pollution in cases of emergency, and (d) a set of conference resolutions.

This document is one of the surveys prepared as a contribution to the development of the Action Plan.

3/ For details see:

- Report of the Executive Director on preparatory activities for an action plan for the protection and development of the marine and coastal environment in the West African Region. UNEP/IG.22/4. UNEP, 1981.

- UNIDO/UNEP: Survey of marine pollutants from industrial sources in the West and Central African Region. UNEP Regional Seas Reports and Studies No. 2. UNEP, 1982.

- UNESCO/UNEP: River inputs to the West and Central African marine environment. UNEP Regional Seas Reports and Studies No. 3. UNEP, 1982.

- IMCO/UNEP: The status of oil pollution and oil pollution control in the West and Central African Region. UNEP Regional Seas Reports and Studies No. 4. UNEP, 1982.

- UNDIESA/UNEP: Ocean energy potential of the West African Region. UNEP Regional Seas Reports and Studies No. 30. UNEP, 1983.

- UNDIESA/UNEP: Onshore impact of offshore oil and natural gas development in the West and Central African Region. UNEP Regional Seas Reports and Studies No. 33. UNEP, 1984.

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I. INTRODUCTION

A. Introduction

Coastal areas are uniquely suited to support a variety of activities and to serve diverse human needs for food, energy, transport and recreation. Some two-thirds of the world's population lives near the coast and a majority of the world's largest cities - 39 of the 66 with populations over 1 million - are in coastal areas. Ninety per cent of the world's fish catch comes from the continental shelf and upwelling regions, and at present, approximately 8 per cent of the world's total animal protein supply comes from the sea. Again, about 20 per cent of the world's oil production comes from offshore areas and it is estimated that about 68 per cent of the world's ultimate recoverable hydrocarbon resources lie in coastal waters 200 metres in depth or less. Finally, the coastal area is a source of many other raw materials in the form of sand, gravel, and a variety of placer minerals such as diamonds. Salt for instance, as an extracted product from the oceans, contributes significantly in food processing and other industrial endeavours. Coastal areas are, therefore, an integral part of the development process in a large number of countries.

The evolution of coastal areas into focal points for tourism, trade, industrial production and transport, in the absence of an integrated and comprehensive plan for their development, often results in negative interactions between activities that act to reduce the potential value of one or more activities. Proper planning and coordination of marine activities can help, not only to manage and minimize conflicts, but to take advantage of positive interactions between activities and maximize the overall benefits

accruing from the coastal area. The value of treating coastal areas as planning entities within the overall framework of national development planning is not always fully recognized and very often countries lack the administrative and legislative basis for implementing such an approach.[1/] In West Africa, where there is a relatively narrow range of marine-related activities and a largely untrapped resource potential, there is a need and an opportunity for managing the growth of individual sectoral activities so as to obtain the optimal mix of activities which maximizes the contribution to national development, while ensuring the continuing productivity of the coastal environment.

The principal objective of the Action Plan is the development and protection of the marine and coastal area environment of the West African Region for the health and well-being of present and future generations. The Action Plan is intended to provide a framework for an environmentally sound and comprehensive approach to coastal area development particularly appropriate to the needs of the people. Any factors, therefore, that mitigate against the maintenance of the marine environment to the extent that the "health and well-being" of the people of the West African region becomes jeopardized will constitute "pollution".

The socio-economic component of the Draft Action Plan must, therefore, bring into focus the major categories of marine pollution in the region, explore their effects on this environment as well as on the people who derive benefits from it, survey past and possible future development activities which may have an impact on the quality of the marine and coastal environment, and subsequently recommend an approach towards effective environmental management which can be incorporated into national and regional development plans of the states of the region.

1/ The United Nations has prepared the following volumes on the subject. Manual on Coastal Area Management and Development. Vol. I - Establishing a National Programme: Economic and Technical Matters. Vol. II - Approaches, Problems and Guidelines, UN/DIESA 1980.

With the above considerations paramount, this paper seeks:

1. To examine existing classification schemes for the coastal and marine environments in West Africa;

2. To summarize the activities of the various socio-economic groupings within the West African coastal area;

3. To discuss the regional natural resource base and its relationship to the coastal area and

4. To examine present and future environmental management and planning issues for the coastal area given the various national development strategies in the West African region.

B. The Significance of the West African Coastal Area in Regional and National Development

The West African coastal area has traditionally played an important, albeit less than major role in West African socio-economic development. Over the years, using dug-out canoes, a number of the coastal ethnic groups developed such competence in sea fisheries that their influence was felt at a considerable distance inland.[1/] With the advent of Western influence in the region, the traditional role of coastal areas was diminished and replaced by one focussed on the need to create the necessary infrastructure to facilitate trade in raw materials destined for Europe. As a result and aided by subsequent national development efforts, coastal areas in West Africa, generally contain the most obvious examples of the effort toward modernization in the region.

Of the 20 countries included in this study, excluding Cape Verde, Sao Tomé and Principé, all but three of the countries have capital cities located

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1/ The Ewe ethnic group of Ghana, Togo and Benin are such an example.

in the coastal area.[1] Until the end of the nineteenth century, almost all these cities had populations of less than twenty thousand. In the colonial period, many of the towns already in existence were adopted as administrative and commercial centres and were linked together by railways and roads. Old towns, by-passed by the new means of communication, declined. The fastest growing towns were those chosen to be the ports, coastal or riverine, at the termini of the railways. They were the obvious centres for the type of trade and commerce of the period, and in many cases were chosen to be colonial capitals. After independence and up until the present, the dominance of the capital cities has been further heighten by various policy decisions adopted by national governments. Minor ports along the coast are declining as the harbour installations and overland links of major ports improve. Government spending on public works and the employment offered in government offices attracts ever more people to the national capitals. Industrial activity, particularly large-scale manufacturing, taking advantage of the same factors, also tends to be located in the coastal areas.

Of more recent vintage but perhaps in the present decade of more significance to the individual economies, is the known and potential energy resource endowment within the coastal area. Current petroleum production in the region is concentrated offshore. In those non-producing countries of the region, prospects for the occurrence of oil and gas offshore range from good to fair.[2] Aside from the obvious benefits accruing from exploiting these resources, additional national desires to increase value

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1/ The countries with non-coastal capitals are Cameroon (capital Yaoundé), Zaire (capital Kinshasa), and Congo (capital Brazzaville). Nigeria is planning on moving the Federal capital from Lagos (coastal) to Abuja (inland) soon.

2/ Described more fully in Section III E.

added through processing such resources will result in further concentrations of industrial activity particularly petroleum-based industries along the coast. Including refineries under construction, there are currently 14 refineries located in the coastal area each releasing varying quantities of toxic wastes into the environment.

Finally, the coastal areas contain resources that if properly utilized could significantly improve the quality of life of the West African peoples. An excellent example of the above can be gleaned from the exploitation of regional fisheries. Though the region boasts of a number of ethnic groups whose proficiency in exploiting the regional fisheries is renowned all along the African coast, efforts at improving the technology available to them to increase their productivity and, therefore, their standard of living, have only been fair and the results mixed. The regional fisheries are dominated by foreign vessels and fleets with little technological transfer to West African society as a whole.

C. Environmental Issues of the Coastal Zone

The sources and extent of pollution in the marine and coastal area environment, though not the subjects of rigorous and exhaustive study on a region-wide basis, have been investigated in part by exploratory missions and over-view studies. Portmann, in the "Gulf of Guinea: Pollution, the need for control and possible mechanisms thereof", identifies the following types and sources of pollution:[1/]

1. Sewage, generally in and around the Port capitals and major coastal towns;

1/ The Gulf of Guinea: Pollution, the Need for Control and Possible Machanisms thereof. J. E. Portmann, FAO/UNEP Joint Project No. FP/0503-77-02.

2. Oil contamination, not common to all countries, but found in ports, harbours and beaches of the countries where it is found. Oil contamination is caused in part by tanker traffic through the region, in part by handling operations in ports and refineries and finally, in part by activities associated with oil exploitation;

3. Timber industry pollution, in the form of logs and plywood remnants in countries like the Ivory Coast, Ghana, Cameroon and Gabon;

4. Industrial effluents, including effluents from refineries and mining operations which are discharged into rivers, the sea or lagoons without prior treatment;

5. Coastal erosion, again, not common to all countries but especially serious in countries like Ghana, Togo, Benin and Nigeria, and generally associated with ocean front construction (ports and harbours, etc.)

6. Pollution associated with agribusiness essentially in the form of fertilizers and pesticides.

Of the problems above, except for oil contamination from sources outside the region and the potential effects of a blow-out or spill which will require contingency plans adhered to by all countries in the region, the remainder point to the need for fundamental changes in the policy of resource utilization in the region. As noted by Portmann, with the provision of adequate oil analysis facilities in the region, it should not be difficult to establish the sources of oil contamination. Once having done this, the problem with external sources of oil contamination can be squarely addressed, the regional risks associated with a blow-out or spill estimated and the requisite contingency plans drawn up. Without the facilities to determine their origin,

this issue will remain the central theme of discussions on pollution while the actual and potential problems associated with the development and management of the region's coastal areas are overlooked.

Sewage pollution in the Port capitals and coastal towns where it has generally been identified as a problem, is being addressed in virtually all of the countries of region. Generally recognized as a problem created by either a lack of treatment facilities or an improper siting of outfalls, it is being corrected by the construction of treatment facilities in Senegal (both Dakar and St. Louis), Gambia (Bangul), Ivory Coast (Abidjan), Ghana (Accra), Nigeria (Lagos), Cameroon (Douala) and Gabon (Libreville). Allowing for hindsight and the historical evolution of many of the Port capitals and major coastal towns, the origin of the problem is readily identified-- in the other coastal towns.
uncoordinated planning. In Tema, for example, which was planned as an industrial town along garden city lines, such social facilities are availsble and generally, the town does not suffer from the environmental problems identified in the other coastal towns.

The remaining classes of pollutants, timber, industrial effluents, coastal erosion and environmental residue concentrations arising from the agribusiness though amenable to short-term and stop gap solutions point to a potentially more alarming problem of improper resource utilization schemes. Apparently missing even in national development plans, is the realization that the desire to obtain higher standard of living involves the deliberate modification of the natural environment (ecology, health, socio-cultural) at a cost to society. Such costs, which vary widely, result from either the failure to adequately consider environmental consequences during regional planning and development or from the lack of knowledge and information necessary to predict their eventual impact. To the extent that these losses occur or go unmeasured, the level of

The significance of the activities which generate the latter types of pollutants, therefore, is not in the severity of damage they can be determined to be imposing on a part of the ecosystem at the present time but, it is in the fact that these activities through both the pollutants they generate and the manner in which they occur, are choking off potential development opportunities that exist around them. Development activities, particularly resource utilization schemes within the region should include a broad array of concerns designed to assess costs that would result if projects were to lead to impairement of the future productivity of the national resource base and to adverse side effects of investment. What is being suggested is that at the outset of a major national or regional development scheme it is necessary to generate some discussion and answers to issues which impinge directly on the future productivity of the entire natural resource base.[1/] In the coastal area of West Africa, in particular, where the concentration of manufacturing activity and the population density is the greatest, and where the existence of environmental degradation is most visible, the opportunity exists for transforming any consensus arrived at in the discussions into corrective and preventive action.

1/ Resource as used in this report, is a term applicable to a wide range of environmental attributes which are of potential use to man, either directly as an input to the agricultural or industrial economy, or indirectly by exchanging the resource for monetary assets.

II. THE COASTAL AND MARINE ENVIRONMENT OF THE REGION

A. Introduction

Like other coastal environments, that of the West Africa Region is a complexity of integrated processes which have three major components: atmospheric, marine and terrestrial. Each component is characterized by a particular set of processes which may be viewed as subsystems contributing to the equilibrium in the entire system. The atmospheric and marine subsystems for example, are largely responsible for the transfer of energy and mass to which the terrestrial materials respond. The variation and interaction within the three components results in different products as evidenced by the diverse types of shore environments in the region. Since each type of shore environment has associated with it specific attributes that can either be harnessed profitably to promote socio-economic development or be adversely impacted upon by such development, knowledge of the individual elemental units that constitute the much larger environment would be invaluable in any management or development scheme.

A review of the literature reveals that although considerable work has been done to generate data on processes within marine subsystems and materials response to these processes (a significant amount of work has been done on the nature of West African coasts for example), relatively little work has been done in respect of the integration of process analysis (atmospheric and marine subsystems) with materials response (terrestrial interface units) in the region. One such attempt, continental in scope, revealed the presence of four major coastal climatic regimes, three marine

sub-regimes and nine types of terrestrial inferfaces.[1/] Given its scope, the atmospheric and marine processes within this study were viewed on a mesoscale within which feature of mean annual motion were resolved at approximately 500 miles while terrestrial features were recognized at a resolution of 20 to 50 miles. The significance of the study is that it provides an excellent example of the steps required to transform purely technical and scientific data on the region's coastal environment into information that is useful to decision-makers and planners in the development of the regional sea. For coastal area management and development at national or local levels, the scale at which the processes referred to were resolved will be changed as may a number of other variables but, the general principles utilized in the transformation process will remain essentially unchanged.

Until the creation of coastal metropolises in the region, coastal areas were generally sparsely populated with the overwhelming proportion of coastal ethnic groups engaged in fishing, trading or farming. Now, however, the coastal areas are among the most densely populated areas in the region and, with most of the capital cities located in them, contain socio-economically, some of the most technological groupings within the region. The opportunity to channel recently acquired technological ability into the productive areas of the coastal economy though enormous, has hardly been exploited. Coastal lagoons, with their capability to support aquaculture in certain cases and to serve as a means of transportation between countries in yet others, have until now been barely utilized.

1/ Classification of the coastal environments of the world. Part II Africa. Technical Report No. 3. Office of Naval Research Geography Programs, U.S. Government, February 1973.

B. Geography of the Coastal Area

Extending from Mauritania in the northwest to Angola in the south, along the Gulf of Guinea, marine, terrestrial and atmospheric processes have created coastal areas rich in resources both living and non-living that have contributed significantly to the region's development.

From the northern coast of Senegal to Dakar, marine trade winds, the dominant longshore drift and powerful waves, backed by the greatest fetch of open water of the Atlantic, are smoothing a low sandy shore (Figure 1). Within this section of the coast, the Senegal and Saloum estuaries are obstructed by variable sandspits behind which are relic lagoons. The head of the Senegal delta divides into several distributaries, especially when in flood. The City of St. Louis, on an islet (2,195m by 320m) contains in its southern settlement of Guet N'Dar one of the largest fishing centres in West Africa. The same factors which are responsible for diverting the Senegal river mouth and for making the unstable Langue de Barbarie sanspit, have made the smooth coastline of Cayor. Dunes rising up to over 40m (130 ft.) extend up to 24 km. (15 miles) inland. Between the dunes and parallel to the coast are the marshy depressions or niayes (meaning clumps of oil palm). In the south, extending up to the Cape Verde peninsula, some lakes are saline and frequently invaded by the sea (e.g. Lake Retba).1/

From the Saloum river estuary to Cape St. Ann in Southern Sierra Leone (Figure 3), the coast and river estuaries have been drowned and this

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1/ The Cape Verde peninsula is itself formed of a group of volcanic islands attached to the continent by peninsulas of sand. It offers many natural harbours. The port of Dakar in the southern part of the peninsula has a deepwater roadstead which is one of the best in all of West Africa.

stretch of coast is thus a ria coastline. Recent marine transgressions which drowned the lowest reaches of the rivers have created good waterways off the coasts of Guinea-Bissau and Guinea. Off Guinea-Bissau, there are some sixty islands; some of which adjoin the mainland, and are connected at low tide (12 ft.) by recently developed lateritic rock. The Bissajos islands further out, were doubtlessly separated from the mainland in the same way. Drowning of rivers with such gentle gradients in this section of the region, has contributed to the slackening of flow and silting of their lower courses. In these areas, since there is no constant longshore drift, and the tidal range is high, sandbars or lagoons do not readily form. Mudflats with mangroves, however, form readily in the estuaries off Guinea-Bissau, Guinea and Sierra Leone.[1/] In Sierra Leon, coastal swamps which average some 32 km. (20 miles) in width, are well defined because of the heavy rainfall (over 3,175mm-125 in.), which falls on a flat and low lying area where much of the sub-soil is clay or sand. The coastal swamps have alternating bands of gravels, grits, sands and clays.

The southern coast of Sierra Leone and the coast of Liberia are characterized by a northwest trending sandspit, which seems to be helped by a tidal range lower than that up north (Figure 2). Along Sierra Leone's southern coast are large areas of coarse marine sand ridges which are relics of former beaches. Lacustrine, lagoon, estuarine,

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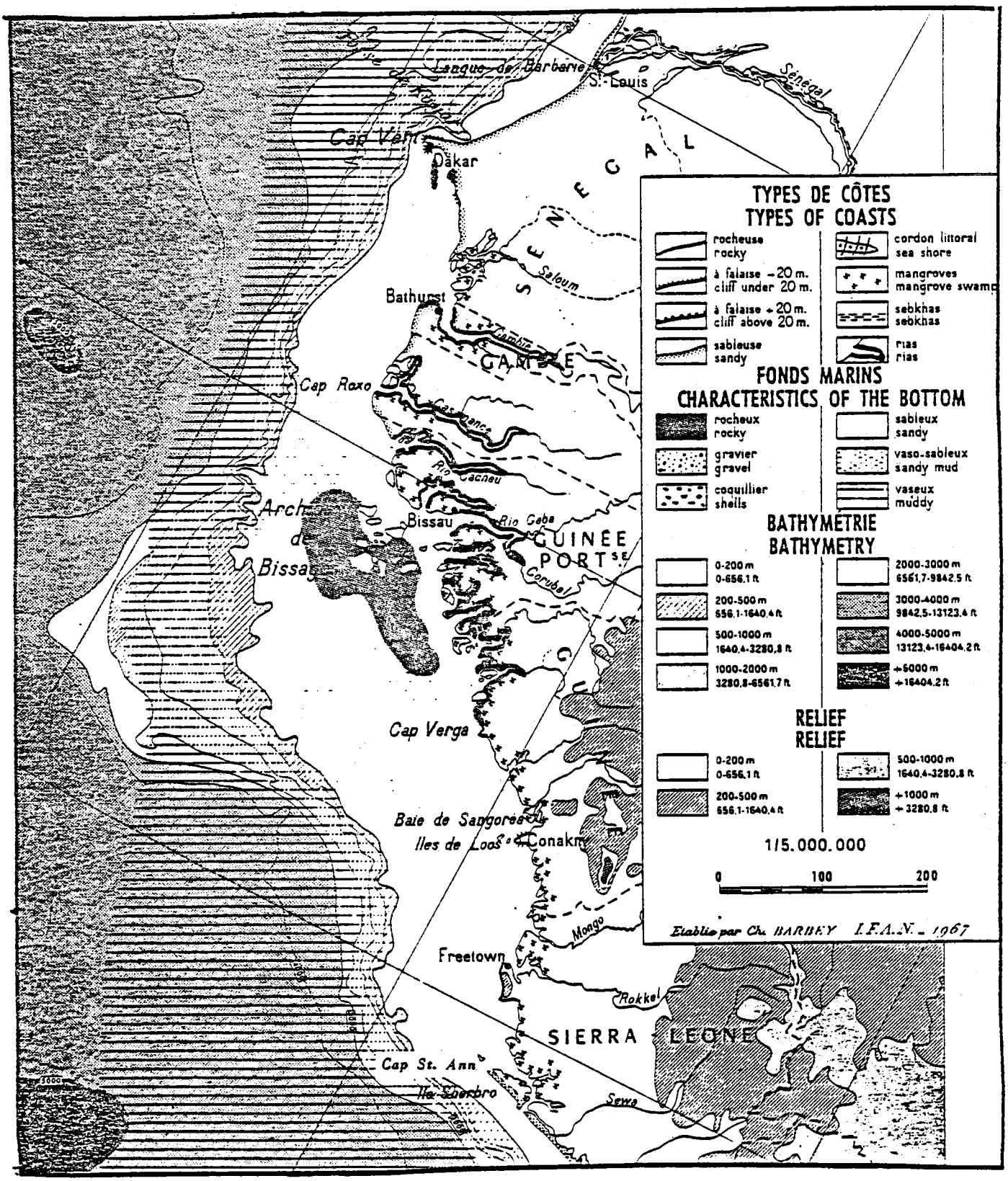
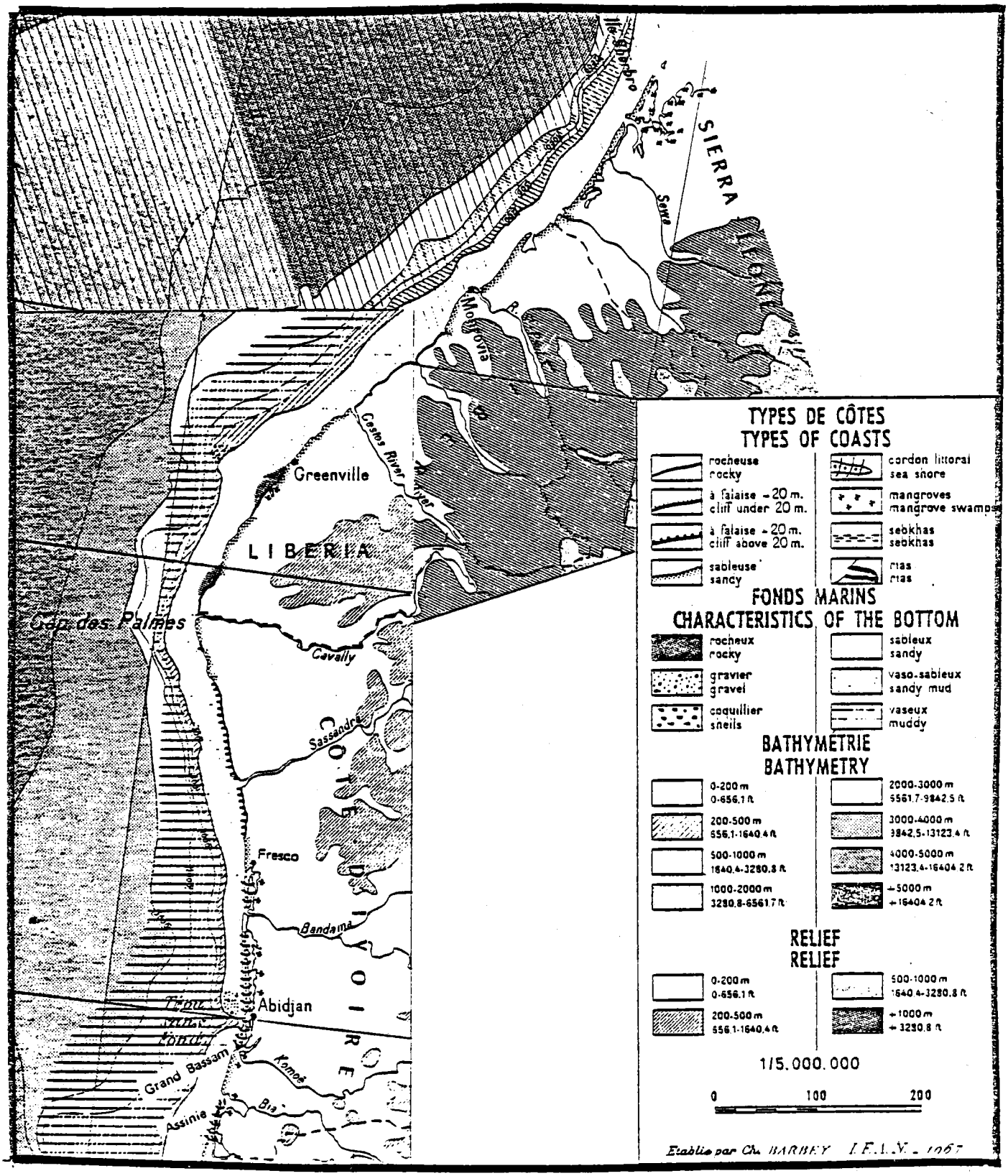
1/ In the Guinea-Bissau, the coastal region is composed on low plains which are badly drained. These plains are watered by rivers emptying into the Atlantic in deep estuaries in the form of fjords. As noted, even though these "Southern Rivers" offer excellent natural harbours, access to them is difficult because of the great expanse of mangrove. This situation is generally duplicated in Guinea and Sierra Leone.



Source : International Atlas of West Africa. O.A.U. Scientific, Technical and Research Commission. 1967

Figure 1: Coastline from the Senegal river to Sherbro island



Source : International Atlas of West Africa, O.A.U. Scientific, Technical and Research Commission. 1967

Figure 2: Coastline from the Sewa river to the Bia river

deltaic and marine conditions have widely occurred in recent geological times.[1/] In Liberia, the coastal plain is about 15-55 km. (10-15 miles) wide and has a forest-savannah mosaic of patches of forest and low bush, with gallery forests along the rivers, mangrove swamps, clusters of thorny bush, and grasslands with some oil palm and dwarf trees.

From the eastern border of Liberia (Cape Palmas), as far east as Fresco in the Ivory Coast, the coast is characterized by low cliffs, averaging 60 m. (200 ft.) in height, with rocky points and intervening sandy bays similar to much of the Ghana coast further eastwards. The western shore of the Ivory Coast and the central part of Ghana have only moderate coastal accumulation. The change in the orientation of the coast in relation to waves of maximum fetch in this area, results in movement away from Cape Three Points. Both coasts have occasional small but abrupt rocky promontories which, in the case of Ghana, provided little shelter for ocean going vessels. From the centre of the Ivory Coast shoreline (Fresco) to Cape Three Points, and again from West of the Volta delta to east of the Niger river, the coasts have suffered submergence. They have been smoothened by continuous longshore drift under the action of heavy surf and are characterized by sandbars and lagoon formations. Yet erosion is or has been taking place at Assinie (Ivory Coast), Keta (Ghana), Grand Popo (Benin) and at Victoria Beach (Lagos). East of Fresco, the coast becomes smooth and sandy, with a long and ever increasing sandbar; this is broken by the Bandama river at Grand Lahou, by the Comoé at Grand Bassam, and by the Bia river and Aby lagoon

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1/ Freetown, capital of Sierra Leone, was founded in a well-known site on the Sierra Leone coastline. It stands on raised beaches at the northern end of the hilly peninsula, adjacent to which is a deep channel of the easily entered, sheltered and large estuary. Upstream at Pepel, is a deepwater loading installation.

at Assinie. The sandbar is everywhere bordered by lagoons on the landward side: on the north shore of the lagoons are tertiary marine and estuarine deposits. Near the Vridi canal at Abidjan is the Trou sans fond, a submarine trench considered a former valley of the Comoé and potentially important as a site for ocean thermal energy conversion (OTEC).

With an elevation of under 60m (200 ft.), the smooth coast from Ivory Coast continues as far as Axim in Ghana. Initially, there is a sandbar backed by the Ehy and Teads lagoons, into which the Tano river empties. Cretaceous-Eocene marine sands, with thin pebble beds and some limestone, lie behind the lagoons up to 16 km. (10 miles) inland. As in the Ivory Coast, oil and gas seepages are known to occur in these formations. Takoradi, further east was Ghana's first deepwater harbour built in the face of great difficulties. From Accra, the capital of Ghana, which lies in a seismically unstable zone (seventeen major and minor shocks since 1850) through to Togo and Benin, the coast is characterized by lowlands with numerous saline lagoons (Figure 3). Wide and rather ill-defined valleys of seasonal rivers cross the plains. Around the saline lagoons and up the Volta river are stunted mangroves. Marine and lagoonal fishing constitute the most important occupation.[1/] The lowlands are fairly productive, especially around the Keta lagoon. Keta, the town has suffered severely in the past from sea erosion. Much of it is built

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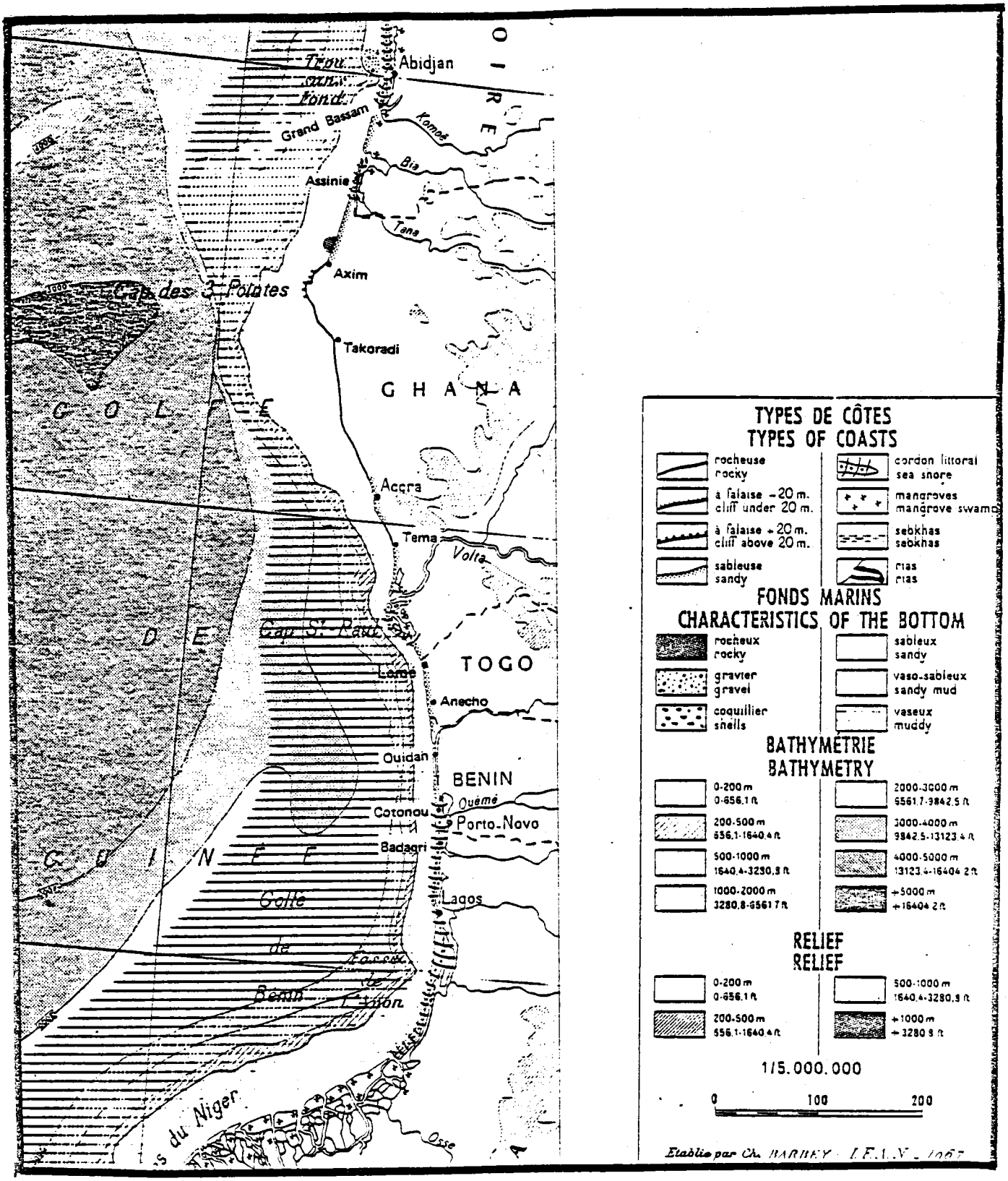
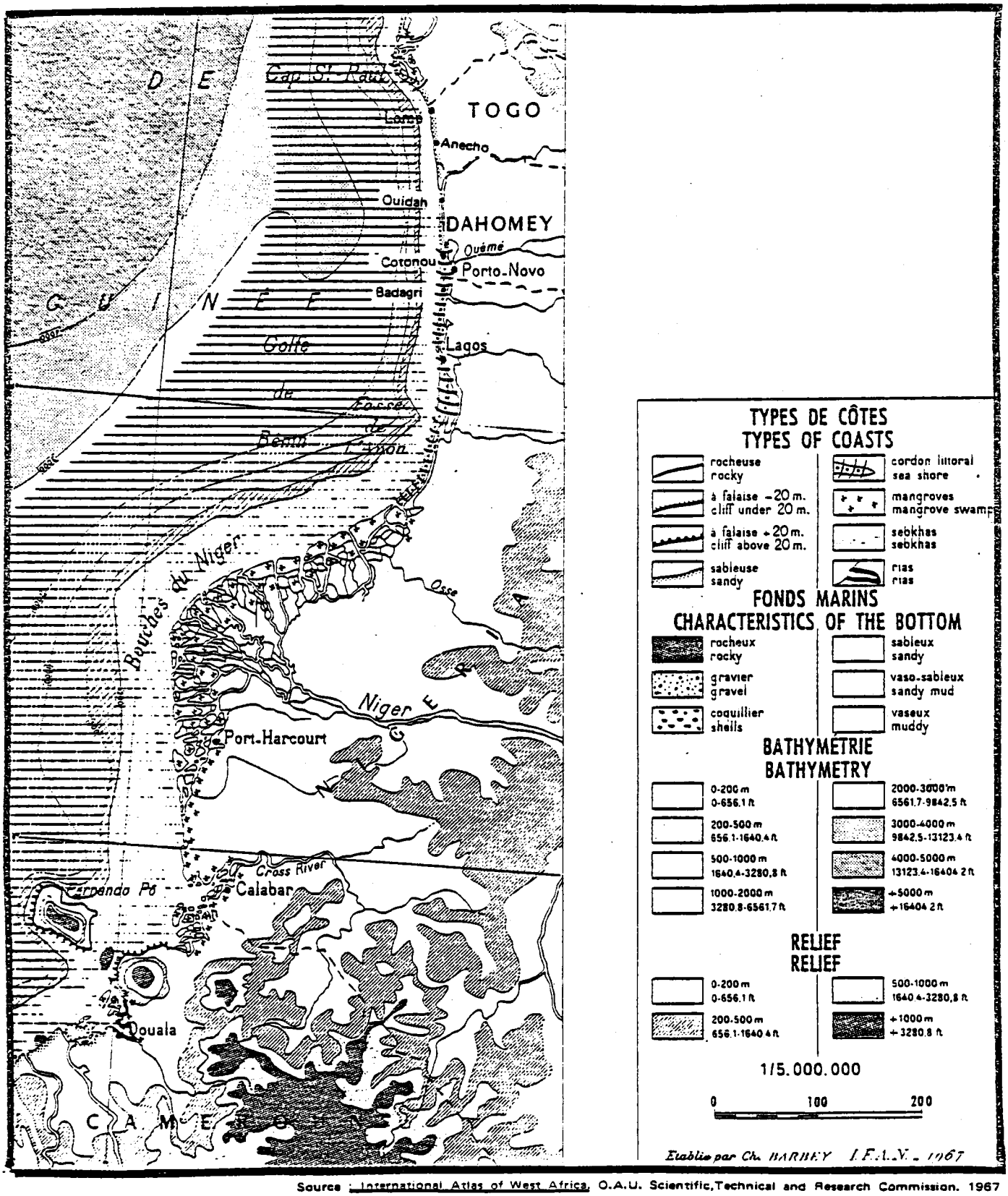
1/ East of Accra at Tema is Ghana's most modern port surrounded by numerous and diverse industries. North of Tema is the Akosombo dam in the Volta gorge of the Akwapim-Togo mountains. Behind this dam is a 400 km (250 mile) long lake which has flooded over 3 per cent of Ghana.



Source : International Atlas of West Africa. O.A.U. Scientific,Technical and Research Commission. 1967

Figure 3: Coastline from Abidjan to the Osse river



Source : International Atlas of West Africa, O.A.U. Scientific, Technical and Research Commission. 1967

Figure 4: Coastline from Cape St. Paul to Douala

on land reclaimed from the lagoon. Northeast of the Keta lagoon, the Terre de Barre has red clays derived from Eocene formations extending to Togo and Benin.

In both Togo and Benin, a smooth sandbar coast is backed by lagoons. In Togo, some of these lagoons extend deeply inland as lakes Togo and Ono. These lakes are former estuaries of the Chio, Joto and other rivers in Togo and of the Çuffo and Ouémé rivers in Benin. Since the late nineteenth century, the sandbar in Togo has been closely planted with coconut palms. Lomé, the capital of Togo, adjoins the Ghana border. Anecho (Petit Popo), near the Benin border, lies more on the southern shore of the lagoon than on the coast. Along the Benin coast, between Ouidah and Cotonou, the extremely dry Accra-Togo coastal climate comes to an end. Sandbar coasts and lagoons characterize this coast and are well developed. The lagoon system here is continuous from Togo to Nigeria. In the west they are narrow, the first being very near the sea; in the east they are broader and deeper. The Porto-Novo lagoon provides a direct waterway to Lagos, but is impaired economically by the international boundary which crosses it. Lake Nokoué, formerly part of the estuary of the Ouémé river has suffered from great siltation resulting in a division of the river into two parts--the Zou and the Ouémé proper. Between them is the well-populated delta with potential for the development of palm, rice and maize. There are two outlets to the sea; the Bouché du Roi east of Grand Popo where erosion continues, and the other from Lake Nokoué at Cotonou, where deposition formerly occurred. The construction of the deepwater harbour of Cotonou, west of the outlet of Lake Nokoué, resulted in a backwash of seawater into the lake.[1/] On both sides of the sandbar agriculture

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1/ The consequences were that stilt supports of lake houses in Lake Nokoué were destroyed and fish died out. Lake fishermen generally either took to sea fishing or migrated to the towns.

flourishes. Many former lagoons have become partly silted especially west of Cotonou. These marshes have the capability to support a range of potential agricultural commodities.

South of the Porto-Novo Creek or Victoria lagoon to Lagos, is the excellent lagoonal waterway previously referred to. South of the Porto-Novo lagoon, are recurved spit ends, shaped by eastward moving material. South of the recurves are subparallel sand ridges, separated by strips of former swamp mud-vegetation. Between the subparallel sand ridges and the sea is a broad belt of sand, terminating in the surf beach. The sandbelt has fishing villages and coconut plantations in Benin. Just west of Badagri the subparallel sand ridges end abruptly marking a former breakthrough between creek and coast. Consequently, in the Badagri area, the outer sand belt is backed immediately by recurved spit ends. Three miles east of Badagri, the recurved spit ends cease, and, consequently, as far as Lagos there is only a comparatively narrow and geologically recent sand belt.

Lagos, the capital of Nigeria, is the most populous and best equipped port in Nigeria. The broad and calm Lagos lagoon, with several islands, a permanently open outlet to the sea, fed by the Ogun river and enfringed with mangroves, affords many development advantages if properly managed. The historical development of Lagos as a major port capital has resulted in a number of difficulties which are now part of a newly devised "metropolitan plan for Lagos".

The magnificent example of a delta, that of the Niger, may be taken to begin 100 km. (62 miles) east of Lagos. Surf, sand, palms and undergrowth give way to smooth water running over a wide mudflat with mangrove and swamp. This great change coincides with a south eastward turn in the direction of the coast.

Instead of an easterly longshore drift, there is a northwesterly one on the west side of the delta. The rivers Benin, Escravos and Forcados, unobstructed by sandspits, are nevertheless increasingly impaired by large submerged bars, that in the Forcados mouth for example, are currently several times larger than in 1900. Until the depth of the navigable channel here decreased, goods bound for Lagos were trans-shipped here. When problems with the channel arose, Escravos was developed. The Escravos entrance, however, requires a longer journey for ships headed for Burutu and Sapele though a shorter journey for those using Koko. Forcados has now been developed as an oil terminal. In addition to the many mouths of the delta, there is a continuous line of creeks and lagoons from the Pennington river northwestward via Forcados, Epe and Lagos to Porto-Novo in Benin. This provides a calm inland waterway for small vessels though obstruction by water vegetation occurs in some parts of the creek-lagoon waterway. On the landward or inner side of this waterway, freshwater swamp vegetation is found while on the seaward side, mangrove is cut for tanning material, constructional timber and fuel. Swamp rice cultivation is developing where the salt content of the soil is low. Further along east of Forcados, mangrove vegetation is luxuriant and swamps are widespread. Fish are the main resource. - Bonny, a major mineral oil export terminal occurs in an area of low population density.

Port Harcourt, up the Bonny River, at the limit of the mangrove area marks an area of dry land. It is Nigeria's second port and centre of the eastern oilfields of the country. East of the delta a sandspit coast is again developed but, lagoons are ill-developed and creeks take their place. Calabar lies 77 km. (48 miles) up the Calabar river, a tributary of the cross river.

C. Classification Schemes for the Region's Coastal Environment

The region's coastal environment offers a variety of attributes which, if properly managed, can contribute significantly to its socio-economic development. Though particular aspects of these attributes have been the subjects of individual study, very little has been done by way of examining the interactions between the major components of this environment (atmospheric, marine and terrestrial) and consequently, of identifying homogenous segments of the coastal environment for management and development purposes. On the basis of available data, Hayden et al.[1/] have developed the only comprehensive classification scheme for the region. Although from the standpoint of scale, the results of this study are not very useful for local management and development problems, they do, however, provide a basis for future work in this field in the region.

In their study, the atmospheric component of the environment or the operating climatic regimes were delineated by air mass analysis. Data analyzed included the dominant air masses, their seasonality, tracking surfaces and confluence of airstreams in the coastal zone. A tabulation of these results for the region is presented below. In all, they identified four major regimes for the region.

Regime 1 encompassed Senegal, Gambia, Sierra Leone and Liberia. Regime 2 encompassed Ivory Coast, Ghana, Togo, Benin, Nigeria, and a section of the extreme North West of Cameroon. Regime 3 encompassed Cameroon, Equatorial

1/ Op. Cit.

Guinea, Gabon, Congo, Zaire and portions of Angola. Regime 4 covered the remaining portions of Angola and Namibia.

Table 1: Characteristics of the Climatic Regimes of the Region

Regime	Seasonality	Air Mass Type	Surface Track	Airstream Confluences
1	Subdominant	Continental tropical/Maritime Equatorial	Continental/ Marine	Divergent/ Convergent
2	Dominant	Maritime Equatorial	Marine	Convergent
3	Subdominant	Maritime Polar	Marine	Divergent/ Convergent
4	Subdominant	Maritime Polar/ Continental tropical	Continental	Divergent

Source: Hayden et al

For the marine component, subregimes were delineated through the analysis of water masses. Since synoptic data sets were unavailable, water masses were identified by two properties -- salinity and temperature -- while taking into account complications created by upwelling and continental run-off. Their results are summarized below:

Table 2: Sea Surface Characteristics of the Region

Subregime	Month	Mean T (^{o}F)	Mean Salinity(0/100)	Mean Density
A	February August	66^{o} 58^{o}	35.00 35.25	1.02535 1.02635
B	February August	82^{o} 77^{o}	34.00 34.25	1.02200 1.02250
C	February August	77^{o} 68^{o}	34.75 35.25	1.02300 1.02475
D	February August	64^{o} 73^{o}	36.50 36.25	1.02660 1.02540

Source: Hayden et al

In all, they identified four marine subregimes in the region.

Coastal interface characteristics were developed by determining the relative configuration of the mainland material with respect to the open ocean (i.e. whether the interface between the mainland and open ocean is direct, mainland interface , whether a linear mass parallels the mainland, barrier interface or whether the interface is interrupted by a fluvial discharge and associated land forms, riverine interface), the chemical composition of the interface material (living organic or inorganic) and the relative particle size of the interface material. In all they identified nine interface types depicted in figure 2 and summarized below in Table 3:

Table 3: Occurrence of Interface Types in the Region

Interface Class	Descriptive Example
A1a	Swamp
A2a	Mudflat
A2b	Sand Coast
A2d	Rock Coast
A2b/A2d	Sand Beach/Rock Hdld
A2d/A2b	Pocket Beach
B2b	Barrier Island
C1a	Swamp Delta
C2b	Sand Delta

Source: Hayden et al.

The superimposition of regime and subregime boundaries on the interface units results in distinguishing individual coastal segments with specific sets of characteristics distinct from adjacent segments, but which may repeat further along the coast. These distinct characteristics are important in developmental activities within the coastal area because they provide scientific guidelines on the suitability of particular segments of this zone for developmental activities.

III. REGIONAL NATURAL RESOURCE INVENTORY

A. Perspectives

Though resource inventories are far from complete, at the present time, it may safely be said that the collective wealth or means for producing wealth in the region under study is considerable. The region, with its many and varied problems, is very well endowed (in range as well) in mineral resources and contains substantial quantities of fuel and energy resources. In the realm of living resources, it is by no means impoverished either in variety or stock of terrestrial and marine flora and fauna. These facts suggested that if this resource inventory was not closely aligned to the purpose of the study, it would result in compilations which were beyond the scope of this report. Stated another way, an inventory of terrestrial flora alone for the zone would embrace discussions on over eight thousand (8,000) species, belonging to over two hundred (200) families and some eighteen hundred (1800) genera. Obviously then, an exhaustive literature survey on the zone's stock of natural resources would be impossible in the scope of this study.

Certain factors, however, loom dominantly in any consideration. Agriculture, for one, is undoubtedly the present and future mainstay of the economies of most of the countries in the region and has to be taken into account in one form or another in a resource inventory. By themselves, the coastal areas of the region are not the most important agricultural areas though they have the ability, collectively, to support a wide range of agricultural pursuits. In undertaking this survey, therefore, a basic question that arose was how agriculture and the potential for it could be accounted for and how to relate to the coastal area.

Factors such as crop zones and scarcities associated with them, population distribution and the impact of urban migration on the primate cities were a few of those factors deemed to carry significant weight in the manner in which agricultural resources were treated in this section.

Mineral resources, especially high value minerals destined for export, in so far as they tend to (a) generate significant infrastructural development such as railway lines and townships and (b) result in the construction of special port facilities or in the expansion of ports, are considered in the report. Though it would be hoped that during the present decade a greater proportion of the minerals produced would be processed and consumed within the region, the absence of effective linkages between mineral production and its consumption, regionally, suggests that their importance vis-a-vis the coastal area and the overall environment will be related to the considerations above. In this connection, therefore, deposits very far inland, including the landlocked states were also considered.

Ports and harbours are considered for two reasons: first, the relative absence of natural harbours and the expense associated with the construction of new ports and harbours attests to the relative value of natural harbours; second, the expansion of an old harbour or the construction of an artificial one generally results in physical modifications of the coastline the effects of which, if not anticipated and properly accounted for, can result in high costs to society.

The energy potential of the coastal and marine environment in West Africa is very large. Though oil and natural gas exploration is fairly recent, there are presently five net oil exporters among the countries of the region. Prospects for oil and natural gas finds offshore West Africa range from fair to excellent in almost all the countries. The ocean thermal energy gradient in the region, fairly close to shore, is also significant and is discussed fairly extensively in an accompanying document.[1/] The negative impacts and potential for environmental degradation arising from poor planning and management of these resources are discussed elsewhere in this series.[2/]

Fisheries and their development in the region are also considered in this section. Major issues as far as these resources, center around increasing the productivity of the socio-economic groupings involved in this industry while decreasing the illegal outflow of the region's resources by foreign vessels and fleets.

1/ UNIDESA/UNEP: Ocean energy potential of the West African Region. UNEP Regional Seas Reports and Studies No. 30. UNEP, 1983.

2/ UNDIESA/UNEP: Onshore impact of offshore oil and natural gas development in the West African Region. UNEP Regional Seas Reports and Studies No. 33. UNEP, 1984.

B. Agriculture

1. Regional considerations

Agricultural pursuits form the basis of almost all the lives of the peoples in the region. In fame and daily significance, a rough classification of collected produce and crops would yield:

(a) Oily fruits - Oil palms, coconut, sheanut, and benniseed;

(b) Cereals - rice, maize, guinea corn, millet and minor cereals;

(c) Roots - cassava, yams, cocoyams, sweet potato, ginger and tiger nuts;

(d) Edible fruits - including the indirectly used fruits of cocoa and coffee (cash crops), and tree fruits such as mango, papaw, orange, lime grapefruit, banana, plantain and pineapple;

(e) Vegetables - groundnuts (used as an oil seed), peas, beans, melons etc. and

(f) Cash crops - other than coffee and cocoa, rubber, sugar cane and tobacco.

Regionally, mainly reflecting climatic and soil differences, zones within which certain crops are characteristic and common may be distinguished. For example, the seasonal distribution of rainfall is especially significant in the production of kola nuts (at least 50 inches of annual rainfall) while maize can thrive on 30 inches of rain but requires soils of more than average richness. On local levels, where edaphic, sociological and economic factors may be more significant, variations to these regional patterns do occur.

Purely economic factors affect crop distribution in the region. Proximity to transport is a powerful determinant of cash crop cultivation. Groundnuts, shelled or unshelled, have a lower value per unit of weight than cocoa so while the latter may be transported by road, the former requires lower cost bulk transport routes such as railways or inland waterways. Crops grown for a standardized article or which need processing, such as the oil palm, coffee and fruits, are best grown in conditions which encourage economies of scale. They are subsequently best cultivated on plantations. In some of the countries, notably the former British colonies, plantations, though permitted, were not encouraged substantially. In the recent past, though many plantations have been established in these areas, the managerial skill for maintaining and/or increasing productivity in them has been in want.

World shortages of certain foods led to trials of mechanized farming of groundnuts in areas such as Kaffrine and Sédhiou in Senegal and of rice in areas in the inland Niger Delta of the Mali Republic. These trials which resulted in limited successes, were hampered by a variety of factors such as the lack of managerial skills, supervision, maintenance, and improper estimation of spares. Areas, obviously most suitable for mechanical cultivation are moderately or thinly populated savanna areas, where present productivity of the land is limited by the amount of hoe cultivation possible just before and during the rainy season. The physical suitability of these areas for mechanized farming must, however, be tempered with the edaphic conditions. For example, a growing body of evidence suggests

that the hoe traditionally used within the region (with its blade set acutely to the handle for light soils and nearer to a right angle for heavy soils) though laborious to use and capable of cultivating only a small area, is well adapted to African soils as it works only on the richer top layer. Deep ploughing is dangerous, bringing up poorer soils and loosening the ground. Mechanized farming equipment for these areas would have to be adapted to account for these types of conditions.

Livestock zones are also clearly defined. For cattle, this zone is especially determined by the tsétse fly, which, so far, has made it virtually impossible to keep Zebu cattle in the southern reaches of the zone. The southern reaches have thus been unable to develop mixed farming though their heavily leached soils would greatly benefit from manure enrichment. The north, freer of the tsetse fly, is the great cattle subregion of the zone. From here, there is a considerable trade to the south. If the tsetse fly danger of the south's wet season could be overcome, cattle movements should no longer be necessary. The Fulani and other groups might become more settled and sedentary crop-farmers might also take to cattle keeping. Cultivated areas would be extended since both soil and man would be enriched.

The economic state of many of the countries restricted marine fishing in the past in as much as capital was insufficient and many of the countries could not build fishing vessels larger than canoes. Inland fishing mostly in daylight hours and characterized by small returns is common. Canoes, often powered by outboard motors, still

constitute the major technological grouping. Fishing, off Mauritania, Senegal, the Ivory Coast, Ghana and Nigeria account for about three quarters of fish caught in the region. Processing depots at Nouadhibou (Port Etienne), Dakar, Monrovia, Abidjan, Tema and Lagos freeze tuna and other fish and do a little canning. Dried fish play a considerable part in trade especially south of 10°N where the tsetse fly prevents cattle farming.

The extensive lagoons of the eastern coast of the region are rich in small fish where the lagoons have not been victims of man-induced physical and chemical modifications. These are mainly caught by nets and elaborate mazes of wicker over considerable areas of the lagoons and especially in Benin.

2. Vegetation and Scoio-economic Objectives

The survival of the region's rain forest beyond another century has been assessed as very doubtful while the woodland zone has been severely degraded. The forests, for example, are being felled to provide space for food crops and cash crops. The former to meet the nutritional needs of the rising population and the latter to generate capital for industrial

development. The rainforests, though, are considered to be very important in the ecological balance of the region. It is felt that among other things, they contribute significantly to relative humidity and rainfall in the region and that by removing them, transpiration from the trees is lost, changing a delicate balance between the temperatures of the land and the contribution of transpiration processes to relative humidity and rainfall. Aubreville 1/ considers that rainforests are responsible for replenishing the southwesterly winds with moisture, without which the savannas would have less rain, lower relative humidity and a shorter rainy season. Each inroad into the frailer parts of the rainforest result in a freer path to the desiccating Harmattan winds. Evidence of this exists in the Ghana coastal scrub and on the Jos Plateau. Removal of the forests is also associated with a modification of the drainage pattern and soil erosion. Finally, the removal of natural vegetation, followed by prolonged over-farming is known to have impoverished several areas (between Dakar and St. Louis in Senegal, southern Sierra Leone, Koforidua in Ghana and heavily populated areas of Onitsha and Owerri provinces in Nigeria).

Selective protection of these resources is paramount for on them depends the very continuance of the basis of West African economy--agriculture. Building and some fuel needs require wood. At the same time, land is needed to feed more people and grow more crops for export. The issues can be resolved only by utilizing available information more fruitfully, generating data on phenomena that are not well understood and ensuring better farming on existing land.

1/ Aubréville, A. "Climats, forêts et desertification de l'Afrique tropicale", Paris 1959.

3. Soil management problems

The soils of the region vary widely in their characteristics and behaviour in relation to plant growth and in their response to various agricultural pursuits. Indigenous cultivation in tropical forests of the region is to a large extent a conservative form of land-use (only small patches are cultivated, cultivation lasts for only a short period, many large trees are not cleared thereby supplying considerable quantities of organic matter, and finally, a significant portion of forest clearing is undertaken with the intention of establishing more permanently managed ecosystems including cocoa, oil palm, coffee and rubber tree crops which are analagous to developed forests in respect of a number of basic ecological relationships) A similar argument may be developed in respect of indigenous cultivators in the Savanna areas. Furthermore, among the indigenous cultivators of the region, agricultural pursuits attain a high degree of sophistication with developed conservation methods, such as tie-ridging being used for soil conservation in savanna areas.

Economic increases in yield can, however, be obtained even in indigenous agriculture, by applications of fertilizers containing any major nutrient. This has been proven not only in experiments on government farms but also by extensive trails on farmers' plots. Response to fertilizers is, however, conditioned by the soil moisture regime and by the variety of crops grown. In most situations in the region, therefore, the effective use of fertilizer depends on parallel development of water control and on crop varieties which maximize the effects of improved husbandry techniques.

Fertilizer application in food crop cultivation is simple but with tree crops it must be undertaken in conjunction with programmes of pest control and combined with more efficient techniques of shading and propagation. The scope for the use of manufactured chemical fertilizers in the zone is tremendous. Since farmyard and green manures are not produced in quantities which are large enough to provide adequate and constant applications, the economic returns could be greater if the industries are located in the region.

Spatial patterns, which are discernible in the region on different rational development of agricultural resources can be built. Given adequate knowledge (local) of the soil character, and its satisfactory representation on an understandable map, the technical knowledge is available by means of which agriculture may develop from essentially indigenous systems to more ambitious ones. This would effect increased production from already productive areas, and ensure efficient development of areas not yet used.

4. Agricultural zones

In Casamance (southern Senegal), Guinea, Guinea-Bissau, Sierra Leone and the Ivory Coast west of the Bandama River (except for the Tabou District), the dominant food crop is generally rice, as it also is of the flood plains of major rivers in the Savannas. Highly appreciated in the region, rice cultivation is extending rapidly. Its special characteristics--high yield, few storage problems and subsequently a potential for markets lying a greater distance from production sources, tied in with continually increased consumption in large urban areas makes rice cultivation an excellent development opportunity. Rice, also tolerates compacted and acidic soils, grows in useless swamps, needs little fallow and

does not upset farm routine. Swamp rices are being cultivated in former mangrove swamps of the Gambia, Guinea-Bissau, Guinea and Sierra Leone and also in inland swamps and river flood plains. Since most of the countries still import large and increasing amounts of this cereal, it may pay to subject the question of rice needs to more detailed examination region-wide.

In the same section of coast, citrus fruits are grown in the upland areas where relative humidity is high, and in areas of high rainfall near the coast in the cassava, yams, maize and tree crops zone. Rubber is important in Liberia and plantations are found in the Ivory Coast, Ghana and the Mid-Western and South Eastern states of Nigeria.

The cassava, yams, maize and tree crops zone includes areas of former or actual rainforest with over 45 inches of rainfall annually. It occupies the coastal areas of Ivory Coast (east of the Bandama River), Ghana, Togo, Benin, Nigeria and the Cameroons. Forest, in this zone, is periodically cut up and burnt to provide plots.

Cassava withstands considerable drought and will grow on almost any soil. For this reason and because it exhausts the soil, it is normally the last crop in a rotation. Extensive cultivation of cassava near towns (e.g. Accra) has exhausted great areas.

Yams are generally the first crop in rotation and they are a fundamental food in this zone. Maize or corn grown outside the rice areas, are the chief cereal of the forest and savanna sub-regions.

Oil palm is indigenous to the swampy parts of the forests. The densest groves are not necessarily where the climatic and soil conditions are most favourable, but where population is or was considerable. Thus, there are many oil palms in southeastern Sierra Leone but fewer in Liberia; more originally in the Ivory Coast and Ghana (before cocoa became more profitable); in Benin and along

vegetable oil, used in cooking, in the making of soap and in many other ways. At several national and regional oil palm research stations, valuable work has been done in improving cultivation of the palm and in selecting and distributing better palms.

Cocoa is the most famous and valuable food crop in this region being grown almost entirely for export. It accounts for about 70.0 % of the total value of the exports of Ghana, and for significant percentages of those of the Ivory Coast, Togo and Nigeria. Requiring deep soils of heavy loam or light clay, rich in potash, and especially those derived from granites, diorites, schists and gneiss, it does not grow on light sandy soils such as those of Eastern Nigeria. Small farms (0.5 hectare) are typical in Ghana, Nigeria, Togo and Sierra Leone whilst in Ivory Coast and Liberia they are cultivated on large plantations. The cultivation of the tree in the region is beset with many problems including the fact that soils are somewhat exhausted in southeast Ghana, and in Abeokuta in Nigeria, that cocoa farmers tend to neglect valuable food crops (and distribution mechanisms for food crops are poor), and from swollen shoot the fungus disease of black pod and from attacks of capsid insects.

Coffee is indigenous to the continent and the region has a variety of crops. Coffee requires a fertile, well-drained undulating yet sheltered environment. It grows in the rainforest of the region up to latitude 8^{o} north. Species include arabica in Cameroon and Guinea, stenophylla in Sierra Leone, Liberica in Liberia, and Gros indénié in Ivory Coast. The Ivory Coast is the world's third largest

producer and its coffee is its greatest export by value. Guinea used to be a very significant producer of coffee.

Kola nuts (Cola nitida, cola acuminata) have been a very significant trade commodity in West Africa since the eleventh century. Requiring less fertile soil than cocoa, kola trees are extensively cultivated in the coastal areas and southeastern interior of Guinea, south central Sierra Leone, northern Ivory Coast, south central Ghana, southern Benin and the Agege--Abeokuta--Benin Belt of Nigeria. Kola nuts come in three colours; claret, pink or white and they have a somewhat similar effect to that of drinking coffee or tea.

Rubber exports, particularly certain species including the funtumia elastica vines were important up to World War I. High rainfall in Liberia encouraged the production of the Heva brasiliensis species. Plantations are significant in Liberia, the Ivory Coast, Ghana and Nigeria.

Coconuts require very well drained loamy soils or sandy soils, high rainfall and high relative humidity. Copra is produced from coconuts while their leaves are good thatching material. Significant plantations along the coast are found in Togo and Benin. Even though their cultivation could be extended along the Ivory Coast, Ghana and southwestern Nigeria coasts this is not currently actively pursued.

Bananas and plantains require deep, rich, loamy soils and between 40-100 inches of annual rainfall or irrigation. Because of their fragility, bananas need to be grown near good transportation routes (central Ivory Coast near Abidjan and Agboville), in Valleys of the

Fouta Djallon in Guinea and on its coast near Foré cariah and Benty.

Pineapples need sandy loam soils of low elevation, preferably near the sea and with moderate rainfall. Exports of pineapple in the region are from Guinea and the Ivory Coast.

Groundnut (Arachis hypogea) does best between 8° and 14°N in rich but sandy soils. The latter are essential, as the pod matures in the soil. There are two types of plants - the spreader or runner and the bunched or erect. Both are annual crops, the runner, however, is more common and has a better yield. On the other hand, the erect is more suitable for intercropping and for heavy red clay soils such as in Zaria, Nigeria. The export of groundnuts depends on cheap bulk transport, so that commercial cultivation is intensive in physically suitable areas near means of transport in Senegal, western Mali, southwestern Upper Volta, and especially in northern Nigeria north of an east-west line through Zaria and into Niger near its boundary with Nigeria.

Groundnuts account for about four-fifths of Senegal's exports, and almost all exports of Gambia. They represent significant sources of foreign exchange to Guinea-Bissau, Mali and Niger. Groundnut is a member of the pea family and inside each pod are two seeds which upon crushing yield an oil high valued for cooking and as a substitute for olive oil. The oil is also used in the manufacture of magarine and soap. The outer shell yields oil of poorer quality and can be used as fuel while the residue of the crushed nuts is excellent cattle cake. Groundnut yield is known to be highly

sensitive to the use of fertilizer (artificial or otherwise) put in with the seed.

Tobacco is very significant in the Cameroons where plantations are well developed. In south central Ivory Coast, Ghana and Nigeria where it is cultivated for the cigarette industry, plantations are not as well developed. Other significant food/cash crop in the coastal area are cocoyams, sugar cane, okro or gumba, pumpkins and beans.

C. Mineral Resource Development

1. Regional consideration

The significance of mineral resources and mineral resource development in different parts of the region has been and still is varied. As far back as the ninth century, historical literature indicates that trade in mineral resources, particularly gold and salt, helped catalyse a number of socio-economic activities that are thought to have provided the economic and political bases for at least three empires in the region. In fact, the search for mineral resources of the precious metal type constituted a major reason for subsequent foreign forays into the region.[1/]

As interest in the precious metals diminished and uses for other metals were developed, the emphasis of regional mineral exploration programmes and mineral resource development schemes were modified. Modern large-scale mechanized mining techniques were only introduced to the region in the latter part of the nineteenth century. Their introduction, coupled with the advent of self-determination in the region, has had a considerable effect on the relative fortunes and development of the countries in the region, and in the degree of importance each country assigns to mineral resource development.

The types of mineral resources amenable to large-scale mechanized mining techniques, the occurrence of which had been previously noted and which, therefore, became the primary suite of objectives of major exploration programmes in the region, were deposits in the iron and ferro-alloys group (iron and manganese), mineral fuels (uranium),

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1/ Basil Davidson, F. K. Buah, Ade Ajayi, "A history of West Africa to the nineteenth century".

non-ferrous industrial metals such as tin and bauxite, minor metals such as ilmenite and rutile, and non-metals such as phosphate rock and sulphur. The limited exploration programmes undertaken since the turn of the century, have revealed the presence of enormous quantities of bauxite and iron ore in several areas of the region, and significant quantities of manganese, diamonds, gold, uranium, columbium, marble, phosphate rock and salt.

The degree of importance each country assigns to its mineral resource development varies as much as the proven stock of mineral resources of the types described above and the availability of the necessary economic, social and political infrastructure. The significance of mineral resources, particularly if revenues from petroleum products are considered as part of this grouping is really marked in some of the countries of the region. This group of countries consists of Gabon, Nigeria, Liberia, Guinea, Angola, Sierre Leone and Togo and their economies are best described as mineral economies. Even if petroleum is not included, five out of the seven countries still have economies dominated by non-fuel mineral production (Liberia, Guinea, Angola, Sierra Leone and Togo). In general economic terms, the significance of the respective national non-fuel mineral industries in the region can be grouped as follows:

1. Very significant that is, the share of minerals in the gross domestic product in these countries, averaged 10 per cent or more during the period 1967-75 and accounted for 40 per cent or more of merchandise exports during the period 1973-76. Countries

falling within this grouping are Guinea, Liberia, Sierra Leone, the Congo and Togo. In the majority of these countries, mineral resource development is viewed as the desirable path for the industrialization of these countries.

2. Significant that is, though the economy is dominated by some other sector such as agriculture or petroleum, mineral production accounts for between five and ten per cent of gross domestic product or at least ten per cent of merchandise exports. The countries in this grouping include Gabon, Ghana, Niger, Senegal, and Angola.

3. Not significant that is, apart from small amounts of quarrying, mineral production is virtually non-existent. In these countries, mineral production accounts for less than five per cent of gross domestic product and less than one per cent of merchandise exports. The countries in this grouping include Benin, the Cape Verde Islands, Equatorial Guinea, Gambia and Guinea-Bissau.

4. Potentially significant this is a subset of the category above, but is differentiated from that group by the presence in these countries of a large stock of proven mineral reserves or the required intrastructure. Mineral production in these countries in future years could contribute significantly to gross domestic product (GDP) and merchandise exports respectively. In this group are Cameroon, Ivory Coast, Mali, Nigeria, and Upper Volta.

The potential role of mineral resource development in sound environmental management and resource utilization schemes in the region could be very significant. In the first instance, the development of mineral resources in the region has, by and large, determined the degree

to which the hinterland has been developed. Export oriented mineral development requires, among other things, a good transportation network to the coast and good port facilities to obtain the high returns from export sales. Many of the existing road and raillines were constructed to facilitate mineral transport to the coast. Several examples exist of past and current activity in this regard and include inter alia, (1) the railroad line constructed in Ghana between 1901 and 1902 linking the gold deposits of Obuasi and Prestea, and the diamond mines of Tarkwa with Takoradi, the port on the Western coast of Ghana constructed to serve this purpose. (2) The 936 kilometre Trans-Gabon railroad started in 1974 and being built to permit the development of the iron deposits at Belinga (566 million tons of sixty-five per cent Fe) and to allow for the expansion of manganese mining near Moanda. This railroad is, in turn, linked to the development of the mineral port at Santa Clara, 20 kilometres north of Libreville, with facilities for bulk ore carriers of up to 300,000 tons. (3) The four mineral railways of Liberia—the first constructed in 1951 linking ore production from the Bomi Hills deposits with Monrovia, the second (1961) along the Mano river, the third (1963) linking the Mt. Nimba reserves to Buchanan along the coast and the fourth linking the deposits of the Bong mountains with Monrovia. (4) The linkage of the bauxite deposits of Sangaredi and Boke (Guinea) by a 136 km. railroad to the port of Kamsar in Guinea. (5) The Congo-ocean railroad line which moves about five million tons of ore per year to Pointe Noire on the Atlantic coast of the Congo. Numerous other examples exist but the examples above illustrate the common denominator the majority of the countries in

the region share with respect to transportation and mineral resource development.

In almost all countries where the phenomenon above has taken place, the railroads invariably provide a means for transporting other items such as agricultural produce and, therefore, can catalyse agricultural development. In certain cases, services have been expanded to enable haulage of other items. In the case of Congo-Ocean railroad, for example, the original capacity of the line was two million tons of ore moved annually. In 1974, when the basic decision to expand the line to five million tons was made, a crucial factor was the associated increase in forest production and thus in revenues from forestry. Similar reasoning went into the decision making processes either at the outset or subsequently, in a number of other countries. These examples serve to illustrate the power of mineral development in opening up other resource utilization schemes in the region. In particular, they suggest that mineral lands containing export-type ore deposits, constitute a major determinant in the provision of transport links between other resources in-land in the region with the coastal area. Mineral resource development can, therefore, provide environmental managers in the region with a means of planning environmental development in the region in general terms.

At the level of the individual mine project, however, specific and unique environmental problems do occur. These problems, which vary throughout the region where mining occurs, depend on the nature and type of ore, the extent of ore beneficiation following its removal

from the ground, the methods used in its extraction, waste disposal practices, the ecological characteristics of the mining area, methods of transportation etc. The literature, on the subject for the region is, however, almost non-existent. It is common knowledge though that mining has greatly affected certain areas of the region in a negative fashion. On the Jos Plateau in Nigeria, for example, tin mining is known to have had severe environmental effects on the adjacent farm lands and discouraged farming. Tin deposits here, concentrated in former and present streambeds were covered in many places first by volcanic basalt and then by a layer of soft beds. Early methods of mining tin in this area consisted of using water to loosen the overburden, digging out the ore and then washing the dark coloured tin bearing gravels in calabashes along the rivers until the black tin oxide remained. After 1936, mechanical methods were introduced to increase ore production. Either a dragline was used to remove the gravels or a powerful water jet was directed at the ore to wash out the tin bearing gravels. In both cases, the gravels were concentrated by pumping the ore through sluice boxes. The resultant excavations and spoil dumps are known to have degraded the soils, destroyed farm lands (though compensation was paid), and silted the rivers. Farmers in the region were generally discouraged from farming as a result of this.

Tin is not the only metal the mining of which has resulted in environmental degradation in the region. 1/ Environmental problems exist with generally all the export-oriented minerals mined on a large scale in the region.

1/ In Sierre Leone, illicit mining of diamonds results in high grading deposits, the scarring of valleys and terraces leaving pockmarked, battlefield-like surfaces and ponds which become insect infested and disease ridden. River drainage has been impeded and increased sediment loads of streams have affected potable water supplies.

Bauxite, iron, manganese, and rutile mining are also known to have resulted in environmental degradation of one type or another in the region. In general, in any mineral development scheme, particularly large-scale projects, a number of environmental concerns need to be addressed during the design stage. Certain aspects are of necessity best dealt with by the mineral developers while others belong to the domain of government or regional planners.

2. Mineral production

In the order of their significance in terms of contribution to annual world production during the period 1970-76, the most important minerals produced in the region were diamonds (both gems and the industrial variety) which contributed an average of thirty-six and fourteen per cent respectively of world production during the period; manganese ore production, thirteen per cent of world output during the period; bauxite, over nine per cent per annum during the period; uranium, a little under seven per cent; iron ore, over four per cent of world output; phosphate rock, over three per cent, and gold, just under two per cent.

Table 4: summarizes mining activity in the region on the basis of mines producing at least 150,000 tonnes of ore per year. Large-scale environmental degradation associated with mining would, generally, but not necessarily, result from operations of this magnitude. Of the thirty large-scale operations, 66 2/3 per cent are open pit operations. Five of these are bauxite operations, four are iron ore mining operations, there are three each for uranium and phosphate rock and two for manganese. The remaining three consist of a lead and zinc mine, a tin operation and a tungsten operation.

Table 4: Major Producing Mines in the Region

COUNTRY	OPEN PITS						UNDERGROUND					
	Total	1	2	3	4	5	Total	1	2	3	4	5
Gabon	2	-	-	1	1	-	-	-	-	-	-	-
Ghana	2	-	2	-	-	-	3	1	1	-	1	-
Guinea	3	-	-	-	2	1	-	-	-	-	-	-
Liberia	4	-	-	-	-	4	-	-	-	-	-	-
Niger	1	-	-	-	1	-	1	-	-	1	-	-
Senegal	2	-	1	-	-	1	-	-	-	-	-	-
Sierra Leone	1	-	-	1	-	-	-	-	-	-	-	-
Namibia	4	-	1	2	-	1	6	2	2	1	1	-
Togo	1	-	-	-	1	-	-	-	-	-	-	-
Total	20	-	4	4	5	7	10	3	3	2	2	-

Source: Mining Magazine, January 1979

1 = 150,000 to 300,000 tonne/year 2 = 300,000 to 500,000 tonne/year

3 = 500,000 to 1 million tonne/year 4 = 1 to 3 million tonne/year

5 = Greater than 3 million tonne/year.

Of the ten underground operations, five produce copper in association with either silver, lead or zinc, three produce gold, one uranium and the last one, zinc in association with lead and vanadium.

D. PORTS AND HARBOURS

Ports and harbours as transportation access facilities for maritime activities are of such fundamental importance to socio-economic development of West African region that a survey of their specific role and scope will reveal significant features in land use planning in the region.

The specific characteristics of the coastal area of the region, as noted in section II. must however, be borne in mind. The coastal area, is one in the region where access by sea is hampered by the prevalence of longshore bars, silted river channels, heavy movement of sand and the general absence of indentations. The inland waterways are navigable only with difficulty; even the better waterways are usually troubled with great seasonal fluctuations, shifting channels and interrupting rapids.

The growth of traffic at ports has been extremely rapid, easily outpacing the rate of ports and harbour development, and even reaching crisis proportions as was the case in Nigeria's ports during the period 1975-76. With a continued rise in the level of traffic at ports and the increased search for petroleum reserves off the coast of West Africa, the problems associated with port and harbour development become more complex. Port development, for example, presents diverse problems in environmental management, further excerbated by its attraction of other socio-economic activities as a result of the infrastructure and services it provides.

Therefore, land use planning for the development of ports and harbour facilities must consider the various features which such development induces with regard to environmental management. The problem of environmental management will arise as a result of the interaction of diverse socio-economic activities that are drawn together by the very provision of ports and harbours. The interactions of greatest concern are the generation of waste and waste products and the estimation of damage functions and their management. Again, natural resource linkages and interrelationships between plant location and urbanization issues, and as a result between transportation needs and environmental needs, call for certain parameters in the evaluation of land use planning in the development of ports and harbours.

The development of ports and harbours in West Africa must be an integral part of an overall development of transport infrastructure. It must relate to the development of road, rail and air transport routes as a ratio of total transportation requirements of the region.

Whatever future regional land use planning calls for in the development of ports and harbours, it must have as its basis the existing facilities, the current flow and the growth rate of traffic through the regions ports and harbours.

E. Petroleum and Natural Gas

For most of the countries in the region, petroleum and natural gas constitute the main, and in many cases the only, energy supply for the developed part of their economies. Aside from the five net oil exporters in the region (Table 10) the remaining countries import almost all of their oil requirements. The problems faced by these countries in obtaining the energy required to sustain acceptable levels of economic growth have greatly increased over the last few years due to higher prices. However, the relative costs of imported oil and domestically produced energy have drastically changed. For the oil importing countries the new level of petroleum prices has two principal implications:

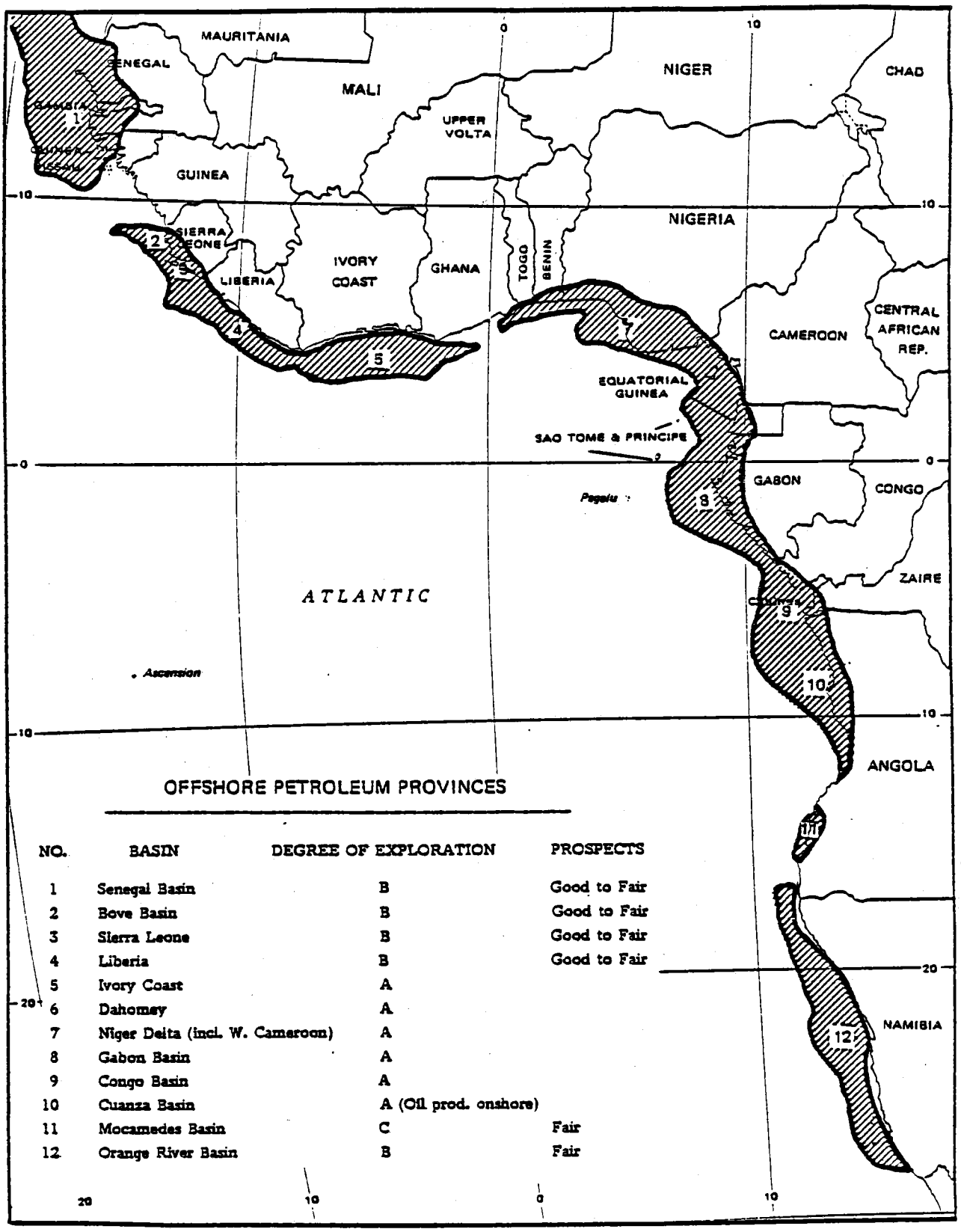
(1) In the short-term, given their very limited ability to conserve oil or to substitute other energy sources for petroleum, they must continue to borrow the foreign funds needed in ever increasing quantities to finance oil imports or else to reduce their rate of economic growth.

(2) In the longer-term, at present crude oil prices, it is now economic for them:

(a) to develop domestic sources of petroleum that were regarded as uneconomic at pre-1973 prices, and to endeavour to expand their known reserves;

(b) to expand the provision of energy from alternative sources in order to substitute for petroleum-based energy supplies.

With respect to developing domestic sources of petroleum and natural gas, Table 6 summarizes the potential for further oil and gas discoveries by country in the region. Within almost all countries in the region, the most promising areas are the sedimentary basins found offshore (Figure 5). The potential impact of



NO.	BASIN	DEGREE OF EXPLORATION	PROSPECTS
1	Senegal Basin	B	Good to Fair
2	Bove Basin	B	Good to Fair
3	Sierra Leone	B	Good to Fair
4	Liberia	B	Good to Fair
5	Ivory Coast	A	
6	Dahomey	A	
7	Niger Delta (incl. W. Cameroon)	A	
8	Gabon Basin	A	
9	Congo Basin	A	
10	Cuanza Basin	A (Oil prod. onshore)	
11	Mocamedes Basin	C	Fair
12	Orange River Basin	B	Fair

Sources : World Oil, Oil and Gas journal and The World Energy Conference.

Figure 5: Offshore petroleum provinces of the Region

offshore oil and gas development on coastal zone management and development is, however, considerably complex and forms one of the series of reports included in the overview studies.[1/] The sedimentary basins of relevance occur along the entire coastline of the region and include: the Senegal basin, Bove basin (or the former Portuguese Guinea Bassan), the areas offshore Sierra Leone (where there is no basin), Liberia, Ivory Coast and Ghana, the Niger Delta (including W. Cameroon), the Gabon basin, Congo basin, Cuanza basin (where oil production also occurs onshore), the Mocamedes basin, and the Orange river basin.

Table 7 summarizes available data with respect to regional reserves, annual production and refinery capacities. Dependent on further discoveries of oil and gas, all figures are subject to fairly rapid change. Including refineries under construction, there are currently fourteen refineries in the region, all located in coastal areas and all releasing varying quantities of toxic wastes into the environment. In a recent study on rapid assessment of water and air pollution sources in Abidjan, Ivory Coast, the safe disposal of oil sludges containing tetranaethyl lead produced as waste from the refinery (3,000 tonnes/yr.) constitutes perhaps the most significant solid wastes control problem for that coastal area environment.[2/] Potentially, therefore, oil and gas development and processing could create environmentally significant degradation if they are improperly planned and managed.

1/ UNDIESA/UNEP: Onshore impact of offshore oil and natural gas development in the West African Region. UNEP Regional Seas Reports and Studies No. 33. UNEP, 1934.

2/ "Rapid Assessment of Water and Air Pollution Sources in Abidjan, Ivory Coast" - Alex. Economo poulos Phd.

Table 5 Current Status of Oil and Gas Producers

Net Oil Exporters	Oil and Gas Producers	Potential Oil and Gas Producers
Nigeria 1/ Gabon 1/ Angola Congo Zaire	Cameroon 2/ Ghana 2/ Ivory Coast 2/	Benin Gambia Guinea-Bissau Guinea Liberia Niger Senegal Sierra Leone Togo

1/ Members of OPEC

2/ Recently joined the list of oil and gas producers.

Table 6 Potential for Further Oil and Gas Discoveries

Good to Very Good	Good	Fairly Good	Fair	Poor to Moderate
Angola	Zaire	Ivory Coast	Sao Tome and Principe	Upper Volta
Congo	Cameroon	Ghana	Equatorial Guinea	
		Benin	Togo	
			Senegal	
			Central African Empire	
			Gambia	
			Guinea	
			Mali	
			Niger	
			Sierra Leone	

Sources: Ocean Industry and World Bank

Table 7 Reserves, Production and Refining Capacity (at year end 1978)

COUNTRY	Reserves[1] (10^6 barrels)	Production[1] (10^3 bpd)	Refineries (1977) Location	Capacity in 000s metric tons
1. Angola	1,365	147	Cabinda	135
			Luanda	1,615
2. Cameroon	143[3]	12	-	-
3. Congo	746	47	Pointe Noire	NA
4. Gabon	467	210	Port Gentil	1,200
5. Ghana	NA	6	Tema	1,450
6. Ivory Coast	NA	NA[4]	Abidjan	1,850
7. Liberia	NA	NA	Monrovia	750
8. Nigeria	12,273	1,905	Port Harcourt	3,000
			Warri[2][5]	5,000
			Kaduna[6]	5,000
9. Senegal	NA	-	Dakar	750
10. Sierra Leone	NA	-	Freetown	700
11. Togo	NA	-	Lome[7]	1,000
12. Zaire	126	18	Muanda	850

1/ World Oil August 15, 1979

2/ World Energy Supplies 1972-1976

3/ Additional oil discoveries were made in 1979.

4/ Will join the ranks of oil and gas producers in 1980.

5/ Refinery in Warri was opened in October, 1978.

6/ Under construction. Production scheduled for 1980

7/ Refinery was inaugurated in January 1978.

F. Fishery Resources and Development

1. Regional Considerations

The primary consideration in the development of the fisheries of the region is the supply of food and the provision of employment in related industries including aquaculture, fish processing and marketing and in the construction of vessels for fishing. Developments at the Law of the Sea Conference and elsewhere have made the countries of the region highly conscious of the opportunities associated with the exploitation of resources in their extended zones of resource jurisdiction.

Despite deficient statistics -- a lot of small coastal fishermen do not keep figures of daily catches -- a survey of fish catch in the different countries of the region shows that sizeable amounts of fish are harvested in the area (see Table 8). Production figures show high harvests in Angola, Cameroon, Ghana, Ivory Coast, Nigeria, Namibia, Senegal, Sierra Leone and Zaire. Namibia with 761,000 metric tons in 1975 has the highest production figures. Despite the known fish resources off the Gulf of Guinea, however, production figures for the years 1970-1975-1976 do not show significant growth over the years.

Table 8 West Africa: Summary of Fish Catches

Country	'000 metric tons 1970	1975	1976
Angola	368.2	153.6	153.6
Benin	31.5	29.9	25.5
Cameroon	70.8	71.6	71.6
Congo	10.9	15.7	19.4
Equatorial Guinea	4.0	4.0	4.0
Gabon	2.9	6.1	6.1
Gambia	5.6	10.8	10.8
Ghana	171.5	254.5	237.7
Guinea	5.0	5.0	5.0
Guinea-Bissau	1.5	1.7	1.7
Ivory Coast	72.4	68.5	77.0
Liberia	14.7	16.6	16.6
Namibia	711.2	760.9	574.2
Nigeria	384.1	478.2	494.8
Sao Tome/Principe	N/A	N/A	N/A
Senegal	187.2	362.9	360.9
Sierra Leone	30.6	67.8	67.8
Togo	8.9	14.4	14.4
Zaire	136.6	113.4	117.4

Source: U.N. Statistical Yearbook

This could be misleading, as these figures do not accurately reflect the volume of catches made by "pirate" (foreign owned) vessels operating off the West African coastal areas. Introduction of modern fishing vessels as well as cold storage and processing facilities along the coastal areas will spur and aid increased production. This will further result in attracting fish processing industries, thus calling for appropriate land-use planning to offset environmental degradation.

There has always been considerable interest in fishing along many parts of the region's coast; some ethnic groups are almost solely devoted to this activity and many large coastal settlements depend on fishery related activities for their well being. More modern commercial operations (mostly dating only from the 1960s) now land larger tonnages than the traditional fisheries in many countries. The importance of fishing varies considerably from country to country. In Mauritania, fish exports rank second but well below iron ore (the fishing industry, like mining, is essentially an enclave activity). Senegal has seen a remarkable increase in fishing in the last decade and ocean products feature significantly among its exports. About 70 per cent of the catch is exported, including shrimp, of which it is Africa's leading producer. Domestic consumption is also high; the country ranks fifth in the world per capita use of fish. Gambia's catch is also increasing steadily and a new company is processing crabs, oysters, and lobsters.

Several of the countries tend to be net importers, though many export tuna and shrimp. Liberia, Ghana, Togo, and Benin have many communities engaged in fishing. In Ghana, fish consumption exceeds that of meat and the industry is credited with about 1.2 per cent of the GNP; nonetheless, it imports sizeable tonnages. Nigeria consumes the continent's largest quantities of fish, but imports about three-quarters of its needs. Foreign vessels play a significant role in sea fisheries, particularly in more distant waters for tuna.

The high demand for fish and the desirability of promoting their consumption to increase protein intake have stimulated efforts to rationalize the industry, though modernization sometimes adversely affects employment in the traditional sector.

As far as fishing itself is concerned, emphasis has been placed on the use of bigger boats, the introduction of powered vessels or outboard motors on pirogues, and the adoption of better and bigger nets, particularly shark, set, and encircling nets. A notable recent development has been the presence of tuna vessels from France, Spain, Japan, and the United States, which operate off practically the entire coast. Some of the regional countries are, however, beginning to operate their own tuna boats.

Provision of better port facilities for fishing vessels has received increased attention. Extensions were made to several ports in the last decade and new installations are planned in many countries in the years ahead. Modern fishing ports have been constructed at Nouadhibou, Dakar, Freetown, Monrovia, Abidjan (a port is scheduled for construction in San Pedro), Takoradi, Elmina, Tema, and Ada in Ghana, Lomé, Cotonou, and Lagos. Tawler and tuna fishing require large-scale and modern shore facilities, but any real improvement in any kind of ocean fishing requires better and safer port installations and trained personnel and management for the more modern fishing fleets envisioned.

2. Fisheries of the region

The region is known for the occurrence of large scale upwelling of deep nutrient laden water which contributes to high organic production and hence rich fisheries. Two types of upwelling have been recognized in the region; one caused by currents which contributes to permanent upwelling and the other induced by seasonal winds. The major areas of upwelling are as follows:

a. A permanent upwelling zone located near Senegal in the northwest where a frontal zone is developed from the southwardly moving cool Canary current;

b. Another permanent upwelling area is near the Republic of the Congo which is developed from the northward moving cool Benguella current;

c. Seasonal upwelling between Ivory Coast and Ghana during the months July-August.

In the region, organic production in general is related to geographic and temporal variations in the physical and chemical characteristics of the region. High productivity and hence rich fishery resources are linked with the following enrichment areas.

1. One along the coast from Senegal to Liberia particularly during February-March and the other from July-August. This is associated with the north-west frontal zone.

2. The other from Gabon to Congo from July-August and February-March linked with southern frontal zone referred to above.

3. A third region of high productivity is along the coast of Ghana-Ivory Coast.

4. High productivity is also known in the region of outflow of Zaire/ Congo river to a distance of about 300 miles.

The lagoons along the coast are also areas of high productivity. In general, high productivity in the lagoons is associated with the dry season when nutrients are concentrated. Productivity during floods or the rainy seasons is generally poor in the lagoons.

Fish and shrimp are the major resources of the region, although in some countries like Senegal, Sierra Leone, Nigeria and others edible molluscs from near shore areas are harvested in considerable quantity.

Pelagic fishes

The Pelagic fishes by far constitute the bulk of the fish resources of the region. Unlike other regions of the Atlantic, the deepwater resources from the mesopelagic and bathy pelagic areas of the Gulf of Guinea are as rich in number and species as those of the epipelagic zone. Lack of technological capability to harvest deep water resources by some countries probably serves as a limiting factor in the exploitation of these resources. Some of the important inshore species include sardines (Sardinella), anchovies (ANchoviella) bonga (Ethmalosa), mullets, threadfish, mackerel, pilchard, and a number of clupeiods, and stomias.

The coastal environment of the region serves as an important feeding and spawning ground for a variety of species. A number of economically important species such as sardinella, bonga and others are found to be closely associated with areas of rich plankton production or upwelling. Many species breed in the inshore waters where their larvae and eggs are found in large concentration (e.g. sardinella, anchovies, bonga and of a number of species of scromboids, mullikds, istiophorids etc.). A number of others such as Alosa and Hilsa are reported to make periodic migration up the river stream for purposes of breeding.

Demersal fishes

The demersal fishes, which unlike those of pelagic zone feed on the bottom, are represented by relatively few species in large numbers. Most of these are typical of the muddy bottom conditions in the area which characterizes the continental shelf of the region. Among the economically important species known in the region are breams, croakers, flat fishes and a number of others belonging to the groups sciaenids, polynemids, ariids, eludiads etc. A large number of these species are found near the bottom in depths shallower than the

thermocline, while the shallow rocky areas are dominated largely by species of Lutganus, Lethrinus and Bastistes.

The total demersal fishery resource of the area is estimated to be 1 million tons and well over half of this is found in the area of Bissagos-Guinea.

Shrimps

The inshore waters in many countries are inhabited by shrimps which constitute an important source of food. The bulk of the shrimp is represented by a common species, Penaelus durorum which is found in great abundance particularly in Nigerian waters and support substantial commercial fishery yield. Shrimps are generally found in depths shallower than 45 metres and are abundant during the wet season and/a few months beyond it (June-December) with a slack period between January and April. There are rich grounds of this species in the vicinity of Lagos between Benin and Escravos and off the Bonny river. The trawable shrimp fishing ground off the coast of Nigeria is estimated to be about 3,000 square miles.

A number of other countries such as Senegal, Cameroon, Ivory Coast, Benin, Ghana also harvest considerable quantity of shrimps. Other crustacea harvested from the near shore include spiny lobster mainly by countries such as Senegal and Ghana.

Marine Molluscs

In countries like Senegal, Sierra Leone, Angola and Equatorial Guinea, a substantial number of edible molluscs are harvested annualy which include Portuguese oysters, bivalve such as Perna perna and many others. These species are mainly confined to the intertidal zone and are highly-susceptible to effluents from the land based origin. A detailed information on utiliza-

tion of this source from other countries is scanty and needs further consideration.

3. Aquaculture

A few countries of the region have embarked upon coastal farming of certain economically important species. In Nigeria, the Government Fisheries Department has been engaged in brackishwater fish culture in the Niger delta particularly dealing with species of grey mullet (Mughil cephalus) shiny nose (Polydactylus sp.) and catfish (Chrysicthys Sp.). In Lagos attempsts are being made to raise the levels of culture of catfish, snake eel (sphage branchus sp.) and Hemichrones. Similarly, oyster culture is being developed in Lagos, Nigeria, and in Sierra Leone by the respective government Departments of Fisheries. In Angola, the culture of mussels, Perna perna, is being actively developed in Ghana and Nigeria, proposals for using lagoons for fish culture is under active consideration. An up to date review on practise of aquaculture in the region is highly desirable to provide better understanding of the use of the coastal area for this economic activity and the existing potential within the region.

IV. ENVIRONMENTAL MANAGEMENT ISSUES AND COASTAL DEVELOPMENT IN WEST AFRICA

A. Problem Identification

The historical development of the West African coastal area has been such that at the present time the coastal area is the repository of a significant proportion of the effort toward industrialization and therefore, of environmental degradation in the region. During colonial times, the economic development of the region was such that external trade in raw materials dominated all other activities to the point that coastal transfer was of vital importance. The progressive development of new resources has led, for example, both to the development of special piers or ports and to special facilities within ports. Current development plans in the region call for a mix of the following: limited processing of local raw materials before export, processing of local raw materials mainly for the home market and, local processing or assembly of imported goods mainly for the home market. A large percentage of these activities, having to take or simply taking advantage of the availability of transport facilities, harbour supply and size of the market, will be located in the coastal area. Additionally, the identification of specific segments of the coastal area as industrial development centres by some of the countries in the region either as a result of the availability of good transport facilities or as a result of energy availability, further confirms that the initial effort in developing experience in environmentally sound resource utilization schemes should be concentrated in the coastal area.

Again, the guidelines for integrated planning and development of resources of the coastal area have been described in previous United Nations reports on the subject.[1/] In general, these guidelines recognize that the potential of an area is dependent upon its range of resource characteristics and the range of activities that could be undertaken in it. Identifying the range of activities assists in determining the environment where that activity thrives best. The combination of the activity and its man-made modification to the environment generates a land-use unit which can further be developed into an economic unit. Against this broad backdrop, two more specific concerns on the modification of the environment can be generated. First, specific criteria can be generated to govern the discharge of wastes and foreign matter into the region's atmosphere and water resources. These criteria should be closely tied into the capacities of these media to bear the stresses imposed by the introduction of wastes. The stresses referred to being directly related to the other uses of the atmosphere or water body in that locale. Secondly, within each land-use unit, and governing each resource utilization scheme, the linkages between materials flow and the socio-environment should be examined. Proceeding from natural resource linkages to optimization of the production process, calls attention to the interrelationships between choice of process, recycling and reuse potential; between plant location and urbanization issues, between waste management and process design, and to other such connections which make the integrated project design sensitive to environmental needs.

1/ "Manual on Coastal Area Management and Development", op. cit.

In the United Nations Environment Programme's exploratory mission to the West African Region in 1976,[1] the types and sources of pollution in the region, summarized in section IC, though reflecting an absence of broad environmental planning in resource utilization generally appeared to lend themselves to solution through discrete, short-term projects.[2] Though such projects should be initiated, it is the contention of this paper that they be undertaken only as a part of the overall effort described in this section.

B. Guidelines for Environmental Management

In the effort to provide effective management of the environment, many countries the world over, have implemented procedures for maintaining environmental quality. The two most popular approaches for air and water are emission and water quality standards. For other resources, the same type of resource protection is achieved through the concept of land-use planning.

1. Environmental quality criteria and standards generation

Emission standards place limits on the amount of a contaminant that an activity or facility of a given size can emit while quality standards restrict the level of the ambient concentration of a contaminant. Only a full consideration of both standards is adequate to protect and maintain environmental quality. In the growing body of literature on the subject, standards have been developed in different countries for both air and water quality.

1/ G. Kanairu and M. Angot "Exploratory Mission on Marine Pollution Problems of the West African Coastal Countries, April-July 1976". UNEP Proj. No. 76-2247.

2/ The Gulf og Guinea: Pollution, the need for control and possible mechanisms thereof. op. cit.

In general, an air quality standard is developed by considering air quality criteria. Air quality criteria are compilations of effects associated with various concentrations and durations of exposure to pollutants, plus other factors such as cost and technological feasibility of emission control, and social questions. Air quality is brought to the requisite standard by the enforcement of emission standards, by land use planning and zoning standards and by other limitations including fuel composition. In both the U.S. and the U.S.S.R. for example, air quality standards are promulgated at a Federal level for regions within the respective countries. In the U.S.S.R., the standards are promulgated by the Federal Ministry of Public Health on the basis of recommendations made to it by a permanent expert committee. In the U.S., the Clean Air Act requires that the Secretary of Health, Education and Welfare designate air quality control regions which may be intra- or interstate, and that the individual states adopt air quality standards for each air quality control region designated by the Secretary. In most countries where air quality and emission standards have been adopted, the reasoning behind the standards and how they have been obtained is readily available.

The intended end use of water determines the degree of pollution permissible by certain specific constituents or characteristics. A logical analysis preliminary to the establishment of water pollution control standards can, therefore, be based upon the division of water sources into end-uses. In the region as in most others, these end uses are public water supply, recreational and aesthetic value, preservation of fish and wildlife, agricultural uses and industrial use. The intended end-use determines the degree of pollution by a specific constituent or characteristic that is per-

earned, varying for each constituent. Water pollutants directly attributable to industrial processes may be categorized as physical, chemical and radioactive.

Physical pollutants include the presence of colour in water, and from among industries, this type of pollution is typical of pulp and paper industries, textile industries and petrochemical and chemical industries. Thermal pollution is another physical pollutant usually associated with waste water from industrial processes. Such pollution is significant inwaters used for contact recreation, for public water supplies and for certain types of aquatic life. The one significant area where thermal pollution may not be a problem is in association with waters destined for agricultural use. Odor and taste in water supplies may be from natural phenomena such as bacteria slime or decaying vegetation. Dissolved gases, volatile organic compounds and dissolved inorganic salts or iron zinc,manganese, copper, sodium, potassium, et al, can also impart these characteristics. Turbidity is another physical pollutant caused by suspended clay or silt, dispersed organics and micro-organisms.

The types of chemical pollutants include the pH, alkalinity (should be sufficient to cause effective floc formation but not high enough to be toxic or to produce a corrosive or encrusting water in public water supplies), total dissolved solids (TDS), concentrations of ammonia, arsenic, barium, boron, cadmium, chloride, chromium, copper, iron, lead, manganese, phosporus, selenium, uranyl ion, zinc, nitrates and nitrites, sulphates and sulphides, CLE's and cyanide. Other classes of pollutants include organic chemicals such as oil and grease, pesticides and herbicides, and the Biochemical Oxygen Demand (BOD's). WHO has compiled standard's representing a consensus of world opinion for air and water quality.

2. Land-use Units and Regional Planning

If regional planning is to be of greatest value to designers, planners, developers and resource managers, it must be comprehensive enough to allow full development of potential, rather than narrowly reflecting special interests. The potential of an area is dependent upon both its range of resource characteristics and the range of activities undertaken in it. Identifying these activities usually includes a modifying description that relates to the environment where that activity thrives best. The combination of the environment and the activity might be described as a land-use unit being made up of both man-made development and natural resources. Land-use units have, thus, a number of characteristics important to regional development. First, they are frequently anchored to certain geographic settings because of heavy dependency upon certain natural or cultural resources (a good example in the region is with livestock especially, cattle. There are clearly defined cattle zones which are determined by the tsetse fly. So far it has been impossible to keep Zebu cattle in the southern part of the zone). Those land-use unit-locations where the least modification of given resources is necessary are most preferred. This represents an ecological approach to resource development. Second, land-use units have great economic impact upon local communities and are 'successful' if they satisfy nearly all of the people who have interests in the activities supported. Therefore, geographic relationship with population concentrations and markets is important to land-use units. Third, the land-use units are productive only

if accessible. Therefore, transportation systems and access are important. Fourth, the fact that an existing service area as offering varied items such/health care and recreational facilities is within easy reach is an advantage to any land-use unit. Finally, the success of a programme of activity in any land-use unit is as dependent upon the quality and functional success of the design, construction and management of the activity as on the other factors enumerated. To summarize, the keys to land-use unit planning of a region are the following factors: natural and cultural resources, transportation and access, infrastructure, and the design, construction, and management of land development.

In the West African region, regional climatic, sedimentary, biologic, and physical process variations preclude a rigid region-wide system of resource management. Any fair system of management must be based upon the concept of natural variation of environments locally and regionally; correspondingly, flexible guidelines should be firmly based upon these variations in properties, composition, and behaviour under various land-uses.

3. Planning issues in resource development

The environmental needs that have to be addressed in integrated project design cover a broad spectrum of concerns within each resource utilization schemes. A fair number of such projects have been described in the literature.[1/] To illustrate their scope, two examples, of particular impart to the region are described below. These examples include the

1/ "Environmental, Health and Human Ecologic Considerations in Economic Development Projects", World Bank, May, 1974.

range of concerns that should be considered when planning for mineral development and those applicable to the development of a pulp and paper industry.

Mineral resource development

A. Environment/Resource Linkages

(a) Will the mining preclude other future use of the area or its resources?

(b) What environmental safeguards will be incorporated into mineral exploration and production agreements?

(c) Will environmental factors, including land-use patterns in the vicinity, be considered in the selection of technology, the location, scale, and design of the operation?

(d) Have the impacts on fish, wildlife and vegetation been considered?

(e) To what extent will mining activities adversely affect local land use, e.g., land subsidence, mine drainage, pollution of water courses, erosion, etc.?

B. Project Design and Construction

(a) What measures will be taken to prevent land subsidence in areas in which underground mining is carried out? Will erosion be a problem? Will reforestation be carried out? Will wash waters be clarified or recycled?

(b) Has a monitoring programme been considered to detect changes in neighbouring plant and animal life caused by mining operations?

(c) Will plans for mining activities consider environmental aspects of regional plans in relation to mining?

(d) Will a system of sequential land-use planning be developed for the site in order to retain its social and economic utility?

(e) Have hydrologic, geologic, seismological, and meteorological studies of the site been made to anticipate and minize damage?

(f) Will underground and/or surface water runoff patterns be adversely affected?

(g) Are there opportunities economically to reclaim or recycle wastes, to reduce effluent volume, or to market byproducts?

(h) Can production technology or design offer possibilities for recycling mining tailings?

(i) Does a comprehensive development plan link the project to environmental aspects of shipping and processing sites? Will the transport of the mined materials present environmental or human ecological problems?

C. Operations

(a) Will mining operations be a source of land erosion and despoilment?

(b) Will strip mines be reclaimed and replanted?

(c) Have provisions been made to reclaim spoil dumps, tailing piles, etc.

(d) Will occupational health safeguards and service facilities for miner's lung disease, etc., be provided?

(e) Will noise associated with blasting and other mining operations have undesirable impacts on nearby populations and wildlife?

(f) What measures will be taken to prevent water pollution from mine drainage directly or indirectly into water bodies?

(g) Will pollution controls be incorporated into processing operations to prevent the discharge of effluents into surface waters?

(h) Will irrigation or drinking water supplies be affected?

(i) What are the specific effluents of concern, and what are their most troublesome characteristics?

(j) Will the discharge of effluents be compatible with other present and future uses of the receiving water, particularly during periods of minimum stream flow?

(k) Will water and land biota be adversely affected from runoffs from spills and tailings?

(l) What provisions have been made to prevent air pollution from coal fires and smouldering slag heaps?

(m) Will processing operations incorporate controls to prevent release of toxic gases, fumes and particulants?

(n) Will access roads constitute a source of dust pollution?

(o) What measures can be taken to reduce air pollution caused by smoke and dust from mining operations?

(p) What effect will drilling, dredging or related exploratory operations have on the marine environment?

(q) Have dredging disposal areas been chosen for minimum deleterious impact upon the biota?

(r) What measures will be taken to prevent water pollution from tower or service boat discharges of oil, sewage or toxic drilling mud?

(s) Do the production systems include accident prevention equipment, such as storm chokes and blowout preventors?

(t) Will safety equipment be monitored regularly?

(u) Has a contingency plan been prepared for coping with accidents such as spills?

D. Sociocultural Factors

(a) What provisions (housing, community services, etc.) have been made for families that will be displaced by or attracted to the mining development?

(b) Will mining operations threaten important archeological deposits or cultural practices?

(c) Could mining operations bring about unwanted changes in local economic activity?

E. Health Impacts

(a) Will the mining development create health or sanitation problems?

(b) Is there an adequate programme for employee safety and occupational health?

(c) Will settling ponds attract insect pests or create other potential disease problems?

(d) Have possible hazards to the health of people attracted to the project site been considered?

F. Long-Term Considerations

(a) Will mining attract large populations involving the provision of health services or urban infrastructure?

(b) Have the effects of possible associated future projects on land use, water and air resources been taken into account?

Considerable data, generally obtainable from ongoing operations, are available within the region for developing the framework through which impacts of future mineral development schemes may be assessed. Again, it must be recalled that large-scale mineral development is fairly recent in the region. Until very recently, very few countries in the region had the economic and social infrastructure to permit the development of the secondary and tertiary industries associated with a mineral industry. As greater quantities of mineral products are processed and consumed within the region, the need to be able to assess the impact of such development, will no doubt, increase. It is in light of this fact that the basic framework for developing the necessary experience to assess the impact of mineral resource development on the region's resource endowment has to be designed.

Pulp and Paper Mill

A. Environment/Resource Linkages

(a) Do plans for plant location and construction take into account environmental criteria regarding surrounding land use, agricultural patterns, water use?

(b) Have hydrologic, geologic, seismological, and meteorological studies of the site been conducted?

(c) What will be the potential impact of plant operations on water quality and on plant, animal and human life?

(d) Does a comprehensive development plan link the project to environmental aspects of raw materials, byproducts utilization, shipping and processing sites?

(e) Are logging operations to be carried out on a sustained yield basis? Are good cutting practices to be followed? Are reforestation plans adequate?

B. Project Design and Construction

Mill

(a) Have alternative sites or locations of the plant been considered in an effort to avoid or mitigate water and air quality degradation?

(b) Is there a comprehensive construction plan for the project that takes into account ecological factors?

(c) Are road patterns, land excavations, fill sites, refuse disposal activities, etc., planned to minimize erosion and other damage to the natural environment?

(d) Will settling ponds create odors near surrounding urbanized areas?

(e) Can a coupling of pulping and paper operations reduce waste-water out-flows?

(f) What are the types and quantities of the waste to be discharged into the environment?

(g) Will controls on air and water pollutants, including odors, be incorporated? Are they adequate in all respects?

Logging

(h) What provisions are being made to minimize erosion and the siltation of water bodies as the result of logging operations?

(i) Is there sufficient information about regional topography and soil types on which to base effective measures for controlling erosion and siltation?

(j) Will the rate and pattern of cutting affect the region's ecology?

(k) Will the logging be carried out in accordance with recognized forest management practices, including provision for cutting patterns and revegetation to retard erosion?

(l) What effect will logging operations and the construction of access roads have on fish and wildlife resources, and on scenic values of the region?

3. Operations

(a) How will chemical raw materials and wastes be handled and stored?

(b) What will be the effects on the environment of storage tank ruptures, leakage or spillage during handling?

(c) Is the process being used designed to recover chemicals and process heat?

(d) Will plant effluents and environmental quality be monitored? Will logging operations be monitored to ensure good practices are employed?

(e) Will operating personnel be trained in environmental protection?

4. Sociocultural factors

(a) Will large-scale logging operations affect human settlements and their economies?

(b) What are the possible consequences of logging and/or pulp and paper production for the impacted communities?

(c) Will logging bring on land-use changes in surrounding areas with significant impact on the residents of the region?

5. Health impacts

(a) Are endemic disease vectors known well enough for the purposes of control in case the project inadvertently increases their influence?

(b) Are present or planned health care facilities and services adequate to meet the increased demands during logging operations?

(c) Is there an adequate programme of industrial hygiene and occupational health for the pulp and paper plant?

6. Long-term considerations

(a) Are there plans for eventual plant expansion or related industrial and residential construction?

(b) Is the site adequate for such later expansion without harmful environmental effects?

(c) Are the forest resources to be managed to assure a sustained yield and not to leave the area denuded of forest cover and impoverished in other ways?

Extrapolating this type of planning process to other activities such as port construction, different aspects of the petroleum industry and other industries such as the fertilizer industry etc., is the first step in ensuring that rewards from the development process are closer to being maximized as opposed to being anything less. Opportunities for making this type of appraisal in all the countries of the region will vary with the economics, natural conditions and interest in the issues addressed. What is desired is that over time, the full range of concerns expressed above will play more significant roles in regional development.

V. POLICY RECOMMENDATIONS FOR THE DEVELOPMENT OF THE REGIONAL SEA

A. Summary and Conclusions

The West African coastal area has in recent times acquired a more significant role in the overall economic development of West Africa. For the landlocked countries in the region, coastal ports represent the only natural outlets for their goods and services, both imports and exports. As a result, these countries have to maintain an interest not only in port and harbour development but also in the transport outlets from the ports and harbours to their producing areas. For the coastal states themselves, this importance is reflected by the continuing desire to further locate industries within the coastal area to take advantage of the accessibility of the area to the main arteries of transport and communication.

Environmental concerns have not played a significant role in regional economic development. Very little effort has been expended in incorporating socio-environmental concerns in development planning and though widespread problems have been discerned in large-scale resource utilization schemes, they have generally been shrugged off as being an inescapable part of the development process. Inland, such schemes include mineral development, timber operations and agricultural development. On the coast, given the advantages of locating industrial activity near existing port and administrative facilities, environmental degradation takes on more visible forms. Environmental degradation here, though amenable to solution via short-term individual projects, will over time become too expensive if an overall framework, wherein an integrated view of resources is perceived, is not adopted. This study recommends that such a framework be adopted.

It urges that the principles of environmental management be institutionalized in the region thereby taking greater advantage of the socio-economic environment.

The coastal area in the region provides such a significant range of concerns and opportunities in environmental management that it can be utilized as a catalyst in this endeavour. The length of coastline covered by the region is approximately twice that of Britain and a little over a third of that of the United States. The bulk of this coastline is presently underutilized. However, potential development opportunities associated with the coastal areas in general may be found along the length of this coast. A cohesive and comprehensive plan, buttressed with projects to alleviate the obvious and existing examples of environmental degradation represents the most attractive route for the region.

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