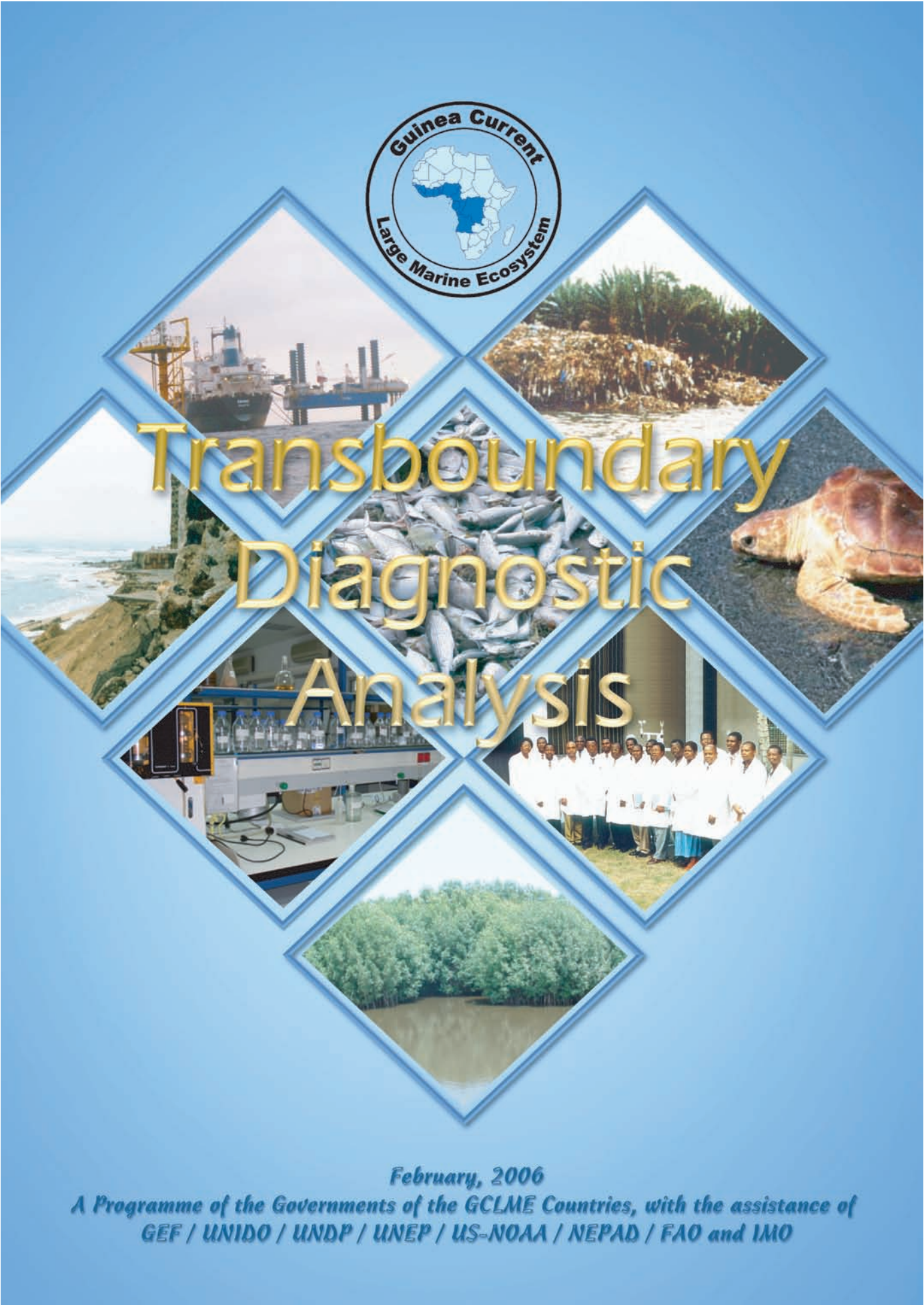

Transboundary Diagnostic Analysis

February, 2006

A Programme of the Governments of the GCLME Countries, with the assistance of GEF / UNIDO / UNDP / UNEP / US-NOAA / NEPAD / FAO and IMO

GUINEA CURRENT LARGE MARINE ECOSYSTEM (GCLME)

TRANSBOUNDARY DIAGNOSTIC ANALYSIS

GCLME Regional Coordinating Unit, Accra, Ghana,
February, 2006
A Programme of the Governments of the GCLME Countries, with the assistance of
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ISBN

Foreword

Ghana has an important stake in the Guinea Current Large Marine Ecosystem. This is made up of trans-boundary waters off the coast of 16 West African countries extending from the Bissagos Island (Guinea Bissau) to Angola, and includes their associated river basins.

The material well being of the people of the countries, in particular, the coastal populations, is tied to these waters. In the last three decades or so, however, man-induced pressures such as over-fishing and pollution from land and sea based activities are limiting the full potential of the Guinea Current Large Marine Ecosystem (GCLME). Coastal erosion and changes in biodiversity pose other problems. There is an urgent need to reverse this trend.

Restoring the ecosystem to good health requires scientific study which began in Accra in April 2003. The Trans-boundary Diagnostic Analysis Document released early this year is one outcome with which we should all be proud to associate.

My understanding is that this document will lead to the development of a Strategic Action Program by the governments of the 16 countries and their development partners, to guide the ecologically sustainable development of the Guinea Current region. This was, indeed, the expectation of the Accra Declaration (1998) adopted by Environmental Ministers from the Gulf of Guinea which served a seminal role in the formulation and subsequent adoption of the Guinea Current Large Marine Ecosystem Project. The attendant benefits are multiple-food security, healthier populations, suppression of escalating poverty, conservation of globally significant biological diversity, and improved foreign exchange earnings.

On behalf of my peers in the sub-regions, I salute this bold endeavor and wish the project success as it begins its planned transition to a technical interim Guinea Current Commission

John Agyekum Kufour
President of the Republic of Ghana

Preface

Today, the Large Marine Ecosystem concept underpins the management interventions of the Global Environment Facility (GEF) and its member states in the core area of International Waters. This concept, predicated on the recognition that the greater part of the causes of marine environmental degradation and living resources depletion respect neither geographical nor political boundaries, provides a large scale (ecosystem wide), holistic and integrated approach to the protection of the marine environment and the sustainable use of its living resources.

The Guinea Current region was the first outside of the USA where the LME concept was applied to coastal and marine environmental and living resources management. The Global Environment Facility (GEF) funded a pilot phase project entitled, "Water Pollution Control and Biodiversity Conservation in the Gulf of Guinea Large Marine Ecosystem" (GOG-LME) which was implemented between 1995 and 1999. The project, an initiative of five (later six, with the participation of Togo) countries in the region [namely Benin, Cameroon, Côte d'Ivoire, Ghana, Nigeria and Togo] was implemented with the technical assistance of UNIDO, UNDP, UNEP and the US-NOAA of the United States Department of Commerce and the collaboration of a host of national, regional and international organizations. The GOG-LME project represented a regional effort to assess, monitor, restore and enhance the ecosystem's capacity and productivity in order to sustain the socio- economic opportunities for the countries in the coming decades.

Recognizing all the achievements of the pilot phase GOG-LME project, the Committee of Environment Ministers responsible for the project during their first meeting in Accra, Ghana in July 1998 called for the initiation of an expanded project to include all 16 countries situated within the natural limits of the Guinea Current Large Marine Ecosystem. The communiqué issued after the meeting (the Accra Declaration, 1998) stated, *inter alia*, that "The development of a Strategic Action Programme (SAP) including a full Trans-boundary Diagnostic Analysis (TDA) leading to the second phase of the Project should be initiated and accelerated ". In response to the Ministers' request to GEF, a PDF-B project "Development of a Strategic Action Programme for the Guinea Current Large Marine Ecosystem (GCLME)" was initiated in 2001 under the umbrella of the Abidjan Convention and with the support of GEF, UNIDO, UNDP, UNEP, US-NOAA and other stakeholders.

The finalization of this important GCLME Trans-boundary Diagnostic Analysis document is a vital step toward the completion and subsequent implementation of a Strategic Action Programme (SAP) for the region. The SAP is to facilitate a regional commitment to integrated management of the GCLME for the sustainable utilisation of its resources.

The Trans-boundary Diagnostic Analysis (TDA) of the GCME is a scientific, technical and socio-economic assessment by which environmental and living resources management issues and problems of the region have been examined. The analysis has also involved the identification of causes and impacts (and uncertainties associated with these) at national and trans-boundary levels, as well as the socio-economic, political and institutional context within which they occur. The identification of the causes has, where appropriate, specified sources, locations, sectors and provided a list of prioritised activities or solutions to address the issues/problems and their root causes. Hopefully, decision making in respect of these issues/problems will no longer be a stab in the dark!

The GCLME region owes a lot of respect and gratitude to many persons, institutions (governmental, UN and non-UN) and other stakeholders for bringing to fruition the preparation of the TDA.

Reports from individual experts as well as the many national and regional workshops organized during the process of finalization of the document contributed much data and information. The inspirational leadership of Drs Kenneth Sherman and Bradford Brown of US -NOAA, Drs Alfred Duda and Andrea Merla of GEF-SEC, Dr Zoltan Csizer and Mr Pablo Huidobro of UNIDO, Dr Andrew Hudson of UNDP, Dr Vladimir Mamaev of UNEP and Prof Dapo Afolabi of the Federal Ministry of Environment, Nigeria was very much appreciated particularly during the PDF-B phase. The UNIDO Project Manager, Dr Chika Ukwe, coordinated all the effort. In the final lap, the illuminating contributions of Prof. Babajide Alo and Dr Gboyega Ajao, respectively the Chair and Rapporteur of the TDA/SAP Working Group proved immensely useful. The encouragement of Drs Abdoulaye Ndiaye of UNDP and Takehiro Nakamura of UNEP is gratefully acknowledged. Prof Sikorou Adam, Executive Secretary of CEDA provided much needed editorial assistance. There are many more persons who are not specifically mentioned here but whose input to the success of the TDA process was no less important.

It has been for me both a joy and a privilege to have participated in this undertaking. The achievement of this task is yet another crucial step on the road to sustainable socio- economic development in the GCLME region.

Prof Chidi IBE
GCLME Regional Director

23 February, 2006
Accra, Ghana

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1. Introduction

1.1 Transboundary Diagnostic Analysis (TDA): content and process

The ultimate goal of the Guinea Current Large Marine Ecosystem (GCLME) project[1], like other Large Marine Ecosystem (LME) approaches, is to secure the development and adoption of a regional Strategic Action Programme (SAP) by member States. The SAP is to facilitate a regional commitment to integrated management of GCLME coastal area and marine ecosystem for sustainable utilisation of its resources. The first step for the Regional SAP is the preparation of a Transboundary Diagnostic Analysis.

A Transboundary Diagnostic Analysis in LME projects is a scientific and technical assessment through which the water-related environmental issues and problems of a region are identified and quantified, their causes analysed and their impacts, environmental and economic, assessed. The analysis involves the identification of causes and impacts (and uncertainties associated with these) at national and transboundary levels, as well as the socio-economic, political and institutional context within which they occur. The identification of the causes should, where appropriate, specify sources, locations and sectors. The TDA also indicates which elements are transboundary in nature and provides a list and prioritises activities or solutions to address the issues/problems and their root causes. Within the context of the TDA, transboundary environmental issues include inter alia:

1. National/regional issues with transboundary causes/sources;
2. Transboundary issues with national causes/sources;
3. National issues that are common to at least two of the countries and which require a common strategy and collective actions to address;
4. Issues that have transboundary elements or implications (e.g. fisheries practices on biodiversity/ecosystem resilience).

The main objective of the Guinea Current TDA is to provide, on the basis of clearly established evidence, structured information relating to the degradation and changing state of the GCLME, to scale the relative importance of the causes and sources of the transboundary water-related problems, and to elucidate practical preventative and remedial actions to ensure the sustainable integrated management of this unique environment. The TDA would provide the technical basis for the development of a SAP, and the full Project Brief, for the GCLME within the International Waters Focal Area of the Global Environment Facility (GEF).

The GCLME Regional Strategic Action Programme once developed and adopted by the participating countries for implementation would re-affirm the joint-commitments to regional co-operation under the tenets of Agenda 21, the Abidjan Convention, the GEF Operation Strategy, the Global Programme of Action (GPA) on the protection of marine environment from land-based activities, the World Summit on Sustainable Development (WSSD) plan of implementation, and the FAO Code of Conduct for Responsible Fishing.

1.2 Design of the Guinea Current TDA

Comprehensive information on the status of the GCLME, the main issues and problems, their causes and impacts, was first generated at the regional GCLME Working Group (WG) and stocktaking workshop held in Accra, Ghana from 14th-17th May 2001 within the framework of implementation of the initial PDF B. The suite of eleven thematic/ sectoral reports covering the five modules of the LME and the national reports from the sixteen countries were examined, synthesised into a regional report and then condensed into a series of analytical tables.

While much data were obtained through this process, each country provided only partial information on the environmental status, so this TDA is a summary of available information only. The major sources of information are listed in the bibliography accompanying this TDA. Gaps in information available for the preliminary TDA were filled during the several meetings of the regional TDA Working Group during which the TDA was updated and completed. Several steps were undertaken to develop the current TDA. These are as follows: (1) identification of major perceived problems and issues, (2) causal chain/Root cause analysis, (3) synthesis matrix, (4) priority areas of future interventions and (5) ecological quality objectives.

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1. See Annex B for a brief history of the GCLME project.

1.2.1 Identification of Major Perceived Problems and Issues (MPPIs)

The identification of the major perceived[2] issues is the first step in the TDA process. The MPPIs are addressed from a status perspective. It answers the questions: What do we know about this problem/issue? What data support the quantification of the extent of the problem/issue? Do the data support these as real problems and issues, or just as perceptions? This analysis took place on a scientific level, including biological, hydrological, physical, social and other perspectives on the problem. The following four MPPIs were identified in the GCLME:

1. Decline in GCLME fish stocks and unsustainable harvesting of living resources;
2. Loss of ecosystem integrity (changes in community composition, vulnerable species and biodiversity, introduction of alien species) and yields in a highly variable environment including effects of global climate change;
3. Deterioration in water quality (chronic and catastrophic) from land and sea-based activities, eutrophication and harmful algal blooms;
4. Habitat destruction and alteration including inter-alia modification of seabed and coastal zone, degradation of coastscapes, coastline erosion.

1.2.2 Causal Chain/Root Cause Analysis

Based on the causal chain concept, this analysis identifies the underlying factors or root causes that contribute to the major perceived problems and issues so that these can be addressed in the implementation of the SAP. As such it improves recognition of connections between the components of the environmental and socio-economic sub-systems through a causal chain analysis. Identification of root causes is important because root causes tend to be more systemic and fundamental contributors to environmental degradation. Interventions and actions directed at the root causes tend to be more sustainable and effective than interventions directed at primary or secondary causes. Because the linkages between root causes and solutions of the perceived problems are often not clear to policymakers, however, interventions commonly are mistakenly directed at primary or secondary causes. This TDA attempts to clarify the linkages between root causes and the major perceived problems to encourage interventions at this more sustainable level.

1.2.3 Synthesis Matrix

The Synthesis Matrix serves as a logistical "Map" for the transboudary diagnostic analysis. It examines the transboundary elements of the MPPIs and then relates them to their major underlying institutional, societal or global root causes. In all cases the root causes are common to a large number of problems and require changes to the role given to environmental issues within the priorities of the governments and the public in general. The matrix identifies three generic areas (issues) where proposals for action can be formulated, viz utilization of resources, environmental variability and pollution/ecosystem health. For each of these generic areas a number of more specific issues ("sub-issues") are identified. A simplified version of the Synthesis Matrix is provided in Figure 7.0-1.

1.2.4 Priority areas of future interventions

The nature of the specific MPPIs identified as contributors to ecosystem degradation and change in the Guinea Current region are examined in terms of management uncertainties (in the case of environmental variability, the uncertainty of the variability per se) and knowledge gaps which need to be filled. They present priority practical and implementable proposals for inclusion in the GCLME SAP and the cost of the required international action where possible. Finally the series of tables identify the outputs (products), which should be obtained through the successful implementation of the actions and lists the stakeholders for each problem and action area identified.

1.2.5 Ecological Quality Objectives (EQOs)

Because the list of possible interventions and actions arising from the analysis of the GCLME problems is so large, a mechanism was needed in order to prioritize the interventions. Borrowing from methodology commonly used in the European Union and other regions, the present TDA identifies a series of draft EQOs, which represent the regional perspective of major goals for the regional environment. The use of EQOs helps to refine the TDA process by achieving consensus on the desired status of the GCLME. Within each EQO (which is a broad policy-oriented statement), several draft specific targets were identified. Each target generally has a timeline associated with it, as well as a specific level of improvement or target status. Thus, the targets illustrate the chain of logic for eventual achievement of the EQO.

1.3 The Next steps towards a sustainable future in the GCLME region

It was quite apparent after the Regional Working Group and stocktaking workshops during the initial PDF B phase that an enormous amount of goodwill, information and ideas had been generated within the region relevant to the sustainable management of the Guinea Current ecosystem. This augurs well for the future and provides a strong foundation, not only

2. "Perceived" is used to include issues which may not have been identified or proved to be major problems as yet due to data gaps or lack of analysis or which are expected to lead to major problems in the future under prevailing conditions.

to develop a viable LME approach to the Guinea Current region, but also to provide a blueprint for how open-system LMEs should be developed internationally.

Correcting decades of over-exploitation of resources and habitat degradation in the Guinea Current ecosystem and the fragmented and sectorally based management actions (the consequence of the colonial/political past and greed) will require a substantial coordinated effort during the next decade, to be followed by sustained action on a permanent basis. A task of this magnitude will require careful planning not only by the government agencies in the sixteen countries bordering the Guinea Current, but also by the other stakeholders. There already exists the willingness on the part of the key players to collaborate to achieve this objective, but the real challenge will be to develop systems and structures that address the naturally highly-variable and potentially fragile nature of the GCLME and its coastal environments within the context of a changing society and world. The many issues and problems, as well as possible solutions, have been identified and prioritized in the TDA tables. The resolve of the governments of the sixteen countries to correct the wrongs of the past and move forward with a new vision to ensure that the GCLME can be sustainably utilized and enjoyed by future generations for the benefit of all would be embodied in the SAP, the elements of which together with the EQOs, have been formulated during the implementation of the supplementary PDF-B phase. The full SAP would be finalized and endorsed by all the countries during the full project phase. It is to be much more than just a piece of paper: it is to be a pragmatic, workable framework and unambiguous statement of common goals and objectives and the means of their achievement. Success will depend on thorough implementation of the principles, commitments and actions to be embodied in the SAP, both explicit and implicit.

In order to accelerate SAP implementation, a portfolio of nine regional and national pilot demonstration projects addressing previously-identified priority transboundary concerns conforming to the five LME operational strategies/modules (productivity, fish and fisheries and other living resources, pollution and ecosystem health, socio-economics, and governance) would be implemented during the full project phase.

In the TDA synthesis and analysis tables for a number of major transboundary problems in the GCLME have been developed. These include inter alia, non optimal harvesting of living resources, uncertainty regarding ecosystem status and yields in a highly variable environment, deterioration in water quality, habitat destruction and alteration, coastal erosion, loss of biotic integrity and threat to biodiversity, introduction of alien species, and inadequate regional capacity (human and infrastructure). Over-arching generic actions which are needed to address these transboundary problems must focus on capacity strengthening and training, legal policy development and harmonization of legislation, transfer of environmentally sound technologies and development/strengthening of regional collaboration or networking in respect of surveys and assessment of the ecosystem status. Specific actions required in the near future in the GCLME will include inter alia:

1. Development and implementation of joint fish stock assessments and development of fisheries management plans among the participating countries;
2. Facilitation of appropriate transboundary frameworks and mechanisms at local, national and regional levels for consultation, coordination and cooperation;
3. Development of institutional capacities of the key agencies and institutions in the region that contribute to the integrated sustainable management of the GCLME;
4. Effective ecosystem assessment and development of an early warning system for ecosystem change;
5. Actions to fill the gaps in our understanding of the GCLME, its functioning, and the factors which affect it (biophysical, social, economic and political);
6. Harmonization of policies and legislation relating to activities affecting GCLME;
7. Activities to minimize and mitigate the negative impacts of development (mining, urbanization, tourism development, resource exploitation) through the promotion of sustainable approaches and the use of appropriate tools;
8. Measures to improve sustainable resource management;
9. Measures to protect biological diversity and restore globally significant habitats including wetlands;
10. Measures to protect the coastlines from the incidence of coastal erosion;
11. Quantification of the impact of global climate change on the GCLME

Policies, structures and actions developed during the implementation phase of the GCLME Programme, i.e. over five years, must by the end of the period be self-sustainable in the region. To achieve this it is essential that mechanisms be in place to encourage, indeed ensure, a substantial degree of co-financing of activities. This can best be done by involving and developing partnerships with maritime and coastal industries, the international community and present and future beneficiaries, i.e. all those who have a stake in the long-term health, productivity and viability of the Guinea Current region as a Large Marine Ecosystem (LME).

2. Physical and biogeochemical setting

2.1 Geographic scope and ecosystem boundaries

Conducting a comprehensive transboundary analysis is only possible if the entire LME, including all inputs to the system, is covered in the study. In the case of the Guinea Current region, which is an open system where the environmental variability is predominantly remotely forced, this should then include the tropical Atlantic sensu latu, the Canary and Benguela Currents and the drainage basins of all major rivers which discharge into the greater Guinea Current region including the Niger, Volta and Congo Rivers. Clearly, such an all-encompassing approach is impracticable in a single project and more realistic and pragmatic system boundaries have to be defined in order to develop and implement a viable ecosystem management framework.

In the Atlantic basin, the current systems are dominated by the effects of the two gyral currents of the north and south hemispheres. In each hemisphere a cold current flows towards the equator along the eastern oceanic margin (southward-flowing Canary Current in the north and northward-flowing Benguela Current in the south). The northern boundary of the Guinea current region is formed by a northward-flowing strong thermal front between the warm Gulf of Guinea waters and a southernly extension of cool waters from the Mauritanian and Senegalese upwelling area, sometimes called the Senegalese upwelling influence (SUI). Offshore, the SUI generally migrates from north of 15oN to south of 7oN on a seasonal basis, providing a fluctuating, but distinct boundary to the region. At the coast however, the seasonal amplitude in boundary position is reduced and remains northward of the Bissagos Islands throughout the year. The SUI shows different seasonal and interannual patterns of variability to Gulf of Guinea.

The southern boundary of the Guinea Current region is less well defined, but is generally thought to be formed by the South Equatorial Current (SEC). The SEC also forms the northern limb of the South Atlantic subtropical gyre and is fed by the Benguela current. From the foregoing, it is obvious that the oceanography of the Guinea Current region is influenced by both equatorial dynamics from the north and seasonal cold-water upwelling in the south.

In summary, the boundaries of the Guinea Current area can be defined geographically and oceanographically. Geographically, the GCLME extends from approximately 12o N latitude south to about 16o S latitude, and variously from 20o west to about 12o East longitude. From an oceanographic sense, the GCLME extends in a north-south direction from the intense upwelling area of the Guinea Current south to the northern seasonal limit of the Benguela Oceanographic Curren. In an east-west sense, the GCLME includes the drainage basins of the major rivers seaward to the GC front delimiting the GC from open ocean waters (a time- and space-variable boundary).

Thus, the GCLME area includes the Exclusive Economic Zones (EEZ) of sixteen countries: Angola, Benin, Cameroon, Congo, Côte d'Ivoire, Democratic Republic of Congo, Gabon, Ghana, Equatorial Guinea, Guinea, Guinea Bissau, Liberia, Nigeria, Sao Tome e Principe, Sierra Leone and Togo. The coastal habitats in the GCLME include nearshore waters, salt marshes, mangrove swamps, estuaries, lagoons as well as other brackish bodies of water. The total length of its coastline is nearly 7,600 km, including the coastline of the island State of Sao Tome e Principe and the insular regions of Equatorial Guinea (i.e., Bioko and Annobon islands). Angola has the longest coastline of approximately 1,650 km (Table 2.1).

Table 2.1: Continental shelves and Exclusive Economic Zones (EEZ) areas of GCLME member countries

Country	Continental Shelf (km^2)	EEZ (km^2)
Guinea Bissau	45,000	156,500
Guinea	47,400	71,000
Sierra Leone	25,600	165,700
Liberia	18,400	229,700
Côte d'Ivoire	10,200	104,600
Ghana	23,700	218,100
Togo	1,300	2,100
Benin	3,100	27,100
Nigeria	46,300	210,900
Cameroon	10,600	15,400
Equatorial Guinea	14,710	283,200
DR Congo	1100	68,400
Congo	11,300	60,000
Gabon	46,000	213,000
Sao Tome & Principe	1,459	160,000
Angola	51,000	330,000

Source: FAO, 1997 & World Resources1994-1995

Major geomorphologic features of the continental shelf include bathymetric undulations of sand ridges, canyons, gullies, dead holocene coral banks, pockets of hard ground and rocky bottoms (Awosika and Ibe, 1998). Submarine canyons are found in some places; off the Vridi canal (Trou Sans Fond), in Côte d'Ivoire; off west Nigeria (Avon Deep), off the Volta Delta in Ghana; off the west coast of the Niger Delta (Mahin Canyon) and off the Calabar estuary both in Nigeria (Allersma and Tilmans, 1993). The lagoons covering more than 100 km2 include Nokoue and Porto Novo in Benin; Ebrie, Aby-Tendo-Ehy, and Grand Lahou in Côte d'Ivoire; Nkomi, Idogo, Ngobe, and Mbia in Gabon; Keta-Avu in Ghana; Lagos and Lekki in Nigeria, and Conkoti lagoon in Congo.

Four subsystems have been delineated in the Gulf of Guinea LME, each defined by its particular characteristics, which nevertheless do not impaire the overall functioning of the guinea current ecosystem (Tilot and King, 1993). These subsystems include:

1. Sherbro area;
2. Central-west African upwelling area;
3. Central gulf of guinea;
4. Southern gulf of guinea.

2.1.1 Sherbro area

The Sherbo area extends from the Bissagos Islands (Guinea Bissau) to cape Palmas (Liberia/Côte d'Ivoire). The area is characterized by an important continental shelf, probably the largest in West Africa. The large riverine input from the important hydrographic system is partly responsible for its thermal stability. Stability here refers to the existence of the thermocline line which separates two water masses; a relatively warm and stable surface water above the thermocline and below it a bottom layer of relatively cold water. In the golf of guinea in general and more especially in the Sherbro area, these two water masses coexist all year long although the position of the thermocline line can fluctuate.

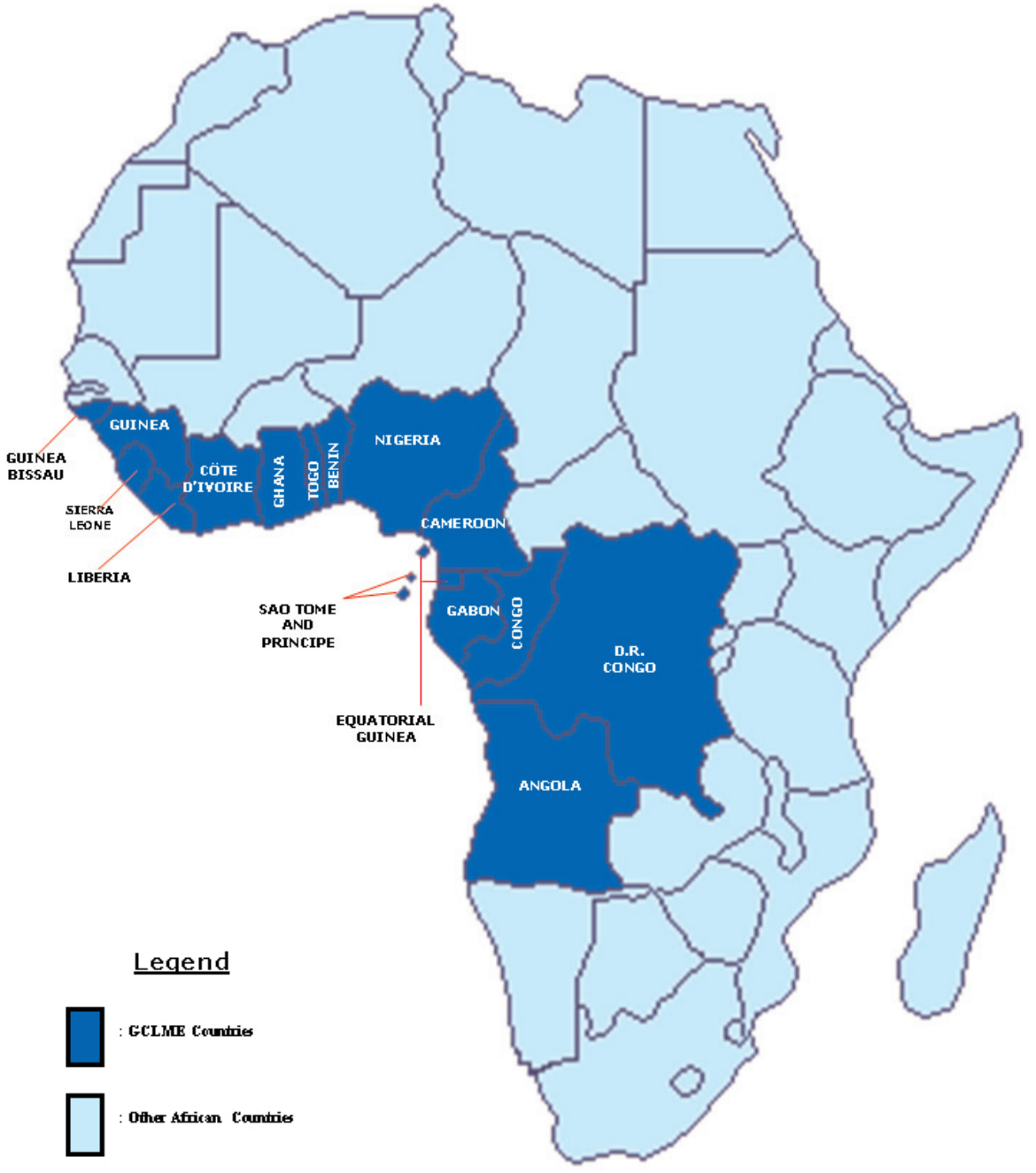


Figure 2.1: Location of the GCLME member countries on the Atlantic coast, Africa.

Photo 2.1: Touristic asset under threats from natural forces and human activities (Cape Esterias beach in Libreville, Gabon).

2.1.2 Central-West African upwelling

The central-west African upwelling extends from Cape Palmas to Cotonou (Benin). This subsystem is thermally unstable because of seasonal upwelling of cold, nutrient-rich and subthermocline water, dominating its annual cycle. It is believed that the dynamics of these periodic upwellings constitutes the biological drive of the sub-ecosystem.

2.1.3 Central Gulf of Guinea

The central gulf of guinea extends from Cotonou to Cape Lopez (Gabon), including the offshore islands of Bioko and Sao Tome e Principe. This area is characterized by thermal stability and a strong picnocline. It largely depends on nutrient input from land drainage, river flood and turbulent diffusion for its productivity (Tilot and King, 1993; Binet and Marchal, 1993). Some studies have shown that seasonal upwellings do occur in the central gulf of guinea (Ibe and Ajayi, 1985).

2.1.4 Southern Gulf of Guinea

The sourthen gulf of guinea extends from Cape Lopez (Gabon) southwards to the nourthern part of Angola. The dynamics of the benguella upwelling and the important input from river discharges of Gabon and Congo as well as the important mangrove swamps of that part are responsible for the high productivity of the sub-ecosystem.

2.2 Hydrography, sedimentation and coastal erosion

Three narrow coastal sedimentary basins, with a few volcanic intrusions and outcrops of hard rock forming the major capes, have developed on the edges of the coastline along the Guinea Current region: from north to south, they include the Côte d'Ivoire basin, the Niger basin (Delta) and the coastal basins from Gabon to Angola (R.E. Quelennec, 1987). All along these three coastal sedimentary environments there is strong influence of the pattern of river basin drainage. Numerous small rivers and four major river systems drain the entire coast of the GCLME from Guinea Bissau to the Democratic Republic of Congo. The GCLME is one of the most endowed areas of the globe in terms of rivers. The most important rivers draining into the GCLME coastal area include:

1. Niger, which drains an area of over 1 million km2;
2. Volta River, with a drainage basin of 390,000 km2 (World Bank, 1994);
3. Congo River with the second largest mean annual run-off and catchment area in the world, with freshwater run-off and sediment discharge estimated at 30-80 tons/km2;
4. Comoe River in Côte d'Ivoire;
5. Sanaga River in Cameroon;

These rivers enter the Atlantic ecosystem from an extensive network of catchment basins transporting great quantities of sediments (Table 2.2). They contribute more than 92 million tonnes of sediment per annum into the Gulf of Guinea (Mahé, 1998; Folorunsho et al., 1998). During the 1970s and 1980s, river inputs decreased in the region coinciding with the period of the sub-Saharan drought (Lamb, 1982) that resulted in reduced flows of almost all the rivers (Mahé, 1998). Substantial quantities of nutrients originating from domestic and agricultural effluents, which are used in primary production, are carried to the sea through this river outflows. Excessive nutrient loading causes eutrophication and harmful

algal blooms, however. The rivers transport industrial wastes, particularly from mining and other land based activities. The most important rivers draining into the GCLME coastal area include:

The majority of these rivers have been dammed mostly for energy and irrigation purposes, resulting in significant alteration of their hydrology and sediment flow, creating inevitable downstream impacts and accelerating coastal erosion processes. The coastal basins, particularly along the Niger delta, are gradually subsiding due not only to the natural geology of the area, but also to human activities such as oil mining and natural gas exploitation. These factors combined, yield negative consequences such as displacement of structures, people and economies of coastal communities and coastal cities (Ibe, 1988).

Coastal erosion constitutes a serious problem in many countries in the GCLME. The rate of the coastal retreat can average several meters per year (for example erosion rates caused by port structures in Liberia, Togo, Benin and Nigeria sometimes reach a staggering 15-25 m per year). Although the coastline is highly subject to natural erosion and sedimentation processes due to high wave energy, strong littoral transport amongst others, erosion has been intensified mainly by human activities, notably through sand mining and exploitation, disturbance of the hydrographical cycles, river damming, port construction, dredging, and mangrove deforestation. Harbour construction activities have altered long shore current transport of sediment and in many cases have led to major erosion and siltation problems. Actions to control erosion around these ports are critically important to maintaining their vitality as sites for growing touristic, recreational, commercial and defence needs. These aspects described above, are particularly relevant to the Western part of GCLME and particularly for the countries Benin, Côte d'Ivoire, Ghana, Nigeria and Togo. Examples of coastal erosion rates in western Africa are given in UNEP (1999) as follows:

1. Liberia:mean recession of 2m per year around Monrovia
2. Ghana: mean recession of 6m per year west of Accra since the closing of the Akosombo dam in 1964
3. Nigeria: coastal recession of approximately 500m has been recorded at Victoria Island since the construction of the Lagos Harbour in 1907 (average of 5 m/year)
4. Togo and Benin: retreat rates of up to 500m have been recorded since the construction of the Lome and Cotonou ports (erosion rate of several meters per year)

Other factors affecting the GCLME coast are pollution and sea-level rise. Particularly within the Niger freshwater river basin, the existing agro-chemical and agricultural run-off, the sedimentation load and the urban and industrial waste waters have certain notable impacts on ground and surface water quality. Along the coast, the potential in terms of sea-level rise and its impacts is also great. Some effects include shoreline retreat and erosion, increased frequency of submergence of the coastal wetlands and salt-water intrusion into estuaries and coastal aquifers.

Table 2.2: Sedimentological characteristics of rivers in some countries of the GCLME

Country	Catchment 1000 km^2	Sediment yield t/km^2 /yr	Sediment load 1000 t/yr	Sand Mi m^3/yr
Côte d'Ivoire				
R. Sassasdra	79		2,900	0.28
R. Cavally	44		5,300	0.51
R. Bandama	97	65	7,200	0.68
R. Comoe	110		6,700	0.64
Total	340		22,100	2.13
Ghana				
R. Pra	38		2,400	0.27
R. Volta	402		15,500	1.06
Total	440	70	17,900	1.33
Togo				
R. Mono	29		1,600	0.18
Total	29	60	1,600	0.18
Benin				
R. Oueme	48		2,400	0.23
Total	48	50	2,400	0.23
Nigeria				
R. Ogun	47		1,100	0.1
R. Niger	2,156		40,000	2.5
R. Cross	60		7,500	0.7
Total	2,263	80	48,600	3.3

(Adapted from Per Roed J., 1989)

2.3 Geology and geomorphology

The Volta, Niger and Congo basins dominate the coastal geology of the Guinea Current region. Another recognizable tectonic feature in the region is the Benue rift, parallel to the volcanic Cameroon mountains that extend into the ocean as islands of Fernando Po, Principe, Sao Tome and Pagalu. Geomorphologically, the Guinea Current Coastal Zone consists of: (1) low-lying sandy barrier islands, behind which are a complex lagoon network that stretches from Côte d'Ivoire to the Niger Delta in Nigeria and creeks; (2) muddy coast e.g. the Mahin mud coast in Nigeria; (3) isolated pockets of clifted and rocky coast especially around Cape Three Points in Ghana, off Senegal and Cameroon occurring as extensions of the African canyon; and (4) a narrow continental shelf. In general the continental shelf of the area is quite narrow ranging between 15 and 105 km. The widest part of the continental shelf is off Guinea. Off Abidjan in Côte d'Ivoire, the shelf is divided into two sections by a "bottomless pit" ("le trou sans fond") that extends almost to the shoreline. From there, the shelf widens towards the east reaching its widest part of about 90 km between Cape Coast and Takoradi in Ghana. The shelf narrows again further eastwards between Tema (Ghana) and Lagos (Nigeria). Off Nigeria, the middle shelf configuration is modified by the Avon, Mahin and Calabar canyons, as well as pockets of dead Holocene coral banks (Williams, 1968; Ssentengo et al., 1986; Awosika and Ibe, 1998). East of Lagos, the shelf widens to about 85 km off the Niger Delta beyond which it (the shelf) narrows to an average width of 30 - 40 km. The shelf generally breaks at depths of between 100 and 120 m (Awosika and Ibe, 1998). A belt of dead corals runs almost parallel to the coastline at a depth of between 50 and 140 m in the Guinea Current Region and submarine canyons occur at a number of locations off Côte d'Ivoire, Ghana and Nigeria.

Photo 2.2: River Comoé winding majestically in coastal Côte d'Ivoire

Major geomorphic features of the Guinea Current shelf include bathymetric undulations of sand ridges, canyons, gullies, dead Holocene coral banks, pockets of hard grounds, rocky bottom and deep seated and shallow fault structures (Awosika and Ibe, 1998). In summary, the coastal morphology of the GCLME region is a succession of:

1. Sandy arid coastal and plains bordered by eolian dunes (Angola);
2. More or less sandy marshy alluvial with estuaries and deltas, colonized by mangrove vegetation (Guinea-Bissau and Guinea, Sierra Leone);
3. Rocky scarps and sandy beaches, alternating with mangrove vegetation (Sierra Leone, Liberia, eastern Nigeria to Gabon);
4. Low sandy coastal plains which alternate with lagoons along the Gulf of Guinea (Côte d'Ivoire, Ghana, Togo, Benin, Congo estuary up to the Angolan border);
5. Huge marshy areas formed by the Niger delta, with mangroves indented by fluvial channels that are subject to tidal influence;
6. Extensive coastal lagoons.

There are also a number of islands and archipelagos in the eastern part of the Guinea Current region namely, Sao Tome and Principe and Annabon in Equatorial Guinea.

2.4 Oceanography

The Gulf of Guinea and adjacent areas of the eastern tropical Atlantic, bordered to the north by the Canary Current coastal upwelling region and to the south by the Benguela Current coastal upwelling region, are affected by five major basin-wide wind-driven cells of ocean circulation. These are the North Atlantic Subtropical (NAS), North Equatorial Cyclonic (NEC), Equatorial Anticyclonic (EA), and South Equatorial Cyclonic (SEC) gyres. The circulation cells are formed due to latitudinal variations in the wind stress, that is due to the existence of the subtropical anticyclones and Intertropical Convergence Zone (ITCZ), which separates the belts of the northeast and southwest trade winds. The major surface currents forming the peripheries of the gyres are the North Equatorial Current (NEC), South Equatorial Current (SEC), North Equatorial Counter Current (NECC), South Equatorial Counter Current (SECC), Guinea Current (GC), and Angola Current (Stramma and Schott, 1999). Other current systems that may affect near surface circulation in the region are the equatorward Canary Current (CC) feeding the NEC in the north and the Benguela Current (BC) feeding the SEC in the south. The NEC, SEC, NECC, and SECC are the westward and eastward cross-basin flows while the Canay Current (CC), Guinea Current (GC), Agulhas Current (AC), and Benguela Current (BC) form the system of the tropical eastern boundary currents. In the seasonal course, the ITCZ migrates from its southern position in winter to its northern position in summer. The circulation cells in the ocean follow the ITCZ migrations with some delay.

Due to the asymmetry in the distribution of water and land in this part of the Atlantic, the ITCZ is mostly located north of the equator and cross-equatorial winds favor oceanic upwelling at the equator. The trade winds pile up warm surface water at the western coast of the Atlantic thus creating a pressure gradient that gives rise to the eastward flowing equatorial undercurrents. These are the Equatorial Undercurrent (EUC), North and South Equatorial Undercurrents (NEUC and SEUC).

An analysis of physical (current velocity, temperature, salinity) and chemical (nutrient salts, dissolved oxygen, chlorofluorocarbons) parameters has shown (Bourlès et al., 2002) that the EUC is located between latitudes 2° N and 2° S, with greatest flow intensity at 100m depth. The SEUC and NEUC are weaker underflows located near latitudes 4° N and 4° S in the 100 to 300m depth range.

The NEC is a broad current that has a westward mean velocity between 10-15 cm/s (Richardson and Walsh, 1986). The NEC reaches peak values of 15 cm/s in boreal summer (Arnault, 1987). The mean eastward velocity for the NECC, meandering between 3 and 10°N, in the eastern part of the ocean is about 15 cm/s. This increases to speeds of more than 30 cm/s in the Guinea Current (Arnault, 1987). The greatest flow of the NECC occurs in boreal summer with eastward speeds of up to 30 cm/s that are reduced during the spring (Richardson and Walsh 1986). The Guinea Current flows east at approximately 3°N along the western coast of Africa (Henin et al. 1986). When it reaches the Gulf of Guinea, it can obtain velocities close to 100 cm/s near 5°W (Richardson and Reverdin 1987). The Angola Current is a poleward continuation of the GC. It forms the eastern periphery of a sub-basin scale cyclonic gyre, the Angola Dome (AD). The center of the gyre is on average located at 10°S, 10°E (Gordon et al., 1991). In the upper layer, the Angola current may be considered an extension of the southeastern branch of the SECC and EUC. Moroshkin et al. (1970) described the Angola Current as a stable flow over the shelf and continental slope of Angola that reaches 250-300-m depths. In general, the current is weaker during boreal summer and stronger during winter. The SEC appears in all seasons as a strong westward flow near the equator (approximately 30 cm/s) and as a broad weaker flow further south near 10°S (10-15 cm/s). There is a great deal of variability in the equatorial ocean since the weakness (or absence) of the Coriolis forces makes the surface flows highly susceptible to wind forcing.

The Guinea Current is weaker during boreal winter and intensifies during the summer (Richardson and Philander, 1987). This flow, like other eastern ocean boundary currents, is characterized by areas of upwelling (Bakun 1978) and increased biological productivity (Binet 1997). The GC is a geostrophically balanced current with isotherms sloping upwards towards the coast. As the current intensifies, the slope becomes steeper bringing the thermocline closer to the surface near the coast. The coastal upwelling and the boreal summer intensification of the GC are thus related (Philander 1979).

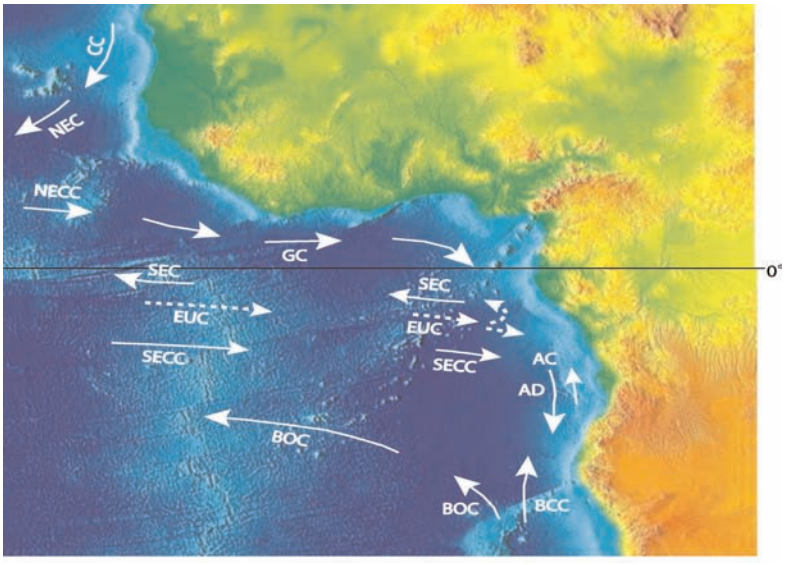


Photo 2.3: Current patterns in the GCLME Region.

Coastal upwelling occurs seasonally along the northern and eastern coasts of the Gulf of Guinea. The major up welling season occurs from June to August and transient upwelling events occur also in January and February. The most remarkable characteristic of the Gulf of Guinea coastal upwelling is the absence of correlation between local wind stress and coastal temperature, at least during the boreal summer season. There is evidence of eastward propagation of the upwelling along the equator and then southward propagation of the signal along the coast suggesting that the seasonal shoaling of the thermocline in the Gulf of Guinea is partly induced by Kelvin waves (Adamec and O'Brien, 1978). This remote forcing of the upwelling is well documented and supported by numerical models and data analyses. However, local-forcing mechanisms may also play a role in modifying the remotely generated upwelling events. Dynamic upwelling has also been reported in the region (Ibe and Ajayi, 1985).

The entire GCLME is highly stratified with a thin surface layer of warm low salinity tropical waters (25-29°C, 33-34 PSU), overlying high salinity subtropical water (19-28°, 35-36.5 PSU). An additional contribution of saline water comes from subducted subtropical water from the North Atlantic. The lower salinities characteristics of the coastal surface water reflect excess of precipitation over evaporation in the Niger delta of Nigeria. On this shelf tropical surface water mass becomes much influenced by river discharges through the existence of a discrete plume of river discharge waters. The stratification of the upper water column along the Guinea Current coast is generally strong except in areas subject to upwelling events (Fig. 2.2).

Using time series analysis, Koranteng (1998) showed that the trend of offshore sea surface temperature in the Gulf of Guinea (obtained from the Comprehensive Ocean Atmosphere Dataset (COADS) (Woodruff et al., 1987)) exhibits a general increase since 1946 (Figure 2.2). The hydrographic regimes and coastal processes in the Gulf of Guinea are the major factors that determine fish stock abundance and distribution in the region (Williams, 1968; 1969; Koranteng et al., 1996). For example, the abundance and distribution of small pelagic fish stocks are controlled mainly by the intensity of the seasonal coastal upwellings (FRU/ORSTOM, 1976; Bard and Koranteng, 1995). During the upwelling, high biological activity takes place; phytoplankton and zooplankton production rise considerably, and most fishes spawn at this time (Houghton and Mensah, 1978). The main fishing season in the area occurs during the major upwelling period (Mensah and Koranteng, 1988).

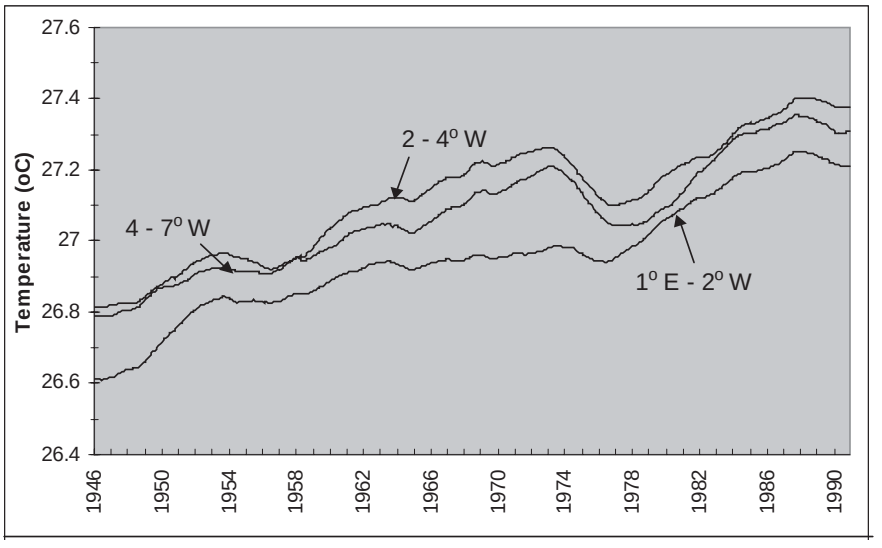


Figure 2.2: Sea surface temperature trends in the Gulf of Guinea. Three areas between the coastline and latitude 4oN and the indicated Longitudes

Both the Canary and Benguela currents transport cool waters towards the Equator and have current speeds of approximately 20 cm/sec. All the currents are essentially wind-driven. As a consequence, the upwelling phenomena, generated by the regional wind systems, dominate in bands of some tens of kilometer widths adjacent to the coast. The cool and richer upwelling waters prevail along the northwestern part from November to April/May along limited parts of the northern parts of the Gulf of Guinea, and strongly in winter along the southern coastline (August), weaker in summer (November-February) (World Bank Report, 1994). The thermal instability and intensive seasonal upwelling (around the Cote d' Ivoire-Ghana border) characterize the northern subsystem of the GCLME. The southern subsystem is generally stable depending on nutrient input originating from land drainage and river flood and oceanic turbulent diffusion, although periodic upwellings have been reported. These characteristics combine to make this area one of the world's most productive marine areas rich in fishery resources and an important reservoir of marine biological diversity.

2.5 Important ecosystems

The coastline of the region is generally low-lying and interspersed with marshes, lagoons and mangrove swamps. A number of estuaries interrupt the barrier beaches that separate mangrove swamps from the sea. A large variety of ecotones or habitats exist in the GCLME. Among these, the most important are: (1) wetlands habitats, (2) coastal lagoons, (3) seagrass beds, (4) sandy beaches and (5) mangrove swamps.

2.5.1 Wetland habitats

Wetland habitats, where mangrove forests are the most apparent features (close to 25,000 km2 from Guinea Bissau to Angola). The areas of highest mangrove concentration are located along the coasts of Guinea and Guinea Bissau, Sierra Leone and in the Niger delta of Nigeria. The huge marshy area formed by the Niger delta is colonised by mangroves indented by fluvial channels that are subject to tidal influence. The delta and associated wetlands of the Niger River rank among the largest mangrove forests in the world at approximately 7,415 km2 (Scott, 1966). The wetland is made up of permanent saline creeks, inter-tidal mangrove swamps, estuaries and beach ridges. Although these mangrove forests are less diverse in terms of species than those found in East Africa, they are the best developed and most extensive in Africa (Table 2.3). Most of the coastal wetlands provide unique ecological conditions and habitats for migratory birds. They function also as a nursery grouinds for valuable fish and shellfish, but remain unprotected with regards to natural and human influences.

Photo 2.4: Environmental degradation resulting from haphazard development of coastal areas in the region (Keta in Ghana)

2.5.2 Coastal lagoons

Coastal lagoons, of the Gulf of Guinea (Table 2.3), are associated with freshwater rivers, deltas, and estuaries and include a wide range of tidal swamps and seasonal marshland. They are like the mangrove swamps areas of high productivity and support the production of adjacent fisheries.

2.5.3 Sea-grass beds

Sea-grass beds which are not very well developed in the region, although there are indications of isolated patches in some estuaries and delta mouths. There are no true reefs along the GCLME coast mainly due to the cool waters of the Benguela and Canary currents.

2.5.4 Sandy beaches

Sandy beaches, particularly along the Angolan coast. They are considered important nesting ecosystems, particularly for sea turtles. Their exposure to strong currents and swells make them extremely dangerous, however. These areas are often subject to marine debris and detritus accumulation.

2.5.5 Mangrove swamps

Mangrove swamps are one of the the most biologically significant coastal ecosystems in the GCLME region (Table 2.3). Mangroves, typically *Rhizophora sp, Conocarpus sp, Avicennia sp, Mitragyna inermis, Laguncularia sp,* occur almost everywhere along the coasts in the GCLME and are dominant in certain places, such as the Niger Delta of Nigeria which has Africa's largest and the world's third largest mangrove forests (Ukwe et al., 2001).

Wetlands and mangrove forests are major habitats in the Niger Delta of Nigeria supporting vegetation that is adapted more or less to continuous water-logging and includes marshes, sloughs and estuaries. The estimated total area of wetlands in the Niger Delta is approximately 1,794,000 ha, consisting of 617,000 ha of saline and 1,177,000 ha of freshwater swamp land (NEST, 1991). These areas serve as spawning and breeding grounds for many transboundary fish species and shrimps. Table 2.5-2 lists many of the mangrove areas in the six countries participating in the pilot phase Gulf of Guinea Large Marine Ecosystem (GoGLME) project.

Presently, mangrove forests in the GCLME region are under serious pressure from over-cutting (for fuel wood and construction timber) and from other anthropogenic activities. Their role in the regeneration of living resources, and as reservoirs of biological diversity, is at stake. Results obtained during the pilot phase Gulf of Guinea LME project showed that in Ghana, 55% of the mangroves and significant wetlands around the greater Accra area have been decimated through pollution and over cutting. In Benin, the figure is 45% in the Lake Nokoué area, and 33% in the Niger Delta of Nigeria. In Cameroon, 28% of the Wouri Estuary has been destroyed and in Côte d'Ivoire, more than 95% of the mangroves in the Bay of Cocody have been cut (Isebor, 1999). Various human activities in the coastal countries destabilise the mangrove ecosystem, consequently affecting the health of the ecosystem.

Table 2.3: Mangrove and important coastal lagoons areas (in km2) of the GCLME region

Country	Marine Area	Mangrove Area	Lagoons	Lagoon Area
Benin	7,900	30	Nokoué Porto-Novo	139.50 17.52
Cameroon	4,500	4,860	*	*
Côte d'Ivoire	30,500	640	Ebrié Aby-Tendo-Ehy Grand Lahou	560 410 250
Equatorial Guinea	82,600	120	Volcanic crater lakes	*
Gabon	62,300	1,150	Nkomi Ndogo Ngobe Mbia	806 582 402 242
Ghana	63,600	100	Keta-Avu Sakumo-Accra Songaw Korle†	330 23.6 18 0.6
Nigeria	61,500	12,200	Lagos† Lekki	460 247
Sao Tome	600	10	*	*
Togo	37,400	*	Togo Vogan (Boko) Aneho	46.6 8 3

(In Awosika & Abe, 1998)
NB: * No Lagoon of appreciable size; † heavily polluted lagoon

Photo 2.5: A mangrove forest in Côte d'Ivoire

Table 2.4: Inventory of mangrove and associated vegetation in six countries of the GCLME

Family	Species	CIV	GHA	TOG	BEN	NIG	CMR
Rhizophoraceae	*Rhizophora racemosa*	+	+	+	+	+	+
	R. mangle		+			+	+
	R. harrisonii		+			+	+
Avicenniaceae	*Avicennia africana*	+	+	+	+	+	+
Combretaceae	*Conocarpus erectus*	+	+		+	+	+
	Laguncularia racemosa		+	+	+	+	+
Papilionaceae	*Dalbergia ecastaphyllum*	+	+		+	+	+
	Drepanocarpus lunatus	+	+	+	+	+	+
Adiantaceae	*Acrostichum aureum*	+	+	+	+	+	+
Gramineae	*Pennisetum purpureum*					+	+
	Setaria sphaecelata						+
	Hyparrhenia rufa						+
Palmaceae	*Nypa fructican*					+	+
	Raphia vinifra					+	+
	Raphia hookeri	+				+	+
Mimosaseae	*Albizzia sp*					+	+
Loganiaceae	*Anthocleista liebretchsiana*						+
	A. vogelii						+
Poaceae	*Paspalum distichum*			+			
	Paspalum vaginatum	+	+	+	+	+	
	Panicum repens						
	Echinochloa pyramidalis						
	Phylanthus muellerianus				+		
Arecaceae	*Phoenix reclinata*		+	+	+		
Ficoidaceae	*Sesuvium pertulacastrum*		+		+	+	
Malvaceae	*Hibiscus tiliaceae*	+	+			+	
Convolvulaceae	*Ipomea pes-caprae*		+			+	
	I. brasilensis				+		
	I. aquatica						
	I. stolonifera						
Portederiaceae	*Eichhornia crassipes*	+				+	+
Pandanaceae	*Pandanus candelabrum*	+				+	
Cyperaceae	*Cyperus articulatus*	+		+	+		+
	Eleocharis variegata	+		+			
	Scleria vogelii	+					
Moraceae	*Ficus ovata*	+					
	Ficus congensis	+				+	
	Ficus sp						+
Typhaceae	*Typha latifolia*					+	
	T. australis		+			+	

Sources: Egnankou, W. N. (1993), Sankare, Y. (1998), Sackey E. L. et al.,(1993), Adomako, J. (1998), Akpangana, K. et al.,(1993), Akpagana, K. (1998), Hoachimou, I (1993), Akoegninou, A. (1998), Isebor, C. E. et al.,(1993), Isebor, C. (1998), Zogning, A. (1993), Nganje M (1998).

2.6 Biodiversity

2.6.1 Avian fauna

The Gulf of Guinea is included in the West African flyway, which is the major annual bird migration route between breeding and wintering areas, including stop-over areas in between. Most of the coastal wetlands in the region provide unique ecological conditions and habitats for migratory birds, many of which come from Europe.

Among the marine and seashore birds found in the Gulf of Guinea are: Common Ringed Plover (*Charadrius hiaticula*), Knot (*Calidris canutus*), Curlew Sandpiper (*Calidris ferruginea*), Bar-tailed God wit (*Limosa lapponica*), Cattle Egret (*Bubulcus ibis*) and the white-winged Tern (*Chlidonias leucopterus*). Also, a number of seabirds breed in the area between Guinea Bissau and Angola. This includes the gull-billed Tern (*Gelochelidon nilotica*), the Royal Tern (*Sterna maxima albididorsalis)* the white-tailed tropic bird (*Phaeton lepturus*) and the brown Booby (Sula leucogaster). It is estimated that the area between Sierra Leone and Ghana holds about 700,000 waders in winter (Smit and Piersma, 1992). A conservative estimate puts the corresponding number between Ghana and Angola at about 300,000 birds.

The main threats to the survival of both endemic and migrant birds in the Gulf of Guinea include habitat loss due to urbanization and agricultural activities, as well as pollution from activities connected with the oil industry. Unfortunately, some of the countries in the region (e.g., Nigeria and Cameroon) are not parties to the Convention on the Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention of 1971). Ramsar sites are delineated, protected, studied and managed.

Table 2.5: List of all endemic and threatened Bird species

Country	Breeding species	Endemic	Threatened	No. of species per 10,000km^2
Angola	765	13	13	156
Benin	307	0	1	138
Cameroon	690	8	14	193
D.R. Congo	929	22	26	153
Congo	449	0	3	140
Côte d'Ivoire	535	0	12	170
Equatorial Guinea	273	3	4	194
Gabon	466	0	1	157
Ghana	529	1	10	186
Guinea	409	0	12	142
Guinea-Bissau	243	0	1	159
Liberia	372	1	13	168
Nigeria	681	2	9	153
Sierra Leone	466	0	12	243
Togo	391	0	1	220
Total	7,505	50	132	

Source: World Resources1998-99

2.6.2 Flora

The GCLME coast is home to vast forest resources that are both biologically and socio-economically significant. forest resources of the tropical coast of some states provide an important source of fuel wood, medicinal plants, food and timber for coastal inhabitants (Galega, 2001). The mangrove species prevalent along the coast provide the nutritional inputs to adjacent shallow channel and bay systems that constitute the primary habitat, spawning and breeding grounds for many aquatic species of commercial importance. Mangroves of the GCLME are particularly important resources for coastal communities as they are used for firewood, fish smoking, building materials, salt production, oyster culture, fisheries and medicinal purposes. Unfortunately, overuse and, to a lesser extent, pollution, haphazard urbanisation and industrial growth are serious threats to the biodiversity of these fundamental and fragile ecosystems and have led to their destruction and reduction. Marine flora biodiversity has received less attention than its terrestrial counterpart, due to probably of more emphasis on the terrestrial components.

Table 2.6: List of some endemic and threatened higher plants

Country	All species	Endemic species	Threatened species	No. of species per 10,000 km^2
Angola	5,000	1,260	25	1,017
Benin	2,000	x	3	899
Cameroon	8,000	156	74	2,237
D. R. Congo	11,000	1,100	7	1,817
Congo	4,350	1,200	3	1,356
Côte d'Ivoire	3,517	62	66	1,118
Equatorial Guinea	3,000	66	9	2,135
Gabon	6,500	x	0	2,197
Ghana	3,600	43	32	1,264
Guinea	3,000	88	35	1,043
Guinea-Bissau	1,000	12	0	655
Liberia	2,200	103	1	1,037
Nigeria	4,614	205	9	1,036
Sierra Leone	2,090	74	12	1,091
Togo	2,000	x	0	1,128
Total	61,871	4,369	276	

Source: World Resources1998-99
NB: * Flowering plants only

2.6.3 Marine species

The GCLME is rich in marine species including molluscs and crustaceans, small mammals such as statungas, otters, *Atilax paludinosus*, *Dasymys incomtus* and large mammals such as *Cephalophus sp*. Molluscs found in this habitat include *Crassostrea gasar* (clams), *Arca senilis* (volutes), *Cymbium pepo*, cones, cowries and conches. These molluscs form an important basis for fish and bird food chains as well as being a major food source for humans. Mangroves also harbor some species of crocodiles and the endangered West African manatee Trichechus senegalensis.

Four of the seven remaining species of marine turtles in the world can be found in the Gulf of Guinea where they lay their eggs at selected places along the shores (Table 2.7). These are the Atlantic Green (*Chelonia mydas*), the Leatherback (*Dermochelys coriacea*), the Hawksbill (*Eretmochelys imbricata*), and the Olive Ridley (*Lepidochelys olivacea*). Green turtles are classified as endangered and Hawksbill turtles are classified as critically endangered (WCMC, 1996). Despite international initiatives to protect these endangered species (Table. 2.7), marine turtles are still secretly hunted for food throughout the Gulf of Guinea. Their eggs are also collected by humans and destroyed by dogs and pigs on the beaches.

In some shrimp fisheries in the sub-region (e.g. in Nigeria and Cameroon), introduction of the turtle excluder device (TED) is being considered. This device allows turtles to escape from shrimp nets when caught.

Marine mammals that inhabit the waters of the Gulf of Guinea are mainly cetaceans (whales and dolphins) and sirenians (manatees). Of special importance are the Atlantic Humpbacked dolphin (*Sousa teuszii*) and the African manatee (*Trichecus senegalensis*). Both species appear on the IUCN Red List of endangered species whereas the African manatee is classified as vulnerable and the humpbacked dolphin as highly endangered under CITES (Donoghue and Wheeler, 1994; WCMC, 1996).

It is reported (Jefferson et al., 1983; Elder and Pernetta, 1991) that whales especially toothed, fin and humpback whales migrate to the waters of the Gulf of Guinea from Antarctica at the end of summer. In Congo, the most important aquatic mammals are Lamantins (*Trichechus senegalensis*), while the Hippopotamus (*Hippopotamus amphibius*) seems to have disappeared.

In general, marine biodiversity in GCLME region is very rich and diverse. The total number of species is not yet well known; already one can expect more than 480 species (Table 2.8). Using a classification based on the important commercially exploited finfish and shell fish provides another magnitude of the importance and diversity of the biodiversity in the GCLME ecosystem (Table 2.9).

Photo 2.6: Marine turtles (typified by Dermochelys coriacea) are part of the biological diversity of the region.

Table 2.7: Status of Marine Turtles in the Guinea Current LME According to IUCN Red List Classification

Species	Common Name	IUCN Red List
Chelonia mydas	Green turtle	Critically endangered
Caretta caretta	Loggerhead turtle	Endangered
Eretmochelys imbricata	Hawksbill turtle	Critically Endangered
Lepidochelys olivacea	Olive Ridley turtle	Endangered
Dermochelys coriacea	Leatherback turtle	Endangered

(Source: WCMC, 1996)

Table 2.8: Marine Biodiversity in West and Central Africa

Flora and Fauna	No of Endemic species	Total species
Seagrasses	0	1
Corals	1	10
Molluscs	1	238
Shrimps and lobsters	3	47
Sharks	1	89
Seabirds	2	51
Marine mammals	2	44
Total	10	480

Source: World Resources1998-99

Table 2.9: Major groups, families and number of species of the commercially exploited finfish and shellfish of the Gulf of Guinea

GROUP	FAMILY	SPECIES
Bony fishes	80	627
Sharks	11	77
Batoid fishes (sawfishes, rays & skates)	7	41
Lobsters	3	3
Shrimps & Prawns	10	17
Cephalopods	7	23
Bivalves	17	47
Gastropods	13	26
Sea turtles	2	6

Source: FAO, 1990

Photo 2.7: Fish diversity: A trawl haul from the GCLME region.

2.6.4 Other species

Table 2.10 presents the number of species of mammals, endemic and threatnened as well as their relative density by country in the GCLME region. From this table D.R. Congo and Cameroon have th e highest number of endemic and threatened species in the region. It should however be considered that these figures are indicative, more studies should be carried out in order to have a pricise idea about this rich and important biodiversity.

Table 2.10: List of endemic and threatened mammals

Country	All species	Endemic species	Threatened	No. of species per 10,000 km^2
Angola	276	7	17	56
Benin	188	0	9	85
Cameroon	297	13	32	83
D.R. Congo	415	28	38	69
Congo Rep.	200	1	10	62
Côte d'Ivoire	230	1	16	73
Equatorial Guinea	184	3	12	131
Gabon	190	2	12	64
Ghana	222	1	13	78
Guinea	190	1	11	66
Guinea-Bissau	108	0	4	71
Liberia	193	0	11	87
Nigeria	274	6	26	62
Sierra Leone	147	0	9	77
Togo	196	1	8	110
Total	3,310	64	224	

Source: World Resources1998-99

In table 2.11 below, the endemic and threatened amphibians are also presented, country-by-country, in the GCLME region. It also appears that Cameroon and D.R Congo have the highest number of endemic and threatened species.

Photo 2.8: Hippopotamus, a threatened species in the Republic of Gabon

Table 2.11: List of some endemic and threatened amphibians

Country	Endemic	Threatened
Angola	22	0
Benin	0	0
Cameroon	66	1
D.R. Congo	53	0
Congo Rep.	1	0
Côte d'Ivoire	3	1
Equatorial Guinea	2	1
Gabon	4	0

Table 2.11 (continued): List of some endemic and threatened Amphibians

Country	Endemic	Threatened
Ghana	4	0
Guinea	3	1
Guinea-Bissau	1	0
Liberia	4	1
Nigeria	1	0
Sierra Leone	2	0
Togo	3	0
Total	169	5

Derived from World Resources1998-99

Reptiles are also present in the region. Their exact number is not yet well known, some sources of information (World resources, 1998-99) indicate ninety-nine endemic reptilian species (Table 2.12), among these 33% are in D.R. Congo and 20% in Cameroon. From these three tables, one can say that D.R. Congo and Cameroon have the highest endemic species in the region. This is also supported at the level of fish biodiversity (Djama, 2000).

Table 2.12: List of endemic and threatened Reptilian species

Country	Endemic	Threatened
Angola	18	5
Benin	1	2
Cameroon	20	3
D.R. Congo	33	3
Congo Rep.	1	2
Côte d'Ivoire	3	4
Equatorial Guinea	3	2
Gabon	3	3
Ghana	1	4
Guinea	3	3
Guinea-Bissau	2	3
Liberia	2	3
Nigeria	7	4
Sierra Leone	1	3
Togo	1	3
Total	99	47

Derived from World Resources1998-99

2.6.5 Protected Areas

Various protected areas exist in the region (Table 2.13). These areas do not adequately represent all the biogeographic zones in the region. Major gaps are apparent in the northern and southern parts of the region. Priority sites in the eastern Gulf of Guinea in the area of Cameroon and Gabon, where there are likely to be a number of important sites for rare and endemic West African coral species and associated marine life have not been identified. However, sites of national importance have been identified. Information is required to begin to plan the development of a system of MPAs that would adequately represent marine biodiversity in the region.

Table 2.13: Number of existing Marine Protected Areas in the GCLME Region

Country	Marine Areas	Coastal Areas
Angola	1	3
Cameroon	0	0
Congo	1	3
Côte d'Ivoire	0	3
Congo Democratic Republic	1	0
Equatorial Guinea	3	0
Gabon	1	1
Ghana	0	5
Guinea Bissau	3	2
Total	10	17

Source: adapted from World Bank/IUCN 1995)

3. Socio-economic and development setting

3.1 Human development and demography

The GCLME is a region of high ethnic-cultural and social diversity. Although the region is endowed with abundant renewable (sun, wind and hydro) and non-renewable (largely hydro-carbon and bio-mass) resources, these have not been optimally utilized for the enhancement of the quality of life of the people (Osuntogun, thematic review). Instead, poverty, paucity of social infrastructure, disease and social instability are the major characteristics of this richly-endowed region. Approximately 24% of the GCLME region's 238.96 million people live in the coastal areas and are heavily dependent on the lagoons, associated wetlands, and inshore waters surrounding them. The highest population density centers are located in some of the cities along the coast, including Accra-Tema (Ghana), Abidjan (Cote d' Ivoire), Douala (Cameroon), Lagos and Port-Harcourt (Nigeria) and Luanda (Angola). The rapid expansion of coastal populations has resulted in high population growth rates (4.49%) and urban immigration.

In 1995, Lagos became the World's 29th largest urban agglomeration, with 6.5 million inhabitants. In 2000, it was the 23rd largest with 8.8 million people. The city has become one of Sub-Saharan Africa's first mega-urban region when its metropolitan population reached 10 million inhabitants around 2002. Lagos, Accra, Abidjan and Douala continue to grow and by 2015 it is envisaged that these cities would become some of the world's largest urban centres with agglomerations of immense importance and great demand for infrastructure and urban amenities as compliments for the welfare of teeming populace of the GCLME countries. Like Lagos, Abidjan is the largest city of Cote d' Ivoire, with an estimated population of 3.3 million and taking up to 627 square kilometers in 2000. Abidjan represents 40 percent of the country's total urban population and 75 percent of its formal employment; Abidjan has a cosmopolitan character and welcomes migrants not only from regions throughout the country, but also from its neighbouring countries, including Burkina Faso (20%), Mali (9%), Guinea (9%), Togo and Benin Republic (12%) among other countries (UN-HABITAT Features). Representing 20% of the population of Abidjan, the residents of the slum areas live in marginal conditions due to labour and housing insecurity. Moreover, they are stigmatized by the rest of the population, and policies taken to improve slums and alleviate poverty, like in the other parts of GCLME countries remain uncoordinated.

In Central Africa, International migration is high in percentage terms (4.2% of the population of the sub-region) but more limited in size (1.5 million). Gabon has the highest percentage of migrants from both the region and the continent. These migratory flows are generated by labour demand in the lumber and mining industries in Cameroon, Equatorial Guinea and Congo Republic which are located around or areas bordering the coastal areas. Without integrated and coordinated policies, based on these estimates, if no pro-poor policies are implemented, urban slum population is projected to double on average every 15 years while total population doubles every 26 years (UN-HABITAT Features, p.2). This population increase in slums is having a spill-over effect on coastal cities and towns as a result of intense rate of urbanization of the coastal cities and areas.

The rapid population growth in the coastal zone has resulted in pollution of social values and culture, socio-economic dislocations and conflicts, in addition to serious environmental degradation. Similar to conditions in the rest of the world, many of the region's poor are crowded in the coastal areas for subsistence socio-economic activities, viz: fishing, farming, sand mining and production of charcoal in the mangrove areas. Additionally, more than 60% of the existing industries in the sub-region are concentrated in the coastal cities. In some instances like Abidjan, Accra, Lagos and a few other places, this concentration has become a major concern. These industrial areas are predominantly sited in major river catchments that drain into coastal wetlands, especially mangroves, lagoons and estuaries, aside polluting the air with an average of 0.52 metric tons of carbon dioxide per capita, thus recording one of the highest incidences in the world (Table 3.1).

Photo 3.1: Popular quarters in Libreville, an example of haphazard urban development in coastal areas.

In metropolitan and urban areas, social problems include inadequate housing facilities, poor state of educational facilities although there has been a remarkable improvement of literacy rate from an average of 47.2% in 1990 to 61% in 2002; relatively poor health facilities although again there is a slight average increase in the life expectancy in the GCLME region from 49 years in 1990 to 49.4 years in 2003, on the average; a relatively poor public higiene and a high crime rate.

Photo 3.2: Houses on the Lagoon in Côte d'Ivoire, yet another example of haphazard urban development in coastal areas.

Infant mortality has also dropped by about 10 percentage points, from . a There is a relatively poor public hygiene and a high crime rate with 113.6 per thousand in 1990 to 103.2 per thousand in 2003. However, the average number of deaths resulting from HIV/AIDS in the region is about 46,000 per country per annum. The average GDP per capita (PPP) at the end of 2003 was 3,563 US dollars. (See table B).

Due to political instability in many countries of the region, it has been difficult to create the institutional setting necessary for environmental management of the Gulf of Guinea as a region. Many of the states of the Gulf of Guinea are engaged in a number of regional initiatives; however these initiatives require greater coordination.

Table 3.1: Summary table of biophysical, social and economic indices of GCLME Countries

	Guinea Bissau	Guinea	Sierra Leone	Liberia	Côte d'Ivoire	Ghana	Togo	Benin
Length of coastline (km)	350	346	402	579	566	539	56	121
Surface area (km^2)	36,125	245,857	71,740	111,370	322,462	239,460	56,785	112,622
Area of continental shelf (km^2)	39,339	47,400	28,625	17,715	10,175	22,502	1,265	2,721
Width of continental shelf (km)	-	87-104	-	16 - 56	20 - 35	30 - 90	21- 32	22-32
Area of EEZ (km^2)	123,725	71,000	215,611	249,734	176,254	235,349	12,045	33,221
Population (million) (yr. In brackets)	1.416 (2005)	7.8	6.02 (2005)	3.4	17.29	21.02 (2005)	5.68	7,46
Population growth rate (p.a.)	1.96	2.8	2.22	2.64	3.8	1.25	2.17	2.82
Population by year 2010	-	10.2	6.7	4.9	27.00	27.0	6.6	9.0
Total artisanal fishers (1990)	1125		30,000	4,400	14,200	210,000	9,000	4,547
Major coastal cities	Bissau Catio Cacheu	Conakry Dubreka Boke Kamsar Forécariah	Freetown Lungi Port Loko	Monrovia Buchanan Greenville Harper Robertsfield	Abidjan Sassandra San Pedro Grand Bassam Grand Lahou	Accra Takoradi-Sekondi Cape Coast Tema	Lomé Aného	Cotonou Porto Novo
Major ports	Bissau	Conakry Kamsar	Freetown	Monrovia	Abidjan San-Pedro	Tema Takoradi	Lomé	Cotonou
Major Lagoon systems	Cufada Wendo-Tcham		-	Lake Piso Lake Shepherd	Ebrié Aby-Tendo-Ehy Grand-Lahou	Keta-Avu Sakumo Songaw Korle Densu	Lac Togo Lomé	Nokoué Porto-Novo Aheme Ouidah

Table 3.1: (continued) Summary table of biophysical, social and economic indices of GCLME Countries

	Guinea Bissau	Guinea	Sierra Leone	Liberia	Côte d'Ivoire	Ghana	Togo	Benin
Mangroves (km^2)	3167	250,000 (ha)	213,900 (ha)	-		1000	10	5
Coastal erosion rate (m/y)	-	1.5	-	-	1.5	3	20	15 - 30
Tidal range (m)	-	4.10 – 4.50	-	-	1.2	1.3	1.5	1.5
Currents (m/s)	-	0.5 – 1.5	-	-	0.5 – 1.5	0.5 – 1.5	0.5 – 1.5	0.5 – 1.5
Major Rivers	Kayauga Koliba Cachea Cumbija	Kogon Tinguilinta Fatala Konkouré	Sewa, Rokel Jong, Little Scarcies, Great Scarcies	Mano, St. Paul Lofa St. John Castos	Comoé Bandama Sassandra Cavally	Volta, Pra Oti Tano Ankobra	Mono Zio Haho	Mono Couffo Oueme
Length of coastline (km)	853	402	296	40	180	885	209	1,650
Surface area (km^2)	923,768	475,440	28,051	2,345,410	342,000	267,667	1,001	1,246,700
Shelf (km^2)	46,300	10,600	14,710	1,150	7359	46,000		48,092
Width of shelf	15 - 85	30 – 80						
EEZ (km^2)	217,313	16,547	303,509	68,400	31,017	202,790	131,397	518,433
Population (million) (yr. in brackets)	128.772 (2005)	16.39 (2005)	0. 536 (2005)	60 (2005)	3.0396 (2000)	1.389 (2005)	0.160 (2000)	11.2 (2005)
Population growth rate (p.a.)	2.6	1.93	2.42	3.1	3.4	2.5	3.2	1.9
Population by year 2010	132	20.0		70	3.175	1.5	0.187 (2005)	
Total artisanal fishers (FAO, 2005)	700,000	65,000	3,000	700		4,300	2,900	35,000

Table 3.1: (continued) Summary table of biophysical, social and economic indices of GCLME Countries

	Nigeria	Cameroon	Equatorial Guinea	DR Congo	Congo	Gabon	Sao Tome and Principe	Angola
Major coastal cities	Lagos Warri Sapele Port Harcourt Calabar	Douala Limbé Kribi Edea	Malabo Bata Cogo Mbeni Riaba	Matadi Boma Moanda	Pointe-Noire	Libreville Port-Gentil Gamba	Sao Tome City Santo Antonio	Luanda Lobito Benguela Namibe Cabinda
Major ports	Lagos Warri Port Harcourt Calabar	Douala Limbé Kribi	Malabo Bata Luba	Matadi Boma Mbandaka Kinshasa Kisangani Kalemi		Libreville Port Gentil	Sao Tome City Santo Antonio	Luanda Cabinda Lobito
Major Lagoon systems	Lagos Lekki		Volcanic Crater lakes	Tonde	Conkouati Malonda	Nkomi, Ndogo Ngové, Banio		
Area occupied by mangroves (km2)	12,200	2,700	120	66,000 (ha)	188	2500	No data	
Coastal erosion rate (m/y)	15 - 30	30 – 50		1.03				
Tidal range (m)	0.6 - 1.5	0.5 – 2.7		0.5-2.0		0.1 – 2.3		
Currents (m/s)	0.5 – 1.5	0.5 - 3		0.5-3				
Major ports	Lagos Warri Port Harcourt Calabar	Douala Limbé Kribi	Malabo Bata Luba	Matadi Boma Mbandaka Kinshasa Kisangani Kalemi		Libreville Port Gentil	Sao Tome City Santo Antonio	Luanda Cabinda Lobito
Major Lagoon systems	Lagos Lekki		Volcanic Crater lakes	Tonde	Conkouati Malonda	Nkomi Ndogo Ngové Banio	No lagoon of appreciable size	
Area occupied by mangroves (km^2)	12,200	2,700	120	66,000 (ha)	188	2500	No data	
Major Rivers	Cross Niger Ogun Imo	Cross Wouri Sanaga Nyong	Rio Cambo Woro Rio Muni	Congo Kasai Ubangi Lukonga	Kouilou Noumbi Loueme	Ogoué Nyanga Komo		Kwanza Congo Lubinda Chilongo

Table 3.2: Total population (in millions) , percentage growth, coastal population and their percentage to the total population as well as the countries' surface areas. of the coastal zone in Relation to Country Population/ Area; and Demographic and other Welfare Measures

Country	Total 1994	Total 2003	Growth %	Coastal 1994	Coastal 2003	Percentage 1994	Percentage 2003	Area km^2
Angola	11.53	13.52	2.7	2.89	3.88	25.07	28.7	1,245,828
Benin	5.18	6.72	2.6	1.86	2.49	35.91	37.05	116,266
Cameroun	13.22	16.09	2.3	1.57	2.11	11.88	13.11	465,425
Congo	2.32	3.76	3.2	0.35	0.44	15.09	11.7	345,196
Cote d'Ivoire	13.5	16.84	2.5	3.74	5	27.7	29.69	322,770
E. Guinea	0.39	0.49	2.7	0.21	0.26	53.85	53.06	27,207
Gabon	1.56	1.34	2.5	0.65	0.87	41.67	64.93	261,764
Ghana	16.7	20.67	2.2	5.47	7.34	32.75	35.51	239,312
Guinea	6.24	7.91	2.3	1.35	1.81	21.63	22.88	245,156
Guinea Bissau	1.09	1.49	2	0.87	1.17	79.82	78.52	33,101
Liberia	2.9	3.37	2.7	1.3	1.75	44.83	51.93	96,826
Nigeria	97.23	136.46	2.6	19.29	25.86	19.84	18.95	913,612
Sao Tome e Principe	0.13	0.16	2.3	0.13	0.16	100.00	100	856
Sierra Leone	4.55	5.34	2.2	2.15	2.87	47.25	53.75	71,706
Togo	4.05	4.86	3.0	1.37	1.82	33.83	37.45	57,334

Sources: Africa: A framework for ICZM, 1996, The World Bank (2005) : African Development Indicators. Coastal Population for 2003 is derived Using the UN - Habitat's 4.49 annual growth rate estimate of slums population in Africa from 1990 - 2001

Table 3.3: Populations in the Coastal Zone in Relation to Country Population and Area

	Urban Demographic Growth	Life Expectancy 1990-2003	Infant Mortality 1990-2003	Adults HIV/AIDS positive %	Per capita Health Expand. 1995 - 2002 US$	Literacy % 1990-2002	Annual Forest change 1990-2000
Angola	5.0	45-47	154-154	3.9	38	-	-0.2
Benin	4.8	52-53	111-91	1.9	20	26 - 40	-2.3
Cameroun	4.5	54-48	85-95	6.9	31	58	-0.9
Congo	4.8	51-52	83-81	4.9	18	67- 83	-0.1
Cote d'Ivoire	3.8	50-45	103-117	7.0	44	39	-3.1
E. Guinea	5.6	47-52	122-97	-	83	-	-0.6
Gabon	4.4	52-53	60-60	8.1	159	-	0.0
Ghana	3.2	57-54	78-59	3.1	17	58- 74	-1.7
Guinea	4.2	44-46	145 104	3.2	22	-	-0.5
Guinea Bissau	5.8	42-46	153-126	-	9	-	-0.9
Liberia	3.4	45-47	157-157	5.9	4	39- 56	-2.0
Nigeria	5.1	49-45	115-98	5.4	19	49-67	-2.6
Sao Tome e Principe	4.3	62-66	75-75	-	36	-	0.0
Sierra Leone	4.3	35-37	175-166	-	6	-	-2.9
Togo	4.4	50-50	88-78	4.1	91	44- 60	-3.4

Table 3.4: Socio Economic Indices of most Countries in the GCLME

	Coastal Area 1994	Coastal Area as % of country Area 1994	Per Capita Electric Power Consumption kwh 2002	Radio Sets per 1,000 1996 - 2003	% of population living under & 1-a day 1994 - 2002	Household expenditure (%) on food (1991-1999)	National Poverty Headcount as % of Population (84-2002)	Poorest 20% (1989 - 2002) share of income held by
Angola	95,410	7.66	108.6	78	-	-	-	-
Benin	7,248	6.23	76.0	445	-	-	29	-
Cameroun	29,378	6.31	160.9	161	17	55	40	5.6
Congo	11,538	3.34	82.3	109	-	-	-	-
Cote d'Ivoire	32,843	10.18	-	185	11	48	37	5.2
E. Guinea	13,414	49.3	-	425	-	-	-	-
Gabon	53,060	20.27	804.3	488	-	72	-	-
Ghana	27,644	11.55	297.2	695	45	-	40	5.6
Guinea	25,175	10.2	-	52	-	39	40	6.4
Guinea Bissau	22,351	67.52	-	178	-	56	49	5.2
Liberia	31,477	32.51	-	274	-	-	-	-
Nigeria	65,880	7.21	68.2	200	70	-	70	4.4
Sao Tome e Principe	856	100.00	-	318	-	67	-	-
Sierra Leone	25,802	35.98	-	259	-	-	83	1.1
Togo	4,570	7.97	-	263	-	-	32	-

3.2 Regional economic characteristics

The economy of the GCLME region is overwhelmingly characterized by poverty. Country Poverty Reduction Strategies Papers (PRSP) facilitated by the World Bank and a host of other donor agencies including UNDP in the different countries showed clearly that in spite of improvements in economic growth over the years, poverty has been increasing in most of the countries of the GCLME. For instance, as many as 67 million or 70% of Nigerians live below the poverty line". The incidence of poverty in Nigeria increased from 27.2% in 1980 to 46.3% in 1985 and 65.5% in 1996, rather than dissipating by 2003 it had gone up to 70 percent. Comparing National poverty headcount as percentage of population of Benin, 29%; Côte d'Ivoire, 58%; Sierra Leone, 83%, Nigeria, 34% to that of Algeria and Egypt of 12 and 17 percent respectively gives a vivid image of poverty of the GCLME countries .The impact of the above is better captured by the omnibus index, the Human Development Index (HDI) for instance, Nigeria has remained low (0.391 in 1998, and 0.439 in 2000 putting the country at the 151st position among 174 countries).

Poverty persists in the region mainly because of a host of factors including inadequate access to the means for supporting rural development, destruction of natural resources and massive corruption of the public sector. There are major linkages between environment and poverty which threaten the health, livelihood and security of the poor. As a result, life expectancy is still only approximately 53 years. The indicators of childhood survival are some of the worst in the world: infant mortality rate (IMR) of 91 and under five mortality rate (U5MR) of 191 deaths per 1000 births, respectively, which are largely caused by preventable diseases. Lack of proper prevention also has lead to extremely high rates of sexually transmitted diseases.

The widespread poverty persists in part due to environmental linkages and socio-political issues. The environment-poverty linkages in the region are indeed widespread and include deforestation, land degradation, desertification, biodiversity loss, tropical storms, drought, pollution, erosion, flooding, windstorms, landslides and climate change impacts. Other issues of importance include losing control of the process of governance because of prolonged military rule, ethnic conflicts over resource control and religious differences, and the marginalization of women.

3.3 Industries impacting and impacted by the GCLME

3.3.1 Fisheries

The rich living marine resources of the GCLME are providing livelihoods and employment for thousands of fishers and foreign exchange for the countries, thus providing food security for the region. The wealth of estuaries, deltas, coastal lagoons and the nutrient rich upwelling cold waters make a major contribution to the diversity of fish life in the GCLME region with an estimated 239 fish species.

The main fisheries resources exploited in each of these zones are small coastal pelagics, large offshore pelagics, demersal finfish, shrimp and molluscs. The small pelagics are represented by the families of:

Clupeidae

1. *Sardinella aurita*, round sardinella;
2. *Sardinella maderensis*, flat sardinella;
3. *Ilisha Africana*, West African Ilisha;
4. *Ethmalosa fimbriata*, bonga shad;

Carangidae

1. *Caranx rhoncus*, yellow horse mackerel;
2. *Trachurus trachurus*, horse mackerel;
3. *Canranx hippos*, crevalle jack;

Scombridae

1. *Scomber japonicus*, Spanish mackerel;
2. *Scomberomorus tritor*, West African Spanish mackerel;
3. *Euthynnus alletteratus*, common tuna;

Engraulidae

1. *Engraulis encrasicolus*, Guinean anchovy.

Large offshore pelagics on the other hand are essentially the Thunidae and Istiophoridae. The tuna fish species are represented mainly by *Katsuwonus pelamis*, skipjack *Thunnus albacares*, yellowfin tuna, and tuna like fishes. Istiophoridae are represented mainly by *Istiophorus albicans*, Atlantic sailfish.

Demersal finfishes consist of an inshore component dominated by the Sciaenid Community principally:

Sciaenidae

1. *Pseudotolithus elongatus*, Bobo croaker;
2. *Pseudotolithus senegalensis*, Cassava croaker;
3. *Pseudotolithus typus*, longneck croaker;

Lutjanidae

1. *Lutjanus goreensis*, Gorean snapper;
2. *Lutjanus agennes*, African red snapper;
3. *Lutjanus dentatus*, African brown snapper;

Pomadasyidae

1. *Pomadasys jubilini*, Sompat grunt;
2. *Pomadasys peroteti*, Parrot, grunt;
3. *Pomadasys rogerii*, Pigsnout Parrot, grunt;

Polynemidae

1. *Polydactylus quadrifilis*, Giant African threadfin;
2. *Galeoides decadactylus*, Lasser African threadfin;
3. *Pentanemus quinquarius*, Royal threadfin;

The deeper water component of demersal finfishes is represented by the sparid community particularly the family of Sparidae mostly represented by the following species:

1. *Dentex angolensis*, Angola dentex;
2. *Dentex congoensis*, Congo dentex;
3. *Dentex macrophtalmus*, Large-eye dentex
4. *Pagellus spp.*, Seabreams;

The shrimp fisheries in the GCLME exploit both inshore and offshore penaeids. The inshore shrimps are represented by *Penaeuss notialis*, pink shrimp and *Parapeneopsis atlantica*, brown shrimp. Whereas the offshore penaeids consist mostly of *Parapenaeus longirostris*, deep water rose shrimp.

Molluscs consist of squids, cuttlefish and octopus. Their exploitation is emerging and still highly localised; their potential is still unknown but it is believed that they can support small scale fisheries throught the region.

Photo 3.3: Fish landing at the beach in Sao Tome e Principe. Fishing is an important economic activity in the region

The food needs of the region are largely met by the coastal fisheries (Tables 3.6 and 3.7), particularly for coastal populations. The per capita supply of fish in the region ranges from 6 to 50 kg/year, and most catch is used locally. In addition to the artisanal and national industrial fisheries, a number of countries negotiate fishing rights agreements with non-coastal countries.

There is little capacity in the nations of the region to effectively monitor and enforce those agreements. It is believed by some regional experts that some of the fish caught in the region by the distant water fleets are imported to the region. In addition there are vessels which fly flags of convenience and some of these are believed to fish undetected by enforcement officials in the region creating additional stress on the fishery resources.

Table 3.5: Food balance sheet of fish landing in metric tonnes and contribution of fish to protein supply (1995-2000 AVG)

Country	Landings	Non food uses	Imports	Exports	Total supply	Population	Supply Per capita
Benin	40,873	0	8,333	682	48,524	5,880	8.3
Cameroon	103,968	0	72,586	1,192	175,362	14,075	12,5
Congo Dem. Rep.	180,311	0	113,439	87	293,662	47,859	6.1
Congo Rep.	44,723	0	17,709	645	61,791	2,807	22.0
Côte d'Ivoire	74,369	35,2	267,694	117,2	189,661	15,201	12.5
Gabon	47,298	0	9,685	2,028	54,987	1,154	47.7
Ghana	444,576	0	158,389	70,059	532,905	18,300	29.1
Guinea	73,710	0	22,969	8,340	88,339	7,772	11.4
Nigeria	427,291	7	503,494	3,717	927,061	106,487	8.7
Sierra Leone	67,030	0	2,502	12,059	57,497	4,194	13.7
Togo	17,297	0	43,545	3,794	57,053	4,177	13.7

Source: CIFA 2002: Working Paper 12 for CIFA 12 Session (CIFA= Committee for Inland Fisheries of Africa)

Information in table 3.6, on landings, trade and supply data refer to fish, crustaceans and molluscs, including all aquatic organisms except whales and seaweeds. These data should be regarded as giving only an order of magnitude of the parameters. Comparision with earlier published data (FAO Yearbook), may not, therefore, give a valid indication of real changes in consumption.

Between 1986 and 1998, the annual catch of both marine and inland species by local fleets of all 16 countries in the GCLME area ranged between 1.147 and 1.462 million metric tonnes (Table 3.6, Figure 3.1; FAO, 2000). The marine fish catch was between 694,000 and 864,000 metric tons. The figures show an increasing trend in fish catches with occasional declines. Fishery products exported out of the sub-region over the period were between 40,000 and 103,000 metric tonnes, representing 2.6-7.1 % of the total production and worth between 45 and 173 million US dollars (FAO, 2000.). This percentage is higher if only fish caught in marine waters are considered. At the same time, the countries of the sub-region also imported 611,000-952,000 metric tonnes of fish (mainly pelagic species) worth between 376 and 595 million US dollars (FAO, 2000). The export and import quantities are depicted in Table 3.6) This table shows that any possible contamination of fishery products in the Guinea Current system is sure to be a transboundary issue with the effects reaching Europe, America and other parts of Africa. It is important to note the high demand for fishery products in the region. This is translated by the importation of large quantities of fresh fish as well as canned fish and fish products).

Declines in Catch per Unit Effort (CPUE) indicate that catch is exceeding sustainable yields in some resources (Ajayi, 1994) while species diversity and average body total lengths of the most important fish assemblages have declined (FAO 2000) These conclusions were agreed by the experts in CECAF. These declines have led to unsustainable destructive fishing methods such as blasting and use of very small mesh nets.

Table 3.6: Fish consumption and percentage contribution of fish in relation to animal proteins (1990)

Countries	Fish Consumption (kg/h/yr)	% Fish contribution in animal protein (1990)
Côte d'Ivoire	13,8	36,1
Ghana	27,1	63,9
Togo	14,4	45,3
Benin	9,7	27,8
Nigeria	8,4	35,3
Cameroon	12,6	28,7
Equatorial Guinea	19,1	61,0
Gabon	28,2	37,4
Sao Tome et Principe	35,1	79,1
Congo	33,4	63,1
D.R. Congo	7,8	34,4

Source FAO: In Njock, (1998)

In 1994 the Working Group Meeting at Centre National des Sciences Halieutiques de Boussoura, Conakry Guinea estimated area biomass declines in demersal species such as croackers and sicklefish was higher than 50% indicative of overfishing and related to increases in fishing effort by artisanal and industrial fishing. Trawl surveys off Ghana conducted by the Fisheries Research and Utilization Branch of the Ghana Department of fisheries found that between 1985 and 1990 the estimated biomass in waters less than 20 m declined from 122,000 to 49,000 t in the rainy season and from 72,000 to 48,000 t in the dry season and related that to increases in trawling effort. Again the magnitude of the declines is indicative of over fishing. Recently biomass estimates of Sciaenidae and Sparidae were estimated by trawling surveys for the Congo and Gabon to be 38,000 tonnes and were considered close to or fully exploited.

Change in species biodiversity in the Gulf of Guinea is still to be elucidated. Some authors of the region believe that for pelagic resources, these changes can be attributed to both natural increase in salinity of shelf waters, changes in meteorological and other oceanographic conditions as well as changes in nearshore biophysical processes (Binet 1995). Environmental changes manifesting a periodic variability in coastal upwelling intensities are also playing a role in coastal pelagic fish abundance fluctuation.

The most significant fluctuation of fish abundance occurred in the West-central gulf of Guinea (Ghana and Côte d'Ivoire) from approximately 1973 to1988. In fact, the most important pelagic stock exploited prior to 1973 in the region was the sardinella species. These species disappeared from the landings against a dramatic increase in abundance of triggerfish (*Balistes capriscus*) in the landings during that period (1973-1988). This has been described as one of the most phenomenal episodes in the history of fish population dynamics. This phenomenon was studied extensively (Korenting, et al., 2000). Results are in favour of a singnificant change in the physical components of the ecosystem namely salinity and water temperature. In the survey conducted under the GOG-LME pilot project (Table 3.8), the bivalve species (*Chlamys opercularis, Pectinidae*) was caught in such large quantities never before recorded in the Gulf of Guinea. It has been suggested that the bivalve species may have been introduced into the region through ballast water.

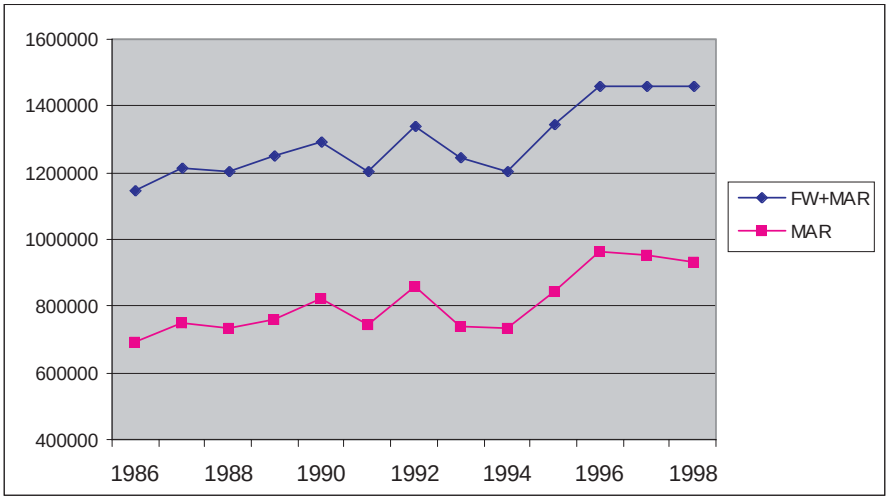


Figure 3.1: Total Fish Production in Home Waters by Countries in the GCLME Region

Table 3.7: Mean catch rate (kg/hr) by depth ranges

0 – 20 m	Côte d'Ivoire	Ghana	Togo-Benin	Nigeria	Cameroon
Fish	132.75	22.00	80.09	140.37	108.81
Crustaceans	3.78	0.01	10.53	16.86	16.54
Molluscs	8.08	134.73	4.53	0.96	1.28
Total	144.60	156.74	95.16	158.18	126.62

21 – 40 m	Côte d'Ivoire	Ghana	Togo-Benin	Nigeria	Cameroon
Fish	162.45	52.93	82.61	153.66	58.15
Crustaceans	3.85	2.56	0.08	18.92	11.37
Molluscs	7.30	95.68	13.50	5.68	2.71
Total	173.60	151.16	96.18	178.26	72.23

41 – 60 m	Côte d'Ivoire	Ghana	Togo-Benin	Nigeria	Cameroon
Fish	273.40	234.81	58.90	141.15	35.60
Crustaceans	1.34	0.49	0.63	9.60	8.30
Molluscs	8.10	8.86	5.10	19.12	2.33
Total	282.84	244.16	64.63	169.87	46.23

Source: F.T. Susainah survey, 1999

Table 3.8: Mean Catch Rate (kg/hr), percentage contribution (all species included)

Depth (m)	C. Ivoire		Ghana		Togo – Benin		Nigeria		Cameroon	
	weight	%	weight	%	weight	%	weight	%	Weight	%
0 - 20	144.6	24.1	156.7	28.4	95.2	37.2	158.2	31.2	126.6	51.7
21 - 40	173.6	28.9	151.2	27.4	96.2	37.6	178.3	35.2	72.2	29.5
41 - 60	282.8	47.1	244.2	44.2	64.6	25.3	169.9	33.6	46.2	18.9
Total	601.0	100	552.1	100	256.0	100	506.3	100	245.1	100

Artisanal fisheries

Artisanal fisheries are sometimes referred to as small-scale, traditional, inshore, subsistence or municipal fisheries. Although these terms have slightly different meanings, they are generally used to define fisheries that have certain technical, economic and social characteristics (Smith, 1979). As such, it is difficult to provide a universally accepted definition of a small-scale fishery. As Lawson (1984) pointed it out, the study of small-scale fisheries must have a special place in any book on fisheries which concerns developing countries because of the importance of the sector in the provision of employment (12 million small-scale fishermen in the world each of whom provide employment for two or three shore-based workers engaged in, for trade, marketing or processing) and food self-sufficiency. In the Eastern Central Atlantic Fisheries Commission region, 70% of the total production comes from the artisanal fisheries.

Photo 3.4: Artisanal Fishing gear (gillnet) in Guinea. The conflict between artisanal and industrial fisheries is a cause for concern in the region

The most popular fishing gears utilised are: castnets, seine nets (or drag), various traps, acadja (or brush park fishing), hook and lines, dragnets and gill nets (Koranteng et. al., 1998). The dragnets disturb benthic organisms in the lagoons and have adverse effects on the functioning of the lagoon ecosystem. The black-chin tilapia (*Sarotherodon melanotheron*) is the most dominant species, cought in lagoons and estuaries of Ghana. The most important marine resources exploited in coastal waters include both small pelagics and demersal resources. Small pelagics are mainly represented by species such as mullets (*Mugil cephalus*), *Ethmalosa fimbriata*, *Sardinella maderensis*, *Sardinella aurita*, *Ilisha africana* and *Scyacium micrurum* (sole). The most important demersal species caught by the artisanal fisheries are of the sciaenid community namely *Pseudotolithus elongatus*, *P. typus*, *P. senegalensis*, *Lutjanus fulgens* (snapper). FAO estimated (1977) that 60% of the catch in the region came from artisanal fisheries.

In Equatorial Guinea, the artisanal fisheries average annual production reported by FAO is 1500 metric tonnes (FAO 1970) and 2000 tonnes by Lagoin and Salmon, (1967a) prior to 1970. In Sao Tome and Principe, artisanal fish catch was on the order of 1800 tonnes in 1967 and 1500 tonnes in 1979 (SCET, 1980c), consisting mainly of pelagics. Van der Knaap (1985) estimated the total maximum potential yield of the inshore artisanal fisheries of Nigeria to be 100,000 tonnes on the basis of comparative figures from similar neighbouring and highly productive coastal systems.

However, pollution from land-based activities such as agrochemicals and the use of harmful fishing methods have been identified as factors that adversely affect fishery resources in general and more especially in coastal and waters, lagoons and estuaries. Throughout West Africa, traditional knowledge is used in the utilization and management of fisheries resources, linked to taboos and other socio-cultural practices (Koranteng, et al., 1998; Entsua-Mensah et al., 1999). This traditional knowledge should be capitalised and intregrated in modern approaches to fisheries management in the region.

Industrial Fisheries

The industrial fishery is sometimes also refered to as commercial fishery. The distribution in time and space of the abundant and diversified fisheries resources of the GCLME is very characteristic. In fact, many of these resources are considered country's resident (supporting national fisheries), shared stocks (same resources in many countries), straddling stocks (resources occupying both the EEzs and international waters) and migratory stocks (life cycle goes through many countries).

These important fisheries resources have attracted many national and/or foreign fishing fleets. Foreign countries or institutions exploiting the fisheries resources of the GCLME include mainly the European Union, Eastern Europe, Korea and Japan. The industrial fishery has a long tradition in the GCLME. In Cameroon for instance, the industrial fishery began in 1912 with a German steam trawler of 22 m long and 55 horse power engine (Monod, 1928) but it was only in the 1950's that fishing activity became important: from 3 trawlers in 1954, the fleet increased to 31 and 38 units in 1983 and 1990 respectively (Djama, 1992). In Nigeria, the number of inshore trawlers increased from 13 in 1971 to 29 in 1976 and 52 in 1983 (FAO, 1987). The 1976 survey performed by the FAO/USSR vessel FIOLENT estimated the commercial demersal fish stocks for the surveyed area off the coast of Nigeria to be 28,600 tonnes (Roberston, 1977). FAO (1996) has estimated the total potential fisheries yield of the entire region at 7.8 million tonnes per year. The unrestricted activities of the industrial fisheries leads to the encroachment to the areas reserved for the artisanal fisheries of the GCLME, resulting to socio-economic conflcts (UNIDO, 2002). FAO (1987) data show that in Cameroon, total fresh fish landings of the industrial fleet in the period 1970-1982 fluctuated between 15,736 tonnes (1974); 20,397 tonnes (1976); 14,230 tonnes (1983) and 12,457 tonnes (1984). Shrimp landings increased from 942 tonnes (1970) to 2360 tonnes (1972), and then decreased again to 1696 tonnes in 1975. Catches went up to 2,438 tonnes in 1977 and dropped dramatically to 268 tonnes in 1980 to increase again to 859 tonnes in 1987. It should be noted that fluctuations in landings indicate instability of the standing biomass and an indicator resource overexploitation.

The industrial fisheries exploit traditionally demersal fish species mostly the sciaenid community as described by Longhurst (1968). However, there is a potential for exploiting commercially invertebrates and new resources such as Arioma bondi which is found in most countries of the region especially in Cameroon and Nigeria. Recent increase of fishing effort has resulted in the decrease of catch per unit effort (c/f) from the fisheries of the region. For instance, the number of trawlers in Cameroon and Nigeria is estimated at around 50 and 400 respectively, this is too much in relation to the estimated biomass of these two countries.

Shrimps exploitation is subject to sequential fisheries and constitutes one of the major problems in the region. In fact, penaeid shrimps, which are major exports of the region, are amphibiotic (juveniles in the lagoons and adults at sea). Lagoons and their organic load are primary ecological factors in successful recruitment to shrimp adult stocks. However, these shrimps are exploited both at the level of the lagoons and at sea. Lagoon fisheries catch mostly juvenile shrimps whereas at sea the remaining adult few recruits are exploited by the industrial fisheries. Often, most of the resources are captured at the lagoon. This situation has led to the collapse of the shrimp fisheries in Côte d'Ivoire (Willmann and Garcia, 1985). Damages to mangroves which are nursery grounds have undoubtedly impacted shrimp production. Sizes of juveniles emigrating from the lagoons vary from year to year and predictability is needed to manage optimally and prevent growth overfishing. The by-catch from shrimp fisheries which represents 70% of the total catch is made essentially of juvenile finfish. This situation is receiving attention around the world as it can have a strong negative impact on the adult spawning biomass, although this impact on the ecosystem is understood only qualitatively. Experience from other regions however leads to the conclusion that the effect is particularly hard on sustainable production of the resource.

Regional working groups looking at the shrimp fisheries off Sierra Leone estimated that catch of southern pink shrimp is within the MSY estimates of between 2,600 and 3,2500 tonnes; however the recent reduction o catches and related decline of catch per unit effort raises overfishing concerns. Likewise, regional experts considered the shrimp stocks in the western and central Gulf of Guinea to be overexploited with an estimated.

Recreational fisheries

Except perhaps in Sao-Tome e Principe, recreational fishing is poorly developed in the region in contrast to the Canary Current area, where big game fishing attracts dedicated tourist dollars from trophy fishermen. There is some potential for similar development in the GCLME. In addition with increasing tourism to the region there is a role for recreational fishing industry for less trophy species to be part of a total tourism experience. Thus recreational fisheries can be a component of tourism, economic development and alternative livelihoods for the stakeholders.

Mariculture

Mariculture is not heavily developed in the region (although freshwater aquaculture has a lengthy history) but has attracted considerable interest from policy makers. In response to this for example Ghana, has instigated mariculture studies in the Volta Delta region. Mariculture holds out the hope of alternative sources to supplement fish food supplies from wild harvest. It also holds the possibility of generating foreign exchange when high value species such as shrimp are raised. The political interest may well cause mariculture efforts to increase before there is a proper understanding of the environmental damage it can cause by such activities as habitat destruction and introduction of disease organisms into wild populations. The policy framework to ensure proper development is lacking.

Other Marine Resources

Cetaceans (whales and dolphins) and marine turtles are found in the GCLME region notably in Congo, Gabon, Cameroon, Benin, Nigeria as well as Guinea and Guinea Bissau, especially during upwelling seasons. Species of dolphins cited include *Orcinus orca, Globiacaphala macrorhynchus, Pseudora crassidens, Feresa attenuate, Peponocephala electra, Sousa teusii, Stenella frontalis, S. climene, Delphinus dilphis. Among whales are Balaenoptera* musculus, *B. physalus and Megaptera novaegliae*. Sites identified as spawning ground for marine turtles in the region include Ebodje (Cameroon); conkouati (congo); Corisco bay and ureka (Equatorial Guinea) for Dermochelys coriacea (Leatherback or Luth turtle), *Lepidochelys olivacea*, *Chelonian myda* (green turtle), and *Eretmochelys imbricata*. These four species are classified as endangered (IUCN red list) and based on their global importance; the European Union through ECOFAC has funded a regional project entitled "Kudu Project" initially called PROTOMAC since year 2000. This project (with headquarters in Libreville, Gabon) covers the East Atlantic coast of Africa, under the framework of Abidjan memorandum on Marine Turtle Protection (MTP) ratified by countries on the east Atlantic coast.

Photo 3.5: Harvesting fish at an Aquaculture facility near Port-Harcourt, Rivers State, Nigeria. Aquaculture holds a huge potential to increasing food availability in the region.

3.3.2 Industries

Even though the level of industrial development is still low in West and Central Africa, the rate of industrialization is increasing along the coastal areas. About 60% of the industries in countries bordering the Gulf of Guinea are located in coastal cities (UNDP/GEF, 1993). Industries range from textile, leather, food and beverage processing to oil and gas and mineral exploitation. These industries discharge untreated effluents directly into coastal waters or into rivers and streams that eventually empty into the coastal waters. This practice impacts negatively on the coastal ecosystem and has resulted in the deterioration of some coastal lagoons (e.g., Korle and Chemu lagoons in Ghana).

3.3.3 Tourism

Tourism constitutes an important industry in many West African coastal countries including Côte d'Ivoire, Ghana, Guinea and Guinea-Bissau. Tourism has had a severe impact along the coast from Dakar to Luanda. The construction of hotels and other recreational facilities located directly on the shoreline has been responsible for the clearing of

coastal vegetation, the filling of wetlands and the increasing load of sewage and solid waste in coastal waters.
The demand for high quality fishery products and ornamental species by the tourism industry has contributed to the overexploitation of lagoon and coastal resources. Degradation of the environment from marine debris is also attributed in part to the tourism industry.

Photo 3.6: Touristic Hotel on the coast of Togo. Construction on the coast often destabilizes the coast

3.3.4 Agriculture

Agriculture is an applied science concerned in the improvement, production, harvesting storing and marketing of food crops, fibres, and animals for human consumption, clothing and shelter and other uses. It is also involved in protecting crops, forest trees and domesticated animals from pests, diseases and weed competition. It also improves agricultural soils texture, maintains soil nutrient levels and monitor the agroclimate of farm areas.

Agriculture is the mainstay and the economic backbone of non-oil producing countries in the GCLME areas. Even Nigeria, Cameroon and Gabon that produce oil, have realized that they cannot put all their eggs in one basket. Unfortunately, agriculture (arable and pastoral) in the GCLME countries is not mechanized. They still practice peasant farming for subsistence living. These areas cannot be mechanized due to high, dense, forest vegetation and the marshy, swampy, nature of the soil. In addition erosion and oil exploration and production activities in the oil producing countries have affected the little farmlands in these areas and have polluted the soils with effluent discharges, drilling cuttings, muds and oil spills. Fishing and fishery activities which are the main agriculture of the GCLME areas are also affected. Fish production in these areas is adversely hampered by two main causes: natural and man-made causes that pollute the coastal waters. The natural causes include: natural coastal erosion, high wave energy and strong littoral movement, while man-made causes include oil exploration and production activities, oil spillage, dredging canalization, river damming, and mangrove deforestation. The fishing ports and their breeding niches are destroyed by these activities. Also effluent discharges from mining companies, agrochemical and fertilizer companies, etc adversely affect the fishes and the food chain. Urban solid wastes (domestic and office wastes) are sometimes dumped into the coastal waters leading to algae boom which affect phyto and zoo plankton production as well as the fishes.

There is great need to encourage fish farmers in the GCLME areas. This can be done by establishing fish farms in various locations in each country, and by establishing hatcheries in aquacultures in suitable areas where fingerlings can be raised. For food crops such as rice, maize, cassava, water yams, bananas and plantains that can be grown in these areas, flood, oil, salt-resistant varieties can be bred for planting in these areas.

3.3.5 Oil and Gas

Oil and gas, though found in only a few countries in the region constitute probably the most important coastal resource of the region. Some of the countries in the region are oil producers and a few (e.g. Angola, Congo, Gabon and Nigeria) are net exporters. Crude oil has recently been found in economic quantities in Equatorial Guinea with estimated reserves 564 million barrels in 2002 and natural gas reserves of about 68.53 billion cubic metres. Other countries with substantial deposits and reserves include Côte d'Ivoire (e.g., Table 3.3-5).

Nigeria is the largest oil producing country in the Guinea Current Large Marine Ecosystem (GCLME) area. The first commercial oil was found by Shell in 1958 in Olobiri in present day Bayelsa State. This was after about 50 years of oil exploration activities in the South Western Nigeria. Since then other oil companies including Mobil, Texaco, Chevron, Agip, Esso and Elf have joined Shell Petroleum Development Company (SPDC) of Nigeria in the oil hunt, exploration and production. In 1963, the first offshore oil was discovered by Gulf, Mobil and Texaco. This rapidly expanded Nigerian oil activities in the Niger Delta.

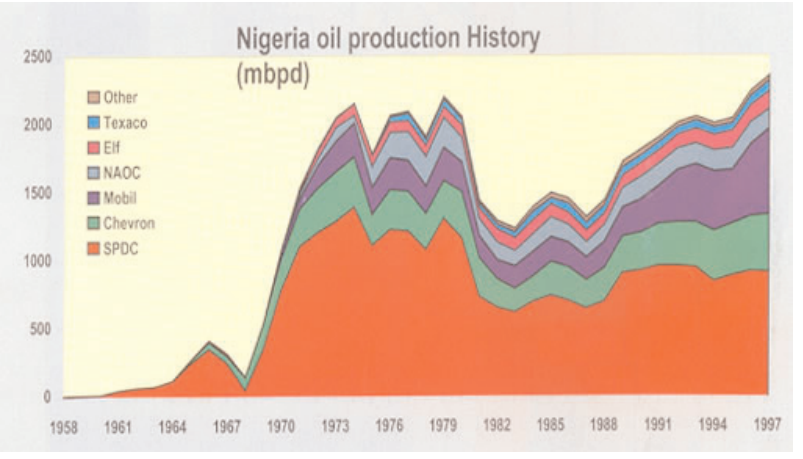


Figure 3.2: Nigeria oil production history (Source: Discover a new Nigeria 2000)

In the past decade (early 1990s) the importance of gas was recognized by the Federal Government of Nigeria and the Oil Companies. The mandate is to stop gas flaring by the year 2008. Gas gathering is taking place in all the operational flow stations.

West African Gas Pipeline (WAGP)

The purpose of the WAGP is to transport natural gas from Nigeria to commercially viable markets in Benin, Togo and Ghana. The pipeline is expected to deliver an initial volume of 140 million standard cubic feet per day (MMscfd) when it is completed in 2006. The capacity of the pipeline however is 462 MMscfd. The transport of natural gas to Benin, Togo and Ghana will help to alleviate the energy needs of these countries, promote investment in thermal energy facilities and encourage economic growth.

Figure 3.3: West African Gas Pipeline Route running from Nigeria to Ghana

Ghana is expected to consume 80% of the natural gas delivered with comparable growth in the neighbouring partner countries. The capital investment of the WAGP project is estimated at US$500 million. It is projected that an additional US$600 would be invested to either develop new power generation facilities or upgrade existing facilities in Benin, Togo and Ghana.

Table 3.9: Oil and gas reserves of major oil producing countries in the GCLME region

Country	Crude Oil Production (thousand bbl/day)	Natural Gas Production (Billion Cubic Meters)	Crude Oil Reserves (Billion Barrels)	Natural Gas Proven Reserves (Billion Cubic Meters)
Nigeria	2,356 (2004)	15.68 (2001)	34.0(2004)	4007 (2004)
Angola	980 (2004)	530 (2001)	22.88 (2004)	45.87 (2005)
Equatorial Guinea	350 (2004)	0.02 (2001)	0.5635 (2002)	68.53 (2002)
Gabon	264.9 (2004)	0.08 (2001)	2.022 (2004)	66.47 (2004)
Congo	227 (2004)	0	0.0935 (2002)	0.4955 (2002)
Cameroon	94 (2004)	0	0.08 (2004)	55.22 (2004)
Côte d'Ivoire	29.3 (2001)	1.35 (2001)	0.22 (2004)	14.87 (2004)

Source: World Resources 1994-95 and CIA World Fact-book; 2005

Similarly, the Chad-Cameroon Crude Oil Export Pipeline transports Chad's hydrocarbons production to the World Market through a major oil terminal on the coastline at Kribi, Cameroon.

Deep Offshore Oil Production - The new frontier and its Implications to the GCLME

The Nigeria's continental shelf is now the new hub of oil prospecting activities, signalling the extension of the frontiers of the Nigerian hydrocarbon play beyond the shallow waters of the Niger Delta. Major recoverable reserves have been discovered in distances of over 100 kilometres and water depths of up to 1500 meters. With production facilities now nearing completion in about two of such huge deep water reservoirs, the potentials of increasing oil production activities in this fragile ecosystem is now real.

Photo 3.7: Oil loading platform in the Region

Nigeria and her south-eastern neighbour, Sao Tome e Principe, have established a Joint Development Zone (JDZ) for Deep Sea Offshore Hydrocarbon Production. This move has eliminated delineation problems and will ensure optimum reservoir utilization. Total area coverage of this JDZ is about 35 km2 and Recoverable oil reserves are estimated at about 9 billion bbl.

3.3.6 Salt production

Salt production is an important industry in the Gulf of Guinea, particularly in Ghana (artisanal and industrial), Angola, Togo and Benin (mainly artisanal production). In Benin, artisanal salt production occurs around coastal lagoons, particularly at Djegbadzi and Avlekete near the town of Ouidah. Production is mainly by women.

In Ghana, artisanal salt production takes place around several coastal lagoons along the coastline with the largest concentration of production occurring along the eastern coast, particularly from Ningo, Prampram and Ada to Adina. Commercial salt production, on the other hand occurs along most areas of the coastline with about 24 companies engaged in salt production by 2000 (CSIR, 2004). Of these, 8 were large to medium scale producers (between 5 and 20 units of 100 ft2 sized concrete or earthen salt pans and ancillary structures) while the rest were small scale producers (CSIR 2004). The industry employs about 5000 people in direct labour with secondary and tertiary employment reaching 15000 people (Ghana National Report, 2002). Current production is about 200000 metric tons per annum (Ministry of Mines, 2002), which is less than 10% of the industries potential, estimated at 2 to 3 million metric tons per annum (Ministry of Trade, 2003).

Conflicts associated with the salt industry, particularly commercial salt production include encroachment into mangrove areas, mangrove habitat degradation, fragmentation and destruction for salt pan construction with its associated loss in fish nursery areas, erosion and pollution of coastal water bodies. Other conflicts include social conflicts of land ownership, pilfering, conflicts between fisherfolk and salt producers over landuse rights and conflicts between commercial producers and artisanal producers.

Photo 3.8: Salt production pond on the coast in Angola

3.3.7 Sand extraction

Direct removal of sand from beaches for the construction industry is a common practice in the sub-region even though this is illegal in some countries (e.g. Ghana). Sand mining aggravates coastal erosion problems. In most countries within the GCLME region including Nigeria, Liberia, Gabon, Ghana, Benin, Cameroon, Angola, Sierra Leone and Togo, unregulated sand mining has contributed to the degradation of coastal areas. In most cases, the mined sand is used for construction, beach replenishments and reclamation purposes. In Nigeria for example, over 13.22 million m3 of sand was dredged from Lagos lagoon between 1984 and 1989 to sand-fill 552 ha of Lekki scheme (1 residential project). Such drastic depletion of sand from lagoons has adverse effects on the dynamics of the lagoon and adjoining shores and consequently exacerbates shoreline erosion. Other impacts would include increased current wave activities and change in the hydrodynamics of the area particularly in the marine environment. Also the increasing depletion of sandy bottom can adversely affect living resources especially the benthic organisms which require sandy bottom and shallow depths for spawning.

Photo 3.9: Artisanal sand extraction on the beach in Lomé, Togo

Photo 3.10: Sand winning on the coast in Benin

4. Policy, legal, regulatory and institutional setting

4.1 Some national and regional policy institutions

Regional and national policies and legal frameworks for sustainable development including management of marine and coastal environments exist in the GCLME Region. Details of the policies for each of the countries can be found in the National Reports developed in support of this Project.

At the regional level, the Abidjan Convention adopted in March, 1981 provides the framework policy for environmental protection of the GCLME Region. The Convention predominantly stipulates regional co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region. The Abidjan Convention and its Protocol on Cooperation in Combating Pollution in Cases of Emergency constitute the legal framework of the West and Central African (WACAF) Action Plan for the protection of the Marine and Coastal Environment. The Convention expresses the decision of the WACAF Region (from Mauritania to Angola at the time of adoption) to deal individually and jointly with common marine and coastal environmental problems. The Convention also provides an important framework through which national policy makers and resource managers can implement national control measures in the protection and development of the marine and coastal environment of the WACAF Region. The Emergency Protocol was designed to assist in the operational response to massive pollution loadings, primarily from accidental marine oil and chemical spills.

At its first meeting (Abidjan, 20-22 July, 1981), the newly constituted Steering Committee of the Convention defined the following priorities:

1. Development of oil spill contingency plans;
2. Combating coastal erosion;
3. Prevention, monitoring and control of marine pollution;
4. Rational development of coastal zones;
5. Capacity building, particularly in the areas of documentation and legislation on coastal and marine management.

Since its entry into force in August 1984, Parties to the Abidjan Convention have, with UNEP's assistance, undertaken a number of activities including:

1. Development of programmes for marine pollution prevention, monitoring and control in cooperation with IMO, FAO, UNIDO, IOC-UNESCO, WHO, IAEA, etc.;
2. Development of programmes for monitoring, controlling and combating coastal erosion in cooperation with UNESCO and UNDESA;
3. Development of national environmental impact assessment programmes for particular coastal sites;
4. Development of national environmental legislation in cooperation with FAO and IMO.

As originally envisaged in the provisions of the Convention, the WACAF Regional Coordination Unit (RCU) was to co-ordinate the implementation of the West and Central African Action Plan and ensures the most efficient use of the regional sea through concerted actions by Member States and the optimal utilisation of their shared living resources. It was to co-ordinate regional (as opposed to national) development of the coastal and marine environment and to assist in the prevention and resolution of disputes that might arise between and among the Parties to the Convention. Lack of resources for the RCU had adversely affected the implementation of the above-mentioned projects, however.
Most of the countries of the region have also ratified several international and regional Conventions relating to the coastal and marine environment such as the International Convention on Civil Liability for Oil Pollution and MAR-POL 73/78 (Also, thematic review) (see Annex I for a full listing of the pertinent Conventions).

4.2 Cooperation in the region

There is an encouraging history of co-operation between the countries bordering the GCLME even if the results, outputs and impacts have been variable. Examples of collaborative activities under the Abidjan Convention include "Control of Coastal Erosion in West and Central Africa (WACAF/3)", "Manual on Methodologies for Monitoring Coastal Erosion in West and Central Africa (WACAF/6)", "Assessment and Control of Pollution in the Coastal and Marine Environment of West and Central Africa (WACAF/2 phases I and II)", and more recently WACAF/11 on "Integrated Watersheds and Coastal Area Management Planning and Development in West and Central African

Region". The countries in the GCLME sub-region also participated in the continent-wide but far from successful UNDP/UNESCO Regional Project (RAF/87/038) on Training and Research for the Integrated Development of African Coastal Systems (COMARAF) and have experience of joint programming in the context of the Fishery Committee for the Eastern Central Atlantic (CECAF) under the aegis of FAO which has been trying to promote joint actions on living resource evaluation and fishery statistics

At the World Summit on Sustainable Development (WSSD) in 2002, the governments recognised that over-fishing and the subsequent declining returns from the fisheries sector are greatly reinforcing the cycles of coastal poverty for millions of rural fishing communities around the world especially in sub-Saharan Africa, while at the same time threatening the marine biodiversity and coastal ecosystems that support fisheries. For this reason, the World Summit on Sustainable Development (WSSD) felt over-fishing represented a serious crisis meriting a concerted effort by the international community over the next 10 to 12 years, to restore the world's fisheries to health by the year 2015 (including the coastal ecosystems that support these fisheries). Some of the specific actions that participating governments, including the countries of the GCLME region, agreed to undertake are:

1. Maintaining or rehabilitating fish stocks to their maximum sustainable yield levels by 2015;
2. Assisting developing countries in coordinating policies and programs aimed at the conservation and sustainable management of fisheries resources;
3. Strengthening donor coordination and partnerships between international financial institutions, bilateral agencies and other relevant stakeholders to enable developing countries to develop their capacity for sustainable use of fisheries;
4. Establishing representative networks of marine protected areas, consistent with international law and based on scientific information;
5. Developing national, regional and international programs for halting the loss of marine biodiversity, particularly in coral reefs and wetlands;

The activities and programmes including agreed targets and action plans have created a new awareness of domestic issues and regional problems and engendered a certain sense of urgency on fisheries depletion and environmental matters. However, their overall impact has been impaired by a lack of success in focusing on transboundary ecosystem-wide International Waters problems and the need to strengthen environmental and resource stewardship at both national and regional levels. This has been exacerbated by the absence of a mechanism for funding incremental costs in the existing Regional Seas Programmes, and a lack of resources for a co-ordination Secretariat. A proposed strategy for revitalising both the Abidjan and Nairobi Conventions exists and was embodied in the GEF funded Medium Sized Project implemented by Advisory Committee for the Protection of the Seas (ACOPS) and which ended with a "Partnership Conference" in September 2002 on the sidelines of the World Summit on Sustainable Development (Rio + 10 Conference) in South Africa.

A challenge facing Africa now is to achieve the Millenium Development Goals (MDGs) which the Heads of Governments adopted at the United Nations Millenium Summit in New York in September, 2000. In the MDGs, African Governments committed themselves to take special measures to address among others the challenges of poverty eradication and sustainable development in Africa. These measures are based on the recognition that the environment is a veritable source of goods and services for economic growth and that environmental degradation undermines prospects of fighting poverty.

National policy and legal frameworks for sustainable development including management of Marine and Coastal Environments for each of the countries can be found in the National Reports developed in support of this project.

5. Major perceived transboundary problems and issues

5.1 Introduction

The identification of the Major Perceived[3] Problems and Issues (MPPIs) is a first step in the TDA process and it constitutes the justification for the subsequent in-depth analyses. The significance of the perceived issues and problems should be substantiated on scientific, environmental, economic, social and cultural grounds. The MPPIs represent the perceptions of the scientific and expert community on the priority environmental issues of the region.

This section of the TDA analyzes the MPPIs to identify the technical basis supporting or refuting each MPPI as a priority issue in the GCLME region. The intent is to provide a technical rationale for prioritizing the MPPIs, to help guide the direction of future interventions to improve the regional environment. It will be of no use to identify major intervention efforts for an MPPI if the technical basis supporting its priority is missing. In such a case, the MPPI can be dismissed as a non-priority issue, or just as importantly, gaps in knowledge can be identified, and filling the gaps can become the next step towards addressing that particular MPPI.

The State of Coastal and Marine Environment of the Gulf of Guinea report (UNIDO/UNDP/NOAA/UNEP, 1998), the Coastal Areas Profiles of the GOG LME coastal states, the National Reports and the Regional Synthesis report summarise some of the studies that have been conducted in the coastal and marine environment of the GCLME. The various studies indicate alarming rates of decline of fisheries resources and significant levels of pollution including pathogens and micro-organisms in sewage, industrial effluents with high organic loading and hazardous chemicals, heavy metals, oils and hydrocarbons, tar balls on beaches, as well as serious problems of coastal erosion and coastal areas management. Other studies have also concentrated on weeds, water hyacinth and algal blooms. Studies have been conducted on marine fisheries resources of the Guinea Current region by CECAF, FAO, FRU-and ORSTOM. Marine environmental and pollution monitoring programmes have also been carried out by WACAF in collaboration with UNEP/FAO/WHO/IAEA. A review of the status of marine fisheries resources in 1994 indicates that apart from offshore demersal resources, all other fisheries in the sub-region are near to full or fully exploited (Ajayi, 1995). This has resulted in the loss of food security and increased conflicts between commercial (industrial) and artisanal (community-based) fisheries.

In summary, it is recognised that the coastal and the marine ecosystem of the GCLME and its resources have witnessed various environmental stresses as a result of the increasing socio-economic and unsustainable development activities. All the above cited studies and assessments have identified four broad coastal and marine environmental problems and issues in the GCLME region, namely:

1. Decline in GCLME fish stocks and unsustainable harvesting of living resources;
2. Uncertainty regarding ecosystem status, integrity (changes in community composition, vulnerable species and biodiversity, introduction of alien species) and yields in a highly variable environment including effects of global climate change;
3. Deterioration in water quality (chronic and catastrophic) from land and sea-based activities, eutrophication and harmful algal blooms;
4. Habitat destruction and alteration including inter-alia modifications of sea floor and coastal zone, degradation of coastscapes, coastline erosion.

The socio-economic and cultural implications from the above broad issues can be tremendous in terms of income reduction arising from a loss of fisheries stocks and catches, loss of recreation and tourism amenities and an increase in water treatment and coastal protection costs. Because of the paucity of reliable, detailed and historic scientific data on coastal, marine and freshwater environment in the GCLME region, a certain degree of uncertainty still prevails in assessing the pollution loading in general. There is an urgent need for a precise qualitative and quantitative assessment of the significant sources of land-based pollution as well as comprehensive assessments of the state of the fisheries resources and extent of ecosystem degradation (including status and trends analysis) in the region.

3. “Perceived" is used to include issues which may not have been identified or proved to be major problems as yet due to data gaps or lack of analysis or which are expected to lead to major problems in the future under prevailing conditions.

Photo 5.1: Typical example of acute coastal erosion (Port-Bouët, Côte d'Ivoire)

The above-mentioned coastal and marine environmental problems in the GCLME can be broken down into the following twelve specific problems:

1. Large-scale changes in the abundance levels of the resident fish stocks near shore and the conditions affecting the sustainability of the straddling, shared and highly migratory stocks of the region, both of which have food security and economic implications for the 280 million inhabitants of the region;
2. Depletion of fisheries stocks due to excessive and unsustainable harvesting of fisheries resources;
3. Lack of prediction of natural fluctuations leading to excess fishing effort;
4. Apparent increase in the frequency and extent of coastal erosion placing fisheries and other coastal communities in danger from loss of roadway and habitable lands;
5. The physical destruction of coastal habitats including wetlands and mangroves, resulting in the loss of spawning and nursery grounds for living resources and the loss of the rich and varied fauna and flora of the region including some endemic and endangered species;
6. Uncontrolled and haphazard urbanization of coastal areas across the region that results in conflicts and imposes great stresses on the environment and resources;
7. Harbour construction activities that generally alter longshore current transport of sediments and in many cases have led to major coastal erosion and siltation problems;
8. Large amounts of sediments emptied by the many large rivers in this region that are important sources of nutrients and suspended matter to the coastal and marine environment contributing to eutrophication and harmful algal blooms with serious implications for ecosystem and human health;
9. Input of largely untreated sewage into the coastal environment impacting on health, tourism and fisheries. Sewage treatment facilities are very limited throughout the region and raw sewage is discharged both into coastal lagoons and the rivers flowing into them. This, combined with the limited tidal water exchange of lagoons, has led to widespread eutrophication;
10. Discharge of untreated and/or partially treated industrial wastes directly into coastal water bodies that contaminate marine life and pose serious threats to human life;
11. Use of pesticides, especially the organochlorine group of compounds, in agriculture and human health protection resulting in an input of residues to the coastal environment that are harmful to living resources;
12. Risks from petroleum pipeline development, accidental spills of petroleum products and operational discharges from shipping (e.g. ship wastes) and the accidental introduction of toxic chemicals and exotic species that seriously damage the receiving ecosystem, leading to food and habitat degradation.

The major impacts originating from individual coastal States that are invariably transboundary in nature in the sub-region include:

1. Various levels of depletion of shared, straddling and highly-migratory fish stocks;
2. Wastage through discard of by-catch with consequent loss of marine resources, biodiversity and biomass;
3. Phenomenal rates of erosion of coastlines;
4. Loss of critical habitats, particularly mangroves and wetlands, that sustain biological diversity and provide spawning and nursery grounds to most of the exploited resources;
5. Haphazard and unrestrained over-development of the coastal areas with incidence of erosion;
6. Toxic chemical and oil spills, as well as discharges of oily ballast and exotic biological species discharges from ship traffic;
7. Socio-economic implications including loss of revenue, food security concerns, resource use conflicts and increasing poverty.

5.2 Major perceived problems and issues

From the national reports, questionnaires and other published materials, the TDA Task Team, constituted under the GCLME PDF-B, taking into consideration the GIWA methodology analysed all the identified perceived regional transboundary environmental problems and issues and grouped them under the following four MPPIs:

1. Decline in GCLME fish stocks and non-optimal harvesting of living resources;
2. Loss of ecosystem integrity (changes in community composition, vulnerable species and biodiversity, introduction of alien species) and yields in a highly variable environment including effects of global climate change;
3. Deterioration in water quality (chronic and catastrophic) from land and sea-based activities, eutrophication and harmful algal blooms;
4. Habitat destruction and alteration including inter-alia modification of seabed and coastal zone, degradation of coastscapes, coastline erosion.

Photo 5.2: Waste on a lagoon shore in Liberia

Below, each of these problems and issues is addressed from a status perspective. It answers the questions: what do we know about each problem/issue? What data support the quantification of the extent of the problem/issue? Do the data support these as real problems and issues, or just as perceptions? This analysis took place on a scientific level, including biological, oceanographic, physical, social and other perspectives on the problem. This is in effect the "status" assessment.

Photo 5.3: Marine litter collection on Kribi beach in Cameroon

The next step was to perform a causal chain analysis; the major perceived problems and issues were analyzed to determine the primary, secondary and root causes for these problems/issues. Identification of root causes is important because root causes tend to be more systemic and fundamental contributors to environmental degradation. Interventions and actions directed at the root causes tend to be more sustainable and effective than interventions directed at primary or secondary causes. Because the linkages between root causes and solutions of the perceived problems are often not clear to policymakers, interventions are commonly mis-directed at primary or secondary causes.

This TDA attempts to clarify the linkages between root causes and perceived problems, to encourage interventions at this more sustainable level. Fortunately, root causes are common to a number of different perceived problems and issues, so addressing a few root causes may have positive effects on several problems and issues. The root causes of most of the environmental and resource problems in the GCLME area have to do with inadequate policy, ineffective compliance monitoring and enforcement, lack of community support and lack of appropriate legislation.

Photo 5.4: Abidjan, a coastal city in West Africa

5.2.1 Decline in GCLME fish stocks and non-optimal harvesting of living resources

Status of the problem/issue

In some countries of the region, there is evidence indicating that the artisanal and more the commercial fisheries have exceeded or are about to exceed the point of sustainability. Major lines of evidence leading to this conclusion include: decrease in the catch per unit effort (Schaefer, 1954), reduction of the length at first maturity (Gayanilo and Pauly, 1997) and reduction of the average size of the fish in the catch (Ajayi, 1994).

Transboundary elements

The major transboundary problem elements identified during the cours of this TDA can be summarized as follows:

1. Loss of income from the fisheries
2. reduce availability of fish and fishery products;
3. Region-wide decrease in biodiversity of the marine living resources including the disappearance of high-quality critical natural resources;
4. Region-wide destructive fishing techniques degrading mangrove habitats;
5. Increasing effort on offshore pelagics and demersal resources;
6. Non-compliance with ecosystem management and the FAO Code of Conduct for responsible fisheries;

Environmental impacts

The environmental impacts of the problem elements mention in the above paragraph can produce the following sad effects:

1. Loss of biodiversity;
2. Change in trophic chain;
3. Changes in community structure due to over-exploitation of one or more key species;
4. Increased vulnerability of commercially-important species;
5. Long-term changes in genetic diversity (genetic erosion);
6. Stock reduction;
7. Loss of top predators;
8. Habitat degradation due to destructive fishing techniques;

Socio-economic impacts

As above, the socio-economic impacts of the problem elements mention in the above paragraph can produce the following sad effects:

1. Reduced income;
2. Loss of employment;
3. Population migration;
4. Conflicts between user groups;
5. Loss of recreational opportunities;
6. Decline in protein;

Over-exploitation of fishery resources, the use of destructive fishing practices and the destruction or modification of ecosystems can significantly affect the region's coastal communities. The GCLME supports a significant world fishery that is important for food security, and as a source of foreign income earnings for the countries. As mentioned in previous chapters, the fisheries sector is very important in the GCLME with regard to its contribution to domestic food security for the countries. IN FACT, Fish consumption is quite high in the region especially in coastal communities and contributes significantly to the protein intakes of the citizens.

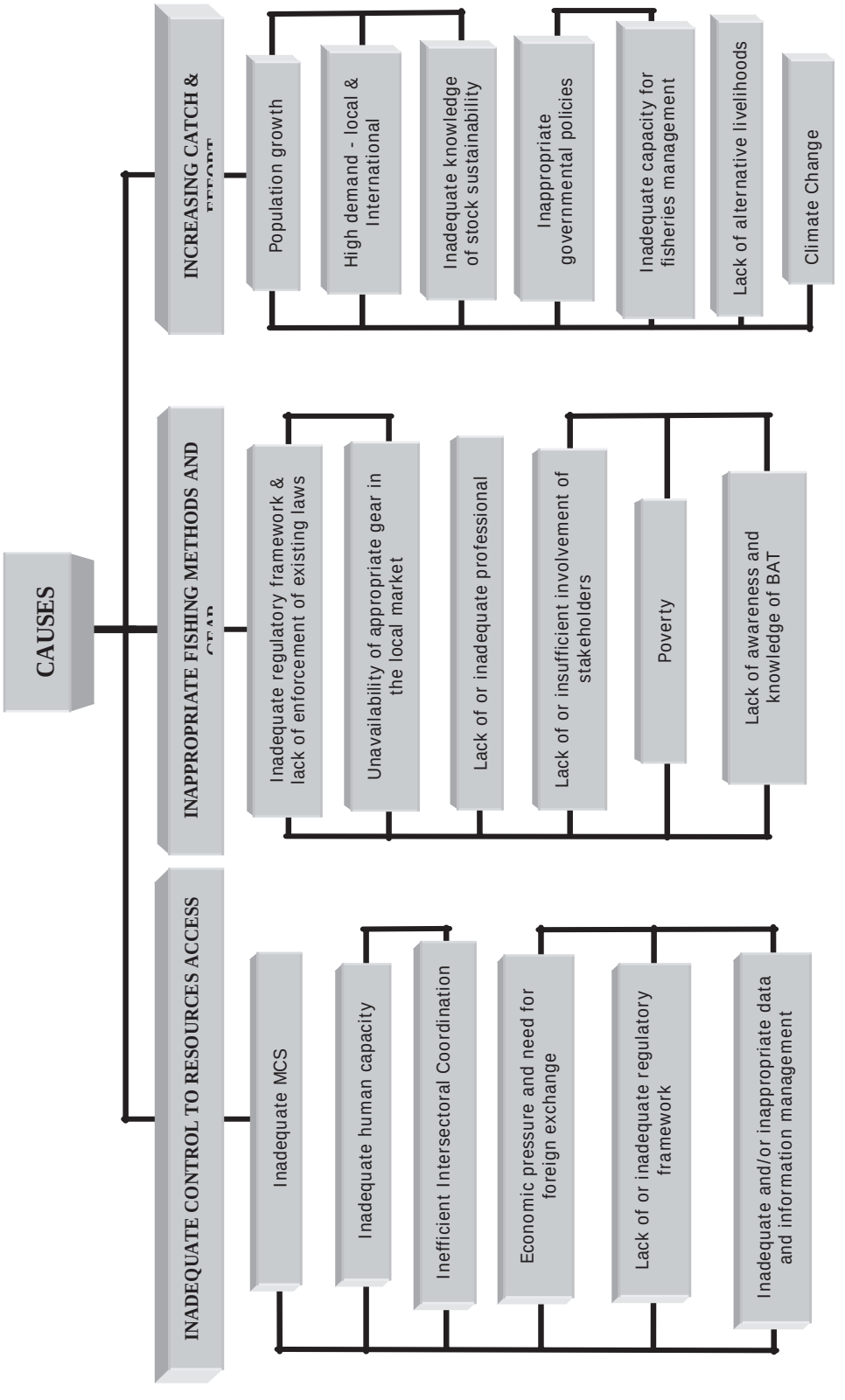
Pelagic and demersal fisheries within the region are being exploited with evidence showing that the landings of many demersal species are currently declining. The decline in fish availability in the subsistence sector has led to the adoption of destructive fishing methods (cheap and easy to practice) such as use of undersized meshes and blast fishing.
Based on present consumption patterns and population growth rate, much of the region especially the large coastal cities of Lagos, Abidjan, Accra and Doaula, will have to produce significantly more fish by 2010 just to meet domestic demand. Pressure on the coastal resources is therefore likely to increase significantly in the immediate future. Despite nutritional requirements and current population growth rate, the industrial (commercial) fisheries sector in the countries within the GCLME export fisheries products (Figure 5.1-1)exacerbating the problems associated with food security n the region.

The contribution of the artisanal fishery to food security, employment and the conservation of socio-cultural traits deserve special attention. In the area of employment, the canoe industry has produced important fleets varying from country to country. There are 7,350 in Cameroon, 8,650 in Ghana and 200,000 in Nigeria (Report of Working Commission I: in Ibe et al., 1998). The motorisation rate for the canoes can reach up to 50% as it does in Nigeria. Direct

employment in terms of fishermen is also high. There are 24,000 in Cameroon and 7,600 in Côte d'Ivoire. For food security almost 90% of the artisanal fisheries landings in all the countries go to direct human consumption (memo).

Photo 5.5: Artisanal fishers preparing for an outing (Down beach Limbe)

Diagram 1: Causal Chain Analysis: Decline in GCLME Commercial Fish Stocks and Non-Optimal Harvesting of Living Resources



Sectors and Stakeholders

The main government sectors involved in the fisheries issues are the fisheries, agriculture and environment ministries and agencies, and municipal and state (provincial) governments. The Stakeholder Analysis identified the energy ministries as major government impact sectors (perhaps for both oil and gas sector impacts as well as hydropower). Affected stakeholders include local fishermen, coastal zone residents, and scientific community.

Supporting data:

The continental shelves of Guinea Bissau, Guinea and Sierra Leone are characterized by coastal fish assemblages (croakers) principally located in nutrient-rich estuarine and inshore areas. The GCLME is already showing evidence of ecosystem stress with major fluctuations of commercially valuable species. Significant changes in species composition have occurred over time as a result of over-exploitation of several demersal fish species especially by foreign trawlers in the inshore and offshore areas. The size spectrum of fish is moving towards smaller size classes. Recent trawl surveys conducted in Ghana showed that significant changes were occurring in the demersal fish biomass in terms of distribution, abundance and reproductive strategy.

A case in point is the historic fluctuations of two species, the grunt and triggerfish in 1970s-1980s. In fact, the grunt maintained for a time its position at the top of the list of demersal fish exploited but later gave way to the triggerfish which dominated the ecosystem during the period mentioned above. After which time, it dramatically decreased in abundance (FAO, 1997). Koranteng and McGlade (2002) attribute the almost complete disappearance of the triggerfish after the late 1980s to observed environmental changes and upwelling intensification in the western-central part of the GCLME, off Ghana and Côte d'Ivoire (Koranteng, 1988). There was a subsequent increase of the Sardinella population. The Sardinella fishery had collapsed in 1973, but subsequently recovered to unprecedented levels during the 1980s (Cury and Roy, 2002). The exploitation rate applied to cuttlefish stocks has been increasing since 1984 and by 1990 was considered to be equal to, or slightly above, the optimal fishing effort. The rate of growth of these organisms appears faster than previously estimated (FAO, 1997).

Photo 5.6: GCLME and other scientists in front of the RV Dr. Fridtjof Nansen during the Flag Off Ceremony of the regional GCLME/IMR/FAO Fish Trawl Survey (4th June-19 July 2005).

Such changes in population dynamics of the demersal resources can be related overfishing, as evidenced by a decline of Catch-Per-Unit- Effort (CPUE) and the taking of young immature fish by artisanal fishermen. They also appear to be related to environmentally-driven changes to pelagic stock distribution. For instance, CECAF (1994) assessed the biomass of the small pelagics in the western and central Gulf of Guinea as 392,000 metric tonnes. The current level of exploitation in the area is close to the standing biomass about 257,000 metric tonnes annually. This clearly indicates the over-exploitation of the resources (Mensah & Quaatey, 2002). The observed recent high catches of the pelagic resources (which exceed the estimated potential yield) are due mainly to the increasing intensity of upwelling in the area).

In Guinea, current estimates based on recent trawl surveys indicate a total biomass of demersal resources to be around 180,000 tonnes, of which 44,000 tonnes are of high or medium commercial value. Assessments made by CECAF in 1991 were updated in 1994 (Working Group held at the Centre National des Sciences Halieutiques de Boussoura,

Conakry, Guinea) and show that total demersal biomass decreased by around 50% between 1991 and 1994. The decrease in biomass of the main demersal species, such as croakers, threadfins and sicklefish, was higher than 50%. It was suggested that this change in biomass was related to the recent increase of small-scale artisanal and industrial fishing efforts. Interactions with the more commercial large-scale fisheries have led to major problems for the traditional artisanal fishery. Fishery production of the coastal area up to 20 m depth was estimated at about 40,000 tonnes per year.

Photo 5.7: Fish measurement during the 1999 Gulf of Guinea trawl survey on board the MV Sussainah in the pilot phase of the project

Trawl surveys carried out on the Guinea continental shelf have shown that between 1985 and 1990 the estimated biomass of coastal resources in waters less than 20 m deep (roughly up to 15 nm offshore) declined from 112,000 to 49,000 tonnes during the rainy season and from 72,000 to 48,000 tonnes during the dry season. This reduction between 1985 and 1990 can be explained by the increase in fishing activity of trawlers in inshore areas.

In Sierra Leone, the artisanal fishery exploits small pelagic species only. Their current level of catches ranges between 22,000 and 30,000 tonnes. Acoustic surveys have estimated biomass to be between 70,000 and 120,000 tonnes, suggesting that catches are still sustainable. Current annual landings for demersal stocks by trawlers ranged from 8,000 to 20,000 tonnes between 1991 and 1993. Reduced catch rates are currently observed in the fishery and the level of exploitation of demersal fish stock is considered high.

Current annual production of Southern pink shrimp in Sierra Leone was found to fall within the MSY estimate of 2,600 to 3,500 tonnes. Reduced catch rates are currently observed in the fishery, and the level of exploitation of shrimp is considered high. In the west and central Gulf of Guinea, potential catches of shrimps were estimated at 4,700 tonnes, and stocks were considered over-exploited. Demersal resources are fully exploited with biomass estimates ranging between 64,000 and 104,000 tonnes.

Marine resources of the Gulf of Guinea are mainly exploited by Côte d'Ivoire, Ghana, Togo, Benin, Nigeria, Cameroon and Equatorial Guinea, among others. Multi-species fisheries are common in the Gulf of Guinea. Small pelagic resources are exploited by small-scale gillnets and semi-industrial purse-seine in Côte d'Ivoire, Ghana, Togo and Benin and exclusively by small-scale fisheries in Nigeria and Cameroon. Coastal demersal resources are composed of sciaenids (exploited by small-scale and semi-industrial fisheries in Nigeria, Benin, Togo and Cameroon), groupers and snappers (fished in Togo and Ghana with hooks-and-lines in untrawlable areas), and sparids (Côte d'Ivoire and Ghana). The white shrimp resources off Nigeria and Cameroon are fished exclusively by artisanal fisheries while pink shrimp is exploited by trawlers of the semi-industrial fishery. Penaeid shrimps in Togo and Benin and in Côte d'Ivoire are caught in lagoon fisheries. The offshore demersal resources of Ghana and Côte d'Ivoire are made up of sparids along with the slope community, while the offshore demersal resources of Nigeria and Cameroon are primarily drift fish and redfishes.

The recent biomass estimates of 7,000 tonnes in Congo and 31,000 tonnes in Gabon for stocks of *Sciaenidae* and *Sparidae* were based on acoustic surveys carried out in 1994. Demersal resources were either close to, or fully exploited. Effort reduction and redistribution would be beneficial, as fishing concentrates in the inshore zone and on juveniles. Small pelagic species (sardinellas, mackerels and anchovies) are important but unstable resources in the Western Gulf of Guinea (Côte d'Ivoire-Ghana-Togo-Benin) and their stocks are shared. Substantial recruitment of *S. aurita* has been observed in Ghana and Benin in 1988 and 1989. The fishing pattern in recent years has been different from that of 1985 and 1987, with regard to the availability of the resources. Potential catches of small pelagics in the west and central Gulf of Guinea have been estimated at 330 000 tonnes and are fully exploited. Little is known about pelagic and demersal resources in the whole southern Gulf of Guinea. Many countries have not developed an appropriate database and research structures to assess stock status.

Acoustic surveys in the northern shelf of Angola indicated for the period 1985-1989 a decline in the biomass of small pelagics (sardinella and horse mackerel). The trend has dramatically reversed during the 1990s and the current biomass level now exceeds 500 000 tonnes. Horse mackerel (*T. trecae*) biomass was estimated at about 250 000 tonnes (1994). High biomass values for both round sardinella and *Madeira sardinella* were also recorded in the South Gabon - Congo region, 135 000 tonnes in 1994. Horse mackerel biomass was estimated at 25 000 tonnes. These estimates indicate a considerable increase in biomass compared to previous survey results, confirming the trends observed in Angola. Small pelagic stocks are considered under-exploited.

The Maximum Sustainable Yield (MSY) for Nigerian fisheries was estimated by Tobor (1990) at 240,000 metric tonnes. According to Moffat and Linden (1995), official catch figures have greatly exceeded the MSY from 1980 to 1989. In spite of the limitations of estimating MSY in circumstances where efforts and standing biomass data may be inadequate, there are other pointers to declining fish depletion and over-exploitation. In Rivers State of Nigeria for example, between 1980 and 1982, catches which ranged between 86,000 to 107,000 tonnes, decreased to values ranging from 16,000 to 19,000 tonnes between 1986 and 1987 period (Moffat and Linden, 1995). This supports the notion that catches were well above the optimum since several years.

Environmental changes manifesting a periodic variability in coastal upwelling intensities are playing a role in coastal pelagic fish abundance fluctuations. For instance, the east and west flows and position of the Guinea Current may play a role in these population fluctuations. Shifts in biomass appear to be connected to a shift in the boundary of the Guinea Current. These alterations have been linked to oceanographic changes including the southward displacement of the Intertropical Convergence Zone (ICTZ) during Atlantic El Ninos.

A large artisanal fisheries sector with strong traditional roots in the region had used bottom set nets, hook and line and beach seines to catch demersal fish for the populations of Sierra Leone, Ghana and Togo. After the 1960s, the GCLME's transboundary, straddling, and migratory stocks attracted commercial fishing fleets. Their fishing efforts exerted extreme pressure on the fishing resources, placing them at risk of collapse. This was exarcebated after 1982 by the return of local industrial fleets that had previously fished other EEZs but were barred from them according to the new United Nations Convention of the Law of the Sea (UNCLOS). This resulted in a significant increase in fishing effort (especially for the demersal fisheries). The time series analysis of CPUE of Koranteng (2002) for both small-sized inshore vessels and industrial trawlers in Ghana showed a consistent rise in industrial trawling from the mid-1970s and a downward trend in the late 1980s in inshore seasonal fishing. There was also a consistent rise in industrial trawling effort and a decline in that of inshore trawlers operated by artisanal fishermen. The CPUE steadily decreases in most of the demersal fisheries of the region as well as the average body length of the target species.

Catches of ISSCAAP Group 45 (shrimp, prawns, etc.) represent 1.4% of the total catches. Southern pink shrimp catches became significant in 1966 and have since regularly increased with a sharp peak, reaching 19 000 tonnes in 1993 before declining to 14 000 tonnes in 1994. The deep water rose shrimp catches have shown a great variability, with a very high value of 19 000 tonnes in 1978 but only about 5 000 tonnes in 1986-88 and 1992-94. (ISSCAAP= International Standard Statistical Classification of Aquatic Animals and Plants)

Table 5.1: Average annual fish landings in the GCLME

Country	Average 1993-95 (10^3 mT)
Angola	77.5
Benin	13.5
Cameroon	41.9
Congo	17.5
Côte d'Ivoire	57.5
Equatorial Guinea	3.3
Gabon	240
Ghana	299.6
Guinea	60.3
Guinea Bissau	5.3
Liberia	3.8
Nigeria	187
Sierra Leone	47.1
Togo	8.7

Derived from World Resources1998-99

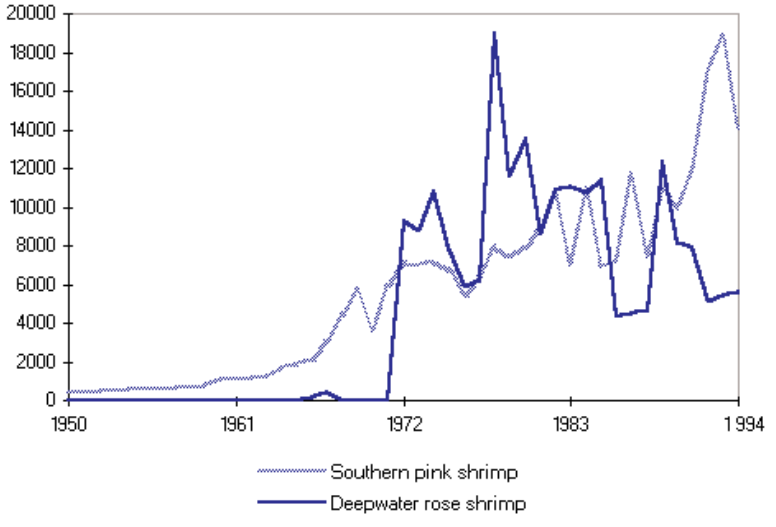


Figure 5.1: Shrimp Catches in the GCLME Region (Source: FAO, 1997).

Table 5.2: Densities (kg/ha) and catch rates kg/hr of total demersal resources and selected species obtained during the Guinea Trawling Survey (GTS) on the continental shelf of Ghana, 1963-1990

SPECIES	*GTS CPUE	Densities (kg/ha)				
	1963-64	1969-70	1981-82	1985-86	1989-90	1990
B. auritus	24-35	2,4	-	8,3	3,5	0,2
E. aeneus	1-24	0,5	-	2,1	0,7	0,8
P. bellottii	12-103	1,6	-	4,9	1,4	1,4
D. canariensis	1-15	1,3	-	2,2	0,9	1,0
S. caeruleostictus	4,39	1,0	-	2,7	1,1	1,8
D. volitans	1,86	0,9	-	0,2	0,6	2,5
P. prayensis	9,26	0,7	-	2,7	1,2	0,7
Sepia spp	1-12	1,2	-	1,2	0,6	3,8
Total demersal	23,5 kg/ha	36,0	93,9	62,1	19,4	22,8

*Sources: FRUB, Tema, In Ajayi (1994) NB: * Guinea Trawling Survey*

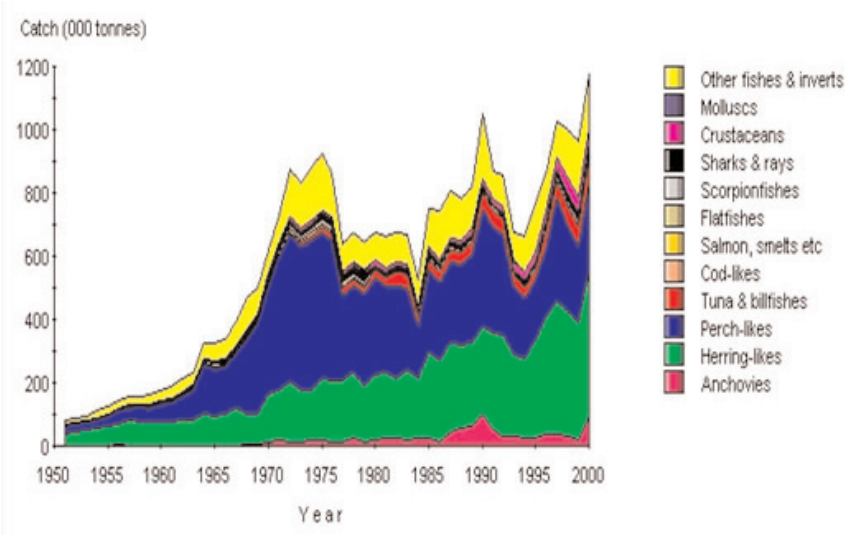


Figure 5.2: Fish catch in the Guinea Current Large Marine Ecosystem (Source: University of British Columbia, at http://data.fisheries.ubc.ca)

5.2.2 Loss of ecosystem integrity (changes in community composition, vulnerable species and biodiversity, introduction of alien species) and yields in a highly variable environment including effects of global climate change

Status of the problem

Environmental changes manifesting a periodic variability in coastal upwelling intensities are playing a role in coastal pelagic fish abundance fluctuations in the GCLME. For instance, the east and west flows and position of the Guinea Current may play a role in noticeable population fluctuations of the Triggerfish that appeared in large quantities in the 1970s but have now completely disappeared. Shifts in biomass appear to be connected to a shift in the boundary of the Guinea Current. These alterations have been linked to oceanographic changes including the southward displacement of the Intertropical Convergence Zone (ICTZ) during Atlantic El Ninos. In addition to natural variability, the ecosystem status is affected by human activities (overfishing, introduction of alien species, and contaminationfrom land-based activities). Inadequate state of knowledge of the ecosystem status and lack of regional coordination in studies of biodiversity, habitats, and ecotones hinders effective management on a national and regional level.

Occasional changes have been witnessed in the biodiversity of the region. The Bivalves species (Chlamys opercularis) was caught in large quantities as never before during a trawl survey conducted in 1998. It has been suggested that the bivalve species may have been introduced into the region through ship ballast water. These changes in biodiversity have been attributed to both natural (intensification of the minor upwelling, water temperature changes) increase in salinity of shelf waters (Binet, 1995) and changes in meteorological and other oceanographic conditions (reduction of rainfall, acceleration of winds and alteration of current patterns (Binet, 1995) and changes in nearshore biophysical processes (Koranteng, 2001).

Transboundary elements

The Guinea Current environment is highly variable and the ecosystem is naturally adapted to this change. Sustained large-scale environmental events such as ENSO, flooding, algal blooms, Benguela and Canary Current intrusions and changes in winds, however, affect the ecosystem as a whole, compounding the negative effects of fishing. These events and changes generally have their origin and cause outside of the GCLME, but are of such a scale that the impacts occur in their international waters areas of all sixteen countries i.e. the changes propagate across external GCLME boundaries and internal geopolitical boundaries. The poor ability to predict events and changes limits the capacity to manage effectively system wide. Additionally, the GCLME is believed to play a significant role in global ocean and climate processes and may be an important site for the early detection of global climate change.

Most harvested fish species are shared between countries and straddle geopolitical boundaries. Past over-exploitation of targeted fish species has altered the ecosystem as a whole, impacting at all levels, including on top predators and reducing the gene pool. Some species, e.g. sea turtles, are threatened or endangered. Exotic species have been introduced into the Guinea Current Region. (This is recognised as a global transboundary problem.)

Socio-economic impacts

1. Food deficit/abundance depending on phase of cycle of natural variability;
2. Lack of ability to depend on reliable artisanal fisheries in some cases;
3. Instability in coastal populations due to fluctuating food sources;
4. Possible intrusion of offshore/industrial fisheries into areas of conventional artisanal fisheries when offshore resources are declining;

Environmental impacts

Sea-level rise and other global change impacts may affect the coastal populations and infrastructure (Tables 5.3 and 5 4).

Table 5.3: Summary of impacts and response costs for a one-meter sea-level rise in Nigeria

Land at risk (km2)	18,120 to 18,396
Population at risk	3,180,000
Value at risk (million)	US$18,134
Important area protection	US$558 to 668
Total protection	US$1,424 to 1,766

Source: French and Awosika, 1993

Table 5.4: Estimated number of people (in millions) that will be displaced by sea-level raise scenarios

S/L Scenarios	0.2m	0.5m	1.0m	2.0m
Barrier	0.6	1.5	3.0	6.0
Mud	0.032	0.071	0.140	0.180
Delta	0.10	0.25	0.47	0.21
Strand	0.014	0.034	0.069	0.610
Total (in millions)	0.75	1.86	3.68	10.00
% Total Pop.	0.07	1.61	3.20	8.70

Source: Awosika et al., 1992

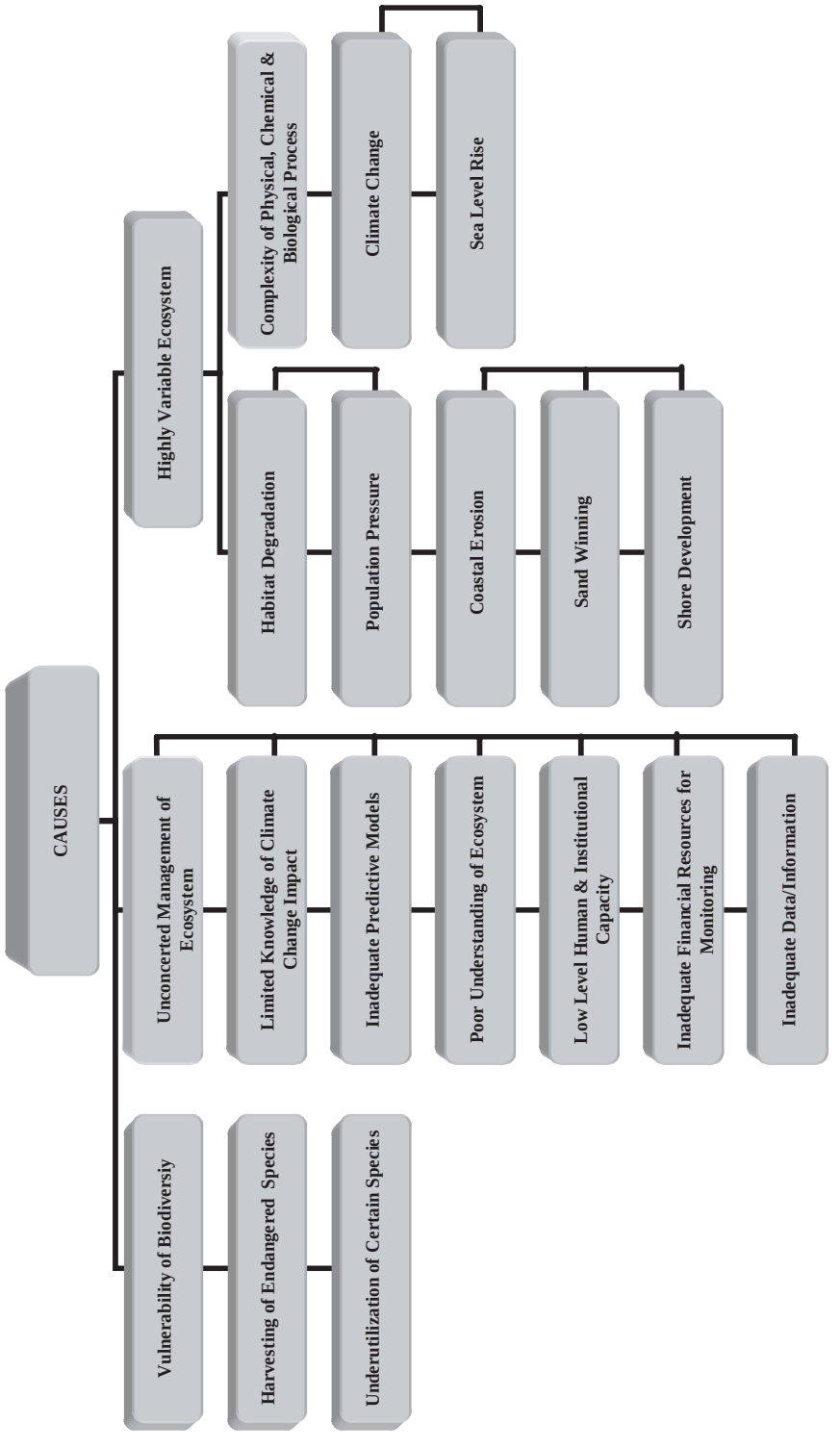


Diagram 2: A causal chain analysis was conducted to determine the primary, secondary, and root causes of global change and uncertainty in ecosystem status.

Sectors and stakeholders

Stakeholders for global change are varied and inclusive. Prominent stakeholders include:

1. Artisanal fishermen;
2. Coastal populations interacting with artisanal fisheries;
3. Local governments;
4. Tradesmen;
5. Children and women;
6. National governments responsible for social welfare of its people;

Supporting data

Plankton research in the Gulf of Guinea began in the late nineteenth century with oceanic expeditions to the area by some European countries to assess the biodiversity in the region. Among the major expeditions were the Buccaneer in 1886, Valvivia in 1898, Meteor in 1925, Dana in 1930, the Atlantide in 1945-46 and the Calypso in 1956 (Voss, 1966). Following such expeditions, the role of plankton in the region's marine productivity gained importance and national institutions responsible for fisheries included plankton monitoring in their activities. For example, in Ghana the Fisheries Research and Utilization Branch (now Marine Fisheries Research Division) carried out monthly monitoring of zooplankton from 1962 to 1995 (Mensah and Koranteng, 1988; Mensah 1966). The data provided a crude indication of future fish biomass.

The GCLME is considered among the highly productive (>300 gC/m2-yr) ecosystem based on SeaWiFS global primary productivity estimates (Figures 5.8 and 5.9). Primary productivity peaks from June to September, stimulated by nutrient level increases related to the first rains in June, upwelling later in the year, and large riverine floods from September to October. Because of the shallow depth of the Guinea Current and vertical migration patterns of the zooplankton, the phytoplankton and zooplankton biomass cycles are in phase with seasonal upwelling. The zooplankton biomass peaks very soon after the phytoplankton blooms. The plankton survey, using Ships of Opportunity, conducted in the waters of the Gulf of Guinea LME during the pilot phase GOGLME project was the first regional effort to monitor the plankton in the sub-region. The results have provided spatial and temporal information on plankton variability in the area.

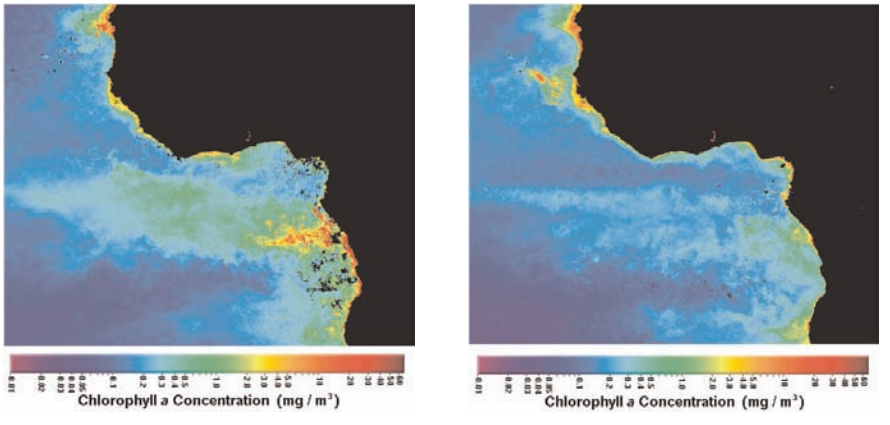


Figure 5.3: Primary Productivity estimated from SeaWiFS (A) data for summer, 2005 and (B) data for fall, 2005.

The primary productivity surveys in the Gulf of Guinea, using these ships of opportunity towing Continuous Plankton Recorders (CPR), indicated new and emerging patterns of productivity that contain at the same time hopeful and distressing signals (Figures 5.8 through 5.9). The hopeful signs come from the discovery of new areas of upwelling (e.g. off Benin and Nigeria) besides those already known which has led to upward revisions of potentially available fish stocks in the Gulf of Guinea. The distressing signs arise from the increasing occurrence of harmful algal blooms indicating intense eutrophication and therefore excessive nutrient loading in the Gulf of Guinea from anthropogenic sources. There is a need for more assessment of plankton amount and type, for more information on currents, upwellings and the availability of nutrients for ocean fauna and flora. Continuous Plankton Recorder (CPR) tows must continue to build upon already acquired results, and must be extended to the natural limits of the LME in order to build a comprehensive Photo of productivity patterns on an ecosystem-wide level, with regard to the LME's carrying capacity for living resources.

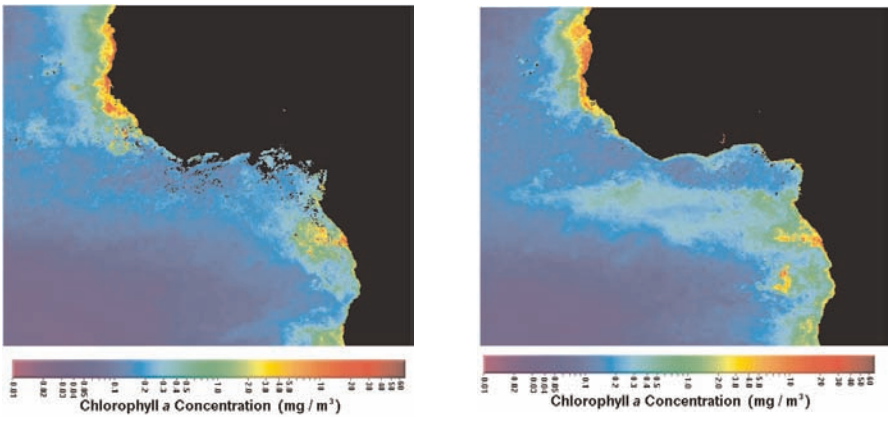


Figure 5.4: Primary Productivity estimated from SeaWiFS data for (A) winter and (D) data for spring, 2005.

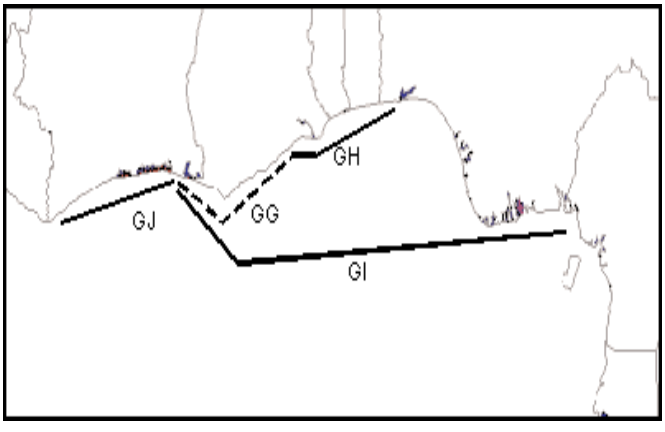


Figure 5.5: Plankton Monitoring Routes during the Pilot phase of the Project (1995 - 1999)

As discussed in more detail in Section 5.1, the GCLME is rich in living marine resources and commercially-valuable fishes, both marine and coastal. Fish species include croaker, grunts, snapper, sardinella, triggerfish and tuna. During the last two decades there have been substantial fluctuations in the fishery, with the triggerfish (Balistes carolinensis) increasing dramatically in the 1970s followed by a severe decrease and the 1973 collapse of the Sardinella fishery. The latter subsequently recovered to unprecedented levels during the 1980s (Binet, et al., 1991). The changes in fishery patterns appear to be related to a new geographical distribution of pelagic stocks. Shifts in fisheries populations may be caused by environmental factors. For instance, Ibe and Ojo (1994) observed that, with the exception of Ethmalosa sp., the Sardinellas appear not to be abundant in the water sectors where the mixed layer is of low salinity and warm water present all the year round (T>240C; /<35o/oo). With global warming it is thus likely that the Sardines may not be found in the Grain Coast and Bight of Biafra sectors that exhibit the above-mentioned characteristics.

The respective east and west flows and position of the Guinea Current may play a role in population shifts. Acoustic surveys taken between 1980 and 1990 indicated a sudden increase in fish density on the Ivorian shelf (Marchal, 1993). The shift in biomass appears to be related to a shift in the boundary of the Guinea Current. These alterations are probably linked to distant climate anomalies, such as the southward displacement of the ICTZ during Atlantic El Niños. A greater understanding of oceanographic processes is needed to improve ecological forecasts. There are indications that anticipated sea-level rise due to climatic changes would affect the aquatic life especially in the brackish waters of the GCLME (Ibe and Ojo, 1994). The change in water level, when it occurs, is likely to upset the breeding habits of some fish already used to existing habitats while new species may or may not survive in the new environment. It is also expected that by possible reduction in upwelling certain types of fish production will be reduced.

Figure 5.6: Mean seasonal phytoplankton colour taken in each degree of longitude along the CPR routes (Source: SAHFOS Report, 1999)

Environmental monitoring in the GCLME region relies mainly on a set of coastal stations, on the Comprehensive Ocean Atmosphere Data Set (COADS) database and on satellite imagery. This provides useful information on a limited set of variables such as SST and wind. These variables can be related to fish population dynamics at different scales of observation including short-term changes in fish availability, year-to-year abundance or lower frequency regime shifts. The joint Soviet-Sierra Leone oceanographic cruises in Sierra Leone waters in 1987-1988 reported a warming up of the waters and a change in the composition of the fish stocks, but longer term data are required before definite inferences can be made concerning the short term trends in fisheries composition/changes due to impacts of climate change. In addition, salinity stress consequent upon the ingress of seawater due to sea-level rise would lead to disruption of the coastal fishery by causing disorganization in the faunal assemblages in estuarine, deltaic and lagoonal environments resulting in the redistribution of species and failures in the reproduction and survival of their eggs/spores and larvae/sporophytes. Predator/prey relationships would be altered to the advantage of predators.

Along the Côte d'Ivoire continental shelf, environmental patterns have been investigated using data collected from 1966 to 1984 (Morliere and Rebert, 1972; Hisard, 1973; Colin, 1988). Characteristics of coastal upwelling and their interannual variability are well documented (Morliere, 1970; Voituriez, 1981; Ibe and Ajayi, 1984). Along the Côte d'Ivoire shoreline, this seasonal enrichment supports pelagic and demersal fisheries, both of which are very sensitive to environmental change (Binet et al.,1991; Pezennec and Bard, 1992; Binet, 1993). Continental influence is linked to four major rivers namely Cavally, Sassandra and Bandama Rivers flowing directly to the Gulf of Guinea, while the Comoe River flows seaward through the Ebrie Lagoon and the Vridi Canal. These large river inputs are high during the flood season from October to December. Rainfalls in the coastal forest area induce local river floods during the rainy seasons, from April to June and from October to November (Binet, 1993; Mensah, 1991). Since 1982, a weekly hydrological sampling (temperature, salinity and Secchi disk measurements) has been maintained around the Abidjan coastal zone (Bakayoko 1990; Cissoko et al.,1995, 1996). The study was to describe the seasonal and interannual fluctuations of physical parameters in relation to major continental (rain, river floods) and oceanographic events (upwelling) in the northern Gulf of Guinea during the 1992-1997 period and to compare these data with older information; and to assess the respective importance of these hydrological factors on the pelagic system (bacteria and phytoplankton) in that coastal station. Results obtained from the study shows that hydrological conditions observed at the coastal station off Abidjan are strongly influenced by the seasonal variability of three major phenomena: rainfalls, river floods and upwellings. Upwelling enriches the neritic ecosystem, exerting an immediate infuence on biological production, on phytoplankton and consequently, on bacterioplankton. Therefore, during four to five months (main upwelling plus short cold events), the coastal ecosystems can be considered as productive.

The neritic area along the eastern Côte d'Ivoire coastline can be presently considered as more productive than a few decades ago with the nutrient-poor situation lasting less time, and the nutrient-rich situation lasting longer. This could explain the recent outburst of small pelagic fishes (Sardinella aurita) in this part of the GCLME (Arfi et al.,2002). This supports the earlier environmental time series analysis conducted by Koranteng and Pezennec (1998) showing transition from a depleted to a prosperous state of Sardinella aurita as CPUE increased from 0.8 to 7.2 tons/day before and after 1980 during the upwelling period. Numerous sources of data have been used to evaluate the natural variability of the GoG LME during the pilot project (Table 5.3.2).

The above impacts are a few of the possible documented consequences of global warming and climatic changes on the ocean dynamics of the GCLME region. These can be further elucidated through the collection of more observational data and development of regional oceanographic models. The partnership with GOOS-Africa would facilitate the development of environmental prediction models for the GCLME region.

The sudden collapse of the Ghana-Ivoirian sardinella fishery from 95,000 t (over and above 40,000 t predicted MSY) to 2,000t a year and its seeming substitution by Balistes spp., trigger fish recording 200,000 tonnes a year up from nothing at all have been recorded in the GCLME. Off Nigeria, tiger prawns, Penaeus monodon hitherto unknown have become commercial whereas Parapeneopsis atlantica, brown shrimp; diminished in abundance. The fisheries assessment survey cruise conducted during the pilot phase Gulf of Guinea LME project found Chlamys sp in quantities hitherto unrecorded. Without a doubt environmental and climatic forcing (Koranteng and McGlade 2002) causative of biomass flips or species succession have to be further researched and factored into management strategies for ecosystem (including species composition and biodiversity) preservation (Ajayi, 2001).

There has been a noticeable increase in the incidence of aquatic weed infestation in some of these countries. Aquatic weeds are a real scourge in coastal waters due to the environmental and socio-economic impacts. For a decade in In Côte d'Ivoire these weeds have invaded coastal sites, drifting with freshwater. The Ivorien government has been aware of the harmful effects of these plants since 1980. The first species, Pistia stratiotes, was endemic to freshwaters. Then in 1984, a new species, Salvinia molesta, originating from America, was introduced. In 1986, a third species, Echornia crassipes, was introduced. Most of the large reservoirs are colonised (Ayamé I and II, Taabo and Buyo), as are the

rivers and the lagoons (Ebrié and Aby). Large rafts of E. Crassipes and associated species are carried seaward and then run aground on the beaches.

Invasion of GCLME coastal waters by aquatic weeds has some negative impacts on the fishing activities and on the fishing zone. Most of the time, the fishing activities are slowed down or even stopped for weeks or months until the weeds disappear. It is difficult, even impossible, to use castnets or mesh nets for fishing. The setting of traps is also difficult because of the inaccessibility of most of the fishing zone. This phenomenon is common in the Aby Lagoon where the boats cannot dock. Furthermore, the aquaculture systems such as the acadjas established in the lagoon cannot be exploited because the entire surface of the lagoon is covered with the weeds. It is difficult to estimate the cost of these impacts on fisheries activities.

The periodic invasion of the Ebrié Lagoon by these aquatic plants slowed down the activities in the port (difficulties for ferry boats or other boats to move or to dock in the port, obstruction of the fishing port). Periodically, the same problem is observed in other coastal waters where the riverine rural population has some difficulties moving by boat from one village to another. It is also difficult to estimate the cost of these impacts on navigation.

One other notable aquatic invasive weed, the water hyacinth, has thrived to the detriment of native species, thereby upsetting the ecological balance and the biological diversity of the region. The increased loading of the coastal waters with nutrients has provided a conducive environment for the growth of the water hyacinths which has spread and covered all of the surface water in the coastal areas from the Benin Republic in the west to the Cross river (Nigeria) and to Cameroon in the east. Since the public awareness in 1985, this phenomenon has attracted the urgent attention of the governments in the region and that of the Economic Community of West Africa States (ECOWAS) with the organization of public seminars with the attendance of experts from within and outside the region. The Governments have accorded the issues of eutrophication and invasive aquatic species topmost priority in their national planning and have set up national committees for its eradication. Unfortunately, little or no progress has been recorded in these efforts to control eutrophication, harmful algal blooms and invasive aquatic species due to the non-adoption of a transboundary and multi-sectoral approach.

Photo 5.8: Aquatic weed infestation. water hyacinth in the Ebrié lagoon, Abidjan, Côte d'Ivoire

Coastal habitats such as shallow estuaries, bays, lagoons and wetlands that are often reclaimed or cleared for habitation, development or agricultural purposes are the most productive nursery grounds for major fish or shellfish. They are therefore critical habitats, which underpin the regenerative capacity of the fishery of the sea (Ibe, 1993). The mangrove forest in the southeastern Niger Delta, estimated to cover approximately 7000km2 is the largest in Africa and the third largest in the world. It plays a vital role as producers of nutrients in primary and secondary productivity and in supporting biologically diverse communities of terrestrial and aquatic organisms of direct and indirect economic value and transboundary significance.

The mangrove ecosystem and associated wetlands are under pressure from overcutting (for fuel wood and construction timber) and from other anthropogenic impacts (e.g. clearing for aquaculture practise) thereby jeopardising their roles in the regeneration of living resources (which translates into a loss or reduction of fishery resources) and 'custodians' of biological diversity as well as in the restoration of the ecosystem quality (Ibe, 1993). The pressure of a subsistence population has adversely affected these mangroves but the discovery of hydrocarbon in the Niger Delta in the mid 1950s may have been the final straw. However, as a result of the development of large urban centres with significant industrialization and human incursion into the coastal fronts, the extent of these lagoon mangroves has been reduced and several species that could be expected to occur are no longer to be found (Saenger et al.,1997). In the last decade or so the Nypa Palm, and exotic species has become distributed throughout the Niger Delta invading and replacing native mangrove species and their associated animal species from many mangrove habitats. Its rapid propagation rate however threatens mangroves further in the region with all known negative consequences. Field assessments carried out during the Pilot Phases Project revealed that the rapidly growing Nypa Palm is presently confined to southeastern Niger Delta. Its rapid propagation rate however threatens mangroves further afield in the region with all the known negative consequences. It has become quite important to clear the Nypa Palm, an invasive alien species that has invaded the Niger Delta and degraded its ecosystem and simultaneously restore the original mangrove vegetation as a civic duty to preserve the integrity of this ecosystem with all the promises this actions holds for the shared International Waters and resources of the GCLME.

Photo 5.9: Effluent from the phosphate mines discharging into Coastal Waters at Kpémé, Togo

Table 5.5: Ecological Processes and Related Scales of Observation for the Ecological and Environmental Data. Methods Used and Main Results Obtained in Côte d'Ivoire

Ecological process	Scale of observation	Ecological data	Environmental data	Method	Results
Availability	Fortnight	CPUE	SST (coastal, COADS)	Multivariate time series analysis	Depend on enrichment process
School size	Fortnight, month	Catch per set	SST (coastal, COADS)	Regression	Depends on food availability
Seasonal Migration	Month	Catch	CUI, SST coastal and COADS	Comparative dynamics (CUI)	Depend on differential food production
Changes in Migration	Month, annual	Catch	SST coastal, Satellite (Meteosat)	Spatial upwelling index	Depend on yearly strength of the upwelling
Inter-annual abundance	Annual	Catch, CPUE	SST, wind	Climprod (production models GAM)	Depend on availability/ Abundance OEW (optimal environmental window)
Long-term abundance	Decadal	Catch, CPUE	SST (coastal, COADS)	GAM, STL (generalized additive models)	Change in the seasonal pattern and in the long term environment
Retention area	Decadal	Eggs and larvae	SST (COADS), satellite	Models (3D, IBM)	Double cell circulation
Reproductive behaviour	Microscale	Individual fish dynamics in space	Global change	Comparative Evolutionary ecology, IBM	Ecology of individuals

NB: CUI= Coastal Upwelling Index; IBM= Individual Based Models; GAM= General Additive Models (Source: adapted from Roy et al., 2002)

5.2.3 Deterioration in water quality (chronic and catastrophic) from land and sea-based activities, eutrophication and harmful algal blooms

Status of the problem/issue

Pollution from Land and Sea-Based Activities has contributed significantly to the deterioration of the water quality of the countries of the GCLME. Domestic and industrial pollutants have mostly been associated with the large coastal cities in the region such as Accra, Abidjan, Lagos, Douala, Port Harcourt and Luanda (see listing of coasltal cities in Table 3.1-1). Most of the industries operating in the region are located in or around the coastal areas and discharge untreated effluents directly into sewers, canals, streams and rivers that end up in the GCLME causing widespread deterioration in the water quality and the health of the coastal inhabitants.

Transboundary elements

Pollution from municipal, industrial and agricultural sources significantly affect transboundary waters and living marine resources of the GCLME. Although most impacts of chronic deterioration in water quality are localised (national issues), they are common to all of the countries and require collective action to address them. Moreover,

chronic pollution can favour the development of less desirable species, and result in species migration. Catastrophic events such as major oil spills and maritime accidents can produce impacts across country boundaries, requiring co-operative management and sharing of clean-up equipment and manpower. Eutrophication and HABs occur in most of the sixteen countries, and these face similar problems in terms of impacts and management, and which require collective regional action to address.

Environmental impacts

Environmental impacts of pollution are widespread, and include:

1. Disease (both human and plants and wildlife wildlife)
2. Decreased water quality (lower oxygen, lower visibility)
3. Die-off of coastal plants
4. Loss of biodiversity
5. Altered habitat
6. Loss of recreational resources
7. Degraded groundwater quality
8. Pollution of food sources

Socio-economic impacts

Socio-economic impacts include:

1. Loss of subsistence due to decline in renewable coastal resources
2. Increased disease due to degraded food sources and water sources
3. Reduced sustainability in coastal villages
4. Increased pressure on central governments to produce alternative livelihoods for population
5. Possible political instability at local or national levels
6. Loss of water for cattle and other domestic animals

Domestic sewage and other wastes, but also coastal and upstream non point-sources of pollution from agricultural, forestry and hazardous waste sites constitute sources of contamination of the fresh drinking water and the water quality in general, both for the surface and groundwater resources. Indeed, the water quality degradation is generally associated with health problems because of the presence of pathogens and other micro-organisms, excess of nitrates and persistent organic micro-pollutants, etc. It is clear, consequently, that human interference (with the land-based activities) in the region, superimposed on natural degradation processes in the coastal and marine areas could induce huge disturbances with large impacts in the concerned environments (loss of habitats and productivity and biodiversity, water quality decline with consequences in the coastal population health, changes in the natural coastal and marine environment equilibrium with frequent, increasing harmful effects; i.e., microbiological and bacteriological contamination in the Korle Lagoon in Ghana and in Ebrie and Lagos lagoons, around Abidjan and Lagos).

The major socio-economic impact expected as a result of microbiological pollution is a deterioration of human health (illness and deaths; e.g., Figure 5.3-1). Epidemiological data show the possible implication of the Ebrié Lagoon and its hydro climatic variations on the endemic nature of some diseases such as Cholera, typhoid, etc. Since 1970, infectious diseases involving bacteria of the Genus Vibrio (such as Vibrio cholerae, V. parahaemolyticus and Aeromonas spp.) have occurred endemically and sporadically among the riverine population of the Ebrié Lagoon (Dosso, 1984). Kouadio (pers. Com.) shows that pollution of the Ebrié Lagoon's shoreline causes olfactory nuisances to the riverine population that has borne a social cost estimated to be 142.2 million in 1998.

Detailed studies and analysis conducted in the GCLME region and in the entire WACAF region show clearly that sewage constitutes the main source of pollution as a result of land-based activities (UNEP, 1999). All the countries assessed reflect high urban, domestic loads, sometimes from industrial origin, which include BOD, suspended sediments, nutrients, bacteria and pathogens (Tables 5.3-1, to 5.3-3). The annual total BOD for the entire WACAF region including the GCLME was estimated to be 288,961 tons from municipal sewage and 47,269 from industrial pollution, while the annual total suspended sediments (TSS) was estimated around 410,929 tons from municipal sewage and 81,145 tons from industrial pollution. Again, the rapid growth of urban populations is far beyond the capacity of relevant authorities and municipalities to provide basic and adequate services such as water supply, sewage and other wastewater treatment facilities. As a result of these domestic and organic biodegradable material discharges, contamination of the water quality, surface waters as well as shallow aquifers and groundwater, is a current phenomenon, mostly in the sub and peri-urban areas where the conditions of overcrowding and poverty are increasing with the growing number of people.

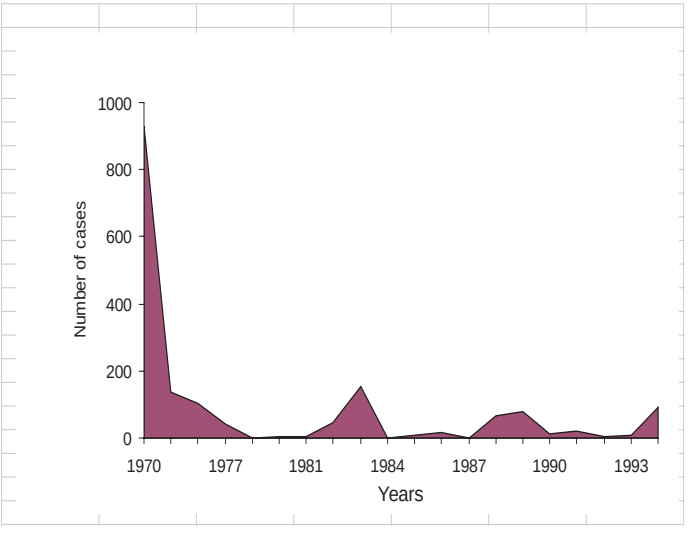


Figure 5.7: Cholera Cases in Côte d'Ivoire

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

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

Oil pollution, which is widespread in the Niger Delta, also results in ecological and public health problems to which women and children are particularly susceptible. The socio-economic impacts of oil spills are enormous.

Social disturbances resulting from reactions to oil spills have unquantifiable impacts on the economy of the immediate areas and communities as well as the nation as a whole. Ghana alone, for instance, discharges about 1,400 tons of waste oil daily or 500,000 tons annually, and it is estimated that the entire sub-region discharges about 4,000,000 tons of waste oil into the GCLME annually.

Pollution from shipping and maritime transport constitutes another source of degradation of the marine environment and deterioration of the water quality of the GCLME and represents a transboundary problem in the region. Ship source pollution is mainly from the discharge of ballast water into the sea and oil spillage from ships.

Undoubtedly, globalization has continued to put demand on maritime transport. More than 90 % of world trade is seaborne. In 2001, seaborne trade came to a record high of 5.88 billion metric tons in its 15th consecutive growth (UNCTAD, Review of Maritime Transport 2001). Most countries of the GCLME are primary exporters of raw materials that feed the major industrial economies. At the same time these countries rely heavily on imports for their socio-economic development and serve as transit ports for neighbouring landlocked states. The increases in maritime transport have come with corresponding pollution and destruction of the marine environment and ecosystem of the GCLME region.

There are standards and conventions regulating ship source pollution within the umbrella of the IMO. Indeed, the emphasis for coastal states is the institution of effective coastal and port state regulation and enforcement and the

establishment of facilities such as port reception facilities. Most GCLME countries however, lack the necessary regulatory framework and port reception facilities. In some cases the manpower capacity to ensure effective regulation of ship source pollution is weak and completely lacking in some places.

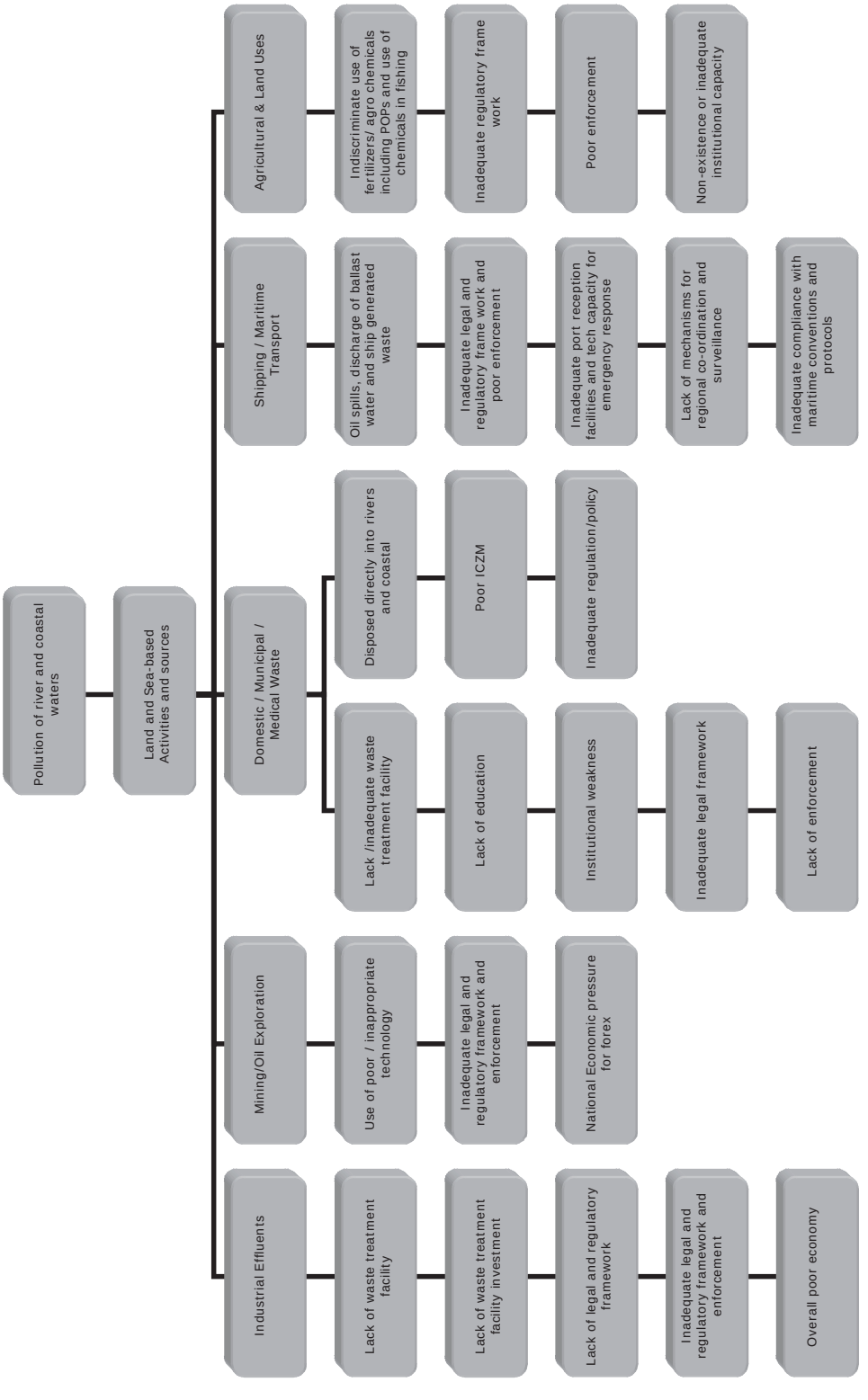
Poverty is also a major contributing factor to the present degradation of the coastal and marine environments in the GCLME, since it constitutes a major impediment to the adoption of new practices or behaviours which are less damaging to these environments. The presence of bilharzia and other water-borne diseases constitutes another important health risk resulting from the deterioration of the quality of water in the freshwater environment. This is due in particular to the changes occurring as a result of the construction of river dams. Good examples can be found in the Volta and Niger river basins

Causal chain analysis

A causal chain analysis was performed to examine the primary, secondary, and root causes of deterioration of water quality (Diagram below).

Photo 5.10: Public toilet built iillegally by coastal settlers on a Lagoon in Sierra Leone

Digram 3: Causal Chain Analysis: Deterioration in Water Quality (Chronic and Catastrophic), Pollution from Land and Sea-Based Activities, Eutrophication and Harmful Algal Blooms.



Sectors and Stakeholders

Sectors and Stakeholders involved with declining water quality are broad. Primary sectors include:

1. Mining;
2. City management;
3. Industry and Finance;
4. Environment;
5. Agriculture;

Primary Stakeholders involved with deteriorating water quality include:

1. Local Government;
2. National government;
3. Fishermen;
4. Farmers;
5. Local villages;
6. Women and children;
7. NGOs;
8. Academia;

Supporting Data

Human activities have adversely affected the coastal and marine environment of the region, leading to reduction in the amenity value, loss of biological diversity, and degradation of the water quality, poor sanitation and negative effects on human health. The main sources of pollution in the coastal areas of the GCLME are from Land-Based Activities and include:

"Point" sources - municipal wastewater (e.g. sewerage and solid waste) and industrial wastewater containing organic loads, heavy metals and nutrients (e.g table 5.3-5).

"Nonpoint" sources - agriculture runoff, such as sediment/silt, salts, and agro-chemicals (pesticides, herbicides, and fertilizers); urban runoff; mining, such as mine dumps, tailings, and chemicals; forestry management (logging and clear cutting increase surface runoff and reduce groundwater replenishment); airborne particulates.

Even though the level of industrial development is still low in the GCLME region, the rate of industrialization is increasing along the coastal areas. As an example, an estimated 60% of the industries in countries bordering the Gulf of Guinea are located in coastal cities (UNDP/GEF, 1993), particularly in Nigeria, Côte d'Ivoire and Ghana. These industries consist of oil refineries, petrochemicals, pharmaceuticals, textile, leather, food and beverage and plastic industries. Mining operations produce large residues that are discharged into coastal waters. For example, large quantities of phosphate residues in Côte d'Ivoire and Togo are discharged from the phosphate industry. Tables 5.6 and 5.7 show some of the extent of pollution in the GCLME region.

Both the increasing rates of the urban population growth (with an average 4-7% growth rate; see Table 3.1-1) and the industries have created negative synergies in terms of human and environmental impact on the coastal regions. A variety of types of pollution from sewage, garbage, industrial and solid waste disposal, oil spills from shipping operations can be found in increasing amounts in the coastal waters of the region.

Table 5.6: Concentration of oil and chlorinated substances in finfish in the GCLME coastal and marine areas (ng/g, wet weight)

Fish	p,p'-DDE	p,p'-DDD	p,p'-DDT	DDT total	PCB	References
Nigeria	3.72 (0.13-14.70)	0.12 (ND-1.05)		4.37 (0.15-18.60)	40.9 (11.0-225)	Osibanjo and Bamgbose, 1990
Sierra Leone	15 (2-36)		11 (2-30)	46 (7-116)	90 (3-825)	Portmann et al. 1989
Benin	0.23	1.79	1.86	3.88		Soclo and Kaba, 1992
Côte d'Ivoire				1.92 (0.13-4.3)*		Kaba, 1992
Cameroon				89.5 (ND-393)	196 (ND-983)	Mbi and Mbome, 1991

Table 5.7: Concentration of oil and chlorinated substances in crustaceans and molluscs in the GCLME coastal and marine areas (ng/g, wet weight)

Molluscs and crustaceans		p,p'-DDE	p,p'-DDD	p,p'-DDT	DDT total	PCB	References
Nigeria	Shrimps, crabs, oysters, snail				37.0 (4.47-152)	94.5 (37-287)	Osibanjo and Bamgbose, 1990
Côte d'Ivoire	shrimps				1.0 (0.17-1.9)*		Kaba, 1992
Cameroon	shrimps				244 (76-540)	342 (ND-705)	Mbi and Mbome, 1991
Cameroon	oyster				113 (ND-181)	209 (ND-716)	Mbi and Mbome, 1991

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

Photo 5.11: The Oil Refinery (SIR) in Abidjan, Côte d'Ivoire, constructed near the lagoon

Table 5.8: Estimated Quantity of Pollutants Discharged to the Ocean from Industrial Sectors in Some GCLME Countries-Côte d'Ivoire, Ghana, Togo, Benin (Tons per year)

Type of Industry	BOD5	SS	Oil & Grease	COD	Ammonia nitrogen	Phenols	Total chromium	Fluoride	Cyanide	Total Phosphorus
Petroleum refining and handling	537.0	314.2	204.5	1496.3	111.4	2.6	6.8			
Edible oils	1828.6	1599.0	1148.0	4575.6						
Beer	2007.4	930.9		2204.2						
Soft drinks	241.6	332.1		605.9						
Soap & detergents	93.6	159.5	11.2	234.0						
Textiles	684.5	752.2		8519.2		12.1	12.1			
Paint	0.5	0.9		1.5						
Flour	57.7	51.3		144.7						
Diary products	189.0	283.5		483.0						
Fruits & vegetables	82.1	101.3		204.8						
Meat	1.4	2.2	0.7	3.4						
Fertilizer		23525.9	0.9		6.3			2330.8		7063.0
Asphalt	27.8	22.4	9.1	164.1	16.2	0.2	0.5			
Steel		14.4	4.4		36.6	0.6			9.0	
Aluminum		1874.4					0.6	1250.2		
Metal plating & coating		44.6						1.1		2.2
Cement	1355.0			3400.3						
Coffee	1875.0	150.0		4686.0						
Cocoa products	329.7	288.3	207.0	824.9						
Wood products (plywood, veneers, lumber)	13.2			33.2		2.6				
TOTAL	9511.3	31731.5	1585.8	28050.7	1705	181	200	3582.1	9.0	7065.2

The deterioration of water quality is one of the most important aspects of environmental degradation occurring in the coastal, marine and freshwater areas in the WACAF region. This deterioration is exacerbated by the often-untreated domestic sewage and industrial effluents being discharged directly into coastal waters. The total annual biochemical oxygen demand (BOD) load from municipal sewage was estimated in 1984 to be 62,535 tons in the northern zone, 205,612 tons in the middle zone and 20,314 tons in the southern zone (Table 5.3-4)

Table 5.9: Domestic waste and waste statistics of some GCLME countries

City- Country	Per capita water used/day	Wastewater treated %	Per capita solid waste generated %
Luanda- Angola	50	0	-
Porto Novo- Benin	22	-	0.5
Douala- Cameroon	33	5	0.7
Yaounde- Cameroon	61	20	0.8
Abidjan- Côte d'Ivoire	111	58	1.0
Libreville- Gabon	100	0	-
Accra- Ghana	4	0	0.4
Conakry- Guinea	50	0	0.7
Lagos- Nigeria	80	-	1.1
Lome- Togo	35	-	1.9

Table 5.10: Estimated amount of municipal sewage in comparison with industrial pollution in the WACAF region including the GCLME countries

Zones	Estimated population *1000*	Municipal sewage				Industrial pollution			
		BOD5 t/year	%*	SS /year	%*	BOD5 t/year	%**	SS t/year	%**
Northern	17.350	62.535	21.6	88.930	21.6	15.320	24.5	18.542	20.8
Middle	117.960	205.61	71.1	292.40	71.1	29.962	14.6	61.243	20.9
Southern	36.800	20.814	7.3	29.598	7.3	1.986	9.5	1.360	4.6
TOTAL	172.110	288.961	100.0	410.93	100.0	47.269	16.3	81.145	19.7

* Percentage of the total amount of municipal sewage in the Region
** Percentage on industrial pollution of the amount of municipal sewage in certain zones
*** Estimated population of the Region, without Mauritania, Cape Verde and Namibia (Africa south of Sahara). (Source: UNEP, 1984).

From industrial pollution, total annual BOD for the region was estimated for the same period to be 47,269-tonnes (Table 5.3-2). Various analyses of the water have shown that most of these discharges contain a heavy load of nutrients, pathogens, microorganisms, organic material, sedimentary particulates, and also trace metals and synthetic compounds. This type of pollution may be even more severe and have more negative impacts around the most industrialized large urban cities: Lagos, Abidjan (Tables 5.3-8 and 5.3-9), Conakry, Accra, etc. Indeed, in these large cities, most of the pollutions originate from BOD5 (12%), total suspended sediments (21%) and chemical oxygen demand (COD, 46%). That these effluents affect the environment can be seen in biota (e.g., Table 5.3-10).

Organic pollution has resulted in eutrophication and, as reported for the Korle and Chemu II lagoons in Ghana and several bays of the Ebrie lagoon in Côte d'Ivoire, in near total oxygen depletion (Table 5.3-7, Acquah, 1998a; Ajao, 1996; Awosika and Ibe, 1998; Biney, 1994; Dufour et al., 1985 & 1994; Gordon, 1998; Guiral, 1984; Guiral et al., 1989). Nutrient loading has direct impact on productivity, fisheries and water quality and is central to the general ecological functioning of the coastal ecosystem. This is especially true of the GCLME region where nutrient loading of the coastal water bodies has had a direct negative impact on the fisheries and water quality and caused outbreaks of water-borne diseases (Acquah, 1998a; Ajao and Anurigwo, 1998; Dosso et al.,1984; Duchassin et al., 1973; Dufour et al., 1985; Kouassi et al., 1990; Metongo et al., 1993). The lack of oxygen on the bottom of shallow areas impacted by eutrophication has also led to massive loss of bottom-dwelling animals. For instance, eutrophication of Nigeria's coastal lagoons, rivers and streams induced the explosive growth of water hyacinth in the early 1980s covering nearly 800km and severely impeding fishing activities and transportation. The 1990 World Bank estimate for water hyacinth control in Nigeria is US$ 50 million annually.

Table 5.11: Pollutant load and discharges from sewage and domestic effluents in Côte d'Ivoire

	Discharges (m3/year)	BOD5 t/year	DOC t/year	TSS t/year	Nitrates t/year	Phosphates t/year
Houses connected in the sewer system	67.500	18.222	40.700	18.500	3.052	370
Houses not connected in the sewer system	97.100	91.797	212.864	212.864		
Total	164.600	110.019	253.564	231.364	3.052	370

Table 5.12: Bacteria Concentration in the Urban Lagoonal Environment in Abidjan

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

Source: Adingra and Arfi, 1997

The agricultural run-off from the irrigation patterns in the river valleys and flood-plains (i.e. interior Niger delta, Volta delta, etc.), including the elevated concentrations of nutrients and pesticides also contribute to increased eutrophication in the estuaries, deltas, coastal and freshwater environments in the GCLME. Moreover, the use of a wide range of persistent organic pollutants (POPs), although the most dangerous of these are banned, including DDT, aldrin and dieldrin and other organo-phosphorous pesticides, increase the water pollution in the region. River inputs carry considerable amounts of sediment as a result of soil erosion and deforestation, which contribute to the siltation of coastal habitats and the decline of water productivity.

This phenomenon, combined with the pollution loads, may explain the considerable problems encountered now in most of the freshwater aquatic areas, such as the Côte d'Ivoire, Nigeria and Benin coastal lagoons, with the presence of significant seasonal invasive aquatic weeds.

The other main sources of pollution from land-based activities in the GCLME region are contamination by litter, solid wastes, plastics and other marine debris which threaten marine life, degrade the visual amenities of marine and coastal areas and has negative effects on tourism and general aesthetics (table 5.3-11 and 5.3-12). This is particularly frequent along the beaches of the main GCLME large cities: Conakry, Abidjan, Accra, Lagos, Luanda, and Douala.

Table 5.13: Typical levels of organic pollution in some coastal lagoon in the GCLME

	Korle Lagoon Accra1	Chemu II Lagoon, Tema1	Lagos Lagoon, Lagos2	Ebrie Lagoon, Abidjan3	Backgroun d4
DO (mg/l)	0-6.2	0-0.5	2.2-9.5	n/a	6.4-6.6
BOD (mg/l)	4.4	71.2-240	n/a	n/a	3.2-5.5
PO_4-P (mg/l)	0.86	0.59-2.85	<0.01-0.5	0.06-0.27	0.06-0.09
NH_4-N (mg/l)	3.8	1.3-12.6	-	0.18-1.11	0.2
NO_3-N (mg/l)	n/a	0.2-0.35	0.1-0.8	0.01-0.28	n/a
Total coliform (No./100 mlx 1000)	635-1,604	n/a	n/a	0-1,735	n/a

1Sources: Biney (1994) Acquah (1998a); Ajao (1990), Kusemiji et al. (1990); Oyewo (1999); Affian (1999); 4Values measures for unpolluted lagoons in Ghana (laloi and Mokwe lagoons), according to Biney (1994). n/a: No (reliable) data available.

Table 5.14: Effluent quality of some industry-specific discharges into Odaw river and Korle lagoon catchment, Accra, 1994/1995

Pollution Indicator	Food and beverages Industry	Chemical Industries Guidelines	World Bank Guidelines
Biological Oxygen Demand (BOD) mg/l	240-4,260	1.0-380	50
Chemical Oxygen Demand (COD) mg/l	700-30,200	24-6,200	250
pH	4.0-11.04	6.7-7.6	6-9
Conductivity (µs/cm)	2.18-4,600	486-562	
Oil & Grease (mg/l)	29-108	24-27	10
Ammonia NH_4 (mg/l)	1.2-70.5	0.48-10	
Temp.	25.7-41.8	-	

Source: EPA Monitoring Results, Accra (1994/1995)

This phenomenon, combined with the pollution loads, may explain the considerable problems encountered now in most of the freshwater aquatic areas, such as the Côte d'Ivoire, Nigeria and Benin coastal lagoons, with the presence of significant seasonal invasive aquatic weeds.

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Photo 5.12: The City Sewage Outfall in Port-bouët, Abidjan, Côte d'Ivoire

Photo 5.13: The Korle Lagoon Sewage Outfall in Korle-Bu - James Town, Accra, Ghana.

This situation is a direct consequence of the growing population densities and their increasing poverty, as well as the difficulties for the local municipalities and governmental authorities to continue to provide the populations with adequate basic services (i.e. solid waste final disposal). The loads of trace and heavy metals, oils, hydrocarbons, including other synthetic organic chemicals micro-pollutants out of industrial wastes and effluents, ports and harbours in the Gulf of Guinea is becoming more and more a source of concern for the ecology and the health of the environments. All these major (point and non-point) sources of degradation from land-based activities show that norms, adequate legislation, reduction of the various types of waste, discharge treatments, follow-up campaigns as well as public education and awareness are an absolute need for the GCLME region. To this end, the formulation of realistic and coherent strategies, which aim at preventing the degradation of the freshwater, coastal and marine environments from land-based activities, must be a high priority for the region.

Table 5.15: Typical Levels of Heavy Metal Pollution in Some of the Coastal Lagoon Systems in the GCLME

Sample	Cd	Cr	Cu	Fe	Hg	Mn	Pb	Zn	Reference
Sediment (ug/g dry wt)									
Lagos Lagoon, Lagos	0.01-15.5	2.9-167	1.5-132	510-85548		98-2757	0.4-483	7.8-831	Okoye *et al.*, 1991, Oyewo, 1999
Ebrie Lagoon, Abidjan		20.7-465	3.0-76.3	1.3-67.0	0.05-0.49	24.0-534	4.0-88.8	5.5-398	Arfi *et al.*, 1994
Unpolluted sediments	0.2-5				0.01-0.08		8-60		GESAMP, 1985 & 1998
Water (mg/l)									
Korle Lagoon, Accra (median)	0.24		0.31				0.08	0.08	Acquah, 1998b
Lagos Lagoon, Lagos (median)	0.002		0.003	0.086		0.021	0.009		Okoye, 1991a
Natural sea water levels	0.005		0.003				0.003	0.02	Acquah, 1998b
Shellfish (ug/g fresh wt)									
Lagos Lagoon, Lagos (median)	0.18		23.6				5.1	240	Okoye, 1991b
Ebrie Lagoon, Abidjan	0.35-0.95		17.5-33.5		0.07-0.19			608-2115	Metongo, 1991
WHO standard	2		30		2		2	1000	Kabulu *et al.*, 1987

Table 5.16: 1996 international coastal clean-up results for some countries in the GCLME

Country	Debris Collected (pounds)	Debris collected (kg)_	Length of beach cleaned (miles)	Length of beach cleaned (km)
Cameroon	16,328	7,422	1.2	0.7
Côte d'Ivoire	5,005	2,275	1.4	0.9
Nigeria	3,121	1,419	2.5	1.6

Source: Awosika, (2002) in LOICZ Reports & Studies No. 25

The coastline of the GCLME region lies to the east and is downwind of the main route of oil transport from the Middle East to Europe. The total volume transported annually along the GCLME, for example, has been estimated to be 706X106 tonnes (Portmann, 1978) and the discharge of tank washings from offshore traffic is a significant source of oil on beaches. However, much of the oil found on beaches is from spills or tank washing discharges from tankers visiting ports in the region (Portmann et al.,1989).

Significant point sources of marine pollution have been detected around coastal petroleum mining and processing areas, releasing quantities of oil, grease and other hydrocarbon compounds into the coastal waters of the Niger delta and off Angola, Cameroon, Congo and Gabon. In the Ebrie Lagos in Côte d'Ivoire (Marchand and Martin, 1985) a wide range of concentrations (1000-24,000 mg/kg) of total hydrocarbons was found in lagoon sediments. The highest concentrations were associated with industrial and domestic sewage discharges. However, a spill of 400 tonnes of oil at a refinery in 1981 was still clearly detectable in 1983 (Portmann et al., 1989). The number of offshore platforms and various export/import oil terminals means an inevitable exposure to oil pollution. About 30% of the approximately 27 oil refineries in the Africa region are located along the coastline. In the largest oil producing countries, such as Nigeria, Gabon, and Angola (Table 5.3-12), production is heavily concentrated in offshore and shoreline installations (World Bank Report, 1994). According to the World Bank (1995), oil producing companies in Nigeria alone discharge an estimated 710 tons of oil yearly. An additional 2100 tons originate from oil spills. The patterns of onshore-offshore winds and ocean currents mean that any oil spill from any of the offshore or shore-based petroleum activities translate easily into a regional problem. Most of the countries also have important refineries on the coast, only a few of which have proper effluent treatment plants, thereby adding to the threat of pollution from oil.

In summary (Table 5.17), the major contaminants in the GCLME originate from various domestic discharges and run-offs (including markets, hospitals, etc.), as well as industrial facilities (from breweries, food, textile, wood processing). Domestic sewage and other wastes, but also coastal and upstream non-point sources of pollution from agricultural, forestry and hazardous waste sites constitute sources of contamination of the fresh drinking water and the water quality in general, both for the surface and groundwater resources. Indeed, the water quality degradation is generally associated with health problems because of the presence of pathogens and other microorganisms, excess of nitrates and persistent organic micro-pollutants, etc. Oil, gas and related products predominate in the some countries in the GCLME, and partly along the Nigerian, Gabonese, Congolese, and Angolan coasts, where beach pollution by oil in the form of tar balls and oil spills is frequently observed.

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

1. Increasing sewage and solid wastes of domestic origin and their effects on public health and water quality decline;
2. uncontrole use of nutrients, pesticides, other herbicides and organo-chlorine substances;
3. Increasing trace metals, oils, hydrocarbons, including other synthetic organic chemicals micro-pollutants, from industrial activities, ports; and, to an ever increasing extent;
4. Atmospheric pollution resulting from gaseous and particulate emissions, from industries and vehicles.

Table 5.17: Main contaminants and their sources in the GCLME region

Pollutants	Producing industry	%
BOD5 (12 %)*	Beer	22.0
	Edible oils	17.3
	Textiles	15.9
	Total	55.2
SS (20.7 %)	Fertilizer	29.5
	Textiles	23.6
	Edible oils	8.8
	Total	61.9
Oil + grease (18.4 %)	Petroleum refining	90.0
	Edible oils	7.1
	Total	97.1
COD (45.7 %)	Textiles	52.0
	Edible oils	11.4
	Beer	7.7
	Total	71.1
Ammonia nitrogen	Petroleum refining	90.7
	Textiles	37.2
Phenols	Wood products	31.9
	Total	69.1
Total chrome	Leather	33.5
	Textiles	33.0
	Total	66.5
Fluoride	Fertilizer	59.9
	Aluminium	40.0
	Total	99.9
Cyanide	Steel and fabrication	100.0
Total phosphorus	Fertilizer	100.0

* Estimated mass of pollutant as a percentage of the total amount of pollutants released to the Region (Source: UNEP, 1984. Reg. Seas Rep.& Studies. 46).

5.2.4 Habitat destruction and alteration including inter-alia modification of seabed and coastal zone, degradation of coastscapes, coastline erosion

Status of the problem/issue

The physical destruction of coastal habitats, including critical wetlands in the GCLME, is causing the loss of spawning and breeding grounds for most living resources in coastal waters and the loss of the rich and varied fauna and flora of the region including some rare and endangered species. Much of the destruction is related to often-haphazard physical development, which exert phenomenal pollution pressures on this international body of water (WACAF Intersecretariat Co-ordination Meeting, Rome, 1993). Coastal geomorphological change, erosion and sedimentation have been identified as having a significant and progressive impact in all the countries in the GCLME, the problem being acute on the lagoon systems.

Human settlements are regarded as a major contributor to eutrophication and the occurrence of aquatic weeds in the GCLME and its marine catchment basins. Nearly all major cities, agricultural plantations, harbours, airports, industries as well as other aspects of the socio-economic infrastructure in the region are located at or near the coast. Results obtained during the Pilot Phase GOG-LME Project showed that in Ghana, 55% of the mangroves and significant wetlands around the greater Accra area have been decimated through pollution and overcutting. In Benin, the figure is 45% in the Lake Nokoué area, in Nigeria, 33% in the Niger Delta, in Cameroon, 28% in the Wouri Estuary and in Côte d'Ivoire, more than 95% in the Bay of Cocody. A mangrove environment characterizes the Congo Democratic Republic coast, which extends for 37 km along the Atlantic Ocean. The production of charcoal from mangrove woods and the pollution caused by hydrocarbon discharge generate serious problems for these forms of critical habitats. The mangrove losses have been estimated at almost 40% of the total surface mangrove areas at the mouth of the Congo River (UNEP, 1999).

Photo 5.14: Coastal forest degradation at Cape Esterias, near Libreville in Gabon

Transboundary elements

Although most impacts may appear localised, habitat alteration or loss due to fishing, coastline erosion and crude oil extraction and mining can cause migration of fauna and system-wide ecosystem change. Uncertainties exist about the regional cumulative impact on benthos resulting from coastal erosion, mining and associated sediment re-mobilisation. Moreover, certain mining activities including sand mining and crude oil exploration and extraction are conducted close to national boundaries and negative consequences may be transmitted across into the adjacent country's EEZ. Inadequately planned coastal developments result in degradation of coastscapes and reduce the regional value of tourism.

Photo 5.15: White sand winning in Gabon following coastal forest degradation

Environmental impacts

1. Loss of habitat
2. Loss of nursery grounds leading to declining productivity
3. Loss of Biodiversity
4. Loss of Fisheries resources
5. Change in land use

Socio-economic impacts

Major socio-economic impacts include:

1. Loss of livelihoods
2. Increased poverty
3. Lack of social stability
4. Possible political unrest
5. Starvation
6. Increased disease
7. Displacement of villages/populations

Coastal vegetation in the region has been decimated by both natural and anthropogenic activities to the extent that a large percentage of the primeval vegetation has been replaced with new species. Modification of the ecosystem in Nigeria, for instance, is a result of man-made and natural activities. While 30% of the modification is caused by natural activities, the remaining 70% are caused by man-made activities (Awosika et al., 2001).

Photo 5.16: Mangrove cutting for firewood in Cameroon. This is among common habitat destroying activities

The natural causes of the modification are storm surge, sea-level rise, salt-water intrusion, subsidence and flooding. The man-made causes are changes in land development and unsustainable exploitation of ecosystem resources. These causes are linked to activities in eight sectors, namely urbanisation (25%), energy production (5%), fisheries (10%), agriculture (15%), mining (10%), fishery (15%), industry (10%) and leisure/tourism (10%). Activities that result in changes in land development are linked to urbanisation (25%), agriculture (15%), mining (10%) and forestry (15%) sectors (Awosika et al., 2001). As of 1980 about 60% of the mangroves in Guinea and nearly 70% of the mangrove vegetation in Liberia were reported to have been lost (Awosika, 2002). The hardy grass Paspalum vaginatum has now replaced the original mangrove vegetation in these countries.

Coastal erosion is the most prevalent coastal hazard in the GCLME region. In Nigeria, coastline erosion causes serious concerns because it uproots coastal settlements, decimates agricultural and recreational grounds, destroys harbour and navigation structures, dislodges oil producing and export handling facilities and upsets the hydrological regime in the

coastal areas (Ibe, 1988). The same scenario is evident in all the other countries of the GCLME. Although natural causes like low coastal topography, high wave energy and nature of sediment are responsible for these high rates of erosion, anthropogenic activities such as construction of harbour protecting structures, jetties, beach sand mining, construction of dams upstream and deforestation are mostly responsible for the high rates of erosion. Harbour construction activities have altered longshore current transport of sediments and in many cases have led to major erosion and siltation problems. Erosion rates caused by port structures in Liberia, Togo, Benin and Nigeria sometimes reach a staggering 15-25 m per year and threaten infrastructure and services (Ibe and Quelennec, 1989). Typical areas of erosion include:

1. Guinea: Murdy and Sexton (1986) reported erosion phenomena in the northern part of Camagenne Peninsula. Widespread erosion has also been reported along the Koba area especially at the mouth of the canals dug to drain excess water from the rice fields to the ocean;
2. Sierra Leone: Collins et al. (1983) reported widespread erosion between Freetown and the eastern border especially off Sherbro Island;
3. Liberia: Coastal erosion along the Liberian coast has been reported around cities like Buchaner, Greenville, Harper and Robertsport. Around the Organization of African Unity (OAU) Beach, Shannon (1990) reported erosion rates of 3 m annually;
4. Côte d'Ivoire: The La Vigie area with its coastal residential area of "Les Tourelles"and Adjoufou suffered extensive damage from erosion and flooding during the summer storms of 1984. Koffi et al. (1990) reported coastal erosion rates of 1-2 m annually along the southeastern coast (Fresco, Vridi, Port Bouet to Ghana border). High erosion rates have been reported in the areas off the Abidjan harbour;
5. Ghana: Along the Labadi Beach, an erosion rate of 3 m per year was reported in the years 1966 to 1975. At Ada near the Volta estuary erosion rates of 2.2 to 2.4 m annually have been reported between 1939 and 1976. The coast line in the Central Region, around Cape Coast is badly eroded. The Keta coast experienced erosion rates of 4 m to 6 m per year between 1923 to 1975. The worst affected sections stretching 7 km have now been protected with the completion of a system of rubble-mound groyne structure. This is the most comprehensive sea protection project that has been undertaken in the GCLME Region as it also involved large scale land reclamation.;
6. Togo: East of the Lome harbour an erosion rate of 20 m per year has been reported while the updrift western side has accreted so much that it is threatening to silt up the entrance to the Lome port. The old coastal road at Aneho was washed away as a result of the erosion;
7. Benin: Erosion is very prevalent along Grand Popo, Seme and east of the Cotonou harbour. According to Adams (1990) erosion was sparked off by the construction of piers around the coastal areas of Kpeme factory, Aneho town, L.M. Hotel and Hotel da Silva. The New Town scheme, which was supposed to be a residential "Hollywood"of Benin, has been devastated by erosion. Many of the roads, houses and other facilities constructed for the residents now lie under the sea;
8. Nigeria: Erosion rates of 25 to 30 m annually have been documented along Victoria Beach in Lagos (Ibe et al. 1984). Although about seven sand nourishment projects, including one completed in 2002, have been implemented on the beach since 1958, erosion continues to wash off large parts of the coast. Other areas wher erosion has been very devastating along the Nigerian coast include Forcados 20 m per year, Brass 16-19 m per year, Eket 10-13 m per year and Awoye along the Mahin mud beach 20-30 m per year (Ibe, 1986);
9. Gabon: coastal erosion causes serious concerns. It threatens coastal infrastructures at Libreville, Pointe Pongara, Port Gentil amongst others.

Loss of biodiversity experienced in the GCLME has also been related to complex ranges of human and natural drivers fuelling habitat degradation and alteration and coastal erosion. The concerns about the hazards and economic loss occasioned by erosion have resulted in intermittent calls for countries of the region with the assistance of donor agencies to adopt one or more of the known coastal erosion defence measures to stem the phenomenal retreat of the coastline (Ibe, 1988). Actions to control erosion around these ports are critically important to maintaining their vitality as sites for growing tourist, recreational, commercial and defence needs. Efforts in the past at abating the nuisance of erosion of the coastline consisted mainly of sand replenishement programmes (especially in Nigeria) using sand either from foreshore or the backwaters. These failed to solve the problem as erosion has continued to devastate the coastline beyond pre-nourishment limits (Ibe, 1988). A review of the situation in Nigeria by Ibe (1988) has traced the failure of this measure to an inadequate knowledge of the inter-relationship between nearshore ocean dynamics and shoreline evolution along the Nigerian coast.

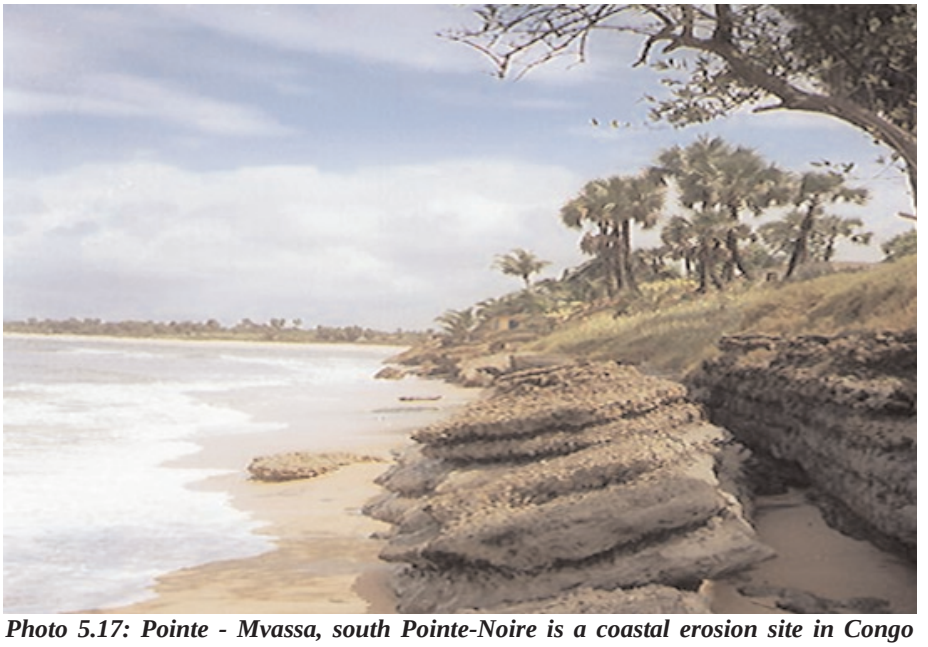


Photo 5.17: Pointe - Mvassa, south Pointe-Noire is a coastal erosion site in Congo Republic

Table 5.18: Average annual erosion rates and study sites* along the Nigerian coastline computed from results of historical studies and/or beach profiling

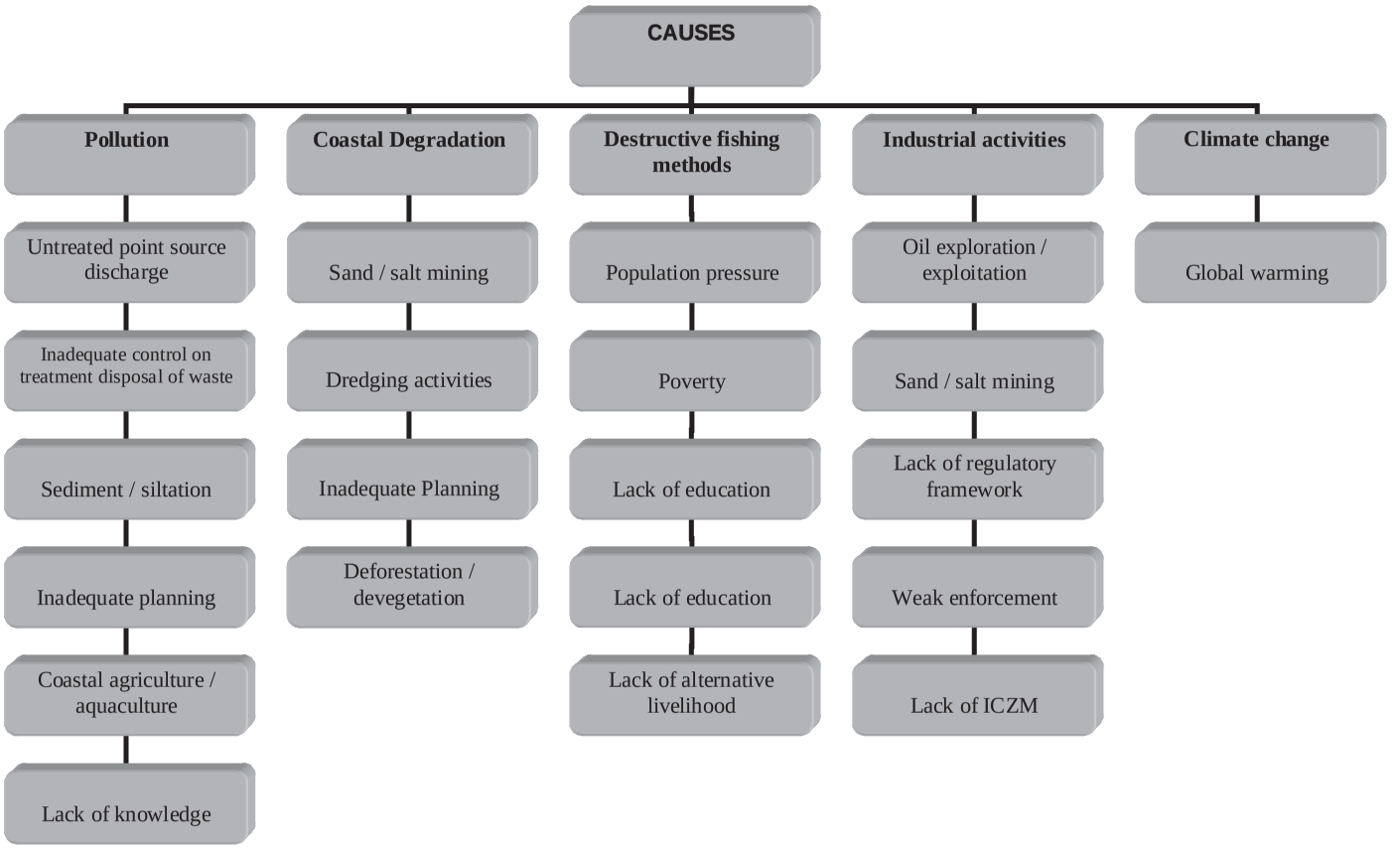
Location	Rates of erosion per year (m)
Badagry Beach (Lagos State)	2-6
Victoria Beach (Lagos State)	25-30
Awoye/Molume (Ondo State)	20-30
Ogborodo/Escravos (Bendel State- now Delta State)	18-24
Forcados ((Bendel State- now Delta State)	20-22
Brass (Rivers State- now Bayelsa State)	16-19
Ibeno-Eket (Akwa Ibom State)	10-13

* Periodic sandfilling of the beach in some of these locations e.g. Victoria Beach and Forcados has prevented them from becoming disaster areas (Source: Ibe, 1988).

Causal chain analysis

A causal chain analysis was performed to determine the primary, secondary, and root causes of habitat destruction and alteration. This is summarized in the diagramme bellow.

Diagram: Causal Chain Analysis: Habitat Destruction and Alteration, Including inter alia Modification of Seabed and Coastal Zone, Degradation of Coastscapes and Coastline Erosion



Sectors and stakeholders

Major sectors of interest have been involved in the causal chain analysis, these include mainly:

1. Industry;
2. Power and Electricity (dams);
3. Water use (dams, river modifications);
4. Agriculture and fisheries;
5. Industry and finance;
6. Transport;

As with the stakeholders' analysis, major stakeholders have also contributed to the causal chain analysis. These include:

1. Local governments;
2. National governments;
3. Fishermen and farmers;
4. Local communities;
5. NGOs;
6. Industry;
7. Agriculture;

Supporting data

The Gulf of Guinea region has one of the highest population growth rates in the world leading to population explosions in the cities. Stemming from the region's early association with the Europeans and its history of trade using the oceans, most of the capital cities are within or around the coastal areas. The cities have also been major attractions for industries as well as for migrant workers, fuelling rapid rural to urban migration and increasing the populations in the coastal areas with all its adverse impacts on the resources of the area. These developmental activities are leading to major changes and pressures from an increasing population in the coastal areas of the GCLME and have resulted in habitat degradation and alterations including loss of biological diversity and productivity, pollution and degenerating human health.

The most obvious of these developmental changes are the actual construction of towns with associated industries and the creation or extension of sea ports (Portmann et al.,1989). Although these are confined to a few locations they are frequently close to areas that are or could be exploited as tourist centres and there have been instances where hotels have been constructed and then affected by expanding towns or coastal erosion brought about by port developments.

One of the severely affected habitats is the mangrove ecosystem. The GCLME region is endowed with large expanse of mangrove forests scattered all over the region. The mangrove ecosystem of the Niger Delta in Nigeria is the third largest in the world providing spawning and breeding grounds for many transboundary fish species and shrimps in the region. The mangrove forests in the region presently are under pressure from over-cutting (for fuel wood and construction timber) and from other anthropogenic impacts (e.g. pollution), thereby jeopardizing their roles in the regeneration of living resources and as reservoirs of biological diversity (Ukwe et al.,2001). Mangroves are also being affected by erosion, either directly or indirectly, by changes in salinity and through the construction of canals. The canals, intended for use as transport pathways, have increased suspended solids in the water leading to destruction of some benthic fauna. This is followed by more permanent damage as the hydrological regime as salt intrusion occurs and the spoil banks impede land run-off.

There are substantial numbers of coastal protected areas in the GCLME region, although for many it has been difficult to determine how far the boundaries extend and to distinguish whether marine elements are included. Nevertheless, an attempt has been made to identify those having some marine focus and which are primarily coastal lands (World Bank/IUCN, 1995). There are no known marine or coastal protected areas in Benin, Ghana, Guinea, Liberia, Nigeria and Togo. Several countries in the GCLME such as Ghana and Guinea have designated Ramsar sites, although they have no formal protection.

Nearly all the main rivers of the Guinea Current region have been damned in at least one location, most of them in the last twenty years or so (UNEP/UNESCO/UN (DIESA), 1985). The dam on the Volta River, for instance, eliminated the regular flooding in the wet season and as a consequence several lagoons, which used to be refilled in times of flood, have been lost (Portmann et al.,1989). A particular concern in the region has been the effect on sediment transport to the sea. In Nigeria, for instance, there are now eleven River Basin Authorities manipulating the hydrological cycles and it is estimated that the construction of their dams has resulted in a 70% loss of sediment catchment area due to the effective entrapment of silt behind dams (Leeming, 1985; Olofin, 1985). In some cases the loss of sediment input is blamed for coastal erosion that has occurred since the construction of some dams. A particularly serious case followed the damming of the Volta River with the partial disappearance of the town of Keta (UNEP/UNESCO/UN (DIESA), 1985). Similar problems have been reported in the Niger Delta of Nigeria (McDowell et al.,1983; Ibe and Antia, 1983).

Table 5.19: Dams in Nigeria Summarized by State

State	Dams	River
Anambra	4	Nkisi, Effiwa, Abina, Ezamgbo
Bauchi	6	Zala, Jamara, Gongola and 3 others
Bendel	3	Oyeni, Ikpoba, Orle
Benue	1	Benue
Borno	2	Ngadda, Yedacram
Cross River	1	Abep
Federal Capital	1	Usuma
Gongola	1	Mayozanpola
Kaduna	17	Tubo, Galma (2); Damari, Tagrai, Dutsin ma, Kusheriki, Galma, Kangimi, Bomo (2), Gurara, Kubani, Sokoto, Tura, Raffin, Jamuna, Kurmin Bi, Chidaviki
Kano	30	Watari, Jakara, Gari, Kara, Baguada, Karaja, Kano, Guzu, Magada, Challawa, Tomes, Tuwari, Dudurun Warrada, Jalau, Tuwara, Kanya, Marashi, etc
Kwara	5	Oyun, Erigi, Oyi, Kampa and 1 other
Niger	13	Chauchanga, Lugai, Iku, Etswan, Oba kegi, Datatisaini, Dinya, Niger, Enika, Kontagora
Ogun	2	Ona, Oyan
Oyo	20	Ebu, Soro, Osse, Omi, Yegun, Oshun (2), Ona, Fofo, Ayida, Opeki, Erinle, Awon, Ofin, Oba, Ara, Alge, Omi, Ogun
Plateau	9	Idyem, Shen, Ravin sanyi (2), Kwalgwal, Lamingo
Sokoto	17	Niger, Sokoto, Garmache, Rima (2), Tributary to River Gagara, Karaduwa, Gada (2), Kurfi (2), Gagoro, Kigo and 2 others

Source: National Inventory on Dams issued by the Department of Water Resources. (Ibe, 1988).

It is important to recall in relation to table 5.19 that, four states (Imo, Rivers, Lagos and Ondo) have no registered their dams. Two States (Katsina and Akwa-Ibom) carved out of old Kaduna and Cross River States in September 1987 had not been created when this list was compiled. Further, the majority of are earth and/or concrete dams, created for water supply and irrigation. Other activities such as fisheries or recreational activities are also practiced.

The reduction of freshwater and sediment discharge in the lower estuarine reaches of the rivers due to dam construction have altered the extent of intrusion of the estuarine salt wedge inland. This has important ecological effects on the flora and fauna of the coastal and nearshore zone in the region. Ibe (Pers Comm.) pointed out that the reduction in freshwater flow has been accompanied by a reduction in inputs of nutrients to the coastal areas leading to significant losses in local fish catches from some parts of the Nigerian coast. A further, more specific instance followed the impoundment of the Volta River in Ghana in which the alteration in the salt wedge intrusion resulted in the displacement seawards of the economically important bivalve Egeria radiate by about 20 km (Ennin and de Graft-Johnson, 1977) in the first decade after completion of the dam. Breeding grounds now occur less than 10 km from the sea (Portman et al., 1989). Other effects noticed include the seasonal spread of freshwater vegetation such as Vallisneria aethiopica, Potomogeton octamebers and Ceratophyllum demersum, as well as the snail hosts of Schistosomiasis (Odei et al., 1981).

Another important anthropogenically-induced alteration of land is brought about by reclamation of coastal marshland areas (Portman et al., 1989). In 1984 alone, extensive dredging of the Lagos estuary and the deposition of the spoil in adjoining mangrove swamps led to high suspended solids in most of the embayment and severe damage to the oyster fisheries (Ibe, Pers. Comm.). The development of port facilities, especially jetties and breakwaters, and the construction of oil rigs for exploration and exploitation of crude oil have interrupted long-shore drift patterns causing striking coastal erosion problems. For example, at Lagos in Nigeria, Victoria Beach has been eroded 2 km inland since the breakwaters were completed in 1912 (Ibe, 1985). Equally striking is the erosion of 0.5 km at Escravos (also in Nigeria) since breakwaters were completed in 1964 (Ibe, 1986). Similar problems were created at the Port of Abidjan when the Canal de Vridi was opened in 1950; since then the beach has eroded to the east of the canal and a road has been cut through (Portmal et al.,1989). Similar serious erosion problems have been reported in Benin, Togo, Sierra Leone and Liberia (Abban, 1986). Coastal areas in the GCLME region are thus, experiencing coastal degradation in the form of coastal erosion, flooding, deforestation, saltwater intrusion and subsidence. Coastal erosion is widespread along most of the low-lying areas and even along some of the cliffed coastline of the region. Erosion rates of up 25 to 30 metres a year have been witnessed in

some countries, principally the Victoria Beach in Lagos, Nigeria (Ibe and Quelennec, 1989).

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

1. Liberia: with a mean recession of 2m per year at Monrovia. Coastal erosion has been severe in Monrovia, in Buchanan and Greenville as a result of land-based activities. Between 1981-1997, about 100m of beaches have been lost;
2. Côte d'Ivoire: with spectacular coastal recession at Port Bouet (more than 10m in 2-3 days, when the phenomenon was aggravated by the construction of the Vridi canal);
3. Ghana: with an average of more than 6m/year West of Accra, since the construction of the Akosombo dam, with the present aggravation of the coastal retreat around Keta;
4. Togo and Benin:due to the construction of the large breakwaters for the Ports of Lome and Cotonou, coastal retreat has sometimes exceeded 150m in 20 years, East of Lome; retreats of more than 300 to 500m had been observed East of the port of Cotonou;
5. Nigeria: particularly, around Victoria beaches, where recession of more than 500 m have been recorded since the construction of the Lagos Harbour in 1907;
6. Gabon and in Angola: occurrences of rapid downslides at the northern part of Cape Lopez, littoral of Gabon and very often long sand spits (restingas) breached along the Angolan coast, have been recorded. Between Luanda and Lobito, coastal erosion has already caused considerable damage. In some localities such as Porto Amboim and Sumbe, coastline retreat has been estimated to between 2-3 metres per year, with the collapse of multiple structures, for example, in Sumbe. The same phenomenon has been noticed in Luanda where areas situated in low topographical areas near the coastline of Mussulo Island have been completely destroyed by the erosion.

The coastal erosion process, especially on the sandy or muddy littoral, constitutes one of the main factors of the degradation of the Guinean coast. Studies undertaken by the Centre de Recherches Scientifiques de Conakry/Rogbane (CERESCOR) have shown rapid recessions of the shoreline. The most affected areas are situated in Koba in the northern part of the coast, Tabounsou in the southern part of the coast and in the vicinity of the Conakry peninsula area; in Koba and Tabounsou, more than 1.8 m per year of coastal retreat have been reported. As a result, there is a serious threat to tourist infrastructures on the coast as well as some residential construction built along the shoreline (UNEP, 1999). Among the causes of this erosion,we can identify the process of sand mining on the beaches for construction purposes. A large part of the coastal erosion process increase is due to hydrodynamic and morpho-sedimentary effects as well as human activities (construction of protection dikes around Conakry harbour, dredging of channel access, coastal sand mining, and anarchical occupation of the littoral by various constructions). These natural ecological or human modifications can lead, if they persist, to biological diversity losses and even to the degradation of the entire ecosystem.

Coastal erosion in Sao Tome, particularly in the southern part of the country, has reached an alarming rate (UNEP, 1999). Some infrastructures (roads, housing, etc.) are seriously threatened. Studies to be undertaken would seek possible options in terms of costs for reducing, in the short term, the threat of coastal erosion phenomenon. Beach mining is also cause for concern. The Government has banned sand mining along the island's beaches, with only a few exceptions. Intensive beach sand mining poses an ecological threat to the equilibrium of critical habitats such as the mangroves or estuaries ecosystem.

One of the most serious problems of the Togolese coast is that of coastal erosion. Over an area of approximately 35 kilometres, between the port and the protected sector, the coast retreats by approximately 10m per year due to the sedimentary deficit caused by the port (and its dike) which blocks the sediment transit on its western side and causes the coastline to retreat in the eastern part of the port of Lome.

Furthermore, the sporadic opening of the lagoonal pass near Aneho as a result of storm waves and the lagoon flood pressure allows the penetration of marine waters which disturb the ecosystem of the Togolese brackish lake. However, the brackish lagoonal waters provoked by freshwater contribution from the Mono River lead to an ecological disequilibrium. These variations in the quality of the water contribute to the change in the habitats of various areas. The littoral of the GCLME region has been (and continues to be) subject to significant coastal erosion processes, linked to natural and man-made causes. The consequences can be sometimes tremendous, with loss of infrastructures, houses, roads, etc.

6. Analysis of Root Causes of the Identified Problems

6.1 Major root causes

Based on the causal chain analyses presented earlier in the TDA (e.g., within each separate section on Major transboundary Problems Perceived and Issues (PPIs), the root causes leading to environmental degradation in the GCLME region include:

1. Complexity of ecosystem and high degree of variability (resources and environment);
2. Inadequate capacity development (human and infrastructure) and training;
3. Poor legal framework at the regional and national levels;
4. Inadequate implementation of available regulatory instruments;
5. Inadequate planning at all levels;
6. Insufficient public involvement
7. Inadequate financial mechanisms and support;
8. Poverty;

6.1.1 Complexity of ecosystem and high degree of variability

1. Changing state of the Guinea Current;
2. Inadequate information and understanding;
3. Difficulty in monitoring and assessment;
4. Poor predictability;

6.1.2 Inadequate capacity development (human and infrastructure) and training

1. Colonial/political past;
2. Brain drain;
3. Limited training opportunities;
4. Limited number of highly trained individuals;
5. Limited funds for infrastructure support;
6. High prices for imported scientific equipment;

6.1.3 Poor legal framework at the regional and national levels

1. Regionally incompatible laws and regulations;
2. Ineffective environmental laws and regulations;
3. Environmental Action Plans not being implemented;
4. Environmental auditing required;
5. Noncompliance or non-observance with laws;
6. Lack of involvement and buy in by stakeholders;
7. Lack of co-management;

6.1.4 Inadequate implementation of available regulatory instruments

1. Inadequate compliance and enforcement (over fishing, pollution);
2. Lack of political will;
3. Inadequate monitoring, control, and surveillance;
4. Apparent lack of transparency in the enforcement of regulations;
5. Indifference and poor communication;

6.1.5 Inadequate planning at all levels

1. Inadequate intersectoral coordination;
2. Poorly planned coastal developments;
3. Inefficient control measures (e.g. to check coastal erosion);
4. Non-operational contingency plans;
5. Limited time horizon of planners;
6. Rapid urbanisation and informal settlements;

6.1.6 Insufficient public involvement

1. Lack of awareness on environmental issues and public apathy;
2. Conflicts about rights of access;
3. Inadequate involvement of the civil society;
4. Inadequate grassroots participation;
5. Non involvement of some stakeholders;

6.1.7 Inadequate financial mechanisms and support

1. Low country GDPs;
2. Unsustainable subsidies;
3. Inadequate budgetary allocation for environmental problems and - data collection;
4. Ineffective economic instruments;

Insufficient funding for infrastructure and management; limited economic opportunity for technical persons;

6.1.8 Poverty

1. Increasing rural-urban drift;
2. Ineffective population control programmes;
3. Lack of knowledge about birth control;
4. Payment of lip-service to poverty alleviation;
5. Unsustainable poverty alleviation programmes;
6. Inadequate capital input towards poverty alleviation;
7. Unsustainable technologies alternatives to traditional practice;
8. Rapid population growth;

Further, this analysis has allowed the identification of the generic root causes of the identified MPPIs in the region so that these can be addressed through the development and implementation of the regional Strategic Action Programme (SAP). The three generic action areas, where proposals for actions can be formulated include:

1. Sustainable management and utilization of resources and habitat restoration;
2. Assessment of environmental variability, ecosystem impacts and improvement of predictability;
3. Maintenance of ecosystem health and management of pollution;

These three action areas and the related proposals for actions are developed in the next chapters of this work.

Root causes of problems identified

1. Complexity of ecosystem and high degree of variability (resources and environment);
2. Inadequate capacity development (human and infrastructure) and training;
3. Poor legal framework at national and regional levels;
4. Inadequate implementation of available regulatory instruments;
5. Inadequate planning at all levels;
6. Insufficient public involvement;
7. Inadequate financial mechanisms and support;
8. Poverty.

MAJOR TRANSBOUNDARY PROBLEMS

1. Decline of commercial fish stocks and non-optimal harvesting of living resources in the GCLME;
2. Uncertainty regarding ecosystem status and yields in a highly variable environment including effects of global climate change;
3. Deterioration in water quality (chronic and catastrophic), pollution from Land and Sea Based Activities, eutrophication and harmful algal bloom;
4. Habitat destruction and alteration, including inter alia modifications of seabed and coastal zone and degradation of coastscapes, coastline erosion;
5. Loss of biotic (ecosystem) integrity (changes in community composition, vulnerable species and biodiversity, introduction of alien species).

Generic action areas

1. Sustainable management and utilization of resources and habitat restoration;
2. Assessment of environmental variability, ecosystem impacts and improvement of predictability;
3. Maintenance of ecosystem health and management of pollution;

Figure 6.1: Summary figure of problems root causes, major problems perceived and issues and their generic action areas to major transboundary problems

Table: 6.1 Sumary table of the main root causes and the contributing Factors

	Main root causes	**Contributing factors**
1.	*Complexity of ecosystem and high degree of variability (resources and environment)*	1. Changing state of the Guinea Current; 2. Inadequate information and understanding; 3. Difficulty in monitoring and assessment; 4. Poor predictability;
2.	*Inadequate capacity development (human and infrastructure) and training*	1. Colonial/political past; 2. Brain drain; 3. Limited training opportunities; 4. Limited number of highly trained individuals; 5. Limited funds for infrastructure support; 6. High prices for imported scientific equipment;
3.	*Poor legal framework at national and regional levels*	1. Regionally incompatible laws and regulations; 2. Ineffective environmental laws and regulations; 3. Environmental Action Plans not being implemented; 4. Environmental auditing required; 5. Noncompliance or non-observance with laws; 6. Lack of involvement and buy in by stakeholders; 7. Lack of co-management;
4.	*Inadequate implementation of available regulatory instruments*	1. Inadequate compliance and enforcement 2. Lack of political will 3. Inadequate monitoring, control, and surveillance 4. Apparent lack of transparency in the enforcement of regulations 5. Indifference and poor communication
5.	*Inadequate planning at all levels*	1. Inadequate intersectoral coordination 2. Poorly planned coastal developments 3. Inefficient control measures (e.g. to check coastal erosion) 4. Non-operational contingency plans 5. Limited time horizon of planners 6. Rapid urbanisation and informal settlements
6.	*Insufficient public involvement*	1. Lack of awareness on environmental issues and public apathy; 2. Conflicts about rights of access; 3. Inadequate involvement of the civil society; 4. Inadequate grassroots participation; 5. Non-involvement of some stakeholders;
7.	*Inadequate financial mechanisms and support*	1. Low country GDPs 2. Unsustainable subsidies 3. Inadequate budgetary allocation for environmental problems 4. Ineffective economic instruments 5. Insufficient funding for infrastructure and management; limited economic opportunity for technical persons
8	*Poverty*	1. Increasing rural-urban drift 2. Ineffective population control programmes 3. Lack of knowledge about birth control 4. Payment of lip-service to poverty alleviation 5. Unsustainable poverty alleviation programmes 6. Inadequate capital input towards poverty alleviation 7. Unsustainable technologies alternatives to traditional practice 8. Rapid population growth

7. Priority Areas of Future Interventions

7.1 Synthesis Matrix

The synthesis matrix serves as a logistical "map" of the TDA through examining the transboundary elements of the problems and then relating them to their major underlying institutional, social and global root causes. The synthesis matrix presents the five major transboundary problems of the GCLME region together with the major root causes and the action areas (Table 6.1).

7.2 Overview of specific transboundary problems, causes, impacts, actions required and anticipated outputs

In the Synthesis Matrices, three broad action areas were identified in order to address the perceived major GCLME problems and the main root causes of these problems. The action areas correspond to the three main issues in the GCLME, namely utilization of resources, environmental variability, and ecosystem health and pollution. For each action area a set of more specific actions was specified in the Synthesis Matrix. These specific actions were formulated collectively through consensus among stakeholders at the second regional GCLME workshop to identify the specific problems associated with each main issue. These have been prioritised and the outputs or solutions emanating from the specific actions have been listed and costed. The essential information has been summarised in the set of analysis tables, which follow. These tabular summaries are necessarily brief, often in point form and where additional clarification has been deemed necessary, this has been provided following each table in the form of explanatory notes.

The following tables and explanatory text examine the nature of the specific problems identified as contributors to ecosystem degradation and change in the GCLME. They examine the management uncertainties (in the case of environmental variability, the uncertainty of the variability per se) and knowledge gaps that need to be filled. They present priority practical and implementable proposals for inclusion in the GCLME Strategic Action Programme (SAP) and the cost of the required international actions where possible. Finally, the series of tables identify the outputs (products) that should be obtained through the successful implementation of the action. Stakeholders for each problem and action area are identified.

7.2.1 Sustainable management and utilization of resources

Sustainable management and utilisation of resources of the GCLME can only be achieved through:

1. Facilitation of optimal harvesting of living resources;
2. Assessment of mining and drilling Impacts and policy harmonization;
3. Responsible development of mariculture;
4. Protection of vulnerable species and habitats;
5. Assessment of un-harvested species and their role in the ecosystem;

7.2.2 Assessment of environmental variability, ecosystem impacts and improvement of predictability

To carry out successfully the assessment of environmental variability, ecosystem impacts and improvement of predictability four major actions have been retained, these include:

1. Reducing uncertainty and improving predictability and forecasting;
2. Capacity Strengthening and Training;
3. Management of eutrophication and harmful algal blooms;
4. Control of coastal erosion;

7.2.3 Maintenance of Ecosystem Health and Management of Pollution

Ecosystem health is a major issue in the GCLME region. For the maintenance and/or rehabilitation of its health, seven major actions are proposed namely:

1. Improvement of Water Quality;
2. Prevention and Management of Oil Spills;
3. Reduction of Marine Litter;
4. Retardation/Reversal of Habitat;
5. Conservation of Biodiversity;
6. Inadequate/Inappropriate Data and Information Management;
7. Governance and Institutional Framework;

Table: 7.1 Sumary table (synthese matrix) of the major problems perceived, their transboundary elements, a summary of major root causes and their action areas.

Perceived Major Problem	Transboundary Elements	Major Root Causes	Action Areas
Decline in GCLME commercial fish stocks both resulting from and leading to non-optimal harvesting of living resources	Most of the regions important harvested resources are shared between countries, or move across national boundaries at times, requiring joint management effort	1,2,3,4,5,6,7, 8	A,B (C)
Uncertainty regarding ecosystem status and yields in a highly variable environment including effects of global climate change	Environmental variability/change impacts on ecosystem as a whole, and poor predictive ability limits effective management. The GCLME may also be severely impacted by global climate change (subceptibility to increased coastal erosion and flooding)	1,2,3,7	A,B,C
Deterioration in water quality (chronic and catastrophic) and Pollution from Land and Sea Based Activities, eutrophication and harmful algal blooms	While most impacts are localised, the problems are common to all the sixteen countries and require collective action to address the pollution from municipal, industrial and agricultural sources. Eutrophication and algal blooms are a common problem in most of the countries and require collective action to address	1,2,3,4,5,7	C
Habitat destruction and alteration, including *inter alia* modification of seabed and coastal zone, degradation of coastscapes and coastal erosion	Uncertainties exist about the regional cumulative impact from petroleum exploration on benthos and ecosystem effect of fishing. Degradation of coastscapes and coastal erosion reduce regional value of tourism	2,3,5,6,7,8	A,C (B)
Loss of biotic (ecosystem) integrity* *Changes in community composition, vulnerable species and biodiversity, introduction of alien species etc.	Fishing has altered the ecosystem as a whole, reduced the gene pool, and caused some species to become endangered or threatened. Introduced alien species are a global transboundary problem	1,3,5,6	A,C (B)

A = Sustainable management and utilization of resources and habitat restoration;
B = Assessment of environmental variability, ecosystem impacts and improvement of predictability;
C = Maintenance of ecosystem health and management of pollution.
1, 2, 3, 4, 5, 6, 7, 8 = Root causes presented in Table 6.1.

Table: 7.2 Summary table of major actions to implement from the generic action areas

Generic action Areas	Major Actions
1. Sustainable management and utilization of resources	Facilitation of Optimal Harvesting of Living Resources
	Assessment of Mining and Drilling Impacts and Policy Harmonization
	Responsible Development of Mariculture
	Protection of Vulnerable Species and Habitats
	Assessment of Non-Harvested Species and their Role in the Ecosystem
2. Assessment of environbmental variability, ecosystem impacts and improvement of predictability	Reducing uncertainty and improving predictability and forecasting
	Capacity Strengthening and Training
	Management of eutrophication and harmful algal blooms
	Control of coastal erosion
3. Maintenance of ecosystem health and management of pollution	Improvement of Water Quality
	Prevention and Management of Oil Spills
	Reduction of Marine Litter
	Retardation/Reversal of Habitat Loss
	Conservation of Biodiversity
	Inadequate/Inappropriate Data and Information Management
	Governance and Institutional Framework.

7.3 Framework for the action area sustainable management and utilization of living resources

7.3.1 Detailed analysis of the issue of non-optimal harvesting of living resources

For the reader of this detailed analysis of the problem of non-optimal harvesting of living resources, it is adviced to consider table 7.3 for easy checks. It is when certain issues cannot be understood in the table that you can consult this analysis.

Causes

1. Fishing overcapacity (too many fishers, too many boats);
2. Inadequate tools for stock assessment (currently available tools for assessment do not always produce effective results e.g. use of single species models under multispecies context);
3. Stock assessment data are not equally available and are not in a uniform format;
4. Assessment tools that are available are not applied equally within the region;
5. Un-selective fishing gears (can induce growth overfishing);
6. Increasing catch of immature fish in many fisheries (non-sustainable utilization of resources);
7. Lack of regional assessment and monitoring - there is no effective and sustainable mechanism within the GCLME region to ensure that regional (ecosystem) assessment takes place;
8. Inadequate scientific information on the resources (the biology, species interactions of harvested and potentially harvestable species are not always well known);
9. Inadequate management mechanism (management options are not based on scientific information;
10. Lack of interinstitutional collaboration at national, sub-regional and regional levels;
11. Over-riding socioeconomic and political pressures);
12. Inadequate monitoring, surveillance and control (even when assessments and quotas are used to manage fisheries, the control and enforcement mechanisms are often lacking particularly where transboundary issues occur);
13. Lack of collaborative management of shared resources;
14. Inadequate institutional and legal framework.

Impacts

Resource depletion (this is an obvious effect of over-harvesting, a depletion of the resource below optimal levels). High by-catch and undersize fish catch (this reduces the production of fisheries, and may lead to ecosystem change (uncertainty) and threaten the biodiversity of the ecosystem. Fisheries impacting productivity cycle (the depletion of, for example, a grazer such as sardine from the system affect the entire food chain and can shift the into a different equilibrium. These changes in the system could reduce yields in other ways which may affect human kind, e.g. changes that favour large gelatinous plankton which is not eaten. Human population migration (local and regional) - Declines in opportunities in resource harvesting at

the coast leads to increased immigration into cities, and the expansion of urban poverty.
Large variation in landings - results should be precautionary approach leading to reduced levels of fishing effort. Regularity of employment, reliability of markets, all suffer when variation in landings is great. Variation of food supply for birds, turtles etc. Humans and other organisms compete for food. Over-harvesting of resources by humans may lead to a decrease in food supply available to seabirds, turtles, and other marine organisms that may themselves be important as touristic resources.

Conflict (e.g. artisanal against. commercial and/or recreational) - Artisanal, recreational and commercial fishers often compete for the same resources. Conflicts among these sectors may increase when resource become depleted. Declining turtle population.Competition for exploited resources - harvesting of pelagic resources can have an impact on food availability for other top predators.

Risks/uncertainty

1. Political instability (Civil unrest, civil war, etc);
2. Irreversible ecosystem change - The degree, to which changes that take place in the ecosystem (as a result of over-harvesting) are reversible, is not known;
3. Biodiversity change (genetic, species, ecosystem) may occur as a result of the over-harvesting of resources, but the lack of good baseline data makes this difficult to assess. Hence we do not know the degree to which over fishing affects biodiversity;
4. Habitat destruction - The degree to which over-harvesting through un-healthy technology (e.g. bottom trawls) is yet unknown. Actions in one country can cause collapse of a shared commercially important stock (eg. collapse of Guinea Current fish stocks as result of gross overfishing by foreign fleats);

Socioeconomic consequences

Financial and job numbers - Over-harvesting of resources reduces the number of jobs and the financial gain accruing to coastal communities. Jobs lost in one country may result in an increase in emigration to another country due to changes in employment opportunities, fishers may move across boundaries due to decrease in local resources availability causing socio-economic and resource strifes in other countries.Loss of national revenue - If resources are over-harvested, or if opportunities to developing new resources on a sustainable basis are missed, then the contribution of those resources to the national revenue base is reduced. Lack of food security (artisanal/industrial) - artisanal fishers depend on fisheries resources directly for protein (large segments of the population depend on artisanal catches for protein); over-harvesting by both the artisanal and industrial sector may erode the food security of coastal artisanal fishers and their families. Loss of jobs in the industrial sector may also increase poverty, and decrease food security. Erosion of Sustainable livelihoods - livelihoods of coastal people may often depend on activities that are based on assets (e.g. fish resources) that are harvested by other sectors. Over-harvesting of those assets, both by coastal dwellers themselves or by industrial harvesting, may erode the livelihoods of coastal people, and bring about increased urban migration and increases in urban poverty and the spreading of poverty-related diseases. Missed opportunities (under-utilization and wastage) - There may be many opportunities for the novel utilization of marine resources. Examples include drugs from both inshore and deep-water invertebrates. A coordinated regional assessment of such resources and coordinated development could bring regional benefits in this area. Competitive edge on global markets - Lost markets are difficult to regain e.g. shrimps and lobsters of high value. Increases or reductions in yields in one area may impact upon another area (country), resulting in market competition among the GCLME countries. To retain a competitive edge in rapidly changing markets, stability of the throughput and quality enhancement that comes with that stability are essential.

Transboundary consequences

Most of the regions important harvested resources are shared between countries (i.e. stradle national boundaries), or move across national boundaries at times. (See GLCME Thematic Report on Fisheries and Regional Synthesis Report). Over-harvesting of a species in one country can therefore lead to depletion of that species in another, and in changes to the ecosystem as a whole. Inappropriate management of regional resources endangers sustainability of resources and consistency of catches, and leads to sub-optimal use. Lower food production, loss of jobs and national revenue, and increased reliance on foreign aid. GCLME countries are currently major importers of fish products. Potential irreversible changes in nature of ecosystem due to depletion of widely distributed ecologically important species. Movement of vessels and humans across borders in response to depletion of resources. Increased local and regional conflicts. Depletion and/or large-scale distributional shifts in predator species in response to reduced prey abundance.Conflict may arise from encroachment, availability of limited space, physical conflict, harvesting of fish at different stages of their life history and harvesting of migratory species.

Activities/solutions

Establish regional forum on monitoring, control and surveillance activities. Establish regional forum for resource use

conflict management/Expand the mandate of the forum for stock assessment and harmonization of management action to include resource use conflict resolution. Provision of information to facilitate regional assessments of shared resources. A structure should be established to conduct regional stock assessments, ecosystem assessments, evaluate resource-environmental linkages, and facilitate post-harvest technology. Joint stock assessments with the BCLME and Canary Current LME should be explored and implemented. Joint surveys & assessments - Carried out cooperatively will help produce enhanced management and optimal utilization. These joint surveys will be offered as a 5-year demonstration of the benefits to the individual nations of joint transboundary assessments. Gathering and calibration of baseline information - This should be done on resources, potential resources before harvest, as well as ecosystems. Cooperative analysis of socioeconomic consequences - Analyses of the socioeconomic consequences of non-optimal and improved use of resources should be done with a view to appropriate intervention within the framework of improving sustainable livelihoods. Cooperative training - Cooperative training will be essential to generate regional capacity needed to address the transboundary issues, and to promote sustainable intergrated management. Cooperative training targeted at communities will so be necessary. Training - in management, enforcement, and the creation of new opportunities. Cooperative assessment of potential new transboundary resources. Potential new resources in both offshore and inshore areas in the GCLME, and should have assessments conducted cooperatively.

Priority

Proposed activities are ranked on a scale of 1-3 in terms of their perceived priority. Only those activites that address transboundary problems requiring incremental funding are listed.

Anticipated outputs

Optimal resource utilization - This is the most obvious output from the suggested solutions; there will be a reduction in the exploitation level of resources that are deemed to be over-harvested so that stocks can be rebuilt to optimum levels, and an increase in the benefit to coastal communities from the improved utilisation of resources. Appropriate legal regimes for fisheries compliance and enforcement Improved forecasting - Joint assessment will enable improve predictions of sustainable resource-harvest levels. Establish regional structure - This regional structure will be responsible for producing annual stock assessment reports, annual ecosystem reports, and provide advice or suggestions of resource harvesting levels, and other matters related to resource use, particularly fisheries. Training packages on management, enforcement, and opportunity creation - all at the regional level to advance the concept of sustainable integrated management of the GLCME. Improved governance, including use of co-management and appropriate stakeholder involvement Regional forum with expanded mandate to deal with resource use conflict established.

7.3.2 Detailed analysis of the issue of mining and drilling impacts

Causes

1. Pipelines
2. Drilling & dredging
3. Seismic exploration

Impacts

Habitat destruction - Habitat destruction from onshore crude oil drilling may be localized, but offshore crude oil exploration and exploitation disrupts large areas of seabed, disturbs the sediments and changes the particle size distribution. The impact of this on benthos and other resources, particularly fisheries resources, needs to be assessed and mitigated if necessary. Seabed modification - Seabed modification, related to habitat destruction, may impact on the exploitation of other resources; for example, pipelines and wellheads and their potential impact on availability of bottom areas to trawl fishing. Coastal soil, beach, intertidal and subtidal profile destruction. Coastal mining moves the coastal soils, alters the beach profile and destroys coastal vegetation, and intertidal and subtidal habitats important as nursery areas, increased beach erosion. Conflicts (fish, oil and gas) may arise between different sectors. Appropriate strategies are needed to decrease the potential for conflicts, and to resolve conflicts that arise (e.g. fishing / oil).Behaviour (e.g. scaring of mammals and fish during seismic surveys) and mortality (e.g. mortality of larvae) of resources - Fish migrating away from, and fish larvae being killed by activities.

Table: 7.3 Facilitation of Optimal Harvesting of Living Resources

Problem statement. Non optimal harvesting of living resources: Non optimal harvesting includes over harvesting, such as overfishing, as well as wastage through dumping of by-catch and/or catching and dumping of juvenile fish. It also includes not taking advantage of resources with the potential to offer sustainable development opportunities (e.g. seaweed, some invertebrates). This often results from a lack of technology or knowledge of the opportunities available.Poaching by distant fleets.

Causes	Impacts	Risks/Uncertainties	Socioeconomic consequencies	Transboundary consequencies	Activities/Solutions	Priorities	Incremental cost 5yr	Outputs
- Overcapacity - Inappropriate fishing methods - Inappropriate fishing tools - Poaching - Lack of regional assessment - Inadequate scientific information on the resources - Non sustainable utilization of the resource - Inadequate management policies - Inadequate MCS - Lack of collaborative management for shared stocks - Over harvesting of turtles - Lack of forecasting capabilities - Inadequate and/or inappropriate governace	- High by-catch & undersized catch - Fisheries impacting productivity cycle - Resource depletion - Human population movements (local & regional) - Large variation in landings - Variation in food supply for birds, turtles - Conflict (e.g. artisanal vs. commercial vs. recreational; conflict with mining) - Declining turtle population - Competition for exploited resources	- Political instability (Civil unrest, civil war, etc) - Irreversible ecosystem change - Biodiversity Change - Habitat destruction - Collapse of commercially important stocks	- Population surge in non fishing areas - Variable and uncertain job market, unemployment - Loss of national revenue - Lack of food security: artisanal /industrial - Erosion of sustainable livelihoods - Missed opportunities (under-utilization & wastage) - Loss of competitive edge on global markets	- Resource decline - Conflict (may arise from encroachment, availability of limited space, physical conflict, harvesting of fish at different stages of their life history and harvesting of migratory species). - Most harvested resources are shared between countries or cross national borders. Over fishing in one country can cause depletion in neighbour country - Lack of common regulations e.g. mesh size creates enforcement difficulties - Common problems - Shared solutions	- Establish regional forum on MCS. - Joint assessments surveys - Gathering and calibration of baseline information - Improve national governance - Improve institutional and legal framework - Analysis of socioeconomic consequences for the whole ecosystem - Assessment of potential of new resources - Establish a regional forum for regional assessment, and management	1 1 1 1 1 1 2 1	$1000 000 $2000 000 $400 000 $400 000 $800 000 $1000 000 $800 000	- Optimal sustainable resource utilization - Improved forecasting - Prevention of irresistable ecosystem change - Establishment of a regional forum - Prevention of irresistable ecosystem change - Regional forum with expanded mandate to deal with resource use conflict established

Risks/uncertainty

Cumulative impacts - The cumulative impacts of lots of smaller impacts from crude oil and gas drilling, as well as the cumulative effects over time, are unknown, but may be significant within the context of the ecosystem. Effects on benthos - The effects of mining on benthic communities are uncertain. Change of biodiversity - It is not known whether mining impacts lead to a reduction in biodiversity in the mined areas. Cost/benefit - Costs and benefits to the environment from mining and drilling in this perspective are unknown.

Socioeconomic consequences

Negative: Exclusion zones around crude oil and mining operations, offshore wellhead
Positive: Reserves - A negative effect of crude oil drilling is the closure of large areas of coastline, restricting access to living resources by coastal dwellers or potential dwellers. A positive effect is that exclusion zones could act as biotic reserves. Reduced artisanal fisheries - This is a negative effect of the exclusion, as well as the impact of mining-related coastal activities. Coastal tourism - The closure of large areas of coast reduces the potential for tourism development in affected areas. Onshore development - Onshore development increases opportunities for jobs, but also modifies habitats through construction and pollution. Coastal migration, urbanization and poverty may be an impact where towns are adjacent to oil drilling areas; disparities in economic opportunities can cause conflicts.

Transboundary consequences

Crude Oil and Gas exploration activities occur in some of the countries (GCLME Thematic Reports). Most of the impacts are localized but uncertainty exists regarding cumulative impacts of oil/gas and Gold mining that added to impacts of fishing and pollution could be significant. As such as assessment of the cumulative impacts of mining/drilling is a prerequisite for sustainable integrated management of the GCLME. The oil & gas industries in the region undertake EIA's for all projects and are working together to consolidate baseline information. This results in an apreciable potential for increasing of co-financing. Most of the countries share common problems relating to oil & gas operations. For example, conflicts between resource users and extraction industries opportunities. Regulation of oil & gas exploration and exploitation and mining activities needs to be standardized and harmonized within the region.

Activities/solutions

Policy harmonization - Cooperative harmonization of oil & gas policies, particularly related to shared resources and cumulative impacts and their mitigation, will be needed. Cumulative impact assessment for GCLME (industry co-funding) - An overall impact assessment of the oil & gas industry is needed. Enhanced consultation (sectoral & regional) is needed to reduce impacts of oil & gas and ensure benefits accrue and conflicts are reduced. Cooperative training will be needed for the effective management of impacts, as well as maintaining living marine resources that continue beyond mining.

Priority

Proposed activities are ranked on a scale of 1-3 in terms of their perceived priority. Only those activities that address transboundary problems requiring incremental funding are listed.

Anticipated outputs

Environmental management plan - An overall environmental management plan for the whole GCLME will be produced, including management plans for mitigating oil and gas drilling and other impacts.
Integrated management - will be the output of the above plan.
Solution to capacity problem - This will be the result of training to improve assessment and management capacity with respect to the transboundary issues.
Regional training packages on managing crude oil, gas impacts, community development following oil well and mine closure
Reduced socio-economic conflicts

Table: 7.4 Summary table for assessment of mining and drilling impacts and policy harmonization

Problem statement: Mining and drilling impacts: Exploration for oil and gas is expanding throughout the Guinea Current with new offshore oil fields being developed in Nigeria, Cameroon, Sao Tome & Principe, Equatorial Guinea, Gabon and Angola. This involves drilling, dredging and seismic exploration. There is substantial oil exploration going on in the above countries while the development of oil/gas fields (with pipelines) are planned for the ECOWAS countries-the West African Gas Pipeline Project). Capped wellheads hamper fishing while drill cuttings and hydrocarbon spills impact on the environment. Extensive Ecosystem effects of these activities are not fully known. The extent of coastal pollution deriving from Gold miningis not well documented but could be significant in Ghana and Cote d' Ivoire transboundary area distant fleets.

Causes	Impacts	Risks/Uncertainties	Socioeconomic consequencies	Transboundary consequencies	Activities/Solutions	Prio-rities	Incremental cost 5yr	Outputs
- Pipelines - Drilling and dredging - Seismic exploration	- Habitat destruction - Seabed modification - Coastal soil, beach, intertidal and subtidal profile destruction - Conflicts (with fishers and fishing communities) - Behaviour of resources - Mortality of larvae	- Cumulative impacts - Effects on benthos - Change of bio-diversity - Cost/ benefit	- Financial & employment benefits - Eexclusion of areas from fishng creates negative immediate impacts but may have longterm benefits as reserves - Reduced artisanal/industrial fisheries - Coastal tourism impacted - Onshore development - effects on coastal communities, from-mining	- Cost of the countries share common problems related to crude oil drill cuttings and wastes - Cumulative impacts are unknown but may be substantial including disruption of benthic habitat - Shared solutions - Spills cross boundaries	- Enhanced consultation (sectoral and regional) - Cumulative impact assessment for GCLME - Policy harmonization	1 1 2	$ 100 000 $ 500 000 [$ 500 000] industry $ 100 000	- Environmental management plan - Integrated management - Solution to capacity problem - Strengthened common regional Policy and Regulation

7.3.3 Analysis of the issue of responsible development of mariculture

Causes

Introduction of exotic fish species - Mariculture may use exotic fish species, which can create threats to biodiversity and ecosystem functionning. Both directly through escapees and indirecty through disease organisms.
Inadequate policy - While some countries have policies in place, others do not. Policy may not be enacted even where it exists.
Differential regional policy - Policies differ among the GCLME countries. It will be necessary to harmonize policies to minimize transboundary effects of mariculture.
Space - The coastline of the region experiences mostly a high-energy wave climate. This means that sheltered water space needed for mariculture is limited, and other sectors also make use of sheltered water, including ports, fisheries and tourism. This results in conflict with other sectors.
Lack of information. One of the reasons mariculture is poorly developed in the region is lack of information and lack of capacity. This is particularly true when it comes to the use of mariculture to develop and broaden the livelihoods of coastal communities.
Insufficient technical expertise - Mariculture, especially cage culture is an activity that requires very high environmental standards; therefore, a well trained group of technical experts is crucial to the success of any sustainable mariculture project

Impacts

Threat to biodiversity - The introduction of exotic species for mariculture purposes may threaten indigenous biodiversity by displacing indigenous species.
Diseases - Introduction of species for mariculture may spread disease, and cause other unwanted side effects.
Conflicts over space/markets - Conflicts among sectors for limited sheltered water space are common. Transboundary conflicts over markets may occur, and countries without clear policies may be denied certain markets.
Eutrophication is a consequence of uncontrolled development of feed-based mariculture systems. Such development must occur only within the confines of strictly enforced guidelines.

Risks/uncertainty

Environmental variability - This creates uncertainty about the suitability of the limited sheltered water space for mariculture.
Market uncertainty - Means that the development of mariculture carries high risk for potential entrepreneurs
Feasibility - The feasibility of mariculture is not known for many potential species.
Threat to biodiversity, introduction and spread of diseases.
Modification of species diversity - Modification of species diversity is likely to occur where accidental species release takes place e.g. in case of cage breakage

Socioeconomic consequences

Employment & sustainable livelihoods - Mariculture has the potential to allow the broadening of the livelihoods of coastal communities if developed with a sustainable community development policy. However, harvesters often have difficulty adjusting to mariculture employment.
Revenue - Revenue may accrue not only to entrepreneurs but also to local communities and to the national revenue base. However, the latter will be small due to the limited water space available.
Potential growth industry - Mariculture is one of the few industries based on living resources that has growth potential. There is very limited capacity for the expansion of harvesting from the wild. Clear sight must be kept of the limited space availability though.

Transboundary consequences

Mariculture is underdeveloped in all countries and is being actively promoted throughout the region in view of its economic and employment potential. Co-operative transboundary activities that promote the responsible development of mariculture will minimise negative enviromental consequences and also help reduce pressure on traditionally (over) harvested resources. Differences in policy among countries in the GCLME could lead to conflicts (e.g. as a result spread of disease from one country to another, alien species invasion of the ecosystem from a country point source, market conflicts etc), and differential development of the mariculture industry. Harmonization of policy will reduce the potential harmful effects of differential development. The introduction of exotic species into the region for mariculture, by any one country, has the potential to lead to transboundary biological invasions of the target organism or other species accidentally introduced with it. Such invasions have the potential to be a threat to the biodiversity of the GCLME as a whole.

Activities/solutions

1. Assess the socioeconomic potential of aquaculture (mariculture) - A full socioeconomic assessment needs to be conducted into the ability of mariculture to contribute to regional economy and the improvement in the living conditions of coastal communities;
2. Conduct feasibility assessment - The feasibility of mariculture for particular species in certain areas of the region needs to be assessed, and the best species for development need to be chosen on the basis of this assessment;
3. Formulate harmonized policy for the region - Crucial if the negative effects of one country's policy on the economic potential of another are to be precluded;
4. Establish a training module in aquaculture - Training will be needed, particularly in terms of promoting community-based mariculture, as well as the overall management of mariculture in the region;
5. Organise a workshop to develop guidelines on sustainable mariculture

Priority

Proposed activities are ranked on a scale of 1-3 in terms of their perceived priority. Only those activities which address transboundary problems requiring incremental funding are listed.

Anticipated outputs

Report on socioeconomic assessment - will include advice for action, particularly targeted at communities. Feasibility report - will include advice on recommended species and areas for regional initiatives. Policy statement - should look at overall and community potential. Training package aimed at managers, communities and potential entrepreneurs.

Table 7.5: Summary table of the analysis for responsible development of mariculture

Problem statement: Mariculture is under-developed. *Mariculture has the potential throughout the Guinea Current region to provide labour-intensive employment, protein and foreign currency from export of high value products. The responsible development of a mariculture industry is hampered by lack of information and capacity and lack of harmonized regional policy. Ecosystem effects of mariculture developments are uncertain; for example introduction of exotic species and transboundary consequences thereof.*

Causes	Impacts	Risks/Uncertainties	Socioeconomic consequencies	Transboundary consequencies	Activities/Solutions	Priorities	Incremental cost 5yr	Outputs
• Inadequate policy • Differential regional policy - policies differ in the sixteen countries • Space • Lack of information • Insufficient technical expertise • Lack of tradition for aquaculture and marine culture • Inadequate fisheries for development • Information / awareness • Lack of regional policies and cooperation	• Threat to biodiversity • Diseases • Conflict over space/markets • Eutrophication • Appropriate fish protein intake	• Environmental variability • Market uncertainty • Feasibility Modification of species diversity • Modification of species diversity	• Employment & sustainable livelihoods • Revenue in the sector • Potential growth industry	• Biological invasion to adjacent country by alien species • Threat to biodiversity • Introduction of potential disease pathogen	• Undertake socio economic and feasibility assessment • promote responsible development of moriculture in GCLME • harmonisation of national policy into a regional framework • Provide mitigations against potential problems • Workshop to develop guidelines on sustainable mariculture	1 1 2 1 1	$ 300 000	• Report on socioeconomic assessment • Feasibility report • Harmonised policy and regional policy • Training package

7.3.4 Threats to Vulnerable Species and Vulnerability of Habitats

Causes

Threats to vulnerable species in the case of habitat vulnerability can have many sources. Some examples from the GCLME include:

1. Salt production - Changes to wetlands and lagoons;
2. Population migration to coast - This is a worldwide trend. Logical consequences are threats to habitats and resources that are attractive to tourists, especially mangroves/wetlands pollution;
3. Pollution - Impacts on threatened populations and resources;
4. Reduction of preys through fishing - Humans catch fish that are the food of marine mammals and seabirds, reducing food available for them;
5. Historical harvesting of marine mammals;
6. Competition for living space and prey (birds, humans) - competion among the marine organisms for food and breeding space. They are also in competition for food and space with human populations;
7. Oil drilling canals - Canals to facilitate oil driling can lead to large scale loss of habitat through erosion;
8. Disruption of natural shoreline movement and sea level rise can exarcebate beach erosion

Impacts

Threat to global biodiversity of coastal birds and marine mammals. Ecosystem change. Loss of wetlands;
Fish resource reduction - This has happened in several lagoons;
Competition for exploited resources - Harvesting of pelagic resources has had a huge impact on food availability for other top predators;
Loss of coastline due to shoreline erosion.

Risks/uncertainty

Lack of policy/legal framework
Lack of enforcement of existing regulation
Potential occurrence of tsunamis in the region.

Transboundary consequences

Most vulnerable species, including several endemics, occur throughout the region and in some cases internationally;
Some vulnerable habitats occur regionally (e.g. wetlands and lagoons and mangroves), and many are of importance to migratory species. Therefore the consequences of any actions, whether national, regional or international, will have direct transboundary consequences and may be of significance globally.
National policies to enable protection of vulnerable species and habitats need standardization/ harmonization throughout the region.

Socioeconomic consequences

Tourism -Vulnerable habitats (e.g. wetlands)/ beaches contribute extensively to tourism.
Migration due to loss of canoe launching areas, loss of fuel, and loss of resource productivity can cause conflicts with other fishing communities or in urban areas.

Activities/solutions

Assessment of status of vulnerable species and habitats -Work has started in some countries, but a holistic regional study is needed.
Appropriate mitigation for combatting beach erosion;
Designation of marine protected areas. Compliance monitoring for pollution;
Development of a tsunamis warning system

Priority

Proposed activities are ranked on a scale of 1-3 in terms of their perceived priority. Only those transboundary activities which address transboundary problems requiring incremental funding are listed

Anticipated outputs

Ecosystem report, - A report on the status of the ecosystem, and the impacts of human activities on the relationships among non-consumptive resources, together with management advice. Application of solutions will mitigate habitat losses

Table 7.6: Summary table of the issue of threats to Vulnerable Species and vulnerability of habitats

Problem statement: Threats to vulnerable species. *Human impact on the ecosystem by way of fishing, increasing pressure on the coastal zone, pollution etc. can impact negatively on components of the system, in particular top predators such as coastal birds Vulnerability of habitats: Several habitats, in particular coastal habitats including nursery habitats have been perturbed or lost as a consequence of development and other human impacts, e.g. loss of wetlands, destruction of mangroves, lagoons, etc. These have transboundary consequences and may be significant globally*

Causes	Impacts	Risks/Uncertainties	Socioeconomic consequencies	Transboundary consequencies	Activities/Solutions	Prio-rities	Incremental cost 5yr	Outputs
• Inadequate policy • Differential regional policy policies differ in the sixteen countries • Space • Lack of information • Insufficient technical expertise • Lack of tradition for aquaculture and marine culture • Inadequate fisheries for development • Information / awareness • Lack of regional policies and cooperation	• Salt production • Population migration to coast • Pollution • Reduction of prey through fishing • Historical harvesting • Competition for space & prey (birds, humans) • Overutilization of mangroves for food etc • Shore development exarcebates coastal erosion	• Lack of policy/legal framework • Lack of enforcement of existing regulation • Potential occurrence of tsunamis in the region	• Tourism • Loss of jobs from loss of resource production through reduction of nursery areas • Migration to urgban areas • Loss of areas to launch fishing canoes	• Most vulnerable species occur throughout the region, many migrate between countries. National activitiies have transboundary consequences. • Common Problems, shared solutions.	• Assessment of status of vulnerable species and habitats both those which are shared between countries and those which play a key role in whole ecosystem. • Appropriate mitigation for combating beach erosion • Habitat restoration programmes (e.g. Mangrove restoration) • Designation of marine protected areas. • Compliance monitoring for pollution. • Development of a tsunamis warning system	1 1 1 1 2 2	$ 2,000 000	• Ecosystem status assessment and report • Losses mitigated

7.3.5 Unknown Role of Non-Harvested Species in the Ecosystem

Transboundary consequences

Unused/under-used stock may have transboundary distributions (e.g. Arioma bondi and A. melanum in Nigeria). Knowledge of what is in the system, its biology, and what role it plays, and how it can be impacted by anthropogenic activities would have an effect in all countries.

Activities/solutions

Joint dedicated surveys & assessment - Such surveys need to be dedicated to the non-harvested species because of the special technology needed.

Risks/Uncertainties

1. Unable to predict impacts of changes in abundance of non-harvested species upon harvested species.
2. Predator/prey relationships
3. Large unknown biomass
4. Market potential
5. Unknown Economic viability
6. Unknown impact of harvest
7. Ecosystem impact of pollution / habitat destruction.

Socio-economic consequences

1. Food security potential.
2. Jobs.
3. Revenues.

Priority

Proposed activities are ranked on a scale of 1-3 in terms of their perceived priority. Only those activities which address transboundary problems requiring incremental funding are listed.

Anticipated outputs

Comprehensive ecosystem model for sustainable integrated management of living resources;
Ecosystem model as a tool for sustainable integrated management of the GCLME;
Improvement in the exploitation of under-utilized living resources

Table 7.7: Assessment of Non-Harvested Species and their Role in the Ecosystem

Problem statement: known role of non-harvested species in the ecosystem. *Role of non-harvested species in the ecosystem is unknown. Assessments of non-harvested species are not conducted. Some of these species probably have high biomass and may have potential for harvesting (and with it job and wealth creation), yet the consequences of harvesting on the food webs and presently harvested species are uncertain. There is a general lack of knowledge on the subject needed for ecosystem management.*

Causes	Impacts	Risks/Uncertainties	Socioeconomic consequencies	Transboundary consequencies	Activities/Solutions	Priorities	Incremental cost 5yr	Outputs
• Lack of information	• All impacts are unknown	• Unable to predict impacts of changes in abundance of unharvested species upon harvested species • Predator/prey relationships • Large unknown biomass • Market potential • Unknown Economic viability • Unknown impact of harvest • Ecosystem impact of pollution / habitat destruction	• Food security potential • Jobs • Revenue	• Unused/under-used stock may have transboundary distributions (e.g. Arioma bondi and A. melanum in Nigeria). Knowledge of what is in the system, its biology, and what role it plays, and how it can be impacted by anthropogenic activities would have an effect in all countries. • Common problem, Shared solutions	• Dedicated joint surveys and assessments of non-harvested transboundary species to provide baseline for integrated ecosystem management.	1	$ 1 000 000	• Comprehensive ecosystem model for sustainable integrated management of living resources. • Ecosystem model for management • Improvement in the exploitation of under-utilized living resources.

7.4 Framework for the action area assessment of environmental variability, ecosystem impacts and improvement of predictability

7.4.1 Highly variable system, uncertainty regarding ecosystems status and yields

Causes

The Guinea Current upwelling area is a highly variable ecosystem with open and variable boundaries. It is unique in that it is bounded at both ends by cold water systems respectvely viz. Canary and Benguela Current. It is sensitive to environmental events (variability and change) in the Atlantic. Unlike some other Current systems (e.g. Humboldt Current in South America) there are few long-term data series to form a baseline against which changes can be predicted or assessed. There is an uneven spread of data between disciplines and between the participating countries. Difficulties in predicting changes in the system are a consequence of:
Complexity of physical, chemical and biological interactions and processes, and the difficulties in predicting environmental variability. Limited understanding of cause and effect relationships, compounded by the problems of predicting not only the environmental variability but also ecosystem impacts. Our limited understanding of driving forces (global linkages). There is also fragmentary evidence linking variability in the Pacific El Niño/La Niña (ENSO) to upwelling regimes in the GCLME. Thus, although there are pointers to the importance of remote physical (global climate) forcing of the Guinea Current, the linkages and mechanisms are not understood. Lack of data/information: Long-term data series are few and, the ecological processes are poorly understood. Inadequate data/information: long-term data series are few and incomplete and, ecological processes are poorly understood.

Impacts

Processes that give rise to variability in the Guinea Current occur on three temporal and spatial scales (A: large scale sustained events; B: decadal changes; and C: high frequency short-lived events and/or episodic events). There is evidence that environmental change/variability does impact on the GCLME in a number of ways. However, in order that these changes can be predicted sufficiently well to be useful for ecosystem management, the cause and effect must be properly quantified. The impact of environmental variability/change includes inter alia the following:

Change to coastal ecosystems from altered wind field (strength and direction) and/or rainfall (quantity and distribution)(AB). Changes in wind frequency direction and strength impact on the supply of nutrients (for productivity), currents and stratification. In addition there is evidence that SST is related to rainfall in the region). Changes in coastline morphology as a result of climatic regime changes and short term events (storms) exacerbated by coastal zone management decisions, e.g. porrly placed jettys, hotels on beaches etc, (BC). Short term events (storms) leading to damage to coastal infrastructure (C). Variations in zooplankton and fish egg/larval survival and higher level impacts (A, B, and C) through changes in primary production and stratification/turbulence caused by changes in wind frequency, direction and strength regulated by remote climatic and hydrographic factors (A= large scale sustained events; B= decadal changes; C= high frequency/short-lived/episodic events). Changes in species' abundance, composition, distribution and availability (A, B and C) i.e. ecosystem response to environmental change. Changes in fish growth, mortality and recruitment (A, B and C) - these have major implications for resource management.

Cross boundary movements of fish, sea birds turtles and marine mammals (A, B and C). The majorities of harvested species of fish either straddle country EEZ boundaries or otherwise move across these boundaries from time to time. These movements/shifts are associated with the life histories of the species and also changes in the environment. The implications of this for sustainable management are obvious; regime shifts i.e. increased variability or a net change towards altered state (B); for example, switching between species such as the dominance of Balistes in the 1970s and 80s. There is evidence linking this to temperature and salinity shifts. These regime shifts can occur naturally - however the impact of fishing can exacerbate the problem.

Risks/uncertainty

Limited understanding of this highly variable system means that it is uncertain whether the observed variability reflects sustained long-term net change or natural cycles, and whether the available data series are sufficiently long to enable us to determine this.

Socioeconomic consequences

The quality of advice given to resource managers is reduced by the ability to predict, with confidence, short-, medium- and long-term changes in the Guinea Current system. A consequence of this is that responsible resource management must err on the conservative side i.e. what is perceived to be (but which may not be). This leads to:

1. Uncertain employment (job losses and gains);
2. Variations in revenue;
3. Sub-optimal utilization of resources (particularly by artisanal fisheries);

4. Lack of food security;
5. Human population movements in response to variable resource availability
6. High production costs e.g. in fish processing;
7. National/regional conflicts;
8. Changes in government revenue, private income and exports;

Transboundary consequences

Sustained major environmental events, decadal changes and major short-term perturbations (e.g. 10- or 50-year storm events) do not respect country EEZ boundaries, but rather impact on the GCLME as a whole. In other words the types of environmental variability/change that are the focus of the GCLME programme are system-wide and in essence transboundary. Many of the transboundary consequences listed below would occur regardless of the high variability of the system. Nevertheless our ability to manage them effectively is limited by our predictive capability. Some of the consequences of increased variability or sustained change include:

Ecosystem

1. Shifts in distribution of biota -for example Balistes;
2. Loss of species/biodiversity - Alien species have also displaced indigenous species such as Nypa palm replacing mangroves in parts of the Niger Delta;
3. Altered food webs;
4. Disruption of fish, bird, turtle and mammal migrations;

Fisheries

1. Unsustainable management of shared and straddling stocks
2. Altered fish spawning patterns and population shifts
3. Unpredictable fluctuations and availability of fish stocks e.g. reduction in the sardine stock in the 1970s
4. Unpredictable and variable distribution of fishery benefits
5. Regional economic instability and unemployment
6. Regional conflicts over declining resources/stocks

Coastal infrastructure

Costly maintenance of coastal infrastructure as a result of degradation by coastal erosion

Climate Change

Changes in the status and/or functioning of the GCLME may affect its contribution to global climate change through its role as a source/sink of CO2 and source of methane.

Activities/Solutions

Without good baseline information and wider regional coordination and articulation, major problems and issues facing the sixteen countries bordering the GCLME cannot be resolved. It is necessary to undertake targeted assessments of priority environment variability issues/problems and to develop appropriate systems, linkages and networking. Development of a suitable needs-driven, cost-effective regional environmental early warning system for the GCLME by cross-linking with existing national systems. Feasibilty assessment of the use of information from the PIRATA moored buoy array in the tropical Atlantic to enhance understanding of links between weather, climate and fish. (PIRATA is an Atlantic equivalent but smaller version of an ocean buoy network in the Pacific, which is used to forecast EL Niños and La Niñas. The value of linking the GCLME with the PIRATA system would be in the forecasting of upwelling regimes and environmental variability and anomalous events originating in the tropical Atlantic.). If the feasibility assessment were to prove successful (and it looks like it will), then there is also an excellent chance of ongoing involvement between the region and PIRATA being funded from country sources and donors. Determination of role of upwelling systems as a CO2 source/sink and methane source. The value of this to the international community has previously been commented on. Moreover it will provide an obvious link between the International Waters and Climate Change components of GEF. A modest demonstration project would be appropriate. Development of community projects for cost effective environmental information gathering and environmental education. Public awareness and involvement are seen as essential components for the successful implementation of the GCLME Programme - both for cost effective information gathering/monitoring and also to help reduce anthropogenic environmental impacts on the ecosystem. Analysis of plankton archives and other (oceanographic) data collections - baseline information for measurement of decadal change. Develop state of the environment analysis/reporting system for use on a regional basis in the GCLME. Develop links with CLIVAR and CLIVAR Africa (CLIVAR = Climate Variability and Predictability Project of the World Climate Research Programme) and with GOOS and GOOS-Africa (GOOS = Global Ocean Observing System of the Intergovernmental Oceanographic Commission of UNESCO). Adapt/develop predictive mathematical models applicable to the region - the utility of this has been referred to elsewhere.

Establishment of regional advisory groups and networking centres. This is a low cost activity with potential large benefits. Develop transboundary environmental variability networking for region - this links in with the proposed early warning system. It will make extensive use of the internet. Establish links with the Canary and Beguela Current LMEs - Clearly the GCLME does not function in isolation from the rest of the south Atlantic, so building bridges/networking with other LME projects could provide valuable spin-offs in both directions.To obtain archived data/information from historical expedition by Europeans

Priority

Proposed activities are ranked on a scale of 1-3 in terms of their perceived priority. Only those activities which address transboundary problems requiring incremental funding are listed.

Anticipated outputs

Proven/validated regional environmental early warning system appropriate for the GCLME in a form which could be used to leverage future country and donor co-financing for permanent implementation. Assessment of utility/application of a PIRATA-type buoy array for the GCLME. Documented assessment of information needed to design monitoring/predictive systems. Assessment of decadal ecosystem changes in the GCLME since the 1950s based on historical/archival data and collections. An established regional environmental analysis/reporting system/network and activity centre (i.e. Productivity Centre; Regional HAB reporting). Useful predictions and models on carrying capacity of the GCLME. Assessment using the best available knowledge and expertise links between the GCLME and the global climate. Identification of cost-effective early-warning indicators of environmental changes that impact on fish stocks in the GCLME. Establishment of regional enviroment network and reporting system - making full use of remotely sensed products and the internet, in a form that it can be self-sustaining operationally.

Table 7.8: Reducing Uncertainty and Improving Predictability and Forecasting

Problem statement: Complex and highly variable system. *The GCLME is a complex and highly variable system for which there is evidence of system change and fragmentary but important evidence of increasing instability/variability. Scales of variability include;: A: large scale sustained events; B: decadal changes; and C: high frequency short-lived events and/or episodic events. Human impacts on the GCLME (e.g. by fishing) is superimposed on the inherent natural variability, and the combined effect of anthropogenic disturbance and this variability have been implicated in ecosystem change and the collapse of harvested resources.There is also considerable uncertainty regarding ecosystem status and yields. Lack of information about and understanding of environmental variability and system-wide impacts hampers sustainable management of GCLME resources and results in the non-optimal utilization of these resources.Coastal erosion is also contributing to the degradation of coastlines, and increased siltation/sedimentation of habitats.*

Causes	Impacts	Risks/Uncertainties	Socioeconomic consequencies	Transboundary consequencies	Activities/Solutions	Prio-rities	Incremental cost 5yr	Outputs
• Complexity of processes • Poor understanding of processes and cause and effect relationships • Poor understanding of global driving forces (linkages) • Lack of data/ information • Inadequate mathematical models	• ecosystems from altered wind field/rainfall • Changes in coastline morphology • Damage to coastal infrastructure • Unpredictable variations in zooplankton and fish egg/larval survival • Unpredictable changes in fish growth, mortality and recruitment	• net change or natural cycles? • Time periods sufficient long to detect changes?	• vulnerability (job losses and gains) • Variation in revenue • Over- and under-utilization of resources. • Treatened food security • Human population migration • High production costs	• Evaluate impacts of climate change on the GCLME • Ecosystem • Shifts in distribution of biota • Loss of species/ biodiversity • Altered food webs • Disruption of faunal migrations • Fisheries • Unsustainable management of shared and straddling stocks • Altered fish spawning patterns and population shifts	• Develop regional early warning system for env. change • Targeted feasibility assessment of PIRATA /GOOS-Africa linkup/application to GCLME • Targeted transboundary assessment of potential hypoxia/ impacts • Conduct plankton trawl surveys and Analyze plankton data archives for measurement of decadal change	1 1 1 1	$ 1 600 000 $ 400 000 $ 250 000 $ 1 000 000	• Regional early warning systems for major env. events/change. • Quantification of utility/ application of PIRATA for Guinea Current region • Information needed to design monitoring/ predictive systems

Table 7.8 (continued): Reducing Uncertainty and Improving Predictability and Forecasting

Causes	Impacts	Risks/Uncertainties	Socioeconomic consequencies	Transboundary consequencies	Activities/Solutions	Priorities	Incremental cost 5yr	Outputs
• Lack of capacity	• Change to coastal • Unpredictable changes in species' abundance, composition, distribution and availability • Regime shifts • Cross boundary movements of fish, seabirds and seal • Difficulties in managing resources sustainably • Operational difficulties with resource utilization • Assessment of anthropogenic impacts difficult	• Long-term	• Livelyhood • Unconcerted management resulting in regional conflicts • Reduced capacity to support artisanal fisheries • Changes in revenue, private income and exports leading to social unrest/instability.	• Unpredictable fluctuations and availability of fish stocks • Climate change • Unpredictable and variable distribution of fishery benefits • Regional economic instability and unemployment • Regional conflicts with other users • Coastal infrastructure • Costly maintenance of coastal infrastructure	• . Develop transboundary state of the enviroment analysis/reporting system • Develop links with CLIVAR • Adapt/develop predictive models • Establish regional advisory groups • Data gathering community projects • Transboundary env variability networking(incl. internet) • Establish links with the Benguela and Canary Current LMEs • Improved governance • To obtain archived data/information from historical expedition by Europeans	1 1 2 2 2 2 1 1 1	$ 100 000 $ 250 000 $ 50 000 $ 300 000 $ 50 000 $ 100 000 $ 400 000 $ 50 000 $ 10 000	• Record of decadal ecosystem changes • Regional environmental analysis/reporting system/ network • Knowledge and expertise on global climate links • Predictions and models • Regional advisory groups • Availability of important/ useful data • Regional env. variability network. • Links with Benguela and Canary Current LMEs

7.4.2 Lack of capacity, expertise and ability to monitor environmental variability

Causes

GCLME member countries are developing countries with requirement to meet the basic living needs of their peoples. These countries are attempting to develop their economies and social structures. Funding for marine monitoring and assessment activities are very limited and policy makers are not always fully aware of the importance of transboundary environmental variability/change in ocean management applications. Viewed collectively, the lack of capacity can be ascribed to the following:

1. Lower priority placed on environmental issues by policy makers
2. Limited inter country exchange of personnel for liaison, experience sharing and training
3. Degrading and downsizing of research institutions
4. Limited training/skill development programmes
5. Limited funds to meet day-to-day running expenses let alone to invest in hardware and capital items.
6. Limited skills to maintain equipment.
7. Limited availability of equipment and supplies -
8. Severely limited numbers of trained personnel and an unequal distribution of skills between countries.
9. Inadequate remuneration for regional researchers
10. Brain drain; loss of personnel to the private sector and overseas

Impacts

The consequences of insufficient funding of research in the GCLME include:

1. Regional imbalances in baseline information, predictive capacity, data collection ability etc.
2. Limited ability to participate in regional decision-making processes, as too few people are available to do the tasks at hand.
3. Inadequate information for identifying indicators of future change
4. Limited interaction between institutions.
5. Collection of information which is not comparable/cannot be integrated across the region

Risks/uncertainty

Although the governments of the region are committed to capacity building (skill/expertise development), this commitment is according to perceived national priorities. There is uncertainty with regard to the priority status of marine science, technology and management at the regional level. Political and economic uncertainty results in potential "recruits" choosing more lucrative careers - particularly those that favour mobility (emigration). Budget size for project implementation

Socioeconomic consequences

The underestimation by policy makers of the importance of developing and maintaining sufficient research capacity to manage the resources of the GCLME has resulted in numerous socioeconomic problems including:

1. Sub-optimal or over utilization of renewable resources
2. Sub-optimal opportunities for resource access/management
3. Absence of comprehensive stakeholder participation
4. Creation of conflicts
5. Poorly informed/advised governments at all levels
6. Low institutional sustainability

All of the above are in turn direct consequences of inadequate/inappropriate communication.

Transboundary consequences

Non cost-effective resource management, research and monitoring activities (fragmented, poorly planned and unlikely to achieve the objectives of ensuring sustainable management). Management of overall system by all 16 countries is not harmonized. Capacity gaps lead to uneven research monitoring efforts in the system as a whole with consequences for resource management e.g. possible bias in information and advice leading to inappropriate decision making. Difficulties to cooperate with respect of sustainable resource utilization. A holistic approach is needed to correct the damage done in the past from fragmentation. Inability to monitor or manage the ecosystem as a whole - The transboundary nature of the issues and problems in the GCLME necessitates a holistic approach

Activities/solutions

The first action must be a comprehensive assessment of the real needs for human capacity and infrastructural development/maintenance relevant to the identified transbouondary issues in which clear priorities are listed. This must be executed in co-operation with all stakeholders to ensure a proper balance and minimum vested interest bias. Poor economic opportunities and career prospects are limiting factors. If not addressed, recruitment and training initiatives will provide little or no long-term benefits. Develop partnerships with private sector. This will promote private sector "buy-in" and provide a point of departure for long-term co-financing with industry and business. Devise, develop and implement appropriate training courses appropriate for the needs of the region, maximizing the use of regional resources working groups. This will be a cost-effective suitable for implementation in developing countries). Creation of regional multidiscipinary working groups as a mechanism for consultation, cooperation and skill development. Interchange of personnel between countries to gain/ transfer expertise and knowledge. Improve networking via Internet. It is envisioned that increased use of electronic commnication is the key to the success of the GCLME programme at all levels. It will be particularly beneficial for training and system monitoring. Improve public information/environmental education. There is a relative lack of public awareness about the GCLME areas, human impacts on the ecosystem, problems to be addressed to ensure its sustainable utilization and conservation of the biodiversity, opportunities for job creation and wealth generation etc. All stakeholders need to be involved in co-management systems. Generate regional activity tools for effective capacity development

Priority

Proposed activities are ranked on a scale of 1-3 in terms of their perceived priority. Except for activity asterisked, only those activities that address transboundary problems requiring incremental funding are listed.

Anticipated outputs

1. Capacity development strategy for the region relevant to addressing transboundary concerns as per the Strategic Action Programme.
2. Increase economic and career opportunities within the region.
3. New institutional networks taking advantage of the internet and world wide web
4. Improved regional management of resources
5. Increased multilevel public awareness of the issues and problems and the need for sustainable integrated management of the GCLME. Increased stakeholder involvement and co-management
6. Improved infrastructure and improved availability of persons with the necessary skills.

Table 7.9: Capacity strengthening and training

Problem statement: Inadequate training and regional disparity. *Storage in capacity and equipment. Inadequate training for environmental management predictionand Disparity in regional capacity*

Causes	Impacts	Risks/Uncertainties	Socioeconomic consequencies	Transboundary consequencies	Activities/Solutions	Priorities	Incremental cost 5yr	Outputs
• Limited inter country exchange (training) • Degrading and downsizing of research institutions • Limited training programs • Lack of running funds • Lack of skills to maintain equipment. • Lack of equipment and supplies • Limited availability of infrastructure, equipment and supplies • Lack of economic opportunities • Lack of concern from the policy makers on the ecosystem issues. • Brain drain	• Limited regional collaboration in training • Inadequate budgetary allocation • Inadequate technical skill for equipment maintenance • Insufficient provision, accessories spares • Insufficient attention to training and man power development • Emigration of technocrats due to poor economic conditions	• Commitment to supporting capacity development by governments of the GCLME region • Political and economic uncertainty • Budget size for project implementation	• Suboptimal or over utilization of ressources, inadequate information, knowledge, understanding required for ressorce management • Unequal opportunity for ressource access / Management • Limited stakeholder participation • Creation of conflict • Insuficient basis for decision making at all levels of government • Low institutional sustainability	• Uncoordinated ressource mangement, research and monitoring programmezs • Non harmonization of mangement of overall system • Disparity in capacity leading to gaps in research and monitoring effort • Inability to holistically monitor and manage the system	• Assess capacity needs to address national and Transboundary issues • Device strategies for creating job opportunities and improving infrastructure and remuneration • Creation of regional multi disciplinary tasks teams • Establish regional collaboration for training, transfer technology and expertise • Improve networking via the internet and other suitable technologies • Improve public education and awareness • Increase stakeholders participation and co-management • Generate Regional Activity Tools	1 N/A to GEF 1 1 1 1 2 1	$25 000 $100 000 $250 000 $250 000 $100 000 $150 000	• Capacity development strategy for region • Strategy for job creation (and salaries) • Improved regional management of resources and establishment and support of institutional networks • Shared expertise

7.4.3 Eutrophication and Harmful Algal Blooms (Habs)

Causes

Natural processes - Algal blooms occur naturally in the GCLME. Some may be harmful. Human impact can cause HABs to spread, and introduce exotic HAB species into the GCLME.
Introduction of cysts into surface waters - Human activities such as drilling, dredging and certain types of fishing disturb the sediments and can release cysts of HAB species into the water column, thereby triggering new blooms, and expanding the area impacted by HABs. Nutrient loading of coastal waters from anthropogenic activities - Increased nutrient loading of coastal waters from sewage discharges, agriculture and industries which increase the probability of occurrence of HAB outbreaks. HABs may occur as the result of changes in the state of the Guinea Current ecosystem. (System-wide monitoring for HABs would be required to discern any definite trend.) There is little or no control over the discharge of ballast water from ships entering national waters in the sixteen countries, and there is a suspicion that these discharges may lead to spread of HABs in the GCLME.

Impacts

1. HABs affect a wide spectrum of activities in the marine environment. The impacts include:
2. Poisoning and mortality of human consumers of marine organisms can occur from HABs.
3. Mortality (mass) of marine organisms. The species at highest risk are the filter feeders (e.g. oysters) and organisms that consume these filter feeders. Mortality can be caused directly by toxins and clogging of gills, and indirectly by depletion of oxygen in the water column.
4. Disruption of mariculture activities - Mariculture is dependent on good water quality. HABs result in disruption or closure of mariculture facilities necessitating expensive water treatment, isolation of facilities, etc. Depending on the nature of the mariculture venture and the HAB, the closure/disruption can be short-lived or permanent.
5. Interference with recreational use of the sea - Apart from being toxic and unsightly, some HABs cause respiratory problems in swimmers and those living in close proximity to the sea.
6. Anoxia which in turn may cause e mortalities of marine organisms

Uncertainties

1. Unknown incidence of HABs as a consequence of insufficient monitoring.
2. Role of algal blooms in the system as a whole
3. Contribution of anthropogenic nutrient loading to incidence of HABs

Socioeconomic consequences of potential HABs occurrences

1. Human mortality. Deaths have occurred and numerous people have suffered respiratory difficulties and gastro-intestinal problems as a consequence.
2. Loss of tourism revenue (see impacts)
3. Increased cost of shellfish production (monitoring, testing, depuration)
4. Loss of fish/shellfish/mariculture markets and jobs. Mariculture is a potentially valuable growth industry in the GCLME. It is constrained by a general lack of information and knowledge, including lack of information about the potential of the HAB problem in the GCLME.

Transboundary consequences

Incidence and effects of HABs are common threats to all countries. HAB outbreaks can be extensive and straddle national boundaries. In addition advective processes together with shipping operations, and bottom trawling, and dredging can redistribute cysts across national boundaries.

Activities/solutions

1. Develop and implement Best Environment Practices/Best Available Techniques for agriculture to reduce discharge of nutrients
2. Develop an HAB reporting system for GCLME region as a whole. This is seen as a high priority within the GCLME. It is also essential for the development of a sustainable mariculture industry.
3. Community awareness projects linked to national ministries of health to alert the public to dangers associated withpotential HABs as needed.
4. Develop national/regional HAB contingency plans which include early warning systems and guidelines for medical practitioners to deal with HAB associated problems
5. Improve national capacity to analyze for toxins and identify harmful species by sharing expertise between countries
6. Mitigation of impacts of HABs on mariculture operations (e.g. relocation of mussels rafts, treat blooms with

"herbicides")

Priority

Proposed activities are ranked on a scale of 1-3 in terms of their perceived priority. Except for activities asterisked, only those activities which address transboundary problems requiring incremental funding are listed.

Anticipated outputs

1. BEP/BAT for agricultural practices
2. Established HAB regional reporting network, with transboundary early warning system(to alert neighbouring state when required)
3. Regional contingency plan for dealing with effects of HABs implemented in all countries as needed
4. Public education materials prepared and distributed regionally as needed
5. Substantial contribution to the sustainable and responsible development of mariculture within the GCLME
6. Proactive integrated management in general

Table 7.10: Management of Eutrophication and Consequences of Harmful Algal Blooms

Problem statement. Complex and highly variable system. *The GCLME is a complex and highly variable system for which there is evidence of system change and fragmentary but important evidence of increasing instability/variability. Scales of variability include; A: large scale sustained events; B: decadal changes; and C: high frequency short-lived events and/or episodic events. Human impact on the GCLME (e.g. by fishing) is superimposed on the inherent natural variability, and the combined effect of anthropogenic disturbance and this variability have been implicated in ecosystem change and the collapse of harvested resources. There is also considerable uncertainty regarding ecosystem status and yields. Lack of information about and understanding of environmental variability and system-wide impacts hampers sustainable management of GCLME resources and results in the non-optimal utilization of these resources. Coastal erosion is also contributing to the degradation of coastlines, and increased*

Causes	Impacts	Risks/Uncertainties	Socioeconomic consequencies	Transboundary consequencies	Activities/Solutions	Priorities	Incremental cost 5yr	Outputs
• Natural processes • Introduction of cysts in surface waters • Nutrient loading of coastal waters from anthropogenic activities • Changing state of the Guinea ecosystem • Introduction of exotic species • Inadequate waste treatment facilities • Inadequate regulatory frame work and poor enforcement	• Poisoning and mortality of human consumers of marine organisms • Mortality (mass) of marine organisms • Disruption of mariculture activities • Interference with recreational use of the sea • Anoxia which in turn may cause mortalities of marine organisms	• Increase or decrease in incidence and intensity of HABs • Role of HABs in the system as a whole • Contribution of anthropogenic nutrient loading to incidence of HABs	• Human mortality • Loss of tourism revenue • Increased cost of shellfish production (monitoring, testing, depuration) • Loss of fish/ shellfish/mari culture markets and jobs • Poverty aggravation • Loss of employment	• Occurrence of harmful algal blooms in the GCLME • Migrations of species across national boundaries • Reduction in gross fish stock in the region • Spread of exotic species across the coastal reaches of the GCLME region • Reduction in tourism potential of the region	• Develop and implement Best Environmental Practices/Best Available Techniques for agriculture for reduction of nutrient loadings • Develop an Eutrophication and HAB assessment and reporting system for GCLME region as a whole • Regional HAB contingency plans • Community projects linked to ministries of agriculture and health • Mitigation of impacts of HABs • Improve national capacity to monitor eutrophication and toxins/species • Expand and strengthen the regional Nutrient Activity Working Group (NAWG) • Regular monitoring to identify early warning signals e.g. - Fish death from choking with diatoms - Clogging of fishing net by blue green algae	1 1 2 1 2 2 1 2	$50,000 $350 000 $100 000 $50 000 $50 000 (National)	• BEP/BAT for agriculture • HAB regional network • Regional contingency plan • Public education mate-rials • Proac-tive management

7.5 Framework for the action area assessment of environmental variability, ecosystem impacts and improvement of predictability

7.5.1 Deterioration in Water Quality

Causes

1. Activities are mainly focused around urban centers, increasing urbanization and associated knock-on effects. Worst effected areas are are the coastal cities where majority of the population reside and the industries are sited
2. Various sectors contributing to pollution, with varied degrees of cross sector co-operative management
3. Knock-on effect of introduced mariculture species and associated water quality pollution effects in protected embayments
4. Variable consistency in application of policy, both nationally and regionally
5. Informal and formal settlements vary in their control of pollution discharges. Pollution is increasing due to urbanization.
6. Shipping activities and hydrocarbon exploration and production are major sources of chronic oil pollution.
7. Growth in coastal informal settlements
8. Absence of, or inefficient regulatory framework

Impact

1. A variety of factors are responsible for deterioration of human health and ecosystem health/resilience (GCLME Thematic Report on Pollution).
2. Species invasion (poorly planned mariculture enterprises), changes in species dominance, reduced yields from ecosystem.
3. Loss of jobs at regional level, reduction of regional tourism potential

Risks/uncertainty

1. Limited data available from which to evaluate existing water quality, so it is difficult to establish a regional baseline.
2. Validity of existing standards and thresholds within the regional context is uncertain.
3. Tracing of impacts back to initial causes is difficult and causation is often unknown.
4. Reduction of pollution in worst affected areas may not be practicable on short/medium term.

Socioeconomic consequences

1. Input of nutrients and associated pollution may cause a short-term increase in production, combined with longer-term stock failure.
2. These consequences are interrelated: pollution decreases tourism, which reduces jobs, which increases poverty, which in turn increases pollution.
3. Poverty aggravation

Transboundary consequences

1. Deterioration of water quality may cause species migration (temporary/permanent). Pollutants from industries/activities near to country borders can be transported across boundaries by prevailing currents.
2. Impacts are (variably) common to each of the participating countries - a "generic" project with flexibility to meet nations' needs should be established. Establishment of common policy is necessary to minimise transboundary impacts.
3. Most water quality issues are common to at least two of the countries and require common strategy and collective action to address.

Activities/solutions

An overall regional working group should be established to effectively co-ordinate integrated solutions to:

1. Environmental quality indicators;
2. Marine pollution control and surveillance;
3. Regional monitoring/inspection of coastal zone;
4. Regional enforcement of standards;
5. Prevention of "polluters" escaping controls by locating in adjacent countries;
6. Design/development of regional protocols and conventions on pollution;
7. Develop model legislation for water pollution to help individual states implementation of conventions and protocols;

Priority

Proposed activities are ranked on a scale of 1-3 in terms of their perceived priority. Except where asterisked, only those

activities which address transboundary problems requiring incremental funding are listed.

Anticipated outputs

Integrated local, national, or regional system implementation with decrease in pollution and associated long-term savings in clean-up and education costs. It is anticipated that the benefits which will be demonstrated by the proposed actions will be such that leverage of national or donor funding for continued implementation following the conclusion of the GCLME will be possible in view of the benefits which will acrue from a modest investment. Model reugulations for GCLME Countries

7.5.2 Explanatory Notes. Problem: Major Oil Spills

Causes

1. Variability of seaworthiness of vessels operational from the region, as well as transport through the region.
2. Equipment failure
3. Deployment of sub-standard ships/tankers in the region
4. Oil pipeline vandalization and sabotage
5. Non-compliances with maritime conventions and protocols

Impacts

General coastal degradation (temporary habitat loss), with varied recovery rate, depending on species vulnerability and spill intensity. (Associated monitoring of fauna/flora recovery is essential.)

Risks/Uncertainty

1. Recovery period in system is sensitivity-dependent;
2. Regional and national peace and political stability are most conducive to programme success;
3. General environmental deterioration leads to aesthetic deterioration and then tourism loss;

Socioeconomic impacts

1. Revenue loss is a function of spill intensity and environmental sensitivity, and duration of spill.
2. Loss of revenue/income
3. Loss of employment

Transboundary consequences

1. Regional co-operation needed in use of equipment/manpower.
2. Riparian/estuarine boundaries are particularly vulnerable.
3. Co-operative management of spills moving across borders. (Management/clean-up of a major spill near country boundary can only be effective if comensurate actions are taken by the neighbouring state)

Activities/solutions

Regional co-operation paramount in standards development: policy, equipment, and techniques.
Dmonstration projects on pollution reduction and control and ICAM

Priority

Proposed activities are ranked on a scale of 1-3 in terms of their perceived priority. Only those activities that address transboundary problems requiring incremental funding are listed.

Anticipated outputs

Regional policy and optimal utilization of resources.

7.5.3 Marine Litter

Causes

1. Rapid urbanization and unplanned settlement, with variable and limited/no control by authorities.
2. Existing formal infrastructure unable to cope with expanding informal developments.
3. Public apathy/indifference.
4. "Lost" fishing equipment and associated "wastes."
5. Non-returnable/disposabale nature of containers of packaging used in the region. (Absence of regulations and incentives for return of containers and use of biodegradable materials)

Impacts

1. Aesthetic and multiple impacts are associated with economic loss, although there may be job creation in the informal sector (waste management).
2. Plastics and ropes (including fishing lines) present a significant amd growing hazard to marine mammals and seabirds (entanglement, ingestion)

Risks/uncertainty

1. Volume of hazardous substances dumping is unknown.
2. Need to identify areas of waste accumulation through natural processes.
3. Positive impacts (job creation in informal sector) are balanced by lack of incentives not to litter.
4. Potential degree of transboundary movement.
5. Issues common to all countries - create a "blueprint" and apply flexibly to all countries.

Activities/solutions

1. Public awareness is key to successful implementation and a sustained clean environment- primary focus is seafarers
2. Common policy/practice and implementation - i.e. "return" products' packaging (bottles, plastic sachets, etc) incentives.

Priority

Proposed activities are ranked on a scale of 1-3 in terms of their perceived priority. Only those activities which address transboundary problems requiring incremental funding are listed.

Anticipated outputs

1. Clean coastal zone
2. Educated and enlightened public
3. Improved legislation and standards implemented from coordinated local/national/ regional levels
4. Reduction of negative impacts on marine mammals and seabirds (particularly relevant to threatened/endangered species)

Table 7.11: Improvement of Water Quality; Reduction of Land-Based Sources of Pollution; Prevention and Management of Oil Spills; Reduction of Marine Litter

Problem statement 1: Deterioration in coastal waters quality. *Deterioration in coastal water quality: Coastal developments and rapid expansion of coastal cities, much of which was unforeseen or unplanned, has created pollution "hotspots". Aging water treatment infrastructure and inadequate policy/monitoring/ enforcement aggravates the problem. Indiscriminate siting of factories/industries*

Causes	Impacts	Risks/Uncertainties	Socioeconomic consequencies	Transboundary consequencies	Activities/Solutions	Priorities	Incremental cost 5yr	Outputs
• Unplanned coastal development • Chronic oil pollution • Industrial pollution • Sewage pollution • Air pollution • Mariculture • Lack of policy on waste & oil recycling • Growth in coastal informal settlements • Absence of, or inefficient regulatory institution • Coastal agricultural activities	• Public health deteriora-tion • Reduced yields • Unsafe edible organisms • Changes in species dominance • Ecosystem health, productivity and resilience • Loss of jobs at regional level	• Few or no baseline data • Performance standards and thresholds • National commitment to capacity-building • Cause-effect relationships	• Loss of tourism • Higher health costs • Altered yields • Reduced resource quality • Aesthetic impacts • Lowered quality of life • Loss of employment • Poverty aggravation	• Transboundary pollutant transport • Migration of marine organisms, e.g. seals • Negative impacts on straddling stocks • "Hotspots" common solutions	• Develop standard environmental quality indicators/ criteria • Establish regional working groups • Training in marine pollution control • Plan/adapt regional pollution monitoring framework • Establish effective enforcement agencies * • Demo projects on pollution control and prevention • Demo projects on ICAM • Joint surveillance • Design/development of regional protocols and conventions on pollution • Develop model legislation for water pollution to help individual states implementation of conventions and protocols	1 1 2 1 1 1 1 2 2 2	$100 000 $50 000 $100 000 $50 000 (National) $1 500 000 $2 000 000	• Shared solutions for water quality management • Regional protocols and agreements • Improved pollution control • Socioeconomic uplift

Table 7.11(continued):. Improvement of Water Quality; Reduction of Land-Based Sources of Pollution; Prevention and Management of Oil Spills; Reduction of Marine Litter

Problem statement 2: Oil spills pollution. . *Major oil spills: A substantial volume of oil is mined and transported through the GCLME region (from oil terminals in producing countries) and within it, and there is a significant risk of contamination of large areas of fragile coastal environments from major accidents, damage to straddling stocks and coastal infrastructure*

Causes	Impacts	Risks/Uncertainties	Socioeconomic consequencies	Transboundary consequencies	Activities/Solutions	Priorities	Incremental cost 5yr	Outputs
• Sea worthiness of vessels/ equipment • Military conflict • Sabotage • Human error • Equipment failure • Deployment of sub-standard ships/tankers in the region • Oil pipeline vandalization and sabotage • Non-compliances with maritime conventions and protocols	• Coastline degradation • Mortality of coastal fauna and flora	• Recovery period • Cost recovery mechanisms Return to peace in Angola	• Opportunity costs (e.g. tourism, fisheries, salt production) • Altered yields • Reduced resource quality • Aesthetic impacts • Loss of revenue /income • Loss of employment	• Resource sharing for containment, surveillance, rehabilitation, etc. • Ramsar site protection (border wetlands)	• Regional contingency plan development • Research/ modeling of recovery periods • Public awareness of notification procedures • Port state control • Litter recycling (Ghana demo project)	1 3 3 2	$500 000	• Regional contingency plan., shared resources, rehabilitation plans, regional protocols and agreements • Cleaner beaches
Problem statement 2: Increasing marine litter. . *Marine litter: There is a serious growing problem throughout the GCLME. Used plastics Waste dumped by ships and fishing trawlers Illegal dumping of toxic waste and containers*								
• Growth of coastal settlements • Poor waste management • Little public awareness and few incentives • Illegal disposal from vessels • Poverty of coastal communities • Ghost fishing • Fishing discards	• Faunal mortality • Negative aesthetic impacts • Damage to fishing equipment	• Accumulation zones • Illegal hazardous waste disposal	• Loss of fishing income • Public health • Cleanup costs • Loss of tourism • Job creation in informal sector	• Transboundary pollutant transport • Transboundary transport	• Harmonization of packaging legislation • Public awareness • Port reception facilities • Regulatory enforcement • Standardized policies Seafarer education	1 3 1 1 2 2 1	1 000 000 $50 000 $100 000 $50 000	• Education material/ documents available regionally • Standardized policies and legislation on packaging/ recycling incentives

7.5.4 Ecosystem Health Declining

Causes

1. Coastal progradation - sand mining activities, subsequent longshore redistribution of sands - sedimentation and other natural processes.
2. Coastal destabilization due to anthropocentric activities.
3. Natural sediment movement (natural rehabilitation of mined areas ~ masking actual impacts, which may possibly occur later and be more severe.
4. Various fishing activities

Impacts

1. Oil exploration-generated drilling and plumes ~ potential re mobilization of heavy metals (food chain impacts) from dredging and water quality deterioration.
2. Mariculture can cause local organic loading and anoxic conditions.
3. Habitat modifications impact on HABs.

Risks/uncertainty

1. Incomplete/lack of data ~ severely limiting ~ but increasingly available due to mining companies' existing programmes.
2. Should standardize framework for evaluation of impacts.
3. Impacts from multiple vessels in close proximity unknown ~ capacity to determine;
4. Necessary to distinguish anthropogenic impacts from natural variability.
5. Altered sediment structure and particle size composition with consequence for benthos and remobilization of certian minerals(metals).

Socioeconomic consequences

1. Unknown costs of rehabilitation and subsequent evaluation of rehabilitation success.
2. Human health affected through knock on effect in food chains.
3. Loss of revenue from renewable resources.

Transboundary consequences

1. Marine fauna migrating due to habitat loss.
2. Sediment remobilization.

Activities/solutions

1. The present status requires proper documentation, and establishment of baseline at regional level.
2. Establish/identify regional parameters for approach to early warning systems and associated quality performance standards.
3. Develop mechanisms of co-operation between industries, ministries and other stakeholders, and strengthen capacity
4. Needs-assessment to improve coastal management expertise.

Priority

Proposed activities are ranked on a scale of 1-3 in terms of their perceived priority. Only those activities which address transboundary problems requiring incremental funding are listed.

Table 7.12: Retardation/reversal of habitats destruction/alteration

Problem statement: Habitat alteration/ destruction. *Several habitats have been altered or lost as a consequence of development and other human impacts. Impacts can be categorized into three areas, viz.:1. Coastal – progradation/ redistribution; 2. Nearshore (< 30m) and 3. Shelf/slope (200 m) mortalities of marine organisms.*

Causes	Impacts	Risks/Uncertainties	Socioeconomic consequencies	Transboundary consequencies	Activities/Solutions	Prio-rities	Incremental cost 5yr	Outputs
• Physical alteration arising from demersal trawling • Variable river sediment input • changing land use • Oil/gas exploration/ production and spills • Mariculture • Natural sediment transport (altered erosion) • Built coastal structures • Human settlement and resource use • Mangroves/coastal deforestation	• Increased turbidity (sediment plumes, etc) • Benthic community destruction • Mobilization of heavy metals • Faunal impacts e.g. reproductive failure • Potential Increased frequency of HABs • Coastal erosion • Organic loading/anoxic conditions • Biodiversity degradation • Shore line change	• Land use conflict • Climate change • Flooding of coastal area • Conflict coming from the use of resource • • Complete lack of data • Framework of impact monitoring • Cumulative local vessels impacts • Impacts from natural spatial and temporal variation	• Costly infrastructure, rehabilitation & maintenance • Loss in mariculture production • Decreasing human health via heavy metal contamination • Loss of fisheries productivity/ revenue, • Opportunity costs • Loss of cultural area / heritage / amenities	• Sediment transport • Common problems, e.g. erosion • Redistribution of marine fauna as a consequences of habitat alteration	• Comprehensive status report • Assess the cause of habitat destruction (third bullet) • Determination and prioritize of the vulnerable zones • Monitor coastal process and dynamic • Replicate preferred solution • Adapt and agree on regional structure to address problem • Apply control measure to limit the failure of coastal defense structure • National project demonstration • Determination of sediment budget	1 1 1 2 1 1 2 1	$ 50 000 $150 000 $100 000 $50 000 $100 000 $50 000	• Comprehensive status report • Regional early warning system and action plan • Transboundary causality established • Regional structures and agreements • Improved coastal planning (Integrated Coastal Areas Management)

7.5.5 Loss of biotic integrity

Causes

Introduction of alien invasive species. Overfishing due to the use of non-selective fishing gears or gears which are not environment friendly (fishing with dynamite and chemicals). There are other identified causes of loss of biodiversity integrity namely various pollution, habitat alteration (including mangrove destruction), and lack of implementation of international conventions (e.g. Convention on Biological Diversity and marine treaties). Lack of holistic approach to fisheries management i.e. single species management.

Impacts

Introduction of pathogens and other commensal species: Alien species (intentionally or inadvertently imported) may arrive with unseen viruses, ectoparasites, and other commensals. There can be also cases of genetic erosion refering to the loss of genetic integrity as a result of hybrid population with as consequences reduction of the population resilience and fitness (ability to cope with future environmental change).

Risks/uncertainty

Invasive ability: the ability of introduced species to survive, reproduce and replace indigenous species. Beneficial or harmful? The "beneficial" assessment is perceived as a socioeconomic one (e.g. shrimps are more easily marketed in select sizes from mariculture than in wild harvest), but the "harmful" assessment is primarily an ecological one. (On the longer term, what may at present be perceived as beneficial may not be sustainable)? This has serious implications for sustainable integrated management of the ecosystem.

Socioeconomic consequences

Alien species:

Potential public health impacts primarily from pathogens and alien species imported with ballast water. Opportunity costs: for example, alien infestations can cause a loss of diving tourism revenue.

Fishing impacts:

Political pressure to over-harvest: In a population recovery period, low quotas often cannot be implemented due to political pressure (leading to a very much longer recovery period). Loss of income: Prolonged recovery periods strain the industry through loss of revenue. Uncertainty of livelihoods: Government policy incentives are needed to encourage alternative job creation to sustain fishers during low yield periods, or a temporary industry shutdown. Modification of food source of consumers: in much of West Africa large segments of the populations depends on fish for their main protein source particularly dried small pelagics. A shift to other marine fish would be difficult due to lack of refrigeration or the processing capabilities. Migration of fishers -- when over-harvesting causes depletion of fish stocks, fishers may be forced to move.

Transboundary Consequences

Cognisance is taken of the existing GEF international ballast water management project, which may include some countries in the GCLME region in its suceeding phases.

The oil producing countries in the GCLME are very concerned about uncontrolled dumping / flushing from ships generally (including bilge waters - not just marine litter and ballast water).

Activities and solutions

Regional (GCLME region) policy on aquaculture / mariculture should be developed and then harmonized with those of neighbouring countries, including Canary and Benguela LME regions. Regional and national management plan for biodiversity conservation must include a framework for assessment and prediction of environmental change impacts. Identification of marine protected areas aimed at the conservation and/or protection of biodiversity. Identify genetic structure of populations as an essential component of a regional biodiversity conservation programme. Harmonisation of national policies to serve as baseline of the regional policy for biodiversity conservation. Establish/identify regional parameters for approach to early warning systems and associated quality performance standards. Develop mechanisms of co-operation and capacity building for biodiversity conservation between industries, ministries and other stakeholders.

Priority

Proposed activities are ranked on a scale of 1-3 in terms of their perceived priority. Only activities that address transboundary problems requiring incremental funding are listed.

Anticipated outputs

Regional quality indicators: Adapt and apply existing environmental quality indicators to the GCLME for specified variables. Harmonised regional policy and emergence of regional protocols. The establishment of a forum for stakeholder participation in negotiating a biodiversity code of conduct is seen as an important outcome.

Table 7.13: Conservation of Biodiversity

Problem statement: Loss of biotic integrity: *This refers to ecosystem impacts including changes in community composition, species diversity, and introduction of alien species – a set of measures of ecosystem health*

Causes	Impacts	Risks/Uncertainties	Socioeconomic consequencies	Transboundary consequencies	Activities/Solutions	Prio-rities	Incremental cost 5yr	Outputs
• Introduction of alien species • Selective fishing mortality (targeted fishing) • Incident mortality bycatch/ discharges • Pollution impact • Over-harvesting • Habitat alteration (e.g. destruction of mangrove areas), beach erosion • Lack of implementation of international laws	• Local extinction especially of benthic species • Introduction of pathogens • Genetic impoverishment (loss of resilience)	• Source of alien commensals? • Invasive ability? • Beneficial or harmful? • Loss of species	• Loss in community income from fishing and mariculture • Potential public health impacts • Opportunity costs, e.g. tourism • Political pressure to over-harvest • Lost income – prolonged recovery time • Uncertainty of sustainable livelihoods • Modification of food source of consumers	• Transfer of alien species via shipping/ mariculture • Natural processes • Fisher migration • Shared stocks •	• Harmonize regional policies • Link with GEF ballast water project • Regional fishing policies co-management • Identification of MPAs (incl. Transboundary areas)- Benin demo proposal • Identify genetic populations structures • Develop forum for stakeholder participation and negotiation of biodiversity code of conduct	1 2 1 1 2 1	$50 000 $30 000 $1500 000 $20 000 $50 000	• Harmonized regional policy • Co-Financing • Regional protocols • Establishment of negotiated marine protected areas • Biodiversity conservation baseline • Reduction/ control of alien introductions, policy decisions, forum established

Table 7.14: Appropriate Data and Information Management

Problem statement: Inadequate/ inappropriate data on living resource and ecosystem: *This is the result over-exploitation of harvested species and under-utilization of non-harvested resource. Information management is hampered by poor data generation and limited infrastructure in GCLME countries Non-availability of uniform regional format for data generation*

Causes	Impacts	Risks/Uncertainties	Socioeconomic consequencies	Transboundary consequencies	Activities/Solutions	Prio-rities	Incremental cost 5yr	Outputs
• Poor data collection, processing, storage and networking • Poor information for data support • Poor data and information exchanging / networking • Lack of harmonization in data collection and dissemination • Lack of data Bank	• Lack of systematic and time series data for adequate information • Poor data and information exchange • Lack of regional integration and harmonization data • Poor decision making based on inadequate data	• Poor support for decision making and political and economic issues • Poor natural and regional planning • Poor expectation based on poor data input	• Poor planning based on poor data • Inappropriate information to all stakeholders • Unfulfilled economic and development goals	• Difficult inter country data standardisation and calibration • Lack of inter country data comparability • Poor ata and information dissemination across the countries • Availability of data with poor regional comparability	• Establish a regional cooperation for data harmonization • Set up centres of excellence for training exchange / networking and support • Liaise and collaborate with appropriate agencies and partners in data and information management • Set up and develop a regional data and information management Centre	1 2 1 1	$250 000 $380 000 $100 000 $900 000	• Harmonized Data • Centre of Excellence • Effective Information Exchange • Regional Data Management Cenntre

Table 7.15: Governance and Institutional Framework

Problem statement: *Inadequate/Inappropriate Governance Regime to address ecosystem integrity and sustainable exploitation of living resources*

Causes	Impacts	Risks/ Uncertainties	Socioeconomic consequencies	Transboundary consequencies	Activities/Solutions	Prio-rities	Incremental cost 5yr	Outputs
• Decision making process regarding the ecosystem and its resources is ineffective because of top-bottom approach • Poor linkages across sovereign, political and language boundaries • Lack of coordination of environmental Policy • Poor environmental awareness and rights • Inadequate region wide institutional framework • Inadequate region wide legal and regulatory framework • Poor co-ordination of environmental activities at the national and regional levels	• Alienation of stakeholders in environmental arrangement • Non-harmoniznation and standardisation of environmental arrangement • Inability to enforce region wide environmental arrangement laws/practice	• Political and economic uncertainty • Political will	• Absence of full stakeholders' participation • inadequately informed government at all levels	• Inadequate regional cooperation • Inadequate harmonization of legal policy and economic framework • Inadequate awareness.	• ICAM • Centre for policy and strategic studies / Centres of Excellence designation • Environmental awareness • Facilitation of effective enforcement • Development of regional environmental laws / regulations • Regional arbitrage centre (environmental) • Development of regional environmental framework for adoption by member states to guide them in the formulation of enforceable national regulations	1 2 1 2 2 3 1	$250 000 $150 000 $350 000 $100 000 $175000 $300 000 $400 000	• Improved Regional Co-orperation • Harmonized Environmental Laws and Standards • Strengthened Enforcement Regimes • Effective Environmental Awareness and outreach Programmes

7.6 Generic action areas

What is not immediately apparent from the above tables is that there are a number of generic actions that cut across the specific actions within each of the three broad action areas, and indeed even between the broad action areas. For the sake of completeness the essence of this alternative but complementary approach is as follows.

7.6.1 Action area on sustainable management and utilization of resources

Generic Actions:

1. Capacity strengthening and training
2. Joint surveys and assessments of shared resources and intercalibration.
3. Policy harmonization and integrated management
4. Co-financing with private sector/industry
5. Development of alternative means of livelihoods or new industries (e.g. mariculture, tourism)
6. Facilitation of a functional governance / institutional arrangements and networking
7. Develop existing data and information network and management system through capacity building, improved infrastructure and institutional management.
8. Strengthening of governance

7.6.2 Action area on assessment of environmental variability, ecosystem impacts and improvement of predictability

Generic Actions:

1. Capacity strengthening and training for management of transboundary concerns
2. Regional networking and international linking
3. Development of regional early warning system, assessment and prediction capability (including re-assessments) and joint response policies
4. Cross-cutting demonstration projects
5. Facilitation of functional institutional arrangements
6. Promote cooperation and improvement of transboundary connections based on data and information management expertise available in the centres of excellence
7. Strengthening of governance

7.6.3 Action area on improvement of ecosystem health and management of pollution

Generic Actions:

1. Capacity strengthening and training
2. Policy harmonization, and development
3. Development of regional framework for assessment
4. Establishment of effective surveillance and enforcement agencies
5. Development of stakeholder participation structures
6. Facilitation of a functional governance / institutional arrangements and networking
7. Strenghtening of governance

What emerges quite clearly from the above approach is that generic actions, such as capacity strengthening and training, the development of regional collaboration or networking in respect of surveys and assessments, and policy development and harmonization, are over-arching actions. These are obvious priorities for GEF support.

Table 7.16: Proposed areas for actions to address environmental problems in the GCLME Region

A.	**Sustainable management and utilization of resources and habitat restoration**	• Facilitation of optimal harvesting of living resources • Protection of critical habitats and vulnerable species biodiversity • Restoration of degraded critical habitats • Responsible development of mariculture • Assessment of non-harvested species and role
B.	**Assessment of environmental variability, ecosystem impacts and improvement of predictability**	• Reducing uncertainty and improving predictability and environmental forecasting • Capacity strengthening and training • Management of eutrophication and consequence of potential harmful algal blooms • Control of coastline erosion
C.	**Maintenance of ecosystem health and management of pollution**	• Improvement of water quality • Assessment and management of land-based sources of pollution • Monitoring the levels and effects of pollutants for compliance enforcement • Identification of hotspots and critical areas and examination of mitigating / alleviation factors • Harmonisation of regulations and regional cooperation • Prevention and management of oil spills • Reduction of marine litter • Retardation/reversal of habitat destruction/alteration • Conservation of biodiversity • Improve integrated coastal area management in urban, rural and industrial areas • Strengthening Public Private Partnerships • Strengthen National & Regional capacity for assessment and evaluation

8. Ecological Quality Objectives

8.1 Introduction

The synthesized Regional Report and the Draft Preliminary Transboundary Diagnostic Analysis identified the major perceived problems of the GCLME as decline in GCLME fish stocks; uncertainty in ecosystem status, integrity, and yields; deterioration in water quality; and habitat destruction and alteration. For a number of these issues and problems, quantitative indicators of loss or degradation are not available. In some cases, the data and information are not uniform throughout the region. Further in-depth studies or retrieval of data and information may be required in order to establish definitive Ecological Quality Objectives (EQOs) for protection and management of natural resources and the environment. However, preliminary EQOs and targets have been established/proposed for the key issues identified for priority action in the immediate future.

8.2 Environmental Quality Objectives, targets and priority actions

As an approach to categorize and prioritize interventions for each major perceived problem and issue, the MPPIs were recast into overall Environmental Quality Objectives. The environmental impacts, socio-economic impacts, and root causes of the various MPPIs overlap to a great extent as might be expected as is indicated in the Synthesis Matrix. Recognizing these overlaps and the priorities derived from the TDA process, the EQOs were limited to three overarching objectives.

8.2.1 Achieve sustainable fisheries

Targets

1. Fisheries structure restored to natural condition of the 1950s by 2020
2. Recovery of two important commercial/artisanal fisheries by 2015

Priority actions

1. Complete effective regional stock assessment 2008
2. Put in place quota system by 2008
3. Implement effective monitoring and enforcement by 2010
4. Enhance food security by using alternative sources such as aquaculture/mariculture
5. Develop and agree on fisheries management plans for three important fisheries
6. Conserve/protect critical habitats

8.2.2 High quality water to sustain balanced ecosystem

Targets

1. Reduce inputs of priority pollutants to the sea by 10% by 2015
2. Improve water quality in 32 priority coastal areas by 2010

Priority actions

1. Develop effective regional monitoring, database and reporting capacity for water quality
2. Agree on regional environmental quality standards
3. Implement legal/regulatory changes to support water quality objectives
4. Provide investments in sewage treatment and industrial process controls to reduce inputs of heavy metals, POPs, excessive nutrients and other priority pollutants

8.2.3 Balanced habitats for sustainable ecology and environment

Targets

1. Halt net loss of mangroves by 2015
2. Reduce eutrophied coastal waters by 50% by 2015
3. Restore beach sediment supply to slow coastal erosion at ten sites by 2010

Priority actions

1. Inventory, monitor and replant mangroves

2. Implement legal/regulatory reforms to protect critical habitat such as mangroves
3. Develop regional agreement on sediment sharing and its restoration
4. Develop research and monitoring capability for assessing eutrophication and its causes
5. Develop concrete management plans with supporting legislation for priority eutrophic sites, including investment activities

Each of the three over-arching EQOs addresses more than one of the MPPIs identified in the region. As such, implementing actions to achieve these EQOs will address the GCLME's MPPIs.

8.3 Address the GCLME's Major Perceived Problems and Issues

8.3.1 Achieve sustainable fisheries

Addresses the following MPPIs:

1. Decline in GCLME fish stocks and non-optional harvesting of living resources;
2. Uncertainty regarding ecosystem status and yields in a highly variable environment including the effects of global climate change;
3. Loss of biotic (ecosystem) integrity (changes in community composition, vulnerable species and biodiversity, introduction of alien species, etc.).

8.3.2 High quality water to sustain balanced ecosystem

Addresses the following MPPIs:

1. Decline in GCLME fish stocks and non-optional harvesting of living resources;
2. Deterioration in water quality (chronic and catastrophic) pollution from land and sea-based activities, eutrophication and harmful algal blooms;
3. Habitat destruction and alteration including inter-alia modification of seabed and coastal zone, degradation of coastscapes and coastline erosion;
4. Loss of biotic (ecosystem) integrity (changes in community composition, vulnerable species and biodiversity, introduction of alien species, etc.).

8.3.3 Balanced habitats for sustainable ecology and environment

Addresses the following MPPIs:

1. Decline in GCLME fish stocks and non-optional harvesting of living resources;
2. Deterioration in water quality (chronic and catastrophic) pollution from land and sea-based activities, eutrophication and harmful algal blooms;
3. Habitat destruction and alteration including inter-alia modification of seabed and coastal zone, degradation of coastscapes and coastline erosion;
4. Loss of biotic (ecosystem) integrity (changes in community composition, vulnerable species and biodiversity, introduction of alien species).

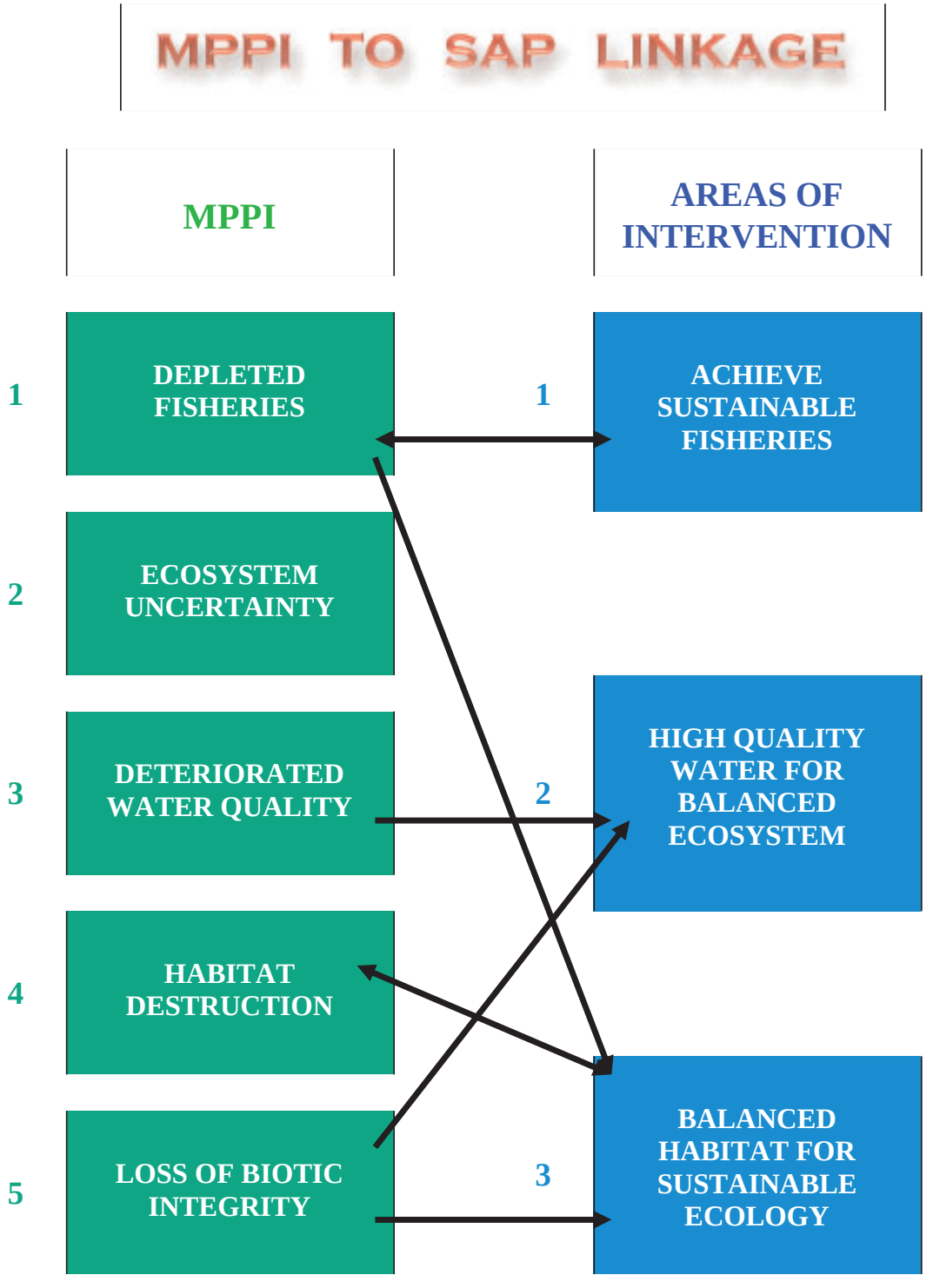


Figure 8.1: Linkages between Major Perceived Problems and Issues with the Areas of Intervention (EQOs) identified in the SAP.

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Annexes

ANNEX A: List of Conventions and Agreements

International Conventions and Agreements of which countries in the GCLME Region are parties to. Date of ratification given; x indicates convention signed/ratified but no date (in indicated year) given.

	GBI	GUI	SLE	LIB	CIV	GHA	TOG	BEN
The Convention on Fisheries and the Conservation of Open Sea Biological Resources		20-Mar-66						
1963 Act Regarding Navigation and Economic Cooperation between the States of the Niger Basin.		21-Nov-80						
1964 Agreement on the River Niger Commission and Navigation and Transport.		21-Nov-80						
1964 Convention on the Development of the Lake Chad Basin.								
1968 African Convention on the Conservation of Nature and Natural Resources.		12-Dec-89			16-Jun-69	X	1979	
1969 International convention on civil liability for damages due to pollution by hydrocarbons (and amendments)		29-Nov-89			15-Jun-75	X		
1969 International convention on the open sea intervention in case of accident likely to lead to a pollution by hydrocarbons Bruxelles, 1969		26-Nov-69			7-Apr-88			30-Jan-86
1971 International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage.		29-Nov-89			5-0ct-87	X		30-Jan-86
1966 International Convention for the Conservation of Atlantic Tunas						X		

ANNEX A (continued): List of Conventions and Agreements

International Conventions and Agreements of which countries in the GCLME Region are parties to. Date of ratification given; x indicates convention signed/ratified but no date (in indicated year) given.

	GBI	GUI	SLE	LIB	CIV	GHA	TOG	BEN
1971 Ramsar convention relative to humid areas of international importance so as to guarantee reinforced protection of stay and nestling place of some migratory species		24-Sep-92			Feb-93	X	09-Jun-95	
1971 Treaty Banning Dumping Nuclear Weapons and Beneath the Sea or on the Sea Bed		Mar 1989						07-Jul-96
1972 Convention on the Protection of the World Cultural and Natural Heritage.		18-Jun-79			1987	X		14-sep-86
1972 Convention on the Regulation of Transshipment at Sea								
1972 Convention on the Prevention of Mari-ne Pollution by the Dumping of Waste.		Apr 1991			09-oct-87	1982		1982
1973 International convention against ships pollution (MARPOL) London		May 1991			5-0ct-87		09-May-90	01-Nov-85
1973 Convention on endangered wild fauna and flora species international trade (CITES) Washington		20-Dec-81			Feb-93	X		28-May-84
1974 International Convention for the Safety of Life at Sea (SOLAS)		Nov 1980						X
1979 Convention on the Conservation of Migratory Species of Wild Animals.		28-May-87			1994			01-Apr-86
1981 Convention for Cooperation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region.		23-May-81			05-Aug-84	23-03-81	1984	07-Sep-97
1981 Protocol relative to cooperation as regards fight against pollution in case of critical situation Abidjan		23-Mar-81			05-Aug-84		16-Aug-83	1994

ANNEX A (continued): List of Conventions and Agreements

International Conventions and Agreements of which countries in the GCLME Region are parties to. Date of ratification given; x indicates convention signed/ratified but no date (in indicated year) given.

		GBI	GUI	SLE	LIB	CIV	GHA	TOG	BEN
1982	Convention on the Law of the Sea.		29-Nov-89			1994	X	19-Aug-94	30-Aug-83
1985	Vienna Convention for the Protection of the Ozone Layer.		Apr 1983			1983	1983		1983
1986	Convention for the Security of the environment					1983	1983		1994
1987	Montreal Protocol on Substances that Deplete the Ozone Layer.		1983				1982		1983
1989	Basel Convention on the Transboundary Movement of Hazardous Wastes and their Disposal.		1995			09-Jun-94			
1991	Abuja Convention for the African Economic Community					1993	1989		1993
1992	Amendement of the Montreal Protocol		Nov 1992						
1992	United Nations Framework Convention on Climatiques Changes		01-Mar-94					08-Mar-95	16-Mar-93
1992	Rio de Janeiro Convention on climate change		1994			14-Nov-94			1994
1992	Water pollution Control and Biological Diversity Conservation in the Large Marine Ecosystem of the Gulf of Guinea, Vienna								1995
1992	Dakar Convention for Cooperation of Atlantic Coastal States								
1992	Convention on biological diversity Rio de Janeiro		07-May-93			14-Nov-94		04-Oct-95	30-Jun-94
1994	Desertification Convention		19-Apr-97						11-Jul-96

ANNEX A (continued): List of Conventions and Agreements

International Conventions and Agreements of which countries in the GCLME Region are parties to. Date of ratification given; x indicates convention signed/ratified but no date (in indicated year) given.

		NIG	CAM	GAB	EQG	CON	DRC	ANG	SAO
1963	Act Regarding Navigation and Economic Cooperation between the States of the Niger Basin.	1963	01 Feb 66						
1964	Agreement on the River Niger Commission and Navigation and Transport.	1964							
1964	Convention on the Development of the Lake Chad Basin.	1964	1966						
1966	Convention internationale sur les lignes de charges		14 Aug 84						
1968	African Convention on the Conservation of Nature and Natural Resources.	1968	29 Sep 78	15-Sep-68			13-Nov-76		
1969	International convention on civil liability for damages due to pollution by hydrocarbons (and amendments)								
1969	International convention on the open sea intervention in case of accident likely to lead to a pollution by hydrocarbons Bruxelles, 1969	1981	14 May 84	29-Nov-69					
1971	International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage.	1981	12 Aug 84						
1966	International Convention for the Conservation of Atlantic Tunas								
1971	Ramsar convention relative to humid areas of international importance so as to guarantee reinforced protection of stay and nestling place of some migratory species					29 –Jun-96	15-Sep-94		

ANNEX A (continued): List of Conventions and Agreements

International Conventions and Agreements of which countries in the GCLME Region are parties to. Date of ratification given; x indicates convention signed/ratified but no date (in indicated year) given.

		NIG	CAM	GAB	EQG	CON	DRC	ANG	SAO
1971	Traite interdisant de placer des armes nucleaires et d'autres armes de destruction massive sur le fond des mers et des oceans ainsi que dans leur sous-sol								07-Jul-96
1972	Convention on the Protection of the World Cultural and Natural Heritage.	1972	07 Dec 82			-	17-Dec-75		
1972	Convention sur le reglement international pour la prevention des abordages en mer	1972	14 May 84						
1972	Convention on the Prevention of Marine Pollution by the Dumping of Wastes.	1975	1982				16-Oct-75		
1973	International convention against ships pollution (MARPOL) London	1973	En cours			27 Jan 1983			
1973	Convention on endangered wild fauna and flora species international trade cities Washington		05 Jun 81	3-Mar-73			18-Oct-76		
1974	Convention internationale sur la sauvegarde de la vie humaine (SOLAS)		25May 80						
1979	Convention on the Conservation of Migratory Species of Wild Animals.	1975	07 Sep 81			3 Mar 99			
1981	Convention for Cooperation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region		01 Mar 83	23-Mar-81		15 Dec 85			
1981	Protocol relative to cooperation as regards fight against pollution in case of critical situation Abidjan		01 Mar 83						
1982	Convention on the Law of the Sea.	1994	19 Nov 85	10-Dec-82			17-Feb-89		

ANNEX A (continued): List of Conventions and Agreements

International Conventions and Agreements of which countries in the GCLME region are parties to. Date of ratification given; x indicates convention signed/ratified but no date (in indicated year) given.

		NIG	CAM	GAB	EQG	CON	DRC	ANG	SAO
1985	Vienna Convention for the Protection of the Ozone Layer.	1983	22 Sep 88			Mar 1994	15-Sep-94		
1986	Convention concernant la securité dans l'utulisation de l'amiante	1983	20 Feb 89						
1987	Montreal Protocol on Substances that Deplete the Ozone Layer.		01 Jan 89				15-Sep-94		
1989	Basel Convention on the Transboundary Movement of Hazardous Wastes and their Disposal.						15-Sep-94		
1991	Convention d'Abuja instituant une communauté economique africaine	1988	1991						
1992	Amendement au protocole de Montréal		10 Aug 92			Mar 1994			
1992	Convention cadre des Nations Unies sur les changements climatiques					1996	8-Dec-94		
1992	Convention on climate change Rio de Janeiro		19 Oct 94						
1992	Water pollution Control and Biological Diversity Conservation in the Large Marine Ecosystem of the Gulf of Guinea, Vienna		Dec 93						
1992	Convention de Dakar sur la coopération des états riverains de l'Atlantique								
1992	Convention on biological diversity Rio de Janeiro		19 Oct 94	12-Jun-92		1996	15-Sep-94		
1994	Convention sur la desertification		Jun-95			8 Jan 99	11-Sep-97		

ANNEX B: Brief History of the GCLME Project

The international community has long recognized the need to manage the marine environment, especially the maritime zones outside the jurisdiction of coastal States. In particular, Governments have been enjoined to take early action to adopt effective national measures for the control of significant sources of marine pollution, including land-based activities, living marine resources depletion and habitat degradation[4]. Governments were also mandated, through various international protocols, to coordinate such management actions regionally and globally. The Abidjan Convention for Co-operation in the Protection, Management and Development of the Marine and Coastal Environment of the West and Central African Region was born out of the need to undertake regional and common approaches to the prevention, reduction and combating of pollution in the marine environment, the coastal areas and related inland waters of western Africa.

In spite of the various sectoral national monitoring and assessment efforts, coastal area and marine data and information provide limited transboundary and integrated regional information upon which management actions and political decisions can be based at regional level negotiations. They are also invariably not designed to assess long-term trends and potential threats of cumulative impacts of human activities. Until recently most laboratories in the region did not have standardised methodologies and techniques for sampling, analysis and interpretation of data. There were relatively limited regional inter-calibration exercises to make their results inter-comparable prior to the implementation of the pilot phase Gulf of Guinea LME Project.

The countries have recognised the environmental and socio-economic challenges facing their common marine, coastal and freshwater resources and have accepted the need for joint stewardship in managing the commonly shared resources of the GC LME in order to ensure its future sustainability.

Motivated by the outcome and declarations made at the United Nations Conference on the Environment and Development (UNCED), a couple of international researchers proposed the adoption of the large marine ecosystem (LME) concept as the ecological framework to achieve the UNCED objectives. The LME concept, which was adopted by the Global Environment Facility (GEF) and member countries, not only provides a holistic and integrated approach for the prevention of pollution in marine and coastal environments, but also provides specific recommendations for the :

1. Development and enhancement of the productivity and potential of living marine resources;
2. Promotion of integrated management and sustainable development of coastal, marine and associated environments.

The current GEF LME Project Approach to integrated management, and sustainable development and use of the resources of the coastal areas and marine environment is a programme that facilitates the development of a regional Strategic Action Plan (SAP) by coastal States towards long-term management through international co-operation within a subregional, inter-regional, or regional framework. This approach is designed to support and supplement national efforts of coastal states to promote integrated management and sustainable development of coastal and marine areas under the coastal states jurisdiction including their Exclusive Economic Zones (EEZ).

The Guinea Current region was one of the first regions where the LME concept was first applied for coastal and marine environmental management. The Global Environment Facility (GEF) funded pilot phase project titled, "Water Pollution Control and Biodiversity Conservation in the Gulf of Guinea Large Marine Ecosystem" was implemented between 1995 and 1999. The project, an initiative of five (later six with the participation of Togo) countries in the region [namely Benin, Cameroon, Côte d'Ivoire, Ghana, Nigeria and Togo] was implemented with the technical assistance of UNIDO, UNDP, UNEP and the US-NOAA (under the United States Department of Commerce) and the collaboration of a host of national, regional and international organizations. The GOG-LME project represented a regional effort to assess, monitor, restore and enhance the ecosystems capacity and productivity in order to sustain the socio- economic opportunities for the countries in the coming decades.

The development objective of the Gulf of Guinea LME (GOG-LME) project was "the restoration and sustenance of the health of the Guinea Current LME and its natural resources, particularly as it concerns the conservation of its biological diversity and the control of water pollution". The following specific strategic objectives were established for the project:

1. Strengthening regional institutional capacities to prevent and remedy pollution of the Gulf of Guinea LME and associated degradation of critical habitats;
2. Developing an integrated information management and decision making system for ecosystem management;
3. Establishing a comprehensive programme for monitoring and assessing the living marine resources, health, and productivity of the Gulf of Guinea LME;
4. Preventing and controlling land-based sources of industrial and urban pollution;
5. Developing national and regional strategies and policies for the long-term management and protection of the

4. Stockholm Declaration on the Human Environment (1972)

Gulf of Guinea LME.

An approach adopted in project implementation was to build onto already existing national infrastructures a regionally co-ordinated and integrated programme of monitoring and assessment and developing among others:

1. System for joint fishery surveys for assessing changes in the spawning stock biomass (ssb) of the important species
2. Structured regional monitoring programme to determine the quality of the coastal areas and the health of the GOG Marine Ecosystem
3. System of coastal and marine ecosystem measurements, information synthesis, and reporting for mitigation of coastal stress
4. Indices of environmental quality assessment of the coastal and marine ecosystem.

The initiation of the GOG LME and the implementation of the capacity building component for monitoring and assessment of the coastal areas and marine environment significantly contributed to the following positive developments including:

1. Laboratories across the region presently using standard validated methods for data generation and also periodic inter-calibration to ensure inter-comparability of results
2. Productivity monitoring with continuous plankton recorder (CPR) on weekly tows have been in progress since November 1995 using ships of opportunity. The results of the monitoring will constitute the basis of estimating marine living resources.
3. Mangrove surveys and studies that have resulted in the publication of draft mangrove distribution and disturbance maps. The maps will form the basis of proposals for mangrove restoration schemes
4. Application of Standard methods for coastal wetlands pollution using WHO Rapid Assessment Guidelines. This has been used in assessing the pollution state of selected lagoons.
5. Fisheries stock monitoring in collaboration with ORSTOM has been undertaken in a living resource survey in the Western Gulf for assessment of fish stocks and their species diversity.
6. Installation of a GIS system for data-base development at the national and regional level, and established protocols for effective exchange of data and information between participating countries, as well as exposing them to other global institutes. Facilitated scheme of co-operation and mutual assistance such as pooling available equipment and facilities in addition to sharing experience and exchanging data and information.

A regional GOG LME environmental monitoring and assessment has thus been born under the GEF project.

Achievements under the pilot phase Gulf of Guinea LME

The outstanding accomplishments of the Pilot-Phase GEF Gulf of Guinea Large Marine Ecosystem (GOG LME) Project (1995 - 1999), as verified in Tri-Partite Review Reports and the final in-depth Evaluation, is ample proof of the catalytic and defining roles that GEF incremental funding can play. Some of the results achieved during the pilot phase include:

1. adoption of Ministerial level ACCRA DECLARATION(1998) aimed at institutionalising a new ecosystem-wide paradigm consistent with GEF operational guidelines for joint actions in environmental and living resource assessment and management in the Gulf of Guinea and beyond;
2. substantial progress in building regional and national water quality, productivity and fisheries assessment and management capabilities based on standardised methodologies;
3. planning and implementation of 2 co-operative surveys (first in the western gulf in July/ August, 1996 and secondly in the entire Gulf, Feb/March, 1999) of demersal fish populations conducted by the 6 countries . The data, albeit limited, have served already as the basis for certain common national regulatory actions for the co-ordinated management of the fish stocks of the Gulf;
4. definition of regional effluent standards based on a detailed survey of industries and recommendations made for the control and significant reduction of industrial pollution;
5. deriving from the survey in (4) above, a successful campaign for reduction, recovery, recycling and re-use of industrial wastes based on the concept of the "waste stock exchange management system" was launched in Ghana as a cost effective waste management tool. The concept will be extended to other project countries;
6. initiation of co-operative monitoring of the productivity of the LME using ships of opportunity. The results give indications of the carrying capacity of the ecosystem which enables projections on food security and by extension, social stability in the sub- region;
7. preparation of coastal profiles for the 6 project countries, followed by the development of National Guidelines for Integrated Coastal Areas Management (ICAM) and the preparation of draft national ICAM plans which were in different stages of adoption by the end of the Pilot Phase Project;
8. establishment of cross-sectorial LME committees in the participating countries consistent with the cross sectorial approach implied in integrated management;

9. accelerating the creation of national and regional data-bases, using harmonised architecture, as decision making support tools;
10. facilitating the establishment of a functional non-governmental organisation (NGO) regional network;
11. promoting active grassroots and gender participation in discussion, decision making and interventions in environmental and resources management ;
12. active collaboration arrangements with other projects and organisations in the region;
13. initiation of community-based mangrove restoration activities in all project countries;
14. successful completion of 41 training workshops with 842 participants (416 in regional workshops and 426 in National ICAM workshops), resulting in the setting up of a regional network of over 500 specialists linked by electronic mail;
15. development of a preliminary Transboundary Diagnostic Analysis (TDA) for the Gulf of Guinea.

Recognizing all the achievements of the pilot phase GOG-LME project as listed above, the Committee of Ministers responsible for the project during their First Meeting in Accra, Ghana in June 1998 called for initiation of an expanded project to include all 16 countries situated within the natural limits of the Guinea Current Large Marine Ecosystem.

Photo 1: A cross section of the Convention Hall during the First Meeting of the Committee of Ministers (Accra, Ghana, 9-10 July, 1998), opened by the Vice-President of Ghana, Prof. Atta Mills. Seated in the front row are the Ministers (and their Advisors) who adopted "The Accra Declaration".

The communiqué issued after the meeting (the Accra declaration) stated, among others, that "The development of a Strategic Action Plan including a full Transboundary Diagnostic Analysis leading to the second phase of the Project should be accelerated". In response to the Ministers' request, a PDF-B project "Development of a Strategic Action Programme for the Guinea Current Large Marine Ecosystem (GCLME)" was initiated in 2001 with the support of GEF, UNIDO, UNDP, UNEP and US-NOAA.

The Commanding Activity of the PDF Block-B Process was the organisation, in Accra, Ghana from 14-18 May 2001, of three back-to-back meetings namely the Working Group (WG), Stocktaking (SG) and Project Steering Committee (PSC), under the aegis of the Abidjan Convention for Co-operation in the Protection, Management and Development of the Marine and Coastal Environment of the West and Central African Region. The objectives of the meeting included the following:

1. review existing information relating to issues and problems of the marine and coastal environment of the GCLME, especially issues of transboundary nature;
2. examine on-going activities, projects and programmes addressing these issues and problems;
3. identify pilot projects for implementation; and
4. set national and regional strategies and priorities for action to be included in the Project Brief for a supplementary PDF-B or full project.

Photo 2: Fishery Scientists and Pollution Experts on the deck of the MV Sussainah during the flag off of a co-operative survey of bottom fish populations conducted by the 6 countries of the Gulf of Guinea in February/ March, 1999

Photo 3: The achievements of the 4 year GOG-LME Project also include skills acquisition. Here, members of the Project's Pollution Assessment and Control Activity Group pose for a group photograph during their Quality Assurance and Intercalibration Exercises at the Laboratories of the Federal Environmental Protection Agency in Lagos, Nigeria, in March, 1999

The stocktaking objectives covered areas beyond the GCLME geographic definitions. The Workshop was designed to bring together stakeholders not only from the GCLME region but also from the Canary Current LME (CCLME) region to the north and Benguela Current LME (BCLME) to the south in addition to representatives of some GEF projects in the greater western African coast from Mauritania to South Africa. The Stocktaking Workshop was successful in affording:

1. an "umbrella" under which the 16 countries of the Project established ownership of the Project and agreed on rudimentary mechanisms for consultation and coordination;
2. first platform for the various regional GEF Projects to begin the important tradition of sharing lessons learned to date through experience and on a continuing basis as the implementation of GEF assisted projects in western Africa continue;

3. an opportunity to discuss the issue of potential overlap between the GCLME Project and complementary GEF Projects in western Africa in order to achieve complementarity and avoid duplication;
4. Presentation of a set of Initial Assessments for the 10 new countries and updated national profiles for the 6 pilot phase countries including a regional synopsis of tranboundary issues and priorities;
5. Presentation and discussion of an initial compendium of 6 country-identified demonstration activities to be implemented in each of the six Pilot Phase countries and 3 regional demonstration activities that would have ecosystem-wide execution;
6. constitution of a GCLME-wide Steering Committee that provided guidance on the preparation of this PDF-B proposal and which will oversee subsequent phases of project development and implementation;

One of the principal outputs of the stocktaking process is the Regional Synthesis Report. The report highlights transboundary issues pertinent to the marine and coastal environment of the Guinea Current region and their root causes including the areas where priority management actions should be urgently undertaken. The report also provides background material necessary for the completion of the full Transboundary Diagnostic Analysis (TDA) and the preparation of a full Project Brief. This last objective takes account of the existence of a preliminary TDA developed during the pilot phase Gulf of Guinea LME project that involved six participating continues. The regional synthesis report thus describes the existing environmental and socio-economic situation in the GCLME based on the:

1. questionnaires completed by experts from each of the 16 participating countries;
2. country reports prepared by national experts;
3. thematic area reports prepared by experts who were actively involved in the pilot phase Gulf of Guinea LME project and based on activities undertaken during the project;
4. comments received from the various stakeholders that participated in the Working Group and Stocktaking Workshops.

The Thematic/Sectoral Reviews were provided by regional experts on the following areas:

1. Plankton Survey in the Gulf of Guinea
2. Nutrients and Water Quality
3. Fish and Fisheries
4. Industrial Pollution
5. Mangroves
6. Socio-economics and Governance
7. Integrated Coastal Area Management (ICAM)
8. Coastal Erosion
9. Geographic Information System
10. Information Communication Technology and
11. Capacity Building

Photo 4: Dr. George Wiafe, a lecturer at the University of Ghana conducted his PhD research on the analysis of CPR samples collected from Côte d'Ivoire to Cameroon under the GOG-LME Project. He attended the Project training workshops for plankton analysis, some of which took place at the SAHFOS Laboratory in Plymouth, England.

The bulk of the initial allocation of PDF Block-B funds were used to assure the planning and successful organisation of the stocktaking workshop. Thus, It was recognised up-front during the approval of the PDF Block-B activity that the financial requirement for the Stocktaking workshop limited funding for the other tasks of preparing a 16 country TDA and Project Brief for a full project and that it was likely that an extra funds would be required to further the stakeholders "buy in" process, define national and regional demonstration project options, and to complete a full scale project brief and ultimately the IAs' respective project documents. With the recommendation of the Working Group and Stocktaking Workshops and the endorsement of the Project Steering Committee, UNIDO, UNDP, UNEP and US-NOAA finalised the supplementary PDF B which was approved by GEF in November 2002.
The objectives of the supplementary PDF B include to:

1. Complete a full Transboundary Diagnostic Analysis (TDA) for the entire 16 country region and a stakeholder involvement plan,
2. Define environmental quality objectives that will provide the first step in an adaptive management strategy for the LME to be encapsulated in the Strategic Action Programme (SAP, to be fully developed within the first six months of the full sized project, along with a comprehensive set of process, stress reduction and environmental status indicators).
3. Fully identify and define a set of 9 country and regional replicable and sustainable national and regional activities and approved by the Steering Committee (that will make a significant contribution to resolving the priority transboundary issues, conserving the fisheries resources and/or protecting globally significant aquatic biodiversity) and complete an analysis of their benefits, incremental costs and co-funding. These 9 demonstration projects will facilitate early implementation of selected elements of the SAP.
4. Develop a regional approach for a Regional Programme of Action on Land Based Activities (RPA/LBA) to facilitate the preparations of National Action Plans that will lead to the formulation and endorsement of a new Protocol on LBA for the Abidjan Convention, in conformance with an ecosystems approach to the assessment and management of the GCLME.
5. Enable the preparation of the Project Brief and respective IA Project Documents.
6. Develop full project activities to assist the Secretariat of the Abidjan Convention to develop the necessary capacity to coordinate and sustain implementation of the SAP following cessation of GEF support.

The full phase GCLME project would assist these 16 countries in making changes in the ways that human activities are conducted in the different sectors to ensure that the GCLME and its multi-country drainage basins can sustainably support the socio-economic development of the region. A project goal would be to build capacity of Guinea Current countries to work jointly to define and address transboundary priority environmental issues within the framework of their existing responsibilities under the Abidjan Convention and its Protocol. It is clear from the results of the stocktaking workshop that the participating countries endorse the need to recover depleted fish stocks, restore damaged coastal habitats, and control coastal pollution.

ANNEX C: List of Ongoing and Past Projects Relevant to the Implementation of the TDA

1. Project EP/GLO/201/GEF/FAO

Title: Reduction of Environmental Impact from Tropical Shrimp Trawling, through the Introduction of By -catch Reduction Technologies and Change of management"

Participating countries

This project involves 13 countries: 7 for full participation (Nigeria, Iran, Venezuela, Costa Rica, Mexico. Indonesia and Philippines) and 6 others that will participate to the Project through joint activities with one of the main partners (Cameroon, Barhain, Colombia Cuba, Trinidad and Tobago). Two countries of the GCLME i.e. Cameroon and Nigeria are involved in this project. These countries are characterized by the fact that they actively participated at preparatory phase, and also have important shrimp fisheries, but the catches are generally smaller than for the main participating countries.

Project Objectives

This Project will address the problem of discarding unwanted by-catch and juvenile food fish in particular through the introduction of appropriate fishing technologies and practices, in combination, where appropriate, with introduction of legislation and a management framework including control and enforcement strategies. The overall objective of the Project is then to reduce discard of fish captured by shrimp , trawlers, primarily by introducing technologies that reduce the catch of juvenile food fish secondary through management and research in the biology of the exploited resources and fishing gear fields.

The ultimate output of the project will be the adoption by several of the participating countries of fishing technologies and practices that are environmentally friendly, so that their shrimp trawling fisheries will enhanced in terms of the environmental performance and reduction of biological impacts and be regarded as more sustainable in the future a direct outcome of the project will be the reduction in number of juveniles caught by trawlers using BRDs (By - catch Reduction Devices) compared to trawlers not using such devices.

Outcome of the project

Part of the overall Work-plan of project EP/GLO/201/GEF is to monitor in each participating country:

1. The ongoing evolution of the commercial shrimp trawling fisheries, covering the number of each major type of vessel involved, estimates of fishing effort and records of their landings;
2. The typical rate of shrimp-catch, by-catch and discards made over an annual cycle by typical vessels from each main sector of the commercial shrimp-trawling fleet, both before, and after adoption of By-catch Reduction Devices (BRDs) by these vessels;
3. The socio-economic changes which may be brought about by the adoption of BRDs in the commercial shrimp - trawling fleets.

Possible linkages

This project will be very useful for the assessment and sustainable management and conservation of biodiversity regional project for data collection since arrangements have been made with industrial fishing companies to use their vessels to collect data and information. The GCLM project should also use this approach with regard to fishing industries

2. Global International Water Assessment (GIWA) (GEF-UNEP)

What is GIWA?

GIWA is the GEF/UNEP project; it makes a major contribution to policies and actions that will lead to protection and more sustainable use of international waters; the products of GIWA are expected to represent the most objective comprehensive assessment of transboundary water issues, and their societal root causes, conducted so far. GIWA carries out collection of data and their processing in 66 sub-regions simultaneously, makes full use of existing assessments and all other available information, incorporate the findings of past water-related programmes and work in close partnership with ongoing programmes to maximize the overall benefit.

The Gulf of Guinea is one of the 66 sub-regions identified by GIWA (Sub-region 42). The GIWA work so far in the Gulf of Guinea concern water assessment of the four basins within the Gulf of Guinea, notably: Congo Basin, Volta Basin, Niger Basin and the Comoe Basin. In each of these basins, environmental assessment of water based on GIWA methodology has been done: assessment of key environmental concerns and issues. Problem areas identified are. i) Freshwater shortage; ii) Pollution; iii) Habitat and community modification; iv) Unsustainable exploitation of

fisheries and other living resources and v) Global change

Possible linkages

Information gather by GIWA will be very useful to finalize the TDA and other aspects of the project. Within the UNEP context, the Regional Seas Programme which includes 13 conventions and action plans and involves more than 40 states; the Global Programme Action for Protection of the Marine Environment from Land-based Activities; the programmes for the management of a number of transboundary river basins as well as number of conventions for which UNEP provides the secretariat

3. Ocean Data and Information Network for Africa, Second Phase (ODINAFRICA-II)

Objectives of ODINAFRICA-II

ODINAFRICA-II is an initiative of 20 African coastal states (12 in the west and Central Africa and Mediterranean: Tunisia, Morocco, Senegal, Guinea Conakry, Côte d'Ivoire, Ghana, Togo, Benin, Nigeria, Cameroon, Gabon and 8 in East Africa: Kenya, Tanzania, Madagascar, Seychelles, Comoros, Mozambique, South Africa, Mauritius). The overall objective of the project is to reinforce capacity building of participating countries on ocean data and information management by providing them will adequate training, equipment and internet facilities; create national data center with aim to collect, analyze and disseminate ocean data and information. A network of scientists and institutions has been established within these countries.

Possible linkages

Eight countries of the GCLME are part of ODINAFRICA-II project including the 6 countries that participated in the first phase of the GOGLME. The network put in place will be very useful for the implementation of the GCLME and also will bear some cost.

4. Control of Exotic Aquatic Weeds in Rivers and Coastal Lagoons to Enhance and Restore Biodiversity in Côte d'Ivoire (UNDP-GEF-Biodiversity)

The infestation of bodies of water by invasive aquatic plants (IAP) initially observed in the early 1980s is now reaching alarming proportions. The main invasive species is *Eichhornia crassipes* but *Salvinia molesta* and *Pistia stratiotes* have also been observed, as have other species (*Lotus*, *Nymphaea*, etc) These weeds are seriously impacting the life of riparian human population; they also pose threat to aquatic life. Some freshwater bodies are entirely covered. Aquatic life is also impacted by oxygen depletion in the lagoons brackish water where large quantities of water hyacinth are carried by floods and accumulate to rot. It is necessary to preserve the very rich but as yet little known biodiversity of the Ivorian ecosystems. Possible synergies should be developed between the GCLME and this project in the context of aquatic biodiversity conservation and pollution

5. Coastal Wetlands Management in Ghana (UNDP-GEF-International Waters)

Design and implementation of a Coastal Zone Management Plan to protect five environmentally sensitive and threatened coastal Ramsar sites of global importance for migratory birds. The project includes: a) monitoring of ecological conditions at the sites; b) preparation and implementation of site management programs and the training of site managers and wardens; and c) relocation of a sewage plant outlet that would have discharged into Sakumo Lagoon. Possible linkages: collaboration will be developed between the GCLME, in particular the demonstration project on mangrove in Nigeria and the integrated coastal zone management project in Cameroon and the Ghana project.

6. Reversing Land and Water Degradation Trends in the Niger Basin (UNDP-World Bank-GEF-International waters)

The objective of this project is the sustainable development of the Niger Basin and the protection of its dry land and aquatic resources and associated biodiversity; the project will support the nine riparian countries which include the following GCLME countries: Benin, Cameroon, Côte d'Ivoire, Guinea Conakry, Nigeria

Possible linkages: countries cited above should at their national level develop synergies with this project with aim to avoid duplication of activities and also to learn from their experience

7. Integrated management of the Volta River Basin (UNEP/UNDP-GEF-International Waters)

The objective of the proposed project is to facilitate the establishment of a multi-country management framework, to produce a diagnostic of main transboundary issues, and to define agreed measures to reverse/prevent resources degradation (Strategic Action programme). The GCLME countries involved in this project are: Benin, Côte d'Ivoire, Ghana, and Togo. Possible linkages: countries cited above should at their national level develop synergies with this project with aim to avoid duplication of activities and also to learn from their experience.

8. African Water Page

The main objective of the African Water Page, published by the Water Policy International is to increase communication on the Continent of Africa between people working on water. However, the level of connectivity to the Internet is very low. With

other forms of communication being a difficulty, the Internet adds enormous potential to data accessibility for professionals, particularly those working in Government service. Not only is data more accessible, but with email, News Groups and WWW communication between sector professionals can also be enhanced. There is a distinct sense of isolation of people working, sometimes against daunting odds, in countries all around Africa. As the African Water Page develops, one of the objectives is to encourage African professionals to become members of a closed forum for sharing of information and support, and to promote frank discussion about some of the difficulties facing African professionals.
Possible linkages: this will be important for dissemination of the project information; the regional project on information should establish collaboration with African Water page and gain for their experience

9. Other projects

9.1. Conservation and sustainable use of forest ecosystems of central Africa region project (Le projet (ECOFAC) financing by European Union;

9.2. Programme of protection and development of marine and coastal environment for West and Centre Africa region (WACAF) jointly implemented by FAO and UNEP in collaboration with UNESCO and IUCN

9.3. Maritime Fisheries project implemented by FAO within the frame work of the COREP (Fishery Committee of the Gulf of Guinea) with the head office in Libreville, Gabon.

9.4. Tropical Forestry Action Programme(PAFT) , a regional initiative with national component and supported by OIBT(Organisation International des Bois Tropicaux) and various donors

9.5. Regional project on on Environmental Information management (PRGIE) implemented within the frame work of GEF World Bank in collaboration with FAO and USAID

9.6. Central Africa Regional project on Environment (CARPE), an initiative of USAID for the countries of the Congo Basin

9.7. Sustainable Management of Central Africa Wetland Forest Ecosystems Programme implemented by IUCN, with GEF support

Possible linkages: there is no framework of coordination to avoid duplication. The GCLME is an opportunity to develop synergies and collaboration mechanism with all these initiatives.

ANNEX D: List of Acronyms

ACOPS	Advisory Committee for the Protection of the Seas
AfDB	African Development Bank
APR	Annual Programme/Project Report
BCLME	Benguela Current Large Marine Ecosystem
CBD	Convention on Biological Diversity
CBO	Community Based Organization
CCLME	Canary Current Large Marine Ecosystem
CECAF	Fishery Committee for the Eastern Central Atlantic
CEDA	Centre for Environment and Development in Africa
COMARAF	Training and Research for the Integrated Development of African Coastal Systems
CPUE	Catch per Unit Effort
CTA	Chief Technical Advisor
DIM	Data and Information Management
EIA	Environmental Impact Assessment
EQO	Environmental Quality Objective
ESI	Environmental Status Indicator
FAO	Food and Agriculture Organization of the United Nations
FEDEN	Foundation for Environmental Development and Education in Nigeria
GCC	Guinea Current Commission
GCLME	Guinea Current Large Marine Ecosystem
GEF	Global Environment Facility
GIS	Geographic Information System
GIWA	Global International Waters Assessment
GOG-LME	Gulf of Guinea Large Marine Ecosystem
HAB	Harmful Algal Bloom
IA	Implementing Agency
ICAM	Integrated Coastal Areas Management
ICARM	Integrated Coastal Area and River Basin Management
ICS-UNIDO	International Centre for Science and High Technology - UNIDO
ICZM	Integrated Coastal Zone Management
IGCC	Interim Guinea Current Commission
IMC	Inter-Ministerial Committee
IMO	International Maritime Organization
IOC-UNESCO	Intergovernmental Oceanographic Commission of UNESCO
IUCN	The World Conservation Union
IW:LEARN	International Waters (IW) Learning, Exchange and Resource Network Program
LBA	Land-Based Activities
LME	Large Marine Ecosystem
LOICZ	Land-Oceans Interactions in the Coastal Zone
M&E	Monitoring and Evaluation
MOU	Memorandum of Understanding
MPPI	Major Perceived Problems and Issues
NAP	National Action Plan
NEAP	National Environmental Action Plan
NEPAD	The New Partnership for Africa's Development
NFP	National Focal Point
NGO	Non-governmental Organization
NPA/LBA	National Programme of Action/Land-Based Activites
NOAA	National Oceanic and Atmospheric Administration
OP	Operational Program
PCU	Project Coordination Unit
PDF	Project Development Facility

PI	Process Indicator
PIR	Project Implementation Review
PPER	Project Performance and Evaluation Review
PSC	Project Steering Committee
RCU	Regional Coordination Unit
RPA/LBA	Regional Programme of Action/Land-Based Activities
SAP	Strategic Action Programme
TDA	Transboundary Diagnostic Analysis
UNDESA	United Nations Department of Economic and Social Affairs
TPR	Tri-Partite Review
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development
WACAF	West and Central African Action Plan
WHO	World Health Organization
WSSD	World Summit on Sustainable Development