The State of the Marine Environment

Regional Assessments

The Hague, July 2006

Foreword

Recognising the significance of the pressure of human development activities on the coastal and marine environment, 108 governments and the European Commission adopted the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) in 1995. They made a commitment to deal with land-based impacts on the marine environment resulting from contaminants namely sewage, persistent organic pollutants (POPs), radioactive substances, heavy metals, oils (hydrocarbons), nutrients, sediment mobilisation, marine litter and the physical alteration and destruction of habitats.

The GPA calls for periodic reviews, taking into account assessments of the state of the marine environment. The UNEP/GPA Coordination Office commissioned a global State of the Environment report as a contribution to the Second Intergovernmental Review Meeting in Beijing in October 2006. This expert report provides a concise global overview of the developments over the last decade within the area of focus of the GPA.

The report relies on information that dates back farther than the adoption of the GPA, largely because of limited contemporary data. At the same time, there often exists a considerable time lag between the pressures imposed on the environment, the development of policies, the implementation of measures and the visible manifestation of their impact. Consequently, while the findings of the report may not be based on as current information as we would like, the resulting analysis is indicative of certain trends in the state of the marine environment as they relate to the GPA.

The State of the Marine Environment: A Regional Assessment informs and compliments the other studies the UNEP/GPA Coordination Office has produced for the Second Intergovernmental Review Meeting.

The report identifies that countries have made considerable progress in developing and implementing appropriate policy responses at national, regional and international levels. Nevertheless, progress over the last decade needs to be sustained and strengthened in response to the growing pressures, with special attention to implementation, enforcement and environmental governance.

The UNEP/GPA Coordination office and its partners are pleased to present this expert report and it is our hope that the findings presented here will further support global, regional and national efforts in implementing the Global Programme of Action. The scientific and logistical support of LOICZ as well as the scientific and financial support by UNEP/DEWA was much appreciated.

Veerle Vandeweerd
Coordinator
UNEP/GPA Coordination Office

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Acronyms and abbreviations

AMCEN	African Ministerial Conference on the Environment
AMAP	Arctic Monitoring and Assessment Programme
AMCOW	African Ministerial Conference on Water
AMSP	Arctic Marine Strategic Plan
ASEAN	Association of South-East Asian Nations
ASOEN	ASEAN Senior Officials on the Environment
BAPCO	Bahrain Petroleum Company
BCLME	Benguela Current Large Marine Ecosystem
BOD	Biological Oxygen Demand
BPoA	Barbados Programme of Action for Sustainable Development of SIDS
BSC	Black Sea Commission
BSEP	Black Sea Environmental Programme
BSERP	Black Sea Ecosystem Recovery Project
BSSAP	Black Sea Strategic Action Plan
CAR/RCU	Caribbean Regional Coordinating Unit
CARICOM	Caribbean Community
CARIPOL	Caribbean Oil Pollution Programme
CEHI	Caribbean Environmental Health Institute
CEP	Caribbean Environment Programme
CLC	Convention on Civil Liability for Oil Pollution Damage
COD	Chemical Oxygen Demand
CSIR	Council for Scientific and Industrial Research
DEAT	Department of Environmental Affairs and Tourism (South Africa)
EBRD	European Bank for Reconstruction and Development
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EU	European Union
FAO	Food and Agriculture Organization
FUND	Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage
GCLME	Guinea Current Large Marine Ecosystem
GEF	Global Environment Facility
GIWA	Global International Waters Assessment
GoGLME	Gulf of Guinea Large Marine Ecosystem Project
GPA	Global Programme of Action for the Protection of the Marine Environment from Land-based Activities
HABs	Harmful Algal Blooms
HDI	Human Development Index
IAEA	International Atomic Energy Agency
ICAM	Integrated Coastal Area Management
ICRP	International Commission on Radiological Protection
ICZM	Integrated Coastal Zone Management
IGR	Intergovernmental Review
IMO	International Maritime Organization
IOC	Intergovernmental Oceanographic Commission
ISPA	Instrument for Structural Policies for Pre-Accession
IUCN	The World Conservation Union
LBS	Land-Based Sources
LC	Lethal Concentration

LME	Large Marine Ecosystem
LOICZ	Land Ocean Interaction in the Coastal Zone
MARPOL	International Convention for the Prevention of Pollution from Ships
MDG	Millennium Development Goals
MPA	Marine Protected Area
MPC	Maximum Permissible Concentration
MPN	Most Probable Number
NEAP	National Environmental Action Plan
NEPAD	New Partnership for Africa's Development
NGO	Non-governmental Organization
NOAA	National Oceanographic and Atmospheric Administration
NPA	National Programme of Action
OECS	Organization of Eastern Caribbean States
OHC	Oil Hydrocarbons
OPRC	Convention on Oil Pollution Preparedness, Response, and Co-operation
PADH	Physical alteration and destruction of habitats
PAH	Polycyclic Aromatic Hydrocarbons
PAME	Working Group on the Protection of the Arctic Marine Environment
PC	Personal computers
PEMSEA	Partnership in Environmental Management for the Seas of East Asia
PHC	Petroleum Hydrocarbons
POPs	Persistent Organic Pollutants
PTS	Persistent Toxic Substances
RAC	Regional Activity Centre
RMS	ROPME Member States
ROPME	Regional Organization for the Protection of the Marine Environment
Roshydromet	Russian Federal Service on Hydrometeorology and Monitoring of Environment
ROWA	Regional Office for West Asia
RPA	Regional Programme of Action
RSA	ROPME Sea Area
SAREC	Swedish Agency for Research Cooperation
SeaWiFS	Sea-viewing Wide Field-of-view Sensor
SIDS	Small Island Developing States
SoE	State of Environment
SPAW	Protocol Concerning Specially Protected Areas and Wildlife in the Wider Caribbean Region
SPDC	Shell Petroleum Development Company
TDA	Transboundary Diagnostic Analysis
TDS	Total Dissolved Solids
TOD	Total Oxygen Demand
UAE	United Arab Emirates
UNCED	UN Conference on Environment and Development
UNCLOS	United Nations Convention on the Law of the Sea
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
US-EPA	United States Environmental Protection Agency
WACAF	West and Central Africa
WCR	Wider Caribbean Region

WEEE	Waste Electrical and Electronic Equipment
WESTPAC	Intergovernmental Oceanographic Commission Regional Secretariat for the Western Pacific
WHO	World Health Organization
WMO	World Maritime Organization
WSSD	World Summit on Sustainable Development
WTO	World Trade Organization
WWF	Worldwide Fund for Nature

Metals and Chemicals

Al	Aluminium
As	Arsenic
Cd	Cadmium
Co	Cobalt
Cr	Chromium
Cs	Cesium
Cu	Copper
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
Fe	Iron
HCH	Hexachlorocyclohexane
Hg	Mercury
Mn	Manganese
NH_4	Ammonium
Ni	Nickel
NO_x	Nitrous Oxides
OC	Organochlorides
P	Phosphorus
PAH	Polycyclic Aromatic Hydrocarbons
Pb	Lead
PBDE	Polybrominated Difenyl Ethers
PCB	Polychlorinated Biphenyl
PCDF	Polychlorinated Dibenzofurans
Po	Polonium
Pu	Plutonium
Se	Selenium
Sn	Tin
SO_2	Sulphur Dioxide
Sr	Strontium
TBT	Tributyltin
Tc	Technetium
U	Uranium
V	Vanadium
Zn	Zinc

Introduction

INTRODUCTION

Over the past decade, degradation of the coastal and marine environments continued globally, and in many places even intensified. The major threats to the health, productivity, and biodiversity of the marine environment result from human activities in both coastal and inland areas. In fact, nearly 50% of the world's coasts are threatened by development-related activities. Some 80% of the pollution load in the oceans originates from land-based sources, including municipal, industrial and agricultural run-off, as well as atmospheric deposition. In addition, coastal habitats are also being altered and destroyed. Increasing habitat alteration and destruction either by physical, chemical, or biological means constitutes the most widespread, frequently irreversible, human impact on the coastal zone.

Natural marine and coastal ecosystems represent tangible economic goods and provide valuable services, such as the treatment and assimilation of wastes, storm protection, production of food and raw materials, recreational amenities, genetic resources, and employment opportunities. According to the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection, the global value of the goods and services provided by marine and coastal ecosystems is roughly double the value of those provided by terrestrial ecosystems and is comparable with the level of global GDP. About one billion people currently live in coastal urban centers. The health, well-being and, in some cases, the very survival of coastal populations depend upon the health and productivity of coastal ecosystems such as coral reefs, mangrove forests, and estuaries. Land-based pollution and physical alteration and destruction of habitats undermine the sustainable use of oceans and coastal areas and their resources. In addition, exposure to pollution in the coastal and marine environments gives rise to human health concerns stemming from direct contact with polluted waters and the consumption of contaminated seafood.

Addressing the intense pressures exerted on coastal ecosystems by human activities require serious commitment and preventive action at local, national, regional, and global levels. Recognizing the growing and serious threat from land-based activities to both human health and well-being and the integrity of coastal and marine ecosystems and biodiversity, in 1995 the representatives of 108 governments and the European Commission adopted the Washington Declaration and the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA). The GPA is mainly concerned with nine source categories: Sewage; Persistent Organic Pesticides (POPs); Radioactive substances; Heavy metals; Oils (Hydrocarbons); Nutrients; Sediment mobilization; Litter; and Physical Alteration and Destruction of Habitats (PADH).

In the Washington Declaration, the governments declared their intention to cooperate on a regional basis to coordinate GPA implementation efforts. Development of national and regional programmes of action is of primary importance. The United Nations Environment Programme (UNEP) Regional Seas Programme and other regional seas programmes and organizations provide an integrated framework for national action programmes. In adopting the GPA, governments expressed their commitment to protect and preserve the marine environment from the impacts of land-based activities and declared their intention to do so by, amongst others, according priority to the implementation of the GPA by providing for periodic intergovernmental reviews of the GPA, taking into account regular assessments of the state of the marine environment.

In this regard, the UNEP Coordination Office of the GPA has published a global state of environment (SoE) report on the GPA, as a contribution to the 2nd Inter-Governmental Review Meeting in Beijing, People's Republic of China, October 2006. The SoE report gives a global overview of the last decade's developments related to the nine GPA source categories. The report sheds light on trends and emerging issues with respect to the GPA source categories and illustrates the developments in several world regions during the last 10 years.

To support this Global Assessment, experts from several world regions were invited by the GPA Coordination Office to prepare an assessment of the state of the environment relevant to the GPA source categories for their respective regions:

1. West and Central Africa;
2. Southern Africa;
3. Eastern Africa;
4. Black Sea;
5. ROPME Sea Area;
6. South Asian Seas;
7. East Asian Seas;
8. Arctic Ocean; and
9. Caribbean Small Island Developing States (SIDS).

Regional experts used available data and information at the regional and national levels in preparing the assessments. Early versions of the papers were presented by the experts at a workshop convened by the GPA in Egmond aan Zee, the Netherlands, on 26 June, 2005, in association with the Land Ocean Interaction in the Coastal Zone (LOICZ) Inaugural Open Science Meeting. The workshop and the drafting of the regional papers provided references to the global SoE process and contributed to regional capacity in terms of assessment. The regional papers were reviewed and commented on by the Regional Seas Secretariats and UNEP regional Offices. The activities were supported by the UNEP Division of Early Warning and Assessment and co-funded by Netherlands Partnership Funds.

The papers report on the environmental state and trends where possible, with an indication of regional hotspots and emerging issues related to the GPA source categories in the respective regions. Also included is a discussion of the relevant institutional and legal framework and progress made in the past decade in protecting the coastal and marine environments from land-based activities, as well as suggestions for the way forward in addressing the GPA issues. In the final chapter the major trends, commonalities, and differences among the regions are highlighted. This chapter also presents the major outcomes of the June workshop and discusses some of the constraints to assessing and addressing the GPA issues in the various regions.

1 - West and Central Africa

INTRODUCTION

This regional overview covers the coastal and marine waters of the West and Central African (WACAF) countries, from the Atlantic Ocean to the Sahara Desert and from the shores of Lake Chad and Angola to Senegal (Figure 1.1). The countries making up this region are Angola, Benin, Burkina Faso, Cabinda, Cameroon, Central African Republic, Chad, Congo, Côte d'Ivoire, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, and Togo (UNEP/GPA 2005a). Although the island of Cape Verde is part of West Africa, its drainage basins as well as its human activities have limited large-scale impact on the marine environment as a result of its small land mass.

There is strong empirical evidence of serious localized degradation in the coastal environment of the Canary, Guinea, and Benguela Currents. However, up-to-date, relevant, and reliable data that can be used to assess the extent of degradation are not easily available or accessible on a national or regional scale. Demography, urbanization, industry, agricultural activities, and economic development exert significant anthropogenic pressures on the coastal zone. Pollution discharges from oil refineries and textile, leather, food, and brewery industries reduce water quality in the coastal zone. The region's main pollution problems are degraded water quality, the loss of critical habitats for migratory and non-migratory species, river effluents entering the ocean, offshore spills, marine debris, beach pollution, as well as industrial and solid waste.

Several regional assessments that examined environmental issues in the WACAF region have been carried out in the past decade. These include the Global International Waters Assessment (GIWA), which has ranked the severity of impacts of freshwater shortage, habitat and community modification and loss, pollution, unsustainable exploitation of living resources, and global change in transboundary water bodies across the globe. Another regional assessment, the ongoing Guinea Current Large Marine Ecosystem (GCLME) project funded by the Global Environment Facility (GEF), carried out a preliminary Transboundary Diagnostic Analysis (TDA) that identified the major perceived problems the countries face as:

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

The above issues are based on an initial analysis of the situation presented in a series of publications emanating from the GEF-funded Gulf of Guinea Large Marine Ecosystem Project (GoGLME) (Akrofi 2002, Bortei-Doku Aryeetey 2002, Cury and Roy 2002, Demarcq and Aman 2002; Hardman-Mountford and McGlade 2002; Ibe and Sherman 2002, McGlade and others 2002a, McGlade and others 2002b, Nauen 2002, Pauly 2002, Roy and others 2002, Scheren and Ibe 2002). Much similarity exists between these issues and those identified by the UNEP Regional Seas Programme Regional Coordinating Unit for the West and Central Africa Action Plan (http://www.unep.ch/regionalseas/regions/wacaf/wafhome.htm). The latter include the following, as well as major constraints and strategies and measures (UNEP/GPA 2005a):

Priority issues

- The decline of water quality due to land-based human activities, such as the introduction of sewage and wastewater from industrial, domestic, and agricultural runoff as well as coastal urbanization;
- Physical degradation and habitat modification; and
- Fishery resources depletion and loss of marine biodiversity.

Major constraints

These include the lack of:

- Detailed scientific data on coastal, marine, and freshwater environments;
- Quantitative and qualitative assessments of the major sources of land-based pollution in the region;
- Best available techniques;
- Effective environmental practices and product substitutes;
- Sufficient technical human resources, equipment, and financial means;
- Adequate legislation and regulatory measures;
- Good economic instruments and incentives; and
- Long-term planning and monitoring systems.

Strategies and measures

- Install adequate sewage and solid waste disposal systems and possible recycling;
- Locate industries in less vulnerable areas, preceded by an assessment of environmental impacts;
- Use of beneficial production technologies and improved port reception facilities;
- Implement and enforce legislation, where needed;
- Land-use planning and improved application of agro-chemicals, including whenever possible, nutrient recycling;
- Seek alternatives to Persistent Organic Pollutants (POPs), in view of their possible impacts;
- Establish integrated river basin and coastal area sustainable management;
- Establish coastal and marine resources surveillance, including appropriate aquacultural methods;
- Improve oil production and implement contingency plans, including MARPOL (the International Convention for the Prevention of Pollution from Ships).

According to UNEP (1999) the lack of detailed scientific data on coastal, marine, and freshwater environments in the WACAF region results in a considerable degree of uncertainty in assessing pollution loads. For example, where data on pollution concentrations are available, data on volumes of discharges are lacking. Where information on types of contaminants is available, no information on transport pathways exists. It is also clear that many of the key sources of pollution are very closely linked, e.g., sewage and nutrients. Knowledge on interaction and synergies between different land-based pollutants in the coastal and marine environments is insufficient. In the case of Cabinda, an enclave of Angola, apart from data on oil production and population, almost no relevant GPA data is available. There is an urgent need for a precise qualitative and quantitative assessment of the significant sources of land-based pollution in the region.

THE WEST AND CENTRAL AFRICAN REGION

Physiographic and ecological character

A detailed description of the regional morphology and river drainage basins, general oceanography, coastal morphology and processes, as well as ecosystem and species diversity is given in UNEP (1999). The following account is a summary from UNEP (1999), with slight modifications and additions.

The region has four narrow coastal sedimentary basins, with a few volcanic intrusions and outcrops of hard rock forming the major capes that have developed on the edges of the coastline: the Senegalese-Mauritanian Basin, the Côte d'Ivoire Basin, the Niger Basin (Delta) and the coastal basins from Gabon to Angola. These four major river systems drain into the coast from Senegal to Nigeria. The Niger and Volta Rivers, draining an area of over 1 million km^2 and 390,000 km^2, respectively, have been dammed for energy, irrigation, and flood control purposes, as have most of the region's rivers. As a consequence, significant alteration of their hydrology and sediment flow has occurred, creating inevitable downstream impacts and accelerating coastal erosion processes. On the coast the potential for sea-level rise and its impacts (e.g., shoreline retreat and erosion, increased frequency of submergence of coastal wetlands, and salt-water intrusion into estuaries and coastal aquifers) is great.

Five distinct and relatively persistent oceanic currents, which are essentially wind-driven, are found off the WACAF coast: Benguela Current, flowing along the southwest African coastal zone (Namibia, Angola); Guinea Current, flowing eastward and south-eastward, which carries warm waters along the coast of the Gulf of Guinea, near the Equator; Equatorial Countercurrent, of which the Guinea Current is a continuation; South Equatorial Current, which flows some distance from the coast, between 10°S and the Equator; and Canary Current, which flows south-westward along the coast in the northern part of the WACAF region and feeds both the Guinea Current and the North Equatorial Current. Due to the high precipitation and numerous rivers on the Central West African coast the waters are generally warm (above 24°C.) and of low salinity (less than 35%). The most important factor characterizing the open ocean waters not only off the Gambia, Mauritania, and Senegal but also off the coast of Ghana, Angola, and Namibia, is the quasi-permanent presence of upwellings, driven by the Canary Current in the north and the Benguela in the south. These cool and nutrient-rich upwellings, which are governed by the position of the Intertropical Convergence Zone and changes in wind patterns, have profound effects on nearshore productivity.

From north to south, the coastal morphology, follows a succession of: (a) sandy arid coastal plains bordered by eolian dunes (Angola, Mauritania, north coast of Senegal); (b) sandy marshy alluvial with estuaries and deltas with mangrove vegetation (southern Senegal, Guinea-Bissau, Guinea, Sierra Leone); (c) rocky scarps and sandy beaches, alternating with mangrove vegetation (Sierra Leone, Liberia, eastern Nigeria to Gabon); (d) low sandy coastal plains, which alternate with lagoons along the Gulf of Guinea (Benin, Côte d'Ivoire, Ghana, Togo, Congo Estuary up to the Angolan border); and (e) extensive marshy areas formed by the Niger Delta, with mangroves indented by fluvial channels that are subject to tidal influence. In addition, a number of islands and archipelagos can be found in the Atlantic Ocean off the coast of West Africa (Canary and the Cape Verde Islands; Bissagos archipelago) and in the eastern part of the Gulf of Guinea (São Tome and Principe, and Annabon in Equatorial Guinea) (Awosika and Ibe 1998).

A number of different types of coastal habitats exist in the WACAF region. Among them are (a) wetlands, with mangrove forests being the most dominant features (extending more than 25,000 km from Senegal to Angola); (b) coastal lagoons, which are found mainly in the Gulf of Guinea, from Côte d'Ivoire to Nigeria; (c) limited expanses of seagrass beds in some estuaries and deltas mouths (Cacheu, Casamance, Geba, Saloum); and (d) sandy beaches, particularly along Mauritania, northern Senegal, and Ghana.

A wide diversity of marine resource species characterizes the coastal waters. These include an estimated 239 fish species, some of which are well known pelagic species such as: *Sardinella aurita, S. maderensis, and Thunnus albacares;* demersal species such as *Arius* sp., *Pseudotolithus typus* and *P. senegalensis, Dentex* sp., *Octopus vulgaris, Cynoglossus* sp.; intertidal molluscs (e.g., *Anadara* sp., *Crassostrea* sp.); and reptiles (marine turtles, crocodiles). Large concentrations of migrant and resident seabirds, as well as waders are found seasonally in Gambia, Ghana, Guinea Bissau, Mauritania, and Senegal; these include *Larus genei and Sterna maxima albididorsalis*. Many species are present in internationally significant numbers (greater than 1% of the East Atlantic flyway). Marine mammals such as the West African manatee *(Trichechus senegalensis)* are also found in some lagoons.

Socio-economic background

Broadly speaking, the countries of the WACAF belong to the group of less and least developed countries, although some states that are rich in natural resources (e.g., Côte d'Ivoire, Gabon, Nigeria) are approaching the level of the newly industrialized economies. A notable fact is that most of the population lives in extreme, if not abject poverty, which is the main driver of degradation of the region’s marine, coastal, and associated freshwater. All the WACAF countries are among those targeted by the Millennium Development Goals (MDG). According to the UN Human Development Index (HDI), the level of human development varies from medium (HDI of 0.72) in Cape Verde to low (HDI of 0.27) in Sierra Leone, which is the lowest among 177 countries (UNDP 2004). Characteristically, these countries have significant and increasing populations without access to safe water or improved sanitation (Figures 1.2 - 1.4).

Significant fractions of the population in the region are poor and live on under US$1 per day. Poverty results in rural-urban drift which causes urban populations to grow considerably faster (average projected increase of 8.5% for the period 2002 - 2015) than birth rates. The fact that a significant number of urban centres and commercial and industrial activities are located in the coastal zone exacerbates the problem of land-based pollution. It is estimated that between 40 - 60% of a population of over 235 million lives in the coastal zone; this is expected to rise to over 320 million by the year 2015. This translated to an annual production of over 25 million tonnes of human waste in 2002, which is expected to rise to over 34 million tonnes in 2015. Much of this sewage will be discharged untreated into the aquatic environment. The draft GCLME TDA noted that land-based sources and activities contribute about 70% of the coastal and marine pollution globally, while maritime transport and dumping at sea each contributes about 10%. The stresses resulting from interactive human developments, including economic and industrial development and consequent increases in harmful impacts on the region’s environment and natural resources have great socio-economic and cultural implications, the most important of which are income reduction arising from the loss of fisheries stocks and of recreation and tourism amenities, as well as increased water treatment and coastal protection costs. This state of affairs presents the background to the discussion on land-based sources of pollution that affect the WACAF coastal waters.

MAIN LAND-BASED SOURCES OF POLLUTION

This paper presents an overview of the current state of the environment in relation to the GPA issues, with emphasis on new data available since the UNEP (1999) report. It also examines if the aforementioned constraints have been effectively dealt with by the proposed strategies and measures. Beyond the UNEP (1999) report, the most reliable transboundary information on the West African region became available through the GoGLME project. Data and information have been collated and presented in three key documents: Ibe and others (1998), Scheren and Ibe (2002), and Scheren and others (2002). In addition, efforts have been made to access additional relevant sources of information for the period 2000 - 2005. Other important sources of information are the studies carried out under the AfriBasins initiative of LOICZ (Arthurton and others 2002) and the GIWA Guinea Current assessment (UNEP 2004).

Sewage and nutrients

Sewage, according to Webster, is 'the contents of a sewer or drain; "refused liquids or matter carried off by sewers". Most of urban coastal WACAF lacks basic sewerage infrastructure, and in some cases even open drains are not present, so the term "sewage" is a misnomer for the situation in much of the region. In these circumstances where numerous diffuse sources exist, the terms "grey" and "black" water are preferred (grey water is wash water, i.e., all wastewater except toilet waste; black water is toilet wastewater). No recent precise data on the quantities of grey or black water being discharged into the WACAF seas were found in the literature. The annual total biological oxygen demand load (BOD) for the entire WACAF region presented in GCLME (2003) is estimated to be 288,961 tonnes from municipal sewage and 47,269 tonnes from industrial pollution, while the annual total suspended sediment load was estimated at around 410,929 tonnes from municipal sewage and 81,145 tonnes from industrial pollution. The rapid growth of urban populations is far beyond the capacity of relevant authorities and municipalities to provide adequate basic services such as water supply, sewerage, and wastewater treatment facilities.

Two examples that provide a rough indication of the magnitude of the production of grey water, as well as of its availability for farming purposes in some coastal cities are from Ghana and Nigeria. The total amount of grey and black wastewater produced annually in urban Ghana has been estimated at 280 million m^3 (Agodzo and others 2003). Since Ghana's industrial development and urban centres are concentrated along the coast, most of this wastewater, treated or untreated, is discharged into the ocean. In selected cities in West Africa, Cofie and others (2003) reported that a significant number of urban farmers use wastewater for crop irrigation (Table 1.1), which is a reflection of the availability of such water. Apart from elevated nutrient levels, the bacterial contaminant load of such water is also very high (Table 1.2). Studies in the Sakumo catchment between the cities of Accra and Tema (Yawson 2004) showed that such high bacterial loads makes the water unfit for contact with humans; a few of the sites have faecal coliform counts above 100,000/100 ml (Table 1.3). Table 1.4 indicates the volume of water used per capita per day and the low proportion of the wastewater that is treated in several coastal cities in the WACAF region.

Of all the GPA source categories, nutrients are the most difficult to quantify given the close linkage with other source categories, as well as their extremely dynamic spatial and temporal variability. There has been no comprehensive regional assessment of nutrients for the WACAF since UNEP (1999). However, it has been estimated that loss of nitrogen via hydrologic export to the Atlantic Ocean is about 1.5 x 10^9/kg; the loss from de-nitrification is estimated at 1.1 x 10^9/kg.

Primary productivity surveys have revealed an increasing occurrence of HABs, indicating intense eutrophication and therefore excessive nutrient loading from anthropogenic sources (Figure 1.5).

Persistent organic pollutants (POPs)

Although fewer pesticides are used in Africa than on the other continents, highly poisonous organic chemical products are applied under inappropriate conditions by women and men with no training or product information. Scheren and Ibe (2002) reported significant levels of organochlorine pollution in sediments and shellfish from the WACAF region (Table 1.5). The current prevalence of DDT in sediment and shellfish samples is due to the continued sale, despite many national bans, of this pesticide. Of the sites studied, Lekki Lagoon in Nigeria had the highest levels of most of the pollutants assessed.

Reports in the popular press in Ghana indicated that an analysis of samples of street food in Accra carried out in 1999-2000 revealed disturbing levels of contamination by pesticides. The organophosphate chlorpyrifos was detected in six out of eight samples of rice and beans. However, local analytical facilities and methododology could not determine if the chlorpyrifos residues exceeded the Codex Maximum Residue Levels of 0.2mg/kg. Chindah and others (2004) examined the toxicity of chlorpyrifos on *Tilapia guineensis* using 96-hour static bioassay. As expected, mortality was found to increase with exposure and with increase in concentration. The 96-hour mean lethal concentration (LC50) was 0.002 µg/l and mean lethal time was less than 24 hours at concentrations of 0.1 µg/l.

Current data on POPs based on the imports of pesticides by the WACAF region turned out to be very misleading due largely to false reporting of such imports. Work by the Pesticide Action Network, a United Kingdom-based non-governmental organization (NGO), suggested that the large quantity of illegal imports, the current in-country stockpiles of obsolete chemicals coupled with the large influx of fake and adulterated pesticides make it impossible to use official imports of chemicals as a reliable indicator of POPs use in the region.

Heavy metals

The most important sources of heavy metal pollution are industrial emissions and effluents. Heavy metals bio-accumulate and bio-magnify in the food chain, which causes serious concern in relation to human health. Scheren and Ibe (2002) investigated heavy metal concentrations in the coastal environment and biota in the region, and found concentrations below the level of detection in several localities (Table 1.6). This could be attributed to the limited industrial development in the WACAF region in general, with the exception of the oil-rich states.

Other sources of heavy metals include road sediments and mobilization from ore-rich mine tailings. For instance, all samples of road sediments in Lagos had high levels of heavy metals (Adekola and others 1999). Among all the heavy metals, iron (Fe) had the highest mean concentrations, which ranged from 729 mg/kg at Public Works Department, Oshodi, to 3,957 mg/kg on Oba Akran Avenue, Ikeja. Lead (Pb) was detected in only two locations in Lagos: 78 mg/kg at the Public Works Department, Oshodi, and 122 mg/kg at Ado-Odo Sango Otta. It is interesting to note that the cadmium (Cd) levels in Ilorin sediments were generally within the same range as those in the Lagos sediments.

Gnandi and Tobschall (1999) performed a number of laboratory experiments to assess desorption of trace metals from Cd-rich phosphorite deposits of Hahotoé-Kpogamé (Togo) using 1 part of sediment to 10 parts of artificial seawater. The results showed that elevated concentrations of the trace elements Cd (17 - 256 µg/l), nickel (Ni, 12 - 193 µg/l), and zinc (Zn, 21- 200 µg/l) were released into seawater by desorption. Thus, the direct disposal of potentially toxic metal-rich mine tailings into the sea may lead to regional coastal water pollution.

Oils (Hydrocarbons)

Accompanying the enormous economic benefits that could be derived from the oil industry are the constant threats of oil spills and the associated negative ecological and socio-economic impacts. Offshore mining and oil drilling activities are major sources of oil pollution, mainly because of leaking pipes, accidents, and ballast water and production-water discharges. Drilling also involves the use of chemical products laden with heavy metals such as vanadium (V) and Ni, which are known to affect marine plants and animals. Oil pollution damages coastal habitats and living resources such as commercial fish stocks, reducing catches and the incomes derived from them. The possibilities of oil spills and their impacts are real, even in non-oil producing countries; this is usually associated with oil distribution by ocean currents and along busy oil tanker routes. The potential for spills are thus widespread as they can occur at any stage in the exploration, extraction, refining, and distribution phase.

The entire Guinea Current and Benguela Current LMEs are particularly at risk from oil pollution (GCLME 2003). In Nigeria alone, a total of 2,676 separate oil pipeline spills were reported between 1976 and 1990. According to the Shell Petroleum Development Company (SPDC) of Nigeria, the volume of oil spilled between 1995 and 1999 as a result of operational accidents and corrosion ranged between 2,000 and 23,000 barrels. According to the Department of Petroleum Resources, between 1976 and 1996 a total of 4,835 incidents resulted in the spill of approximately 2,446,322 barrels of oil. In the period 1978 - 1980, the particularly high volumes were due to three major spills: GOCON Escravos spill in 1978 of 300,000 barrels; SPDC 1978 Forcados Terminal Tank Failure (about 580,000 barrels); and the Texaco Funiwa incidence of 1980 involving 400,000 barrels (Awosika and others 2002). From 1995 to the present, 349,020 km of seismic lines have been cut and 530 exploration wells drilled in Central Africa (Angola, Cameroon, Congo, Equatorial Guinea, Gabon). The impact of oil spills on marine fauna in the WACAF region is still not quantified for most species. Daka and Ekeweozor (2004) studied the acute toxic effects of a Nigerian crude oil (Egbogoro Liner II) on the mangrove oyster, Crassostrea gasar, in bioassays. The 96-hour LC50 value for the oysters ranged from 135 to 545 ppm.

Sediments

The FAO World River Sediment Yields Database (FAO 2005) provides information on the sediment yield of several WACAF rivers, which ranges from 3.1 - 483 tonnes/km^2/yr (Table 1.7). The role of impoundments in trapping sediments before they reach the sea has been demonstrated for the Volta River by Gordon and Amatekpor (1999) who also pointed out that sediment entrapment by dams cannot be the sole reason for coastal erosion. Given that land-use practices are not improving and desertification and deforestation are increasing, the relatively low sediment yield of 48 tonnes/km^2/yr of sediment for a highly impacted river basin such as the Volta (FAO 2005) must be a result of sediment entrapment.

The dynamics and magnitude of sediment entrapment by impoundments in the WACAF region is, however, yet another area where concrete data are lacking.

Morales (1979) noted that a major source of sediments, besides rivers, is the large-scale transportation and deposition of dust by desert winds. Large quantities of dust (13 million tonnes/season) are moved mainly from the Saharan and Sahelian zones and deposited at sea and on land all the way across the Atlantic Ocean. Recent satellite imagery from the European Space Agency illustrates this phenomenon (Figure 1.6). This material not only "fertilizes" the Latin American and Caribbean forest belt, but also provides trace nutrients including phosphorus (P) that promote the growth of oceanic plankton.

There is a strong link between sediments and physical alteration and destruction of habitats. Mangroves are a case in point as they influence the quality and quantity of sediments that are exported from the coast. Anthony (2004) examined the relationship between the circulation of fine suspensions in a mangrove-colonized estuarine complex and short-term mangrove substrate accretion and medium-term mangrove swamp geomorphic evolution in Sherbro Bay, Sierra Leone. The estuarine reaches of streams emptying into the bay have relatively high levels (0.8 - 40 g/l) of suspended silts and clays in association with the turbidity maxima (5-50 g/l) at the interface between freshwater input and saltwater intrusion. However, the surveyed mangrove swamp plots showed much lower levels of silts and clays (0.09-0.6 g/l) and low rates of accretion (1.1-3 mm/yr). The latter was mainly attributed to the short duration of tidal flooding due to the high substrate elevation within the tidal range, as well as to the low settling potential of the very fine-grained suspensions circulating in the swamps. The importance of this is that although mangroves are trapping the coarse sediments, the finer particles still reach the sea. Therefore, removal of mangroves will change the entire dynamics of sediment export to the sea, which will impact on adjacent habitats such as seagrass beds and coral reefs.

Coastal and marine litter

GIWA characterized the Gulf of Guinea as severely impacted by solid waste (UNEP 2004). Households and small industries generate the largest quantities of non-hazardous waste, which exceed industrial outputs by several orders of magnitude, as seen in Port Harcourt, Nigeria (Table 1.8). Solid waste collection in Port Harcourt is largely limited to private contractors who are not very efficient. The uncollected solid waste accumulates in the drainage systems, which when obstructed, amplify flooding, and expose residents to considerable health risks.

According to Scheren and others (2002), solid waste and marine debris for just the Gulf of Guinea region is estimated at 3.8 million tonnes/yr of mainly putrescible or non-hazardous waste. Plastics (fishing-related products, packing materials, and carrier bags) make up 62% of the waste per 500 m^2 of beach. The average number of items found on the beaches was 23/m^2. Derraik (2002) has drawn attention to an inconspicuous and previously overlooked form of plastic pollution: plastic scrubbers, which are small fragments of plastic (usually up to 0.5 mm in diameter) derived from hand cleaners, cosmetic preparations, and air blast cleaning media. In air blasting technology, polyethylene particles are used for stripping paint from metallic surfaces and cleaning engine parts, and can be recycled up to 10 times before being discarded, sometimes significantly contaminated by heavy metals. Derraik also noted that there are many possible impacts of these persistent particles on the environment, e.g., heavy metals or other contaminants that could be transferred to filter-feeding organisms and other invertebrates, ultimately reaching higher trophic levels.

Information extracted from Awosika (2002) illustrates the magnitude of the coastal and marine litter problem in the WACAF (Tables 1.9 and 1.10). The report that over 10 tonnes of litter/km were collected from beaches in Cameroon is very disturbing. However, this debris is not generated only in Cameroon but also by up-current countries from which it is transported through longshore drift to the Cameroon coast.

Physical alteration and destruction of habitats

Physical alteration and destruction of habitats along the WACAF coast is very common, especially in the vicinity of river mouths and lagoons. This is evident in shoreline erosion, removal of vegetation such as mangroves, changing hydrological patterns, and water abstraction and impoundment by the opening of channels to the sea or by physical structures such as ports and harbours. Arthurton and others (2002) used the Driver-Pressure-State-Impact-Response framework to illustrate the linkage between the dual drivers/pressures of deforestation and cultivation and their impact on the coast. The latter includes the degradation of wetland habitats, which results from reduced water retention in the catchment and greater severity of flooding (Finlayson and others 1998, Gordon 1998, 2000).

A recent estimate (Ade Sobande and Associates 1998) suggested that about 50% of Nigeria mangroves may have been lost as a result of oil industry operations. For instance, in State River, Nigeria, a total of 71.4 km^2 of mangroves, equivalent to 1% of the river's total mangrove area, have been converted by various oil exploration activities (Table 1.11). Using the factors derived from this table, it is estimated that oil exploration in Central Africa (Angola, Cameroon, Congo, Equatorial Guinea, Gabon) would have affected at least 350 km^2 of coastal habitats in the period 1995 to the present.

Dredging and unconfined creek bank spoil disposal is extensive in the Niger Delta (World Bank 1995, Human Rights Watch 1999), but little or no data and information are available on the extent of the problem or on the quantity of waste spoils disposed of. However, a major oil company generated approximately 20 million m^3 of waste spoils between 1990 and 1996 (Ade Sobande and Associates 1998). ERML (2002) reported that a major oil company generated about 5 million m^3 of sulphate-rich dredge spoils in creating a shipping channel approximately 15 km long and 100 m wide. It is expected that the amount of abandoned spoils is even higher, taking into account the activities of other oil companies, the nearly 50 years of such operations, and the observed high sedimentation/siltation rates that often necessitate frequent maintenance dredging.

CONCLUSIONS

The first GPA Intergovernmental Review Meeting, which took place in November 2001, the Governments made committments to, among other things, mainstream GPA activities and capacity building (UNEP/GPA 2005b). It is unfortunate that this does not seem to have been effectively implemented in the WACAF region. From the foregoing, it is clear that none of the eight constraints previously mentioned has been adequately addressed. A major problem, as already stated, is the lack of detailed scientific data on the region's coastal, marine, and freshwater environments. This is related to the lack of quantitative and qualitative assessments of the significant sources of land-based pollution in the region, which in itself is a result of insufficient technical human resources, equipment, and financial means.

Though the best available techniques may not necessarily be the most expensive, sufficient capacity to apply them is not being developed. Until the magnitude of the problem has been understood and measured, by scientifically credible means, a comprehensive solution will not be forthcoming. The use of models has been proposed as one way to bridge the data gaps (e.g., Bormann and Diekkrüger 2004). Models, however, only function accurately when there is sufficient real data; the on-going GEF-funded GCLME project is a significant step towards the collection and analysis of data.

Environmental hotspots

Environmental hotspots can be considered as sites where threats are high or sites that are sensitive because of high biodiversity and/or relatively productive and/or pristine conditions. Though pollution is moderate in the WACAF region, threats are more serious in coastal hotspots associated with the larger coastal cities (UNEP 2004). A GEF medium-sized project (Development and protection of the coastal and marine environment in Sub-Saharan Africa) had, as one of its objectives, identification of hotspots in several of the countries in the WACAF region. In general, pollution hotspots related to the GPA issues include river mouths and estuaries that are heavily impacted by land-based pollution from urban and industrial areas, as well as by increased sediment loads. The study identified three areas in Ghana: Sakumo I wetlands (hotspot), Korle lagoon (hotspot), and the Lower Volta Mangroves (sensitive area). In Nigeria: three hotspots (Lagos Islands, Ogoni-Land/Bonny Area, and Eket Area) and three sensitive areas (Akassa/Brass/Santa Barbara Rivers, Barrier Island between Dodo and Nun Rivers, and Opobo area). In Côte d'Ivoire: two hotspots (Ebrié Lagoon and the eastern part of the littoral) and three sensitive areas (Aby and Grand-Lahou Lagoons and the maritime zone under national jurisdiction). In the hotspots the major issues are nutrients, sewage, and solid wastes. In oil-producing countries, operations related to oil exploration, extraction, storage, and transport give rise to oil pollution hotspots, such as the Niger Delta. Significant point sources of marine pollution have been detected around coastal petroleum mining and processing areas, where large quantities of oil, grease, and other hydrocarbon compounds are released into the coastal waters of the Niger Delta and off Angola, Cameroon, Congo, and Gabon (GCLME 2003).

Has the situation concerning the GPA issues improved or worsened during recent years?

In general, the situation concerning the GPA issues has worsened in recent years. Over the past decade, human population, urbanization, and industrialization have increased in the WACAF region. So too have the associated pressures on the environment, aggravated by the lack of adequate data and information and limited human, financial, and technological resources. This trend is best illustrated by the increase in the quantity of sewage entering the coastal environment from coastal urban centres, which have shown significant growth in recent decades. The increasing occurrence of HABs is indicative of intense eutrophication from anthropogenic activities. Other pollution indicators such as tar balls and the quantity of marine debris have also increased. In addition, habitat destruction has also increased, as a result of the intensification of development activities in coastal areas. The issues identified by UNEP (1999) continue to be a priority, as a consequence of the persistence of the constraints to effective environmental management in the region.

Has progress been made in protecting the marine environment during the last 10 years?

Progress in the protection of the marine environment from land-based activities is evident in past and ongoing efforts to obtain data and information through projects such as GIWA, the Afribasins initiative, the GoGLME project, and the on-going GCLME project. The latter is an ecosystem-based effort to assist countries adjacent to the GCLME to achieve environmental and resource sustainability. New environmental policies and legislation related to the protection of the marine environment have also been developed. However, slow implementation, enforcement, inadequate monitoring, and lack of data and information have impeded progress in protecting the marine environment from land-based sources of pollution. Several international NGOs such as the Worldwide Fund for Nature (WWF) and Wetlands International have programmes in the WACAF region aimed at conserving and protecting sensitive areas from degradation; these support activities of national governments who have established coastal Ramsar sites. The existing network of marine protected areas (MPA) from Mauritania to Guinea comprises nine national parks, 10 nature reserves, two large biosphere reserves, and a number of traditional sacred areas. Other countries have equally complex systems of protected areas.

The way forward

The way forward is for several management and policy interventions to be undertaken in order to mitigate the degradation of the coastal environment in the WACAF region. Over the past two decades the need for these kinds of interventions has been reiterated by reviews such as this. It is unfortunate that despite clear indications of the magnitude, growth, and negative impacts of coastal degradation, very little is being done to mitigate them apart from a few demonstration projects. The following should be considered in planning the way forward:

- Obligatory sustainable wise use practices to conserve coastal resources. More coastal and marine protected areas should be established not only to minimize human impacts but also to provide sites for research to better understand coastal processes;
- Ecosystem level research, which is necessary for fundamental understanding of the natural and human-induced processes operating in coastal environments, accompanied by comprehensive monitoring and research to identify impacts and to develop remedial actions for coastal zone improvement;
- Tighter regulations to control inflow of nutrient and chemical contaminants to coastal habitats coupled with enforcement of penalties imposed for illegal and unsustainable development that impacts these habitats;
- Education programmes on the social, economic, and ecological value of the region's coastal and marine habitats and their resources; and
- Improved dialog and interaction between scientists, policy-makers, and resource managers to ensure informed decisions regarding the management of coastal environments.

There are many examples of the congruence between the problems, challenges, and opportunities regarding the freshwater environment and those faced by the GPA, e.g., many of the concerns relating to sewage and/or wastewater are similar, as are many of the issues surrounding governance, financing, capacity building, and partnerships with the private sector. Therefore, cooperation between the freshwater community and the GPA is needed to achieve true integration of river basin and coastal area management. It is by working in such a manner that the tremendous potential for synergy generated by a cooperative effort can be realized.

The Environment Initiative of the New Partnership for African Development (NEPAD) and Bodies of the African Union such as the African Ministerial Conference on the Environment (AMCEN) and the African Ministerial Conference on Water (AMCOW) offer an opportunity for the last four of the eight constraints listed above to be addressed. The need for effective environmental practices and product substitutes, adequate legislation, and regulatory measures, as well as good economic instruments and incentives, cannot be addressed in isolation. Issues relating to fair trade, the World Trade Organization (WTO) General Agreement on Tariffs and Trade, and the negative impacts of globalization on developing economies also need to be addressed. All of the above require long-term planning and the use of monitoring and evaluation systems that can inform WACAF decision-makers if progress is being made towards meeting the development needs of their people and achieving the goals of the GPA.

Authors

Prof. Chris Gordon
Centre for African Wetlands/Zoology Department, University of Ghana, Legon, Accra, Ghana
Tel: + 233 21 512835/6; Fax: + 233 21 512837; e-mail: cgordon@ug.edu.gh

Prof. Chidi Ibe
Guinea Current Large Marine Ecosystem Project PMB CT 324, Accra, Ghana
Tel: + 233 21 781335; Fax: +233 21 781226; e-mail: c.ibe@unido.org

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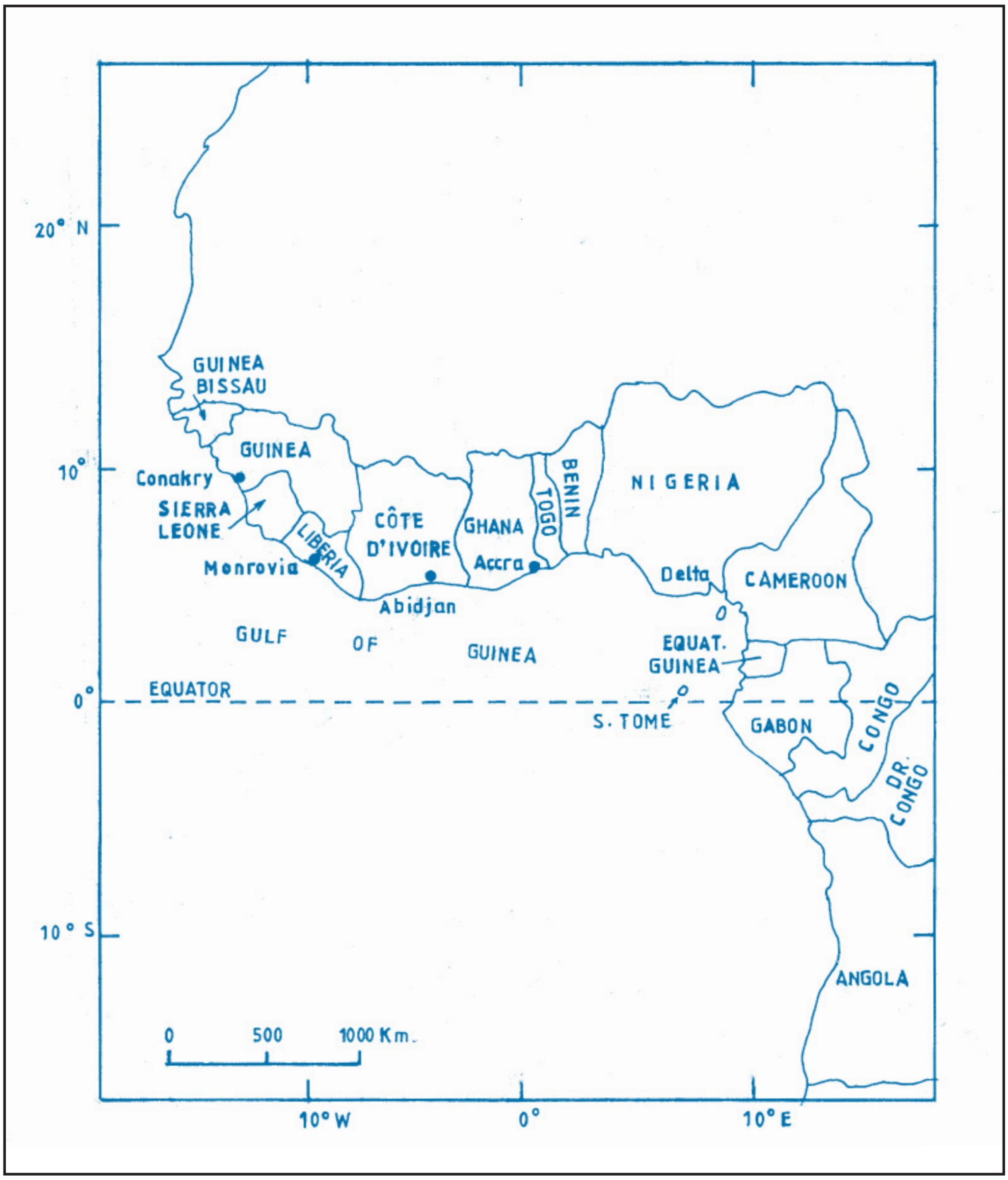
Figure 1.1

Coastal countries of West and Central Africa



(Source: GCLME 2003)

Figure 1.2

UNDP Human Development Index for selected WACAF countries

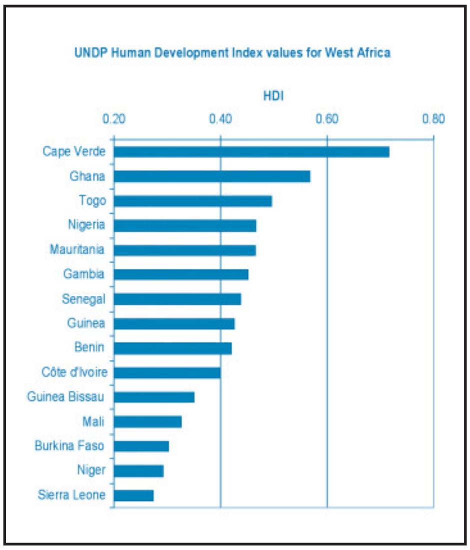


Figure 1.3

Urbanization in selected WACAF countries

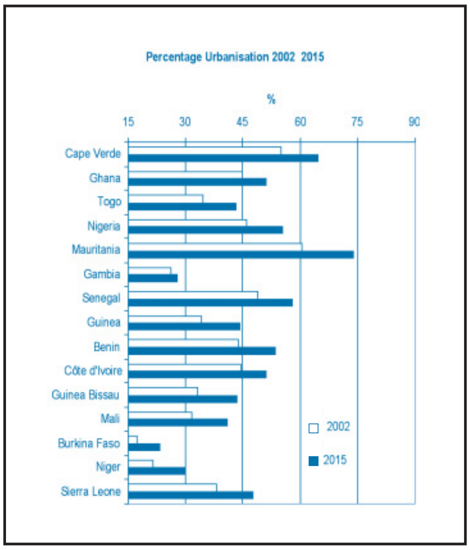
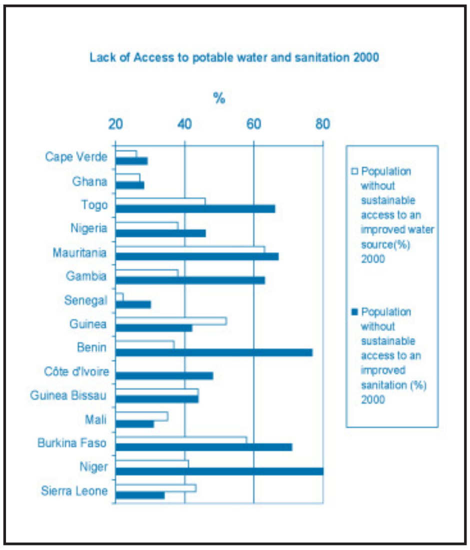


Figure 1.4

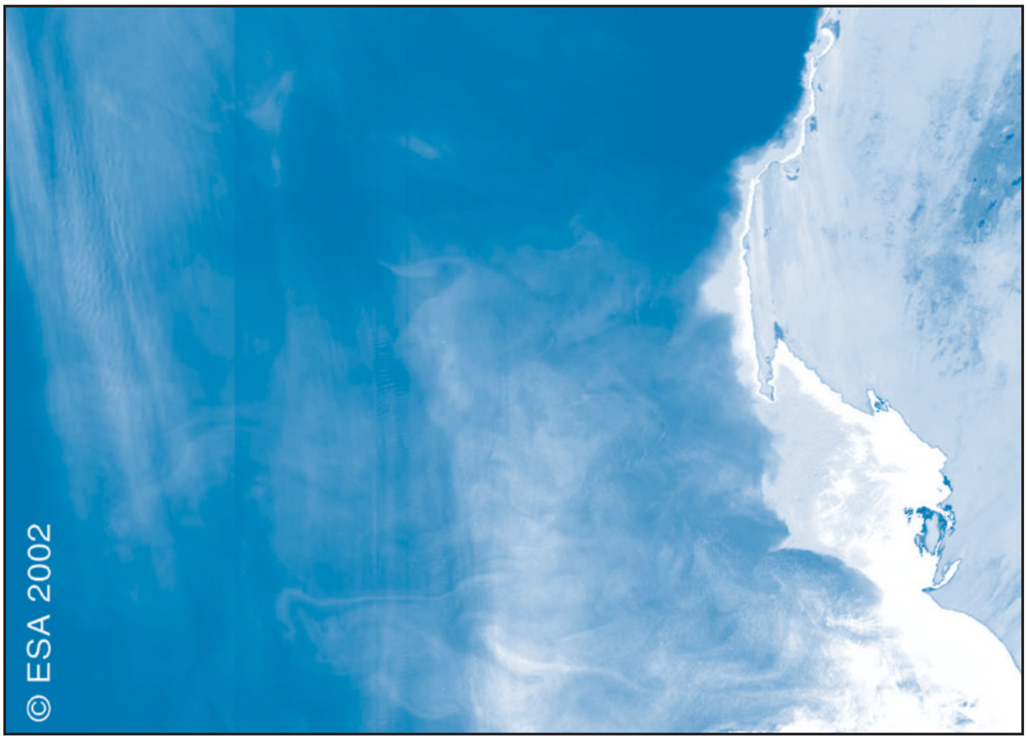
Potable Water and Sanitation in selected WACAF countries



(Source: UNDP 2004)

Figure 1.5

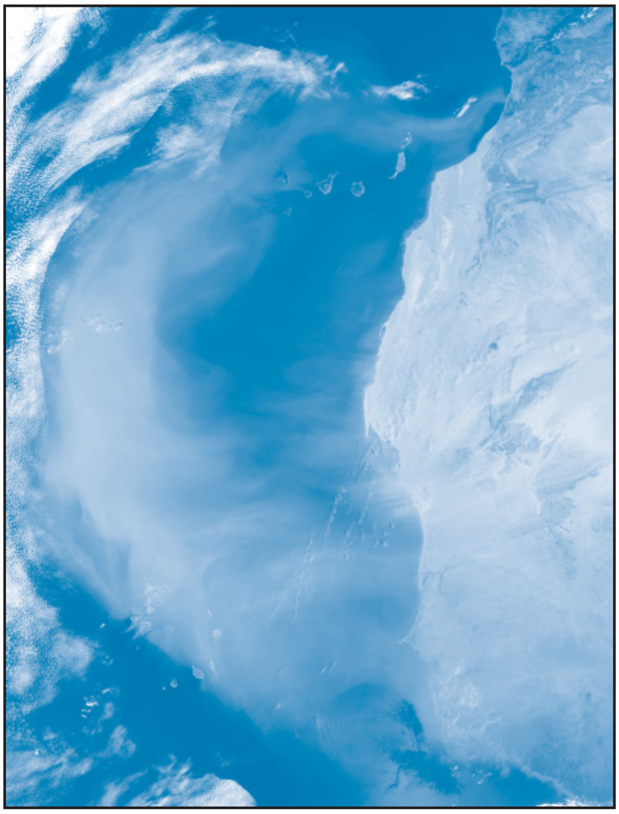
Algal blooms in the Atlantic Ocean caused by input of allochthonous nutrients



(Source: ESA 2002)

Figure 1.6

Aeolian transport of dust from the Sahara across the Atlantic Ocean



(Source: ESA 2002)

Table 1.1

Number of open space vegetable farmers in selected cities and their surroundings in West Africa

Cities	No. farmers
Lomé	1,500
Cotonou	570
Accra	1,000

(Source: Modified from Cofie and others 2003)

Table 1.2

Quality of irrigation water in several WACAF sites

Sampling Site	Distance from city centre (km)	Conductivity (µS/cm)	Nitrogen (NH_4 +NO_3) (µg/l)	Phosphorus PO_4-P (µg/l)	Faecal Coliform x 10^6 (MPN/100 ml)
Kaase	4	1,203	104.5	11.3	11.3
Asago	9	1,336	118.9	51.7	51.7
Adwaden	18	931	78.6	75.4	75.4
Ofoanase	32	849	78.1	47.7	47.7

(Source: Modified from Cofie and others 2003)

Table 1.3

Faecal coliform counts in the Sakumo Catchment

	Faecal Coliform (No./100ml)							
Month/Site	MAD	MOT 1	LAS	MAM	KAT	MOT 2	SAK 2	SAK 1
Nov-02		170	210	275	670	1,680	560	250
Dec-02	105	195	205	225	170	185	340	185
Jan-03	75	50	35	700	800	130	100	10
Feb-03	880	660	220	200	260	4,000	640	60
Mar-03	500,000	5,920	80	20	No data?-	112,000	0	0
May-03	96,000	1,050	4,300	350	950	152,000	50	150

(Source: Yawson 2004). [MAD - Madina; MOT 1 - Motoway Site 1; MOT 2 - Motoway Site 2; LAS - Lashibi; MAM - Mamahuma dam; KAT - Katamanso; SAK 1 - Sakumo site 1; SAK 2- Sakumo site 2)

Table 1.4

Water use and wastewater treatment in some WACAF coastal cities

City - Country	Per capita water used/day (litres)	% wastewater treated
Luanda- Angola	50	0
Porto Novo- Benin	22	No data
Douala- Cameroon	33	5
Yaounde- Cameroon	61	20
Abidjan- Cote d'Ivoire	111	58
Libreville- Gabon	100	0
Accra- Ghana	40	0
Conakry- Guinea	50	0
Lagos- Nigeria	80	No data
Lomé- Togo	35	No data

(Source: Modified from GCLME 2003)

Table 1.5

Typical levels of organochlorine compounds in coastal waters and coastal lagoon systems in the WACAF

Sample	Aldrin	Dieldrin	endrin	heptachlor	lindane	DDT	PCB
Sediment (ppb)							
Ebrié Lagoon, Abidjan	No data	No data	No data	No data	0.5-19	1-997	2-213
Lagos Lagoon, Lagos	19.3	28	12	28	No data	No data	No data
Lekki Lagoon, Nigeria	ND-347	190-8460	ND-129	190-8460	0.11-4.9	No data	No data
Shellfish (ppb)							
Ebrié Lagoon, Abidjan	19.9-132	13.5-168	6.1-74.0	13.5-168	12.5-93	No data	8.9-43.9
Ocean at Limbé, Cameroon	ND-12.0	No data	No data	No data	ND-5.3	ND-481	ND-716

(Source: Scheren and Ibe 2002). ND- not detected

Table 1.6

Typical levels of heavy metal pollution in some coastal lagoon systems in the Guinea Current LME

Sample	Cadmium	Chromium	Copper	Iron	Mercury	Manganese	Lead	Zinc
Sediment (µg/g dry weight)								
Lagos Lagoon, Nigeria	0.01-15.5	2.9-167	1.5-132	510-85 548	ND	98-2757	0.4-483	7.8-831
Ebrié Lagoon, Côte d'Ivoire	ND	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
Aby Lagoon, Côte d'Ivoire	ND	ND	ND	ND	0.0-16.5	ND	ND	ND
Unpolluted sediments	0.2-5	ND	ND	ND	0.01-0.08	ND	8-60	ND
Water (µg/l)								
Korle Lagoon, Ghana (median)	0.24	ND	0.31	ND	ND	ND	0.08	0.08
Lagos Lagoon, Nigeria (median)	0.002	ND	0.003	0.086	ND	0.021	0.009	ND?
Natural sea water levels	0.005	ND	0.003	ND	ND	ND	0.003	0.02
Shellfish (µg/g fresh weight)								
Lagos Lagoon, Legos (median)	0.18	ND	23.6	ND	ND	ND	5.1	240
Ebrié Lagoon, Côte d'Ivoire	0.35-0.95	ND	17.5-33.5	ND	0.07-0.19	ND	ND	608-2 155
WHO Guidelines	2	ND	30	ND	2	ND	2	1,000
						Mercury	**Arsenic**	**Selenium**
Fish (µg/g fresh weight)								
Aby Lagoon, Côte d'Ivoire						0.07-0.39	0.05-0.13	0.29-0.54
WHO Guidelines						50	ND	ND
Vegetable species (µg/g dry weight) e.g., Pistia stratiotes (Water lettuce)								
Aby Lagoon, Côte d'Ivoire						0.82	7.42	4.40

(Source: Scheren and Ibe 2002). ND- not detected

Table 1.7

Sediment yield of some WACAF rivers

River	Country	Sediment yield (tonnes/km^2/yr)
Fafa	Central African Republic	3.1
Chari	Chad	3.9
Bangoran	Central African Republic	4.4
Gribingui	Central African Republic	5
Rima	Nigeria	7
Senegal	Senegal	8
Bahr Sar	Chad	8.4
Ouham	Central African Republic	9.4
Logone	Chad	14.9
Sanaga	Cameroon	20
S. Pedro	Ivory Coast	22
Tano	Ghana	22
Niger	Nigeria	33
Faleme	Mali	40
Volta	Ghana	48
Mbam	Cameroon	85
Tsanaga	Cameroon	210
Sokoto	Nigeria	212
Gagare	Nigeria	225
Zamfara	Nigeria	344
Bunsuru	Nigeria	438
	Nigeria	483

(Source: FAO 2005)

Table 1.8

Estimated total solid waste and sludge generation by industry and households in the Port Harcourt area (tonnes/yr)

	Medium and large-scale industries	Households and small industries
Putrescible waste	6,495	95,625
Non-hazardous waste	1,796	31,875
Hazardous waste	127	No data
Non-hazardous sludge	990	No data
Hazardous sludge	13,617	No data

(Source: Ashton-Jones and Oronto 1994)

Table 1.9

Debris from beaches in the WACAF region

Country	Debris collected (kg)	Length of beach cleaned (km)	Weight of debris (tonnes) per km
Cameroon	7,422	0.7	10.6
Côte d'Ivoire	2,275	0.9	2.5
Nigeria	1,419	1.6	0.9

(Source: Modified from Awosika 2002)

Table 1.10

Categories of debris collected during the 1995 beach clean-up at Victoria Beach, Lagos, Nigeria (Total weight of debris collected: 1,260.9 kg)

Categories of debris	Number of pieces	% composition of total
Plastics	6,768	31.86
Foamed plastics	2,161	10.17
Glass	1,462	6.88
Rubber	1,563	7.36
Metal	2,664	12.54
Paper	3,542	16.67
Wood	2,219	10.45
Cloth pieces	862	4.04
TOTAL	**21,241**	**99.99**

(Source: Awosika 2002)

Table 1.11

Oil industry activities by Shell Petroleum and mangrove conversion in State River, Nigeria

Activity	Area of mangrove converted (km^2)
Seismic Operations (56,400 km of seismic lines)	56.4
Drilling (349 drilling sites)	4.5
Production 700 km of flow lines 400 km of pipelines 22 flow stations 1 oil terminal	10.5
Total (=1% of mangroves in State River)	**71.4**

(Source: van Dessel and Omuku 1994)

2 - Southern Africa

INTRODUCTION

For the purposes of this assessment the Southern Africa region comprises Angola, Namibia, and South Africa (Figure 2.1). The Angolan coastline stretches over a distance of about 1,650 km from the border with the Democratic Republic of Congo in the north to the Kunene River in the south. Situated to the north of the Congo River is the province of Cabinda with a coastline of 150 km. The coastal zone ranges from desert in the southern more temperate zone to a typical tropical regime in the north. In the south the oceanic regime is dominated by the productive cold Benguela Current, while the north is mainly influenced by the warm Angola Current. Bays are generally shallow indentations in the otherwise straight coastline. The only deeply indented bay is at Namibe in the south. Most of these sheltered bays are protected by northward trending sand spits such as those at Luanda, Lobito, and Tombwa. There are about 22 estuaries that are permanently or seasonally open to the sea (Morant 1999, Sardinha 2000).

The coastline of Namibia extends over a distance of about 1,500 km from the Kunene River in the north to the Orange River in the south (Boyer and others 2000). The Namib Desert, the world's oldest arid region, lies along Namibia's entire coast. Except for the Kunene and Orange rivers, there are no other perennial systems along the Nambian coast, although there are about 9 ephemeral systems (Morant 1999).

The coastline of South Africa is about 3,000 km long, stretching from the Orange River on the west coast to Ponta do Ouro on the east coast. Two major circulation oceanic systems bound the South African coastline: the warm south-flowing Agulhas Current along the east and south coasts and the cold north-flowing Benguela Current along the west coast (Figure 2.2). The South African coastline is very rugged, with few sheltered embayments and is dominated by high wave conditions and strong winds for most of the year. Along this coastline some 250 estuaries represent much of the only sheltered marine habitats; as a result they are important for biodiversity protection, as well as the focus of coastal development.

MAJOR PRESSURES ON THE MARINE ENVIRONMENT

According to Sardinha (2000), the major pressures on the marine environment along the Angolan coast are:

- Informal settlements and associated sewage and solid waste pollution;
- Offshore oil and gas exploration where the discharge of drilling muds and cuttings, as well as of produced water (containing pollutants such as volatile organic compounds and poly-aromatic hydrocarbons) are a concern;
- Overexploitation of fisheries; and
- Physical modification of coastal habitats (e.g., through erosion).

As a consequence of the civil war, the majority of the population in Angola moved to the Atlantic coast where many reside in informal settlements surrounding the urban centres along the coast. Roughly 20% of the total population currently lives in the capital city of Luanda, although other coastal towns have growing populations. A shortage of potable water in these coastal centres is likely to be another consequence of the rapid pace of urbanization. Because of poor urban infrastructure, there is a very real danger that this rapidly expanding urban population will pose a serious pollution threat to the inshore marine environment.

With a predominantly semi-arid climate, the coastal regions of southern Angola, Namibia in its entirety, and the west coast of South Africa have a relatively limited agricultural potential. This implies that, in the absence of other income-generating opportunities, the population relies increasingly on the sea for its livelihoods or subsistence, particularly in Angola. On the east coast of South Africa the growing population also places increasing pressure on the inshore environment.

Pollution threats to the coastal and marine environments in Namibia are generally low and at present are mainly linked to development nodes along the coasts, in particular Walvis Bay and Lüderitz. Potential threats to these environments include:
- Biodegradable organic pollutants introduced by fish processing plants in Walvis Bay (16 factories) and Luderitz (7 factories) (Boyer and others 2000);
- Oil pollution associated with shipping traffic in and around the ports at Walvis Bay and Luderitz;
- Garbage (including plastics) and sewage disposal from ships anchored nearshore; and
- Accidental sewage spills (as far as could be established there are no piped sewage discharges into the marine environment).

Marine and coastal diamond mining between Lüderitz and the Orange River mouth is probably the main activity responsible for coastal habitat modification and destruction along the Namibian coast.

South Africa has an estimated population of 40 million people, about 30% of which lives within 60 km of the coast. The major issues threatening South Africa's coastal and marine environments were identified during a study conducted as part of a GEF project (Clark and others 2001).
These are, in order of importance:
- Reduction in the quantity and quality of available freshwater entering estuaries and the marine environment (mainly through river runoff);
- Overexploitation of marine living resources;
- Loss and modification, including physical alteration and destruction of habitats, primarily as a result of urban development; and
- Marine pollution.

In terms of marine pollution the major threats (or potential threats) relate to:
- Maritime transportation (e.g., accidental and deliberate oil spills and dumping of ship garbage);
- Contaminated stormwater runoff (e.g., from informal settlements and hard surfaces in urban areas);
- Inappropriate sewage (or municipal wastewater) discharges;
- Industrial discharges (including fish factories and other chemical industries);
- Dumping at sea, particularly dredge spoil; and
- Possible atmospheric sources.

In summary, the main land-based activities posing threats (or potential threats) to the marine environment in Southern Africa include:
- Disposal of **untreated sewage**, either through diffuse inputs from informal settlements or through effluents discharged from malfunctioning sewage treatment plants;
- **Coastal developments** (urbanization) and coastal mining activities, contributing to the modification and destruction of coastal habitats;
- **Water abstraction** (e.g., dams) resulting in a reduction in freshwater inflow to the marine environment (including estuaries). This, in turn, causes a reduction in the amount of sediment and nutrients that would naturally have reached the sea;

- **Inappropriate agricultural practices**, resulting in the deterioration in the quality of the river water entering the marine environment, e.g., by introducing toxic substances and excessive nutrients (from the inappropriate use of pesticides and fertilizers) and increased suspended solid loads as a result of soil erosion;
- **Contaminated stormwater runoff** from large urban areas along the coast, introducing toxic substances such as trace metals and oils (hydrocarbons) to the marine environment;
- **Industrial wastewater discharges** (mainly fish factories and oil refineries) introducing a range of pollutants to the marine environment, depending on the industry type; and
- **Fossil fuel fires** (large informal settlements) and traffic emissions (large urban areas) possibly introducing pollutants to the marine environment via the atmosphere.

As previously highlighted, **overexploitation of living marine resources, offshore oil and gas exploration**, and **activities associated with maritime transportation** pose an equally serious threat to the marine environment of Southern Africa, if not greater than those listed above. However, these are not considered to be land-based and are therefore not discussed further in this assessment.

DEVELOPMENT OF LEGAL AND INSTITUTIONAL FRAMEWORK

An informative historical perspective on policy responses to environmental issues on the African continent is provided in UNEP (2000). As far as could be established, current legislation in Angola specifically dealing with land-based sources of marine pollution is limited to that concerning oil and gas exploration in accordance with the Ministry of *Petroleum's Regulations on Operational Discharges Management*, issued under Article 23 of the Decree on Environmental Protection for the Petroleum Industry. Environmental aspects related to oil and gas exploration and production operations in Angola are regulated by the Ministry of Petroleum in collaboration with the National oil company, Sociedade de Combustiveis de Angola U.E.E (SONANGOL) (Morant 1999).

With the promulgation of the General Environmental Law in Angola, responsibility for the implementation of national environmental policy rests with the Ministry of Urban Planning and Environment and the Ministry of Fisheries. The Ministry of Petroleum, which administers the Decree on Environmental Protection for the Petroleum Industry, has also engaged with the International Maritime Organization (IMO) and the International Petroleum Industry Environmental Conservation Association for assistance in formulating a National Contingency Plan for the prevention and management of oil pollution in Angola (Sardinha 2000).

In Namibia, there is currently no legislation dealing specifically with the control of land-base sources of pollution. Existing legislation addressing waste management and pollution control is complicated and scattered in a variety of statutes and regulations, most of these being the old South African laws. There is also a lack of clarity as to which legislation applies and which ministry or institution is responsible for particular issues. However, in 1999, a Pollution Control and Waste Management Bill was drafted, designed to address these deficiencies and consolidate the legal framework, as well as to address the institutional fragmentation. Once this is implemented, it would make provision for the Integrated Pollution Control Licence as well as regulations for the storage, transport, management, and disposal of waste.

In terms of combating oil pollution - including that which may come from activities in the harbours at Walvis Bay and Lüderitz - Namibia formulated a National Oil Spill Contingency Plan that provides the framework for the national response to oil spills. This contingency plan is coordinated by the Government Action Control Group housed in the Directorate of Maritime Affairs in the Ministry of Works, Transport, and Communication.

In the past 10 years, South Africa's greatest effort in combating the impact of land-based activities on the marine environment has been in the development of sound environmental policies and legislation. For instance, in 1998, the National Water Act, which placed a strong emphasis on resource management, was promulgated. Protocols and policies that have since been promulgated under this Act relating to the management and control of impacts from land-based activities on the marine environment (including estuaries) include:

- *Methodology for the Determination of the Ecological Water Requirements for Estuaries* (RSA DWAF 2004a);
- *Operational Policy for the Disposal of Land-derived Wastewater to the Marine Environment of South Africa* (RSA DWAF 2004b). This operational policy outlines the Department of Water Affairs and Forestry (DWAF) new thinking in relation to discharges to the sea. In line with international trends and the national objective of efficient and effective management of South Africa's resources, priority is given to a receiving water quality management approach. The policy provides Basic Principles and Ground Rules as a framework within which disposal practices for land-derived water containing waste will be evaluated when marine disposal is a possible alternative for the disposal of wastewater. It also provides a management framework within which such disposal needs to be conducted (RSA DWAF 2004c); and
- *A Guide to Non-point Source Assessment* (Pegram and Görgens 2001) and *Managing the Water Quality Effects of Settlements* (RSA DWAF 1999). Of particular concern is contaminated runoff from informal settlements. To this end the DWAF, currently responsible for the management and control of pollution from land-based sources in South Africa (including stormwater runoff), has prepared these guidance documents.

The White Paper for Sustainable Coastal Development for South Africa (April 2000) also sets out a policy that aims to achieve sustainable coastal development through integrated coastal management. The policy is currently being defined in the National Environmental Management: Coastal Zone Management Bill to provide better control of coastal development without compromising economic development and job creation. South Africa also enforces Environmental Impact Assessment (EIA) Regulations (under the Environmental Conservation Act) whereby new coastal developments are required to undergo an EIA before authorization.

South Africa's Department of Environmental Affairs and Tourism (DEAT) has also proposed a National Environmental Management: Air Quality Bill that will introduce a comprehensive air quality management system for South Africa (www.info.gov.za/documents/bills/2003.htm). The new legislation will address the protection of the environment against air pollution as well as the cumulative impact of pollutants on the receiving environment, including the marine environment. DEAT is faced with the challenge of trying to leap from a 1960s control programme to a modern air quality management programme.

The DEAT Marine and Coastal Management also recently initiated a State of the Coast reporting programme for the marine and coastal environments of South Africa. The aim of this initiative is to compile the first State of the Coast Report for South Africa. The report will address numerous issues facing the marine and coastal environment and will use environmental indicators to track changes in a range of natural and anthropogenic components over time. More detail on this project can be found at http://dbn.csir.co.za/soc.

The Benguela Current Large Marine Ecosystem (BCLME) Programme (www.bclme.org) is currently playing a key role in institutional collaboration in Angola, Namibia, and South Africa. For example, one of its projects, Base-Line Assessment of Sources and Management of Land-Based Marine Pollution in the BCLME Region, is specifically aimed at assessing the current status, identifying gaps, and proposing a standardized framework for the management of land-based marine pollution sources in the region.

STATE OF THE MARINE ENVIRONMENT RELATED TO THE GPA ISSUES

Available and readily accessible information was reviewed to highlight trends over the past 10 years and emerging issues on the state of the marine environment in Southern Africa in relation to the nine source categories of the GPA: sewage, POPs, radioactive substances, heavy metals, oils (hydrocarbons), nutrients, sediment mobilization, litter, and PADH. The assessment focused on these categories in so far as key land-based activities were responsible for such trends and emerging issues (some of the pollutant categories can also be affected by activities at sea, e.g., offshore maritime transportation).

A category that currently is not included in the GPA but which constitutes a land-based impact that affects the marine environment (particularly estuaries) of Southern Africa, is the reduction in freshwater inflow. This was also assessed.

Sewage

No data on the volume of sewage disposed of in the marine environment (either directly or through river outflow) could be located for Angola. As has been reported, a large portion of the Angola's population moved to the coast during and after the civil war (post-1974). As a result of poor urban infrastructure, untreated sewage is most likely discharged into the sea in increasing volumes. Using the estimated population increase of Angola as a proxy (Figure 2.3), the volume of untreated sewage entering the marine environment, particularly in the vicinity of Luanda and other larger coastal towns such as Benguela, Lobito, Namibe, and Cabinda would have increased markedly over the past 10 years.

In Namibia, pollution of the marine environment from land-derived sewage is not considered a major concern as the population densities along the coast are low and concentrated in a few development nodes (Henties Bay, Swakopmund/Walvis Bay, and Lüderitz). Being a water-scarce area, residual or grey water is usually re-used after treatment (e.g., for watering of gardens and golf courses). A portion of the treated sewage effluent from Swakopmund is disposed of in the sea (estimated at about 350,400 m^3/yr). Localized pollution incidents, however, do occur and are mainly linked to drain seepage and overflow from malfunctioning pump stations.

In South Africa disposal of sewage to the marine environment ranges from preliminary treated sewage discharged offshore, to secondarily treated effluent discharges to the surf zone and estuaries, to untreated sewage entering the marine environment from informal settlements through stormwater runoff. A summary of the estimated annual volumes is provided in Table 2.1. Data indicate that there has been no marked increase in the volume of sewage discharged to offshore areas, although over the past 10 years disposal to estuaries and the surf zone has almost doubled and tripled, respectively, reflecting the rapid population growth in coastal areas along the South African coast during this period.

The design of offshore sewage outfalls in South Africa since about 1985 has followed the receiving water quality objectives approach where effluent quantities and composition must be within limits that would meet site-specific Environmental Quality Objectives, as recommended in the *South African Water Quality Guidelines for Coastal Marine Waters* (RSA DWAF 1995). Long-term environmental monitoring programmes at these outfalls (as part of the licence agreements) have indicated no detrimental impact on the marine environment. Of greater concern is the rapid increase in discharges to less dynamic and sensitive areas such as the surf zone and estuaries, where effluents from malfunctioning or overloaded treatment facilities are adversely affecting the marine environment, albeit in a localized manner. However, the newly-adopted operational policy for the disposal of land-derived wastewater will, in future, also require better management and control of these systems.

Untreated sewage that enters the marine environment from informal settlements, although probably comprising a relatively small component of the total sewage load to the marine environment, remains a concern, particularly in the larger coastal cities such as Cape Town, Port Elizabeth, and Durban. Attempts are being made by local authorities to link as many dwellings as possible to sewage reticulation systems, but the demand continues to outgrow the supply.

Bathing beaches within the larger urban centres in South Africa (e.g., Cape Town and Durban) are regularly monitored by the local authorities. As is probably the case in many of the other urban centres in the region, contaminated stormwater runoff is considered the main cause for non-compliance with recommended water quality criteria. However, to protect the safety of bathers continuous efforts are being made to improve this situation, as demonstrated at beaches in False Bay, Cape Town (Table 2.2).

Persistent Organic Pollutants (POPs)

In Southern Africa river runoff from catchments where agriculture is the major land-use is probably the greatest source of land-derived POPs (mainly pesticides) to the marine environment. Agricultural activities in Angola are mainly related to small-scale subsistence farming. River runoff is therefore not considered to be a major source as pesticides are not used on a large scale. In Namibia, the Orange River, at its border with South African is considered the most important source of pesticides to the marine environment since its catchment drains excessive agricultural areas in South Africa (Vetter and others 1999).

No quantitative data could be located on pesticide loads entering the marine environment from rivers along the South African coast. The lack of data is partly as a result of the high cost involved in analysing such pollutants on a routine basis. Since agriculture is a major land-use activity in the country, river runoff is likely to contribute to POPs loads (in particular pesticides) entering the marine environment. In the subtropical and tropical regions of Africa, DDT has also been re-introduced to combat mosquitoes and needs to be highlighted as a potential source of POPs to the marine environment.

Being relatively insoluble in water, POPs enter the food chain and accumulate in fatty tissues of higher trophic levels (e.g., marine mammals). Pesticides have been detected in fatty tissues of seals and dolphins along the Namibian and South African coast (Vetter and others 1999), although, in general, levels were not considered to reflect serious pollution.
Radioactive substances

No data on the status or trends of radioactive pollutants entering the marine environment from land-based activities could be located for the Southern African region. However, at present it is not considered to be a major concern as there is currently only one nuclear power station, which is subjected to strict legislation (www.radwaste.co.za/regulation.htm), in the region situated near Cape Town (RSA DWAF 2004b).

Heavy metals and oils (hydrocarbons)

Land-based activities that introduce both heavy metals and oils (hydrocarbons) to the marine environment in Southern Africa are considered to be much the same and are therefore discussed simultaneously. Key land-based activities that are potential contributors to trace metal and oil (hydrocarbon) loads into the marine environment in the region include:

- Industrial wastewater (e.g., associated with harbour activities and oil refineries);
- Contaminated stormwater runoff from urban areas (Taljaard and others 2000); and
- Runoff from rivers used for maritime transportation.

Quantitative data on the status of the marine environment related to heavy metal and oil pollution could not be located for either Angola or Namibia. In Namibia such pollutants are introduced to the marine environment mainly through activities in the harbours at Walvis Bay and Lüderitz, but are not considered to be a major issue elsewhere along the coast. In Angola oil refineries and other oil production facilities are located at numerous places along the coast, mainly from Luanda northwards (UNEP 1999), and are likely sources of heavy metals and oils to the marine environment. The Congo River, along the northern border of Angola, is the only shipping route into the Democratic Republic of the Congo and is likely to contribute to the heavy metal and oil loads in the marine environment, but this is difficult to quantify at present.

The estimated volumes of industrial wastewater discharges likely to introduce heave metals and oils to the marine environment in South Africa are presented in Table 2.3. Oil refineries are located in Cape Town, Mossel Bay, and Durban, while chemical, textile, and wood pulp plants and aluminium smelters are mostly concentrated along the east coast (Durban and Richards Bay). The last quantitative assessment of stormwater runoff to the marine environment for South Africa was done in 1991 (CSIR 1991). Estimated stormwater volumes and associated trace metals and oil loads from some of South Africa's larger urban centres are given in Table 2.4. Taking into account the vast increase in coastal populations over the past 10 years, it is expected that the volume of stormwater runoff (as a result of the increase in hard surfaces) and associated trace metal and oil loads are likely to have increased since 1991.

In order to assess the actual long-term impacts of anthropogenic trace metal loads on the marine environment, DEAT has been conducting a mussel watch programme along South Africa's west coast (currently the long-term monitoring programme does not include oils-hydrocarbons). As monitoring sites are located along the shoreline, the mussel watch is probably a good indicator of land-based inputs of heavy metals. Results from different stations tend to show similar results, as illustrated in the example from a station near Cape Town (Figure 2.4). Results for Cd, Pb, Zn, and mercury (Hg) did reflect inter-annual variations, but as yet no clear long-term (increasing) trends seem to be apparent.

Nutrients

The major source of nutrients (inorganic nitrogen and phosphorous) to the marine environment in the Southern African region include:

- Sewage (including untreated sewage through diffuse stormwater runoff (particularly from informal settlement areas);
- River runoff from catchments where agriculture is the major land-use; and
- Industrial wastewater discharges, in particular fish processing industries.

As already discussed, in Angola the increase in the volume of untreated sewage and associated nutrients entering the marine environment, particularly in the vicinity of Luanda and other coastal towns would have increased markedly over the past 10 years, consistent with the estimated population increase. Agricultural activities in Angola consist mainly of small-scale subsistence farming. Since fertilizers are not used on a large scale, river runoff is not considered to be a major source of nutrients. A recent study by the World Commission on Water for the 21st Century revealed that among other international rivers, the Congo River, along the northern border of Angola, is still relatively unpolluted in terms of agricultural irrigation (nutrients), industrial waste, and sewage, as there are few industrial centres along its banks (Environmental News Service 1999).

Nutrient input to the marine environment through land-derived sewage and river runoff is not a major concern in Namibia. The only perennial rivers are the Orange and Kunene on the South African and Angolan borders respectively, and, being a water scarce country, sewage wastewater is largely re-used after treatment. However, areas like Walvis Bay and Lüderitz support numerous fish factories. Sixteen such factories at Walvis Bay and seven at Lüderitz discharge nutrient-rich effluents to the marine environment. Although no easily accessible data could be located on nutrient loads from these industries, the loads are largely dependent on annual fish landings and therefore vary from year to year.

Rough estimates of changes in nutrient loads entering the marine environment of South Africa over the past 10 years are presented in Table 2.5. Currently most of the routine sampling of nutrient levels in South African rivers is focused on inland surface water resources, which are often not representative of the levels that ultimately enter the marine environment due to marked changes in water quality between the sampling point (far upstream in the catchment) and the sea. Nutrient loads from smaller catchments probably also have their greatest impact on estuaries. These estuarine systems act as purifying systems where nutrients from the catchment are absorbed, resulting in cleaner water entering the sea. This nutrient removal function is manifested in excessive weed growth or phytoplankton blooms in estuaries, rather than in the adjacent marine environment. This is particularly evident during low flow periods (dry season) when the river water entering the estuaries can have high nutrients levels (e.g., due to agricultural irrigation return flows), as well as longer residence times within the estuaries.

Eutrophication of coastal waters (or signs thereof) is primarily linked to situations where nutrient-rich effluents are discharged directly to the sea. Such situations are limited mainly to the west coast where large volumes of fish factory effluents are discharged into sheltered bays, e.g., Saldanha Bay (Monteiro and others 1998).

Sediment mobilization

Land-based sources contributing (or potentially contributing) to the sediment load in the marine environment in Southern Africa include:

- River runoff (e.g., inappropriate agricultural practices, over-grazing and deforestation resulting in soil erosion); and
- Stormwater runoff (e.g., from informal settlements).

Changes in the sediment load to the marine environment from river runoff over the past 10 years have not been quantified for this region. Similarly, changes in inputs from stormwater runoff are also not properly quantified.

In Angola the sediment loads introduced through river runoff are not likely to have changed markedly over the past 10 years since agricultural and forestry activities in the interior were markedly reduced by the war. In addition, there are no new major dam developments on the Angolan rivers that could have altered sediment loads in the past decade.

Changes in the natural sediment loading to the marine environment over the past 10 years are not considered to be a major concern in Namibia. There are no westward flowing perennial rivers within the borders of the country and being mainly arid, sediment input through stormwater runoff is negligible.

Being a semi-arid country, many of the larger rivers in South Africa have been dammed, potentially reducing sediment loads to the marine environment, depending on the proximity of the dams to the coast. On the other hand, inappropriate agricultural practices in other catchments have contributed to increased sediment loading in the marine environment. Although changes in sediment loads have been estimated for some individual systems, these mainly relate to changes in inputs to estuaries (RSA DWAF 2003a, 2004e, 2004f). These studies have also provided estimates of change from the reference condition (prior to human interference) and do not reflect changes over the past 10 years. Such changes that have occurred in the past decade are considered to be incremental compared to changes in sediment loads over the past 30-50 years. However, the potential impacts of altering catchment-derived sediment loads to the marine environment have been highlighted in South Africa and a number of research initiatives are being planned to address this issue. This is particularly important along the South African east coast where river runoff is considered an important natural source of sediment and nutrients to the inshore marine environment, e.g., Thukela River (RSA DWAF 2004f).

Litter

In Southern Africa urban stormwater runoff is probably the single most important land-based source of litter in the marine environment. Although there are no quantitative data to support this, photographs taken at coastal cities, particularly those with large informal settlements where garbage removal services are lacking, clearly support this observation.

Taking into account the large increase in the population of coastal urban areas in Southern Africa in the past decade (Figure 2.3), it is expected that the litter introduced through urban stormwater runoff would also have increased markedly. To combat such pollution, the South African DEAT is currently embarking on a number of clean-up initiatives along the coast through its Coast Care Programme.

Stormwater runoff is not a major concern in Namibia, but the lack of effective services for collection of garbage from foreign fishing fleets anchored outside port boundaries (e.g., Walvis Bay) results in waste being dumped into the sea causing a serious litter problem on adjacent beaches.

Physical alteration and destruction of habitats

In Angola coastal erosion is considered to be a major concern in terms of the physical alteration and destruction of habitat (PADH). Although natural factors (e.g., storms) contribute to erosion, human activities (e.g., destruction of coastal vegetation, coastal structures erected in sensitive areas) are also a major contributing factor. In large urban areas such as Luanda, Benguela, and Lobito coastal erosion has resulted in considerable damage to infrastructure (UNEP 1999). No quantitative data are available on trends over the past 10 years, but using the increase in population as a proxy and given that most of the population is concentrated in the coastal areas, PADH is probably also increasing accordingly.

Along the Namibian coast destruction of coastal habitats is largely associated with diamond mining activities between Lüderitz and the Orange River mouth. No easily accessible information could be located on trends over the past 10 year. However, two projects under the BCLME Programme - *Data Gathering and Gap Analysis for Assessment of Cumulative Effects of Marine Diamond Mining Activities and Assessment of the Cumulative Effects of Sediment Discharges from On-shore and Near-shore Diamond Mining Activities*- are currently addressing this issue for the BCLME region (focusing on South Africa's west coast and Namibia).

Up until 20 years ago, South Africa differed from many coastal countries in that the centre of industrial activity was located in the interior of the country. Heavy industries developed around the gold mines, which are now becoming economically unviable. As a consequence, coastal areas are being targeted for industrialization, as reflected by the development of Richards Bay and Saldanha Bay and a new industrial node being developed at Coega near Port Elizabeth. Development pressures on the coast therefore have recently increased dramatically, and it is expected that this trend will continue.

Very little of the area above the high water mark along the South African coast has been unaffected by urban and industrial development. Furthermore, the 39% of the coast seen as undeveloped is fragmented and may not function effectively as ecological units (Clark and others 2001). Habitat loss above the high water mark is largely attributed to activities shown in Table 2.6.

Below the high water mark there has been considerably less habitat alteration as a result of development (e.g., ports and mining). Clark and others (2001) estimated that 10% of the total subtidal area of South Africa has been altered and attributed 50% of this to port and marina development, 40% to diamond and mineral sand mining, and 10% to various recreational facilities (e.g., tidal pools). Probably of greatest concern is the impact on intertidal estuarine habitats important for over-wintering Palaearctic migrant bird species.

Should these habitats be severely degraded or destroyed, a drastic reduction in the numbers and even extinction of these species could occur.

In the longer-term sea level rise could result in the elimination of many intertidal areas, particularly estuarine habitats as these become constricted between the rising water level and existing coastal developments.

Reduction in freshwater inflows

Within the Southern Africa region, major impacts of the reduction of freshwater inputs are currently a concern mainly in South Africa. This country is predominantly semi-arid, with an average rainfall of about 450 mm/yr, well below the world average of about 860 mm/yr, while the evaporation rate is comparatively high. As a result, South Africa's water resources are, in global terms, scarce and extremely limited with the combined flow of all the rivers amounting to approximately 49,000 million m^3/yr, less than half of that of the Zambezi River, the largest river close to South Africa (RSA DWAF 2004g).

South Africa depends mainly on surface water resources for its urban, industrial, and agricultural requirements. As a result, surface water resources are extensively exploited throughout most of the country. About 320 major dams with a total capacity of more than 32, 400 million m^3 already account for 66% of the total mean annual runoff (RSA DWAF 2004g). Freshwater runoff is further limited by smaller dams and water abstractions occurring directly from the rivers.

As a result of the high water demand in relation to supply, the freshwater inflow (including floods) reaching South Africa's estuaries and adjacent marine environment has been markedly reduced. This poses a major threat to the functioning of many estuarine systems and hence to the life-cycles of many fish and invertebrate species with an obligate estuarine phase in their life cycles. Lamberth and Turpie (2003) estimated that in 2002, the total value of estuarine and estuary-dependent fisheries was R1.251 thousand million (US$208.5 thousand million). Thus, loss of estuarine functions could have a severe economic impact on inshore fisheries.

Based on recent assessments (CSIR 1998, RSA DWAF 2002, 2003a, 2003b, 2003c, 2004e, 2004f, 2004h), the most important consequences of reduction in freshwater inflows, which in turn affect the ecological functioning and sustainability of these estuarine systems, include:

- Increase in the frequency of mouth closure of temporarily open/closed estuaries (e.g., cutting off important habitats for marine organisms that rely on estuaries for one or more of their life history stages);
- Increase in the extent of saline intrusion in permanently open systems (e.g., changing the salinity regime, which in turn alters the ecological characteristics of estuaries); and
- Increase of siltation in estuaries (due to a decrease in floods, which scour sediments).

Taking into account the increase in water demand over the past 10 years, it is likely that the ecological status of most of South Africa's estuaries have been modified, particularly the smaller systems that require a large proportion of their mean annual runoff to function properly.

A comparison between the health status of 27 South African estuaries assessed in the 1990s (Whitfield 1995, 2000) and more recently (Turpie 2004) showed a decline in the health of six of the 27 estuaries evaluated.

However, Turpie (2004) also concluded that many of South Africa's estuaries are still considered to be in a relatively good state:
- Excellent condition (28%)
- Good condition (31%)
- Fair condition (25%)
- Poor condition (15%)

The distribution of South Africa's estuaries, in terms of their health status, is illustrated in Figure 2.5. Although the deterioration in the health of estuaries in urban areas is probably more related to pollution and habitat destruction, the deterioration in health of the rural catchments is mainly the result of reduction in freshwater inflow.

CONCLUSION

Hotspots and trends over the past 10 years

In the Southern African region the vast increase in coastal populations over the past decade, particularly in Angola and South Africa (and to a lesser extent Namibia) is the key driver in terms of the contribution from land-based activities to the deterioration of the inshore marine environment. This is primarily manifested in a marked increase in:
- Sewage and associated nutrient loads;
- Physical alteration and destruction of habitats;
- Contaminated urban stormwater runoff; and
- Litter.

Hotspots in the region are mainly linked to large urban centres in:
- Angola - Luanda, Benguela, Lobito, Namibe and Cabinda;
- Namibia - Walvis Bay/Swakopmund; and
- South Africa - Saldanha Bay, Cape Town, Port Elizabeth, East London, Durban and Richards Bay.

The entire coastline of South Africa is increasingly coming under threat from PADH. Agricultural land is being re-zoned to accommodate large coastal developments such as golf estates particularly along the country's east coast (Kwazulu-Natal).

From the foregoing it is concluded that the situation concerning GPA issues in southern Africa probably worsened over the past 10 years.

Has progress been made in protecting the marine environment during the last 10 years?

Progress in the protection of the marine environment from land-based activities began mainly through recognition by the three countries of the urgent need to address this issue. This is manifested, e.g., in projects such as the *Base-Line Assessment of Sources and Management of Land-Based Marine Pollution in the BCLME Region*, undertaken as part of the BCLME Programme. In the case of South Africa this is further manifested in the array of new environmental policies and legislation with the goal of protecting the marine environment developed during this period.

The way forward

Over the next 10 years the protection of the marine environment from land-based activities, among other threats, will depend largely on the effectiveness with which the knowledge from recent research studies is applied and new legislation implemented in the three countries. In addition, the establishment of appropriate long-term monitoring programmes to detect trends related to the effects of land-based activities on the marine environment should be a key priority (and challenge) for Southern Africa and other developing regions over the next decade. A major concern in the region, as is the case in many developing countries, is the lack of appropriate data to quantify the effects of land-based activities on the marine environment. Developing countries usually have urgent socio-economic priorities such as combating poverty and improving health and education services, as a result of which issues related to the protection of the natural environment, are often not adequately addressed. Towards meeting this challenge a demonstration (GEF funded) project of the GPA coordination office - Addressing land-based activities in the Western Indian Ocean (WIO-LAB) - was initiated in 2005. The project represents a partnership between UNEP/GPA and the eight participating states: Kenya, Madagascar, Mauritius, Mozambique, Seychelles, South Africa, Tanzania, and Comoros.

The main objectives of the project are to:

- Improve the knowledge base and establish and demonstrate regional strategies for the reduction of stress on the marine and coastal ecosystem by improvin-g water and sediment quality;
- Strengthen the regional legal basis for preventing land-based sources of pollution, including the implementation of the GPA; and
- Develop regional capacity and strengthen institutions for sustainable, less polluting development, including the implementation of the Nairobi Convention and its action plan.

The Council for Scientific and Industrial Research (CSIR) in South Africa has been recently designated the Regional Activity Centre for the monitoring and assessment phase of this project, which aims to encourage a regional assessment of land-based sources of pollution in the marine and coastal environments (A.Naidoo, CSIR, pers. comm.).

Author

S. Taljaard*, P.D. Morant*, L. van Niekerk1* and A. Iita**

*Council for Scientific and Industrial Research, P.O. Box 320, 7599 Stellenbosch, South Africa
Tel: +27 21 888 2494; Fax: +27 21 888 2693;
First author email: staljaar@csir.co.za
**Ministry of Fisheries and Marine Resources, P.O. Box 912, Swakopmund, Namibia

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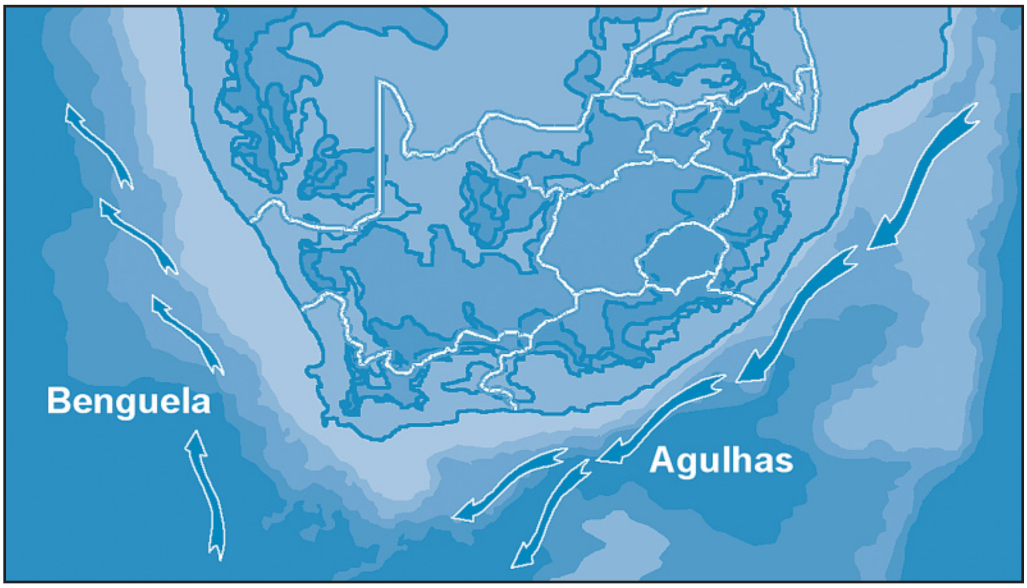
Figure 2.1

Countries included in the southern Africa region: Angola, Namibia, and South Africa

Figure 2.2

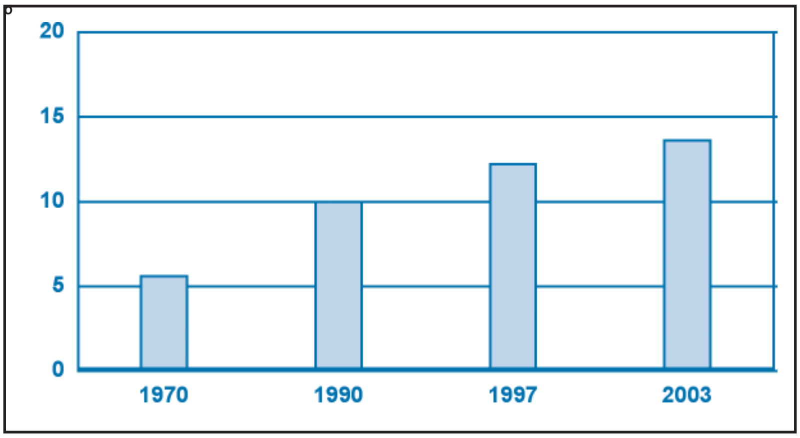
Southern Africa major coastal circulation systems



(Source: RSA DWAF 2004a)

Figure 2.3

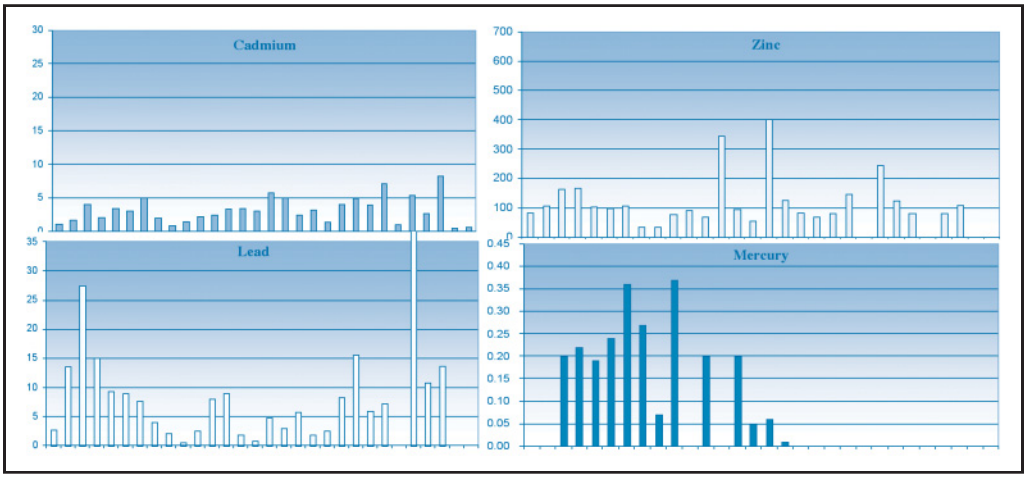
Estimated population of Angola from 1970 to 2003



(Source: RSA DWAF 2004a)

Figure 2.4

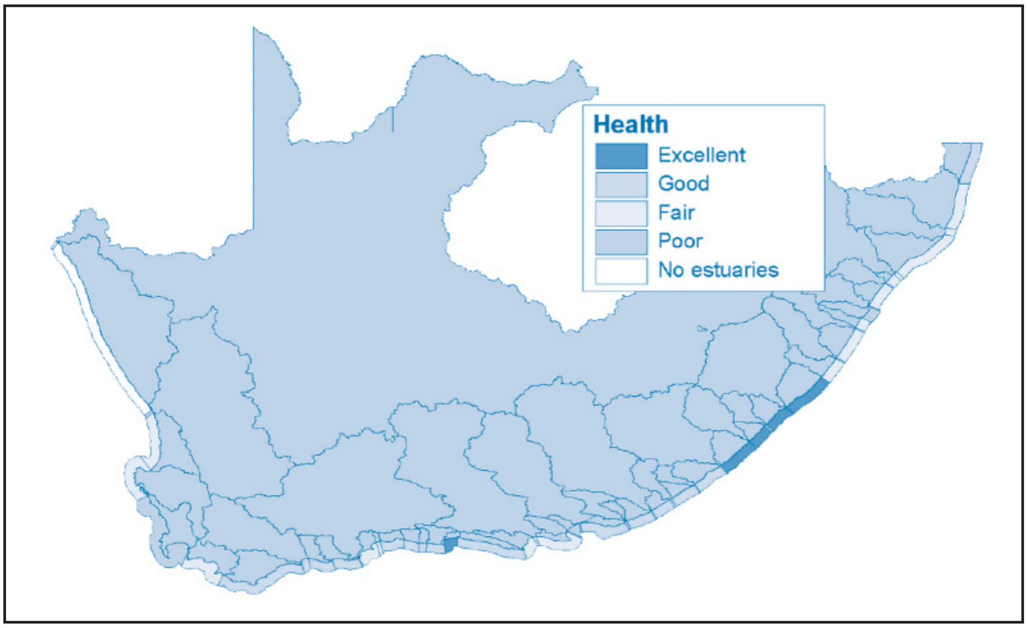
Trace metal concentrations in mussel tissues along the South African coast (Cape Town)



(Source: G Kieviets, Department of Environmental Affairs and Tourism, Marine and Coastal Management, South Africa)

Figure 2.5

The health status of South African estuaries



(Source: Turpie 2004)

Table 2.1

Estimated volumes of sewage effluent discharges to the marine environment in South Africa

Type	Estimated volume (million m³/yr)	
	1991	2004
Offshore marine outfalls (preliminary treatment)	110.6	122.5
Surf zone discharges (mainly secondary treated)	33.6	109.0
Estuarine discharges (mainly secondary treated)	21.4	55.5
Diffuse sources through stormwater runoff (untreated)	No data	No data

(Source: CSIR 1991, RSA DWAF 2004d)

Table 2.2

Compliance of beaches along the False Bay coast (Cape Town) with national and international quality guidelines for contact recreation

Year	No. of sites	% Beaches along the false bay coast that complied with microbiological targets			
			European Union		
		South Africa	Guideline	Mandatory	Australian
1995	46	74%	74%	91%	89%
1996	47	70%	70%	94%	94%
1997	47	79%	79%	89%	89%
1998	52	84%	84%	88%	90%
1999	50	90%	90%	98%	100%

(Source: Taljaard and others 2000)

Table 2.3

Estimated volumes of industrial waste-water discharges to the marine environment and associated pollutant categories in South Africa (no data found to estimate loads)

Industry type	Estimated volume (m^3/day)	Pollutant category				
		Sediments (suspended solids)	Nutrients	Heavy Metals	Oil	Radio-active substances
Coastal mining	128 800	√				
Fishing industry	44 834	√	√			
Chemical/textile	15 460			√		
Oil refinery	8 254			√	√	
Wood pulp/aluminium smelter/ fertilizer	293 000	√	√	√		
Nuclear power stations (cooling water)	No data					√

(Source: RSA DWAF 2004d)

Table 2.4

Estimated volumes and pollutant loads from stormwater runoff from larger urban centres along the South Africa coast

Urban area	Estimated storm-water runoff (million m³/yr)	Estimated pollutant loads (tonnes/yr)			
		Suspended solids (Sediments)	Nutrients	Trace metals (mainly Iron)	Oils
Richards Bay	10.87	5.930	40	170	77
Durban	143.97	73.670	440	2.270	939
Port Elizabeth	37.93	19.420	114	601	247
CapeTown	64.34	32.490	190	1.010	413

(Source: CSIR 1991)

Table 2.5

Changes in estimated nutrient loads (mainly inorganic nitrogen and phosphate) entering the marine environment from land-based activities over the past 10 years

Type	Estimated nutrient load (tonnes/yr)	
	1991	2004
Sewage to offshore (preliminary treatment)	3.800	4.200*
Sewage to surf zone and estuaries (mainly secondary treatment)	650	1.950*
Stormwater runoff (main urban areas contribute 780 - see Table 2.4)	980	Probably higher, but no data
Industrial discharges (mainly fish processing industries on west coast)	2.900	No data
Rivers (using the following as examples):		
- Orange (west coast) (RSA DWAF 2003a)	No data	150
- Breede (south coast) (RSA DWAF 2004b)	No data	250
- Thukela (east coast) (RSA DWAF 2004c)	790 **	860

(Source: CSIR 1991, RSA DWAF 2004d)

** Calculated from volumes estimated for 1991 and 2004 (refer to Table 2.1) and estimated loads for 1991 (CSIR 1991).*
*** Reference Condition (i.e., prior to human interference).*

Table 2.6

Percentage contribution by various activities to coastal habitat loss

Sector	% Contribution to Coastal habitat loss
Urban and residential land use	56
Ports and harbours	16
Coastal mining	16
Industry	11
Tourism developments*	1

**Refers to areas that solely support tourism developments. Where such developments occur within existing urban and residential areas, it was difficult to separate them based on the data available and such developments were, therefore, included under urban and residential land use.*