REGIONAL SEAS

UNITED NATIONS ENVIRONMENT PROGRAMME

Marine Pollution in the East African Region

UNEP Regional Seas Reports and Studies No. 8

Prepared in co-operation with

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

UNEP 1982

PREFACE

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

The Regional Seas Programme at present includes ten regions 1/ and has over 120 coastal States participating in it. It is conceived as an action-oriented programme having concern not only for the consequences but also for the causes of environmental degradation and encompassing a comprehensive approach to combating environmental problems through the management of marine and coastal areas. Each regional action plan is formulated according to the needs of the region as perceived by the Governments concerned. It is designed to link assessment of the quality of the marine environment and the causes of its deterioration with activities for the management and development of the marine and coastal environment. The action plans promote the parallel development of regional legal agreements and of action-oriented programme activities.

Decision 8/13(C) of the eighth session of the Governing Council of UNEP called for the development of an action plan for the protection and development of the marine and coastal environment of the East African region. As a first activity in the region, UNEP organized in October and November 1981 a joint UNEP/UN/UNIDO/FAO/UNESCO/WHO/IMCO/IUCN exploratory mission which visited the eight States of the region 2/ in order to:

- assess each State's interest in participating in a future regional programme;
- consult with Governments with a view to identifying activities that may usefully be included as part of a comprehensive action plan;
- make a preliminary assessment of the environmental problems in the region, including the problems related to the environmentally sound management of marine and coastal natural resources and activities influencing the quality of the marine and coastal environment;
- collect available scientific data and information pertaining to the development and implementation of the action plan planned for the region; and
- identify national institutions that may participate in implementing an action plan once it is adopted.

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

2/ Comoros, Kenya, Madagascar, Mauritius, Mozambique, Seychelles, Somalia, and United Republic of Tanzania.

The findings of the mission were used to prepare the following six sectorial reports:

- UN/UNESCO/UNEP: Marine and Coastal Area Development in the East African Region. UNEP Regional Seas Reports and Studies No. 6. UNEP 1982;

- UNIDO/UNEP: Industrial Sources of Marine and Coastal Pollution in the East African Region. UNEP Regional Seas Reports and Studies No. 7. UNEP 1982;

- FAO/UNEP: Marine Pollution in the East African Region. UNEP Regional Seas Reports and Studies No. 8. UNEP 1982;

- WHO/UNEP: Public Health Problems in the Coastal Zone of the East African Region. UNEP Regional Seas Reports and Studies No. 9. UNEP 1982;

- IMO/UNEP: Oil Pollution Control in the East African Region. UNEP Regional Seas Reports and Studies No. 10. UNEP 1982; and

- IUCN/UNEP: Conservation of Coastal and Marine Ecosystems and Living Resources of the East African Region. UNEP Regional Seas Reports and Studies No. 11. UNEP 1982.

The six sectorial reports prepared on the basis of the mission's findings were used by the UNEP secretariat in preparing a summary overview entitled:

- UNEP: Environmental Problems of the East African Region. UNEP Regional Seas Reports and Studies No. 12. UNEP 1982.

The overview and the six sectorial reports were used as the main working document and information documents for the UNEP Workshop on the Protection and Development of the East African Region (Mahé, Seychelles, 27 - 30 September 1982) attended by experts designated by the Governments of the East African region.

The Workshop:

- reviewed the environmental problems of the region;

- endorsed a draft action plan for the protection and development of the marine and coastal environment of the East African region;

- defined a priority programme of activities to be developed within the framework of the draft action plan; and

- recommended that the draft action plan, together with a draft regional convention for the protection and development of the marine and coastal environment of the East African region and protocols concerning (a) co-operation in combating pollution in cases of emergency, and (b) specially protected areas and endangered species, be submitted to a conference of plenipotentiaries of the Governments of the region with a view to their adoption (UNEP/WG.77/4). The conference is to be convened by UNEP in early 1984.

CONTENTS

INTRODUCTION

Definition of the region

1. The East African region encompasses the coastal and marine areas of four countries on the East Coast of Africa from Somalia in the horn of Africa, through Kenya and the United Republic of Tanzania to Mozambique in the south-west; and four island countries in the South-West Indian Ocean namely: Comoros, Madagascar, Mauritius, and Seychelles. Comoros consists of four islands: Grande Comore, Anjouan, Mayotte and Moheli, Mauritius includes other small islands principally Rodrigues. Seychelles has the greatest number of islands, numbering over 100, Mahé being the biggest and most important. Madagascar is the largest of all the islands and could be considered a sub-continent. All the islands in the region are volcanic in origin except most of Seychelles which is granitic.

2. The region lies between the tropics of Cancer and Capricorn, latitude 13°N to 30°S and longitude 32°E to 67°E; bordered in the north by the Arabian Sea and in the west by the Pacific Ocean (figure 1). The total land area involved is 3.54×10^6 km^2, coastline 11,790 km and total shelf area 373,964 km^2 (table 1). Somalia is distinct from the rest having 983 km of its coastline along the Gulf of Aden and 1,876 km along the Indian Ocean. The total population of the region is about 54.6 million, a unique blend of African, Polynesian, Indian, Chinese and European origins. Seychelles has the highest per capita fish consumption and Somalia the lowest, despite the rich fish resources off its western coast due to upwelling. The climate is generally tropical with dry and rainy monsoon seasons, though some areas such as Mauritius and Seychelles have a sub-tropical maritime climate. Mauritius, its island Rodrigues and part of Madagascar and Mozambique are prone to cyclones at certain times of the year, during the north-east monsoon season.

3. The position of the Indian Ocean as the third largest ocean in the world is not matched by its low fishery productivity of about 0.037 tonnes per km^2 of surface area and 0.412 tonnes per km^2 of shelf area compared to 0.189 and 3.987 for the Pacific, and 0.219 and 2.699 tonnes per km^2 for the Atlantic oceans respectively. The comparatively low productivity is attributable to its oceanographic characteristics described below. The West Indian Ocean with its marine resources is a common but largely under-exploited wealth shared by the eight countries in the region.

Hydrography

4. Hydrographic data such as salinity, temperature, dissolved oxygen and ocean currents are useful parameters for predicting the fate and dispersion of pollutants in the sea.

5. The hydrographic characteristics of the Indian Ocean waters have not been fully understood although the main circulation patterns in the region have been fairly well established not least during the International Indian Ocean Expedition (IIOE) from 1959 through to 1965 (Düing, 1970, Schott, 1977). Tomczak (1979) has reviewed the oceanography of African waters including the South-West Indian Ocean.

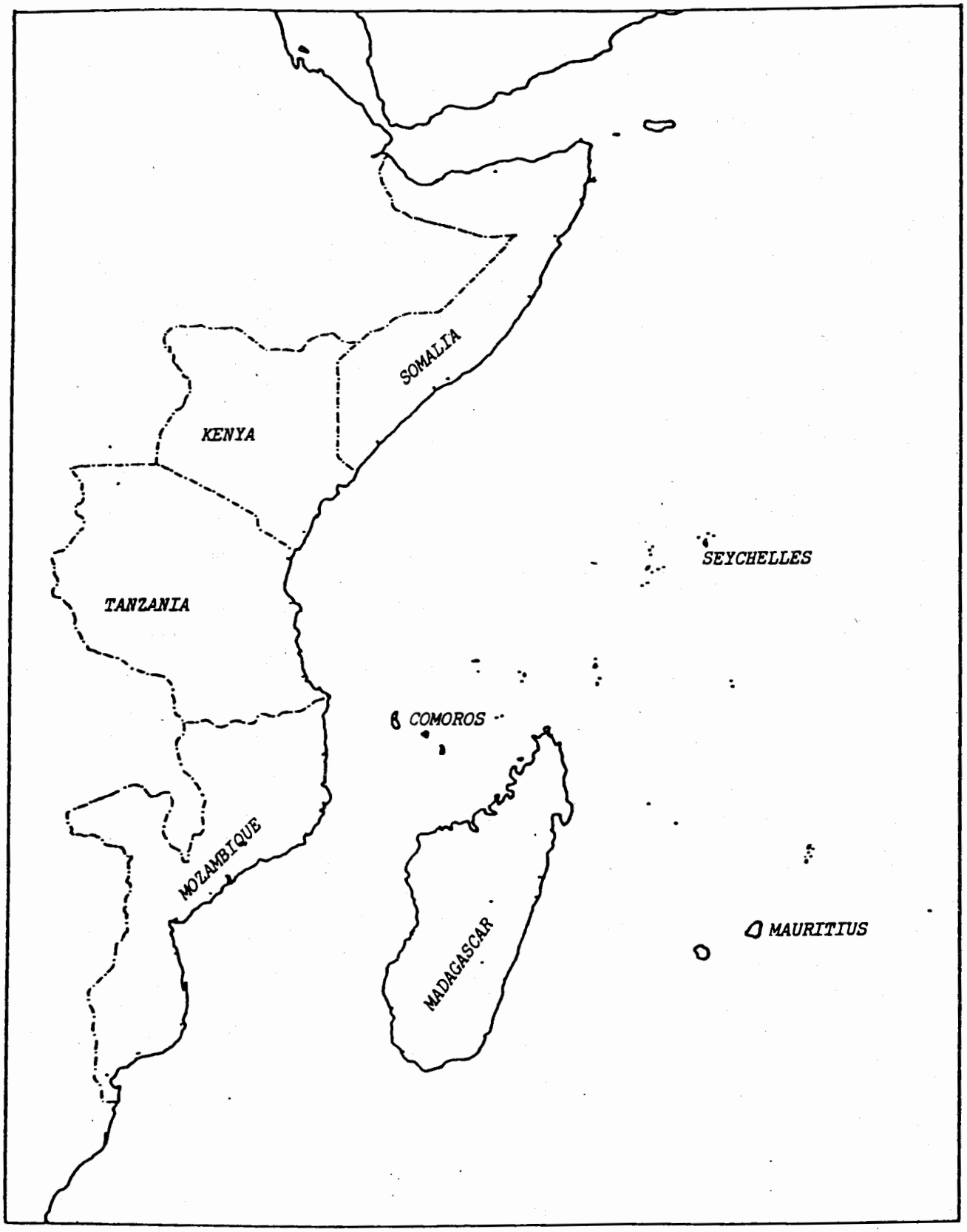

Figure 1 : The East African Region

Table 1 : General profile of countries in the East African region

ɔuntries	Land area (km^2)(1)	Estimated shelf area - depth range 0-200 (km^2)(2)	Length of coastline (km)	Estimated population 1980 (million)(3)	Marine fish landings 1980 (1,000 metric tons)(3)	Per capita fish-consumption 1980 (kg life weight)(4)
ɔmoros	2,236	900	350	0.33	4.0	12.4
ɛnya	582,650	6,500	500	16.40	5.4	3.3 (5)
adagascar	595,790	135,000	4,000	8.74	12.0	6.0 (5)
auritius	1,865	1,600	200	0.99	5.3	17.7
ɔzambique	738,030	120,000	2,500	10.47	31.7	3.5
ɛychelles	443	48,000	600	0.06	5.0	82.0 (6)
ɔmalia	637,657	32,500	3,000	3.64	11.0	0.6
anzania	939,703	30,000	800	17.00	49.2	10.0 (5)

1) ANON, 1981
2) FAO, Fishery Country Profiles and FAO/IOP, 1979
3) FAO, 1981
4) FAO, ICS printouts Fish. Dept. unpubl.
5) Note that freshwater fish supply exceeds marine catch
6) Note that per capita fish consumption is subject to great variation due to comparatively small number of inhabitants and yearly variability in total supply (consumption by tourists is not separately accounted for)

Although a typical feature of tropical waters is a warm, surface water layer with small annual temperature variations, the hydrography of the Indian Ocean waters is influenced by seasonal variations of the monsoon trade winds.

6. In the Southern hemisphere, the South Equatorial Current, about 12° south of the equator, is the principal current flowing all year round from east to west. Part of the current branches off north-east of Madagascar to form the East Madagascar Current while the main stream splits after the northern tip of Madagascar into a southward current flowing through the Mozambique Channel to form the perennial Mozambique Current (figure 2). The northerly component of the South Equatorial Current forms the East African Coastal Current. The latter is the main surface layer of water bathing the continental shelves of Kenya and Tanzania with nutrient-deficient water, resulting in the low biological productivity of their coasts. South of Madagascar, the East Madagascar Current and the Mozambique Current merge at about 26°S to form the Agulhas Current. South of 30°S the West Wind Drift is operational.

7. The situation in the Northern hemisphere changes with the monsoon winds. During the period of the south-west monsoon (April to October), representing the summer period in the Northern Indian Ocean, an eastward surface current, the South-West Monsoon Current, prevails, extending southwards to about 7°S. The South Equatorial Current now flows northwards forming the Somali Current, whose root lies at about 10°S. The prevailing strong wind with a speed of over 600 cm/s influences the Somali Current to continue its northerly flow, bending eastwards off the Somali peninsuls into the Arabian Sea. The strong-flowing Somali Current with speeds of about 300 cm/s transports about 50-65 million m^3/s of water (Düing and Szekielda, 1971) penetrating deep into the oceanic water mass and causing an upwelling along its left flank in Somalian coastal waters. The upwelling induces the comparatively high productivity off the Somalian Coast and is most intense between 5°N and 11°N. The turbulence associated with this phenomenon brings nutrient-rich, cold subsurface waters with temperatures below 20°C to the surface, thereby enriching the surface waters with nutrients. The average temperature of the surface water during this period is about 24°C and the salinity, 35.0 ppt.

8. The nature of the Somali Current has been the subject of continuing investigations by the international scientific community (Findlater, 1969; Düing and Szekielda, 1971; Leetma, 1972; Schott, 1977). The current consists of a northward component, the major component, and a southward (minor) component. It has been shown that the northward component is due to local wind-induced upwelling (Cox, 1970).

9. During the north-east monsoon winter period in the Northern hemisphere, (November to March), the surface currents' flow is changed from its clockwise pattern to anti-clockwise in the Northern Indian Ocean. The north-east monsoon winds now prevail and the North-east Monsoon Current, otherwise called the North Equatorial Current, is well developed and operative, flowing westwards down to 3°S. The Somali Current is now less strong, reverses its flow partly to form the Equatorial Counter Current with its axis at 7°S and partly flows downwards to join the Mozambique Current. The turbulence of the waters is minimal because of the now weak Somali Current (speed less than 10 cm/s) and a thermocline exists at about 60-80 m with the surface waters having a uniform temperature of about 28-30°C and a salinity of 34.5 ppt. A weak upwelling on the right flank of the Somali Current is presumed to occur in the region of previous upwelling (Schott, 1977), while for reasons of continuity, downwelling occurs on its left flank.

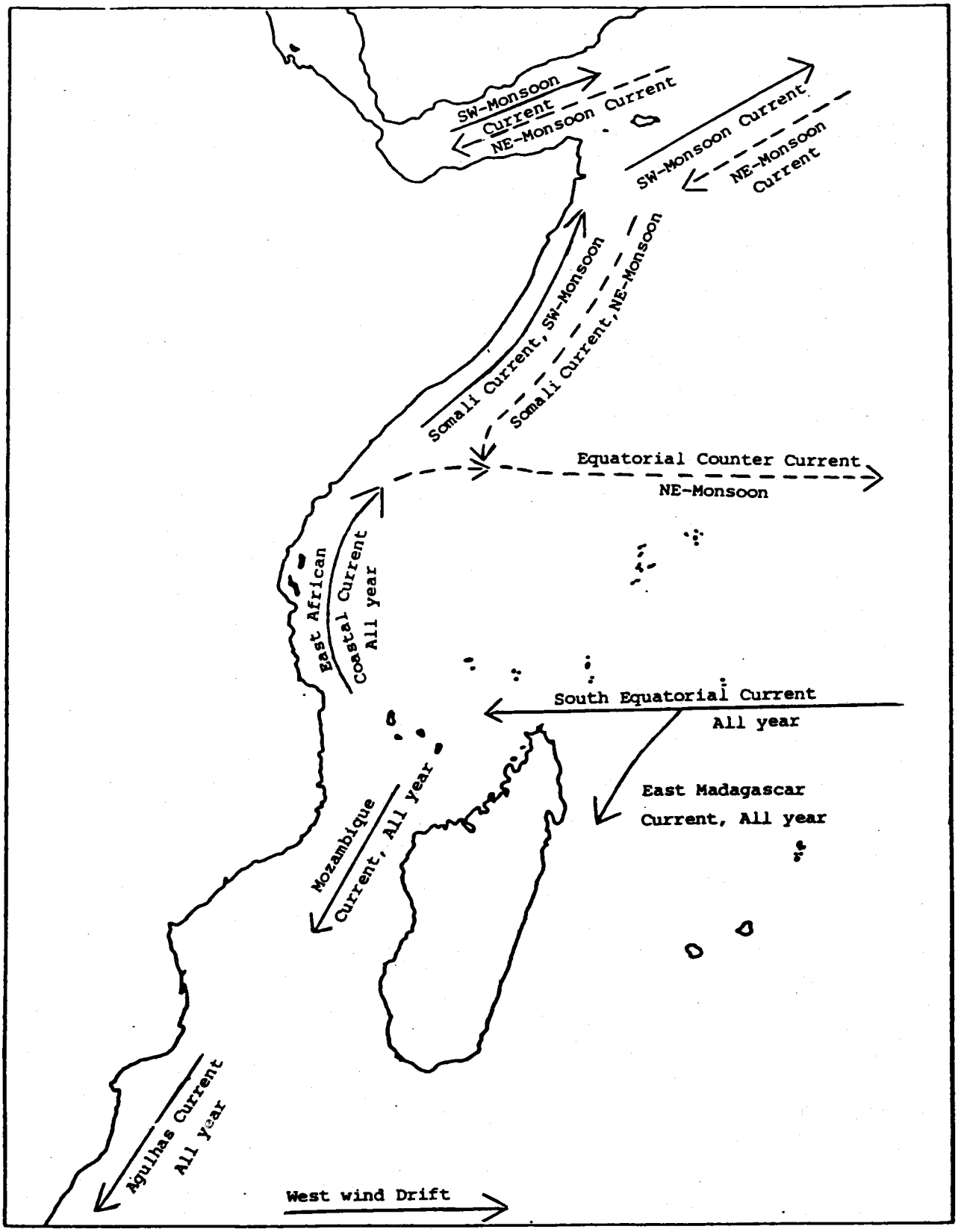

Figure 2 : Current system of the North and West Indian Ocean

10. Developments in oceanic circulation studies on the Indian Ocean, principally by the IIOE, have indicated the presence of the Equatorial Undercurrent which had previously been reported in both the Atlantic and Pacific Oceans. The current was reported to be present only during the north-east monsoon (Swallow, 1964).

11. From the foregoing, the East African region may be classified into three hydrographic zones:

(i) Somalia upwelling zone: Somalia.

(ii) Monsoon currents zone: Tanzania, Kenya and Seychelles.

(iii) Agulhas and Mozambique current zone: Mauritius, Madagascar, Comoros and Mozambique.

12. In the third zone, the current flow patterns would be subject to seasonal cyclonic influence in Mauritius, north-east of Madagascar, and parts of Mozambique.

13. It is understood that the description of the surface current system in the Western Indian Ocean is only very approximative and that research is still under way to elucidate the underlying forces, particularly to find out which role local conditions play as inducing forces for the Somali Current, as opposed to the large-scale wind system. From satellite photos of sea-surface temperatures, it can be deduced that the processes are more complex, involving discontinuous local phenomena.

Ecosystem distribution

14. The marine ecosystems in the region with economically significant exploitable resources, serving beneficial, multifunctional purposes and vulnerable to adverse effects of pollution are: estuaries, mangroves, lagoons, coral reefs, and the deep ocean. Broadly these ecosystems can be classified into two:

(i) Coastal ecosystems: estuaries, lagoons and mangroves.

(ii) Off-shore ecosystems: coral reefs and deep ocean.

Coastal ecosystems:

15. Estuaries are semi-enclosed bodies of water that are connected with the ocean whose waters are regularly diluted by fresh water derived from rivers and land run-off. Estuarine waters are therefore salty or brackish in nature. The circulation in an estuary depends on the amount of freshwater discharge, the strength of the tidal current, and the amount of vertical mixing. Major estuaries are those of the rivers Ruvu, Ruvuma, Wami and Rufiji (Tanzania), Tana, Galana-Sabaki (Kenya), Zambezi (Mozambique), and Juba (Somalia). The Rufiji river estuary is the largest in the region. Amongst the island states, Comoros and Seychelles do not have big rivers and hence no significant estuaries. The island of Madagascar has estuaries mainly on the east and west coasts but the 400 km long Pangalanes Canal on the east coast interferes with the estuaries there.

16. Estuaries are breeding habitats for a variety of penaeid shrimp and prawn species, oysters and fish. Being shallow waters, they offer good fishing grounds for the artisanal fisherman. Penaeus indicus is the dominant prawn species. Gaps in information about important species of estuarine fishes in the region have to be

17. Mangroves are typical littoral plants (trees or shrubs) occupying estuarine areas, bays of islanda, sheltered tropical and sub-tropical coasts. Sometimes referred to as 'mangrove forest' or 'tidal forest', they serve as habitat for a wide variety of characteristic fauna and flora.

18. MacNae (1974) had reviewed the mangrove forests and fisheries of the Indian Ocean, while the global status of mangrove ecosystems has been the subject of a recent IUCN publication (Saenger et al., 1981). Available data are given in table 2. Rich mangrove forests abound along the East African coast from Mozambique to Kenya colonizing the estuaries of big rivers such as the Zambezi, the Rufiji and the Tana. Madagascar has the most extensive mangrove forest covering an area of 3,207 km^2 and over 1,150 km of coastline. The major concentration is along the north-west coast of the island with a minor pocket in the north-east. Insignificant mangrove forests are found in Mauritius, Comoros and Somalia. In Seychelles, pockets of mangroves occur on the west coast of Mahé, and in the smaller islands of Curieuse, Praslin, La Digue and Silhouette.

19. Some of the endemic mangrove species in the region are mainly trees: Avicennia marina (Forsk.) Vierh.; Bruguiera gymnorhiza (L.) Lamk.; Heritiera littoralis Ait. and a few shrubs, for example Lumnitzera racemosa Willd (Saenger et al., 1981).

20. Mangroves serve multifarious functions of great benefit to mankind. Apart from naturally attenuating coastal erosion by acting as wave-breakers, mangrove trees are currently being used in the region, (with over-exploitation in some cases) for making poles, and for fuel, timber and tanning extracts. Salt evaporation ponds exist in mangroves in Mozambique and Tanzania. The latter country is currently producing about 100,000 tonnes of salt from the mangrove areas (Mwaiseje and Mainoya, 1981). The mangroves provide a habitat for crabs, shrimps, prawns, molluscs and fish, which serve as a rich source of animal protein to the coastal population. They also serve as nursery grounds to some commercially important fishes such as Chanos sp., Mugil sp., and Hilsa sp., and provide shelter for certain species of penaeid prawns such as Penaeus indicus, P. merguiensis, P. monodon, and most species of Metapenaeus. About 6,600 tonnes of shrimps were landed along the East African coast in 1971 (MacNae, 1974).

21. Lagoons are calm, shallow (0-20 m) water bodies enclosed between the fringing reefs and the shore and occur all over the region with widths varying from 8 to 10 km. The island States are surrounded by lagoons of various widths and depths. Lagoon waters have a high biological productivity and provide a habitat for a wide variety of fish species. For example, sting rays (Dasyatidae), pipefish (Syngnathidae), sardines and anchovies (Clupeidae and Engraulidae), sand-dwelling eels (Myrichthidae), scavengers (Lethrinidae), soles (Soleidae), and parrotfish (Scaridae) abound in the waters (Bock, 1978). Furthermore, it is a nursery area for juveniles of many fish species including: gobies (Gobiidae), rockhoppers (Salariidae), damselfish (Pomacentridae) and grey mullet (Mugilidae). Beds of seaweed and sea-grass colonize the floor of the lagoon. The most abundant endemic species of sea-grsss is Cymodocea.

22. The ecosystems in the land-sea interphase described in the foregoing sections are more often interfered with and degraded by man due to their proximity to land.

Off-shore ecosystems:

23. Coral reefs are brittle, shallow-water, solid structures formed from the calcareous skeletons of live corals and algae and their remains in sea-water.

Table 2 : Available data on mangrove area extent and length of mangrove coastline in the East African region

(Source: MacNae, 1974; Saenger et al., 1981)

Country	Mangrove Area km^2	Mangrove Coastline, km	% Total Coastline
Comoros	Negligible a/	a/	
Kenya	587	a/	
Madagascar	3207	1150	28.7
Mauritius	Negligible a/	a/	
Mozambique	850	1194	48.3
Seychelles	Negligible a/	a/	
Somalia	Negligible a/	a/	
Tanzania	500 (820)*	a/	

a/ No data available
* FAO/IOP 1979

well-oxygenated saline water for optimum growth. The salinity and temperature regimes in the waters of the West Indian Ocean provide the right conditions for coral growth. The coral reef and the associated biota constitute the coral reef community. Generally, coral reefs are one of the most biologically productive ecosystems in tropical waters.

24. Coral reefs are classified into three types, fringing reefs, barrier reefs and atolls. Fringing reefs occur either in continuity with a land or island mass and are generally close to the shore. Reefs fringing the mainland and big islands are usually separated from the shore by lagoons while those fringing smaller islands often grow on the island slope itself. Barrier reefs occur parallel to the shoreline along continents but are separated for up to several kilometres by relatively deep water. They are often found seaward of the fringing reef region. Atolls are reef islands or horse-shoe shaped ridges of reefs enclosing a lagoon.

25. There is a dearth of information on the coral reefs in the region, the community structure and taxonomic classification of the economic species in the reef community. Barrier reefs do not exist in the region. Fringing reefs occur along the East African coastline from Mozambique to Somalia stretching over a distance of 8,000 kilometres. The continental shelf is very narrow, varying in width from 4-10 km to a maximum of some 50 km along the coast of East Africa with gaps in the reef in areas where fresh water disgorges into the sea from large rivers such as the Sabaki and Tana, and inhibits coral growth. The northernmost coral reef in the region is in Somalia, while the southernmost is around Inhaca Island in Mozambique. The volcanic island countries of Comoros and Mauritius are also encircled by a narrow continental shelf while most of the islands in Seychelles have a much wider one. In Madagascar, the continental shelf is narrow on the east coast and wider on the western and southern coasts. The most extensive shelf is in the north of the country. Huge atolls are found mainly around Aldabra and Cosmoledo in Seychelles.

26. The reef ecosystem is probably the most productive biologically of all the ecosystems under consideration. Maximum fish yield in some coral reef areas was estimated at 4-5 km^2 (FAO/IOP, 1979). Most of the catches in the region consist of inshore reef fishes and fishing is principally artisanal because trawling is impossible in the shallow waters around the reefs.

27. The demersal fish resource potential in the region, including crustaceans, is believed to be in the order of some 280,000 t annually, while landings in 1979 amounted to about 58,000 t. The dominant fish species in the catch were seabreams, sea catfishes, demersal percomorphs, croakers, scavengers and others. Spiny and rock lobsters and unidentified natant decapods are the major crustacean categories. Molluscs are barely exploited. (Indian Ocean Fishery Commission, 1981).

28. Apart from fisheries, the coral reefs provide valuable economic tourist potentials, recreational amenities and study areas for scientific research. They play an important role in breaking the surf, thus protecting the coastline. Although reef corals in temperate regions are known to host algae endowed with a wide range of pharmacologically active compounds, no such information exists on the reef habitats of the region.

29. The deep ocean is another important offshore environment. As mentioned before, the continental shelf of the region is very narrow. There is a sharp drop-off into the bathypelagic and abyssal zones containing deep ocean water (depth > 1,000 m). The deep ocean waters are cold and dark receiving little light if any from the surface. The oceanic surface waters (photic zone) support diverse plankton communities. The productivity of the bathypelagic zone is dependent on a steady vertical and lateral supply of organic matter, either from the oceanic photic zone

or from the biologically productive epipelagic zone (zone above the continental shelf).

30. The primary production in major parts of the Indian Ocean is among the lowest in world oceans. Likewise the total productivity of the oceanic waters of the region is assumed to be low; on the other hand, fish species diversity is high and over 4,000 pelagic fish species are reported (Ssentongo, 1979). Exploitation of pelagic fish resources requires more sophisticated fishing techniques and manpower than the traditional artisanal fishery methods. Hence, all fishing in this zone is carried out mainly by foreign fleets under bilateral agreements.

31. The potential of small pelagic species, such as carangids (jack and horse mackerels), mackerels and clupeids (herring-like fish) was tentatively estimated at 500,000 to 650,000 t annually, of which about half should be expected in the richer upwelling zone off Somalia. Landings in 1977 (with the exception of Somalia, for which no recent estimates are available) amounted to about 40,000 t (Indian Ocean Fishery Commission, 1981).

32. Yellowfin tuna, bigeye, albacores and marlins are big pelagic fish of major economic interest, often found between latitude 10°N and latitude 35°S in the region. Some other pelagic stocks in the region are billfish, sharks, squids and cuttlefish. Estimated tuna catches by foreign longline fleets in the region for 1977 were about 40,000 t (Indian Ocean Fishery Commission, 1981) (see table 3).

33. Almost all countries in the region have programmes for tuna fish export as a means of foreign exchange earning by setting up a canning industry with the aid of foreign expertise.

34. From the foregoing, it can be seen that the coast-associated and offshore ecosystems in the region offer valuable socio-economic resources and multifunctional benefits which must be protected from the harmful effects of pollution resulting from a variety of human activities. A detailed classification of the various habitats in the region has been described in IUCN/UNEP (1982): Conservation of Coastal and Marine Ecosystems and Living Resources of the East African Region. UNEP Reg. Seas Rep. Stud., (11).

TYPES, SOURCES, LEVELS AND EFFECTS OF POLLUTANTS

35. It is pertinent to re-state the GESAMP definition of marine pollution as a useful criterion for any assessment of marine pollution problems in the region. GESAMP defined marine pollution as:

> "the introduction by man directly or indirectly of substances or energy into the marine environment (including estuaries) resulting in such deleterious effects as harm to living resources, hazards to human health, hindrance to marine activities including fishing, impairment of quality of use of sea-water and reduction of amenities."

36. Although this definition limits marine pollution to problems attributable to man-made activities, it may be noted that natural changes to the environment do occur. For example, the colouration of certain estuaries or sea-water is caused by dissolved organics such as humic acids naturally present within the water basin. The presence of high background mercury levels in marine fish, for which no previous history or source of pollution could be held responsible, is also noted. However,

Table 3 : Tuna catches by foreign longline fleets[a/] in the 200-mi economic zones of the South-West Indian Ocean in 1977, by species (t)

(from Indian Ocean Fishery Commission, 1981)

Area	SO BF[b/]	YF	ALB	BE	SJ	SF	Marlins	Sail	Total	Catch rate[c/]
Comoros	0	482	65	159	0.4	3	76	1	786	1 486
French southern territory	136	5	38	14	0	1	1	0	196	1 024
Kenya	0	418	4	310	0.5	9	37	1	780	1 648
Madagascar	2	390	938	157	0	26	58	1	1 572	1 076
Mauritius	9	3 281	1 775	1 100	8	47	321	12	6 552	1 314
Mozambique	0	220	53	79	0	1	57	0	411	1 194
Réunion	1	207	869	84	0	10	48	1	1 220	1 044
Seychelles	2	14 894	212	8 444	18	115	475	33	24 193	1 850
Somalia	0	980	4	851	2	19	145	3	2 004	1 954
Tanzania	0	2 010	50	1 376	6	27	126	3	3 597	1 808
Total	150	22 887	4 008	12 574	35	258	1 344	55	41 311	

a/ Japan, Korea and the island of Taiwan. Only a small part of this catch is landed in the area for trans-shipment or processing.

b/ SO BF = Southern bluefin tuna
YF = Yellowfin
ALB = Albacore
BE = Bigeye
SJ = Skipjack
SF = Swordfish
Marlins = Blue and striped and black marlin
Sail = Sailfish
Source: IOFC/DEV/80/48

c/ Catch rate in kg/2 000 hooks representing daily catch for all species for comparison:

(i) Indian Ocean all 200-mi zones 1 535 kg/2 000 hooks
(ii) Indian Ocean high seas 1 240 kg/2 000 hooks
(iii) Entire Indian Ocean 1 326 kg/2 000 hooks

most problems of serious ecological and socio-economic importance result from man's activities.

37. Substances or energy released into the marine environment at levels not causing apparent deleterious effects on living resources and man are known as contaminants. Of course, contaminants can graduate into pollutants with time, especially if they persist via bioaccumulation and/or biomagnification along trophic levels.

38. Marine pollution originates principally from land-based sources and maritime activities (or activities within the marine environment). The major sources of pollutants from land are sewage and domestic/commercial waste discharge; industrial waste outfalls; agricultural wastes disposal; river run-off and riverine transfer of pollutants from land; mining activities (metals and non-metals); atmoapheric transportation apart from air pollution. Marine-based pollution sources may be: maritime and oil tanker traffic causing oil pollution problems; exploration and exploitation of sea-bed resources for oil and minerals; sand and coral mining; coastal constructions and dredging; ocean dumping.

39. The various transfer routes of pollutants into the marine environment outlined in the foregoing can lead to four types of pollution as well as aesthetic impairment: physical, chemical, microbiological and thermal.

40. Aesthetic aspects of marine pollution comprise, for example, odour nuisance from anoxic coastal waters; littering of beaches, bays and estuaries with bottles, plastics, metal cans, old tyres, etc., thereby impairing or obstructing the use of aea-water and causing a reduction of amenities. Phyaical pollution pertains to silt and sediment load carried into estuaries and the coastal environment by rivers, rendering sea-water turbid, creating ecological stress on fauna and flora, e.g. corals and causing hindrance to coastal shipping activities.

41. Chemical pollution is a direct consequence of the introduction by various pathways of toxic inorganic chemicals, e.g. mercury, cadmium, chromium and lead, and persistent toxic chemicals such as chlorinated pesticides and polychlorinated biphenyls (PCBa) which could be acutely toxic to marine organisms when present at high concentrations, or cause devastating physiological and behavioural disorder responses when present at sub-lethal concentrations. Wildlife and man suffer harmful health effects which sometimes manifest themselves through reproductive failures due to the ingestion of marine biota polluted with chemicals. Petroleum hydrocarbons belong to this category.

42. Microbiological pollution is caused by sewage pollution of coastal waters and associated biota, resulting in contamination of coastal waters, fish and shellfish with epidemic-causing pathogenic organisms such as Salmonella typhi and Vibrio cholerae. Serious health risks are posed to man through body contact with such polluted water, e.g. bathing or swimming or ingestion of raw or half-cooked contaminated seafoods caught in such waters.

43. Thermal pollution results from the discharge of thermal power station cooling water effluents or hot effluents from industrial complexes, usually with high temperatures of 40°-60°C, into estuaries or lagoon waters. Fishes in tropical waters are known to live just below their upper lethal temperature limit (30°C) for their survival, so that any addition of heat energy into the marine environment is detrimental to their survival. Heat could result in fish kills or in altering the natural behaviour of stressed biota.

44. A qualitative overview of the marine pollution situation by country is given

Table 4 : Overview of marine pollution situstion in the East African region

Country	Sewage	Industrial waste	Agricultural waste	Siltation/ River input	Oil pollution	Coastal construction and dredging
Comoros	?	?	?	P	P	?
Kenya	P	P	P	P	P	P
Madagascar	P	P	P	P	P	?
Mauritius	P	P	P	P	P	?
Mozambique	P	P	P	P	P	P
Seychelles	?	P	P,?	P	P	P
Somalia	?	?	P	P	P	?
Tanzania	P	P	P	P	P	P

? = Situation not significant enough (or uncertainty about situation) to cause concern.
P = Situation recognized to be a problem even if effect is localized.

Interaction between socio-economic development of the region and marine pollution

45. Capital cities all over the world are usually the most densely populated urban centres because of the variety of employment opportunities and other incentives they offer. Six capital cities in the region are on the coast. A rapidly growing human population and settlements in the coastal zone exert pressure on the coastal environment and resources. The population explosion in the coastal cities has made nonsense of government plans for provision of increased amenities.

46. Improper sewage disposal is a serious problem. Sewerage plants, where they exist, are poorly maintained and their capacities grossly exceeded. Dispoaal of sewage into rivers, estuaries, and bays with limited capacity to assimilate the high oxygen-demanding organic loads poses localized pollution problems in coast-associated ecosystems and undesirable public health effects.

47. Industrialization policies without a component for environmental quality and protection of living resources disregard disposal of industrial wastes according to acceptable principles. The main preoccupation is for industry to help alleviate unemployment problems and produce essential consumer goods. Since industrial developments are financed by foreign investors, deliberate lack of insistence on the incorporation of treatment facilities into industrial processes and lack of national legislation for abating or controlling pollution may be offered as incentives to industrialists. Hence, dangerous chemicals some of which are acutely toxic to man and marine biota are being introduced into the marine environment due to the discharge of industrial wastes into rivers, estuaries and lagoons.

48. Poor agricultural practice, mismanagement and over-exploitation of forest resources have resulted in extensive deforestation and severe soil erosion problems. Coral reefs and associated biota have been damaged or destroyed in some cases through the resulting siltation. Harbour and port developments and growing human settlements involving coastal construction and dredging are similarly causing siltation and coastal erosion problems. Coastal erosion, in turn, is threatening highways and houses close to the coast.

49. Crude or refined petroleum fuel is imported for industrial and other energy requirement purposes. Frequent oil spills in harbours and discharge of waste oil into rivers and estuaries are threatening the coastal environment and living resources.

50. On the other hand, tourism, which is the main foreign exchange earner in some countries and which others hope to develop, is also influencing marine pollution. Rapidly expanding tourist hotels on beaches are contributing to the sewage load in the coastal environment. The desire to disinfect tourist beaches of insect pests has resulted in the spraying of beaches with toxic pesticides which eventually end up in the sea.

51. Pollution of estuaries and lagoons, and the destruction of coral reefs by pollution siltation and dynamiting, deplete the numbers of crustaceans and fishes. The resultant smaller fish catch is detrimental to the development of the traditional artisanal fishery in the region. The above socio-economic developments can all be causative factors of marine pollution.

Industrial wastes

52. The level of industrialization in the region is modest as judged by its

most cases. Albeit, industries are varied and diversified, oriented towards food processing and the manufacture of import-substituting products. Industries are generally concentrated in the coastal zone and capitals because of readily available infrastructural facilities including access to the ports for importation of raw materials.

53. Except for Comoros, Seychelles and Mauritius, all the countries have oil refineries of various capacities and hence different marine pollution potential which will be discussed in the chapter on oil pollution. Food-processing industries discharging organic wastes high in BOD such as breweries and slaughterhouses are found in all countries except Comoros which has no brewery; textile factories exist in Kenya (Mombasa), Tanzania (Dar es Salaam), Mozambique (Maputo), Mauritius (Port Louis), Seychelles (Victoria) and Madagascar; distilleries in Comoros, Tanzania, Mauritius and Seychelles; whilst Mauritius is the greatest producer of cane-sugar. Some other polluting industries in the region are cement factories in Kenya (Mombasa), Mozambique (Maputo), Tanzania (Dar es Salaam), and Mauritius and pesticides and bicycle manufacturing factories in Tanzania (Dar es Salaam). A pulp and paper mill is planned for Mozambique while a fertilizer factory is earmarked for Mombasa.

54. The characteristics and volume of the effluents from the various industries depend not only on the technology applied but also the manufacturing process. The polluting potential of the wastes generated is also a function of the volume of effluents discharged, their dilution in the receiving water, and their toxicity to marine life. Most of the factories often discharge their wastes without treatment directly into estuaries, lagoons, bays or the sea. Some discharge their wastes into rivers which flow into coastal waters. The industrial policy is geared towards providing employment and satisfying domestic needs. Little attention seems to be given to the question of pollution. Moreover, there are no effluent guidelines on discharge criteria for industrial wastes. Hence, industries discharge their wastes carelessly into the nearest water-course. Industries operationally generate three types of wastes: discharges to the atmosphere, liquid wastes and solid wastes. Only the latter two will be considered here. Pollution associated with current liquid waste disposal practices will be discussed first.

Liquid wastes:

55. The type of industry causing marine pollution problems in the region varies from country to country. Table 5 gives the general characteristics of effluents from selected industries (Helmer and Mörgeli, 1978) including a few from Tanzania as a guide for a qualitative assessment of the pollution potential and impact on the marine environment of some of the industries in the region. Due to paucity of information on the capacity of the various factory plants and corresponding volume of effluents discharged, the load of industrial waste discharged into rivers, the coastal environment or the sea cannot be calculated.

56. Localized marine pollution problems from the discharge of untreated industrial effluents into rivers and coast-associated ecosystems already exist in some countries. In Mauritius, untreated effluents with high BOD from the principal industry in the island, the sugar-cane processing industry (and there are 21 factories) are discharged into rivers and coastal waters and have been implicated in fish mortality in estuaries.

57. For example, effluents from the Monloisir sugar estate have grossly polluted the River Rempart estuary. The Solitude Distillery, generating an average of 200 m^3/day waste water high in organic load discharges into the River Citron which downstream feeds a prawn and fish pond in the Pamplemousses area. The high BOD load

Table 5 : Characteristics of waste water from selected industries

(Sources: Helmer and Mörgeli (1978); Tanzania Ministry of Lands, Housing and Urban Development (1980)).

Industry	pH	Suspended solids (SS) mg/l	BOD_5 20°C mg/l	COD mg/l	Miscellaneous constituents	Pollution aspects
Refinery	-	-	200	-	oil - 30 mg/l phenol - 30 mg/l	mineral oil and phenols
Cotton textiles	8.0-11.0	30-50	200-600	-	detergents, dyes chromium 30 mg/l	alkali, BOD, dyes and various chemicals
Distillery	4.3	4,000	29,000	65,000	high sulphate	high BOD, SS, putrescibility and low pH
Fertilizers (ammonia and urea)	8.0	3,700	30	330	NH_3N-510 mg/l arsenic	toxicity due to free ammonia and promotes eutrophication
Pulp and paper (kraft process)	6.9- 9.8	600-2,300	150-420	700-1,000	mercaptans, sulphides	large volume, high pH, SS, colour and toxicity

able 5 continued...

ndustry	pH	Suspended solids (SS) mg/l	BOD_5 20°C mg/l	COD mg/l	Miscellaneous constituents	Pollution aspects
anzania reweries, Ilala ar es Salaam	4.2	-	9,500	34,900	spent grain, yeast, dilute caustic soda	high BOD, low pH, toxic to fish
inguenti battoir anzania	7.3	714	1,000	2,990	blood, rejected meat pieces	high BOD, unpleasant odor
riendship extile Factory anzania	11.5	229	90	57	detergents, dyes starch, chemicals	high pH, high BOD and dyes

of the effluent from the distillery has depleted the receiving river of oxygen and wiped out aquatic life. The fish pond is also polluted and fish kills are reported. Effects of industrial pollution have been manifest in inland streams and on the coastal environment in other parts of Mauritius.

58. In Mozambique, the Matola River is polluted by effluents from the Textlom factory which discharges into it after traversing the adjoining mangrove creek. The river also receives untreated effluents from some food processing factories during its course to Maputo Bay. The contribution of untreated industrial wastes to the pollution of the bay has not been assessed but adverse ecological consequences cannot be ruled out. The cement factory located on the ooast near Matola harbour may be causing air pollution problems and a good proportion of the particulate matter released into the air could end up in the sea.

59. About 70-80 per cent of the industries in Tanzania are located in Dar es Salaam. The waste waters from over 30 different factories representing different polluting industries such as textiles, abattoirs, breweries and chemical plants, end up in the sea owing to the discharge of untreated wastes into rivers, creeks and bays. Tanzanian distilleries at Mbozi Road discharge about 36,000 litres per day of spent molasses into the Dar es Salaam harbour. The high BOD of the organic waste has most probably depleted the discharge area in the harbour of oxygen and adversely affected fisheries.

60. The Msimbazi River, apart from sewage pollution, is also seriously polluted by organic and toxic industrial wastes. Wastes from chemical industries manufacturing toxic pesticides such as DDT and from a bicycle factory using cyanide and chromium in its processing methods end up in the river and the sea. The Msimbazi Creek is also the recipient of waste oil from garages. The complex nature and variety of the industrial wastes accentuated by synergistic effects of the different pollutants have produced adverse ecological effects.

61. Comoros is on the threshold of industrialization and as such, there are no significant marine pollution problems from industrisl activities. The major industry on the islands is the production of an essence by distillation of ylang-ylang plant leaves. The volume of waste generated is small, and its direct discharge into the ses is highly diluted by sea-water rendering it harmless.

62. The level of industrial activity is generally low in Somalia. The majority of the few industries existing in the country are medium-scale and located inland, and do not pose any pollution threats to the marine environment. However, a unique example of the deleterious effect on human health, safety and loss of amenity due to careless discharge of untreated industrial effluent into the ses was evident in Mogadishu. An abattoir, slaughtering about 45 camels, 175 cows and 240 goats and sheep daily is located on the beach about 100 metres from the sea. The raw effluent containing blood, intestinal waste, and characteristically high in BOD and suspended solids, is disposed of through a closed pipe into s large open ditch, which serves as a form of treatment pond. The overflow from the pond goes along an open shallow drain into another open ditch for further biological treatment. The system is not maintained and there is overflow of the water rich in organic waste into the inshore waters. The volume of waste from the abattoir is fairly large. Its polluting effect on the coastal waters and beach would be considerable during the rainy season due to large volumes of run-off and flooding. Taking into account the adjacent municipal dump contributing highly polluting leaching and run-off, the pollution stress and impact on the coastal waters is worth investigation. This unwholesome incursion of the abattoir waste into the sea has attracted sharks into the lagoon waters. About 6-10 people have been reported to be victims of shark attack while swimming.

63. In Kenya, most of the industries in the coastal zone are concentrated in the west mainland area of Mombasa. Because the industries are medium-scale and mainly agrarian, discharge of their untreated low volume wastes into the sea has not produced any significant pollution problems (Kenya, Ministry of Local Government, 1977).

64. The current level of industrial activity in Seychelles generates little effluent and it is well assimilated by discharge into the coastal waters. Some localized coastal pollution problems however exist. Two furniture factories in the Mont Retraite area have been dumping sawdust into the bay. An area of the sea bed 100 m by 20 m is covered by a 4 m thick carpet of dust. This type of waste load is characteristically high in oxygen demand, biodegradable and detrimental to aquatic life. In addition, the discharge into the sea of about 20,000 litres of spent wood preservative liquor containing high levels of copper and arsenic four times a year by the Seywood Factory could cause harmful effects in coastal biota around the outfall. Copper toxicity in fish is scientifically well established and ingestion by man of fish or seafoods contaminated with cyanide is extremely harmful.

65. A major industrial development project in the country is the 20 megawatt Ocean Thermal Energy Conversion (OTEC) plant which has been initiated. It is recognized that adverse environmental impacts can occur in the construction and operational phases of OTEC plants but that the risks can be reduced to acceptable levels through proper planning and design. Environmental concerns include construction impacts, particularly if reefs are involved, and operating impacts associated with upwelling of nutrient-rich water.

66. Certainly, the current low level of industrial activity is not endangering the marine ecosystem on a regional scale, but the improper handling and discharge of industrial liquid wastes are causing serious localized problems in some countries.

Solid wastes:

67. From the foregoing, it is apparent that present liquid waste disposal mechanisms are causing localized marine pollution problems in the region. Dumping of domestic and industrial solid wastes on tipping sites located on the coast has marine pollution potentials too.

68. Again, the nature and volume of solid wastes vary in different countries depending on population and levels of industrialization and technological development. In most countries of the region, domestic and industrialized solid wastes are disposed of together in Government-approved sites on the coast, usually for land reclamation purposes. However, the tipping sites are often not operated according to any generally accepted principles.

69. In Mombasa, solid waste comprising broken glass materials, metal containers, paper and cardboard materials, hazardous wastes, used lubricating oils in containers, expired medicines from hospitals, old toxic chemicals and animal cadavers are at present dumped in an uncontrolled landfill at Makupa Creek south of Makupa Causeway. The landfill is located here for reclamation of wasteland and swamps partly covered by shallow water. There is open-air burning of the wastes. No precautionary measures are taken to prevent landfill leakages from polluting the adjoining creek water nor to circumvent run-off of leachates during the rainy season. The East African Railways and Harbours Corporation operate another refuse tip at Makupa Creek opposite the municipal landfill for the disposal of solid wastes from foreign ships and the harbour as well as unplaigned cargo contained in

70. This mode of solid waste management is hazardous and unacceptable because the leachates are high in BOD and contain large amounts of dissolved toxic metals and persistent toxic organic chemicals, which have deleterious effects on flora and fauna in the creek (see table 6).

71. In Tanzania, the crude tip at Tabata in Dar es Salaam is on the banks of the Luhanga River, which is a tributary of the Msimbazi River, and the latter eventually discharges into the sea. Solid wastes of all sorts, including hazardous substances, are dumped at the site. Seepage and leaching during the rainy season also pose serious marine pollution problems. The rivers Luhanga and Msimbazi are already heavily polluted. Ultimate pollution of Msimbazi Bay, where the river joins the sea, seems inevitable.

72. Solid waste disposal by landfill is similarly used for land reclamation in Mauritius and Seychelles.

73. In Mauritius, at Roche Bois tip, located on the coast in the Port Louis area, domestic, commercial and industrial solid wastes are dumped crudely and incinerated in the open air. About 70 tonnes of solid wastes are discharged per day at the site which is about one hectare. This crude tip has been operating for about 35 years. The adjoining lagoon is heavily polluted with vehicle tyres, glass and plastic containers and a lot of inert suspended matter. The pollution stress on the lagoon environment is worsened by an abattoir and a piggery also discharging their high oxygen-demanding waste, untreated, into the lagoon. Consequently, Roche Bois lagoon waters and the region around Tombeau Bay are polluted and devoid of any fish or flora.

74. The experimental sanitary landfill site at Les Saline, on the coast near Fort Victoria at Port Louis, is also a potential marine pollution source. Leachates from the site could be flushed back to the sea at high tide due to the high water table in the area.

75. The municipal dumping site, at a small bay in the La Retraite area of Victoria, Seychelles, on a segregated portion of the lagoon, is aesthetically unpleasant with high, though localized, marine pollution potential. There is a continuous exchange of water between the tip and the rest of the bay. Neither extent of pollution nor the ecological consequences have been assessed.

76. The situation at Mogadishu, Somalia, is no different from the above cases. A big tipping site is located right on the coast, close to the city abattoir. The tip is uncontrolled and infested with vermin. Its marine pollution potential is high especially in the rainy season when leachates run off directly into the sea.

77. Marine pollution problems from municipal solid wastes are insignificant in Comoros, but abandoned motor vehicles are dumped into the sea at Moroni. Whilst this may be advantageous in providing shelter for some fish species, the hindrance and nuisance to marine activities, such as bathing and sailing, make the practice unacceptable.

78. The extent of degradation of the coastal environment caused by general lack of proper industrial wastes handling highlighted thus far is significant in some countries, and appropriate remedial action is needed. A more detailed account is given in UNIDO/UNEP (1982), Industrial Sources of Marine and Coastal Pollution in the East African Region. UNEP Reg. Seas Rep. Stud., (7).

Table 6 : A typical landfill leachate composition

(Source: Mombasa sewage master plan)

Parameter	Concentration (mg/l)
Alkalinity	8,045.00
BOD_5	24,642.00
Hardness	5,027.00
Suspended solids	349.00
Calcium	2,234.00
Chloride	1,257.00
Iron (total)	399.00
Magnesium	378.00
Nickel	0.27
Organic nitrogen	178.00
Phosphate	7.90
Potassium	1.373
Sodium	1,061.00
Sulphate	383.00
Zinc	13.20
pH	5.80

Domestic and municipal wastes

79. The liquid and solid wastes handling practices in the region are contained in WHO/UNEP (1982), Public Health Problems in the Coastal Zone of the East African Region. UNEP Reg. Seas Rep. Stud., (9).

80. The characteristics and quantity of domestic and commercial wastes generated in the region vary from country to country, depending on size of population, standard of living and cultural habits.

81. The general pattern of raw sewage disposal in coastal towns and cities is to discharge it raw into streams and rivers which empty into estuaries, mangroves or lagoons, or directly discharge it into the sea. There is partial sewerage only in a few urban coastal towns such as Mombasa; Maputo and Beira (Mozambique); Dar es Salaam and Tanga (Tanzania); Victoria (Mahé, Seychelles) whilst Mauritius has about 60 per cent sewerage in Port Louis and Plaines Wilhems (table 7). Comoros, Somalia and Madagascar have no sewerage system and rely principally on pit latrines and septic tanks for containing human waste.

82. Disposal of sewage into the sea by pipeline from the sewerage system is sometimes adopted, relying on efficient dilution and dispersion by sea-water. Generally, discharged sewage is not treated. Although a few sewage purification plants (usually primary treatment) exist in Kenya, Tanzania, Mauritius and Seychelles, with the exception of the latter country, whose new plant is currently under-utilized, their capacities are small compared with the population served and are often poorly maintained.

83. The sea outfalls in most cases are not far enough from the coast nor submerged sufficiently to avoid beaches being polluted. Sometimes the outfalls are broken and neglected causing serious pollution of beaches and lagoons.

84. The population of the major coastal towns constitute about 6 per cent of the total population within the region (see table 7). An assessment of the oxygen-demanding organic load from untreated domestic waste causing marine pollution problems is given in table 7, which also shows the major coastal cities in each country and estimates of their annual organic load discharged into the Western Indian Ocean. The BOD_5 figures are calculated on the assumption of 20 BOD_5 per person per year and 30 per cent BOD_5 reduction due to partial treatment. It is also assumed that only coastal towns with a population of more than 100,000 would contribute significantly to marine pollution from sewage. The data in some cases may be inaccurate due to imprecise information with regard to population figures and extent of sewerage. No account has been taken of other domestic sewage discharges into the sea through open drains and gutters as no information is available on the quantity of effluent involved.

85. Sewage pollution does not seem a serious regional problem yet as approximately 7,340 tonnes/year BOD_5 organic load, or 0.62 tonnes/year BOD_5 per regional coastline, enter the Indian Ocean and these amounts can easily be assimilated by high dilution with sea-water. However, sewage pollution could be a problem in the future as plans are afoot for new sewerage schemes in Malindi and Lamu in Kenya, and rehabilitation and expansion of existing ones in Mombasa, Port Louis and Dar es Salaam.

86. At present, sewage pollution poses localized but serious marine pollution problems in some countries, for example, Maputo Bay and Dar es Salaam harbour.

Table 7: Estimated discharge of domestic sewage from major cities on the coasts (estimated 20 kl/capita/year)

Country-City	Population (Estimated) 1980	Length of Coastline Expressed in Km.	Population Sewered	%	BOD_5 ton/yr.	BOD_5 Km coastline ton/yr.
Kenya	15,300,000	500				
Mombasa	440,000		88,000	20	1760	3.52
Malindi	14,000					
Lamu	6,000					
Regional/Total	460,000		88,000	19	1760	3.52
Tanzania	17,540,000	800				
Dar es Salaam	760,000		112,500	15	2250	2.81
Tanga	100,000		10,000	10	200	0.25
Lindi	30,000					
Regional/Total	890,000		122,500	14	2450	3.06
Mozambique	10,200,000	2500				
Maputo	770,000		77,000	10	1540	0.62
Beira	220,000		55,000	25	1100	0.44
Quelimane	100,000		10,000	10	200	0.08
Nampula	100,000		10,000	10	200	0.08
Pemba	30,000		3,000	10	60	0.02
Regional/Total	1,220,000		155,000	13	3100	1.24
Comoros	400,000	350				
Moroni (G.Comores)	16,000					
Moheli	4,500					
Anjouan	10,000					
Regional/Total	30,500					

(Table 7 continued...)

Country-City	Population (Estimated) 1980	Length of Coastline Expressed in Km.	Population Sewered	%	BOD_5 ton/yr.	BOD_5 Km coastline ton/yr.
Madagascar	8,500,000	4000				
Tamatave	60,000		9,000	15	180	0.05
Majunga	70,000					
Tulear	40,000					
Diego-Suarez	45,000		4,500	10	90	0.02
Regional/Total	215,000		13,500	6	270	0.07
Mauritius	936,000	200				
Port Louis	250,000		150,000	60	3000	15.00
Plaines Wilhems						
Curepipe	57,000		40,000	70	800	4.00
Beau-Bassin/ Rose-Hill	72,000		50,000	70	1000	5.00
Phoenix	36,000		25,000	70	500	2.50
Regional/Total	415,000		265,000	64	5300	26.50
Seychelles	65,000	600				
Victoria	25,000		6,250	25	125	0.21
Regional/Total	25,000		6,250	25	125	0.21
Somalia	3,850,000	3000				
Mogadishu	400,000					
Merca	55,000					
Kismayo	60,000					
Berbera	50,000					
Regional/Total	565,000					
GRAND TOTAL	3,820,500		650,250	17	13,005	

87. In Maputo, there are 10 sewage outfalls into the sea receiving only partial treatment. Consequently, Maputo Bay waters and fish are polluted with pathogenic organisms. Public bathing and fishing have been officially prohibited in the bay for environmental health reasons based on a study by the national Ministry of Health (Laboratoria de higiene da agua e alimentos, 1980).

88. In Tanzania, a few kilometres' stretch of the Dar es Salaam coast is polluted with sewage and industrial wastes. Faecal lumps and floating solids litter areas around the harbour, Banda market beach and the Ocean Road beach. The sewage pipe at Ocean Road ses outfall is broken. A foul odour, due to severe oxygen depletion of the waters, pervades the coastline. The natural flora and fauna within the polluted area have been smothered.

89. In Dar es Salaam, the mangroves on the estuary of the Msimbazi River have been contaminated with domestic sewage and industrial wastes. The Msimbazi River itself is polluted with sewage (table 8). The natural fauna in the mangroves, such as crabs and oysters, are under stress while the plankton has almost disappeared.

90. Pollution of the marine environment in Dar es Salaam by domestic and industrial wastes had been studied as part of the background information for the Dar es Salaam Sewerage and Sanitation Master Plan Report (Tanzania, Ministry of Lands, Housing and Urban Development, 1980). Chemical characteristics of domestic and commercial wastes in Dar es Salaam are shown in table 9 indicating the polluting nature of the wastes. The data obtained are similar to those of domestic wastes elsewhere.

91. In Mauritius, evidence of sewage pollution exists along the shore within the vicinity of the Fort Victoria sea outfall in Port Louis. The Fort Victoria sewage treatment plant receives and treats combined domestic and commercial wastes before discharging into the sea through the outfall, which is about 500 metres offshore. However, during periods of energy failure or mechanical breakdown, the treatment plant is by-passed and raw sewage is discharged into the sea. Carpets of algae along the shore and a foul odour indicate organic pollution of the waters.

92. Minor and localized sewage pollution of coastal waters exists in Mombasa and Malindi in Kenya, but the waters are safe for recreational uses and no adverse effects on fisheries have been reported (Kenya, Ministry of Local Government, 1977).

93. Moroni and Fomboni in Comoros do not have any significant pollution problems from sewage. Domestic sewage disposal in Victoria does not pose serious marine pollution problems in Seychelles. Only a small percentage of the population is connected to the sewerage system, affecting the hygienic conditions, but with a very limited impact on the marine environment. Seven major tourist hotels with about 300 beds each are located along the coast. Although each hotel treats its sewage through septic tanks, the waste water eventually seeps into the sea.

Agricultural wastes

94. More than 90 per cent of the population in the region is engaged in agricultural activities which invariably contribute significantly to the gross domestic product in most countries. With the agrarian green revolution and self-sufficiency in food being the pre-occupation of most Governments, modern agricultural methods involving the use of agricultural chemicals such as pesticides and fertilizers are replacing traditional and less efficient farming systems. Increasing the yield of valuable cash crops such as cotton, sugar-cane, tea and

Table 8 : Bacterial survey of Msimbazi River and tributaries

(Source: Tanzania Ministry of Lands, Housing and Urban Development (1980))

Sample point	Faecal coli/100 ml (44.5OC)
New port road	3,000
Kigogo road	11,000
Morogoro road	64,000
Selander bridge (at low tide) *	30,000
Selander bridge (at high tide)*	1,090

Note: It has been suggested that the tidal connections are broken at present due to road construction.

Table 9: Characteristics of domestic and municipal sewage in Dar es Salaam, Tanzania, and other places

Location	Classification	Suspended solids mg/l	BOD_5 mg/l	COD mg/l	pH	NH3-N mg/l
Storm water drain Gymkhana Club	Residential	387	390	745	6.9	25
City centre drain	Residential	233	170	380	6.9	10
City centre	Residential and commercial	1,092	135	285	8.0	26
Lugalo barracks	Institutional	369	180	267	6.9	-
Brazil*	Domestic (6 towns)	200-350	280-340			
Kenya	Sewage (Nairobi, Nakuru)	550-662	448-940			
Nigeria	Raw sewage	1,252	909			

*Helmer and Mörgeli (1978).

95. Some large-scale agricultural plantations are found in the coastal zone while the majority are located inland. River transportation of agro-chemicals through land run-off during the rainy season is the main pathway of these chemicals into the marine environment.

96. From discussions with Ministries of Agriculture and Fisheries in the region, it was clear that persistent and ecologically harmful chemicals of proven toxicity to fishes such as organochlorine insecticides are widely in use. They include DDT, dieldrin, lindane, aldrin, thiodan, and toxaphene.

97. DDT is used extensively for aerial spraying of cotton-fields around Margarini in Malindi, areas around Quelimane, Nampula, Pemba, Beira and Monapo in Mozambique, and in south-west and north-west areas of Madagascar. Products containing DDT and dieldrin are also sprayed aerially for tsetse fly control in Kenya, Somalia, Tanzanis and Mozambique. Aerial drift from the spraying areas, co-distillation with soil moisture during the dry season and precipitation during the rainy season will transport these chemicals into the marine environment in the region.

98. Apart from applicstion in agriculture, DDT is used for disinfection of harbours in Kenya while diazinon, an organophosphorous pesticide, is used for a similar purpose in Seychelles, including regular spraying of tourist beaches in Victoria (Mahé) and Praslin Island.

99. Chlorinated and other classes of pesticides such as organo-phosphorus, carbamates and pyrethroids are also used for agricultural food crops. Ecologically unsafe herbicides, for example, 2,4-D and 2,4,5-T (which contains a highly toxic impurity, dioxin) are in use in Madagascar, Mozambique, Mauritius and Kenya. Mauritius is currently utilizing large quantities of pesticides for food crops and the sugar-cane plantations located along the coast. Organo-mercuric fungicides which have been banned in the developed countries due to mercury toxicity are currently in use, though in limited quantities, in Kenya and Madagascar.

100. Poor agricultural land use practices are causing severe soil erosion problems. (See UN/UNESCO/UNEP(1982), Marine and Coastal Area Development in the East African Region. UNEP Regional Seas Reports and Studies No. 6). The coastal and marine environment ultimately receive a reasonable quantity of these pesticides applied inland due to run-off during the rainy season.

101. A fairly large amount of fertilizers is being used in the region for food crops in Mozambique, Tanzania, Kenya, Somalia, Madagascar and Mauritius. Rivers draining agricultural areas carry a lot of fertilizers into the coastal zone from run-offs. The serious sedimentation problems due to soil erosion in Madagascar, Mozambique, and Malindi and Mombasa in Kenya are already introducing a lot of nutrients into estuaries and lagoons, resulting in eutrophication. The adverse effects, though localized, are already evident in marine ecosystems. The Ministry of Agriculture in Mauritius attributes the decline of fisheries in estuaries and lagoons to pesticides run-off, another consequence of poor agricultural practice. Helicopter spraying of parathion has been reported to kill fish in the Limpopo River which flows into the Indian Ocean.

102. With the development plans of all Governments in the region giving prominence to agricultural development but with little environmental awareness, increased amounts of pesticides and fertilizers would be used, thereby enhancing the pollution threat to marine ecosystems.

Pollutants carried by rivers

103. Rivers constitute an important pathway by which pollutants from land sources enter the marine environment (SCOR working group 46, 1981). River discharges often affect characteristics of coastal waters more than the open ocean. The environmental impact, however, depends on the discharge volume of the river, the characteristics and level of pollutant loads carried and climatic factors.

104. From the foregoing sections, it has been amply demonstrated that rivers are a major transport pathway of sewage, industrial effluents and agricultural wastes and hence introduce toxic inorganic substances such as mercury, copper, cadmium and lead and persistent toxic organic substances such as DDT, and dieldrin into the marine environment. Rivers traversing thermal power stations carry waste oil into estuaries and bays as exemplified by the St. Louis River in Mauritius. In addition, such rivers run the risk of picking up polychlorinated biphenyls (PCBs) which are used as insulation oils for electric capacitors and transformers. PCBs, though similar in chemical nature to DDT, are more persistent in the environment, carcinogenic and ecologically more harmful (Riseborough et al., 1972).

105. Major rivers discharging into the Indian Ocean from the eight countries in the region are listed in table 10, their distribution being very uneven. The Rufiji River in Tanzania with an average water discharge of 1,133 m^3/sec is the largest in the region. The impact of the various river discharges would depend on climatic factors and the assimilative capacity of the receiving coastal ecosystem.

106. Due to systematic deforestation, the Galana-Sabaki River is heavily silted at its estuary in Malindi arising from the incursion of storm water from upland into the river. The beach at Malindi is highly silted and already causing concern to the Kenyan Government because of the possible adverse impact on tourism. A similar problem exists on the Tana River, where severe damage to marine fisheries was reported, although it was mentioned that remedial action had been taken here.

107. Other countries in the region also expressed concern about siltation problems. A heavy silt load is carried by the Limpopo and Zambezi rivers into the sea in Mozambique, due to severe soil erosion arising from bush burning and new human settlements. The Island of Inhaca is also suffering from severe soil erosion and now has a silty beach. While Comoros does not have the problem of chemicals and sewage input into the sea because of its present stage of development, the poor agricultural practice of planting hillsides and marginal lands with non-soil-binding crops has been causing serious erosion problems. Hence, the coral reefs are silted in Moroni and Anjouan. Seychelles also experiences siltation problems in harbours and estuaries due to poor agricultural practices.

108. A localized sedimentation problem exists on the south-east coast of Mauritius resulting from carry-over of topsoil into the sea by rivers during the rainy season. The situation is most severe in Madagascar. Over-exploitation of mangrove forests and deforestation from intense bush fires enhanced soil erosion and has resulted in the loss of 1 million hectares of topsoil per year; while shifting agricultural cultivation produces an annual loss of 200,000 hectares. All the sediment load ends up in the sea via rivers. Sedimentation problems are manifest in Toliara (Tuléar) and Antseranana (Diego-Suarez) in south-west and north Madagascar respectively. The magnitude of the problem was observed during an aerial flight. The Betsiboka River has delivered about 100 million cubic metres of sediment over the past 25 years into Mahajanga (Majunga) harbour. Consequently, the coral reefs and the associated reef community have been smothered, while coastal shipping and fishing activities have been paralysed.

Table 1C : Major rivers draining into the Indian Ocean

Country	Rivers
Comoros	none
Kenya	Galana-Sabaki, Tana
Madagascar	Betsiboka, Managoki, Manambolo, Onilahy, Tsiribihina
Mauritius	Grande Rivière, St Louis
Mozambique	Limpopo, Lurio, Rovuma, Save, Zambezi
Seychelles	none
Somalia	Juba
Tanzania	Pangani, Rufiji, Ruvu, Ruvuma (Rovuma), Wami

109. Thus far, siltation and sedimentation from erratic land use practices and soil erosion constitute a major environmental problem in the region, bearing a complex variety of socio-economic implications. The key aspects of the soil erosion/siltation problem are assessed in full detail in UN/UNESCO/UNEP(1982), Marine and Coastal Area Development in the East African Region. UNEP Reg. Seas Rep. Stud., (6).

Oil pollution

110. Petroleum pollution of the sea and coastal environment seems to be the major marine pollution problem in the region. Concern about the problem and the possible adverse impact on tourism, a major source of revenue in many countries in the area, was expressed by all Governments.

111. The major oil pollution source is from oil tankers en route between the Middle East and Europe through the Mozambique Channel flushing their tanks at sea. The magnitude of the problem was observable on a flight between Moroni and Moheli in Comoros during which a several-kilometres- long stretch of oil at sea along the Comorian coast was observed. Other sources of oil input into the sea include discharges of oil resulting from accidental spills. Frequent spills of small quantities of oil are common in all the harbours during operational transfer of oil from crude oil tankers into storage reception facilities on land.

112. Some recorded incidents of oil spills in the region are given in table 11. Other sources of oil pollution at the ports are discharge of oily bilge-water from cargo ships and fishing boats; pump failures, pipe leakages and pipe bursting during handling of petroleum imports and exports. Localized oil pollution at ports varies from country to country and according to intensity of activity. While Kenya and Tanzania for example, each have two ports, Mozambique has six ports along its coast, namely: Matola, Beira, Quelimane, Angoche, Macuze and Nacala.

113. All the mainland African countries and Madagascar have petroleum refineries of various capacities while Comoros, Mauritius and Seychelles only import refined oil products. The refinery effluents contribute to oil pollution of the sea in the former countries. Information gathered on annual quantities of refined oil is given in table 12. Information was also made available on the volume of effluent from the refinery in Mombasa which is about 100,000 m^3/day of oily waste water. Based on the IMO regulation of 100 mg/l in refinery effluents, about 10 tonnes of oil is being released daily to the coast around Mombasa.

114. Other less important sources of oil input into the marine environment, though having significant local impact in coastal environments and rivers, are land-based waste oil discharges from garages, thermal power stations and a few industries. Lack of available data makes it impossible to estimate quantitatively the relative contribution of each oil pollution source in the region but table 13 gives the global picture.

115. Tourism contributes substantially to the gross domestic product of Seychelles, Mauritius and Kenya while other countries such as Tanzania, Mozambique, Somalia and Madagascar plan to expand the tourist sector. Tar balls have been observed on tourist beaches in Kenya (Malindi and Mombasa), Madagascar, Seychelles, Mozambique and Mauritius, and this is aesthetically distasteful to tourists.

116. Tar ball pollution of beaches had been studied only in Kenya, by the Marine and Fisheries Research Institute in Mombasa. As expected, the tar concentrations

Table 11 : Available information on recorded oil spills in the region

Country	Spillage	Damage caused	Quantity of oil involved (tonnes)
Somalia	-		-
Kenya	accidental spill from oil tanker, BRITISH CAVALIER off Mombasa Harbour in 1975 and 4 incidents of refined product spillage from refinery	-	97
Tanzania	accidental spill from oil tanker at harbour on 9/1/81	Mangrove forest near harbour affected	50-100
Mozambique	2 major & 14 minor crude oil spills recorded in the harbour	Mangroves affected	-
Seychelles	crude oil from Royal Fleet Tanker grounded 8 miles NE of Mahé in 1976	-	-
Mauritius	the TAYEB grounded on the reefs of Mauritius	-	2,000

- no information available

Table 12 : Crude oil import figures and quantity of oil refined in the region

Country	Crude oil import (million tonnes)	Volume of refinery effluent (m^3/day)	Name of refinery and quantity of oil refined (million tonnes)
Somalia	0.3	-	Iraqsoma (Mogadishu) 0.3
Kenya	4.0 approx.	100,000	East African Oil Refinery 3.0
Tanzania	1.6	-	Tanzanian-Italian Petroleum Refinery 1.6
Mozambique	1.0	-	Refinery in Motola 1.0*
Madagascar	0.65	-	Solitary Malagasy Refinery of Toamasina, Solvina, (Tamatave) 0.65
Mauritius			0.25 (refined oil import)
Seychelles			0.06 (refined oil import)
Comoros			-

* Estimated
- No information available

Table 13 : Estimated volumes of crude oil and petroleum hydrocarbons introduced into the world oceans

(Source: McCaull and Crossland (1972))

Sources of pollution	Million tonnes
Normal transport by tankers	0.53
Offshore drilling	0.10
Normal ship traffic	0.50
Discharge of refineries	0.30
Petroleum waste water from land-based sources and through rivers (industry and traffic)	0.55
Oil spills, accidents (all sources)	0.20
Immediate discharge, total	2.18
Via the atmosphere (from burning processes in industry, domestic and traffic)	10.00
Man-made oil pollution	12.18
Natural submarine seepages	<0.10

north-east monsoon in the Monsoon Current and Mozambique/Agulhas Current hydrographic regions. Individual tar balls weighing over 3 kg were recorded during the Mombasa study (Munga, 1981).

117. Used lubricating oils from garages are not disposed of in any organized manner and disposal varies from burying underground to discharging into drains, rivers and creeks. The disposal of waste oil tar into the Msimbazi River from garages has contributed to the pollution of the mangrove habitat and biota in Msimbazi Creek in Dar es Salaam. Oil and tar residuea covering the roots and thereby blocking the lenticels of mangrove pneumatophores has stunted mangrove trees. Waste oil pollution of the creek has smothered oysters (Crassostrea sp.) and other filter feeders. Moreover, oil floating on water has caused severe oxygen depletion and anoxic conditions in the creek.

118. Discharge of waste oil from the St. Louis thermal power station, which consumes about 25,000 gallons of oil per day, and a central bus service station into the St. Louis River in Port Louis, Mauritius, has polluted the river and contributed largely to the pollution of Grand River Bay, smothering all aquatic biota in its waters. Restricted cases of fish tainted with oil have been reported in the country.

119. Despite the difficulty of quantifying the various sources of petroleum hydrocarbon pollution in the region, there is no doubt that oil tanker traffic is its major source. National resources to control and combat oil pollution are virtually non-existent in the region. Only Kenya has an oil pollution control vessel in the form of a 200-ton barge for mechanical oil recovery in case of minor spills. Limited stocks of chemical dispersants were available in all the ports visited. However, no baseline studies on marine pollution from petroleum hydrocarbons had been carried out in the region. An assessment of its magnitude and effect on ecosystems would be desirable in view of oil and oil dispersant toxicity to marine biota.

120. The pollution is likely to worsen if oil were discovered as a result of the current intenaive oil prospecting and exploration efforts in the region. A more complete account is given in IMO/UNEP (1982), Oil Pollution Control in the East African Region. UNEP Reg. Seas. Rep. Stud., (10).

Coastal construction and dredging

121. Some countries in the region have indicated in their development plans the intention of expanding old ports and building new ones because of increasing maritime trade and rapid expansions in various sectors of the economy. Port and harbour developments, involving construction or enlargement or dredging, invariably have environmental consequences which could be detrimental to or modify the coastal ecosystem (IMCO, 1980).

122. Coastal structures and barriers have altered the water flow within the Mombasa harbour to such an extent that the coastline around Fort-Jesus has been seriously eroded. The Kenyan Government, during the 1979-1983 development plan, intends to deepen the entrance to Mombasa harbour, which would involve major dredging operations. The building of a second major port at Manda Bay, near Lamu, is also under consideration (Kenya, Ministry of Power and Communications, 1977).

123. The environmental impact of these major port development activities is worthy of consideration. Dredging csuses suspension of sediments in coastal waters. Dredge-suspended sedimenta interfere with light penetration into coastal waters and

exert both biological and chemical oxygen demands (Johannes, 1975), and are therefore highly polluting with possible adverse effects on fisheries and corals.

124. The Mozambican Government is planning to embark on a major expansion of Beira port in connection with the proposed exploitation of the huge coal deposit around Tete in the north-east of the country. Apart from the siltation and coastal erosion problems that may arise, handling of huge quantitites of coal at the port would cause serious coastal pollution and ecological problems if adequate measures are not taken.

125. Damage and destruction of reef communities due to dredging was observed in Seychelles (Vine, 1972) after the construction of the country's new International Airport and Victoria Harbour in 1970. According to government sources, recent aerial photographs suggest that after about 10 years the ecosystem has recovered. However, severe coastal erosion has been observed to the east of Victoria caused by sea-wall structures. Worse marine pollution problems may still be encountered after executing other major coastal development programmes already scheduled. These include the building of a fishing port and a new commercial port (Seychelles, Ministry of Planning and Development, 1981), to be financed through international funding.

126. In Comoros, expansion of the Port at Mutsamudu in Anjouan, which will involve lengthening of the jetty, has also been planned. The threat to marine living resources in the harbour area may be increased because of the present heavy sedimentation problems at the port.

127. A project for reclamation of the sea area for port-related industries has been planned by the Mauritian Government in the Mane Rudje area. The Malagasy Government is also contemplating deep-water ports on the north-west coast of the country.

128. The projects described above illustrate pollution problems that may arise from port dredging and land reclamation activities in the region and the possible consequences of proposed port development projects. The pollution problems generated by these activities are localized in nature and therefore do not constitute a regional problem. Further details may be found in UN/UNESCO/UNEP (1982). Marine and Coastal Area Development in the East African Region. UNEP Reg. Seas Rep. Stud., (6).

Effects on human health

129. Deleterious effects such as hazards to human health resulting from the pollution of the coastal and marine environment have two components, namely: (a) reduction in amenity such as use of beaches for recreation: bathing, snorkeling, skin diving, etc.; (b) poisoning by ingestion of seafoods (fish and shellfish) contaminated with pollutants. Table 14 gives the major categories of pollutants and their effects on living resources.

130. Localized problems of sewage pollution of estuaries, lagoons and bays have been identified in the region and microbiological pollution is known to exist. Microbiological pollution of these coastal waters with pathogenic organisms poses serious health risks and a reduction of amenities to bathers. Apart from such polluted waters being aesthetically unpleasant the contraction of minor skin ailments by bathers has been reported on the sewage-polluted beaches of Dar es Salaam and Maputo Bay. Many cases of hepatitis, gastro-enteritis and skin diseases have been reported in Dar es Salaam. Cholera outbreaks had also been reported in Dar es Salaam and Maputo. The Mozambican Government has prohibited bathing in parts

Table 14 : Major categories of marine pollution

(Source: IMCO, 1970)

Category	Harm to living resources	Hazards to human health	Hindrance to maritime activities	Reduction of amenities
Domestic sewage including food processing wastes	++	++	(+)	++
Pesticides	++	+	-	-
Inorganic wastes including heavy metals	++	++	-	(+)
Radioactive materials	?	+	(+)	-
Oil and oil dispersants	+	?	+	++
Petrochemicals and organic chemicals	+	?	(+)	(+)
Organic wastes including pulp and paper wastes	++	?	(+)	+
Military wastes	+	?	+	?
Heat	+	-	+	-
Detergents	(+)	-	-	(+)
Solid objects	+	-	+	++
Dredging spoil and inert wastes	+	-	+	

++ important; + significant; (+) slight; ? uncertain; - negligible.

of Maputo Bay during the warm season to safeguard public health, after a study in 1980 by the National Ministry of Health (Laboratorio de Higiene da Agua e Alimentos, 1980). Escherichia coli counts of 24-46,000/100 ml were recorded st some sampling points in the polluted bay.

131. It is a common sight to see passers-by and motorists covering their noses due to the stench emanating from sewage-polluted Msimbszi Creek in Dar es Salaam and no recreational activity exists in the area.

132. The general impression gained by the mission was that the types of problems discussed above were only serious in a few places and the extent varied from country to country. However, there have been no epidemiological studies.

133. The coastal waters receive some toxic chemicals such as inorganics, e.g. mercury, cadmium, lead, arsenic and cyanide and organics, e.g. DDT, dieldrin, and probably PCBs from river run-offs, precipitation and disposal of industrial wastes. The abiotic and biotic processes which these chemicals undergo in the marine environment result in their distribution between the aqueous layer and sediments. Sea-grass, plankton, fish and shellfish retain these persistent chemicals in their tissues.

134. A recently completed study in Seychelles involving a survey of mercury level in 12 economically-important fish species and the blood and hair of some of the population exposed to mercury by ingestion, is worth mentioning (Matthews, 1981). While most legal limits of mercury in fish in various countries are set at 0.5-1.0 mg/kg fresh weight, some fish species were found to have mercury levels of 1.0-2.0 mg/kg. The source of these elevated concentrations has not been established. Some persons of the test population were found to have mercury levels in their blood close to the threshold dose for mercury, corresponding to the acceptable daily intake, ADI, of 3-7 ug mercury per kg body weight, as recommended by the World Health Organization. Seychelles is the country with the highest fish intake per capita in the region, with an average of 80 kg fish consumption annually (see table 1). No epidemiological studies have been undertaken to assess the public hazard. The levels of mercury found in fish are worth further investigation, especially since the tuna fish industry is expanding in the region.

135. Table 15 indicates metal levels in a rock oyster (Crassostrea cucullata) and in Pinna sp., as part of the marine studies in respect of the Mombasa Water Pollution and Waste Disposal Study (Kenya, Ministry of Local Government, 1977). Conclusions csnnot be drawn from the results due to inaccuracies in the analysis, but they can be said to indicate the presence of metals in the tissues.

136. A potential health hazard which needs to be investigated on a regional or sub-regional basis is the recent Ciguatera poisoning incidents in Mauritius and Seychelles due to ingestion of fish containing a toxin, probably stemming from dinoflagellates (planktonic algae). In Mauritius, infested toxic fish are believed to be concentrated around the northern and western coasts, in the vicinity of Rodrigues Island, St. Brandon, Agalega Island, and on the Saya de Malha and Nazareth banks. About 10 per cent of the annual fish catch from the lagoon and the bank is discarded due to this problem with resultant soci-economic consequences. In Seychelles, about 10 cases of Ciguatera fish poisoning have been reported (Rogers, 1981). Ciguatera episodes are often associated with coral reef destruction in tropical waters due to pollution, mining operations and plundering by souvenir hunters. Evidence has also accumulated showing the involvement of trace metals and a vsriety of hydrographical situations (LoCicero, 1975; Taylor and Seliger, 1979; Bagnis et al., 1979).

Table 15 : Metal contents of Crassostres cucullata and Pinna sp. in ug/g on a dry weight basis

(Source: Kenya Ministry of Local Government (1977))

Station	Zinc	Lead	Cadmium	Copper
S5	3,200 - 4,400	12 - 360	2.2 - 2.9	175 - 328
S4	2,700 - 5,200	3.2 - 4.0	2.2 - 9.1	18.1 - 97
N2	1,800 - 3,500	13 - 43	2.3 - 3.0	4.5 - 242
N5	1,600 - 2,400	2.3 - 13	4.4 - 4.5	7.5 - 20.3

137. Environmental health effects of marine pollution seem to have received little attention in the region and the existing wide gaps in knowledge about the extent of the problem need to be filled.

INSTITUTIONAL FRAMEWORK USED FOR THE ASSESSMENT OF MARINE POLLUTION

138. There are institutions in most of the countries of the region which are engaged in marine investigation related to physical oceanography, fishery resource surveys and stock assessment. Most are government institutions and a few are within universities. Very little marine pollution assessment is being undertaken. The major constraints are the acute shortages of skilled manpower and equipment to undertake such studies.

139. Some countries in the region have neither a polytechnic nor a university. Some of the fairly old marine research institutes were residues of pre-independence periods. Few competent scientific personnel are at present available. The few universities in the region do not offer marine science and analytical chemistry in their curricula nor have they active postgraduate programmes for marine pollution research and training of young researchers. The problems are complicated by general lack of funds. Through bilateral agreements with foreign Governments and assistance from United Nations agencies, some marine training and research institutes have been established in connection with fishery resources development programmes. In a few institutions within the region some limited marine pollution assessment studies have been carried out.

140. An outline of the general activities of some of the marine research institutions in the region is given below. A useful reference in this connection is the ECA/UNESCO/UNEP Directory of Marine Research Centres in Africa.

141. Mozambique has four marine science institutions:

(i) Centre of Ecology, Faculty of Biology, Eduardo Mondlane University.

(ii) Marine Biological Station, Inhaca Island, part of the Centre of Ecology in (i).

(iii) Instituto de Desenvolumento Pesqueiro (IDP), Maputo.

(iv) Centro de Treinamento Pesqueiro de Matola, Maputo.

The two centres of ecology of the University of Mondlane are research and training institutions. The station at Inhaca Island, manned by one marine biologist, is there to research into the problems of artisanal fishery on the island and offer laboratory training for undergraduate biology students. The centre has a good reference collection of corals, fish and crustaceans. The centre at Maputo has a staff of five marine biologists and a land-use planner, and recently initiated a research programme on the influence of pollution on mangrove crabs.

142. However, because of the Government's priority for training of science teachers for aecondary schools, academic staff are fully engaged in teaching with little emphasis on research. The remaining two institutions offer training to students and fishermen in addition to research in fish stock assessment and management by IDP.

143. The Direccao Nacional de Aguas (National Water Directorate), Maputo, though a young department, was identified during the mission as having potential capability for marine pollution monitoring. Ongoing studies include sediment discharge of certain rivers into estuaries, and attempting to evaluate environmental effects of the proposed pulp and paper mill. A big handicap is the lack of sophisticated equipment for measurement of trace and ultratrace pollutant levels. The Ministry of Health, Directorate of Preventive Medicine and Public Health, Maputo, currently engaged in mercury determinations in marine fish, is another institution with capabilities in assessment and eventually monitoring of certain types of pollution.

144. Tanzania has four institutions dealing with marine science:

(i) Institute of Marine Sciences, University of Dar es Salaam, Zanzibar.

(ii) Kunduchi Fisheries Research and Training Institute.

(iii) Mbegani Fisheries Research and Training Institute.

(iv) Kunduchi Marine Biological Station, Zoology Department, University of Dar es Salaam.

The latter is actively involved with the ecology and assessment of pollution on mangrove and coral reef ecosystems and associated biota. The central government chemical laboratory, Dar es Salaam, is a well equipped analytical laboratory with some experience in analysis of marine pollutants.

145. In Kenya, the departments of botany and zoology, Faculty of Science, University of Nairobi, are planning undergraduate and postgraduate courses in marine science. No marine pollution assessment study has been undertaken due to lack of staff, equipment and funds. However, two staff members are engaged in marine studies on algae and mangrove ecology.

146. The Kenya Marine and Fisheries Research Institute, Mombasa, which was the former East African Marine Fisheries Research Sub-station, is yet to enter into full operation. The institute is trying to rebuild its staff but has no sophisticated analytical equipment such as gas chromatographs and atomic absorption spectrophotometers for surveillance of heavy metals and chlorinated hydrocarbons, due to lack of funds. Despite these limitations, it has recently carried out studies on tar ball pollution of tourist beaches (Munga, 1981).

147. The Government Chemist's Department, Mombasa, with a wide range of analytical equipment suitable for marine pollutant determination, which has been involved with analysis of mercury in fish, is another new institution.

148. In Somalia there is a plan by the Government to establish a Marine Science Research Institute in Gezire, about 18 km south of Mogadishu.

149. In Madagascar, there are three marine research centres:

(i) Station Marine de Tuléar (Centre Universitaire de Tuléar).

(ii) Institut National de Géodésie et de Cartographie, Tananarive.

(iii) Centre National de Recherches Océanographiques (CNRO) Nosy-Bé.

None of these institutions is engaged in marine pollution assessment studies due to lack of relevant equipment and specialists in the field. Tuléar and part of CNRO,

Nosy-Bé's current research involves fish and shrimp resources assessment, and a systematic inventory of the algae of Madagascar.

150. In Mauritius, there are two marine research centres:

(i) Research Division, Ministry of Fisheries, Port Louis.

(ii) Natural History Museum, Port Louis.

Both are engaged in pollution monitoring. The Ministry of Fisheries complained of lack of equipment and has one staff member on training abroad to learn analytical techniques.

151. Comoros has no institutional framework whatsoever for pollution monitoring. There is neither a polytechnic nor a university in the country.

152. Although Seychelles has no higher institutions, the Fisheries Division, Ministry of Agriculture and Land Use with the assistance of foreign experts, has been involved, amongst other activities, with studies on fishery resource surveys and post harvest investigations. The division recently completed and published the results of a study on mercury in 12 species of fish including tuna; and also in the hair of fishermen, and the blood of mothers and new-born babies. Not least, the Grand Anse Agricultural Experimental Station, of the same ministry, is expecting a consignment of analytical equipment including an atomic absorption spectrophotometer as a grant from the USAID. While these facilities may be employed for marine pollution measurement through inter-divisional co-operation, no local personnel competent to use the equipment is available.

153. The lack of national and regional resources to assess marine pollution or undertake research establishing the fate of various categories of pollutants is obvious. Some marine pollution inveatigations were carried out in connection with Mombasa and Dar es Salaam sewerage master plans respectively, but these were conducted by overseas consultants. All the Governments are fully aware of the shortcomings and have requested assistance in the assessment of environmental pollution, and help in identifying appropriate analytical equipment for monitoring.

CONCLUSIONS AND RECOMMENDATIONS

154. The marine pollution problems of the region vary in nature and magnitude from country to country. Oil pollution of the coastal waters and beaches originating from oil tankers en route to Europe from the Middle East washing their tanks at sea is the most serious pollution problem in the region. The magnitude and impact of the problem could have been greater if the Suez Canal had not re-opened in 1975. Tar balls on beaches constitute a threat to the economics of the region.

155. Other sources of oil pollution such as minor spillages from bunkering operations and discharge of oily bilge water are localized in harbours. Gaps in knowledge exist about pollution from used lubricating oils and tars from garages and industrial sources but the situation is serious in few countries only and confined to rivers, creeks and estuaries.

156. Siltation caused by poor land uae practice, deforestation and soil erosion is the next major problem affecting all countries in the region. Siltation has caused pollution of coral reefs and depletion of reef fishes with adverse socio-economic

consequences. The problem is so serious in some countries that mangroves and biota have been destroyed and harbours abandoned.

157. The extent of marine pollution from sewage, industrial wastes and agricultural wastes varies throughout the region but the problems are localized in coastal ecosystems, such as estuaries, mangroves, bays and lagoons. This could be classified as a regional problem only as far as it relates to being a common problem, but it requires national solutions.

158. There are virtually no regional resources to combat major oil spills and control oil pollution. National capabilities are also inadequate and confined to limited stocks of dispersants.

159. There is a general lack of public awareness about the deleterious effects of environmental and in particular marine pollution. Harmful health effects of coastal and marine pollution have been experienced in a few countries although not on a large scale. It is easy to underestimate the extent of coastal and marine pollution problems in the region. There are no epidemiological studies to assess health effects of marine pollution adequately. The dangers of chronic toxicities from sublethal levels and synergistic interactions between chemical pollutants entering the marine environment require that the nature and extent of the problem be investigated. No information exists about the extent of aerial transportation of lead from fuel combustion into the coastal and marine environment and its effects on marine biota. Many of the countries in the region have their airports on the coast. The same holds for atmospheric fall-out of other pollutants.

160. There is an acute shortage of national and regional resources to monitor marine pollution. Wide gaps exist in the information available in each country on the state of the coastal and marine environment. Being fully aware of these problems the Governments are keenly seeking remedial solutions.

Recommendations at the national level

161. One of the obvious problems is the difficulty of obtaining accurate information on marine pollution problems in most of the countries. Hence, there is a need for a National Data Bank in each country to collect all scientific data on environmental pollution problems and marine pollution in particular. Sewage pollution of coastal waters is a serious public health hazard already apparent in a few countries. It is important for Governments to improve sewage disposal methods. Sewage outfalls, where they exist, were often improperly sited. Hydrographic characteristics of coastal waters should be investigated for efficient dispersal of sewage before siting and installing sewage outfalls. There should be enactment of enforceable national laws to control land-based sources of pollution in order to protect the marine environment and its living resources, based on scientifically based, relevant and appropriate national criteria. It is easier to prevent industrial pollution than remedy its deleterious effects on marine ecosystems. Environmental impact studies should be required for all new industrial establishments and provision of waste treatment plants made compulsory where necessary. In this respect, studies are needed, and a guide book on types of wastes generated by each industry, their relative polluting potential, and suggestions on mode of disposal and site for disposal are required. Not all industrial effluents require elaborate treatment plants. Studies will be needed in each country to characterize the industrial effluents and categorize those requiring minimal treatment and are dischargeable into big rivers or estuaries with suitable assimilative capacity, and those requiring in-plant sophisticated treatment and disposal through municipal sewers and treatment plants to ensure removal of

substances harmful to marine life. Old polluting plants should be encouraged to modify their processes. As a general principle, waste recycling should be encouraged.

162. General environmental education campaigns should be intensified to reduce siltation problems from the current poor agricultural land use practices and deforestation, resulting in erosion. National land use policies should encourage land conservation practices. Erosion and siltation are harmful to terrestrial and aquatic ecosystems, and alleviation imposes high costs.

163. Toxic chemicals such as pesticides are entering the coastal and marine environment through land run-off and aerial spraying. There should be national regulations and effective controls on the importation and use of toxic chemicals including pesticides and there is a need for scientific monitoring of the impact on marine ecosystema.

164. Effective and enforceable national laws on oil pollution are required. There will be a need for oil pollution surveillance and monitoring programmes, which should include chemical dispersants because of the danger to benthic organisms, larvae and juveniles of fish and shrimps.

165. In view of the increasing cost of fuel, recycling of used lubricating oils as fuel for thermal energy, blending them with clean fuel for further utilization or with solid wastes such as bagasse may be worth considering.

166. None of the countries has manpower resources to implement any marine pollution laws enacted. Enforcement of legislation requires monitoring of pollution. In view of the acute lack of resources for marine pollution monitoring, Governments should draw up an inventory of present capabilities and equipment available and encourage the sharing of facilities among institutions within each country. Government institutions should co-operate more with one another and with the universities. As a means of harnessing limited resources, the establishment of a National Environment Laboratory with a marine pollution component should be encouraged.

167. Multidisciplinary marine science programmes incorporating physical and chemical oceanogrsphy, marine biology, ecology and applied analytical chemistry, should be introduced in polytechnics and universities. Training of scientific and technical manpower should be encouraged through granting of scholarships or foreign assistance programmes. For the maximum benefit to each country from these training programmes, scientists in government and other institutions should also participate in order to give the universities more time for teaching and research.

168. As soon as a pool of pollution monitoring experts has been trained, each country should initiate baseline studies on marine pollution.

Recommendations at the regional level

169. A regional data collection system (data bank) should be initiated, which could be put at the disposal of members for exchange of useful information on common marine pollution problems, e.g. mechanisms and laws for controlling siltation and oil pollution in each country. To this end, a regional quarterly information bulletin might be established. Likewise, information on the degradation by pollution of certain habitata and coastlines, and on Ciguatera fish poisoning, as well as other such data could conveniently be recorded and exchanged. Such regional co-operation should develop close relations with existing relevant regional bodies, such as the Indian Ocean Fishery Commission (IOFC) and the Commission for Inland Fisheries of Africa (CIFA).

170. The general lack of awareness about marine pollution is regrettable. Environmental awareness in the region should be increased by providing material for public enlightenment to each country.

171. Waste disposal is carried out negligently and without environmental concern. In view of the economic importance of artisanal fisheries and other uses of the coastal and marine environment, guidebooks on waste characteristics of polluting industries, providing information on each type of industry, the type of wastes generated, suitable sites and methods of disposal, and waste recycling and utilization where appropriate, should be produced and made available to Governments to minimize environmental disturbance.

172. Enactment of laws setting standards requires pollution monitoring studies as a control. These should be preceded by baseline and surveillance studies, which, so far, do not exist anywhere in the region.

173. Since pollution assessment is a very important component of any action plan, as a prerequisite, training of marine pollution monitoring scientists should be strengthened. Analysis of marine pollutants such as petroleum, heavy metals, pesticides and PCBs requires special analytical skill and training. The establishment of national environment pollution monitoring laboratories may usefully be encouraged. Marine science in universities and basic research in this field should also be promoted. Regional training workshops for pollution assessment should be geared towards generating national and regional background data which are lacking. Such training would require assistance from outside the region.

174. Following the workshop training, there should be national baseline studies with a regional exchange of methodology and results. In agreement with the Governments of the region, a well equipped institution may be designated the co-ordinating centre for regional marine pollution assessment. However, as far as possible, the training workshops should be scattered throughout the region for maximum benefit to all countries.

175. In view of limited financial resources, a network of collaborating institutions in different aspects of marine pollution may be initiated, involving a sharing of facilities and the free exchange of scientists and technicisns.

REFERENCES

BAGNIS, R., KUBERSKI, T. and LAUGIER, S. (1979). Clinical observations of 3009 cases of Ciguatera (fish poisoning) in the South Pacific. Am.J.Trop.Med.Hyg., 26(6) 1067-73.

BOCK, K. (1978). A guide to common reef fishes in the West Indian Ocean. London, Macmillan Education Ltd.

COX, M. D. (1970). A mathematical model of the Indian Ocean. Deep-Sea Res., 17 47-75.

DUING, W. (1970). The regime of the monsoon currents in the Indian Ocean. IIOE Oceanogr.Monogr. (1), 68.

DUING, W. and SZEKIELDA, K. (1971). Monsoonal response in the western Indian Ocean. J.Geophys.Res. 76 4181-7.

FAO (1981). 1980 Yearbook on fishery statistics, Vol.50, Catches and landings. FAO. 386 p.

FAO/IOP (1979). Report of the FAO/IOP Workshop on the fishery resources of the Western Indian Ocean south of the equator. Mahé, Seychelles, 23 October - 4 November 1978. FAO/UNDP, Indian Ocean Fishery Commission, Indian Ocean Programme, IOFC/DEV/79/45 99 p.

FINDLATER, J. (1969). A major low-level air current near the Indian Ocean during the northern summer. Q.J.R.Meteorol.Soc., 95 362-80.

HELMER, R. and MORGELI, U. W. (1978). Review of the liquid waste disposal situation along the Gulf of Guinea and adjacent areas. IOC/FAO/WHO/UNEP International Workshop on Marine Pollution in the Gulf of Guinea and Adjacent Areas, Abidjan, Ivory Coast, 2-9 May 1978. WHO,CEP/77,10 24 p.

IMCO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) (1970). Report of the second session, Paris, 2-6 March 1970. UNESCO pag.var.

IMCO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) (1980). Marine pollution implications of coastal area development. Rep.Stud.GESAMP,(11) 114 p.

IMCO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) (1981). Report of the 12th session, Geneva, 22-29 October 1981. Rep.Stud.GESAMP,(14) pag.var.

INDIAN OCEAN FISHERY COMMISSION (IOFC) (1981). Review of fishery development in the southwest Indian Ocean region. Paper presented at the first session of the Committee for the Development and Management of Fisheries in the southwest Indian Ocean. Le Morne, Mauritius, 22-24 April 1981. FAO, IOFC:DM/SW/81/4 16 p.

JOHANNES, R. E. (1975). Pollution and degradation of coral reef communities. In: Tropical marine pollution, edited by E.J.F. Wood and R.E. Johannes. Elsevier Oceanogr.Ser.,(12) 13-51.

KENYA MINISTRY OF LOCAL GOVERNMENT (1977). Mombasa water pollution and waste disposal study. Vol.6. Marine investigations. Nairobi, Republic of Kenya. pag.var.

KENYA MINISTRY OF POWER AND COMMUNICATIONS (1977). Manda Bay Port, feasibility study of Kenya's second port. Nairobi, Republic of Kenya. pag.var.

LABORATORIO DE HIGIENE DA AGUA E ALIMENTOS (1980). Inquerito sobre a poluiçao da bahia de Maputo. Maputo, Ministério da Saúde, Direcçao de Medicina Preventiva. (mimeo) pag.var.

LEETMA, A., (1972). The response of the Somali current to the southwest monsoon of 1970. Deep-Sea Res.,19 319-325.

LOCICERO, V. R. (ed.) (1975). Proceedings of the First International Conference on Toxic Dinoflagellate Blooms, Boston, Mass., 4-6 November 1974. Wakefield, Mass., Massachusetts Science and Technology Foundation. 540 p.

MACNAE, W. (1974). Mangrove forests and fisheries. FAO/IOFC/DEV/74/34 35 p.

MATTHEWS, A. D. (1981). Mercury in fish of the Republic of Seychelles and hair and blood mercury levels of part of the population exposed to methyl mercury through fish consumption. Fish.Bull.Fish.Div., Seychelles, (9) 62 p.

MCCAULL, J. and CROSSLAND, J. (1974). Water pollution. New York, Harcourt Brace Jovanovich.

MUNGA, D. (1981). Some observations on petroleum pollution along the Kenyan coast. Paper presented at the Symposium/Workshop on Aquatic Resources of Kenya: A need for research. Nairobi, 13-19 July 1981. (mimeo).

MWAISEJE, B. and MAINOYA, J. R. (1981). Mangrove habitats, problems of conservation in Tanzania. Paper presented at the International Society for Tropical Ecology, Silver Jubilee Symposium, Bhapal, India, 5-10 October 1981.

RISEBROUGH, R. W., HUSCHENBETH, E. and JENSEN, S. (1972). Halogenated hydrocarbons. In: A guide to marine pollution, edited by E.D. Goldberg. New York, Gordon and Breach. 1-17.

ROGERS, J. F. (1981). Pilot scale development of processed fish products in the Seychelles. Fish.Bull.Fish.Div., Seychelles,(16) 9 p.

SAENGER, P., HEGERL, E. J. and DAVIE, J. D. S. (eds.) (1981). First report on the global status of mangrove ecosystems. IUCN, 132 p.

SCHOTT, F. (1977). The response of the Indian Ocean to the monsoon. Results of the Indian Ocean experiment. Nat.Resour.Dev., 6 112-120.

SCOR Working Group 46 (RIOS) (1981). River inputs to ocean systems. New York, United Nations, 384 p.

SEYCHELLES MINISTRY OF PLANNING AND DEVELOPMENT (1982). Feasibility study of a port and land reclamation project, Seychelles. Mahé, Ministry of Planning and Development, Department of Works, 8 vols. pag.var.

SSENTONGO, G. W. (1979). Marine fisheries in Africa. In: Lectures presented at the Sixth FAO/SIDA Workshop on Aquatic Pollution in relation to Protection of Living Resources. FAO, TF-RAF 112, Suppl.1 19 -30.

SWALLOW, J. C. (1964). Equatorial undercurrent in the western Indian Ocean. Nature (Lond.), 204 436-437.

TANZANIA MINISTRY OF LANDS, HOUSING AND URBAN DEVELOPMENT (1980). Dar es Salaam sewerage and sanitation study, Master plan. Dar es Salaam, The Unied Republic of Tanzania, 6 vols. pag.var.

TAYLOR, D. L. and SELIGER, H. H. (eds.) (1979). Toxic dinoflagellate blooms. Development in Marine Biology, vol.1. New York, Elsevier North Holland Inc. 505 p.

TOMCZAK, M. Jr. (1979). Regional oceanography of African waters. In: Lectures presented at the Sixth FAO/SIDA Workshop on Aquatic Pollution in relation to Protection of Living Resources. FAO, TF-RAF 112, Suppl.1 1-18.

VINE, P. J. (1972). Coral reef conservation around the Seychelles, Indian Ocean. Biol.Conserv. 4 304-305.

ANON (1981). Africa south of the Sahara (1981-82). London, Europa Publ., 11th ed. 1383 p.

PUBLICATIONS IN THE UNEP REGIONAL SEAS REPORTS AND STUDIES SERIES

No. 1 UNEP: Achievements and planned development of UNEP's Regional Seas Programme and comparable programmes sponsored by other bodies. (1982)

No. 2 UNIDO/UNEP: Survey of marine pollutants from industrial sources in the West and Central African region. (1982)

No. 3 UNESCO/UNEP: River inputs to the West and Central African marine environment. (1982)

No. 4 IMCO/UNEP: The status of oil pollution and oil pollution control in the West and Central African region. (1982)

No. 5 IAEA/UNEP: Survey of tar, oil, chlorinated hydrocarbons and trace metal pollution in coastal waters of the Sultanate of Oman. (1982)

No. 6 UN/UNESCO/UNEP: Marine and coastal area development in the East African region. (1982)

No. 7 UNIDO/UNEP: Industrial sources of marine and coastal pollution in the East African region. (1982)

No. 8 FAO/UNEP: Marine pollution in the East African region. (1982)

No. 9 WHO/UNEP: Public health problems in the coastal zone of the East African region. (1982)

No. 10 IMO/UNEP: Oil pollution control in the East African region. (1982)

No. 11 IUCN/UNEP:Conservation of coastal and marine ecosystems and living resources of the East African region. (1982)

No. 12 UNEP: Environmental problems of the East African region. (1982)

No. 13 UNEP: Pollution and the marine environment in the Indian Ocean. (1982)

No. 14 UNEP/CEPAL: Development and environment in the Wider Caribbean region: A Synthesis. (1982)

No. 15 UNEP: Guidelines and principles for the preparation and implementation of comprehensive action plans for the protection and development of marine and coastal areas of regional seas. (1982)

No. 16 GESAMP: The health of the oceans. (1982)

No. 17 UNEP: Regional Seas Programme: Legislative authority. (1985)

No. 18 UNEP: Regional Seas Programme: Workplan. (1982)

No. 19 Rev. 2. UNEP: UNEP Oceans Programme: Compendium of projects. (1985)

No. 20 CPPS/UNEP: Action Plan for the protection of the marine environment and coastal areas of the South East Pacific. (1983)

No. 21 CPPS/UNEP:Sources, levels and effects of marine pollution in the South-East Pacific. (1983) (In Spanish only)

No. 22 Rev. 2. UNEP: Regional Seas Programme in Latin America and Wider Caribbean. (1985)

No. 23 FAO/UNESCO/IOC/WHO/WMO/IAEA/UNEP: Co-ordinated Mediterranean Pollution Monitoring and Research Programme (MED POL) - Phase I: Programme Description. (1983)

No. 24 UNEP: Action Plan for the protection and development of the marine and coastal areas of the East Asian region. (1983)

No. 25 UNEP: Marine pollution. (1983)

No. 26 UNEP: Action Plan for the Caribbean environment programme. (1983)

No. 27 UNEP: Action Plan for the protection and development of the marine environment and coastal areas of the West and Central African region. (1983)

No. 28 UNEP: Long-term programme for pollution monitoring and research in the Mediterranean (MED POL) - Phase II. (1983)

No. 29 SPC/SPEC/ESCAP/UNEP: Action Plan for managing the natural resources and environment of the South Pacific region. (1983)

No. 30 UNDIESA/UNEP: Ocean energy potential of the West and Central African region. (1983)

No. 31 A. L. DAHL and I. L. BAUMGART: The state of the environment in the South Pacific. (1983)

No. 32 UNEP/ECE/UNIDO/FAO/UNESCO/WHO/IAEA: Pollutants from land-based sources in the Mediterranean. (1984)

No. 33 UNDIESA/UNEP: Onshore impact of offshore oil and natural gas development in the West and Central African region. (1984)

No. 34 UNEP: Action Plan for the protection of the Mediterranean. (1984)

No. 35 UNEP: Action Plan for the protection of the marine environment and the coastal areas of Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates. (1983)

No. 36 UNEP/ECLAC: The state of marine pollution in the Wider Caribbean region. (1984)

No. 37 UNDIESA/UNEP: Environmental management problems in resource utilization and survey of resources in the West and Central African region. (1984)

No. 38 FAO/UNEP: Legal aspects of protecting and managing the marine and coastal environment of the East African region. (1983)

No. 39 IUCN/UNEP: Marine and coastal conservation in the East African region. (1984)

No. 40 SPC/SPEC/ESCAP/UNEP: Radioactivity in the South Pacific. (1984)

No. 41 UNEP: Socio-economic activities that may have an impact on the marine and coastal environment of the East African region. (1984)

No. 42 GESAMP: Principles for developing coastal water quality criteria. (1984)

No. 43 CPPS/UNEP: Contingency plan to combat oil pollution in the South-East Pacific in cases of emergency. (1984)

No. 44 IMO/ROPME/UNEP: Combating oil pollution in the Kuwait Action Plan region. (1984)

No. 45 GESAMP: Thermal discharges in the marine environment. (1984)

No. 46 UNEP: The marine and coastal environment of the West and Central African region and its state of pollution. (1984)

No. 47 UNEP: Prospects for global ocean pollution monitoring. (1984)

No. 48 SPC/SPEC/ESCAP/UNEP: Hazardous waste storage and disposal in the South Pacific. (1984)

No. 48/ Appendices SPC/SPEC/ESCAP/UNEP: Hazardous waste storage and disposal in the South Pacific. (1984)

No. 49 FAO/UNEP: Legal aspects of protecting and managing the marine and coastal environment of the East African region: National Reports. (1984)

No. 50 IUCN/UNEP: Marine and coastal conservation in the East African region: National Reports. (1984)

No. 51 UNEP: Socio-economic activities that may have an impact on the marine and coastal environment of the East African region: National Reports. (1984)

No. 52 UNEP: Arab co-operation for the protection and development of the marine environment and coastal areas resources of the Mediterranean. (1984)

No. 53 UNEP: UNEP Regional Seas Programme: the Eastern African Experience. (1984)

No. 54 UNIDO/UNEP: Contingency planning for emergencies associated with industrial installations in the West and Central African region. (1985)

No. 55 FAO/UNEP: Marine mammals: global plan of action. (1985)

No. 55/ Annex FAO/IUCN/IWC/UNEP: Marine mammals: global plan of action. (1985)

No. 56 GESAMP: Cadmium, lead and tin in the marine environment. (1985)

No. 57 IMO/UNEP: Oil spills and shoreline clean-up on the coasts of the Eastern African region. (1985)

No. 58 UNEP: Co-operative programmes sponsored by UNEP for the protection of

No. 59 UNEP: Environmental problems of the marine and coastal area of India: National Report. (1985)

No. 60 IUCN/UNEP: Management and conservation of renewable marine resources in the Indian Ocean region: Overview. (1985)

No. 61 UNEP: Action Plan for the protection, management and development of the marine and coastal environment of the Eastern African region. (1985)

No. 62 IUCN/UNEP: Management and conservation of renewable marine resources in the South Asian Seas region. (1985)

No. 63 IUCN/UNEP: Management and conservation of renewable marine resources in the Kuwait Action Plan region. (1985)

No. 64 IUCN/UNEP: Management and conservation of renewable marine resources in the Red Sea and Gulf of Aden region. (1985)

No. 65 IUCN/UNEP: Management and conservation of renewable marine resources in the East Asian Seas region. (1985)

No. 66 IUCN/UNEP: Management and conservation of renewable marine resources in the Eastern African region. (1985)

No. 67 UN/UNEP: Coastal erosion in West and Central Africa. (1985)

No. 68 GESAMP: Atmospheric transport of contaminants into the Mediterranean region. (1985)

No. 69 UNEP: Environment and resources in the Pacific. (1985)

No. 70 UNESCO/ROPME/UPM/UNEP: Proceedings of the Symposium/Workshop on oceanographic modelling of the Kuwait Action Plan (KAP) region. (1985)

No. 71 IUCN/ROPME/UNEP: An ecological study of the rocky shores on the southern coast of Oman. (1985)

No. 72 IUCN/ROPME/UNEP: An ecological study of sites on the coast of Bahrain. (1985)

No. 73 SPC/SPEC/ESCAP/UNEP: Ecological interactions between tropical coastal ecosystems. (1985)