REGIONAL SEAS

UNITED NATIONS ENVIRONMENT PROGRAMME

Marine and coastal area development in the East African region

UNEP Regional Seas Reports and Studies No. 6

Prepared in co-operation with

UNESCO

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PREFACE

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

The Regional Seas Programme at present includes ten regions 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

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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

- identify national institutions that may participate in implementing an action plan once it is adopted.

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 Series 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.

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INTRODUCTION : MARINE-RELATED GEOGRAPHY OF THE EAST AFRICAN REGION

1. The coastline of the Western Indian Ocean includes the East Coast of Africa and the islands of the Western Indian Ocean: Madagascar, the Comoros, Mauritius and Seychelles. There is a broad geographical similarity in the characteristics of the coastal areas of the continental mainland from Mozambique well into Somalia, although the specific characteristics of the coastal areas on the continent differ to a considerable extent from place to place. Since Madagascar is also generally characterized by continental-type coastal features due to the effects of large-scale riverine inputs of fresh water and sediment derived from its large upland catchment areas, the coasts of East Africa and Madagascar can be treated together as continental-type coastlines. In the East African Region, these coastlines are broadly characterized by alternating regimes of beaches and rocky outcrops with fringing coral reefs, and large estuarine areas characterized by delta formation and extensive growth of mangroves. While the fishery resources of the continental shelf itself tend to be rather limited although by no means fully exploited currently - due to the generally narrowness of the shelves, the mangrove areas are rich in crustaceans including crabs and other species, which are primarily taken on a subsistence basis in the wetlands, but predominantly multiple species of shrimp. These generally have their nursery areas in the mangrove forests and are harvested in large quantities in the shallow nearshore waters. The wetland areas also serve as nursery and shelter areas for a variety of small pelagic fish species which are currently fished on an artisanal basis but which could become subject to commercial operation as well. Shoreline areas not subject to the effects of the great river systems are by and large characterized by extensive growth of corals, which form a more or less unbroken quasi-barrier reef from central Mozambique through Somalia. The corals generally protect the adjacent shoreline from erosion and also provide the source of the calcareous material responsible for the extensive sandy beaches of the region, which generally occur in various configurations between the extended river deltas. The lagoons between the coral reefs and the shore, as well as the areas immediately outside the reefs, are also productive habitats for a variety of reef species which are primarily taken by traditional means including gill netting and handlining.

2. The coastal zone of both East Africa and Madagascar is generally comprised of a rather narrow coastal strip, from several to several tens of kilometres (km) in width, behind which the land rises more or less quickly to highlands which commonly take the form of elevated savannahs but are sometimes mountainous in nature. While in some areas, like parts of Kenya and southern Somalia, the coastal strip even outside immediate river basins or flood plains is relatively productive for agriculture, in others - Mozambique, the United Republic of Tanzania, and Madagascar - it is generally of marginal suitability for agriculture, largely owing to such natural conditions as unsatisfactory soil types, extreme temperatures, and unfavourable seasonality of rainfall. Except in Mozambique, the coastal strip along the continental-type coastlines of the region support no more than about ten per cent of the national population, even when a major urban centre is located on the coast, such as Dar es Salaam or Mombasa. Many secondary urban centres are located on

the coast, especially ports - such as Beira in Mozambique, Mombasa in Kenya and Toamasina (Fr.: Tamatave), Toliara (Fr: Tuléar), and Antseranana (Diego-Suarez) in Madagascar. Many tertiary population centres are also to be found on the coast - often where they were established as trade towns, frequently by Arab traders: these include Kismayu and Merca in Somalia, Lamu and Malindi in Kenya, and Bagamoyo and Tanga in Tanzania. There are generally ethnic and religious distinctions between the coastal populations, mainly Arab in origin, and those of the highlands, representing more indigenous groups. As a result of such factors, much more intensive land utilization for agriculture and livestock raising tends to occur in the interior highlands in this subregion, while the coastal economy tends to be founded on small-scale agriculture, especially in riverine valleys and plains; artisanal fisheries; and maritime-related commerce.

3. The smaller islands of the Western Indian Ocean - treated as a separate subregion in the present report - are actually quite disparate from a geographical and economic perspective, although their environmental management problems can be considered together. In terms of physical geography, the Comoros are small, rugged volcanic islands which support a population largely of African and Arab origin now given primarily to subsistence farming and fishing. The islands have severe resource limitations and are subject to considerable environmental strain resulting from traditional human activities such as abstraction of building materials from beaches and reefs, and agricultural and silvicultural practices which result in considerable loss of vegetative cover and soil erosion. Traditionally the chief export and foreign exchange earner has been the sale of aromatic fragrances extracted from exotic perennial flowering plants, and to a lesser extent other essential oils and spices.

4. Mauritius, in contrast, although a volcanic island, is characterized by a much less rugged topography which has favoured the large-scale cultivation of sugar-cane. As a result of the encouragement of immigrant workers from Asia (mainly Indians) to provide agricultural labour, the island today supports a population of nearly a million. Despite its large population and limited land area, however, the primary issues for Mauritius appear to be economic rather than environmental, since homebuilding and agricultural practices here have not apparently had an undue effect on the environment, including the marine environment, and the immediate coastal areas and nearshore lagoons and reefs appear to be in generally good condition. There has been some depletion of the limited fish and crustacean stocks associated with the reef system, however, and preservation of the quality of the coastal and marine environment continues to be of special concern both in connection with continued enjoyment of a pleasant lifestyle and with the continued growth of tourism as a major economic activity.

5. The central, most populated islands of the Seychelles are granitic in composition and are believed to be a fragment of a previously-existing continental mass. Although the rugged granitic topography of these islands makes agriculture difficult, it endows them with a unique scenic beauty as well as a marine potential somewhat greater than that of the shelfless volcanic islands. These islands lie on a relatively broad continental shelf which provides a basis for a small-scale commercial fishery in relatively nearshore waters; other shelf areas exist not far from the main islands; and the coralline islands within Seychelles' jurisdiction also provide resource-based economic opportunities. There is also a potential for increased utilization of larger pelagic fish stocks, especially several varieties of tuna. The limited land mass of Seychelles, its rugged topography, and the economic and aesthetic significance of its scenic resources creates, in addition, special needs for the careful planning of human activities on the islands, especially the

PROBLEMS IN THE MANAGEMENT OF THE CONTINENTAL-TYPE COASTLINES

Geographical characteristics of the shorelines, coastal areas, and marine-related upland systems

6. The chief geographical characteristics of concern in considering the effect of land use practices on the marine environment along the continental-type coastlines are the nature of the immediate shoreline areas (beaches, lagoons, reefs and dunes; or estuarine areas including mangrove forests); the patterns of human occupancy and activity in the relatively narrow coastal strip which generally consists of a gently sloping plain; and the utilization of upland areas in ways that may affect the coastal or marine environment, especially through changed rates or volumes of freshwater release or sedimentation.

7. The chief coastal land use issues from a marine perspective are livestock raising and agriculture in the coastal zone; the planning, control, and servicing of urban development in this area; the planning and assessment of major coastal facilities such as industrial projects, tourist facilities, and ports; the development of marine fisheries; and the conservation of coastal and nearshore natural resources.

8. Mozambique: Perhaps nowhere on the East African coast more than in Mozambique is the effect of great river systems felt on the coastal and the marine environment. Since most of the coast lies on the Mozambique Channel it is, for the greater part, protected from the strong forces of wind-driven waves from the open Indian Ocean. In combination with the effects of the southward-flowing Mozambique current, the relatively low-energy nature of the coast facilitates the deposition and longshore transport of large volumes of riverine sediment. It has also permitted the establishment of extensive regions of mangrove forest, reported to total 850 km^2. The Zambezi River, in central Mozambique, is one of the largest rivers in Africa and drains a catchment area of some 1,250,000 km^2; its peak water flow reaches as much as 15 - 20,000 m^3/sec during the rainy season from January to March. In addition to the Zambezi, the Rovuma River on the border of Tanzania and the Lurio River, also in the north; the Pungüe, Busi, Gorongose and Save Rivers which enter the Bight of Sofala off the middle of the country; and the Limpopo, Incomati and Maputo Rivers entering the Bay of Maputo, also carry large volumes of sediment into coastal wasters and on to the continental shelf. In all, some twenty-five main rivers enter the Indian Ocean along the Mozambique coast.

9. Where such major rivers have not caused the formation of offshore sand banks or permitted the extension of deltas or mangrove forests, there are significant areas of coral-fringed coast, coastal dunes, and swampy areas protected by barrier beaches and islands. Fringing corals occur south to Mocambo Bay north of the Bight of Sofala, mostly following the shoreline since the continental shelf in the north is extremely narrow. Below this point, and in areas not characterized by active delta formation, there are extensive beaches protecting marshy areas and also secondary coastal dune systems. Barrier islands are found in the south and strings of rocky islands in the north. The coastline is not, however, heavily indented except by the large Bight of Sofala; in the approximately 2,000 km straight distance from Natal State to the Tanzanian border there is a shoreline of 2,470 km.

10. Although the features of the Mozambique coast are distinct and variegated, it can still be compared to the other continental-type coastlines of the region. But Mozambique, unlike the other countries, does not have terrain rising sharply to

country is predominantly comprised of a low-lying plateau of moderate elevation descending through a sub-plateau zone to the sea; 45 per cent of the total land surface has an elevation of less than 1,000 m. Similarly, for climatic and other reasons, the internal areas are not as extensively developed in Mozambique as in other countries, and fully three quarters of the total population is said to be concentrated in the coastal area, i.e. in a strip approximately 40 km wide, especially in the vicinity of Maputo, Beira, and other major towns. This coastal population concentration does not include the immediate coastline, however, owing to limited agricultural potential and the absence of infrastructure such as major coastal roads. In fact, the coastal region in general is characterized by sandy soils, including riverine and deltaic alluvial soils and compacted red sands. These unconsolidated soils are particularly susceptible to degradation after human disturbance.

11. Tanzania: The coastline of Tanzania, which is primarily characterized by sweeping sandy beaches, rocky outcrops, and developed fringing coral reefs, is also punctuated by extensive growths of mangroves near the mouths of large rivers such as the Rufiji and the smaller, intermittent rivers. The estimated population of the coastal zone in 1975 was 975,000, with Dar es Salaam then accounting for about 517,000. (The national population in mid-1978 was some 17,165,530). The central coast region, which is generally below 100 m in elevation, constitutes a strip 13 - 16 km wide seaward of the 300 m contour. The coastal strip is subject to rainfall at any time of the year, although there are somewhat disparate rainy seasons along the coasts with two rainfall peaks in the north and one in the south. The entire coastal area, however, is subject to the north-east (December-March) and south-west (May-December) monsoon.

12. The total extent of mangroves along the Tanzanian coast has been put at 500 km^2, primarily occurring at the mouth of the Rufiji River, but recent studies suggest that this figure should be considerably raised - to include 1,000 km^2 for the Rufiji alone. The total catchment area of the Rufiji River is some 177,500 km^2; its average discharge is 1,133 m^3/sec.

13. Agricultural potential in the coastal strip is not as great as in other areas of the country. The most productive and heavily populated areas of Tanzania occur in the northern highlands (around Arusha and Kilimanjaro) and to a lesser extent the southern highlands, which are characterized by relatively rich reddish-brown volcanic soils. Livestock raising tends to be concentrated on the interior plateaux which are characterized by loamy soils of moderate fertility. But considerable agriculture is practiced on the soils of flood plains and river valleys, including the coastal strip. The fact that these areas are subject to periodic flooding has, however, made organization of rural settlement and agriculture on a village basis difficult.

14. Kenya: The Kenyan coastline extends about 450 km and the coastal zone is some 15-20 km in width. About a million people live in this area, making for overall population densities of 100-200/km^2. About 375,000 people live in Mombasa, Kenya's major seaport.

15. Coral reefs fringe the Kenyan coast (1/2-2 km offshore) except where the influence of river systems is felt. This includes the mouths of the Umba and Ramisi Rivers, which are characterized by extensive mangrove forests, and the area north of the town of Malindi, where seasonal flooding by the Sabaki and Tana Rivers has led to deposition of sediment on the beaches and in the nearshore lagoons and has also led to mangrove growth. In addition to the river-type estuaries, there are also

16. The Kenyan coastal zone supports important agricultural activities including the production of food for local consumption and the growth of export crops. Important food crops include cassava, maize, and cowpeas, with rice being grown in irrigated areas, marshes, and flood plains; bananas, mangoes, and pineapples are also grown for domestic consumption and for export. Cashews, coconut, and sisal are grown on an export basis, and coffee is becoming increasingly popular among small growers. Several projects exist for the expansion of cotton cultivation as well as the large-scale production of other crops in the coastal zone.

17. Livestock raising in the coastal lowlands is limited by the tsetse fly, but reduction of this vector through bush clearing, especially in river plains, could lead to increased livestock raising in the coastal zone. In addition to mangroves, other forested areas still exist in the coastal zone; some of these have been designated as forest reserves or national parks.

18. Somalia has an extremely long coastline of some 3,200 km, of which about 1,000 km in the north borders the Gulf of Aden and the remainder faces the Indian Ocean. The coastline generally consists of a series of sandy beaches broken by rocky outcrops, including low limestone cliffs. There are extensive fringing reefs all along the coast, and although the continental shelf is generally 10-15 km in width, it extends 50-60 km in the north-east. Seasons at the coast are associated with the south-west and north-east monsoons.

19. Most of the national territory consists of dry savannahs, subject to fluctuating seasonal and yearly rainfall, which are widely used for grazing of livestock; temperatures and humidity are higher along the coast. There are no perennial rivers or even major rivers except in the south, where the Juba River continuously and the Shebelle River (Uebi Scebeli) intermittently flow into the Indian Ocean. Elevated sandy bluffs on the coastline and coastal limestone deposits suggest a marine origin for the non-alluvial coastal area in the south. The sandy soils of the coastal bluffs have proved particularly subject to degradation, especially in connection with livestock grazing during dry periods. As a result, large destabilized dunes have formed along the south coast; these tend to move north-west with the offshore monsoonal winds. At present an estimated 500,000 hectares (ha) area is subject to active dune movement. The shifting dunes are threatening primary agricultural land in the fertile interriverine region and are affecting infrastucture, such as the coastal road and power lines.

20. Both the Juba and Shebelle rivers provide water for agriculture in a fertile interriverine region that may contain as much as 7.5 million ha of potentially cultivable land, of which some 70,000 ha are currently cultivated. The Shebelle River is so extensively used for irrigation that its flow seldom reaches the sea. In the interriverine area, bananas are extensively cultivated for export by State farms and large private growers, and small growers produce rice and maize for domestic consumption. Other fruits such as papayas are also grown, especially for the domestic market.

21. Madagascar: While the Malagasy coastline and coastal zone generally conform to the overall description of continental-type coastlines given above, climatic factors and the topography of the adjacent upland systems are widely divergent in different areas of the country. The north-west coast from the area of Nosy Bé to Cap St. André and parts of the west coast contain the most extensive mangrove forests in the entire region. Madagascar has been estimated to have some 3,200 km^2 - or about 300,000 ha - of mangroves in all, with special concentrations at Mahajanga (Fr.: Majunga), Morondava, Morombe and other areas, such as Nosy Bé, where large

22. The north-east, by contrast, is a mountainous region with little habitable area near the coast. Tropical crops are raised in the valleys of this region, however, and the rugged coastline is indented and contains the great natural harbour of Antseranana (Diego-Suarez).

23. The south-west is a well-watered region of coastal plains rising to savannahs, and supports both large herds of cattle and subsistence farming of paddy rice and manioc as well as production of such cash crops as cotton and tobacco. There is an extensive barrier reef formation, some 24 km in length, off the south-west coast at Toliara (Tuléar).

24. The southernmost province, Toliara, has completely arid conditions. However, it also harbours large cattle herds.

25. The east coast, on which lies a narrow coastal strip rising rapidly through rugged topography to the central mountains, is hot and humid and accounts for the greatest production of such valuable tropical crops as coffee, vanilla, cloves and sugar-cane. The east coast has extensive fringing reefs and coral sand barrier beaches, behind which run a chain of lagoons. These were connected to form an inland waterway called the Pangalanes Canal, which was once navigable by small vessels for some 700 km. Few mangroves grow on the east coast, due to the relatively energetic nature of the waves from the open Indian ocean, but the internal lagoons have for the most part been colonized by herbaceous plants.

Substantive problems in the management of continental-type coastlines

General problem: Changes in flow characteristics and sedimentation rates of
- the erosion/sedimentation/hydrodevelopment complex

26. Perhaps the most obvious effect of human activities on the marine environment of the Western Indian Ocean is the tremendous increase in siltation from major rivers as a result of soil erosion, caused chiefly by upland activities. All over the region the effects of increased sedimentation are visible to the observer and have also been reported locally. In certain cases, quantitative estimates are available concerning the scale or effects of river-borne sedimentation.

27. Sedimentation along the continental-type coastlines has begun to change the very nature of the shoreline and the related natural systems in many areas. The huge volume of sediment that is being carried down the major rivers of the region is slowly increasing the formation of river deltas and other estuarine areas and encouraging the spread of mangrove forests. Sedimentary accumulations in the coastal zone are affecting the natural courses of rivers, extending flood plains and modifying the composition of beaches and sea bottoms.

Soil erosion - its characteristics and causes

28. While some soil erosion occurs within the coastal zone, the most significant problems of soil loss are in inland areas - especially the elevated plains or uplands where most of the population of East Africa and Madagascar is concentrated. The erosion/sedimentation problem is unique among the environmental problems of the region as its effects, although originating primarily in areas well inland, are also felt in important ways on the coast.

29. Officials and others in the region appear to be aware of the consequences of

possible loss of hydroelectric and irrigation potential resulting from river-borne sedimentation. But there is, understandably, considerably less awareness and concern about the effects of large-scale sedimentation on the coastal and marine environment. Nevertheless, the effects of these processes on marine systems can ultimately produce severe economic losses as well as affect other values. These factors should therefore definitely be considered in assessing the need and means to control upland activities which result in soil erosion and loss of vegetative cover.

Cultivation

30. The agricultural practices used by large inland populations in their traditional patterns of cultivation must certainly be considered a major cause of soil loss. The key concern in this respect are patterns of shifting cultivation and associated practices (such as burning of original vegetation) which continually bring new areas into cultivation in an attempt to exploit their short-term agricultural potential, and the extension of systematic cultivation into marginal areas.

31. In Kenya, for example, with an overall population growth rate of 3.8 - 4.0 per cent and 90 per cent of its population practicing subsistence farming in the countryside, cultivated areas have been expanded into areas of marginal rainfall, dry-season pasture, slopes greater than 15°, and river margins. In addition, the relatively higher potential soils that constitute only about 20 per cent of the total national area have come under more intensive cultivation, and soil conservation programmes have not been applied sufficiently either to pre-existing or emerging agricultural patterns.

32. In Mozambique, encouragement of maize cultivation by the Government and its new popularity at the local level has led to increasing areas being devoted to this crop. Since maize is relatively drought-susceptible, however, soil has been destabilized in the maize areas during dry periods. There are also more general difficulties in popular cultivation of maize and other staple crops such as cassava in sandy soils, which is often accompanied by burning to clear the land of scrub prior to cultivation. In addition, planned large-scale agricultural projects, especially in areas newly brought under cultivation, may not be suitable. There is a severe shortage of technical assistance for central planners and local officials for making decisions about the wisdom of locating agricultural communities or projects in various areas and the appropriate type and intensity of cropping.

33. In Madagascar, some two thirds of the entire country has a high slope - some 400,000 km^2 in all. Due to the igneous baserock in the interior, highland soils are ferrous and erosive, with a soil fragility index of 0.2 - 0.4. Large areas (approximately 200,000 ha) of vegetated surface are converted to agricultural use each year through shifting cultivation, or "tavy", especially in the forested regions of the eastern highlands. As a result of continued shifting cultivation, associated bushfires, the natural weakness of the soils in upland areas, and other factors, as much as 65 per cent of the land surface of the entire country may be insufficiently covered by vegetation to prevent soil degradation. Moreover, frequent periods of intense rain in many parts of the country (1.5-3.0 mm/min) can rapidly erode these areas.

Direct deforestation

34. Another major cause of the loss of stable vegetative cover leading to soil erosion is deliberate cutting of vegetation either as a result of organized forestry

timber for commercial purposes may be great, it is controlled in principle by national forestry departments, usually through a licensing system. However, the harvest of domestic fuelwood, although poorly recorded, greatly exceeds the licensed or formally recorded harvest of timber for other purposes. This uncontrolled collection of firewood puts great stress on soils, especially in arid or semi-arid areas.

Livestock raising

35. Livestock raising, especially in arid or semi-arid areas, can also be a major cause of soil erosion through overgrazing or the destabilizing effect of animal footfalls or tracks on soils. The drier inland or upland areas throughout the subregion are extensively used for livestock raising and large numbers of animals, especially cattle, are raised, largely by pastoralists. FAO has derived the following figures for total numbers of cattle (1978): (in millions) Kenya 9.8, Madagascar 9.0, Mozambique 1.3, Somalia 4.0, Tanzania 15.2.

36. Livestock raising has been acknowledged to lead to serious soil erosion, especially in drier areas and when animals are allowed to congregate or graze near the banks of rivers or in the vicinity of artificial water catchments such as irrigation works or watering ponds.

37. In Somalia, which derives 75-85 per cent of its export earnings from livestock products, livestock concentrations on arid rangelands are such that a system of various types of reserves has been created to regulate grazing. The Somali people are for the most part pastoral nomads; although they do not tend to raise animals near the coast, animals are brought down to coastal areas during the rainy season to escape the tsetse flies which proliferate in other areas. But since the coast is quite arid and characterized by unconsolidated soils, this practice has contributed to dune destabilization and ultimately desertification, or creation of shifting dunes, which is widely observable south of Mogadishu.

38. In Madagascar, the consequences of widespread cattle raising in inland plateaux are compounded by the use of large bushfires to remove thickets and forest to create pasturage. One million hectares of cover were reportedly lost in this way in 1979 but officials claim that this rate was brought down to 100,000 ha in 1980. To combat this problem the Government has enacted legislation with strict criminal penalties to protect forests and taken other measures. These are difficult to implement, however due to psychological and political factors. In addition to legislation, the Government has initiated campaigns in the mass media and the schools; has taken active measures to preserve forest ecosystems; and in other sectors has introduced agronomic and social planning efforts including resettlement of rural populations after scientific suitability analyses.

39. Throughout the region, livestock raising is important both for foreign exchange and to supply basic human nutritional needs. Ways must be found to organize and manage large-scale decentralized livestock raising so that severe soil erosion does not result.

Rural settlement patterns

40. Continued growth of the traditional rural economy would necessarily place additional stress on soil and forest resources. In the subregion, however, distinctive political and social developments have influenced the pattern of settlement in rural areas so that even more stress could be placed on these natural

41. In Mozambique, Tanzania, and to a lesser extent Madagascar, villagization campaigns have been instituted in order to improve the organization of rural life. Normally, villages have been formed on the basis of rural populations already existing in the immediate area, but in some cases populations have been moved considerable distances or into undeveloped areas.

42. The creation of village centres can lead to increased stresses on the village area and surrounding countryside. Concentration of rural populations into villages tends to result in overcultivation of land in the immediate vicinity of the village, sometimes regardless of its inherent suitability for sustained agriculture. In the new village sector, agriculture is intensified and practiced in a more limited area. But in certain cases adequate technical assistance or necessary infrastructure, equipment, or supplies cannot be provided. As existing areas are depleted, new areas near the village may be brought into cultivation or the cycle of cropping shortened.

43. Naturally vegetated areas around new villages also become subject to intensified collection of forest products, especially fuelwood. Livestock tend to become concentrated within the vicinity of the village, leading to overgrazing and soil destabilization.

Scale and effects of coastal and marine sedimentation

44. There are few quantitative estimates of total sedimentary matter delivered to the coast although figures on sediment load have been derived for some rivers, usually in connection with hydrodevelopment projects. It is believed, however, that the total volume of continental material reaching the Western Indian Ocean from the region amounts to some $4.81 \times 10^{14} m^3$. Sediment discharge through Stiegler's Gorge on the Rufiji R. in Tanzania (the site of a proposed dam) is estimated as 15-25 million t/y. Riverine discharge of sediments into marine systems becomes a problem when the characteristics of specific marine systems or the viability or economic benefits of related human activities are affected.

Accretion of beaches and loss of tourism potential

45. The Sabaki R. in Kenya has discharged a large volume of sediments that, due to the southward current along the Kenya coast, have effected the beaches and coral reefs at and near Malindi. Together with the Tana R. further to the north, sediment discharge from the Sabaki is thought to have had a major effect on the coral reefs of northern Kenya. At Malindi itself there has been considerable beach accretion, reportedly as much as 500 m over the last ten to fifteen years, with the fastest rate occurring within the last eight years. As a result of this accretion the existing jetty at Malindi has become dysfunctional, the beachfront of major hotels has receded, and the quality of the sand and water in the tourist area has deteriorated. These reports are corroborated by scientific studies. The recent deposition of sediment in the area of Malindi and northwards increases towards the mouth of the Sabaki R., as does its organic content. Furthermore, analyses of grain sizes and mineralogical composition indicate that the recent depositions in the area are of terrigenous origin, and correlate well with the material generated by the Sabaki. In addition to effects on the beaches and shorefront, sediment from the Sabaki has also been deposited in the nearshore lagoon and on to the coral reefs, which lie only about 1/2-2 km offshore in this area. This is of special concern because two nationally-designated marine parks - the Malindi and Watamu Marine National Parks - are located in coral reef areas just south of Malindi, and the entire area from Malindi past the Watamu park is included in the Watamu Marine National Reserve.

46. Sedimentary accumulation near tourist and scenic areas could have economic as well as aesthetic effects. Tourists or recreationalists may be unwilling to continue coming to areas characterized by beaches or reefs that have become degraded, causing losses in yearly revenue and jeopardizing valuable private and public investment in the tourism infrastructure.

Effects on coral reefs

47. Sedimentary discharges from major river systems may kill coral through smothering, loss of light due to increased turbidity, and nutrification which leads to growth of algae and other organisms. Sedimentary depositions on the sea bottom also prevent coral from attaching to the sea bed and colonizing new areas. The possibility of coastal erosion should also be considered. Coral reefs of the fringing or barrier type protect the shorefront from the effects of ocean waves. Lagoons between raised coral reefs and the shore also tend to accumulate sand and other sediments transported by coastal physical processes, providing additional protective material. Loss of the coral reefs, especially in higher-energy areas where mangrove forests and stable accumulations of sedimentary material do not easily form, could cause erosion of the shoreline.

Flooding in river valleys, coastal plains, and deltas

48. Loss of retentive vegetation and stable soils in catchment areas and accumulation of sediment along the course of major rivers can cause flooding and consequent loss of agricultural and settlement potential. Flooding may happen in highland valleys, as in the plateau around Antananarivo in Madagascar, but usually occurs along the main channels of rivers and near their mouths. The area of Antananarivo, with a population of more than 700,000, is subject to severe siltation of rice paddies and periodic flooding by rivers. Such severe sediment accumulation problems, even in highlands, are related to the grave erosion problems in the country. Soil loss of 260 t/ha/y have been recorded in the area around Antananarivo; in the country as a whole, watershed areas have been found regularly to lose 25-40 t/ha/y of soil, and as much as 300 t/ha/y in highland areas.

49. In Tanzania, changes in the flood pattern of the Rufiji R. were first noticed in the 1940s and the pattern in succeeding years has confirmed a more rapid peaking of river level after rains. This is interpreted as resulting from increasing deforestation and erosion in the river basin leading to faster run-off. Increased flooding in river valleys, extending to coastal plains and estuarine regions, could adversely affect agricultural potential in the subregion and create hazards to human life. Increased incidence and magnitude of floods on major rivers could affect traditional agricultural practices in flood plains as well as threaten the viability of irrigation systems and related intensive agriculture. An increased flooding cycle could also increase sediment discharge at the mouths of rivers and under certain conditions could affect marine life through sudden massive inflows of fresh water.

Effects on the characteristics and productivity of estuarine areas

50. Probably the most important marine resource generated by the estuaries of the region are the shrimps that have their nursery areas in the mangrove forests. It is generally agreed that the occurrence of large shrimp populations requires extensive wetlands, and in this region, mangrove areas. Other marine species of commercial value also rely on the estuaries; there are significant catches of small fish and also crabs in or off most of the estuaries of the region.

and other biological productivity. The estuaries constantly derive organic and mineral material from inputs of sediment, and slowly release soluble components and solids into coastal waters. Prolonged high rates of sedimentation can also provide a basis for the continued growth of estuarine areas into deltas that provide an extended transition zone between river and marine systems. The extension of deltas prevents the occurrence of a process of ecological succession by which such areas are slowly converted into firm ground and can no longer provide a strong basis for marine productivity. Thus, increased sedimentation from inland sources could in certain instances actually have beneficial effects on estuarine productivity.

Deposition of sedimentary material on the continental shelf

52. Like the establishment of deltas on the coast, the deposition of sedimentary material on the continental shelf, outside coral reef and coral sand areas, can have beneficial effects on marine productivity. Similar to the organic matter that accumulates in estuaries, muddy sea bottoms provide nutrients for marine species, including shrimp during their adult stage.

53. Extensive sedimentary deposits are located off the mouth of the Rufiji R. in the Mafia Channel in Tanzania; at Sofala Bank on the wider portion of the continental shelf off Beira in Mozambique and in deep waters of the Mozambique Channel, both resulting from sedimentation from the Zambezi R.; along the north-west and west coasts of Madagascar; and to a lesser extent in association with other rivers in the region. All of these depositional areas sustain shrimp populations.

54. Significantly increased sedimentation from the major rivers could also have adverse effects on fisheries, however, including shrimp. Over-rapid discharge of riverine sediments into ocean waters can reduce light penetration and interfere with phytoplankton productivity. Accumulation of sediments on the sea bed can result in the creation of large areas of unconsolidated bottom subject to turbidity and the formation of sand waves. These conditions can actually reduce biological productivity and interfere with fishery efforts.

Depositional and erosional regimes at the shoreline

55. Increased sedimentary discharges from terrestrial sources into the coastal marine environment can result in the formation of delta-type areas and accretion of beaches. Very large accumulations of sediment can, however, so burden underlying sedimentary strata as to cause areas of the coastal zone to subside. This process, which has been reported for the central coast of Mozambique adjoining the Bight of Sofala, can lead to coastal erosion as local sea-level rises. In the case of this region, which is characterized by some of the greatest tidal fluctuations in Africa (6.3 m at Beira) and other strong natural forces, local sea-level change could have great effects on the stability and configuration of the coastline.

Siltation affecting hydropower facilities and irrigation works

56. In many parts of the world, especially Africa, siltation along rivers has threatened the viability of existing hydropower dams and brought into question whether potential hydropower resources could realistically be developed. East Africa has a unique hydropower potential that is only beginning to be developed. Massive sedimentation from soil erosion in catchment areas could threaten this development. Feasibility studies of dam projects in the region now commonly include analyses of probable siltation at dam sites, as well as along river channels. Irrigation works can also be affected by siltation. Some irrigation works along the Shebelle R. (Uebi

Effects of major hydrodevelopment projects on regional coastal and marine systems

57. Large hydrodevelopment projects on the major rivers of East Africa and Madagascar, for hydroelectric power generation, irrigation, or flood control purposes, could affect their flow and sedimentation rates. Such projects would also change the characteristics of the river valleys and flood plains and permit the extension of systematic agriculture by providing water for irrigation. These changes could have major effects on the pattern of human activity in the coastal zone and on coastal and marine natural resources.

Major hydrodevelopment projects

58. The rivers of East Africa rise from narrow coastal lowlands into upland savannahs and mountains to their points of origin in the lakes of the Great Rift Valley system, including Lakes Victoria, Tanganyika, and Nyasa, and other upland catchment areas. The major rivers of Madagascar also originate in large upland catchment areas and mostly descend through the Western Central Savannahs to the Mozambique Channel. The combination of abundant water resources in the highland areas, large natural catchment areas, and long drops through a variety of terrain towards the coast creates great hydropower potential. Large hydrodevelopment projects on the major rivers can also be justified by needs for flood control and irrigation. Such projects in the subregion include the Cabora Bassa Dam in Mozambique, the Stiegler's Gorge area project in Tanzania and the Bardera Dam project in Somalia.

Changes in flow characteristics and sedimentation rates

59. The dams could exercise a major controlling effect on the flood cycle, except that this factor may be diminished by management of the projects primarily to provide electric power. Deposition of river sediments into the dams will prevent these sediments from reaching the sea, but may cause the rivers below the dam to pick up more sediment, thereby tending to scour river bottoms, carve banks, and create gorges in their lower reaches. This could cause a certain contraction of the flood plains. But sediments lifted from lower reaches of the rivers would probably not be sufficient to replenish the load previously carried by the river from the highlands to its mouth or delta. Thus the amount of sedimentary material entering the ocean may also be reduced and delta formation may be slowed or stopped altogether.

60. Another consequence of dam construction is the effect of water management for hydropower and irrigation purposes on the spawning and growth cycle of marine organisms in the estuaries. As a result of deliberate water management decisions at the dams, the flow of fresh water may be cut off, delayed, or reduced during periods that are critical for marine species. The reduction of freshwater inputs, either on a seasonal or permanent basis, may also lead to intrusion of salinity further up the mouths of the rivers, affecting estuarine habitat. On the other hand, irrigation of new areas near the fresh/salt water interface in a river plain could reduce salinity in these areas and reduce the extent of the productive estuarine transitional zone. But further intrusion of saline water up rivers as a result of lessened freshwater flow could also lead to salinization of agricultural fields that depend on river water for irrigation.

61. Mozambique: Fisheries officials in Mozambique are concerned about the effects of the Cabora Bassa Dam on the delta of the Zambezi R., which provides the primary

partial damming at Cabora Bassa, increasing salinity has been noticed in the marginal agricultural region along the river. The spread of plants adapted to saline conditions, including mangroves, in inner delta and estuarine areas has also been observed. Delta building has apparently also stopped or been severely reduced. A lowered water level has also been noticed in the delta. No effects on the shrimp harvest have yet been felt.

62. Tanzania: Studies have been performed on the possible effects of damming the Rufiji in connection with the Stiegler's Gorge project, Phase One of which was originally scheduled to be completed in the year 1990 but has now been postponed to 2000. Saline penetration into the delta of the Rufiji has been found to reach 5-40 km in various conditions, and it is thought that this intrusion would be reduced by the proposed dam, which would even out the flow of the river at a fairly high level. As for the outer areas of the delta, it was estimated that after the effects of dam emplacement were transmitted downstream, there would be a continuing recession of shoreline at a rate of as much as 1 m per year.

63. Officials currently believe, however, that these changes would not have major effects on marine life, even though the estuary of the Rufiji, with its extensive mangroves supports an important shrimp stock.

64. Kenya has significant estuaries at Vanga, Mombasa, Mtwapa Mida Creeks, the Sabaki and Tana River mouths, and in the Lamu archipelago. Only the Tana and Sabaki Rivers of the Kenyan rivers draining into the Indian Ocean have been dammed or appear to possess a hydropower potential. There are small shrimp fisheries in northern Kenya based on the estuaries and offshore banks of the Lamu archipelago and the Tana and Sabaki Rivers. On the Tana River, damming has been reported to have noticeably reduced siltation at the mouth of the river; marine fisheries in the area seem, however, to be improving.

65. Somalia: Marine productivity in Somalia differs from south to north. The estuary of the Juba (Giuba) River is located in the south and a seasonal upwelling characterizes the north-east coast at the end of the south-west monsoon period. As these distinctive bases of marine productivity become better understood, different types of management measures will probably have to be undertaken for each. Protection of the estuarine areas in the south do not appear to have been accorded official priority to date. In fact, for the most part, the water of the Shebelle R. is extracted before the river reaches the sea. Although the Juba, which originates in the Ethiopian highlands, has a constant flow at its mouth, this may be affected by the Bardera Dam. At present, the probable environmental effects of the Bardera Dam are not well understood, although outside assistance has been obtained to inquire into environmental factors, including downstream effects on the estuary of the Juba. The Juba is known to carry a large volume of sediment, and there is a shrimp fishery around its mouth.

Agricultural development in river valleys and flood plains

66. In Mozambique several projects are under way to expand systematic irrigated agriculture in river valleys, especially for the cultivation of paddy rice. Large areas are already dedicated to rice cultivation in Zambezia Province, and several efforts are being made, with outside assistance, to bring new areas under cultivation. It is thought that the total rice-growing potential in the country is some 240,000 ha. Large projects have been commenced in Choguè, about 50 km up the Limpopo R. from the sea, where 16,000 ha are being converted to rice; in Mopeia, about 120 km up the Zambezi R.; and in Cabo Delgado Province. In Zambezia Province,

over-irrigation which has raised the water table and broken down the freshwater lens. There is a need for careful management of the river and estuarine system to prevent such losses of agricultural potential.

67. In Tanzania, water from the proposed Stiegler's Gorge dam would provide irrigation for intensive agriculture, including expanded rice cultivation, in the lower Rufiji river valley. The proposed dam site is about 210 km from the sea; the flood plain below this point is 10-20 km wide and about 150 km long, ending in a crescent-shaped delta about 60 km wide. The flood plain has traditionally supported both subsistence and cash crop farming. Traditional methods have largely, however, given way to more intensive, village-based agriculture, especially on the fringes of the flood plain. Construction of the dam could ameliorate the flooding problem that has prevented the development of systematic agriculture in the plain. It could also provide a regular source of irrigation water for areas that are now beyond the reach of the floods or only intermittently watered by the river.

68. In Somalia, completion of the Bardera Dam could result in the creation of as much as 220,000 ha of irrigated area, although realistic estimates range from 180 to 200,000. Nevertheless, the costs of realizing the great agricultural potential connected with this project are extremely high. Another project linked with the promotion of intensive agriculture of irrigated areas in Somalia is the construction of a urea plant with a yearly output of 50 t/y. This plant exceeds present needs for urea, since the existing irrigated area totals only some 50,000 ha. Economical exports of the production are also unlikely because of the high costs of producing urea from imported heavy oil.

Problems in the management of the coastal zone

69. The coastal zone along the continental-type coastlines of the region is generally not as heavily populated nor as extensively utilized for agriculture or livestock raising as the more productive highland areas. The general climatic and geological characteristics of the region still, however, make the management of these activities in the coastal zone problematic. Because of the link with maritime transportation and historical patterns of cultural contact, major population centres and certain industrial facilities are usually located on the coast. The coast also supports the small but economically significant population who rely on fishing. The coastal zone, in addition, contains important natural resources and offers special economic opportunities.

Rural development in the coastal zone

Traditional agricultural and livestock raising practices:

70. Rural populations in the coastal zone, as elsewhere, tend to practice shifting cultivation, with new areas being subject to clearing and planting in a regular cycle. Bushfires are often used for land clearing in connection with this traditional practice, in coastal areas as well. In Mozambique, bushfires, or queimara's are reported to be particularly severe on the coast. Both the systematic depletion of new areas for their latent agricultural potential and associated burning are of special concern along the coast because they can lead to destabilization of fragile coastal soil structures such as bluffs and dunes. In Mozambique, small gardens, known as shamba's through much of the region, are also routinely established along the banks of streams and ponds, and in interdune areas. This practice is also observable along river banks in Kenya, and probably occurs throughout the region. Livestock raising can also be especially destructive near

Major agricultural projects in the coastal zone

71. In several places in the region, major agricultural projects are located in the coastal zone. Rice is grown in flood plains and coastal lowlands, with the assistance of irrigation, in Kenya, Mozambique, Somalia, and other areas. Tropical fruits such as bananas, mangoes and papayas are also grown in these areas in Kenya and Somalia, and in Kenya pineapple is cultivated in the dry hinterland of the coast. Other export crops such as cashews, coconut, coffee, and sisal are grown at various places near the coast throughout the region, both on plantations and by small growers.

72. In addition to existing centralized agricultural developments, a number of agricultural projects are planned for the coastal zone in the region, largely at the initiation of the national Governments. In certain cases, these plans are linked to development of new irrigation systems and in others they are primarily organizational in nature and intended to increase the production of cash crops and to provide additional employment opportunities for the rural population.

73. In Kenya, the Ministry of Agriculture is implementing two major agricultural projects on the coast, the Kwale-Kilifi Integrated Development Project and the Magarini project near Malindi. Both these projects will provide agricultural employment for families and involve the cultivation of cash crops including cashews and cotton.

74. In Madagascar, the Government has been encouraging the expansion of cultivation of sugar-cane and such high-value tropical crops as vanilla and cloves. Many of these crops are grown in warmer coastal areas, especially in the east and north-west. The expansion of areas subject to centralized export crop agriculture has in some cases forced traditional farmers on to marginal agricultural lands, including slopes. Erosion has resulted from their burning and shifting cultivation of such areas.

Intensified decentralized agriculture

75. The development of decentralized agriculture, often along traditional lines but on an intensified basis or with altered social organization, can also have important effects on the pattern of rural life in the coastal zone and on coastal resources. Villagization of rural populations can place additional strains on natural resources, such as vegetative cover and soils.

76. In Mozambique, although few new villages have been established in immediate proximity to the sea, the formation of villages has occurred in coastal areas, including river plains. Soil conditions are quite marginal in some of these areas and increased population concentrations around villages could tend to lead to erosion of the sandy soils. The villagization movement is reported to be well advanced in several coastal provinces, including Maputo and Inhambane.

77. In Tanzania, there has historically been a rural agricultural population in the Rufiji R. valley and the flood plain of the Rufiji in the coastal zone. In order better to provide services, deal with the negative effects of flooding, and organize this rural society in line with national development principles, rural populations were relocated into villages along the sides of the flood plain. As a result, the populations of upstream villages became cut off from their traditional agricultural areas, and agriculture downstream also suffered because of the distance between residential and agricultural areas. While traditional cultivation of the

Meanwhile, the development of the infrastructure necessary to support systematic agriculture, including irrigation, has been slow in coming.

Urban development in the coastal zone

78. Throughout the subregion urban centres are located on the coast. These include primary urban centres that have served as national capitals, such as Maputo, Dar es Salaam and Mogadishu; major port cities such as Mombasa, Beira, Mahajanga, Toliara, and Toamasina; and tertiary urban centres, often founded and developed in connection with patterns of trade and settlement in periods prior to independence. Populations in the coastal zone outside the major urban areas, are generally growing no more quickly and sometimes considerably more slowly than overall national populations.

New urban growth centres

79. Small urban areas on the coast occasionally experience accelerated growth as a result of special coastal or marine-related economic circumstances. The outstanding example at present is the town of Malindi in Kenya, which is experiencing rapid population growth as a result of the expansion of tourism in this area. This explosive growth of the permanent population has resulted from direct employment in the tourist industry (approximately 2,000 jobs) and associated services such as handicrafts. It has severely taxed the ability of local authorities and the private sector to provide adequate housing and public services. No sewage system exists at present; meanwhile, septic tanks are being constructed and many residents also use pit latrines, which authorities recognize as a potential health hazard.

80. A physical plan for development of the town has been adopted, including economic development and diversification. An industrial area has been set aside by the Municipal Council which is administered by the Kenya Industrial Development Authority. An area has also been created for small-scale industries. Other necessary facilities and infrastructure are also being created; for example, a slaughterhouse has been established about 1 km inland.

81. The tremendous growth in Malindi illustrates the difficulties small municipalities on the coast may have when they become subjected to rapid population growth linked to tourism or other special economic situations related to coastal or marine development. In Kenya, where tourism is as yet centred between Mombasa and Malindi, there is a prospect of further growth of the tourist areas. Lamu may become a target for tourist expansion in the future. Future growth areas for tourism on the Kenyan coast include intensified development in the area between Mombasa and Malindi and the Kwale area south of Mombasa.

Intermediate urban areas

82. Smaller urban centres on the coast have the problem of general urban growth and also experience difficulties in upgrading and expanding their limited existing infrastructure. As a result, sanitary conditions may be poor and other municipal services inadequate. In Mombasa, however, Kenya's major port city , attempts are being made to rationalize the process of urban growth and to increase the service area of municipal infrastructure.

83. Most of the housing in Mombasa is of the local, Swahili, type, although more space-intensive buildings are found in older neighbourhoods on the Island and some substantial family residences are found along the shorelines. Unplanned housing

Population may reach 700,000 by 1996. The growth of the urban population is expected to occur mostly in the Mainland areas of the city. A practical land use configuration for a much enlarged city population of one million spreading along the three major roads was developed in the Mombasa Skeleton Plan of 1975, which is intended to guide governmental authorities in their planning, granting of permits and investment decisions.

84. The economic foundations of urban life in Mombasa are maritime commerce, large industrial and energy facilities and small workshops, and tourism. As the numbers of permanent residents and visitors increase, retail trade and the service sector can be expected to continue to expand.

85. The primary land use and resource conservation problems appear to be to plan the expansion of new areas in order to preserve urban amenities and prevent unsanitary conditions from occurring, and to upgrade and expand existing public infrastructure such as sewerage and water supply and maintain a level of public services such as solid waste disposal without exceeding limitations on existing equipment and facilities. Only 17 per cent of the entire population of Mombasa is currently connected to a centralized sewerage and treatment capacity, for example, all in one section of Mombasa Island. Elsewhere septic tanks and soak pits are used. Treatment of wastes in the municipal system is only primary (sedimentation); liquid effluents are discharged about 0.5 km out to sea and sludges are trucked to the municipal dump site - a landfill in what used to be a saltmarsh or tidal flat - and spread. A feasibility study has been performed on construction of additional municipal sewage capacity for the West Mainland, however, and work is expected to begin in 1982, with financial support from international lending organizations. (See also WHO/UNEP: Public health problems in the coastal zone of the East African Region. UNEP Regional Seas Rep. and Stud. No. 9)

86. In the absence of upgraded infrastructure, the potential for water pollution and unsanitary conditions in Mombasa is great, especially due to the fact that it almost entirely surrounds internal water bodies. (It has a shoreline of fully 250 km). Sprawling settlements outside the central part of the city, furthermore, could interfere with scenic and conservation values.

Large urban centres: Physical planning, public services, and social policy

87. From the land use planning and resource conservation standpoints, the key issues for large urban centres are to keep pace with the rate of population growth in planning urban expansion, to exercise regulatory authority over key developments that could affect the quality of urban life, and constantly to upgrade and expand public services including sanitary systems so that the carrying capacity of the urban and surrounding environment is not exceeded.

88. Dar es Salaam has experienced extremely rapid population growth, which reached 932,000 in 1979. Consequently housing is the critical development problem, since the informal employment sector appears to be able to continue to absorb the rapidly growing population.

89. As a result of the rapid growth of squatter settlements there is little clearly defined growth pattern for the city as a whole; growth has primarily occurred along major roads, especially the road towards Morogoro. A previous master plan, developed in 1968, projected urban expansion north-south along the coast, but in fact growth has occurred to the west and along the major roads. A potential urban corridor is also appearing to the west of Dar es Salaam along the highway to

population away from Dar es Salaam. Corridor development along the major roads is also being encouraged by a tendency of higher-class residents to establish neighbourhoods outside the city boundaries and to commute to the city.

90. Accommodation of new residents in the future will result in both infilling of the existing urban area and in such extensions of urbanized areas. Infilling of the existing urban area could result in a population in this area of nearly a million.

91. Apart from directing the pattern of growth, planners in Dar es Salaam have the difficult task of providing for the redevelopment of existing urban areas and upgrading and extending municipal services including infrastructure. Municipal infrastructure in Dar es Salaam is generally inadequate for the city's present size; it is also subject to maintenance deficiencies. The limited road system perhaps accounts for the tendency of settlements to follow major existing roads which provide the only transportation links. More problematic, however, is the absence of sufficient municipal sewage treatment capacity. (See paragraphs 96- 101 of WHO/UNEP: Public health problems in the coastal zone of the East African Region).

92. Maputo is also subject to a high rate of population increase, with urban population estimated today at 770,000. The city has been subject to large growth of population in uncontrolled settlements surrounding the "concrete town" of the central planned area. For details on the municipal sewerage system see paragraph 75 of the WHO/UNEP report cited above.

93. In the unplanned areas, human activities around residential structures and footpaths among the houses tend to destabilize the sandy soil; this leads to heavy loss of soil through surface run-off during heavy rains. Since Maputo is largely situated on bluffs slowly sloping to the sea, it is probable that large amounts of soil are transported to the Bay. Although these sediments would probably be vastly outweighed by the contribution from rivers, they could cause inshore siltation as well as carry coliform bacteria and even heavy metals or other pollutants into nearshore areas of the Bay.

94. A Land Law has been adopted which generally establishes a collective system of land tenure and provides for official approval for residential development. No regulations have been promulgated as yet, however. Physical plans exist for urban areas, especially Maputo, which are formulated on the national level through the current National Directorate for Housing in the Ministry of Public Works and Housing. These plans are implemented by the executive councils of the cities. Within national capacities services are being provided for existing and new unplanned areas in the capital. There is, however, a policy favouring decentralization of population so that considerable resources are being devoted to upgrading infrastructure in rural areas.

95. Mogadishu: The current population of Mogadishu is about 350,000. Unlike the other capital cities on the coast in this region, Mogadishu does not appear to be subject to a large immigration from rural areas causing the spread of unplanned areas. Most of the housing in the city appears to be of a permanent nature, with stone walls fashioned from aggregates with limestone morter. The physical layout of the city appears to have been dictated by its transportation infrastructure, which is generally adequate for a city of this size. (See map VI.) Town planning proper is only beginning in Mogadishu, with the delineation of areas for future industrial use and residential expansion.

96. Land within the urban area, as elsewhere, is under national ownership;

the local authorities. Some squatter settlement is reported, but enforcement is reportedly rigorous and the number of squatters small.

97. Mogadishu has absolutely no sewerage at present. There are plans to develop a sewer system , but officials would prefer to avoid discharge into the ocean and favour dispersal on land followed by reuse of domestic wastes in some manner. For futher details see paragraphs 88-90 of the WHO/UNEP report already quoted.

98. Despite its coastal location, the city of Mogadishu and its residents, except for a minority, do not appear to take full advantage of the amenities of life on the coast. The beaches and reefs are of fine quality, but there would appear to be a tendency to dispose of solid wastes, including miscellaneous articles and also organic matter, off seawalls or on to beaches, reducing amenities at the shoreline. There appears to be little artisanal fishing activity immediately off Mogadishu, although foreign visitors report catches of skipjack using handlines just offshore.

99. The traditional Arab style of house construction utilized requires extensive mining of limestone from ancient coral beds under the coastal dunes in the vicinity of Mogadishu. Mining of limestone is visible in dunes in the north of the city on a labour-intensive basis and south of the city in shallow beds using bulldozers. In the north, firing kilns have also been constructed in the dunes to accommodate the limestone that is quarried in the area. These activities have devegetated and destabilized the dunes in these areas. The Government is reportedly drafting a law to control these practices.

Major facilities in the coastal zone

100. A variety of major facilities are located in the coastal zone, usually in connection with the use of coastal waters for transportation or waste discharge, or proximity to coastal natural resources. The careful siting of such facilities, assessment of their effects, and the evaluation and management of existing facilities are of concern because of their potential effects on the marine environment and coastal resources.

Industries (See also UNIDO/UNEP: Industrial sources of marine and coastal pollution in the East African Region. UNEP Reg. Seas Rep. and Stud. No. 7)

101. Owing to the state of development in the subregion and the historical pattern of primary natural resources production, regional industries, including those near the coast, are for the most part agro-industries for processing agricultural products. These industries include sugar mills and molasses plants; cashew husking works; pineapple canneries; rice mills, copra drying facilities and a variety of other light processing or export preparation facilities for other crops such as groundnuts, coffee, cotton and sisal. Most agro-industrial plants do not entail special environmental problems such as the release of exotic substances; they can, however, make large contributions to the biochemical oxygen demand (BOD) of receiving waters due to the discharge of large quantities of organic matter. In the case of sugar, most of the mills in the region now appear to be using all or most of their organic wastes (bagasse) for the production of energy at the plant by burning.

102. Cement plants are in operation at several places along the coast, including Mombasa, Matola (the port of Maputo), and Dar es Salaam. Apart from environmental problems with the dust and other particulate matter released from these plants, they are often located on the coast to take advantage of limestone deposits there. Care should be taken to ensure that the quarrying of limestone in connection with the

103. Chemical plants are also located in several places, including Mombasa and Dar es Salaam. These plants create a danger of toxic effluents containing complex organic substances or heavy metals being released into rivers or coastal waters. The consequences of release of chemicals from these or other facilities could be particularly severe in estuarine areas, where they could tend to be cycled between sediments and the water column.

104. Textile plants, often quite large, are located at several coastal points, including Mombasa and Maputo. In Dar es Salaam, effluents from the textile plant several kilometres inland are channelled into the Msimbaze Creek via a drainage ditch into a small stream. Textile wastes may contain toxic dyes, including heavy metals, which should be assessed as to their effects on the aquatic environment and exposed human populations.

105. Fish processing plants are located at various ports and small-scale industries are to be found all over the region in coastal towns and cities. These industries mostly involve the fabrication and assembly of consumer products, or the fashioning of handicrafts. Some extremely localized pollution may occur from these activities.

106. Mogadishu has a special problem with an abattoir on the shore, the wastes from which are apparently drawing sharks through a hole in the reef, to nearshore water. This has resulted in a number of shark attacks in this area, which was Mogadishu's most popular beach.

Tourist facilities

107. Kenya's coastal tourism has been called "the workhorse of Kenya's tourism" because of its dependability year to year and because of the number of tourists accommodated. The other coastal areas in the subregion are not nearly as advanced in the development of tourist facilities. Most Governments at present, in fact, appear rather undecided about the development of tourism. Nevertheless it must be recognized that tourism, while potentially linked to social problems and, if not managed carefully, not an effective contributor to national revenues, can potentially provide an economic basis and rationale for the conservation of coastal resources and the preservation of local traditions.

108. So while only Kenya appears to be aggressively pursuing coastal tourism at present, other Governments in the region are making some provision for the future development of tourism. Mozambique, which does have some tourist facilities, is formulating regional plans for tourist development in Belem, Macubi, and Punta do Or. Tanzania has some coastal facilities, including hotels just outside Dar es Salaam (such as at Kunduchi Beach) and a lodge on Zanzibar, and is contemplating accepting further investment. Somalia plans no State investment in tourism, but will allow private investment if appropriate. Madagascar has a traditional coastal resort area in Nosy Bé, but the Government does not appear to be promoting tourist investment particularly, although several facilities still exist in this area and there is a constant, if small, stream of visitors. Extremely limited facilities also exist in other coastal areas, largely for business visitors, including the seaside towns of Toamasina, Toliara, and Antsiranana.

Ports

109. Major ports on the coast are generally associated with either primary or secondary urban centres. For the most part they do not appear especially polluted, except when occasional spills of oil have occurred. The section of the Pangalanes

refinery. Little expansion of ports, or creation of new ports, is planned in the region, except where major development of the mineral resources of the interior or coast or offshore waters is anticipated. Thus Beira may experience considerable expansion in the future when the Tete coalfields up the Zambezi River are developed. Vilanculos in Mozambique may have a new port developed to accommodate the processing of natural gas, including fertilizer production, that is expected in connection with development of off- and on-shore natural gas fields in this area. In Madagascar, a new port is being planned to replace the existing port of Mahajanga, which has become unusable due to the large volume of sediment entering the port from the Betsiboka River.

Energy facilities

110. Several refineries exist on the coast, at Mombasa, Matola (Maputo), Dar es Salaam, and Toamasina, which pose obvious dangers for the coastal environment. Moreover, oil spill prevention equipment is extremely limited and contingency capacity, including spill control and clean-up facilities, is not available on site. (See also IMO/UNEP: Oil pollution control in the East African Region. UNEP Reg. Seas Rep. and Stud. No. 10).

Fisheries development

111. In general the periphery of the Indian Ocean, and especially the Eastern African area, are characterized by primary biological productivity lower than that of the other oceans, except for certain, previously mentioned, favoured locations, owing to the narrow continental shelves. (See also IUCN/UNEP: Conservation of coastal and marine ecosystems and living resources of the East African Region. UNEP Reg. Seas Rep. and Stud. No. 11).

112. Coastal fishery potential in the region is therefore limited and the major fisheries occur in shallow shelf areas for shrimp; in nearshore waters and in estuaries for small, including small pelagic, species; and on and near reefs for reef fishes and demersal species. The Western Indian Ocean is, however, also characterized by the presence of schools of highly migratory, or large pelagic, species, especially small tunas (bonito and skipjack); these could form the basis of an offshore fishing industry.

113. FAO compiled estimates for total marine fisheries production by the countries in the region, which illustrate the currently very limited catches; these are reproduced in the annex to this report.

Enhancement of artisanal fisheries

114. Several types of artisanal fisheries exist in the subregion, and generally employ altogether several thousand full-time fishermen in each country. Methods used include seining, gill netting, handlining, dropping traps, or constructing weirs.

115. Owing to the variety of habitats fished and the distance between scattered fishing areas, the marketing of local fishery products derived from the artisanal fishery is limited by transportation and other infrastructural deficiencies. The national Governments in the region have therefore embarked on various programmes to improve the situation. These predominantly include the formation of fishermen's co-operatives to channel governmental assistance to fishermen. Public commercial enterprises have also been established to provide central reception and marketing

116. Because of the techniques used in the artisanal fishery, there is little prospect of overfishing, although certain areas, such as nearshore reefs, can be fished to the point of depletion. The artisanal take of certain species, such as shrimp returning to their spawning grounds in the estuaries, should perhaps be limited when maximum return would be achieved by an organized commercial fishing effort that exploited these species at the most appropriate time and place.

Improvement of commercial fishing operations (See also FAO/UNEP: Marine pollution in the East African Region. UNEP Reg. Seas Rep. and Stud. No. 8)

117. The commercial fishing industry in the subregion is primarily for prawns. A large by-catch of fish is associated with prawn harvesting by trawlers; in Kenya this catch is occasionally marketed. In Mozambique the by-catch, mostly caught by foreign vessels engaged in joint ventures with the Mozambican Government, usually does not reach local markets.

118. Commercial fishing operations in the subregion are restricted by several factors, but there are prospects, based on a number of currently underexploited species. Some of the small pelagic stocks in the area may justify commercial purse seining. Unexploited stocks of deep demersal fish exist, for example, in deeper shelf areas off Mozambique, and there are known to be several species of deep-water crustaceans in regional waters, including deep-water shrimp, lobster and crabs.

119. Because of the difficulties that are present in expanding the commercial fishery, it would appear inadvisable to make significant public investment until improved scientific information is obtained. For unfamiliar species, the market will also have to be tested concerning the acceptability of the product and promotional efforts may also be required. Finally, expansion of the local commercial fishery would involve investment in both improved vessels and gear, and substantial upgrading of fish processing and storage facilities in major ports (as well as allocation of port space to fishing vessels).

The regional shrimp fishery; other crustaceans

120. For the most part, the shrimp stocks are caught in shallow continental shelf areas just off major estuarine systems. The shrimp form swarms near the shelf where they are harvested by trawlers. In several places in the subregion it is thought that maximum sustainable yield (MSY) for the shrimp fishery has been reached and that additional fishing effort would tend to deplete the resource. In general, a variety of regulatory approaches are used, including determination of total allowable catch (TAC) on an area-wide basis, seasonal and area closures, and restrictions on gear, such as minimum net size.

121. In Madagascar, on the north-west coast, shrimp are harvested all the year in shallow waters on the continental shelf about 5 - 30 m in depth. There is a restriction on amount of take and certain areas, thought to be spawning areas, are closed during the period December - February. Detailed records of landings, which are concentrated at Nosy Bé, are being kept by the Centre National de la Recherche Océanographique (CNRO) located there, and area-specific and total mathematical estimates are being made of sustainable yield. It is thought, however, that overall the fishery is currently operating at MSY. About 5,000 t/y are harvested in all.

122. In Mozambique, shrimp catches were probably 6,000-7,000 t during the period 1974-1976 but apparently declined to under 2,000 in 1978. Shrimp exports have historically accounted for about 10 per cent of total export earnings and amounted

companies are also engaged in the fishery. There is also some small-scale fishing for local consumption.

123. In Tanzania the extensive mangrove areas of the Rufiji Delta and the offshore banks of the Mafia Channel are believed to possess a mean potential annual productivity of 2,786 t. Total catch amounts to about 715 t, most of which is derived from the delta and not the offshore area. It is thought, therefore, that considerable scope exists for the expansion of this fishery.

124. In Kenya there is a small shrimp fishery with under ten medium-sized trawling vessels involved, mostly in Ungwana Bay north of Malindi at the mouth of the Tana River. Catches of some 7 t/month per vessel are recorded, with a fish by-catch of perhaps double that.

125. In addition to shrimp there are other exploitable crustaceans in the subregion. Several hundred tonnes of lobster are caught annually although there is probably a potential for a few thousand. There is also a very large potential crab stock in the mangrove forests; in north-west Madagascar alone it is thought that a 200 tonne yearly harvest may be possible, while only some 15 tonnes are caught per year currently.

126. For the shrimp fishery, the primary concerns of the States of the subregion, from the point of view of socio-economic planning and resource conservation, are to try to increase local economic participation in the shrimp industry and to prevent overfishing or other damaging harvest practices. The extent of foreign participation lowers the ability of the Governments to obtain reliable information on the fishery, to observe fishing operations and enforce correct practices, and to participate in downstream activities such as processing and marketing. For other crustacean species, the chief difficulty seems to be in marketing the relatively small quantities available (lobster) on an export basis, and in providing infrastructure and developing a local market for the more plentiful species (crab).

Conservation of coastal resources

127. Several categories of activities that affect coastal resources have been discussed in this section. Mention should also be made, however, of certain coastal features themselves, which warrant special protection because their degradation could result in the loss of economic and other values. Public education and improved enforcement efforts could help in all these categories.

Prevention of overcutting and conversion of mangrove forests

128. Several coastal activities can lead to the destruction or conversion of mangrove forests. Mangroves are cut to provide construction materials, such as poles, as well as to produce charcoal and firewood for domestic use. Although throughout most of the region officials recognize the importance of preventing loss of mangrove forests, there continues to be illegal cutting of mangroves.

129. Mangrove areas are also occasionally converted into salt production ponds. Mangroves have been converted for this purpose just outside Maputo, and recently salt production in a mangrove area was expanded near Kunduchi Beach outside Dar es Salaam.

130. In view of the important functions of the mangroves in marine productivity, especially for shrimp, it is important that their cutting and conversion be

Preservation of amenities

131. As coastal populations grow there is increased strain on the amenities of the coastline, including the unspoilt characteristics of beaches and other open areas. The quality of life in coastal urban areas will become subject to increasing stress from population growth and the difficulty of providing adequate infrastructure.

Protection of the landscape

132. Expansion of economic activities in the coastal zone can spoil views in scenic areas. Mineral extraction facilities, including rigs for recovery of oil and natural gas and associated industrial plants, as well as other structures, can degrade the aesthetic resources of the coastal zone both for local populations and tourists. Development of natural gas fields and associated liquifaction or fertilizer production facilities at Vilanculos in Mozambique, for example, could affect the scenery of this visually interesting area. Care should be taken in the siting and design of facilities along the coast so that they do not intrude unduly upon features of the natural landscape.

Conservation of rare marine species

133. Human activities and residence on the coast threaten certain rare marine species that, in addition to being of scientific interest, are a natural legacy of the region. These include the dugong and several species of sea turtle, as well as colourful reef fishes, shells, and corals, especially in marine areas of recreational interest. Measures should be taken to protect these species from interference by man.

Protection of coastal dry forests

134. Dry forests, sometimes limited, exist in the coastal strip throughout the subregion. They will be threatened increasingly in the future by clearing for agriculture and settlement and for collection of fuelwood and construction materials. Conservation measures should be taken to preserve them as wildlife habitat, scenic assets, and an important factor in the preservation of soil erosion.

Protection of sea dunes

135. Human activities near the coast, including agriculture and livestock raising but also simple human movement, may destabilize sea dunes, potentially leading to coastal erosion. This problem has been observed in southern Mozambique, for example.

Protection of lagoons and barrier islands

136. Barrier islands and their internal lagoons are also very sensitive to human activity, especially construction, as well as to man-induced changes in water circulation. The biological productivity of the lagoon waters of the Pangalanes Canal in eastern Madagascar, for example, is reported to have disappeared as a result of construction and sediment accumulation cutting off interchange of lagoon water with the sea. Adverse effects have also been noticed in barrier islands and their lagoons in southern Mozambique. Weakening of such protective formations could lead to hazards during storm periods.

Procedural issues: Formulation and implementation of governmental policy affecting marine and coastal resources

137. In countries where the coastal zone has not traditionally played the major role in national economic development, systematic procedures may be required to ensure that marine and marine-related resources are conserved and developed in the national interest. One characteristic of the marine "sector" is that, as for the environment as a whole, responsibility for its maintenance and enhancement is generally scattered among a number of decision-making entities. Formulation of a marine policy that can provide for the optimal conservation and development of coastal and marine resources will thus necessitate the co-ordination of governmental functions that are usually split among several agencies. A variety of means may be employed to achieve this result. Caldwell and Bentley (1974) have developed a useful ten-point schema for the incorporation of environmental factors into national decision-making.

General policy formulation

138. It can be very useful to have general policy on natural resources, perhaps embodying marine resources, included in national development plans and in fundamental laws. The national development plan of Kenya refers to such policy more than once, and the capital investment plan of Somalia is expected to contain some general points on resources, as well as to adopt a resource development orientation. The basic Land Law in Mozambique includes a provision on environmental protection.

Marine environmental monitoring and baseline studies

139. Although most of the countries of the subregion have not yet begun to discharge large quantities of dangerous substances, such as industrial effluents, into the marine environment, it may be wise to begin soon to perform baseline studies on the chemical and biological properties of the coastal environment so that adverse changes may be quickly noted and corrected. Aerial and other mapping techniques for coastal resources, including mangrove forests and protective features such as beaches, dunes and barrier islands, may serve a similar function. Expansion of the existing limited baseline and basic study capacity would appear to be warranted.

From sectoral policies to balanced development strategies

140. Apart from general policy statements, other means, i.e. joint physical planning exercises, should be found to reconcile substantive conflicts between sectoral development policies and plans in order to formulate truly balanced development strategies.

Environmental assessment procedures

141. Formal environmental assessment procedures, conducted on an interagency basis, could be helpful, especially for major projects or other developments planned in the coastal zone. To a certain extent, existing scientific advisory groups would naturally perform this function, at least on an informal basis. The National Council for Scientific Research (UTAFITI) in Tanzania, for example, has a number of environmental evaluation projects under way, formulated under the guidance of the Man and Biosphere (MAB) Programme of UNESCO; one of UTAFITI's projects concerns coastal resources and the marine environment. In Madagascar the Académie Malgache d'Innovation helps to conduct evaluations of proposed projects involving natural

Environmental co-ordination and conflict resolution

142. Several nations in the region have recognized the importance of giving the environmental perspective an institutional representative at the national level. In Kenya the National Environment Secretariat has been formed in the Ministry of Natural Resources and may become autonomous in connection with the passage of organic environmental legislation in the future. In Tanzania consideration has been given to adopting a similar structure and meanwhile a de facto interagency committee has been formed and meets on a regular basis under the auspices of the Ardhi Ministry. In Somalia a National Environment Committee has been organized on an informal basis, with multiple agency personnel in attendance; the committee has apparently not met frequently, however. In Madagascar there is an interministerial MAB committee which serves an advisory role, and formation of a special commission on industrial pollution is contemplated. In Mozambique, although no regular interagency co-ordination mechanism for the environment exists, regular consultation is reported to occur among national agencies concerning marine issues, specifically involving the Secretary of State for Fisheries when fishery resources or habitats could be affected by planned developments. Experience in several countries has shown the utility of regular interagency consultation both on a general basis and in regard to particular projects, especially with respect to potential impacts on marine and coastal resources. These consultations could be made more effective by establishing a formal conflict resolution mechanism as well.

Special planning mechanisms

143. In addition to overall intersectoral co-ordination and physical planning, special mechanisms may be applied in particular cases to co-ordinate the actions of governmental bodies. Certain geographical areas could be delineated for special treatment or special co-ordination. Similarly, different areas could be classified into a system of protective restrictions ranging from national parks to various qualified reserve statuses.

Co-ordination with local government, the mixed sector, and private organizations

144. In addition to co-ordination at the national level, the orderly conservation and development of coastal and marine resources will require co-ordination between national Governments and local bodies in the coastal zone, State enterprises and similar organizations with interests in the development of marine and coastal resources; and private entities with holdings or interests in these resources. In those countries with political structures alongside the State administrative structure, there will also be problems in co-ordinating technical or administrative decisions with political processes. The special case of the mixed sector economic unit, with governmental support and authority but with development functions resembling those of the traditional private investor, must also be considered especially carefully.

PROBLEMS IN THE PLANNING AND MANAGEMENT OF THE SMALL ISLAND ECOSYSTEMS

145. The small islands of the Western Indian Ocean have limited coastal resources which are subject to a much higher level of direct human utilization than the continental-type coastlines. On such small islands nearly every major human

Geographic characterization of the small islands of the Western Indian Ocean

146. All the smaller islands in the region share severe constraints on land, especially land suitable for agriculture and residential construction; other natural resources; and water supplies. The terrestrial resource base is essentially limited to its agricultural potential and forest products. There are no significant mineral deposits on any of the islands under consideration, except for aggregates (sand and gravel), and guano found in certain outlying areas subject to Mauritian or Seychellian jurisdiction. Their remote oceanic locations present severe transportation difficulties and limit energy supplies. Yet the islands offer characteristic and pleasant lifestyles based on their abundant scenic resources. There are limited opportunities for the development of marine fisheries. And tourism offers potential revenues and other contributions to the national economy, as well as a vehicle to increase international contacts.

147. The Comoros have perhaps the most severe resource limitations, especially in view of their small size and relatively large population. These limitations are compounded by the scarcity of developable land due to the geology of the islands. The Comoros are volcanic islands of varying age that have formed as a result of the movement of a centre of volcanic activity through the northern Mozambique Channel. Their varied topography and soil characteristics reflect this formation. Grande Comore is dominated by the volcanic shield of Mt. Karthala and is characterized by rapidly rising volcanic slopes cut by stream-beds. Soil is shallow and water tends to run off quickly, limiting the water supply available for human use. The coast is rough and largely formed of low cliffs of volcanic rock. Beaches have historically been limited in extent. The shelf around the land mass drops off steeply on all sides to the sea. There is a narrow coastal strip in some areas which is occasionally saturated by surface run-off and in some spots sustains a small growth of mangroves.

148. The other islands of the Comoros are considerably more eroded and are generally characterized by steep mountain slopes and deep valleys. The coastlines contain flatter areas protected by fringing reefs, and the submerine shelf is broader. Little sand exists on the shoreline at present. Soil is deeper on these islands, and because of the nature of the underlying rock is also more productive for agriculture. Water supplies have historically been more abundant due to rainfall being retained in vegetated uplands. The island of Mayotte, still administered by France, is old enough to have developed an internal lagoon which produces the highest fish catches in the islands, and also provides a protected anchorage.

149. A table presenting basic information on surface area, rural land use, population, and population density for the islands has been drawn up by Latrille and Subréville (1977).

150. Apart from subsistence agriculture and some fishing, the Comoran economy, as already stated, has traditionally relied on the export of specialized agricultural crops - historically a source of perfume essence called ilang-ilang, and increasingly on cloves. Vanilla and coconuts are also grown, as well as small amounts of coffee and aromatic plants. Subsistence farming and other human activities put a considerable strain on the natural resources of the islands. The cultivation of rainfall rice, notably on steep mountain slopes, results in severe erosion of upland areas. Sand is taken from beaches and coral from nearshore areas for residential construction, depleting the beaches and coral reefs of their biological, aesthetic and protective values. The collection of wood for firewood and also to prepare coral for use as lime can lead to deforestation. These effects

expected to double before the end of the century. In 1977, short-term population growth and settlement difficulties accompanied the repatriation of about 18,000 Comorans from Madagascar and the need to resettle about 500 families due to an eruption of Mt. Karthala.

151. Mauritius has a surface area of 1,865 km^2, accounting for nearly all of the national territory of some 2,040 km^2. The population is extremely large for an island of this size, some 896,471 in 1978, making for a density of 481/km^2.

152. The topography of Mauritius is generally favourable for agriculture and about half the surface of the island is planted in sugar - some 87,400 ha. Highland plateaux unsuitable for sugar are now devoted to tea, and some higher interior sections contain large forest reserves which provide water catchment.

153. Owing to its good agricultural organization and the generally high level of education and economic development, few of the population are engaged in full-time subsistence pursuits. (The economically active population in 1972 was estimated at 223,227). The problems in Mauritius relate to the development of a viable economic base for its large population. Except for its agricultural potential, Mauritius is poor in natural resources. The single crop, sugar, accounts for three quarters of its foreign earnings and occupies 90 per cent of cultivable land. Energy resources have not been discovered, although the island's sugar industry is energy self-sufficient based on the burning of bagasse (sugar cane residues) and also sells electric power to the central grid. Nevertheless the lack of natural resources and shortage of energy have led to chronic balance of payments problems resulting in external devaluation and internal inflation. The foreign exchange situation has been helped by the aggressive development of a tourist industry which is now the second greatest contributor to national revenues.

154. Mauritius possesses extensive and fine coral sand beaches that are protected by fringing reefs which surround nearly 80 per cent of the island's perimeter. Since historically the pattern of development in Mauritius has been directed by agriculture, there has not yet been major residential development at the coast. As a result the coastal areas generally remain open as a scenic and recreational resource for residents and visitors.

155. Mauritius' commercial centre is Port Louis, the island's only port. Export processing zones for industry were created here in 1971 to facilitate economic diversification, but such industries are having a difficult time at present due to stagnant international trade conditions, competition and protectionism in the developed countries. At present, fully 44 per cent of the population live in the urban area which extends from Port Louis, through Plaines Wilhelms, to Curepipe in the centre of the island.

156. In addition to the main island, Mauritius administers several dependencies, e.g. the island of Rodriguez (population of 27,842 in 1978), with an area of some 104 km^2, surrounded by a coral reef on which fishing and agriculture are conducted. The dependencies of Agalega and St. Brandon are two small islands associated with commercial fishing operations. Mauritius also has jurisdiction over the Chagos Archipelago in the Central Indian Ocean.

157. Seychelles consists of a cluster of mainly granitic islands, the chief island being Mahé, and a large number (nearly one hundred) of outlying coralline islands. The total population is about 63,000 and of this fully 93 per cent live on Mahé and its neighbouring islands of Praslin and La Digue; 40 per cent of the total

158. The granitic character of the main islands presents special problems for urban and residential development and for agriculture. There is an extreme limitation on potentially developable land, including land for agriculture. On Mahé only about 1,000 ha are cultivable and even here the soils are generally poor. Beyond this area steep rocky slopes make residential construction difficult. The agricultural prospects are somewhat better on the islands of Praslin and La Digue. In addition, the Government hopes to develop agricultural projects on the outer coralline islands. Export crops have traditionally included copra and cinammon but these have been declining in recent years; small crops of vanilla and tea are also grown.

159. The problem of limited developable land has constrained the growth of the city of Victoria. Just prior to 1976, a major reclamation project was completed adding considerable area in the central district and providing space for a number of public facilities including a sports stadium. A new port was developed in connection with this project.

160. There is a coastal strip around parts of Mahé, including the area just south-east of Victoria. A certain amount of urban development is occurring in this area, including light industrial facilities, residential development, and public facilities. Other coastal areas have physical potential for residences or tourist facilities, especially South Mahé, but development is restricted by the shortage of dependable water supplies on this part of the island.

161. Since 1975 tourism has been the main component of the domestic economy. Tourist arrivals reached 78,852 in 1979, but declined to 71,762 in 1980, a 9 per cent decline primarily attributed to higher travel and destination costs and the general world economic recession. Hotel beds in all categories of service numbered 2,726 in 1980; one major hotel complex is currently being constructed on Mahé but further private investment in hotels on the island is being discouraged, apparently for environmental reasons, and investors are being directed to the neighbouring islands, especially Praslin. The Government itself hopes to develop tourist facilities on some of the outer islands.

162. The outer coralline islands of the Seychelles, which are largely underdeveloped today, account for fully one half of the surface area of the archipelago. They are flat and relatively fertile, producing one third of the Republic's copra crop. Government policy is to develop the outer islands for agriculture and fisheries by resident settlers; the Islands Development Company, a parastatal, was formed in 1979 to this end, and infrastructural improvements have been undertaken. Sustained development of these islands for agriculture could lead to contamination or breakdown of the underground water lens, and care must be taken to preserve the fragile natural systems of these islands.

163. Although its land resources are very scarce, Seychelles has jurisdiction over an extensive marine area which may provide the basis for an expanded fishing industry. The main islands are situated on a 27,000 km^2 continental shelf, the Banks Reefs, with a depth rarely exceeding 80 m. This area is part of the country's nearly 1,000,000 km^2 declared exclusive economic zone. In addition, there are fishery resources in the shallow waters in the external and internal lagoons of the coralline islands. These resources are used by the local populations on some of these islands. In other cases, such as Aldabra Island, located over 1,000 km away from the main group at the entrance to the Mozambique Channel, the development of resource-based activities may be curtailed by conservation considerations. Aldabra is the home of a vast number (over 150,000) of land tortoises, and possesses a fine internal lagoon and tropical fauna and flora little affected by man.

Conservation of natural resources

Conversion of coastal natural areas

164. Because of the small size of these islands, their natural resources are particularly subject to loss as a result of human activities.

165. The absolute limitation on land on the islands and their generally restrictive topography result in natural areas being converted to agricultural or urban use, used for other purposes such as industrial and tourist facilities, or removed from agriculture for a variety of other reasons. But natural areas, both along the coast and inland, provide a number of valuable attributes: wildlife habitat; aesthetic appeal; water catchment, flood prevention, and erosion control functions; and in certain cases a filter for wastes resulting from human activities. Mangrove areas are especially important in terms of these functions, since they retain water and soil released during storms; afford a habitat for fish and crustaceans, as well as other wildlife; and provide a stabilizing structure for unconsolidated muddy sediments.

166. Very few mangrove areas currently exist in Mauritius. There are however limited pockets of mangroves, especially in the east where they are sustained at the mouths of rivers which provide sediment inputs, especially during heavy rainfall periods. There appear to be few activities threatening these areas at present, since they are not currently subject to development.

167. On Mahé in the Seychelles, on the other hand, extensive mangroves used to exist on the north-east coast of the island, from Anse Etoile to Pointe Cascade. Many of these areas have disappeared as a result of a variety of activities. Reclamation and urban conversion claimed the mangroves in the vicinity of Victoria, and continuous small-scale reclamation is proceeding, under permit, by shorefront residential owners.

168. Another, larger, remaining concentration of mangroves occurs directly across Mahé Island at Port Launay peninsula, on the borders of the Port Launay National Marine Park.

169. In the Comoros some mangrove areas exist on the different islands. On Grande Comore, mangroves occur in the occasionally saturated coastal strips which accumulate rainwater and sediment after storms. On the other islands, with their flatter tidal zones, mangroves can establish themselves at the shorefront. In certain areas, where sand has been removed from beaches by human activity or where beaches do not exist or are subject to rapid deposition of sediment from upland activities, mangrove pockets appear to be expanding. In the Comoros the mangroves do not currently appear to be subject to a great amount of deliberate human disturbance.

170. Apart from mangroves, which tend to grow in transitional zones between river and surface run-off water and the sea, other vegetation at the shoreline can serve important functions. Vegetation on dunes or the foreshore can stabilize ocean sands and prevent erosion by wind or waves especially during storm periods. In the Comoros, there is considerable systematic collection of firewood on all the islands that would not appear to allow plentiful vegetation to grow even along the coastline. On Mahé and the other main islands in the Seychelles, there has been a tendency to cut vegetation between the coastal road and the sea. The Government has acted to prevent clearing seaward of the coastal highway and is also developing an

to be a recognition of the importance of vegetation in the coastal strip for preventing wind and wave erosion, as well as for limiting the penetration of fields adjacent to the sea by salt spray. Tenacious plants are present on dry sand areas on the foreshore and considerable stands of casuarina have been planted close to the sea as a windbreak.

171. Apart from the immediate coastline, coral reefs and salt marshes are among other areas which should be protected for their natural values. Land uses adjoining such areas should also be regulated to the extent necessary to preserve their natural values.

Shoreline alteration

172. The limited construction activity on the Comoros and the relatively high-energy conditions on the coastline in Mauritius have prevented alteration of the shoreline except in the immediate vicinity of urban areas. In the Seychelles there is a tendency to locate public infrastructure, such as roads, and also private residences, right at the edge of the sea, because of land scarcity, the aesthetic appeal of shorefront residences and thoroughfares, and the low-energy conditions at the coastline. This has resulted in considerable alteration of the shoreline including the construction of seawalls at the base of coastal roads, around public landfills, and adjacent to shorefront residences especially where there has been reclamation. Scouring of the beaches near the seawalls can be observed, indicating that these alterations are causing some erosion.

Sand, gravel, and coral extraction

173. The removal of sand and gravel from beaches and nearshore areas for construction purposes, as well as the extraction of coral from coastal reefs, can lead to chronic erosion of the coastline as a result of loss of the energy-diffusing effects of sand and the shelter provided by reefs.

174. These processes all appear to be well advanced in the Comoros. Comorans follow the Arab style of stone housing, fashioning their permanent houses out of concrete blocks, when these are available, or lava rocks cemented together with a mortar of limestone derived from coral. The high density of population on the islands results in considerable strain on available sand and coral resources. Few beaches remain on any of the islands, although there are reports that beaches existed some time ago.

175. The method of handling coral appears to vary somewhat between islands. Everywhere it is collected from offshore sources, in increasingly deep areas, nowadays by diving. After collection it is burned to recover its amorphous limestone content. The method of burning differs from place to place, but in all cases appears to be responsible for considerable utilization of wood.

176. One can only speculate about the results of such systematic extraction of sand and coral. Some effects are already observable or inferable, however. Very few actual beaches exist on any of the islands, as noted. Former reef areas and nearshore lagoons have been transformed into mud flats, especially in Anjouan. This would appear to have resulted from the combination of depletion of sand, taking of coral heads, and the build-up of terrigenous sediments washed down from the slopes as a result of soil erosion. In other areas, erosion by the sea has begun to affect the coastal road such as the one west of Mutsamudu on Anjouan. This may result from the loss of the protective functions of fine-grained beach materials and the

177. Given the traditional method of construction in the Comoros and the acute shortage of building supplies and hard currency with which to import prepared building materials, it is difficult to see how these strains on marine resources can be alleviated. A demonstration project is being conducted on the use of puzzolane, or ground lava rock, for an aggregate; several trial houses will be constructed using this material. Another possibility is construction using clay bricks. Some clay deposits exist on the islands, especially on Moheli.

178. Some taking of sand from beaches has occurred in the Seychelles but steps were, and are, being taken to prevent adverse effects. Sand was extracted from Grand Anse beach for several years at a rate of about 35,000 t/y. There has reportedly been a partial loss of the beach as a result. There are several other sources of sand and gravel in the Seychelles currently being exploited, including both terrestrial and shallow water marine sources in the north-east. Existing legislation requires a permit for extraction of sand between the low and high tide lines; the Government plans to extend this landward to cover extraction from the coastal plain, where many excavated areas are observable.

179. In the Seychelles, there is a programme to identify offshore sources of limestone. Little research has been done to date to find offshore sources of sand and gravel, although sandy areas have been discovered on the continental shelf in connection with fishery survey work. No detailed acoustical surveys of potential submarine reserves of aggregates have yet been undertaken, nor has economic analysis of the possibility of relying on offshore sources.

180. In Mauritius, terrestrial deposits of marine sediments are exploited by licensees under the supervision of the Planning Division. Sand is systematically scraped down to the ground water level and then the area is recovered and replanted. There is no recovery of sand deposits from the area between coastal roads and the sea, and areas are chosen so as to minimize the possibility of coastline destabilization or the resulting ultimate coastal erosion. A large quantity of aggregates - some 800,000 tonnes of coral sand - are used per year for construction purposes in Mauritius.

Agricultural and silvicultural practices on slopes

181. Due to limited land and pre-emption of certain potential agricultural lands, steeply sloping areas are used for agriculture on some islands. This practice can lead to acute and chronic soil erosion in upland areas, to landslides and other hazards including flooding of lower areas during heavy storms, and to siltation of reefs and nearshore areas.

182. In the Seychelles, for example, numerous cuts in the steep hillsides are observable on Mahé and the other main islands, resulting from agricultural and silvicultural practices in these areas. Some higher hillsides are used for cinnamon or tea cultivation, especially by lease from the Government, and these practices appear fairly conservative of soil. In lower areas other agricultural activities have been tried, however, sometimes leading to severe soil erosion. There is a requirement of terracing of agriculture on areas with a slope exceeding 25 per cent, but this requirement seems too lenient to handle the problem completely. On Praslin and Curieuse there is evidence of bushfires even on higher slopes. The Government has been encouraging the growing of mahogany as a replacement tree in certain areas; this species may provide better retentive qualities than other tropical hardwoods, but its planting must be preceded by clear-cutting.

183. In Mauritius, certain erosion problems have been experienced, but they are currently of a localized nature. Some research has been done into the occurrence of soil erosion, largely based on general agricultural suitability criteria and also field observations. In general, there was significant soil erosion only where the land was in mixed cropping, and little where sugar-cane, a soil-conservative crop, was grown. In addition, proper cultivation practices for cane, including contouring and use of cane trash to cover the soil during exposed periods, could almost entirely eliminate erosion associated with this crop. Generally, the erosion problem in Mauritius seems limited.

184. Visual inspection of the beaches, external lagoons and reefs reveals little terrigenous sediment accumulation. It is reported, however, that the effects of erosion are noticeable at the outlets of rivers, especially in the aftermath of storms when reddish sediment plumes are observed. The sources of these sediments are primarily upland agricultural areas and especially land on the sides of roads and in cleared and developed areas.

185. Although the loss of soil particles does not appear to be severe, the loss of soluble nutrients through surface run-off may present a problem that could affect the state of the external lagoons and reefs. There appears to be some nutrification of lagoon and reef, indicated by the presence of holothurians and algae as well as sea-grasses. It is not known whether this condition is natural or has appeared recently. The large-scale and continuous use of fertilizers on sugar fields could provide the source of nutrients received into the lagoons. However, there may be other causes of these phenomena, including discharge of household wastes or leachate from septic tanks by hotels and other developments on the coast.

186. Soil erosion has reached crisis dimensions in the Comoros, especially on Anjouan. The denudation of the soil on the upper mountain slopes has already led to localized water shortages as streams have become intermittent, and is apparently threatening the viability of fringing coral reefs and creating mud flats in lagoon areas. But the most severe loss is, of course, to the productive potential of the land itself.

187. The worst problems on the islands are found on Anjouan and Moheli, as a result of historical factors which caused the pre-emption of the agricultural area of best potential for perennial crops grown for export. As a result of the pre-emption and the absolute shortage of primary land, subsistence farming has been forced up the hillsides, where it is practiced on very steep slopes right up to the tops of mountains. Although some terracing is present, slopes steeper than 30 degrees are cultivated without terraces. The primary crops grown in this way are bananas (23,000 t, 1965), cassava and other roots (23,000 t) and rain-fed rice (2,800 t), as well as other vegetables and fruits. Paradoxically it is precisely the export crops, which are primarily perennial shrubs and trees, that would be suitable for the marginal areas. Government intervention seems to be called for so that the limited agricultural resources of the island are optimally used, in order to meet the goals of both export earnings and internal food sufficiency. Programmes are also required to improve cultivation techniques in all areas, including the export sector. Latrille and Subréville (1977) have drawn up useful tables showing the dimensions of the land utilization problems in the Comoros.

Construction and residential development on slopes

188. Residential and other development on slopes, especially during the construction phase, can also lead to acute or chronic run-off, soil erosion, and

of limited land availability for urban development, residential development is often allowed on hillsides. This technique can also help to preserve limited agricultural lands from urban expansion. But residential development on hillsides can lead to continuing soil loss as well as severe erosion during the construction period when the ground is exposed. Even when the actual building is supervised, the use of heavy equipment to clear areas before construction often goes uncontrolled. This situation has prompted the Planning Division in Seychelles to draft a circular to the effect that the use of heavy equipment itself is a form of "development" subject to planning approval.

189. Severe erosion can also be caused by the building of roads and other facilities. In Seychelles, construction of the new Cayol Access Road by the forestry department led to a complete wash-out by rains, causing flooding in the coastal plain and considerable siltation. An interagency agreement has since been concluded through which the forestry department will consult with the Planning Division on such projects.

Major reclamation projects

190. In order to obtain adequate space for urban, industrial, port and other uses, reclamation projects are often carried out on islands, with major effects on the configuration of the existing shoreline and the natural characteristics of the area in question.

191. No major reclamation projects have taken place yet in the Comoros, but the feasibility of expanding the port of Mutsamudu on Anjouan is being considered. This project would result in a lengthened jetty, some dredging of a deep mooring, and possibly the filling of an area at the shorefront for harbour space.

192. In Mauritius an area near the harbour in Port Louis which had been reclaimed, in the 1950s for mosquito control, is now projected as an industrial zone. Parts of the port itself are also on reclaimed land, including a new bulk loading facility for sugar. There are plans to reclaim a new area for harbour uses in Mer Rouge in the northern part of the harbour.

193. The largest reclamation on the islands of the region to date is the expansion of the urban area of Victoria and creation of a new port there. The feasibility of an additional major reclamation is being examined, in order to provide expanded roadway, port, commercial, and fishing capacity. The project, by far the largest in the Seychelles to date, would involve creation of a causeway, or alternatively a fill, extending from Victoria to the airport. The Government intends to commission a full environmental assessment before proceeding.

Deforestation

194. Forested areas are especially valuable to small islands since they prevent soil erosion and rapid run-off and provide water catchment in upland slopes. In the Seychelles the taking of firewood for domestic consumption does not appear to be putting undue strain on forested areas; most of the population uses alcohol stoves. Some loss of forest occurs as a result of poor land use practices such as failure to provide terraces or water breaks in steep areas in connection with agriculture, construction or silviculture.

195. In Mauritius the large population of the island utilizes considerable volumes of trees and shrubs for domestic purposes. The annual consumption of fuelwood is

sell fuelwood, about five times as much fuelwood is taken illegally from forest reserves than is sold by the department. Large amounts of firewood are also taken from private land. Although most of the population has kerosene or alcohol stoves, the use of firewood is reportedly growing as a result of increased prices of these fuels.

196. In the Comoros, forest loss is reported to be in a "crisis" situation. Forested areas are experiencing a marked decline as a consequence of cutting for construction materials, industrial use, and especially fuelwood which is mostly collected in the form of small branches on the lower slopes of about 500-800 m elevation on Mt. Karthala, in Grande Comore, and everywhere on the other islands. Concessions have even been granted for the cutting of the forest on Mt. Karthala. It is clear that the Comoros cannot continue to sustain such a high level of forest loss for fuelwood and other consumption.

Prevention of coastal hazards

197. Coastal hazards may be created when vulnerable human uses are allowed to occur in dangerous areas or when human activities cause changes in natural systems on the coast that create dangers to man.

Stormwater run-off

198. Water running off from the interior of islands during storms can create hazardous conditions on the coastal strip or along watercourses. Where such problems are anticipated it may be advisable to limit the use of susceptible areas. For example, in the Seychelles, flooding of the coastal strip and along river channels has occurred, sometimes near human settlements and even schools and other public facilities. The location of these structures should be re-examined or other protective actions taken, where necessary. Flooding from storm water also occurs in the Comoros, and can be expected to increase with the deforestation and erosion of inland areas. Recently a bridge by the coast over a stream-bed south of Moroni on Grande Comore was completely washed away by storm waters. In the future such facilities may have to be redesigned or preventive measures will have to be taken upland. Freshwater flooding of the coastal strip is also reported in Mauritius, especially during cyclones; due to the limited utilization of this area, however, severe damage does not usually occur.

Littoral erosion and sea-water inundation

199. Residences or other structures on or near the shoreline can destabilize coastal dunes and lead to beach and dune erosion during storms. Similarly, such structures may be susceptible to inundation by sea-water during storm periods. Some littoral erosion and inundation are reported in Mauritius during cyclone periods. Erosion can be observed at the shorefront in certain areas, especially near structures on the coastline.

Avoidance of user conflicts

200. User conflicts arise, especially in physically constrained circumstances, whenever particular human activities (uses) adversely affect others. Certain uses should be carefully examined because they tend to degrade an entire range of values or opportunities provided by the coastal and marine environment, and therefore

Agricultural land preservation

201. Limited primary agricultural land on islands is often threatened with conversion to other uses, especially residential development. In the Comoros, the agricultural land problem largely consists of the pre-emption of primary land suitable for diversified agriculture by export crops. On Mahé, Seychelles, the extremely limited primary agricultural areas are threatened by slow urban expansion and residential development. A broad indication of rural and agricultural areas for the main islands was provided in the Seychelles Structure Plan (1975) but this plan is only advisory and is very general in nature. In early 1982, in line with the Government's policy of achieving agricultural self-sufficiency, an Agricultural Land Identification Committee has been formed on an inter-ministerial basis and the year declared as the Year of Agriculture. The Committee is expected to identify primary agricultural land and to strive to prevent its conversion through residential or other development. Limitation of development in the coastal strip or other flat areas will tend, however, to force it on to hillsides where serious soil erosion problems could result.

202. In Mauritius, where three quarters of export earnings are derived from sugar cultivation, the preservation of agricultural lands is one of the primary objectives of the National Physical Development Plan. But a large percentage of the island's population lives in Port Louis and the town of Curepipe, and the area between, Plaines Wilhelms, has been experiencing rapid urban growth. In order to prevent continued rapid urban expansion in this agricultural area, planners will attempt to create development centres in other areas which are less suitable for agriculture.

Water-dependency

203. Especially where favourable shorefront sites are limited, general development along the coastline can crowd out water-dependent uses, affecting the maritime feeling of the coast and imposing additional costs on water-dependent activities and potentially the public. In the Seychelles a number of facilities are being built or operated in the coastal strip, primarily by para-statal organizations, that do not necessarily require a coastal or shorefront location. This situation even exists to a certain extent at the old port in Victoria. In Mauritius most of the rural coastline is not yet developed. In Port Louis, at the harbour, an industrial zone has been created; most of the industries included in this zone are not dependent on the harbour or on proximity to the water, except perhaps as a waste medium. Such a pattern of utilization of the waterfront, especially in the harbour area, can result in a need for redevelopment or harbour expansion as other, water-dependent, uses arise. The siting of facilities on the coast should therefore be assessed very carefully in terms of their water-dependency.

Shoreline access

204. Shoreline access for the public, including recreationalists and fishermen, can be denied by coastal development. This does not appear to be a great problem in the region as yet, especially in Mauritius where a substantial fraction of the coastline is open and available for recreational use. In the Seychelles, continued shorefront development could obstruct access in certain areas but the Government intends to preserve access directly and through the construction of related facilities, such as parking lots, where necessary. The problem of shoreline access can usually be handled through the normal planning process, for example, by inserting conditions into permits for facilities or on subdivision approvals.

Aesthetics and amenities

205. Aesthetic intrusion and reduction in amenities due to poor design, inappropriate construction, or negligent waste management practices, can affect the enjoyment of the coastal environment by residents and visitors alike. As such, they can ultimately lead to economic losses due to their effects on tourism, as well as to unquantifiable psychological and social effects. Waste disposal in the coastal area may also become a health hazard.

206. In the Comoros there is a considerable litter problem at the coastline caused by the tendency to use the shorefront as a disposal site. Conditions are visibly bad in this respect at coastal settlements such as Moroni and Mutsamudu. Small disposal grounds can be found along the sea-coast, even directly adjacent to hotels. There is also a sanitation problem resulting from human wastes being discharged into pit latrines or even in the open, right near or just back from the sea. Children can be observed playing in or near the sea near all these areas.

207. In Mauritius, the general level of cleanliness is apparently high as far as solid wastes are concerned. There are reports, however, of unsatisfactory environmental and possibly sanitary conditions resulting from deficiencies in treatment of wastes by hotels.

208. In the Seychelles, there is a general problem of visual clutter and mixed use directly adjacent to major tourist centres. There is also a tendency to dispose of solid wastes at inappropriate locations, especially along stream-beds. Some of the wastes wash into the nearshore waters during rainy periods. In some areas houses are built quite close to the sea and surface run-off or soakaways from their septic tanks could affect the shore and nearshore waters. Outhouses directly over coastal waters can occasionally be observed, for example, on Praslin. Public education would seem to be an important component in the elimination of the solid waste problem, although improved standards for facilities and enforcement of sanitary practices may also be required.

209. The problem of visual clutter and mixed use near recreational and tourist areas may call for some form of zoning of these activities so that interference and potential hazard do not occur. For example, at Beau Vallon Bay beach in the Seychelles, concessionaires operate high-speed powerboat activities for water-skiing, para-gliding, and the like in areas also used by swimmers. The presence of various small businesses, including snack bars and guest houses, tend to degrade the perceived values of waterfront recreation.

Marine and coastal resources development: fisheries and tourism

210. The island states have opportunities to derive increased economic benefits from their marine and coastal resources through the development of fishing and tourism.

Fisheries development

211. Fishery activities on the islands range from artisanal efforts through various commercial operations. Since internal transportation would not appear to pose serious constraints except on the Comoros, the distinction between artisanal and commercial fisheries may be made not so much on the basis of market distribution but on the nature of the equipment and commercial organization involved.

Artisanal fisheries

212. In the Comoros coastal fishing is limited by the absence of submarine shelves. Small shoals exist off Anjouan and Moheli, but of the total 6,500 t/y catch fully 3,500 tonnes is taken in the lagoon of Mayotte. About 3,500 fishermen are thought to be involved, in about 140 villages. Equipment poses severe constraints, since most fishermen use traditional dug-outs with outriggers, without power. There is seasonal fluctuation because fishermen are sometimes unwilling to go out during monsoons. Given the equipment and general conditions, risks are high and income is low, providing few opportunities for the fishermen to bring in catches beyond their immediate needs. Even if there were a larger catch, it is probable that few people in the general population would have the means to purchase it.

213. In Mauritius, the artisanal fishery focuses on the lagoons and immediate offshore waters. About 2,000 persons are involved in fishing and 500 of them are members of co-operatives which have been formed by the Government to channel assistance efforts. The equipment used by the artisanal fishermen is modern if small, and generally consists of small motorized launches. Catches from the lagoons total about 2,000 t/y historically, but fell to 1,300 tonnes in 1980 probably as a result of cyclones. Official policy is to decrease the level of fishing in the lagoon, as it is felt that stocks are already overexploited. Some fish are cultured in enclosures or barachois constructed in the lagoons which are privately owned and maintained.

214. In the Seychelles, a variety of methods are used in nearshore waters, including trapping, gill netting, and handlining. Day ventures go out in whaleboats (30-35' open boats) to more distant areas, handlining for semipelagic and demersal species. These trips are often organized through agreements whereby the individual fishermen, some or all of whom fish independently, agree to compensate the vessel owner for transportation. Some beach seining is done, especially during mackerel runs. Sometimes the mackerel catch is unexpectedly large and cannot be sold on the local market, especially if caught late in the day. Fishing effort is often curtailed during the south-west monsoon, and local supplies become strained. The total number of fishermen in the Seychelles is reported to be about 1,500, but this includes fishermen working on commercial schooners as well as those using strictly artisanal methods.

Commercial fishing operations (except large pelagics)

215. There is currently no commercial fishing industry in the Comoros. Although the Government would like to establish a commercial venture, external financing has not yet been made available. In Mauritius three local companies organize fishing expeditions to outlying shoals, including the distant Chagos Archipelago. These operations are directed at both demersal species and small pelagics. The annual catch is some 2,500-3,500 tonnes, valued at approximately 17,000 Mauritian rupees ($2,100) per tonne.

216. In the Seychelles, with an extensive continental shelf surrounding the main islands and other shelves and shoals as well, most of the commercial fishing is handlining done from small schooners. These boats stay out for as long as a week, and carry ice. Nevertheless they work the Banks Reef, or shelf area 10-250 km from Mahé, almost exclusively. The catch from these operations has traditionally been sold on the local market, but slowly an export capacity has been developing, based on the establishment of freezer facilities intended to store fish for local consumption during monsoonal periods in which fishing is curtailed. The processing

tonnes, must be accumulated before a foreign commercial vessel can be diverted to pick up the product for export. It is thought that total catch, primarily of demersal but also including pelagic species, from the Banks could reach some 15,000 t/y. Total catch at present is probably some 5,000 t/y. A major factor hindering infrastructural planning is uncertainty over the extent of the tuna fishing potential. Pilot operations are now being conducted by foreign participants.

217. In both Mauritius and the Seychelles, significant amounts of fish catches from the banks are unusable due to ciguatera poisoning. In Mauritius 10 per cent of this catch must be discarded for this reason.

Aquaculture

218. Aquaculture can be successful on islands, providing there is good return on limited land and seabed use. Most success has probably been realized with prawns and oyster grown for the luxury, especially tourist, market. Mauritius produced 18 tonnes of prawns in 1980, but so far oyster cultivation has been unsuccessful. Activities in the Seychelles, including attempted oyster cultivation in a bay, have not succeeded to date.

Development of tourism

219. Tourism can provide an economic incentive to preserve characteristic natural features as well as other aspects of island life. Tourism also, however, has a range of other effects, such as secondary development in tourist areas, including commercial and residential facilities as well as other social effects.

220. In the Comoros, tourism is limited by a number of factors, including the lack of hotel rooms and other infrastructure, but also by the scarcity of natural circumstances favourable to mass tourism, such as sandy beaches. It has been suggested that cautious development is warranted, based on "quality" tourism, i.e. personally arranged tours including visits to islands other than Grande Comore. Government capital investment was discouraged in favour of intensified promotional efforts, especially in view of the fact that the number of visitors is subject to wide fluctuations and hotel occupancy has been running at only about 12 per cent.

221. In Mauritius tourism is the second foreign exchange earner after sugar exports. The target for tourist growth has been set at 200,000 visitors by 1985, but the industry is being re-evaluated as a result of scrutiny concerning its actual contribution to national earnings after the costs of imports are subtracted.

222. The coast of Mauritius is well suited to large-scale tourism since there are extensive areas available for development and because Mauritius' social and economic organization is capable of generating well designed and efficient tourist services and facilities. Tourism is being used positively in physical planning in connection with the preservation of scenic coastal areas. Although there are 300 km of developable coastline, only some 55 km have fine beaches. The National Physical Plan therefore identifies certain areas as having the best potential for tourism and also natural preservation.

223. In Seychelles tourism reached a peak of over 70,000 arrivals in 1979 but has fallen since then owing to adverse world-wide economic conditions. Government policy originally favoured a target level of 150,000 visitors per year, but this level has now been revised downwards to 120,000. Furthermore, new private investment on Mahé has been stopped and the Government is encouraging private

Desroches in the Amirante Is. and the Farquhar Group. Some major installations are still being completed on Mahé, however, such as the large, 500-bed complex at Val Mer.

224. Seychelles has considerably more restraints on its tourist development than Mauritius. The small islands contain only limited extents of beaches, with Mahé having 31.4 km (28.2 per cent of the coastline) and Praslin and La Digue 20.0 km (47.2 per cent) and 8.0 km (55.2 per cent) respectively. High quality beaches suitable for intensive tourist development, based on an analysis of overall attractiveness, accessibility, sand quality, coral and rocks, gradient, marine growth and currents, are of course much more restricted totalling 10.8 km in all on the central islands with 5.6 km on Mahé, 3.5 km on Praslin and 1.7 km on La Digue.

225. Tourist development on the Seychelles, especially on Mahé also encounters other physical problems. Existing tourist areas are already crowded with various uses in some cases, such as adjacent to the prime sandy beach at Beau Vallon Bay. A number of low-grade hotels, including guest houses and inns, exist in this area. These conditions may strain existing scenic resources.

226. Tourism revenue was estimated at some 166 million Seychelles rupees (SR) in 1980, down from a peak of SR 172 million in 1979. It has been estimated that tourism represents about 70 per cent of export earnings, 46-55 per cent of total domestic product, and employs directly or indirectly 7,060-8,140 workers. In view of the vital economic importance of this activity to Seychelles, great care will have to be taken to ensure that the islands preserve and enhance their tourist attraction, not least by strict conservation of natural resources.

Resource planning and policy implementation on the islands

227. On the islands, the problem of information exchange is not nearly so acute as for the continental-type coastlines, but small mistakes arising from failure to co-ordinate policy can have profound effects. Here, therefore, the primary institutional need for management of coastal and marine resources appears to be designing an effective and comprehensive system of control for activities that affect these resources.

Planning and permitting procedures: Mauritius and Seychelles

228. In Mauritius development is controlled primarily through the issuance of development and building permits. In the case of the five constituted municipalities, the municipal councils issue both these permits; for the remainder of the island, which is subject to three district councils, the councils pass on applications for development permits but building permits are issued by the central Ministry of Works. In both cases, applications for the two types of permits are referred to a subcommittee of the Town Planning Board and a staff recommendation accompanies the application. In addition, applications may be referred by the Board to other government agencies such as Fisheries or Agriculture. There is a National Physical Development Plan, which is an indicative document advising officials about the desirability of various activities on the basis of a general text and large-scale maps. In certain municipal areas there are also master plans and zoning maps.

229. In Seychelles, the Planning Division of the Ministry of Planning and Development sits as the Town and Country Planning Authority under the Town and

planning control, and a general permit has been issued for others (including certain home modifications and the construction of houses of less than 100 m^2 coverage) in the statute. Most other activities require the two permits above. For exempted activities, inspections are still performed, for safety and environmental reasons, by inspectors of the Division. Even if an activity is exempted or generally permitted, the Division asks for notification, which provides it with an opportunity to examine the project and consult with the responsible party if necessary. A number of inspections are usually carried out during construction, at least four for a residence. An occupancy permit has to be obtained by a landowner prior to taking up residence in a new house. Subdivision is also controlled by the Planning Division.

230. A number of permits from other authorities are necessary for residential development. Landowners drawing water from untreated water supplies or watercourses are required to obtain a permit for abstraction from the Stream Board, and homeowners proposing to use a treated water system are required to obtain a permit for connection from the Seychelles Water Authority, a para-statal organization recently formed to take over the functions of the old administrative water board.

231. A number of general policies govern the activities of the Planning Division in its approval processes. There is a Structure Plan for the main islands dating from 1975, which contains broad zoning categories and large-scale maps. This document will be updated to serve as a comprehensive plan. In addition, there is a master plan for the town of Victoria.

232. Although there appear to be adequate mechanisms in the land development control procedures both in Mauritius and Seychelles, the documents at the comprehensive plan level appear to be somewhat abstract and difficult to apply, as well as divorced from the development approval procedures. Some means might be considered to formulate more specific policies on development with significant effects on natural resources, especially marine-related resources, and to provide for their practical implementation. The current absence of such an approach can also make for a certain arbitrariness in the administration of permit approvals; in the absence of general policies and a procedure to resolve conflicts, recommendations could tend to be made by staff, and decisions by officials, on a case-by-case basis. Apart from this, there would appear to be some continuing problems of co-ordination among government agencies in devising and implementing policy on the utilization of natural resources.

High-level land suitability classification

233. The limited land resources on the islands, and especially the danger of pre-emption of primary agricultural land, suggest that strengthened procedures should be found to ensure that land is reserved for this and other suitable uses. Given the importance of the question of land suitability, it would appear that a high-level decision-making body should be involved. Furthermore, it must be recognized that land use controls cannot be effective in abstracto but must be coupled with sound development planning; this will ensure that the absence of current economic possibilities does not lead to the conversion of important lands away from the uses to which they are most suited. For example, the absence of adequate development support for diversified agriculture should not be allowed to cause a development of primary agricultural areas for urban or tourist use or production of export crops. The island States in this region should therefore consider the formation of high-level land use commissions and an accompanying land use classification process that could help preserve their scarce terrestrial

created to draft more detailed maps and guidelines. The commission is also empowered to change classifications as the economic situation changes, either during a regular review process or upon petition.

Marine policy formulation

234. In the islands, despite their close association with the sea, there are not always explicit policies on coastal and marine development. Development policies tend to take traditional shapes and to be centred on general economic development and social services, as well as the separate traditional sectors. It may be advisable to formulate general policies on marine resources, therefore, to ensure that the marine perspective is thoroughly integrated into development planning. Such general policies could be adopted in the usual ways as policy statements in the national development plan, as recommendations of special advisory bodies, or as executive directives.

Marine policy co-ordination

235. On islands, unco-ordinated actions by government agencies can have serious effects on coastal resources. Once marine resources policies are established, therefore, procedures should be found by which a government body will have powers to implement them and ensure that this perspective is adequately represented in multi-agency government decision making. A notable step in this regard is the expected formation of a general environment commission out of the existing Parks and Conservancy Commission in the Seychelles. This legalization is expected to give the Commission broad governmental oversight and co-ordination responsibilities, and to greatly expand the role of the Commission from its previous concentration on parks administration.

Marine resources evaluation

236. In view of the limited information currently available about the state of marine resources, including coastal resources, studies should be performed to determine the condition and functions of various marine and coastal systems. The information derived from this exercise could be utilized effectively in formulating and implementing marine policy, as well as in assessing the effects of proposed projects.

Coastal impact assessment

237. Projects should be assessed for their effects on coastal resources, including space utilization near the coastline. The question of water-dependency should be examined, so that scarce coastal areas are not utilized inappropriately. Procedures should be found to inject the assessment of effects on marine resources and activities into existing planning and approval processes.

SPECIAL PLANNING PROBLEMS RELATED TO DISTINCTIVE OCEANOGRAPHIC CONDITIONS

238. Regardless of the characteristics of the coastline, whether it be continental or insular, special oceanographic conditions sometimes pose distinctive problems for economic development and physical planning.

Upwelling zones: The north-east Somali coast

239. As mentioned previously, the north-east Somali coast is characterized by an upwelling towards the end of the south-west monsoon around October. This upwelling is responsible for very high primary productivity since it brings up nutrient-rich waters from the deep ocean. The upwelling results in great productivity of small pelagic species, mostly sardinellas.

240. In order to exploit these conditions, major investments have been made to increase fishing activity along this coast. A semi-industrial fishery was created based on small motorized boats operated by fishing co-operatives. There was a major effort to train the population for fishing, including several thousand refugees from the interior who were brought to the area to support themselves in this and other ways. Apparently the results have not been good, primarily because of lack of training, spare parts for the boats, and infrastructure.

241. One characteristic that makes this situation especially difficult to plan is the great variability of this type of fishery, based on seasonal upwellings. In certain years, due to winds and current regimes, upwellings fail to materialize or are weakened. Extensive fishing effort during such periods can cause a fisheries collapse similar to that associated with the El Niño phenomenon off Peru in the early 1970s. The development of this fishery will therefore have to be particularly responsive to the need to retain flexibility so that, even if the overall harvesting strategy is successful, catches can be effectively limited without undue social costs when necessary to maintain the stocks until more favourable conditions are re-established.

Highly migratory species

242. The presence of highly migratory fish species such as tuna also poses special problems for national resource planning. While the potential for expansion of this fishery in the Western Indian Ocean is apparently great, there are difficulties in devising an appropriate fishing strategy and establishing a sustainable catch. Furthermore, activities in other countries in the region could affect the stock so that separate national planning efforts may need to be co-ordinated. Estimates of total potential catch of tuna in the Western Indian Ocean range from 200-500,000 tonnes. At present little is taken by the States of the region, although several Governments have indicated that they believe foreign fleets are active, including within 200 n.mi. off shore.

243. The development of this fishery poses special problems for national planners. Rapid development of the fishery could outstrip national infrastructure, e.g., for freezing, cold storage, and port space. On the other hand its failure to grow rapidly could penalize premature capital investment. The uncertainties will be compounded by the effects of the fishery on regional stocks, due to the highly migratory nature of the species. In addition, interested foreign entrants may tend to "shop around" for the most favourable conditions in which to locate their operations. Thus there may be difficulties in arranging joint venture or licensing arrangements, and regional exchange of information, and possibly policy co-ordination on this issue could also be helpful.

Ocean energy potentials

exploit ocean energy potentials may soon develop to an operational level, including tide and wave power. Ocean thermal energy conversion (OTEC), the derivation of energy through exploitation of the differential in temperature between surface and deep waters, is however closest to operationalization. Small OTEC plants have been operated and there are prospects for commercial development, especially of small plants located on the edge of the continental shelf not far from the shore.

245. Two programmes for the development of ocean energy in the region may be mentioned. Mauritius is reportedly experimenting with wave energy generators. Seychelles is investigating OTEC development using a small plant located at the edge of the continental shelf about 60 km south-west of Mahé. This plant would supply some 20 MW, about the total consumption of Mahé at present.

CONCLUSIONS AND RECOMMENDATIONS

246. Land use problems are first and foremost national in character. Indeed, land use issues have been basic issues in national development throughout the region and in all probability they will continue to be important national issues. Only rarely will land use practices in one country affect another through direct environmental effects transmitted by the ocean. The major contributor in this regard would be the transport of sediments from rivers, but this problem will by and large be confined to border areas. Other aspects of land use, such as the pattern of industrialization, including the siting of major facilities, could also have environmental effects that could be transmitted across national frontiers. To date however, few examples of such transnational marine pollution exist in the region. Furthermore, the region is extremely large and contains no enclosed or semi-enclosed marine waters.

247. Land use planning problems, including upland land use practices and the management of resources in the coastal zone, nevertheless have a regional character resulting from certain similar organizational and physical problems. Within the two subregions considered - consisting of the continental-type coastlines of Kenya, Madagascar, Mozambique, Somalia and Tanzania, and the island ecosystems of the Comoros, Mauritius and the Seychelles - there are many common environmental problems. There are also general organizational problems that have some common features throughout the region. Finally there are limited classes of marine resources, such as the highly migratory fishery species, that are shared by all the States.

248. In addition to the various recommendations contained in the body of this report, the following general suggestions may be made for action on the national and regional level on coastal and marine development:

A. Basic and baseline study and environmental monitoring capability

249. Throughout the region there are deficiencies in basic scientific and technical study capabilities and the ability both to carry out studies of baseline environmental conditions and to monitor the effects of human activities on the coastal and marine environment. Improved facilities, training, and other support programmes would appear to be needed to make good these deficiencies.

B. Environmental assessment programmes

C. Training and assistance

251. Additional personnel should be trained and programmes created to support greater understanding of the marine and coastal environment and sound principles for its conservation and development.

D. Institutional changes

252. Various institutional measures should be considered in order better to formulate and implement policy on marine and coastal resources. Additional efforts should be made to co-ordinate the actions of government agencies around this focus.

E. Specific programmes

253. Various specific programmes should be undertaken in order to provide for conservation and development of marine-related resources. Two possible areas of interest would be:

(i) Improved utilization of fuelwood and development of alternative domestic energy sources

254. Deforestation is proceeding over much of the region as a result of fuelwood consumption. In other places fuelwood has become scarce and alternative sources of energy for household purposes have not been developed. The fuelwood cycle should be rationalized to the extent possible by improving the efficiency of existing stoves and facilities for the production of charcoal. Government-administered fuelwood programmes should be undertaken, including supervision of cutting of fuelwood in existing reserves and establishment of fuelwood plantations where necessary. Other biomass energy sources such as biogas production should also be investigated.

(ii) Regional co-operation on tourism

255. The States bordering the Western Indian Ocean do not form an integrated region in terms of racial, linguistic, cultural, or even shared environmental factors. Yet as a result of their geographical situation they share certain problems. These include issues of a geopolitical nature; the environmental effects of oil tanker traffic; and the financing of national development through enhanced foreign earnings. Greater regional co-operation in tourism could result in more foreign earnings by increasing the flow of visitors and encouraging quality tourism with maximum earnings potential. Tours could be arranged including visits to several places in the region, which would capitalize on the very disparateness of the region. For example, tours could be designed which take advantage of some of the coastal or island locations and at the same time the game parks of East Africa. Such regional tours could also include cultural and scenic stops in Madagascar. Such a package could attract visitors from more remote parts of the world and tap new visitor markets.

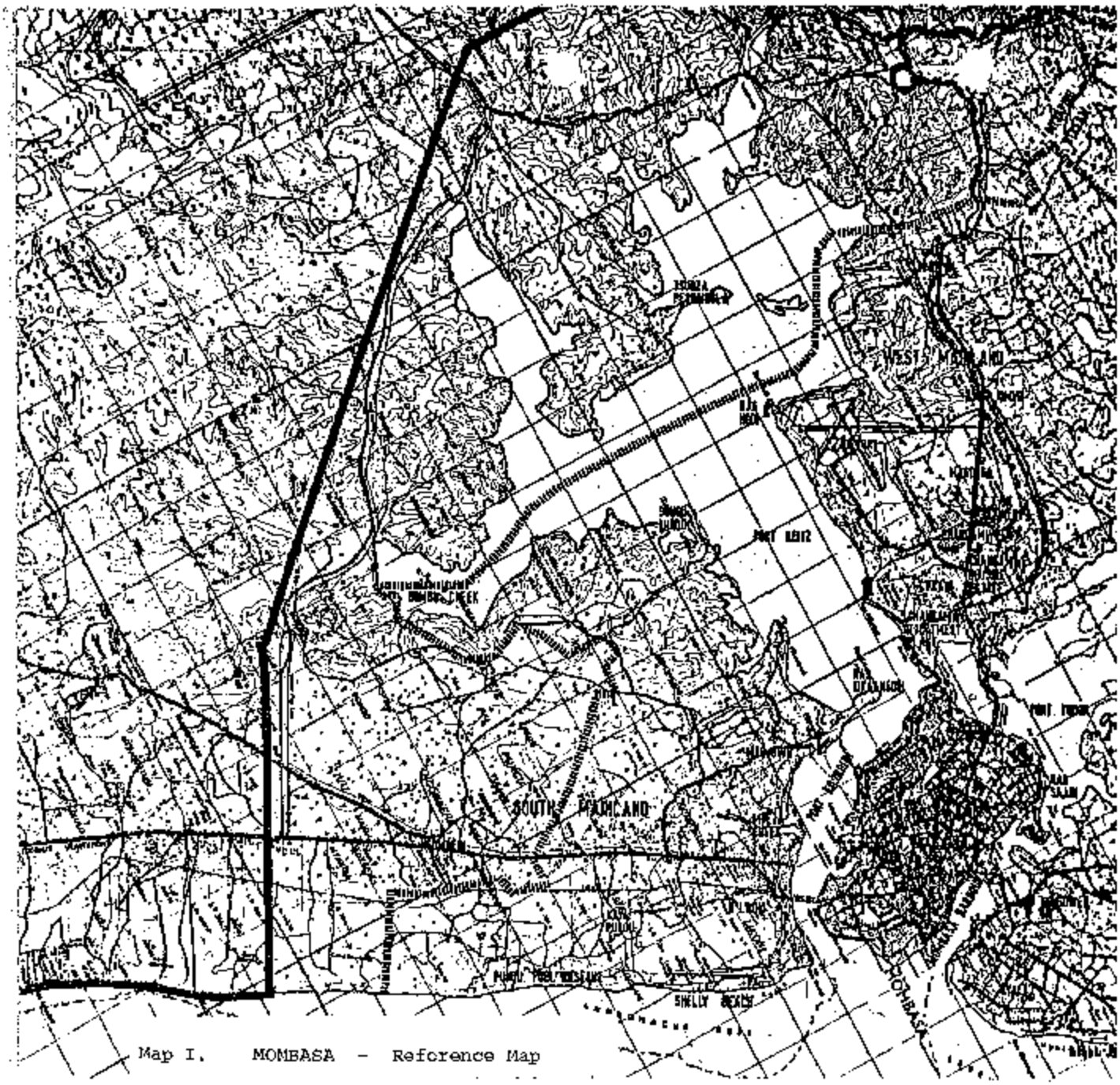
256. Some regional co-operation has been attempted in tourism. The islands, including Réunion, were formerly members of a tour organization. Discussions have been held on the formation of a new regional tourism association. The Seychelles have supported such an approach for several years. Perhaps regional co-operation in tourism development could help to develop this coastal activity, providing increased economic returns and additional justification for careful management of the coastal zones of the States in the region.

ANNEX

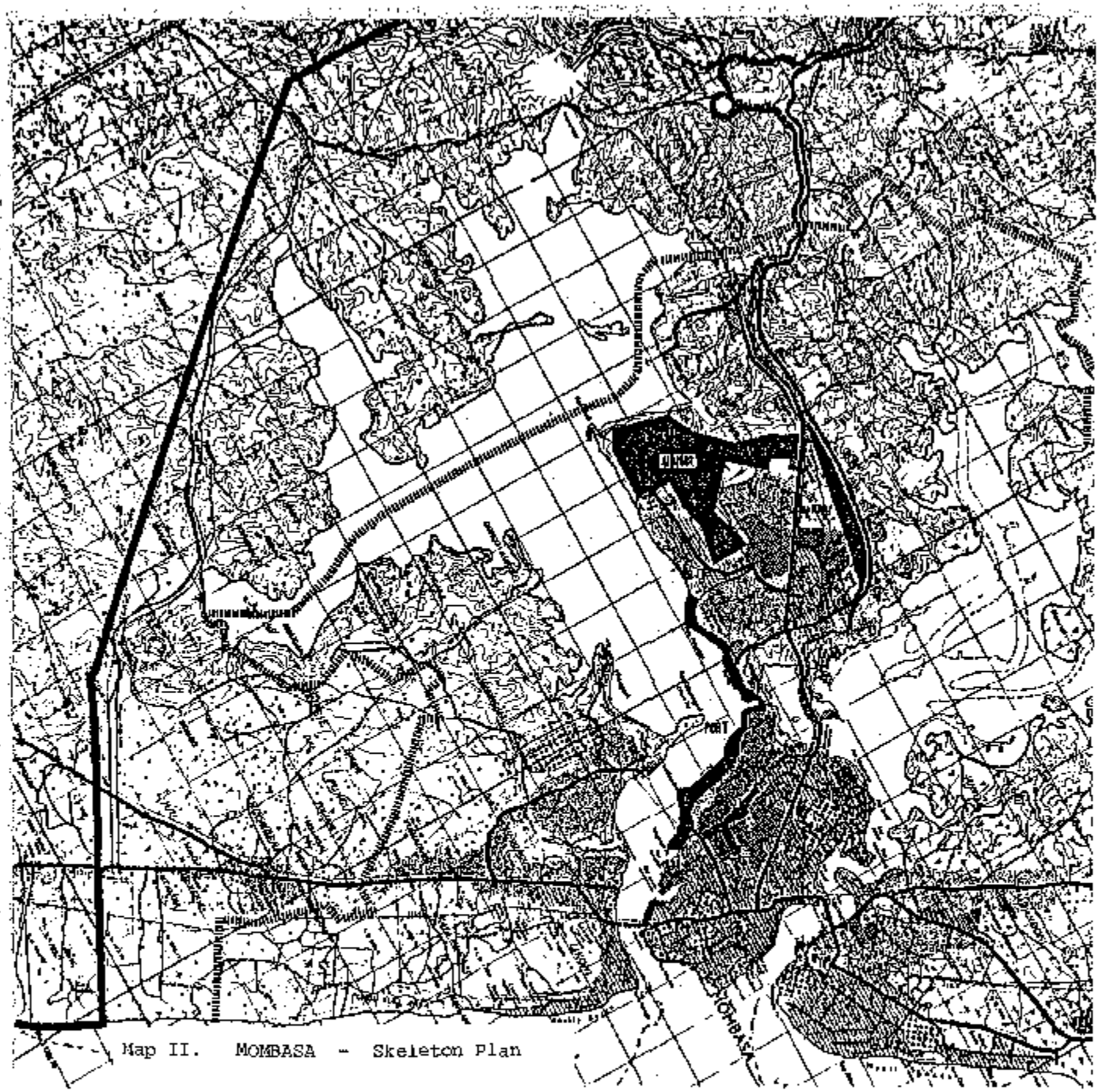
General profile of countries in the East African Region

Countries	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 f landings (1,000 metric
Comoros	2,236	900	350	0.33	4.0
Kenya	582,650	6,500	500	16.40	5.4
Madagascar	595,790	135,000	4,000	8.74	12.0
Mauritius	1,865	1,600	200	0.99	5.3
Mozambique	738,030	120,000	2,500	10.47	31.7
Seychelles	443	48,000	600	0.06	5.0
Somalia	637,657	32,500	3,000	3.64	11.0
Tanzania	939,703	30,000	800	17.00	49.2

(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 sm and yearly variability in total supply (consumption by tourists is not separately accounted

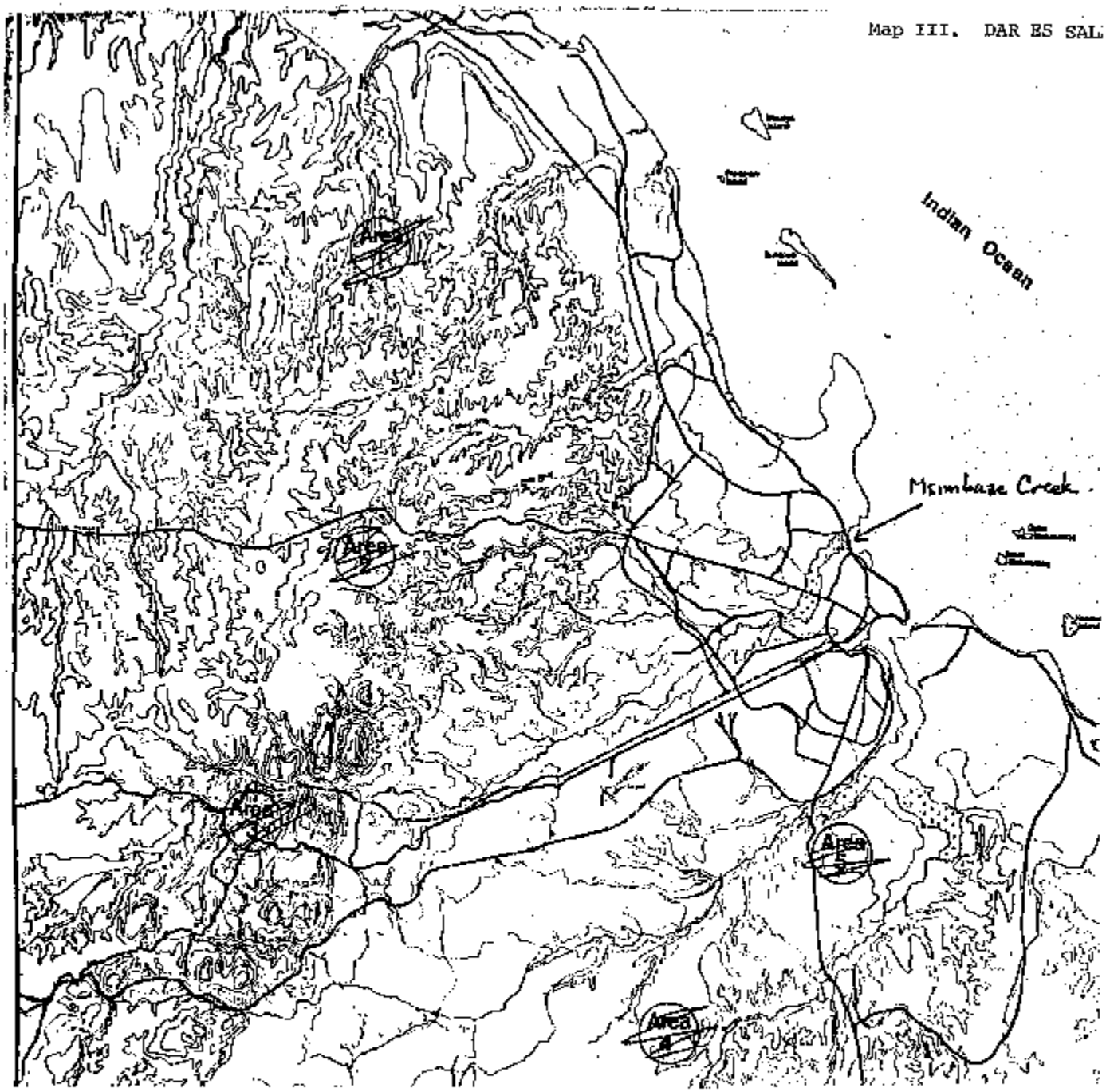


Map I. MOMBASA - Reference Map

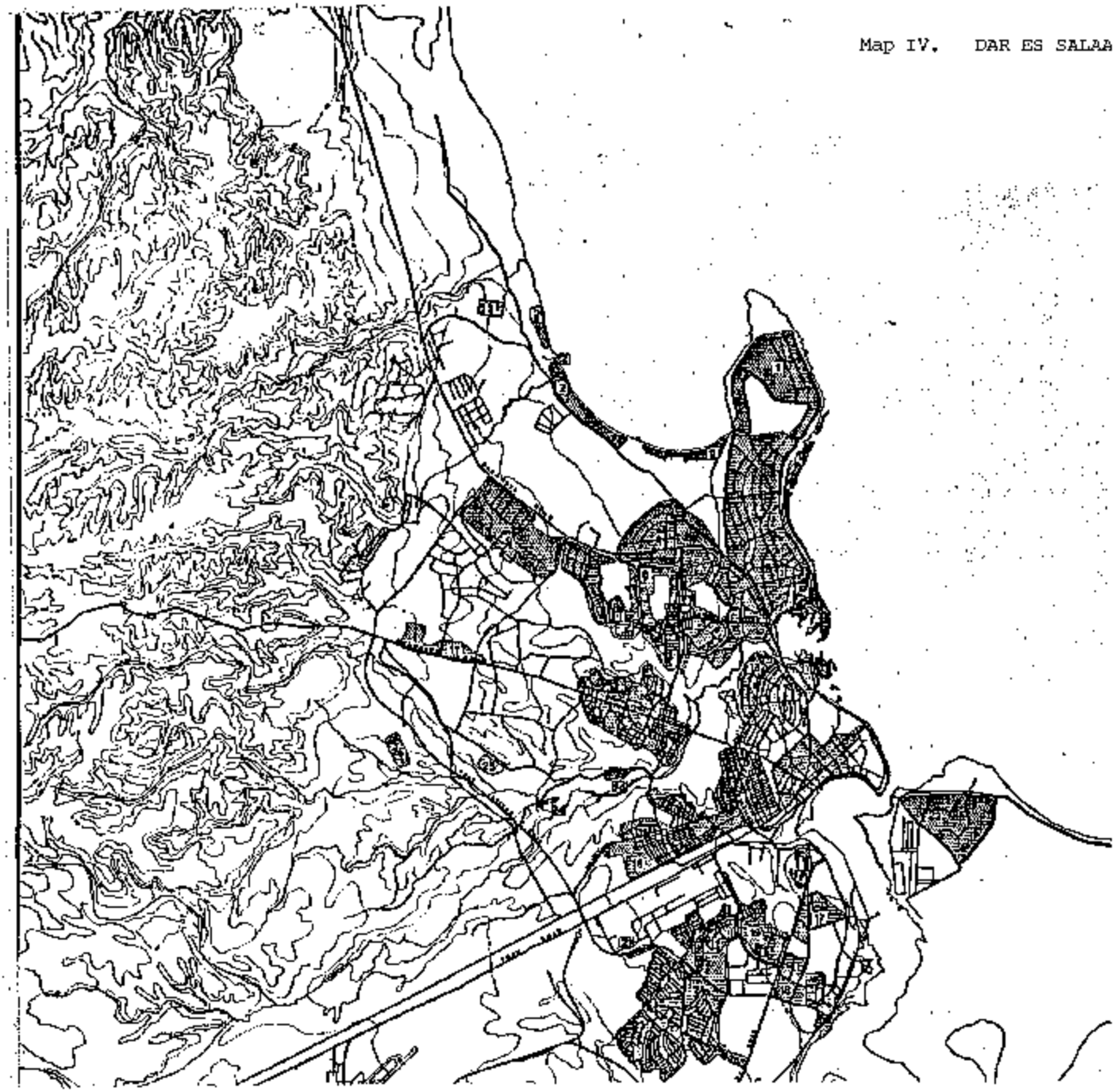


Map II. MOMBASA - Skeleton Plan

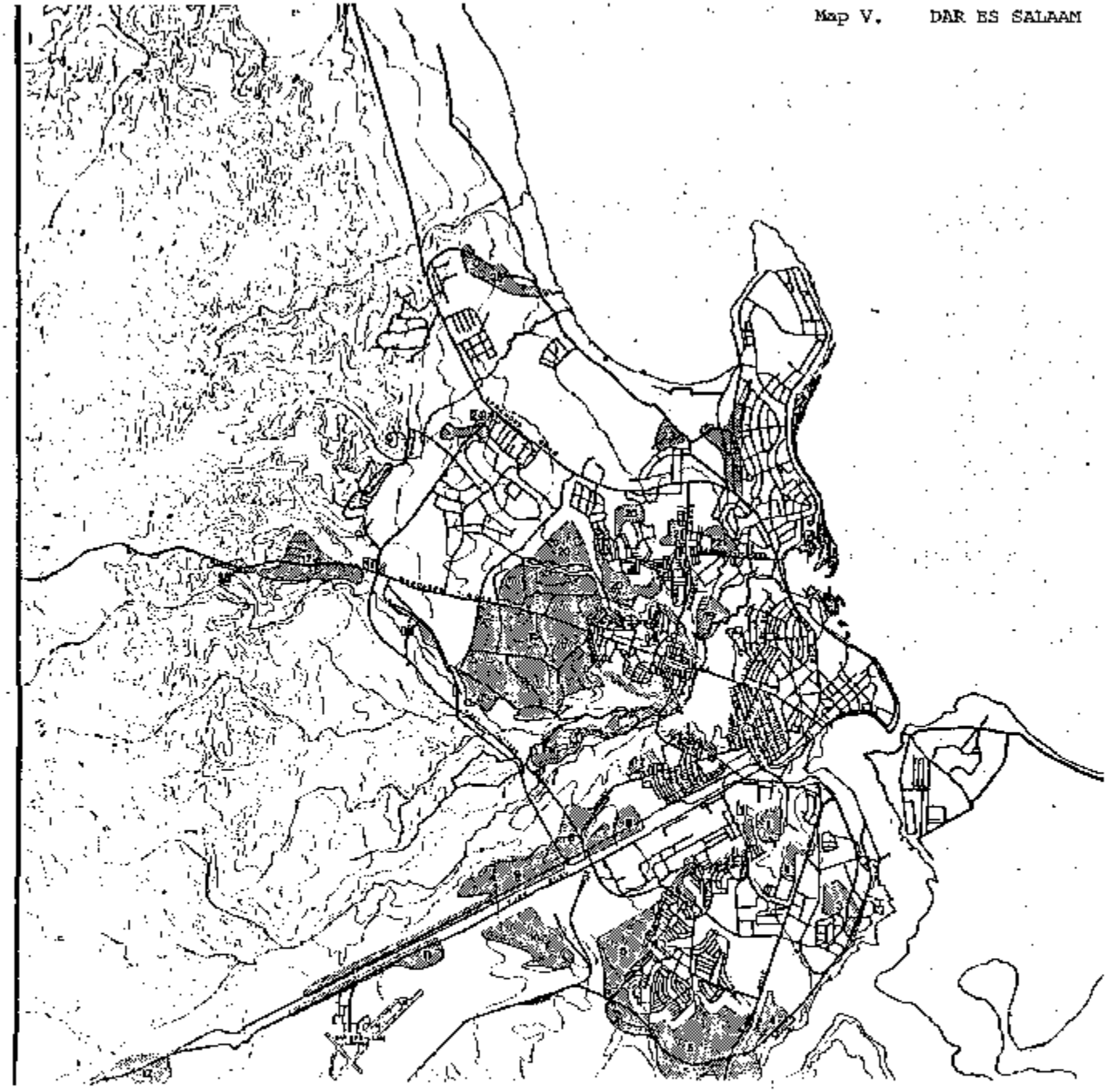
Map III. DAR ES SAL

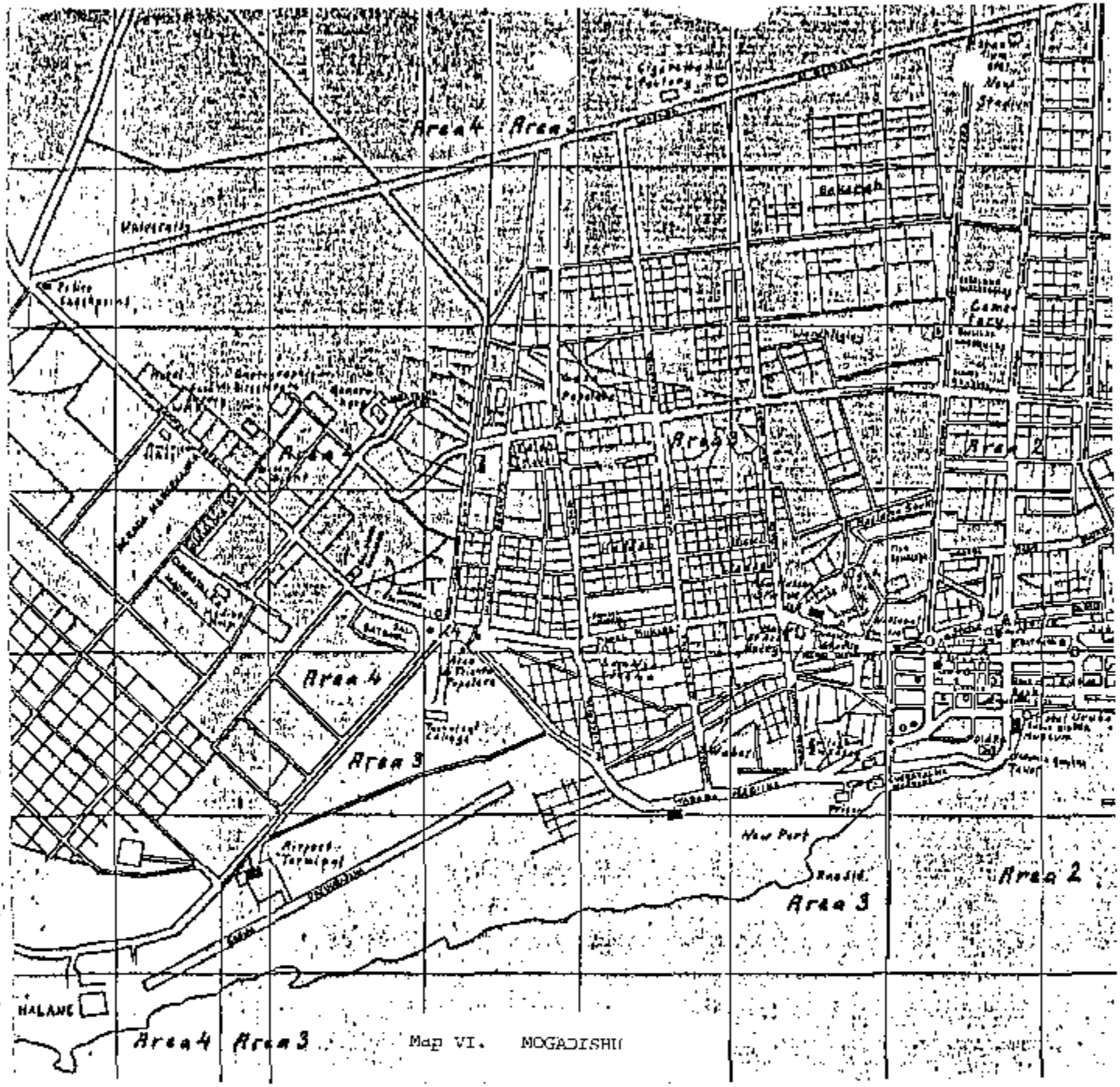


Map IV. DAR ES SALAA



Map V. DAR ES SALAAM





Map VI. MOGADISHU

REFERENCES

ARIANE VAN BUREN, E. (1980). The Chinese development of biogas and its applicability to East Africa. In: UNEP, Energy Report Series: Energy and Environment in East Africa. (Proc. Wkshp., Nairobi, March, 1980) No. ERS-3-80.

ATKINS LAND AND WATER MANAGEMENT (1981). Rufiji Basin Study Programme: Study of the Impact of the Stiegler's Gorge Multipurpose Project on Fisheries in the Rufiji Delta and Mafia Channel. Rufiji Basin Development Authority (Tanzania) (RUBADA).

BANTJE, H. (1979). The Rufiji agricultural system: Impact of rainfall, floods and settlement. Bureau of Resource Assessment and Land Use Planning (BRALUP), University of Dar es Salaam. Research Ppr. No. 62.

BERRY, L. (1981). Tanzania: Physical and Social Geography. In: Africa South of the Sahara (1980-81), London, Europa Publ.

CALDWELL, L. and BENTLEY, A. (1974). Organizational and administrative aspects of environmental problems at the local, national and international levels. In: United Nations Dept. of Economic and Social Affairs, Organization and Administration of Environmental Programmes (New York, 1974), U.N. Document No. ST/ESA/16, U.N. Sales No. E.74.II H.5.

COMMONWEALTH SECRETARIAT AND GOVERNMENT OF SEYCHELLES (1980). Victoria Master Plan, Final Report (Sept., 1980), prepared by Colin Buchanan and Partners, in association with Norman and Dawbarn and Coopers & Lybrand Associates, Ltd.

EEC (1980). Comoros: An island nation in a difficult economic situation. The Courier, No. 69 (September-October 1981).

ENDEAN, R. (1977). Pollution of coral reefs. In: Fifth FAO/SIDA Workshop on Aquatic Pollution in Relation to Protection of Living Resources. (Manila, 17 Jan.-27 Feb., 1977).

EPTING, J. and LAIST, D. (1979). Perspectives on an ocean management system. Ocean Development and International Law.

FAO (1978). Country Statement on the Kenya marine fisheries. In: Report of the FAO/IOP Workshop on the Fishery Resources of the Western Indian Ocean South of the Equator (Mahé, Seychelles, 23 Oct.-4 Nov. 1978).

FAO (1979). Report of the FAO/IOP Workshop on the fishery reserves of the Western Indian Ocean south of the equator (Mahé, Seychelles, 23 Oct.-4 Nov. 1978), FAO Report No. IOFC/DEV/79/45 (Rome: January 1979).

FAO/MAURITIUS SUGAR INDUSTRY RESEARCH INSTITUTE (1973). Land Resources and Agricultural Suitability Map of Mauritius (and accompanying booklet).

FAO/UNDP (1978). Development of fisheries in the Exclusive Economic Zone of Somalia. Report of an FAO/UNDP International Indian Ocean Fishery Survey and Development Programme Mission, Indian Ocean Programme, Tech. Report No. 19, FAO Doc. IOP/TECH/78/19.

FINN, D. (1980). Interagency relationship in marine resource conflicts: Some lessons from OCS (Outer Continental Shelf) oil and gas leasing. Harvard Environmental Law Rev. 359390.

GLANTZ, M. (1980). El Niño: Lessons for coastal fisheries in Africa? Oceanus 21(4): 9-17.

HOVE, A. (1978). Some aspects of current sedimentation, depositional environment and submarine geomorphology of Kenya's submerged continental margins. In: C. Odidi Okidi, (Ed.) Management of Coastal and Offshore Resources in Eastern Africa, (Proc. Workshop, Nairobi, 26-29 Apr. 1977) Institute for Development Studies, Univ. of Nairobi, Occasional Paper No. 28.

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 (Ref. Stud. GESAMP (11).

KIAYE, S. (1978). Town planning in Mombasa. In: Proceedings Sixth FAO/SIDA Workshop on Aquatic Pollution in Relation to Protection of Living Resources (Nairobi and Mombasa, Kenya, 12 June-22 July 1978).

KINYANJUI, D. and BAKER, P. (1980). Report on the institutional framework for environmental management and resource use in Kenya. Republic of Kenya, National Environmental Secretariat.

KRISTOFERSON, L. (1980). The Seychelles: Finding energy in remote places. Ambio 10(5): 211-212.

LATRILLE, E. and SUBREVILLE, G. (1977). Exploitation agronomique des cartes de l'inventaire des terres cultivables. Ministère de la production et des industries agricoles, Republique fédérale islamique des Comores.

LEWIS, I. M. (1981). Somalia. In: Africa South of the Sahara (1980-81), London, Europa Publ.

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

MARTIN, E. (1975). Malindi - the Historic Town on Kenya's Coast.

MASAKHALIA, Y. (1976). Development planning in Kenya in the post independence period. Econ. Bull. for Africa (U.N. Econ. Comm'n for Africa) 12(1): 19-44.

MORGAN, W. (1981). Kenya: Physical and Social Geography. In: Africa South of the Sahara (1980-81), London, Europa Publ.

NORAD AND VHL RIVER AND HARBOUR LABORATORY (Norway): Report on Hydraulic Studies in Lower Rufiji River. RUBADA (Tanzania), Rufiji Basin Multipurpose Development: Stigler's Gorge Power and Flood Control Development.

NORCONSULT A. S. (Nairobi) (1976). Mombasa Water Pollution and Waste Disposal

ODINGO, R. (1980). The development of hydroelectric power resources in East Africa, with special reference to Kenya. In: UNEP, Energy Report Series: Energy and Environment in East Africa (Proc. Wkshp. Nairobi, March, 1980), No. ERS-3-80.

PATHMARAJAH, S. M. (1981). Pollution and the marine environment in the Indian Ocean. UNEP, Regional Seas Reports and Studies No. 13.

PELISSIER, R. (1981). Mozambique: Physical and Social Geography. In: Africa South of the Sahara (1980-81), London, Europa Publ.

REPUBLIC OF KENYA (1971). Development Plan 1979-1983.

REPUBLIC OF KENYA, NATIONAL ENVIRONMENT SECRETARIAT (1977). Environmental Management Report.

REPUBLIC OF KENYA (1980). Tourism in Kenya, Investment Prospects.

REPUBLIC OF KENYA (1981). Ministry of Environmental and Natural Resources. Report of the GOK/UNEP/UNDP Project on Environment and Development.

REPUBLIC OF KENYA (1981). Tourism Market Report.

REPUBLIC OF SEYCHELLES (1981). National Development Plan 1981-85.

SALM, R. (1978). Conservation of marine resources in Seychelles. IUCN, Morges, Switzerland.

SENTONGO, G. (1978). Marine fisheries in Africa. In: Proceedings Sixth FAO/SIDA Workshop on Aquatic Pollution in Relation to Protection of Living Resources (Nairobi & Mombasa, Kenya, 12 June-22 July 1978).

SIVALINGAM, S. (1981). Basic approach to mariculture, problems and development strategies. Government of Kenya/UNDP/FAO Pilot Project: Development of Coastal Agriculture. (mimeo).

TANZANIA, MINISTRY OF LANDS, HOUSING AND URBAN DEVELOPMENT (1978). Uhuru Corridor Regional Physical Plan.

THOMPSON, V. (1981). Madagascar. In: Africa South of the Sahara (1980-81), London, Europa Publ.

TINLEY, K. L. (1971). Determinants of coastal conservation: Dynamics and diversity of the environment as exemplified by the Mozambique coast. Proceedings of the SARCUSS Symposium on Nature Conservation as a Form of Land Use, Gorongosa National Park. pp. 125 - 152.

TINLEY, K. L. et al (1976). Wildlife and wild places in Mozambique. Oryx 13(4): 344350.

TOMCZAK, M. (1978). Regional oceanography of African waters. In: Proceedings Sixth FAO/SIDA Workshop on Aquatic Pollution in Relation to Protection of Living Resources. (Nairobi & Mombasa, Kenya, 12 June-22 July 1978).

UNITED NATIONS DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS. OCEAN ECONOMICS AND

VIDOT, S. and RATCLIFFE, C. (1977). The exportation of frozen fish from a developing small-scale fishery. In: Ministry of Overseas Development (UK), Tropical Products Institute, Handling, Processing and Marketing of Tropical Fish (Proc. Conf. London, 5-9 July 1976).

WESTERN, D. and SEMAKULA, J. (1980). The present and future patterns of consumption and production of wood energy in Kenya. In: UNEP, Energy Report Series: Energy and Environment in East Africa, (Proc. Wkshp, Nairobi, March, 1980) No. ERS-3-80.

WORLD BANK (1979). The Comoros: Problems and Prospects of a Small, Island Economy, 177 pp.

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