REGIONAL SEAS

UNITED NATIONS ENVIRONMENT PROGRAMME

Industrial sources of marine and coastal pollution in the East African region

UNEP Regional Seas Reports and Studies No. 7

Prepared in co-operation with

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

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

1/ Mediterranean, Kuwait Action Plan Region, West and Central Africa, Wider Caribbean, East Asian Seas, South-East Pacific, South-West Pacific, Red

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.

CONTENTS

INTRODUCTION

Geography of the region

1. The geographical region covered by the East African Action Plan (EAF) consists of the coastal regions of Eastern Africa and the Indian Ocean islands in the area extending from about 13°N to 30°S and from 32°E to 67°E. It covers a vast area which contains the equator and lies mostly in the southern hemisphere. As a result of its location, the area experiences a wide variety of climatic and oceanographic conditions which vary from tropical to temperate.

2. More precisely, the area consists of the coastal regions of Comoros, Kenya, Madagascar, Mauritius, Mozambique, Seychelles, Somalia, and the United Republic of Tanzania, including the wide stretch of the Indian Ocean connecting these coastal regions. On the African continent, that is from Somalia to Mozambique and on Madagascar, the term "coastal regions" refers to the land mass extending continuously from the shoreline to about 20 km inland and includes river estuaries and the body of water lying directly in front of the shoreline. All areas can be considered coastal for Comoros, Mauritius and Seychelles.

3. Agriculture, including subsistence farming, is the main occupation of the region. The principal export crops include coffee, tea, sugar-cane, cotton, cashew, coconut, vanilla, sisal and cloves and the main consumer crops include maize, rice, cassava and bananas. Livestock breeding and artisanal fishing are widely practiced. Agriculture is the principal source of raw materials for industry. Thus industrial activities in the region are highly oriented toward processing raw agricultural produce into semi-finished or finished goods.

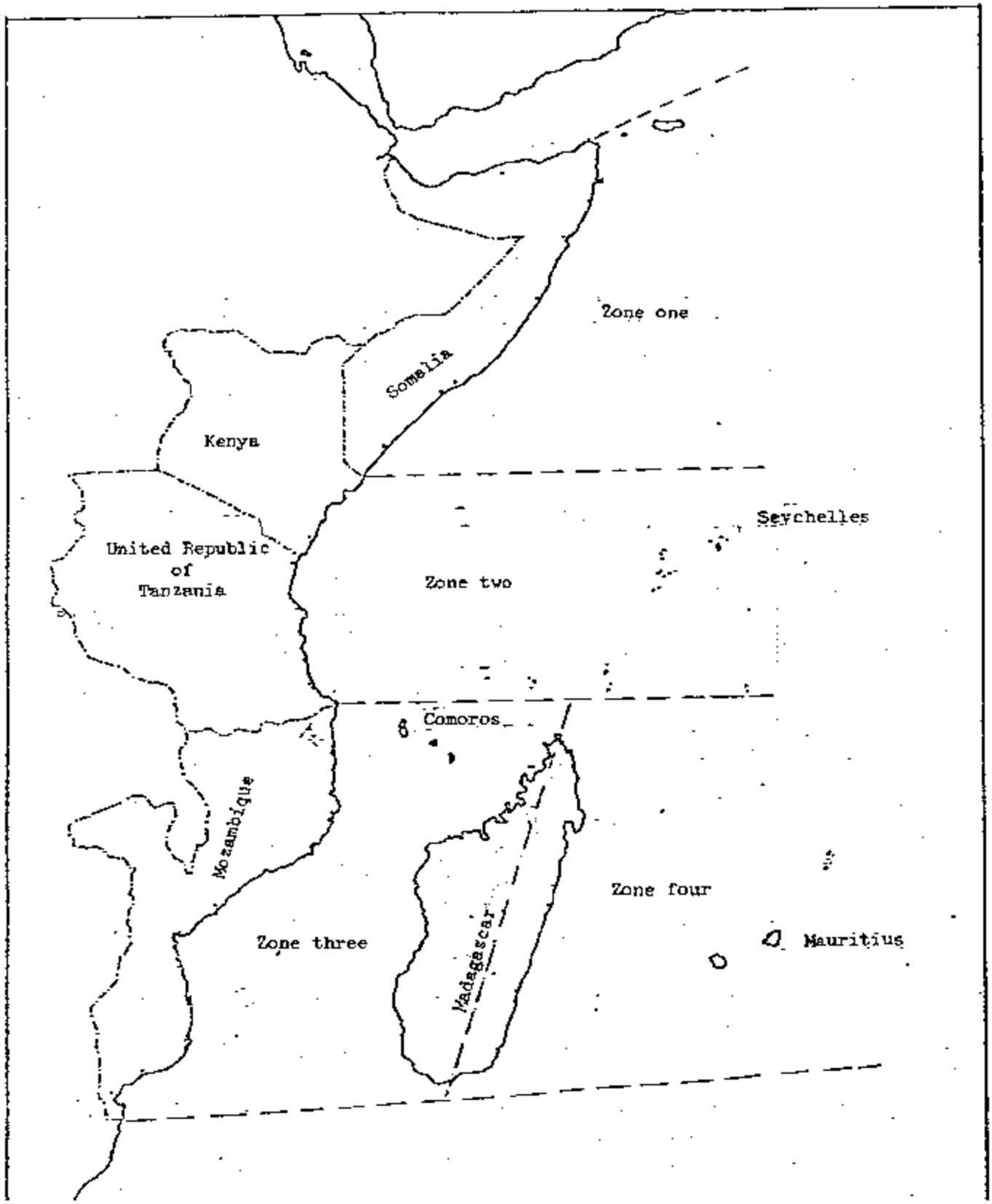
Classification into zones

4. The East African region may be classified into four zones, as shown in the figure, on the basis of the main hydrographical characteristics of the region. To obtain the zone boundaries shown in the map, the actual limits of the major ocean currents in the region have been slightly modified and approximated by nearby borders.

5. The classification provides a convenient and practical means of assessing industrial inputs into the ecological matrix of the region. From the classification, present levels and types of land-based pollution inputs into the different subcompartments of the region can be estimated and appropriate sites located for various types of activities.

6. Zone one extends from the northern limits of the East African region (about 13° N) off the horn of Africa to just south of the equator (about 2°S). This zone is characterized by the Somali current which completely reverses its flow biannually in response to monsoon seasons. The zone is further characterized by a permanent upwelling area off the Somali coast.

The zones of the East African region



7. Zone two, extending from about 2°S to about 10°S and dominated by the eastward-flowing Equatorial Counter Current, is a zone of dynamic offshore mixing. This zone lies between the westward-flowing North-East Monsoon Current and the westward-flowing South Equatorial Current.

8. Zone three extends from about 10°S to the southern limits of the East African region off the coast of Mozambique. The main hydrographical current here is the fast-flowing southward Mozambique Current which feeds from the South Equatorial Current and flows into the Agulhas Current around 26°S. Within the Mozambique Channel, the Mozambique Current moves southwards with a shoreward component along the Mozambique coast and gradually generates a counter current offshore which flows northwards along the Madagascar coast.

9. Zone four lying immediately to the East of Madagascar and extending to just beyond Mauritius, and from about 10°S to about 26°S, is marked by the westward flowing South Equatorial Current. The South Equatorial Current is deflected by the islands of Mauritius and Madagascar into two components which reunite just off the Southern part of Mozambique to form the Agulhas Current. This zone is also characterized by cyclones. The division of the region into the four zones is shown in the following table:

Zones of the East African Region

Zone	Countries	Major Current
I	Somalia	Somali Current
II	Kenya, Tanzania Seychelles	Equatorial Counter Current
III	Mozambique, Comoros Madagascar	Mozambique Current
IV	Madagascar, Mauritius	South Equatorial Current

General analysis

10. For Kenya, Madagascar, Mozambique, Somalia and the United Republic of Tanzania, identification of industries most likely to have a direct or indirect impact on the quality of the marine environment in the region was limited to industries located on the coast or on rivers and streams flowing into the sea. For the rest of the region, because of the small size of the islands and the patterns of settlement, all industries were considered. Estimates of pollution potentials of industrial activities were based on the assumption that industries would dump waste into rivers, streams, the sea or the atmosphere.

11. A general view of the industrial classification scheme for this report is given in annex I. Agro-industries whether they are primary process industries producing semi-finished products (e.g., oil extraction, beef, milk pasteurization etc.) or [illegible] sophisticated technology and other chemicals

operations. There is a wide disparity in the distribution of tertiary or manufacturing industries in the region with a greater occurrence in countries rich in natural resources and having a cheap energy source and a diversified economy. To assess the impact of pollution from tertiary industries in the region, detailed information about production, materials and processes used is necessary.

INDUSTRIAL ACTIVITIES

Introduction

12. Pollution from industrial sources is the main concern of the present report[1/]. Although pollution from industries is small compared to other pollution, when it occurs it is usually highly localized and may thus cause environmental problems. The level of industrial pollution varies widely in the different zones; where there are more industries or intensive industrial development planning, there is a greater potential risk from industrial pollution.

13. Industrial activities in the region are on a much smaller scale than agriculture and commerce. Industry accounts for a small percentage of the gross domestic product in all of the countries, and the labour force has few industrial workers. The industries vary widely but are generally oriented towards agriculture and the processing of local raw materials.

14. Throughout the region, there is an intensive effort to both increase and diversify industrial activity. Larger, more sophisticated, manufacturing industries are becoming more necessary and capital investment and technology is sometimes sought from foreign investors by granting special industrial concessions that often appear to compromise environmental quality.

15. In zone one, where the predominant land-based activity is herding, the industrial sector is highly oriented toward meat and milk processing, and the production of leather. Artisanal leather processing is quite common. The marine environment thus receives wastes from slaughter houses and leather processing industries. Pollution in this zone is characterized by high biological oxygen demand (BOD), suspended solids and grease.

16. Zone two is more complex, with important inputs coming from primary and secondary process agro-industries as well as a few tertiary industries. The pollution load cannot be estimated from the data obtained but it can be inferred

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1/ Pollution in the region from the agricultural and municipal sources is discussed in the reports:

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

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

from the pollution studies on the Msimbazi River in Dar es Salaam, that this zone has a high pollution load, concentrated around the bays in Dar es Salaam and in Mombasa.

17. Industrial activities in zone three are highly concentrated in the coastal towns in Mozambique and Madagascar. Studies on pollution in Maputo Bay, done in 1980, showed serious industrial pollution of the bay. The shortage of data of industries in Mozambique precludes any meaningful assessment of the level of pollution in this zone.

18. Industrial activity in zone four is dominated by the cultivation of sugarcane and the processing of sugar in Mauritius. The extensive use of fertilizers and pesticides presents a serious problem. Pollution from industries cannot be effectively determined from the information available but it would appear that pollution is highly localized along Port Louis harbour and vicinity in Mauritius. In Toamasina (Tamatave), Madagascar, industrial pollution may become a more serious problem.

Estimated pollution discharges

19. Pollution loads may also be estimated from the daily or yearly production figures, from water consumption or from the number of employees in a given plant. However, basing pollution loads on the number of employees is not likely to give reliable results because factories often try to make the industries labour-intensive.

20. Annexes II through IX show information pertinent to industries in the coastal towns of the region. It can be inferred from the information that industrial discharges in the region consist mostly of liquid wastes containing large concentrations of dissolved and suspended organic matter. These wastes, with high BOD and suspended solids come largely from primary and secondary process agro- and food-processing industries, and are generally released into rivers and streams or directly into the sea. The decomposition of the organic matter in the waste water depletes dissolved oxygen endangering certain sensitive species of marine life. Discharges of wastes containing essential elements such as nitrogen and phosphorus may result in an algae bloom.

21. Industrial sludges are rare because the treatment of industrial wastes is not widely practised. Some industries in the region regularly obtain sludges from oxidation ponds. Industrial solid waste from industries or industrial zones within urban areas is treated like regular urban solid waste in most cases. This was the case in Port Louis, Mauritius, where five lorries are assigned to the commercial areas. Sludges may also be burnt as in the case of a mill in Maputo. However solid wastes from industries are generally dumped into municipal solid waste dumps, which are areas of land-fill near the sea. In Mahé, Seychelles, the dumping was directly into a small bay away from the city of Victoria. The dumping area is contained by a "dry" stone wall and it is being covered with red earth. However, the nature of the retaining wall is such that sea-water permeates into the dumping ground resulting in leaching of organic matter into the sea. The Seychelles Government is currently looking into the feasibility of establishing some form of sorting and recycling plant.

22. On a regional basis, air pollution is on a small scale and its contribution to

pollution. For example, the ylang-ylang distilleries in Comoros burn wood to produce the steam used in the extraction process and thus contribute (minutely) to air pollution in the region. Sugar-cane plantations in Mauritius, are often flamed to expedite harvesting. The burning of bagasse and other fuels in sugar factories, and flares at oil refineries also contribute to air pollution. Refined crude oil often contains 1.2 - 1.7 per cent sulfur, which is oxidized to sulfur dioxide during burning.

23. Laboratories are needed to estimate the level of pollution in industrial effluents throughout the region. However, such facilities are often not available.

Pollution assessment

24. The pollution impact varies widely within the region depending on the types of activity as well as on the ability of the coastal environment to respond to the impacts.

25. Land-based activities may exert both a direct and indirect impact on the marine environment. This impact is most acute in the coastal waters and estuaries which are delicate, highly sensitive and very critical to man's use of the sea and its resources.

Zone one

26. The main industries in zone one are located in and around Mogadishu and Kismayo, the principal towns on the coast in the region. Industrial activities in this zone are dominated by agro-industries.

27. Livestock breeding of cattle, camels, sheep and goats is the main rural occupation in Somalia. Pollution inputs thus largely consist of untreated effluents from slaughter houses and leather and affiliate industries. These wastes are characterized by high BOD and suspended solids, repugnant odours and high levels of nutrients which may cause algal blooms.

28. The management of industrial waste waters in the zone has improved over the years in response to the growing environment impact of some of the discharges. A shoe factory in Mogadishu has attempted evacuation of waste waters from its septic tanks without success due to the large volume of the waste water and is presently seeking alternative solutions. A slaughter house has redesigned the system for the discharge of effluents and is presently using a number of interconnected stabilization ponds and collecting the sludge from filled ponds for agricultural use. However the responses and waste management practices in the different industries vary widely and are not systematic or thorough. In view of the existing problems and the increased danger expected from the increasing scale and diversity of industrial activities, appropriate legislation and standardization of industrial waste management practice is necessary.

Zone two

29. In zone two, the level of industrialization is perhaps the highest in the region, and the largest inputs are generally from agro-industries. This zone receives inputs from many industries of various types of which a good number are small-scale manufacturing industries. It receives large seasonal inputs from the mainly [illegible]

the vicinity of the industries. Compared to effects due to other types of activities, such as municipal sewage, siltation and sedimentation due to poor agricultural practice, pesticide accumulation and tarballs from maritime transport, the impact of industrial pollution in the zone is quite small. Nevertheless, pollution does have immediate effects on the environment (such as the creation of anaerobic zones) and may potentially, slowly and invisibly accumulate, invade and alter the marine environment.

30. A number of environmental problems due to industrial activities in the zone have been identified. These include problems arising from the discharge of effluents from coffee and sugar factories into rivers and streams (for example, near Mombasa). In Malindi, Kenya, an industrial estate will place a new industrial park about 15 km from the sea and away from the town to reduce the environmental impacts of the park on the town and permit appropriate industrial development. In Dar es Salaam, in the United Republic of Tanzania, an extensive study of pollution carried out in 1979 as part of the master plan of the municipality revealed that 27 of the 658 industries in the city were causing pollution problems by discharging untreated factory effluents into municipal sewers and the Msimbazi River and its tributaries. In Seychelles, pollution from industrial sources is still relatively insignificant due, in part, to the small population and limited natural resources. Industrial activity is largely based on agriculture with coconut, cinammon, fruit canning and fisheries development being the main concerns.

Zone three

31. This zone receives land-based inputs from Comoros, Mozambique and western Madagascar. Due to the small population, limited resources and land space, industrial activity on Comoros is on a much smaller scale and pollution inputs are trivial and limited to small local effects. Inputs from western Madagascar come mainly from agro-industry effluents concentrated in the Mahajanga Bay and in the coastal waters of Tuléar. The coastal provinces of Mozambique are very heavily populated and heavily cultivated. Over 70 per cent of the 10.5 million population live in the coastal provinces with about 10 per cent of the total population living in Maputo. About 63 per cent of the industries of Mozambique are in Maputo; 17 per cent are in Beira with the rest spread throughout the country. Mozambique has a number of rivers (such as the Zambezi and the Limpopo) that drain many parts of central-southern Africa. Major industrial inputs from Mozambique consist of industrial effluents entering Maputo Bay from the Matola River as well as factory effluents from Beira and from the rivers with large industries within the prescribed distance from the coast. The industrial sector in Mozambique is quite diversified but still predominantly agro-based with sugar, cotton, cashew and sisal as main raw materials.

32. Industrial pollution was noted in studies by the Laboratory of Food and Water Hygiene of the Ministry of Health of Mozambique in 1980 following outbreaks of cholera in Maputo Bay. A number of industries in the Maputo suburb discharge effluents into the Matola River that flows through the industrial zone into the Maputo Bay. The bay has been declared out of bounds for swimming and fishing because of the high level of pollution.

Zone four

33. This zone, extending from eastern Madagascar to just beyond Mauritius, is very highly flushed by the South Equatorial Current. The majority of industrial inputs

extractive industries as well as primary and secondary process agro-industries also make contributions most of which are concentrated in the bays and estuaries.

34. The Saint Louis River flowing into the Grand River Bay in Mauritius receives industrial waste water from an industrial zone and studies have shown the bay is polluted. For a number of years, a sugar estate dumped untreated wastes into a stream which eventually polluted a fish pond downstream at Pamplemousse. A distillery has been dumping its wastes into the River Citron which has become coloured red and has no more fish.

35. The Pangalanes Canal in Tamatave, Madagascar, flows through a highly industrialized part of the city. Municipal wastes and industrial effluents are dumped into the canal without treatment. There are large patches of oil on the surface and the banks are coated with tar.

Projected industrial development

36. The physical impact of industry on the environment is largely dependent on the physical conditions of production. The following is a discussion of both existing and projected industrial developments likely to affect the marine environment in the next five years. Projected industrial developments that are likely to affect the coastal areas directly or indirectly are of two types, the creation of new projects in the coastal towns and the improvement of on-going projects.

Zone one

37. Three new industrial projects have been selected from those planned for 1982-1986 in Somalia. These are:

- a urea plant in Mogadishu to be constructed near the petroleum refinery. The plant will have a production capacity of 90 t of ammonia and 150 t of urea per day (330 days a year);

- a shoe factory which will produce about 500,000 pairs of shoes per year from locally tanned leather for local and export use;

- a mini steel-rolling mill to be created in Mogadishu which will produce steel bars from iron and steel scrap for use in reinforced concrete. This plant will produce 10,000 t per year initially, and 17,000 t per year when in full operation.

38. Modernization and expansion projects include the expansion of facilities at a milk plant in Mogadishu to handle 40,000 litres of fresh milk coming from six collection centres throughout the country from which the plant will produce pasteurized milk, yogurt, fermented milk and soft cheese. There are also plans to expand the foundry and mechanical workshop in Mogadishu for the manufacture of fittings such as pipes, sanitary ware etc.

Zone two

39. The industrial sector in Kenya is one of the most highly diversified in the region. It is however, still largely dominated by agriculture. Industrial activity in the coastal areas is small compared to that in Nairobi and the rest of the

40. Projected industrial developments in the coastal zones most likely to affect the marine environment and its resources in the period 1979-1983 include projects for the creation of new industries, as well as for improvement of existing ones, for example the rehabilitation of sugar production at Ramisi, the creation of a new cashew processing plant at Kwale and the construction of fish processing facilities at Lamu, Shimoni and Vanga.

41. Also planned are the creation of an industry to process and can fruits and vegetables in the coastal province. This industry will operate two cassava factories for the production of animal feed for export to Europe with a capacity of 60,000 t per year. Other factories will process pineapples, mangoes, mushrooms and other foods.

42. It has been suggested that industrial development in Seychelles is constrained by such conditions as limited natural resources, limited infrastructure for industrial activity, in particular in the scientific and technological fields and in standards and quality control; shortage of skilled and unskilled labour and management; and shortage of financial resources. However, considerable efforts are being made on several fronts. The first steps have been taken in the establishment of a scientific and technological infrastructure through the creation of a Research and Development Division within the Ministry of Planning and Development. This Division has at its disposal partially equipped meteorology, chemistry and physics laboratories to permit it to achieve its objectives of innovative research and adaptive development.

43. Research and development work has been undertaken in new and renewable sources of energy to substitute the oil presently imported for the country's energy requirements. In particular the following projects are being looked into:

- development of a producer gas plant using wastes from the coconut industry to generate electricity. This project is particularly useful in the context of the outer coral islands;

- development of low-cost solar water heating systems;

- development of a biogas system adapted to the geophysical condition of the islands. This project is particularly useful with regard to the outer coral islands where there is a danger of contamination of the underground water lens through use of untreated animal feaces as manure;

- a very promising pre-feasibility study has been completed on the micro-hydroelectric potential of Mahé;

- a study of the wind energy potential of the archipelago is being undertaken;

- on a longer term, the possibility of generating electricity by an ocean thermal energy convection system on a macro-scale is being considered for Mahé and nearby granitic islands.

44. Studies have been initiated and work started in order to process as much as possible of the available local raw materials:

- a fruit and juice canning industry has been constructed at Pointe la Rue, Mahé,

- an integrated carbonization pre-feasibility study has just been completed. This project aims at producing activated carbon from coconut shells for export, and pyrolysis-oil and charcoal from forestry and saw mill wastes. This project will provide the country with a new high value export product and will boost the declining copra industry;

- studies are being undertaken to assess the clay deposit with a view to setting up a small-scale ceramics industry;

- a chicken farm is under construction in Mahé and will produce broilers for the chicken abattoir using the premises of the former Laiterie des Iles de Mahé.

Great efforts are being put into producing more food - vegetable crops, fruits, animal rearing and fishing - for both domestic consumption and for export.

Zone three

45. Industrial development in Comoros is limited by many conditions. Prominent among these are the shortage of raw materials, the absence of minerals, lack of investors, lack of skilled manpower, limited transport infrastructure, limited energy resources and a small local market. Regardless of these limitations, serious efforts have been made to develop a realistic industrial sector which is small but can develop and diversify within the constraints. A number of project studies carried out to assess the industrial potentials of various resources have indicated the potential for industrial projects.

46. The project to manufacture poultry feed integrates with four other existing small-scale industrial projects including the setting up of a grinding mill, and the manufacture of fish flour, of coconut oil and of corn flour. Other small-scale industrial projects for which studies have been completed and financing is being sought included the manufacture of salt from sea water, manufacture of rubber shoes, mattresses and paints, and modernization of the soap factory. Projects still being considered include the manufacture of agricultural machinery and a maintenance workshop.

47. In Mozambique, development is oriented towards stimulating industrial activity based on the country's agricultural, mineral and energy resources. A number of detailed studies of industrial projects have been carried out in all the major sectors and some projects are already being executed.

48. Development involves rehabilitating or creating industries to raise the level of mechanization of agriculture, creating the basis for heavy industries (steel, cast iron, aluminium), mining, stimulating export-oriented industries (fish, cashew-nuts), and developing industries which would provide goods for local consumption. Most of Mozambique's industries are concentrated in Maputo and Beira and these developments will definitely affect the marine environment.

49. A number of industries of Tamatave, Madagascar[2/], are located on the Pangalanes Canal. There are plans to dredge the portion of the canal as part of a general project for the collection, treatment and disposal in the canal of urban and industrial wastes. FAO has conducted studies on opening the canal to the sea to improve canal use.

50. Further developments of interest in Tamatave include planned dredging of the port and the construction, now underway, of silos at the port for grain storage. The industrial aspects of the general development plan of Tamatave and the other coastal towns of Madagascar were not available.

Zone four

51. Solid-waste dumping at the Rachoir Dump just outside Port Louis, Mauritius at the estuary of the Terre Rouge Stream is part of a project to reclaim the highly silted area (at the mouth of the stream) known as "Mer Rouge" for an industrial zone to be reserved for raw materials processing industries. Details of the exact nature of the industries were not available.

INDUSTRIAL WASTE TREATMENT AND DISPOSAL PRACTICES

Introduction

52. The need to treat industrial wastes before discharging them into the environment or municipal sewers comes out of concern for the environment and the implications for human health and well-being. This concern varies widely with the level of environmental awareness and the risk of environmental damage likely to be caused by the untreated waste. The damage or environmental impact of the slowly accumulating waste may also depend on the raw materials and production techniques.

53. The production of waste by industry is inevitable. As such, waste treatment should be a routine requirement where the danger of environmental damage exists. This danger can, however, be avoided or greatly reduced by siting industries together and away from urban centres in appropriate industrial zones where they are likely to take advantage of important facilities necessary for production and waste management.

54. The level of industrialization varies quite widely in going from one country to another. The variation is due to several important factors such as available raw materials, available capital, level of technological manpower, economic infrastructure, etc. Certain industries are, however, common to a number of countries in the region and their industrial technology as well as wastes and waste handling practices can be expected to be similar.

Case studies of particular industrial installations

Slaughter houses

55. The slaughter house is situated about 100 m from the shores of the Indian Ocean. Cows (175 per day), camels (45 per day) and sheep and goats (240 per day) are slaughtered, year round, on concrete slabs in large hangers. Blood and offal is washed off and drained into a receiving tank connected to a chain of open oxidation ponds by a large sewer. Blood, stomach contents and small scraps of meat are washed off the slabs into the collection tank. From there they travel through a buried sewer with several inspection chambers towards the oxidation ponds. The inspection

Breweries

56. Started in 1973, the brewery at Mahé produces beer (30,000 hl), stout (15,000 hl) and nine different soft drinks (30,000 hl) annually, mainly for local consumption. Its fermentation tanks are cleaned weekly. Other containers are cleaned monthly, using water. Bottles are cleaned with a 2.5 per cent caustic soda solution that is recycled about 14 times before disposal. The factory uses about 34 t of caustic soda annually and protein-based glues for use as labels on bottles, as well as 8,000 m^3 of water per month.

57. All waste water from washings is combined in a large receiving septic tank connected by a sewer line to a nearby beach where it is discharged into the sea through a 200 m outfall. Water used in brewing is analysed and treated but waste waters are not analysed. There have been no complaints from local residents.

Distilleries

58. This distillery at Salimini, about 150 years old, extracts fragrant essential oils (essence) from the flowers of the ylang-ylang tree. The oils are used as stabilizer in the manufacture of perfumes. Other oils, including lemon grass, palmarosa, basil, jasmin and cloves, are extracted. There are 32 small private distilleries, in addition to those mentioned in annex II, which produce over 120 t of oil yearly.

59. The ylang-ylang flowers are weighed and introduced into large commercial extractors and steam distilled. The vapours are condensed and the floating oils collected in fractions. The steam is generated from wood-fired boilers. The hot condensate water is recycled in the alembics.

60. After extraction (about 3 hours) the flower residues, recycled water and cooling water (sea water from a storage tank) are released into a small outside collection basin. The temperature of the mixture is about 50°C. From the basin the waste water and plant residues flow via a narrow open canal into the beach, about 200 m away. The canal is cleaned regularly and the recovered plant residues used in agriculture as manure. Effluent water at the outfall was about 40°C. However, the impact on the environment is localized and not significant.

Textile mills

61. The textile mill at Maputo is about 8 km from the coast and about half a kilometre from the Matola River. The mill (one of five in Mozambique) produces about 9.5 million m^2 of finished printed cotton fabrics a year from raw local cotton, mainly for the local market. It went into operation in 1973.

62. About 1,000 t per month of caustic soda is used, as are other chemicals such as acids, dyes, wetting agents, water-treatment chemicals, detergents and starch. Effluents from the various units of the mill (washing, bleaching, drying, printing, rinsing, design etc.) are collected and drained into a large treatment tank (about 15 m x 6 m x 3 m). The sedimentation tank has three portions, two small partitions at either end and a large central chamber. The effluent flows to an evacuation sewer leading to the Matola River. The sludge is regularly removed and burnt.

63. Despite this treatment, excessive foam was formed as the effluents passed into

evident and the dye colour marked the course of the discharge in the slow moving river water.

64. Thus the treatment of effluents by sedimentation alone is inadequate. Studies on the effluents entering the Metola River have shown that the effluents from the textile mill have a pH of 11.86, caused by the large quantities of caustic soda used by the factory.

Sawmills

65. There are a number of sawmills in the region producing timber for local furniture and construction, and for export. Besides the few pulp and paper mills found in the region, sawmills are the principal industry for the exploitation of the large forestry reserves of the region. Although the industry has not been developed to nearly the same extent in all the countries of the region, exploitable forestry reserves with a rich variety of hardwoods are found throughout the region. Exploitation has been largely unsystematic and unplanned resulting in deforestation and extensive surface erosion and siltation of river estuaries and coastal waters.

66. Sawmills are often located on rivers on or near the coast to facilitate the transportation of logs to the mill and the handling of finished products and wastes. The logs are cut in the forest and quite often floated on the river down to the mill. At the mill the logs are sawn into timber and the shavings are discarded into or near the river or coastal waters. Depending on the purpose for which it is intended, the timber is treated with appropriate preservative chemicals and dried before being released to the local market or for export.

67. Sawmills were visited in Comoros and in Seychelles. In a sawmill that produces about 1,000 tonnes of sawn timber a year, a commercial chemical product know as "Celcure A" containing 18.7 per cent Arsenic pentoxide hydrate, is used in the curing of the timber. About 4 tonnes of the chemical is used a year. A solution of "Celcure A" is prepared and placed into the treatment tank containing the wood to be treated. It is left in contact with the wood for a number of days after which the remaining solution is drained into a receiving tank and re-used. The treatment tank is washed every three months and the washings and spent solutions released via an evacuation duct into the nearby coastal waters. Accidental spillages from the treatment tanks are possible and are reported to have occurred before.

68. The sawdust is picked up for various uses, e.g. gardening, mixed with soil for flooring, burning, etc. Excess sawdust just piles up and is occasionally carried off in surface run-off following rainstorms into nearby coastal waters.

69. The following are general recommendations for better waste management in the industries visited and described above.

Slaughter houses

70. The blood and offal should be systematically collected and processed into animal feed. Stomach contents could be collected for use as manure or for biogas. The present method of waste disposal is expedient but creates more problems and is wasteful.

Breweries

premises also contribute to pollution and should be considered in the waste treatment procedure.

Distilleries

72. The decomposition of cooked plant residues in the effluents produced obnoxious odours. This and other problems due to the effluents, such as heat and dissolved organic and suspended matter, would be greatly reduced by filtering to remove the plant residues for use as manure, and by cooling and treating the effluent by use of a proper oxidation pond or sedimentation tank.

Textile mills

73. Analysis of effluents to determine and apply appropriate treatment, a more elaborate treatment process, including pretreatment of effluents from certain units and recovery of certain materials from wastes should be considered.

Sawmills

74. The use of the arsenic pentoxide containing compound should be eliminated due to the toxic nature of the arsenic.

CONCLUSIONS AND RECOMMENDATIONS

75. The following conclusions may be drawn from information obtained on industrial pollution in the East African region:

(a) industrial activities do not now cause regional pollution problems as the level of industrial activity in the region is very low. Industry does, however, contribute to pollution problems in a few isolated cases. Due to the steady increase of investment for industry an increase in pollution problems is to be expected;

(b) the industrial pollution that there is at present in the region comes mainly from agro-industries, which are the largest industrial sector in the region and highly oriented towards the processing of local raw materials;

(c) treatment of industrial wastes, before discharge into the environment, is rare. Although a few of the newer industries have some waste treatment facilities, wastes are generally directly dumped or discharged into rivers, streams, lagoons or coastal waters.

76. In view of the above remarks and conclusions, and in addition to those recommendations made at the end of the previous section, it is hereby recommended that:

(a) there be a detailed, and systematic survey of industrial activities in the region;

(b) increased assistance be provided to the countries of the region by

(c) in formulating regional action plans, Governments of the region should undertake appropriate measures to assess present levels of pollution in the environment, identify sources of pollution and establish the assimilative capacity of the environment, so as to provide a sound basis for the formulation of suitable guidelines for waste treatment and standards for discharge and periodic monitoring. Governments should formulate or update and enforce regulations necessary to control, reduce and ensure proper management of pollution-generating activities. Governments should also institute environmental considerations in development planning, using information from those Government departments and those public sectors concerned.

Annex I

CLASSIFICATION SCHEME OF THE INDUSTRIAL SECTORS

REPRESENTED IN THE REGION

Raw Materials or Process	Product
Primary Processes	
Ripe fresh beans	Coffee
Fresh sisal leaves	Sisal fibre
Raw cashew nuts	Roasted nuts
Seeds	Edible oils
Cows	Beef
Various plants	Oils (essence)
Secondary Processes	
Sugar cane	Sugar
Vegetable oils	Soap
Fruit juices	Wines
Latex	Rubber
Skins	Leather

Annex II

ENTERPRISES AND PRODUCTS IN COMOROS

Enterprise	Product
Société Anonyme de la Grande Comore (SAGC)	Timber, logs
Société Comorienne de Bambao (SCB) Distillery	Cloves, vanilla, essential oils
Etablissement Grimaldi	Essential oils
Etablissement Kalfane	Essential oils
Savonnerie Comorienne de Moroni (SAVOCO)	Soap, table oil
L'Industrie Comorienne du Cocotier	Copra
Société de Patsy à Anjouan	Soft drinks

Annex III

ENTERPRISES AND PRODUCTS IN KENYA (MOMBASA)

Enterprise	Product
Coast Saw Mills Ltd.	Timber, doors, furniture
Coastal Industries Ltd.	Cotton seed oil, copra, cakes
Kisumuwala Oil Industries Ltd.	Vegetable oil, soap
Naushad Trading Co.	Crude coconut oil
Kilifi Cashew Nut Factory (Kilifi)	Cashew nuts
African Cotton Industries Ltd.	Cotton wool, towels
Jethabhai Industrial Works	Soap
Tombooth Ltd.	Skins, hides
Umoja Rubber Products Ltd.	Shoes, rubber goods
Ramisi Sugar Factory	Sugar
AAN Industries Ltd.	Toilet paper, napkins
Blankets Manufacturers (Kenya) Ltd.	Blankets
Bamburi Portland Cement Co. Ltd.	Cement
Cable works Ltd.	Roofing felt, adhesives
Cables & Plastics Ltd.	PVC pipes, cups etc.
East African Match Co. Kenya Ltd.	Matches
E.A. Paper Bag Manufacturers Ltd.	Envelopes, bags
The Eastern Chemicals Industries Ltd.	Sodium silicate, glass

(Annex III continued...)

Enterprise	Product
Kaluworks Ltd.	Aluminium, plastics, enamelware
Kenya Glassworks Ltd.	Glass bottles
Polytabs Ltd.	Polystyrene, polyurethane
Salt Manufacturers of Kenya Ltd.	Sea-salt extraction
E.A. Oil Refinery	Petroleum fuels
Towel Manufacturers Ltd.	Cotton towels
Asodia Steel Fabricator Ltd.	Farm machinery
African Marine & General Engineering Co. Ltd.	Ship repairs, foundry
Brollo Kenya Ltd.	Steel pipes, sheets etc.
Corrugated Sheets Ltd.	Sheets (galvanized)
Crown Paints & Building Products Ltd.	Paints, pipes, fittings
Doshi Enterprises Ltd.	Cold-rolled steel, plates etc.
Kenya Casements Ltd.	Steel, Aluminium doors, windows
Kenya United Steel Co. Ltd.	Steel bars, wires etc.
Kenya General Industries Ltd.	Iron sheets, gutters etc.
Kenya Asbestos Cement Co. Ltd.	Corrugated sheets
Metal Galvanizers Ltd.	Galvanized buckets
Nashidas & Co. Ltd.	Aluminium and steel utensils
Steel Africa Ltd.	Steel coils, sheets
Van Leer East Africa Ltd.	Metal drums, pails

Annex IV

ENTERPRISES AND PRODUCTS IN MADAGASCAR

Enterprise	Product
Anteranana (Diego-Suarez)	
Sirama	Sugar
S.N.B.C.E.	Sugar, alcohol
Manivico	Meat
Cosalimad	Salt
Scim	Oil, soap
Mahajanga (Majunga)	
Kaderbay	Edible oil
Seim	Oil, soap
Famako	Fish, shrimps
Somapeche	Fish
Fitim	Jute bags
Jerybo	Hosiery, weaving
Sotema	Textiles
Chandrana	Soap, oil
Gib	Oil, soap
Cimenterie d'Amboanio	Cement

(Annex IV continued...)

Enterprise	Product
Toliara (Tuléar)	
S.N.H.U.	Oil, soap, foods
Sifor	Bags, rugs, cords
Sumatex	Textiles
Eninjara	Galvanized sheets
Sica	Oil, rice
Zema	Fertilizers
Toamasina (Tamatave)	
Tamalu	Aluminium utensils
Macoma	Galvanized roofing, sheets, nails
Somalaval	Paints
Sovema	Glass bottles
Sosimae	Enameled utensils
Elge	Packing cartons
S.M.R.	Petroleum refinery-fuels
Zeren	Fertilizers

Annex V

ENTERPRISES AND PRODUCTS IN MAURITIUS

Enterprise	Product
Grand Textile Co.	Textiles (integrated)
Mauritius Paper Ltd.	Newsprint
Simplex Mills Ltd.	Woollen blankets
Premier Footwear Industries Ltd.	Tennis shoes
Modern Industries	Retreaded tyres
Mauritius Jute & Textile Industries Ltd.	Jute and jute bags
Years Producers (Mauritius) Ltd.	Baker's yeast
Blue Marlin	Towels, napkins
Mauriplastics Co. Ltd.	Plastic bags
Ramthor Textile Co. Ltd.	Textiles (printing), synthetics
Mauritius Breweries Ltd.	Beer, ale, stout
Maurco Ltd.	Paints (oil, emulsion)
Grewals (Mauritius) Ltd.	Timber
Mirovere Ltd.	Mirrors, stained glass
General Development Co. Ltd.	Steel products
Nabee Industry Ltd.	Nails, metal doors, windows
Bata Shoe Co. (Mauritius) Ltd.	Footwear (plastic, rubber)
Perfection Dry Cleaners	Dry cleaning

(Annex V continued...)

Enterprise	Product
Retreaders Ltd.	Retreaded tyres
Mauritius Cosmetics Co.	Toothpaste, perfumes
Blanche Birger (General Industry) Ltd.	Paints, furniture
Mauritius Oil Refineries	Vegetable oil
Margarine Industries Co. Ltd.	Margarine etc.
Paper Converting Co. Ltd.	Toilet, sanitary paper
Malrebourg Paints Co. Ltd.	Cement, paints
Electric Starter & Storage Batteries Ltd. Batteries Ltd.	Batteries
Jet Industries Ltd.	Steel
Plyform Ltd. (Sayed)	Plastic (expanded)
Marine & Tar Products Co. Ltd.	Antifouling
Mauritius Tuna Fishing & Canning Enterprises Ltd.	Tuna fish canning
Detergents Ltd.	Detergents
Mauritius Paints Ltd.	Paints, plastic, emulsion
Mauritius Pharmaceutical Manufacturing Co. Ltd.	Pharmaceutical products
Rubber Industries Ltd.	Retreaded compounds
Mauritius Confectionery & Biscuit Manufacturing Co. Ltd.	Sugar confectionery
Cernols Chemicals Ltd.	Industrial chemicals
Dehydration Industries	Vegetable, fruit dehydrated
Aluminium Enterprises Ltd.	Aluminium ware, steinless steel ware

(Annex V continued...)

Enterprise	Product
Plastic Industry (M) Ltd.	Plastic goods
Food Canners Ltd.	Food, fruit canning
Gilbeys (Mauritius) Ltd.	Gin, vodka, other liquors
Everbright Dry Cells Ltd.	Dry cell batteries
Ship Breaking Steel Rolling Mill	Steel bars
Mauritius Rice Milling & Allied Industries	Rice (milling)
O.K. Distillery	Rum, alcohol
Maurifoods Ltd.	Vegetables & fruits processing
Grains & Feed Milling Co. Ltd.	Vegetables, grains processing
The Mauritius Chemical & Fertilizer Industry Ltd.	Chemical fertilizer
Plastic Pipes & Products	PVC pipes
Colourlab Ltd.	Film processing
Roselyn Cottage Farm Ltd.	Chicken meat
Paper Containers Co. Ltd.	Paper bags
Iron & Steel Co. Ltd.	Steel bars
Marbella Ltd.	Tiles
Mauritius Molasses Co. Ltd.	Molasses
Mauritius Portland Cement Co.	Portland cement
Medine Sugar Estates Co. Ltd.	Sugar
Ferney Sugar Estate	Sugar
Flacq United Estates Ltd.	Sugar

(Annex V continued...)

Enterprise	Product
New Goodwill Co. Ltd.	Wines, rum
Omega Wine Factory Co. Ltd.	Wines
Oxenham, E.C. & Co. Ltd.	Wines
Alliance Spinners Ltd.	Textiles
United Batteries Co. Ltd.	Batteries
Livestock Feed Ltd.	Animal feed
Mon Loisir Sugar Estate Ltd.	Sugar
Serix Ltd.	Textile printing

Annex VI

ENTERPRISES AND PRODUCTS IN SEYCHELLES

Enterprise	Product
Bel Ombre Engineering	Tyre retreading
Jwan Jetha & Co.	Coconut oil, ice cream
Kim Koon & Co.	Soap
A. J. Albert	Essential & aircraft oils
Seychelles Breweries	Beer, sodas, wine bottling
Chelle Plastics	Plastic products
Tropicolor	Paints (oil, emulsion)
Uwe Industries	Plastic products, chemicals, cosmetics
Glacis Distributors	Liquid soap
Seychelles Timber Co.	Timber (furniture, construction)
Sader Rassool	Coconut oil
Andre Monder	Essential oils
Harry Berlouis	Essential oils
Petit and Dumbleton	Cement, tiles
A. Chetty	Essential oils
Tradewind Smokeries Ltd.	Ham, sausages, fish processing
Abattoir de Mahé	Beef

Annex VII

ENTERPRISES AND PRODUCTS IN SOMALIA (MOGADISHU)

Enterprise	Product
Mogadishu Oil Mill	Coconut, cotton, seed
Pasta Factory	Flour, noodles
Kilometre 7 shoe & Tanning Factory	Leather, shoes
Hides & Skins Agency	Leather
Bayl, Mogadishu	Soap, detergents
Mogadishu Milk Factory	Milk
Kismayo Meat Factory	Meat, corned beef
Kismayo Tannery	Leather
Mogadishu Meat Factory	Meat
Mogadishu Soft Drinks and Soda Factory	Fruit juices, sodas
Cigarette & Matches Factory	Matches, cigarettes
Mogadishu Foundry & Mechanical Workshop	Cast iron, Aluminium, steel
Aluminium Utensils Factory	Aluminium utensils

Annex VIII

ENTERPRISES AND PRODUCTS IN THE

UNITED REPUBLIC OF TANZANIA

Enterprise	Product
Dar es Salaam	
Tanzania Portland Cement Co. Ltd.	Portland cement
Friendship Textile Mill	Textiles
Kilimanjaro Textile Mill	Textiles
Tanganyika Dyeing & Weaving Mill	Textiles
Calico Textile Mill Ltd.	Textiles
Texwell Mills Ltd.	Textiles
Afro Textiles Ltd.	Textiles
Coast Textiles Ltd.	Textiles
Textiles Manufacturers of Tanzania	Textiles
National Knitwear Industries	Textiles
Tanzania Breweries	Beers
Darbrew Ltd.	Beers
Tanzania Distilleries Ltd.	Liquors
Bobby Soap Industries Ltd.	Soap, detergents
Farmal Industries Ltd.	Soap, detergents
Soap & Allied Industries Ltd.	Soap, detergents

(Annex VIII continued...)

Enterprise	Product
Mansoor Daya Ltd.	Chemicals
Hoerst Ltd.	Chemicals
Saps Chemicals Ltd.	Chemicals
Shell Chemicals Ltd.	Chemicals
Robiallac Paints Ltd.	Paints
Sadolin Paints Ltd.	Paints
Leyland Paints Ltd.	Paints
Kioo Ltd.	Glass
Simba Plastics Ltd.	Plastics
Cortex Metals Ltd.	Plastics, metals
Tegny Plastics	Plastics
Ache Muedo Ltd.	Plastics
N.C.G. Chemicals Ltd.	Plastics
Banco Products Ltd.	Plastics
Tropical Foods Ltd.	Plastic bags, cups etc.
Rubber Industries Ltd.	Plastics
Tanzania Shoe Co. Ltd.	Shoes, rubber goods
Mt. Carmel Rubber Trading Ltd.	Shoes, rubber goods
Tanganyika Retreading Co. Ltd.	Tires, retreads
Rajani Industries Ltd.	Tires, retreads
Kunduchi Salt Works	Table Salt from sea water
Tanzania Chemical Industries Ltd.	Acids

(Annex VIII continued...)

Enterprise	Product
Keko Pharmaceuticals Co. Ltd.	Insecticides
Shellye Ltd.	Food processing
Tropical Products Ltd.	Food processing
National Milling Corporation Ltd.	Fruit canning
Tanitai II	Cashew nut factory
Tangayika Packers Ltd.	Meat processing
Vingunguti Abattoirs	Meat processing
Tropical Products Ltd.	Food processing
Vitamin Foods Ltd.	Food processing
Tomango Food Products Ltd.	Food processing
Tanzania Dairies Ltd.	Food processing
Tanzania-Italian Petroleum Refining Co. Ltd.	Petroleum fuel
Aluminium Africa Co. Ltd., Steel Cast Division	Steel
Tanga	
Tanga Cement Co. Ltd.	Cement
Sabuni Industries Ltd.	Soap
T.I.P. Soap Co. Ltd.	Soap
Shell Craft Ltd.	Sodium silicate
Tanzania Fertilizer Co. Ltd.	Fertilizers
Pangani Salt Works	Table salt
Steel Rolling Mills	Steel (building)

(Annex VIII continued...)

Enterprise	Product
Lindi	
Cashew Nut Factory	Cashew nuts
Rafiki Saw Mills	Timber
Regional Water Office Workshop	Repair shop

Annex IX

EMPLOYEES BY INDUSTRY IN MOZAMBIQUE

Industry	Number of employees	
	Government	Private
Cement	1 612	-
Flour and Sweets	1 457	1 299
Footwear	1 299	1 116
Glass	1 243	-
Hygiene Products	221	245
Matches, Pesticides, Fertilizers	405	402
Mechanical Construction	2 334	980
Metallurgy	1 043	780
Oils (fats)	1 310	1 915
Paints	145	126
Paper	768	77
Petroleum	1 130	-
Plastics	672	387
Rubber	600	00
Salt	3 500	2 150
Soft drinks	3 476	-
Sugar	37 326	5 480
Textiles	1 729	11 242

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