



# Eastern Africa Atlas of Coastal Resources



# TANZANIA

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A project of the United Nations Environment Programme with the support of the Government of Belgium

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# Eastern Africa Atlas of Coastal Resources

## Tanzania



United Nations Environment Programme



Directorate-General for International Cooperation (DGIC)  
Ministry of Foreign Affairs, External Trade and International Cooperation  
Kingdom of Belgium



United Republic of Tanzania

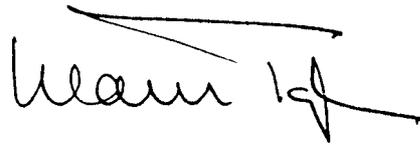


Institute of Marine Sciences, University of Dar es Salaam  
Zanzibar, Tanzania

The Government of Belgium, through its Directorate-General for International Cooperation, and the United Nations Environment Programme are pleased to be associated with this worthwhile project under the auspices of the Division of Early Warning and Assessment. We have always had a special interest in the Eastern African Action Plan activities and we see this project as providing a sound information management basis for the sustainable management of the coastal and marine resources of this region.



H. E. Mr Leo Willems  
*Ambassador of Belgium in Nairobi,  
Permanent Representative to UNEP*



Klaus Töpfer  
*Executive director  
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# Foreword

Tanzania has over 800 km of coastline, characterised by a mixture of beautiful sandy beaches, rocky outcrops, extensive coral reefs, and dense mangrove stands, especially around river deltas. Among the more famous of these natural resources are the beaches of Bagamoyo, the Jozani Forest Reserve, the coral reefs of Mafia, Zanzibar and Pemba, and the Amboni Caves. These coastal ecosystems support a wide variety of marine life. In addition, the coastal area's historical attractions, including old buildings, ruins, and monuments, particularly those in Zanzibar and Bagamoyo, are among the finest in the region. It is also rich in cultural attractions, mainly related to people's values, customs and traditions.

Coastal resources are valuable assets to the country and the coastal and marine environment provides numerous opportunities, thus encouraging concentrations of people and development activities there. In Tanzania over 20% of the population lives in its five coastal administrative regions, which encompass about 15% of the country's land area. These areas are subjected to increasing pressures from a variety of activities, such as fishing, coastal aquaculture, salt making, waste disposal and the indiscriminate cutting of mangroves and coastal forests for fuel and timber.

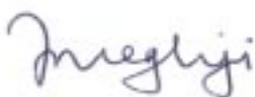
Environmental challenges such as marine pollution, the use of destructive fishing methods and over-fishing, habitat destruction, coastal erosion and coastal urbanisation are highly complex issues, and require an integrated approach to address them. In this regard, the availability of relevant information and expert advice from various disciplines is necessary for the formulation of appropriate management actions. A number of marine environmental studies have been conducted in the country on aspects such as fisheries, mangroves, coral reefs, erosion and coastal tourism, among others. However, most of the information generated is not accessible for management purposes.

Through the Eastern African Coastal Resources Database and Atlas project, some of the data and information gathered have been processed and transformed into base maps on land and water use and functional zones using geographical information systems (GIS). Other data and information have been stored in the database established at the Institute of Marine Sciences of the University of Dar es Salaam and will be updated regularly. The database will help in achieving improved description, assessment, analysis and management of environmental issues.

This Atlas of marine and coastal resources in Tanzania is designed to raise the awareness and understanding of non-specialists, particularly decision makers, resource managers, students, and the general populace, on coastal and marine environmental issues and related challenges in Tanzania. It is written in non-technical language to make it easy to understand and use. It is hoped that the information contained in it will establish a new baseline of practical information to guide the research and planning of management initiatives in the coastal areas.

The book underlines the importance of the coastal and marine environment, not only as an environmental concern, but also as a political, social and economic issue. Used appropriately, I believe that it will go a long way in assisting decision-makers and resource managers in making informed decisions concerning the management of the coastal and marine environment. That is, decisions that will promote sustainable utilisation of resources for the benefit of present and future generations.

Lastly, I note with satisfaction that a number of individuals and institutions with different mandates and expertise have been involved in the implementation of this project and the preparation of this Atlas in particular. Such efforts are essential in laying the foundation for improved coordination and integration among institutions, and critical components for effective coastal management.



Hon. Zakia Hamdani Meghiji, MP.

MINISTER FOR NATURAL RESOURCES AND TOURISM

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Overall responsibility for EAF/14 project management and administration was based within the Division of Early Warning and Assessment of UNEP in Nairobi. The overall Project Coordinator was Mr Lieven Bydekerke with support from Mr. Dixon Warunge. The project coordinator also provided the structure for development and establishment of the GIS database and technical backstopping. The project assistant was Mr Mwangi Theuri who also managed the scientific nomenclature and scanning facilities.

The development of the coastal resources database and the geographic information system (GIS) framework were undertaken by the Institute of Marine Sciences (IMS) under Dr Julius Francis, the then Director of IMS and the Database Manager Mr C. Muhando. Africover Eastern Africa project of the Food and Agriculture Organisation of the United Nations was responsible for satellite imagery interpretation and land cover classification. Data entry and map digitising were done by Mr C.A. Muhando, Mr A.H. Kombo and Ms F. Mohammed.

The data were located, accessed and collated by the Tanzanian Working Group chaired by Dr Julius Francis the then Director of the Institute of Marine Sciences, who also acted as the In-Country Coordinator. The members of the Working Group were: Dr M. A. K. Ngoile, IMS, University of Dar es Salaam; Mr C. A. Muhando, IMS, University of Dar es Salaam; the late Prof. A. Semesi, Department of Botany, University of Dar es Salaam; Mr Mohammed Adam, Zanzibar Land Use Planning Unit; Mr A. Shindika, Division of Fisheries; Mr J. Daffa, National Environment Management Council; Dr C. Horril, Tanga Coastal Zone Conservation and Development Project; and Mr Gerald K. Mango, Physical Planning and Research, National Land Use Planning Commission.

The text was compiled from contributions by members of the Working Group as well as from Mr S. Mahongo and Dr Y. Mgaya. In addition, Drs J. D. Kabigumila and M. Kyewalyanga contributed to some of the sections and boxes. Language editing of the textbook was done by Drs A.Y. Mreta and H.R.T. Muzale of the Department of Foreign Languages and Linguistics, University of Dar es Salaam.

Photographs were taken by the late Mr Mussa Katembe (pp. 1, 5, 8, 20, 40, 50, 58, 72, 78, 85); Yusuf Khamis (pp. 18, 27, 45, 49, 51, 52, 56, 64, 76), Chris Muhando (pp. 9, 35, 37); Fabby Nielsen (p. 69); Mohamed Suleiman (pp. 65, 75); and Matthew Richmond (pp. 17, 30, 32, 36, 39, 39, 40, 98). The illustration on p. 77 was drawn by Mohammed Nur and the cover photo of rusting trawlers at Dar es Salaam Harbour is by Matthew Richmond.

The maps in this book were designed by Mr C. Muhando, A. H. Kombo, J. Francis and Lieven Bydekerke, and were based on data retrieved from the EAF/14 database in Tanzania, the World Conservation Monitoring Centre and the Environmental Systems Research Institute. The base maps were digitized from topographic maps acquired from the department of survey and mapping at a scale of 1:50,000.

Technical editing and layout was by Daisy Ouya, who was also responsible for production. Reproduction and Distribution Section, Division of Conference Services, United Nations Office at Nairobi was responsible for pre-press and printing.

# Introduction



Boarding canoes at Msemo Village in Mtwara

## THE EASTERN AFRICAN REGION

### The Coastal Environment

The eastern African region is comprised of Somalia, Kenya, Tanzania, Mozambique, Comoros, Madagascar, Mauritius, Seychelles and Reunion (France) whose coasts are washed by the waters of the western part of the Indian Ocean. The coastal and marine environment of the region contains diverse and valuable ecosystems such as coral reefs, seagrass beds, mangroves and beaches. Its coastal environment is characterised by ecosystems of high marine biodiversity and rich and diverse resources. Coral reefs and their associated ecosystems are the most biologically diverse of all the ecosystems. These ecosystems are the backbone of the livelihood of coastal communities and contribute significantly to the economy of the countries.

In the recent past, however, these ecosystems have started to show signs of degradation, attributed to both natural factors (leading to coral bleaching) and anthropogenic causes (such as pollution from both land- and marine-based sources, municipal and industrial waste). For instance, the coral reefs in the region are increasingly threatened by a number of factors, including destructive fishing methods, sewage and industrial waste. These factors, together with the coral bleaching event of 1998, have put the coral reefs of the region at great risk.

The issue of shoreline changes is increasingly becoming a major social, economical and environmental concern to a large number of countries in the region. About 12% of the total population of the mainland States (Kenya, Mozambique and United Republic of Tanzania) lives within 60 km of the shoreline. With a growth rate of 4–7% per annum including migration, the coastal population in the eastern African region exerts heavy pressure on coastal and marine habitats and resources. Economic activities such as agriculture and related industries,

tourism and mineral extraction also disturb and degrade natural conditions and processes. The capacity to manage coastal and marine environment degradation caused by human-induced activities (especially destructive fishing methods, sewage and industrial effluents discharges) and natural processes (that include coastal erosion, sea-level rise) has been greatly reduced in the region and the degradation of coastal resources and habitats comes with serious social and economic implications.

In general, widespread poverty, rapid population growth, destructive resource exploitation practices and inappropriate or poorly planned development, are among the major factors that have contributed to the growing environmental degradation observed in a number of places in the eastern African region. The transboundary and common nature of the problems that face the coastal and marine environment of the region calls for cooperation within an adequate legal and institutional framework for effective protection and management of this fragile ecosystem.

## The Eastern African Action Plan

In their endeavour to address the problems of their coastal and marine environments, the governments of the eastern African region came together under the framework of the Regional Seas Programme of the United Nations Environment Programme (UNEP) in 1985 and adopted the Eastern African Action Plan (also called the Nairobi Convention) and its two protocols. Eleven years later, in May 1996, the Convention and its related protocols came into force. The Regional Seas Programme at present brings together 13 regions of the world with over 140 coastal states and territories. In Africa 43 coastal states participate in four of the Regional Seas Programmes, of which nine are party to the Eastern African Action Plan. The Action Plan has been contributing to and developing a number of initiatives on the protection, management and sustainable development of the marine and coastal environment at different levels of governance.

The Nairobi Convention is geared towards an effective coordination mechanism for its implementation in a region-wide effort to ensure a harmonised approach in addressing the pressures and demands on Africa's coast through concerted intergovernmental dialogue. This is being achieved in part by putting in place comprehensive strategies, measures and structures for adequate coastal and marine area management, as recommended by the decisions of the Contracting Parties to the Nairobi Convention. To ensure sustainability the multiple demands on our coastal resources require the best management strategies and tools based on sound scientific information.

## THE EASTERN AFRICAN COASTAL AND MARINE ENVIRONMENT RESOURCES DATABASE AND ATLAS (EAF/14 PROJECT)

### Background

More than 25 million people — about a quarter of the total regional population—live in the coastal cities of eastern Africa. (Since there are few other opportunities for employment, they turn to the sea to make a living.) The eastern African countries have a narrow coastal plain generally between 10–20 km wide. The coastline has many towns and fishing villages, industries, farms and tourist resorts. This means that industrial and residential activities and the resultant pollution are concentrated in narrow coastal strips. Shallow continental shelves extend for only a few kilometres offshore before plunging down to 2000 metres.

The predicament that faces eastern African nations today is that while they are depending more and more on the coastal zone for their livelihood and well-being, the natural habitats and ecosystems which sustain these resources are being destroyed or stressed. Administrators and managers must seek to strike a balance between the many conflicting demands being made on the coastal environment, ensuring that its limits of tolerance for sustainability are not exceeded. In order to do this successfully, they need as a priority, a comprehensive information base giving them a holistic view of the resources, the demands, and the various

direct and indirect physical interrelationships. Such information will facilitate the harmonisation, implementation and monitoring of appropriate management strategies within an adequate legal framework for the sustainable development of the coastal and marine environment of the Nairobi Convention area.

One instrument that can help collate, analyse, synthesise and apply large amounts of information in a simple, visual representation is the electronic database organised on a geographic spatial basis. Its ability to put together resource data, demands, potential impacts and the various factors influencing them, on to a single, graphic representation makes an electronic database a most versatile and sound tool for decisions on resource use. Commonly referred to as geographic information systems, or simply GIS, the database is a computer-assisted system for the input, storage, retrieval, analysis and display of interpreted geographic and statistical data. The database is typically composed of a large number of map-like spatial representations.

Gradually, institutions in eastern Africa are gaining access to the hardware and software as well as the expertise needed to make full interactive use of the potential offered by an electronic GIS database. The EAF/14 project prepares the way for this eventuality by establishing a regional GIS database. The Tanzanian Coastal Resources GIS Database, located at the Institute of Marine Sciences, Zanzibar, is quite detailed and comprehensive. It is updated regularly and it is possible to retrieve from it the most up-to-date basis for decisions, especially in emergencies (e.g. spillages).

It is now becoming a basic task in any coastal resources management study that analysis of the resource base of the study area be made so that planning for its allocation and use can be done on a rational basis. The coastal GIS database has been developed on this basis, categorising the resources according to their types, extent and nature of use; an economic evaluation based on present and future uses; the socioeconomic characteristics and activities of the human communities which will be affected by resource use in the study area; and the impacts these activities have on the resource base and human communities. Such information forms the database on which future planning actions and policies can be formulated.

The established GIS database provides a convenient tool for resource assessment, planning and management because it can carry out a number of analytical functions, is integrative and spatial and can be updated easily. The data collated and input into the GIS are of various types and from various sources (conventional maps of different scales, aerial photographs, satellite imagery, tabular data and surveys). These data have been converted into a consistent internal format and scale within the GIS. The various map layers for a particular area have been geometrically registered with one another and with a base map. This conversion ensures in turn that the data can then be retrieved and outputted in the form of a consistent scale.

The GIS also facilitate overlays. For example, a delineated coastal zone map overlaid on a soils map. Calculation of area is one generic operation found in the coastal GIS. The GIS can also be used to integrate information about the environment and resources to determine areas that are suitable for a specific use. Similarly, it is possible from the coastal GIS database to prepare suitability maps for specific uses of a resource. Each resource sector (fisheries, forestry, agriculture and resource-based tourism and recreation) may be identified separately as a suitable area for its own use. It is essential that all these assessments be studied together and incorporated so that coastal resources can be put to optimal use with the minimum of conflicts in terms of impacts on the resources and on people—the coastal GIS easily helps in these.

It is also possible to make user-defined local maps from the GIS database to meet the specific needs of the coastal manager. The coastal GIS will therefore help the resource planner make trade-off decisions in resource allocation. The database that is already in the GIS will be used to determine the impacts of a particular decision or a proposed development. This, in turn, will help in deciding whether a certain resource allocation model is desirable in terms of its impact on the environment. The established GIS tool will not stop at the planning level.

As projects are implemented, the results and impacts on the resources can be monitored and the database updated from time to time.

While this GIS capability is likely to meet the current needs of a number of administrative institutions and some academic and research agencies in Tanzania, the electronic format of the database definitely keeps it beyond the reach of a large number of potential users. Therefore, the first, major substantive output of the database is an appropriate 'atlas' textbook produced for use as a working document. The Tanzania coastal resources publication is one of the volumes in a series of such publications in the eastern African region. This book is expected to become a major reference work for scholars and administrators alike.

Tanzania's decision-makers, planners, administrators, resource managers and their scientific advisers are identified as the prime users of the database and the textbook. They need access to comprehensive environmental information in order to help bridge the gap between scientific understanding of Tanzanian coastal processes and sound management of the environment. However, the production of the textbook in particular recognises the needs of those numerous other potential users, and it has been designed accordingly. The textbook can be used as a stand-alone text or together with the coastal resources GIS database located at the Institute of Marine Sciences.

In addition to being an excellent tool for professional managers of coastal resources, the GIS database and the publication works in other ways to enhance the protection and wise use of coastal resources. It is expected to expose weaknesses in the available information base thus helping to focus the research effort by experts; to inform and educate members of the public, making them more sensitive to the multiple issues that need to be resolved, rarely without some cost; and to provide an excellent record—and a subsequent measure—for policies, objectives and goals adopted for coastal zone management.

The beneficiaries of the GIS database and the coastal resources textbooks are the people of eastern Africa who, in the face of development, must make hard decisions affecting the coastal environment and its resources. For planning purposes, the database developed under the EAF/14 project covers a corridor of about 100 km of the coastal and marine environment stretching from Tanga in the north to Mtwara in the south. It is envisaged that the database of coastal resources and the associated textbook will meet the demands of the local policy makers, administrators, planners, developers, environmental resource managers, marine ecologists and the general public for synthesised and harmonised information on the coastal and marine environment in Tanzania. The EAF/14 project is confident that the increased accessibility to information is an important step towards the wise use and sustainable development of the coastal and marine environment of the eastern African region.

Eventually, the Eastern Africa Atlas of Coastal Resources will serve as the information base for the Eastern African Action Plan and the Tanzanian volume is a step forward in this direction.

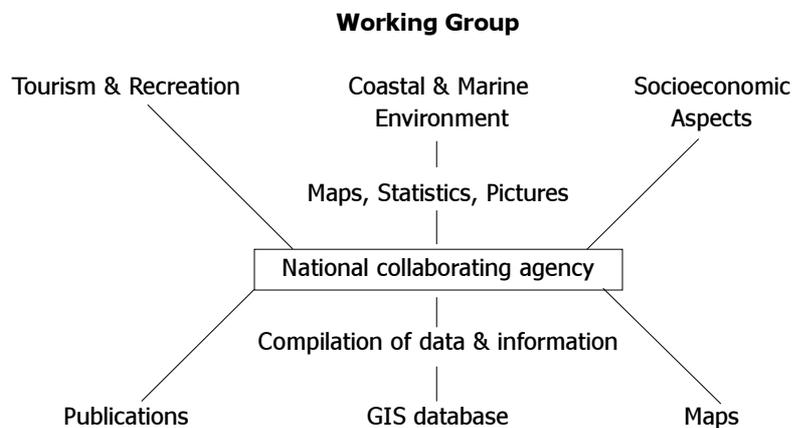


Fig. 1. Structure of the EAF/14 Project, as implemented in the countries

# PART 1

## The Coastal Environment

J. FRANCIS, S. MAHONGO AND A. SEMESI



The coastal village of Msanga Mkuu

### PHYSICAL CHARACTERISTICS

#### Climate

The climate of Tanzania can broadly be classified into four types: the hot, humid coastal plains; the hot, arid zone of the central plateau; the high, moist lake regions; and the temperate highland area. The climate is controlled mainly by two major factors:

- its geographical location within 1 °S–12 °S latitude, which creates a truly equatorial setting, with high temperatures, high humidity (60 to 80%), low wind speeds and absence of a cold season, and
- its position on the eastern edge of Africa, exposed to the large seasonal changes brought about by the general circulation of air over the Indian Ocean.

The monsoons have the dominant influence on wind direction and strength, temperature and rainfall, among others. The word 'monsoon' is derived from an Arabic word meaning seasonally reversing winds. There are two monsoon seasons, namely the Northeast monsoon (Kaskazi) which prevails from November to February and is characterised by higher air temperatures (> 30°C) and weaker winds, and the Southeast monsoon (Kusi) which lasts from April to

September and is marked by lower air temperature (approximately 25 °C) as well as stronger winds. Occasionally, the Southeast monsoons are associated with epidemic events such as storms and cyclones (Table 2). The months of March/April and October/November are the inter-monsoon periods and usually are the calmest. June and July are the windiest months while March, April and November experience the lowest and most variable wind speeds.

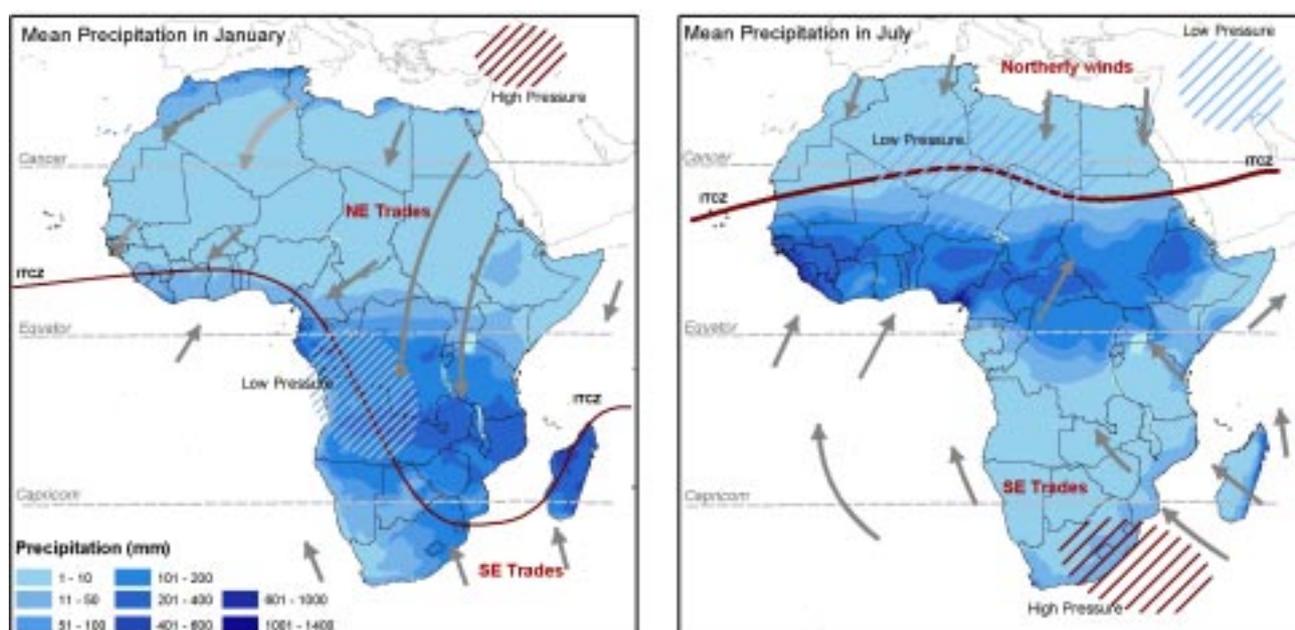
Date	Event	Affected Places	No. of Human Deaths
4 April 1872	Cyclone	Zanzibar, Bagamoyo	Not specified
15 April 1952	Cyclone	Lindi, Mikindani, Mtwara	34
1989	Tropical storm	Dar es Salaam	7
August 1994	Cyclone	Zanzibar	5 (children)

Mtwara, which is situated at the southernmost coast of Tanzania, probably experiences the highest wind speeds at the coast. The wind directions at this locality are predominantly northerly and easterly during the Northeast and Southeast monsoons respectively.

**RAINFALL**

Rainfall in the tropics depends mainly on the movements of the air masses that cover the globe. The sun is overhead at the Equator on 21 March, the Tropic of Cancer on 21 June, the Equator again on 21 September and the Tropic of Capricorn on 21 December. The sun’s heat causes a low-pressure zone that encircles the earth roughly parallel to the Equator and that moves north and south following the sun. This zone is often called the inter-tropical convergence zone (ITCZ). Map 2 shows the rough location of the ITCZ over the Indian Ocean in January and July.

The dry season that prevails in the northern coastal areas during the period January–February arises from the effect of the Northeast monsoons, since the air masses that move mainly over land, having originated from the dry Arabian Gulf, are dry. From March to May, the ITCZ has moved northward to the Equator such that the southern and northern air masses now converge over Tanzania and convection currents cause rainfall.



Map 2. Prevailing winds and approximate location of the inter-tropical convergence zone (ITCZ) over Africa, January (left) and July (right) (after Ker et al., 1978)

Between June and September, the winds turn and Southeast monsoons prevail. Although these have crossed the Indian Ocean, a dry period ensues as the high ground of Madagascar has caused most of the moisture to fall. By October, the ITCZ is on its way south and remains over Tanzania for a short while, bringing the short rains.

Besides being close to the Equator, Tanzania is generally rather dry, with more than half of the country receiving on the average less than 800 mm of rainfall per annum. The entire coastal area, which rises from sea level to about 200 m, has a mean annual rainfall ranging from 900 to 2000 mm. Rainfall increases northwards and it is highest on the islands. The island of Pemba receives the highest amount of rain (1916 mm/year), followed by Mafia (1877 mm/year) and Zanzibar (1565 mm/year). Lindi receives the lowest amount of rainfall (917 mm/year). Map 3 provides an overview of rainfall and windspeeds at the Tanzania coast.

Two types of rainfall regimes prevail on the Tanzanian coast:

- A unimodal type with a single annual maximum, generally between December and April, which prevails in the southern areas such as Mtwara, Lindi and Mafia. These areas receive the heaviest rains in April except Mtwara, which receives the heaviest rainfall in January. The rainy season in Mafia extends from November to May and the island receives the heaviest rains of 577 mm in April, which is the highest in the country.
- A bimodal type composed of a long rainy season (March–May) and a short one (November–December) which prevails in the northern areas such as Pemba, Tanga, Dar es Salaam and Zanzibar. The long rains are heavier than the short rains, while the heaviest rains are received in either April or May.

## Geology and Soils

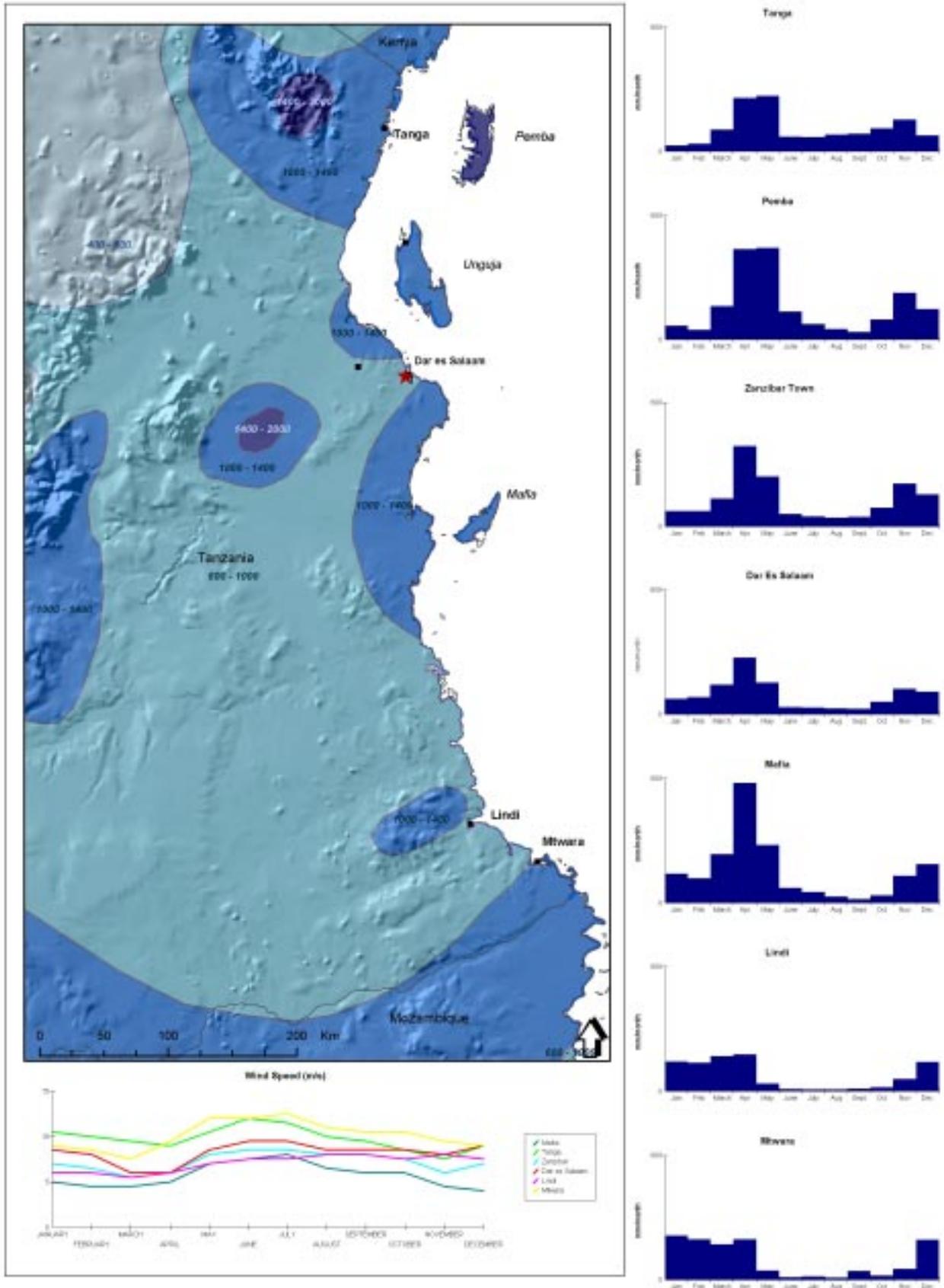
Most of the country lies on the Great African Plateau with altitudes ranging between 1000 and 2000 m above mean sea level, the exception being the narrow coastal belt. The coastal plains are composed of both marine and terrestrial sediments. If we refer to the Geologic Time Scale, which is simply a list of the ages of the earth and its past life forms, the ages of sediments range from Jurassic through Cretaceous to Tertiary and Quaternary (see Table 3 and Map 4). Much of the coast is of Pleistocene and Recent coral limestone. A belt inland from the coast, an area of continental and coastal deposition of Cretaceous and Tertiary period, includes limestone, sands and gravel. The marine rocks consist chiefly of marls, limestone and shells. The rocks of Zanzibar, Pemba and Mafia are composed of calcareous sediments with some marine clays, sandstone and coralline limestone and they range in age from Miocene to Recent.

Zanzibar and Pemba are part of the ancient Miocene Rufiji/Ruvu River delta. Due to periods of isostatic movement and block faulting over the coastal Tanzania and offshore deltaic zone, only Zanzibar, Pemba, Mafia and the Latham Island areas remain above sea level as land blocks of the original delta.

Tanzania is mostly underlain by rocks of igneous metamorphic origin, part of the crystalline complex that makes up the interior of Africa. Intense structural movements have caused a considerable variety of rock types.

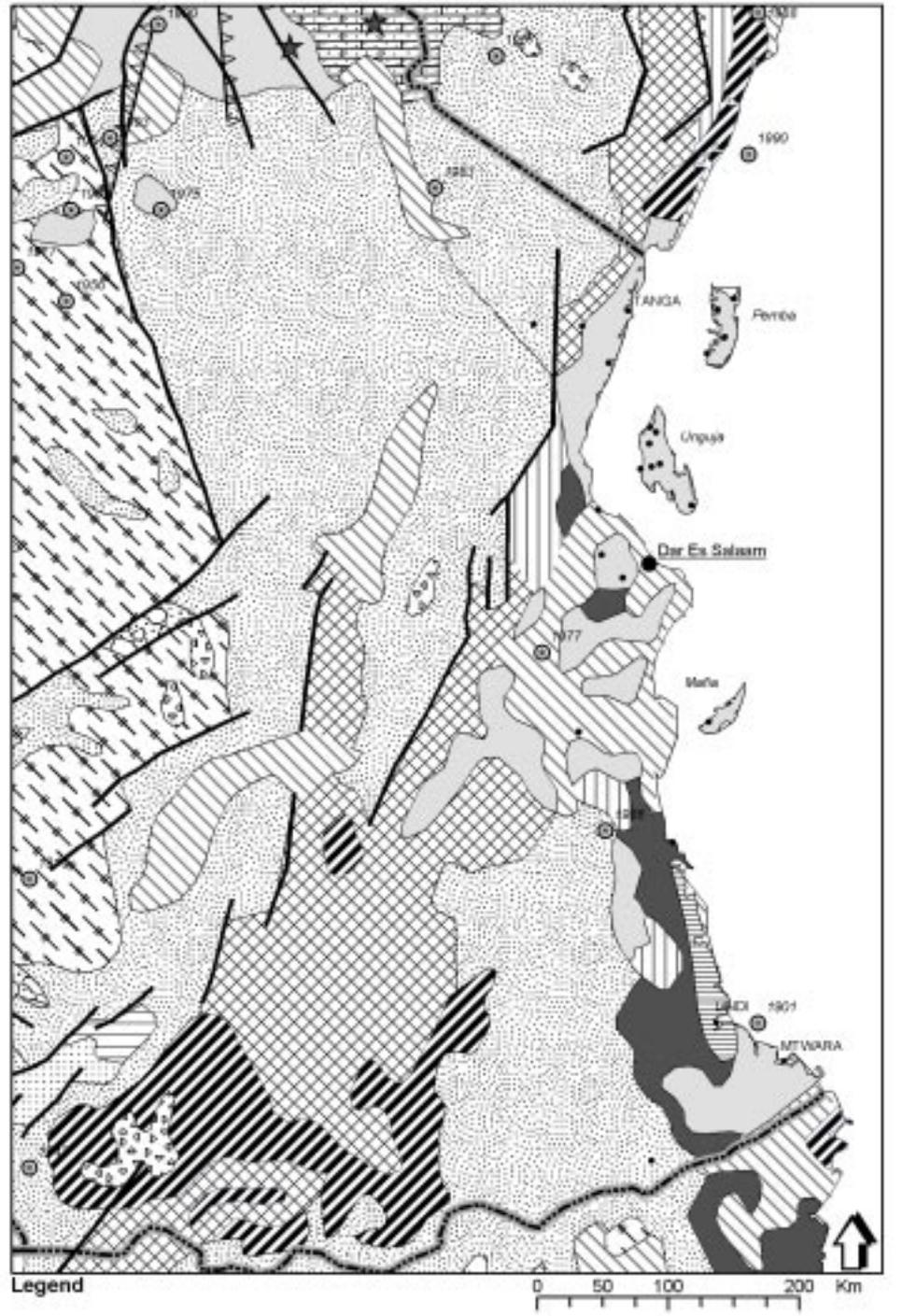
The soil types of coastal areas in Tanzania include: recently deposited alluvium that is mostly found in river estuaries; dark clays on older alluvial deposits which are found along the Rufiji Delta and Tanga; and grey bottomland soils, found mainly in the coastal plains.

The most fertile soils are found on river basins, in the volcanic areas and on alluvial deposits of volcanic origin. Loamy sand and sandy loam soils have high potential for agriculture while heavy clays, clay loam and sandy clay loam, usually associated with poor drainage and/or tillage problems, are of low agricultural potential. In the coastal area and islands, the soils are predominantly sandy and coralline with poor moisture-holding capacity, extreme alkalinity and hard subsoil, resulting in poor drainage.



Map 3. Map and graphs showing average annual rainfall distribution and monthly average windspeed

Era	Period	Epoch	Age (Yrs)	Life Forms	Major Geological Events Affecting Africa	
Cenozoic	Quaternary	Holocene	10,000	Modern life forms	Glaciation of East African Mountains. Widespread formation of river terraces and raised beaches.	
		Pleistocene	2 M	LAST ICE AGE, large terrestrial mammals, mammoths, mastodons, first modern man, cave paintings		
	Tertiary	Pliocene	7 M	First Australopithecines, tool-making, Neanderthals	Main period of volcanic activity in East Africa.	
		Miocene	25 M	Large sharks, whales, first hominids		
		Oligocene Eocene	40 M 55 M	First grasses, anthropoids First marine and large terrestrial mammals	Main period of East African rift faulting began, lava flows in Ethiopia.	
Paleocene			64 M	Many kinds of mammals		
	Mesozoic	Cretaceous		137 M	AGE OF DINOSAURS, molluscs, dinosaurs, first primates, flowering plants,	Deposition of marine sediments in many areas.
			Jurassic		195 M	First belemnites, squids, frogs, birds, salamanders,
Triassic				225 M	First turtles, cycads, lizards, dinosaurs, mammals	
Paleozoic	Permian Carboniferous	Pennsylvanian		280 M	First mammal-like reptiles	Ice Age in Central and South Africa.
				325 M	COAL AGE, first conifers	
		Mississippian		345 M	First reptiles, spiders	Crustal warping causing continental basins.
	Devonian		395 M	AGE OF FISH, first insects, ammonites, jawless fish, placoderms, amphibians		
		Silurian		440 M	First land plants, ferns, lycopods, sharks, boney fish	
	Ordovician		500 M	First corals, starfish, sea urchins, blastoids, eurypterids, bryozoa, scaphopods, vertebrates		
Cambrian			570 M	First trilobites, conodonts, forams, sponges, worms, brachiopods, nautiloids, chitons, clams, snails, monoplacophorans, crustacea, crinoids, cystoids, carpoids	Ice age in parts of North Africa	
	Archaeozoic	Precambrian		>570 M	First simple plants and invertebrate animals: algae, bacteria, jellyfish	Ancient mountain building period and ancient glaciations. Oldest recorded rocks are 3500 million years, from South Africa



Map 4. Geological map of coastal Tanzania (numbers indicate year of last earthquake)

From Bagamoyo to Mchungo, soils are only sandy with imperfect drainage. From Mchungo to Lindi, soils are essentially composed of clay (with imperfect drainage) with some loamy sand enclaves (about 10% of the coastal length). From Lindi to the Tanzania-Mozambique border, soils are sandy (50%), loamy sand (25%) or clay (25%), with mainly imperfect drainage. Some areas like Kunduchi, Msasani Peninsula to Mjimwema in Dar es Salaam, as well as most parts of Zanzibar are coralline, with reddish-brown sand of late Tertiary origin. Alluvial deposits are found along river basins, notably the Ruvu, the Wami and the Rufiji.

Apart from the Kilwa Kivinje and Tanga-Pangani zones, soils along the Tanzanian coast have generally severe to very severe limitations that restrict the range of crops or the capability to produce perennial forage crops. Soils located on the southern coastal part of Tanzania are capable of producing only perennial crops and improvement practices are not feasible.

## Hydrology

The coast is strongly influenced by rivers that bring to it water, sediment, nutrients and pollutants. Tanzania is traversed by a number of rivers and streams, which could broadly be divided into four drainage basins, namely the Indian Ocean drainage, the Atlantic Ocean via Lake Tanganyika, the Lake Victoria-Nile complex that drains into the Mediterranean Sea and the Rift Valley depression (Map 5). The Indian Ocean drainage system is the largest drainage basin, covering almost 20% of the country and constituting about 50% of the surface runoff. The Rufiji, one of the largest rivers in Africa, contributes 50% of this runoff. The river has an annual discharge of 1133 m<sup>3</sup>/s (Table 4).

**Table 4. Length and Catchment Areas of the Indian Ocean Drainage System**

River	Length (Km)	Mean Annual Runoff (Million m <sup>3</sup> )	Catchment ('000 Km <sup>2</sup> )
Umba			6.7
Pangani (+ others)	360	627 (at Hale)	42.1
Msangasi			4.7
Mligaji			2.8
Wami		3,280 (at Manderu)	46.4
Ruvu		1,370 (at Morogoro Bridge)	18.4
Mbezi (+ others)			7.7
Rufiji: Ruaha Mkuu	750		
Rufiji	640	22,250 (at Stiegler's Gorge)	177.4
Matandu			18.6
Mbwemkuru			16.3
Lukuledi			12.95
Lupululu			6.0
Mambi (+ others)			5.3
Ruvuma	640		52.1
Lake Malawi – Ruhuhu			14.0
Others			13.1

The surface river flow regime and moisture conditions in the country correspond to the general rainfall pattern. The peak outflow from major rivers that discharge into the Indian Ocean occurs between March and May. Rivers and lakes start rising in November/December and experience a maximum in March–April, with a recession period from May to October/November. The hydrological year starts in October/November and ends in September/October. In the dry northern and central parts, with annual rainfall of 500–800 mm, streams are seasonal. On the highlands, as well as on most western parts of the country, where rainfall is in the range of 1200–2600 mm, the streams and rivers are perennial.

The Pangani, Ruvu and Rufiji river basins experience frequent water use conflicts arising from increased competing demands on water for domestic use, irrigation and hydropower generation.

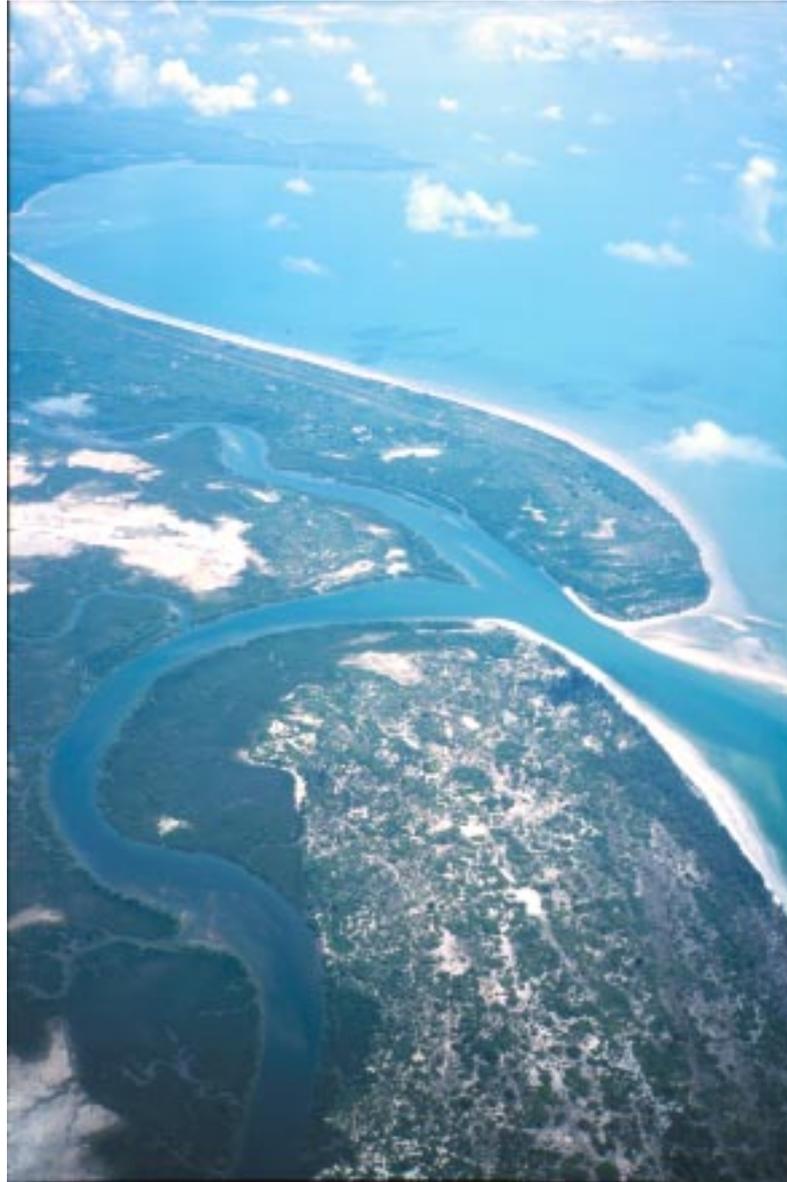


Map 5. River system in coastal Tanzania

## GROUNDWATER SOURCES

Groundwater potential in Tanzania, whose recharge is mainly from rainfall, varies from one locality to another and so does its development. The country as a whole has a good potential of groundwater resources. With the exception of the Pangani river basin, groundwater development has mainly concentrated on shallow wells for domestic purposes. On the coast, the Pangani basin has a good potential and adequate supplies that can be obtained for domestic, industrial and irrigation purposes. Adequate supplies can, therefore, be extracted for Tanga municipal water supply. At present, 88% of groundwater extracted in the Pangani basin is used for irrigation, 4% for industrial use and 8% for domestic use.

In the Pangani basin, parasitic formations on the slopes of Mount Kilimanjaro play a major role in recharging the plains, as they are quite porous. Other areas of recharge include the fault zones in Same near Usambara Mountains, at contact zones in the Usagara



Aerial view of a river mouth in Tanzania

belt and the Karoo/volcanic areas. Recharge mechanism in Makutupora in the Wami/Ruvu basin is through major fault lines surrounding the basin.

The presence of iron and manganese in groundwater along the coastline of Tanga, Coast and Mtwara regions affects the physical quality of water. Higher levels of iron and manganese result in coloured turbid water immediately the water gets into contact with air, for example, during drilling. In such cases, colour and turbidity levels are above the Tanzanian Drinking Temporary Water Quality Standards.

The groundwater mineralisation process in various geological formations has resulted in differences in chemical water quality in different parts of the country. Along the coast and in islands, the groundwater is salty in most areas. In most cases, electrical conductivity exceeds 2000 S/cm thus making the water undrinkable and certainly unsuitable for irrigation. Such situations occur where boreholes are sunk into basement rocks. High levels of iron, colour, turbidity and COD (chemical oxygen demand) is a major problem in many water sources. Groundwater quality in Mtwara and Lindi regions, especially along the coast, is corrosive due to the presence of carbon dioxide (CO<sub>2</sub>), with pH values reaching 4.0. Bacteriological quality of deep groundwater in the country is generally better than that of shallow wells and surface

water. In most cases, the water does not need to be disinfected unless it has been contaminated, mostly with faecal matter.

## Coastal Features

The most prominent features along the coast include fringing platforms, limestone cliffs, sandy ridges and beaches and mangrove forests in the riverine estuaries and deltas. More specifically, the coastline could broadly be categorised as follows:

### FRINGING PLATFORMS

The coastal geomorphology of the Tanzanian coast is characterised by a fringing intertidal rock platform commonly more than a kilometre wide. The platform is composed of rocks of Pleistocene age or earlier which have been planed to a sub-horizontal surface by erosion. Holocene sand terrace, a metre or two above the normal high water mark, flanks these platforms.

### CLIFFED SHORELINES

Cliffs predominantly consist of coralline limestone and are prominent along the coast. They are characterised by undercut notches and clear vertical zonation of flora and fauna. Indented coves shelter small beaches of calcareous sand made up of coralline particles and shell fragments.

### BEACH ROCK SHORELINES

The beach rock is made up of lithified sediments consisting of calcareous sandstone, which are generally coarse and pebbly. The shorelines gently dip seawards and in some parts they are masked by modern beach sand.



Rocky bouldered beach, Matemwe

### HOLOCENE BEACH TERRACE SHORELINES

These are very dynamic shorelines composed of unlithified sand with a typical height of some 5–6 m above tidal datum. The terraces, which in some places extend landward for several hundred metres from the present-day shoreline, have beach ridge landforms and are elongated sub-parallel to the existing shoreline.

Dunes are limited and only found in southern Tanzania, south of Mtwara town and are covered by sparse vegetation.

### DELTAIC SHORELINES

This type is characteristic of low lying coastal areas that receives a large supply of terrestrial sediments. They are associated with river and tidal deltas. Sand spits and mangrove shorelines also fall in this category.

### SMALL ISLANDS

There are numerous small islands along the Tanzanian coast; some are raised fossil coral platforms and others sandbanks. They include Yambe, Karange, Mafia, Songo Songo and Mbudya off mainland Tanzania and Chapwani, Kibandiko, Changuu, Bawi, Chumbe, Misali, Latham and Mnemba off Zanzibar. These islands support some terrestrial vegetation and fauna (including, for instance, the giant coconut crab, *Birgus latro*). The smaller islands do not support human settlements due to the unavailability of freshwater, but fishermen may visit them for short periods. Some of these islands are critically important for the nesting activities of turtles and birds. The uninhabited island of Latham, for instance, is a turtle nesting site and is important internationally as a seabird nesting site for the only major seabirds in East Africa—greater nested tern *Sterna bergii*, masked booby *Sula dactylatra*, brown noddy *Anous stolidus*, sooty terns *Sterna fuscata*, and others.

## Oceanography

### CURRENTS AND TIDAL REGIME

Ocean currents and tides are important features that strongly influence the distribution of marine organisms and the availability of nutrients. The dominant major currents prevailing in the coastal waters of Tanzania are the South Equatorial current, which flows westwards permanently at around 12° S and the northward-flowing East African Coastal current (EACC). The EACC is strongest in the southern monsoon (April–October) with an average speed of about 2 m/s and occasionally reaching 3.5 m/s and weaker during the northern monsoon (November–March), with an average speed of less than 0.5 m/s.

Three main water masses have been identified off the Tanzanian coast. Firstly, surface water (depth < 100 m) brought to the west from the Bay of Bengal and the eastern Indian Ocean are by the South Equatorial current. It is characterised by a temperature of 22–30 °C and salinity of less than 35.4‰. The second is the high salinity water found at a depth of 150–250 m. This is thought to originate from the Arabian Sea and/or the subtropical surface waters. The third is the Indian Ocean Central water, which is found at 250–500 m depth and has temperature of below 18 °C.

The water flow in Tutia reef area on the island of Mafia, for instance, is of strategic importance. It is at this point that the EACC divides to proceed along the Mafia Channel and the outer reef. It is, therefore, believed that the larvae produced within the Tutia reef and adjacent areas of southern Mafia contribute to the maintenance of reef-related marine life, including commercial fish stocks, in Tanzania and East African coastal waters to the north.

The tides along the Tanzanian coast are of semi-diurnal type, characterised by two occurrences of both high and low waters within a day. These are the mean spring tide of about 3.5 m and mean neap tide of about 2.5 m. The age of the tide (time lag between the new or full moon and the peak of spring tide) in most of the areas ranges from one to two days.



Sandy Beach at Mnazi Bay, Mtwara

Tides not only influence ecological processes in the coastal waters but also play an important role in socioeconomic activities of the coastal communities. In most of the coastal communities, tides determine amongst other things: the fishing period, type of fishing gears to be used and market time.

The two peaks of monthly sea level in Zanzibar occur during the transitional months (March/April and October/November (Figure 2). A number of factors contribute to seasonal variations in monthly sea level. These include steric effect, current and wind regime. However, variations in monthly mean sea level are attributed to changes in sea surface temperature.

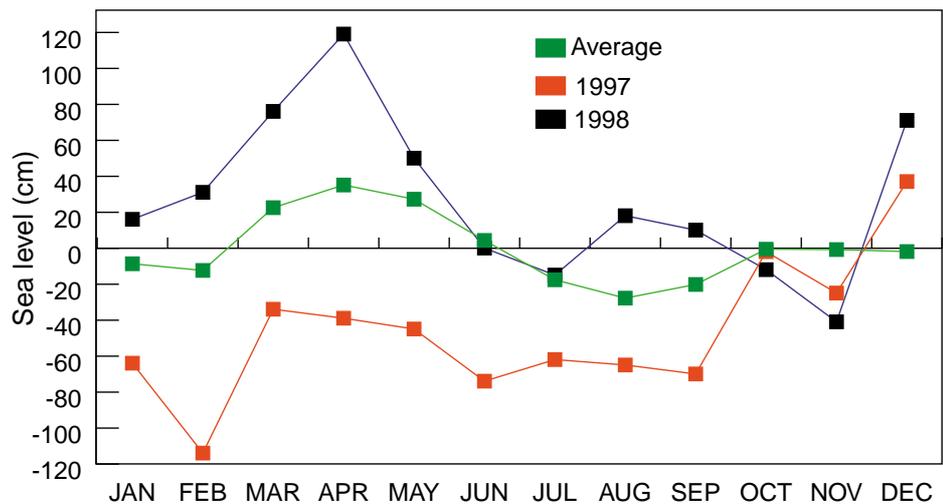


Figure 2. Monthly mean sea level for El Niño year (top); average (middle) and non-El Niño year (bottom)

### SEA SURFACE TEMPERATURE

Sea surface temperatures exhibit seasonality that is influenced by changes in the water masses of the Indian Ocean and by climate factors. During the Southeast monsoon, the South Equatorial current brings water of relatively low temperatures from the Pacific Ocean, while during the Northeast monsoon, the South Equatorial current draws water of high temperatures from the same. These changes are in turn reflected in the temperatures of the East African Coastal current. The sea surface temperature along the coastal waters of East Africa within the latitude band 0–10° varies from the highest of 28–30 °C, occurring in March and April, to the lowest sea surface temperature of 24 °C, in August and September.

The sea surface temperature of the coastal waters of Tanzania averages at 27 °C but may reach 25 °C during July to September and rise to 28 to 29 °C in shallow areas during January to March (Figure 3). The depth of the upper mixed layer varies from 20 m (March and November) to 100 m (June/July), due to the seasonal variations of the wind speed and direction.

Temperature variations, particularly offshore, are mainly diurnal as they are controlled by day heating by solar radiation and night cooling. In the near-shore waters, the temperatures are semidiurnal due to effect of the tides.

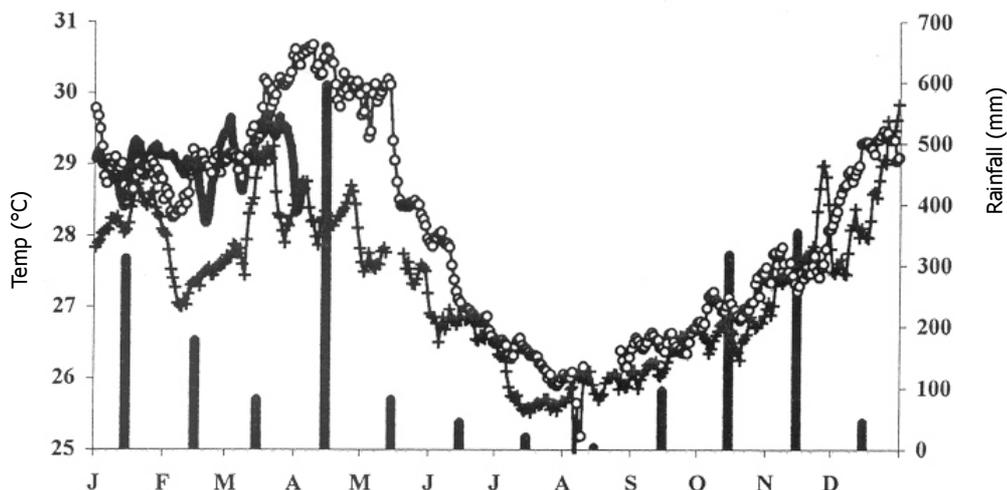


Figure 3. Monthly mean rainfall for 1998 and water temperature for 1997 (line with crosses); 1998 (line with circles) and 1999 (solid line)

### SALINITY

Salinity values are lower during May following the peak freshwater outflow and highest in November. The salinity values start to decrease in February before the beginning of rains. This is attributed to the advection of lower salinity water from the south. In open ocean, salinity values normally range from 34.0 to 35.5‰. However, the salinity is low nearer the coast due to freshwater runoff.

### CHLOROPHYLL-A CONCENTRATION

Chlorophyll-a is a universal pigment in all primary producers capable of oxygenic photosynthesis. (Figure 4) Its concentration can thus be used as an indicator of productivity of coastal waters. To estimate primary productivity, the amount of chlorophyll-a is measured in a phytoplankton sample, as collected in a given volume of ocean water. The amount of chlorophyll-a can be calibrated with productivity as measured by other techniques.

As is generally the case with the Indian Ocean, the chlorophyll productivity in Tanzanian waters is very low when compared with other areas of the tropics. Biomass, as measured in terms of chlorophyll-a, ranges from 0.04 to 1.4 mg/m<sup>3</sup>. Generally, richer zones are characteristic

### Box 1. EL NIÑO/SOUTHERN OSCILLATION (ENSO)

El Niño was originally recognised by fishermen off the coast of South America as the appearance of unusually warm water in the Pacific Ocean, occurring near the beginning of the year. El Niño means 'The Little Boy' or 'Christ Child' in Spanish. This name was used for the tendency of the phenomenon to arrive around Christmas.

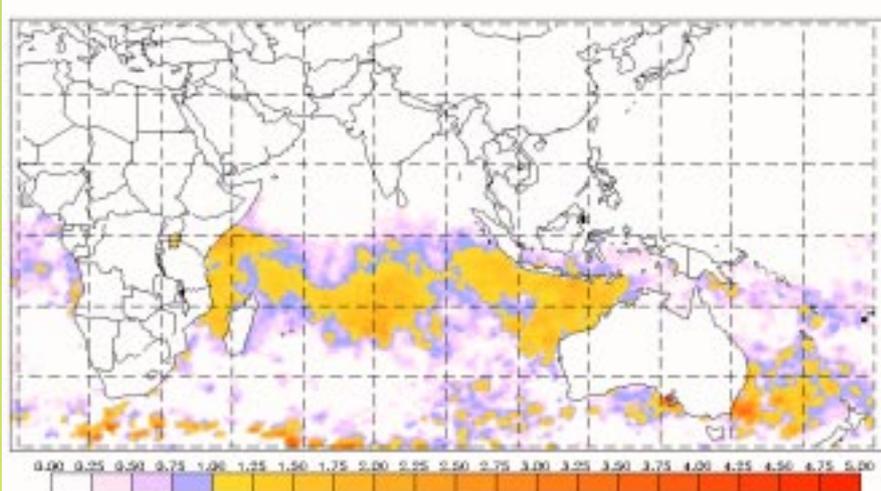
ENSO is related to oceanic and atmospheric phenomena; they tend to recur every two to nine years. They are characterised by increases in sea surface temperatures of the tropical Pacific Ocean, suppression of upwelling nutrient-rich water along the coast of South America and disruption of the trade winds. The ocean warming covers a band from 10°N to 10°S and extends more than 90° of longitude. Typically, the warming starts late in the boreal spring or summer and builds to a peak at the end of the year, with the event usually being over by the following summer.

El Niño and the Southern Oscillation change atmospheric circulation on a global scale. Although each El Niño event is unique, there are sometimes similar weather patterns, known as teleconnections. Global teleconnections linked to ENSO include lower-than-normal precipitation in western Oceania, India, southeastern Africa, and northeastern South America, and excessive precipitation in western South America and eastern Equatorial Africa.

ENSO events, particularly the extreme ones, have been associated with damage to coastal resources, agriculture, transportation, housing and human life in five continents.

The 1997–1998 El Niño event was one of the strongest this century and in Tanzania it was associated with floods and increased sea surface temperatures. This event caused significant ecological, social and economic impacts to the country. Some of the examples of the impacts were:

- Changes in sea surface temperatures that contributed to the bleaching of coral reefs experienced in most of the country.
- Severe disruption of rail and road systems in the country as a result of the heavy rains and consequent flooding.
- Flooding which killed more than 100 people and left 155,000 people homeless. Over 128,000 hectares of agricultural land were flooded, leading to major future food shortages.



Sea surface temperature anomalies on 1.24.1998. Coral bleaching events have been noted in areas where the SST exceeds the climatological maximum for that region by 1 degree C or more. Several examples of this phenomenon occurred in 1998. This product highlights SST anomalies which are greater than one degree above the maximum monthly climatological SST.

The Hotspot Chart uses a color table which highlights anomalies greater than 1.0 degree C in yellow-red, with anomalies between 0.25–1.0 degrees C in purple-blue.

(Source: NASA website, <http://psbsgi1.nesdis.noaa.gov:8080/PSB/EPS/SST/climohot.html>)

**Box 2. POTENTIAL HARMFUL MARINE MICROALGAE ALONG THE COASTAL AREAS OF TANZANIA**

Seafood can contain harmful/ toxic microalgae, which can intoxicate finfish or shellfish and consequently the consumers thereof. In countries like Japan, the USA, Canada, Thailand, Spain, Mexico and some European countries, where toxic microalgae have been shown to cause significant damage, including death to the seafood consumers (human beings, birds, marine mammals) and to the economy, these microalgae have been extensively studied and monitoring programmes exist.

In other areas particularly the tropics, such as the eastern African region, records of harmful microalgae and their effect are scanty, probably because very few studies have been carried out. However, some isolated cases of seafood poisoning exist, which could be linked to the presence of harmful microalgae in the waters. An example is the case in 1996 in Pemba, where more than 20 deaths occurred after individuals consumed turtle meat. It should be noted that some turtle feed on macroalgae, and some harmful microalgae, such as *Gambierdiscus* sp. are benthic, they attach to the macroalgae and other substrates. It is possible that the turtle had consumed macroalgae harbouring harmful microalgae.

In Tanzanian waters, a number of studies have shown the existence of potentially harmful microalgae, both planktonic and benthic. Several species were reported, and these could be grouped into four major groups including: cyanobacteria, dinoflagellates (the majority), diatoms (only one species, *Pseudonitzschia* sp.) and prymnesiophytes. The most important fish poisoning in Zanzibar/Tanzania waters and in the western Indian Ocean region in general is ciguatera fish poisoning, caused by a benthic dinoflagellate *Gambierdiscus toxicus*.

Survey conducted in Unguja and Pemba in 1997 to identify potentially harmful microalgae and fish intoxication found that the magnitude of the effect depends on the part of the fish consumed. Some fish such as shark (viscera), rays (viscera) and groupers (flesh) were identified to have caused severe damage. On the other hand, the viscera of carangids and swordfish and the flesh of moray eel and spinefoot caused moderate effect. Some of the symptoms reported include diarrhoea, vomiting, dizziness, abdominal pain, skin problems and allergies.

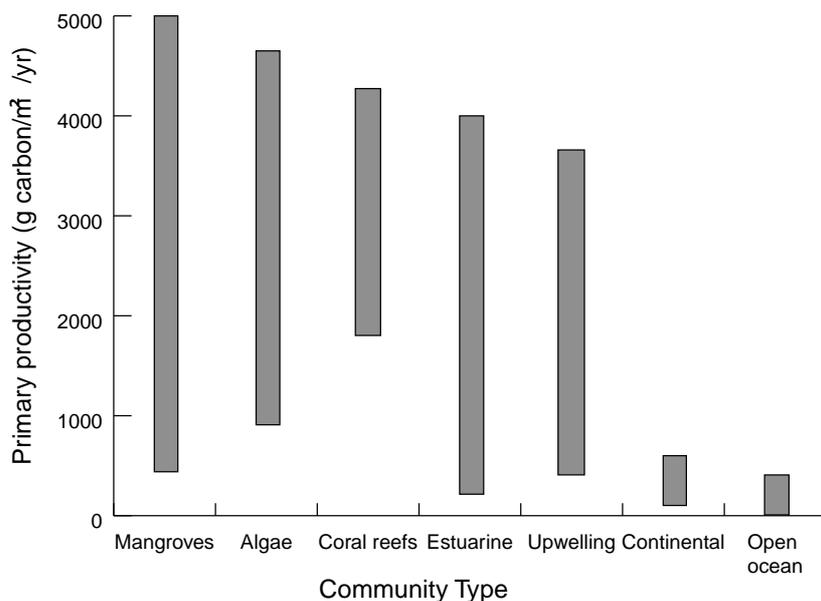


Figure 4. Ranges of primary productivity of some major tropical communities

of coastal upwelling areas, with a biomass exceeding 500 mg/m<sup>3</sup> in some places such as in the Atlantic coast of West Africa. Comparative spatial distribution data for chlorophyll-a concentration are not available in Tanzania. However, inshore waters support higher levels of biological production compared to those in the offshore. This is mainly because coastal waters have high nutrient levels, provided by continental runoff.

Chlorophyll concentrations in the coastal waters of Tanzania are generally higher during the northern monsoon and lower during the southern monsoon. The higher concentration during the northern monsoon is attributed mainly to less mixing to depths of below optimal light intensity, greater residence time in neritic conditions because of the slower coastal current, greater runoff and nutrient input from rivers and greater availability of biologically assimilable nitrogen. Consequently, phytoplankton biomass and fish catch and reproduction are highest during this period.

## COASTAL ECOSYSTEMS

### Coastal Forests

The coastal forests and thickets of Tanzania are remnants of the once extensive lowland forests of East Africa covering about 59,000 km<sup>2</sup>. These forests which comprise wooded, secondary and edaphic grassland, are part of the Zanzibar-Inhambane Regional Mosaic. This phytogeographical region covers the coastal belt from Somalia to the mouth of the Limpopo River. It is 50–200 km wide inland from the coast except up river valleys and mostly below 200 m in altitude. There is, however, no single agreed definition of 'coastal forest'. Varying levels of disturbance further complicate this problem, as degraded forest and thicket may preserve some characteristics of the previous forest communities. In this work, mangroves have not been included in the range of coastal forests.

Coastal forests in Tanzania cover about 350 km<sup>2</sup>. However, they are small, highly fragmented, separate forest patches, most of which are less than 500 ha in size and some carry a conservation status. These are individually distinct, with a high level of local forest endemism and a great array of different communities and endemism. Tanzanian coastal forests have 105 endemic plants, 20 endemic reptiles, 40 endemic butterflies, 5 endemic birds, 5 endemic mammals and 5 endemic amphibians. For example, the tree *Sterculia schiebenii* is endemic to Chitoo Forest Reserve, Lindi Region. The Kiwengoma Forest Reserve in Rufiji district has 4 endemic plants (*Tricalysia* sp., *Pavetta* sp., *Chlorophytum* sp. and a fern *Nephroleptis* sp.). Of the 105 endemic plant species recorded in Tanzania coastal forests, more than 50% are located in Rondo forest, Lindi district. In addition, the Gendagenda forests in Handeni and Pangani districts contain the rare *Saintpaulia* sp. (African violet) and wild coffee (*Coffea* sp.) which is of potential value in crop breeding.

The most extensive coastal forests are Gendagenda Forest (28 km<sup>2</sup>), Msumbugwe (30.93 km<sup>2</sup>), Mafi Hill (45.08 km<sup>2</sup>), Kiono-Zaranginge (20 km<sup>2</sup>), Ruvu South (30.93 km<sup>2</sup>), Pugu Hills (25 km<sup>2</sup>), Kazimzumbwi (23.5 km<sup>2</sup>), Rondo (40 km<sup>2</sup>) and Kiwengoma (22 km<sup>2</sup>) forest reserves. Other forest reserves that attract considerable interest include Mahuta, Pande, Vikindu, Kisiju, Mchungu, Kikale, Ngarama, Pindi, Chitoo, Ndiba, Ruawa, Matapwa, Litipo, Chilanga and Mlola forests (Map 6). The Kiono-Zaranginge Forest in Bagamoyo district contains at least three endemic plant species and 12 globally scarce species. The Pugu Forest, on the other hand, ranks second in terms of biodiversity among coastal forests in East Africa. About 15 plants are believed to be endemic or near endemic and around 65 species of forest birds are known. Many coastal plants are exploited for medicinal use, examples of which are shown in Table 5.

The five species of mammals that are endemic to coastal forests are the golden-rumped elephant shrew (*Rhynchocyon chrysopygus*), Ader's duiker (*Cephalophus adersi*), African woolly bat (*Kerivoula africana*), Pemba fruit bat (*Pteropus voeltzkowi*) and the bat species *Rhinolophus deckenii*. Rare species found in the coastal forests and elsewhere are the lesser pouched rat (*Beamys hindei*), the eastern tree hyrax (*Dendrohyrax validus*), Seychelles fruit bat (*Pteropus*



Map 6. Distribution of coastal habitats (corals and mangroves) and selected terrestrial land cover types

*seychellensis*) and the African elephant (*Loxodonta africana*). The Jozani forest in Zanzibar is the main habitat of the endemic red colobus monkey (*Colobus kirki*). There are many invertebrates; for example, there are around 40 endemic species of butterflies, and at Kiwengoma forest alone, there are around 25 species of millipedes 15 of which are new species.

Communities that depend on the forest resources surround the coastal forests. The most important income-generating uses of the coastal forests are the production of charcoal, firewood and timber. The forests also provide non-wood products such as medicine, honey, mushrooms, fruits and thatch grass. Charcoal making is a major means of generating income, followed by timber selling. Carpentry, carving and weaving of mats or baskets are also income-generating activities that utilise forest resources.

Presently, the coastal forests in Tanzania are under heavy pressure. They are threatened by unsustainable human activities including logging of canopy trees for timber and fuel, removal of hardwood poles to build houses, burning of woody plants to produce charcoal and wholesale removal of woody vegetation for conversion of the land to agriculture. Uncontrolled bushfires (which are usually started by humans) are the worst threat in some forest reserves such as Chitoo Forest Reserve and Rondo. To some forests, such as Mlola Forest Reserve in Mafia Island and Kazimzumbwi in Coast Region, clearing for farmland is the major threat. Pugu Forest Reserve is threatened by mining as it contains one of the largest deposits of kaolin in the world. In some of the forests, the natural vegetation has been replaced with exotic species such as parts of Ngezi in Pemba, Pugu, Vikindu and Rondo forest reserves in Tanzania Mainland.

The coastal thickets are mainly characterised by scattered trees and shrubs with climbers and lianas. The canopy cover is less than 40% and dominated by trees such as *Dalbergia melanoxylon*, *Sclerocarya caffra* and *Annona senegalensis*. Common shrubs include *Suregada zanzibariensis*, *Phyllanthus reticulatus*, *Strychnos spinosa* and *Catharanthus roseus*. Common lianas and climbers include *Macrotyloma axillare*, *Cissus quadrangularis*, *Landolphia kirki*,

**Table 5. Some Examples of Medicinal Plants of the Tanzanian Coastal Forests**

Affliction	Species	Local Name	Part	Preparation
Snake bite	<i>Vismia orientalis</i>	Mtunokitumbi	Bark	Rub bark on affected areas
Prolonged menstruation	<i>Diospyros natalensis</i>	Kibombo	Root	Boil root with chicken meat and drink broth
Sunburn and fever	<i>Monanthes taxis buchananii</i>	Mpeki	Leaf	Grind leaves, mix with water and drink
Ulcers	<i>Eriosema nutans</i>	Mwiru	Roots	Make tea from roots and drink
Washing new-born child	<i>Oxyanthus</i> sp.	Mgwaza	Roots	Boil roots and use warm infusion
Womb, postnatal pain	<i>Chlorophytum sparsiflorum</i>	Naliwe	Leaf	Crush leaves in water and drink
Fever in infants	<i>Microcoelia exilis</i>	Nyandegge	Leaf	Put leaf in cold water and bath baby in it
Gonorrhoea	<i>Ancylobotrys modestus</i>	Mkula	Root	Soak root in water and drink
Malaria	<i>Dichrostachys cinerea</i>	Kikulagembe	Twigs	Burn twigs and inhale smoke
Childbirth, sex determination	<i>Schlechterina mitostemmato</i>	Namwana	Stem	Make tea from stem bottom for male, stem top for female
Hernia	<i>Alchornea laxiflora</i>	Kitwatwa	Leaf	Chew leaves to stop pain



Red Colobus monkeys, Jozani forest

*Tinospora oblongifolia* and *Ipomoea coptica*. The herb layer comprises species such as *Waltheria indica*, *Triumfetta rhomboidea* and *Agathithantherum bojeri*.

## Coastal Grasslands

In the coastal areas the dominant grass species is *Hyparrhenia rufa*. Other abundant grass species include *Sporobolus marginatus*, *S. pyramidalis* and *Heteropogon contortus*. The woody vegetation is dominated by *Combretum* spp. Others are *Acacia seyal*, *Dichrostachys glomerata* and *Baphia kirkii*, while the palm *Hyphaene* is common on the poorly drained soils. In the Rufiji floodplain, for example, there are palm savanna *Borassus aethiopum* and *Kigelia africana* trees.

## Estuaries and Other Wetlands

Associated with either large river basins or topographical configurations of the coastal plain are a number of freshwater marshes, swamps and lakes. Brackish water swamps and mudflats occur in the large estuaries and delta of the Rufiji, Ruvuma and other river mouths. A typical estuary environment is found on the Pangani river mouth of Pangani Bay. The Pangani estuary is macro-tidal with a typical funnel shape. Swamps in estuaries and river delta are often lined with mangrove trees/forests. Mud flats occur in shallow calm water bays associated with silt mud deposits from rivers such as the Wami. In Tanga region they occur from Kilanje creek at Mtangate bay northwards to the Kenya border. The Mavunji creek in Nangurukuru mud flats and swamp cover a total area of 62 km<sup>2</sup>, while in Mtwara, within the shelter of Mnanka Island, mud flats with their back swamps cover some 16.5 km<sup>2</sup>. These ecosystems support a variety of aquatic fauna and avifauna including seabirds, mangrove kingfish, coastal waders and pelican.

There are many species of commercial and non-commercial fish in rivers, lakes and swamps. Hippopotami are common in coastal wetlands and cause crop losses to farmers. They are hunted mainly for their meat. Crocodiles (*Crocodylus niloticus*) are found in rivers and swamps adjoining mangrove areas especially along the Rufiji, Ruvuma and Wami rivers. They are

hunted mainly for their skin or just killed to allow easy passage by the local people. These are also sites of many birds such as stork and herons. The wetland flora is typical of coastal eastern Africa with reeds, many floating and emergent herbs and submerged species.

## Mangroves

Mangroves are marine tidal forests. They are most luxuriant around the mouths of large rivers and in sheltered bays and are found mainly in the tropics where annual rainfall is fairly high. (Map 6) The plants are unusually adapted to anaerobic conditions of both salt and fresh water environments and have adapted to muddy, shifting, saline conditions. They have stilt roots that project above the mud and water in order to absorb oxygen. However, the trees are only part of this complex mangrove ecosystem, which includes associated bodies of water and soils as well as a variety of other plants, animals and microorganisms.

**Table 6. Mangrove Areas in the Administrative Blocks in Tanzania Mainland**

Block	Forested Areas (Ha)	Non-Forested Areas (Ha)*
1. Tanga and Muheza Districts	9403	3528
2. Pangani District	1756	1279
3. Bagamoyo District	5636	3548
4. Dar es Salaam Region	2168	1045
5. Kisarawe District	3858	2193
6. Mafia District	3473	892
7. Rufiji District	53,255	14,357
8. Kilwa District	22,429	14,308
9. Lindi District	4547	2754
10. Mtwara District	8942	4408
11. Unguja Island	6000	
12. Pemba Island	12,000	
Total	133,467	48,312

\*Includes creeks, salt pans and bare saline areas.

The mangrove forests of Tanzania Mainland cover about 115,500 ha and those in Zanzibar cover 18,000 ha (Unguja Island 6000 and Pemba Island 12,000 ha) (Table 6). There are nine species of mangrove trees in Tanzania, though not all are found in every forest (Table 7). *Xylocarpus mulluccensis* is very rare but *Avicennia marina*, *Rhizophora mucronata* and *Ceriops tagal* are abundant. The mangrove ecosystem, however, includes much more than just the trees and encompasses terrestrial, freshwater, marine and estuarine systems. Therefore, the mangrove habitats in Tanzania are diverse and are best-developed in estuaries such as the Rufiji delta. Mangrove tree species normally occupy specific habitats in the forest. As a consequence, they exist in zones often dominated by one tree species. For example, *Sonneratia alba* occurs in areas where tidal water reaches daily and where the salinity is almost constant, close to that of sea water. *Rhizophora mucronata* forests are dominant on muddy soils and often form extensive pure stands. On sandy soils, however, the species fails to compete with others. *Bruguiera gymnorhiza* is often found as a zone between *Rhizophora mucronata* and *Ceriops tagal* zones or mixed with them. *Heritiera littoralis*, a riverine mangrove species, grows only in habitats with low salinity and is restricted to areas in the vicinity of river mouths. Such sites are usually only flooded by spring high tides. *Avicennia marina* can tolerate high levels of salinity, varied flooding regimes, compacted substrate, sand flats and newly deposited sediments. As a result, it is the most widely distributed species. However, it does poorly on muddy soils. *Xylocarpus granatum* is most often found mixed with *Avicennia marina* and it grows on raised portions where flooding takes place only for a few days a month and where there is fresh water influence. As is the case for *Heritiera littoralis*, *Xylocarpus granatum* is an important element of the riverine mangroves but does not form pure stands (Figure 5).

Most mangrove species have extensive root systems, which are adapted to the conditions of fine-grained soils that are, to varying degrees, low in oxygen and poorly consolidated.

Table 7. The Species Composition and Area Occupied by Mangrove Trees in Mainland Tanzania		
Classification	Area (Ha)	% of the Total Area
<i>Rhizophora</i> dominant, with <i>Avicennia</i> , <i>Ceriops</i> , <i>Sonneratia</i> , <i>Bruguiera</i> , <i>Heritiera</i> and/or <i>Xylocarpus</i>	55,549.9	49
<i>Sonneratia</i> -almost pure stands	1223.3	1
<i>Sonneratia</i> dominant, with <i>Avicennia</i> , <i>Bruguiera</i> and/or <i>Rhizophora</i>	6123.2	5
<i>Heritiera</i> -almost pure stands	91.2	0
<i>Heritiera</i> dominant, with <i>Avicennia</i> , <i>Bruguiera</i> and/or <i>Rhizophora</i>	8188.4	7
<i>Avicennia</i> dominant, with <i>Rhizophora</i> , <i>Bruguiera</i> , <i>Heritiera</i> , <i>Ceriops</i> and/or <i>Xylocarpus</i>	17,141.6	15
<i>Avicennia</i> – almost pure stands	1687.4	1
Mixture of <i>Avicennia</i> and <i>Ceriops</i>	17,432.7	15
<i>Ceriops</i> dominant, with <i>Rhizophora</i> , <i>Avicennia</i> and/or <i>Bruguiera</i>	8037.9	7
<b>Total mangrove</b>	<b>115,475.6</b>	<b>100</b>
Water in creeks	24,076.0	
Clear-cut areas	4435.0	
Bare, saline areas	20,740.0	
Salt pans	3093.0	
Non-mangrove forest inside the reserve	5069.3	
<b>Total reserve area</b>	<b>172,888.9</b>	

*Rhizophora mucronata* trees have prop roots, *Avicennia marina* and *Sonneratia alba* have pneumatophores which rise above the surface of soil, while *Bruguiera gymnorrhiza* and *Ceriops tagal* trees have knee roots. *Xylocarpus granatum*, on the other hand, has small buttress roots. All these specialised roots are perforated with lenticels to improve gaseous exchange.

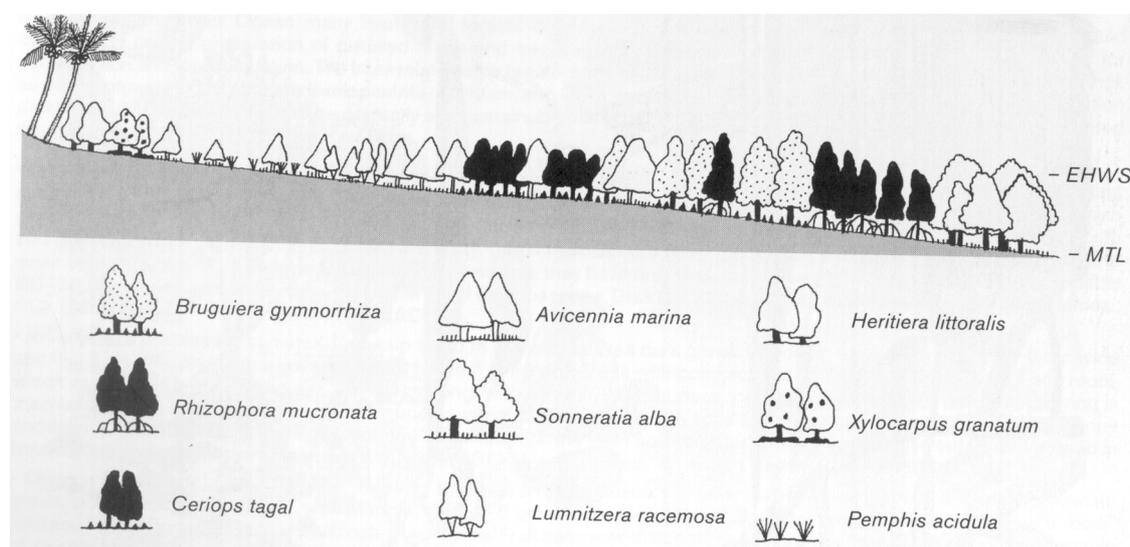


Figure 5. Mangrove tree species and zonation on eastern African shores  
(Source: *A Guide to Seashores of Eastern Africa and the Western Indian Ocean Islands*)

Mangroves have many direct and indirect uses to the communities, particularly for house building, firewood, boat building and poles (Table 8). Their massive root systems serve to trap sediments and nutrients and, therefore, absorb the latter through their root systems. When their leaves drop into the surrounding mud and water, they are broken down by various animals and microorganisms eventually decomposing to provide a rich source of food for other animals and plants. Some of these small particles of vegetation, called detritus, are

exported out of the mangrove ecosystem and form the food base of nearshore marine organisms. The mangrove ecosystem provides feeding, breeding and nursery areas for prawns, shellfish and fish. Consequently, yields are higher from the fisheries in the mangrove-fringed coastal waters than in areas where there are no mangroves. Mangroves are also home to numerous species of mammals such as monkeys and birds.

**Table 8. Direct Uses of the Mangrove Tree Species in Tanzania and Their Names in Kiswahili**

Species	Kiswahili Name	Uses
<i>Avicennia marina</i>	Mchu	Inferior firewood (used for boiling of brine fish), smoking and production of lime, building dugout canoes and beehives; leaves used as goat and cattle fodder; branches support beehives.
<i>Bruguiera gymnorhiza</i>	Msinzi or mshinzi	Good firewood used for fish smoking, fishing stakes and poles.
<i>Ceriops tagal</i>	Mkandaa	Good firewood, poles, fishing stakes and fence posts.
<i>Heritiera littoralis</i>	Msikundazi or mkungu	Good firewood, timber for boat building, furniture and dhow masts.
<i>Lumnitzera racemosa</i>	Mkandaa dume	Good firewood
<i>Rhizophora mucronata</i>	Mkoko or mkaka	Good firewood, poles, fence posts, fish traps and fishing stakes.
<i>Sonneratia alba</i>	Mlilana or mpira	Inferior firewood, commonly used in boat building, pneumatophores used as fish net floats.
<i>Xylocarpus granatum</i>	Mkomafi	Good firewood, used for fish smoking, boat building and making furniture. The seeds are used to treat stomach problems and the fruit pulp to cure rashes.



Mangrove ecosystem

The role of mangroves in preventing erosion can be assumed to have great significance in the estuarine system. The presence of mangroves in such a strategic position aids in preventing unnecessary loss of soil and other resources due to the battering effects of wave action and, to a minor extent, high winds, both associated with tropical storms. Mangroves build land through the accumulation of silt and detritus and while the mangrove coastal barrier may be battered and damaged in severe storms, it grows back naturally. In contrast, no man-made coastal protection barrier is capable of self-repair. Mangroves also protect coral reefs by reducing siltation by trapping the sediment washed down from upland waters. If living corals are covered with sediment, they cannot survive; they eventually die. The coral reef is then unable to grow and expand and many other organisms that depend on it cannot survive either.

## SEAGRASS MEADOWS AND SEAWEEDS

### Seagrasses

Seagrasses are flowering plants, which grow underwater with their roots embedded in the sediment. They occur in shallow waters and estuaries that allow sufficient sunlight to penetrate to allow photosynthesis. This, sometimes, results in forming extensive meadows that help to trap sediment and stabilise the seabed (Figure 6). Seagrasses grow best in the quiet, protected waters of healthy estuaries and lagoons, often in beds, or meadows, that are easily delineated for classification as critical habitat areas. The seagrass beds normally extend shoreward to the point where wave action prevents them from rooting. The seagrasses that grow near mangrove forests are often the richest in life forms.

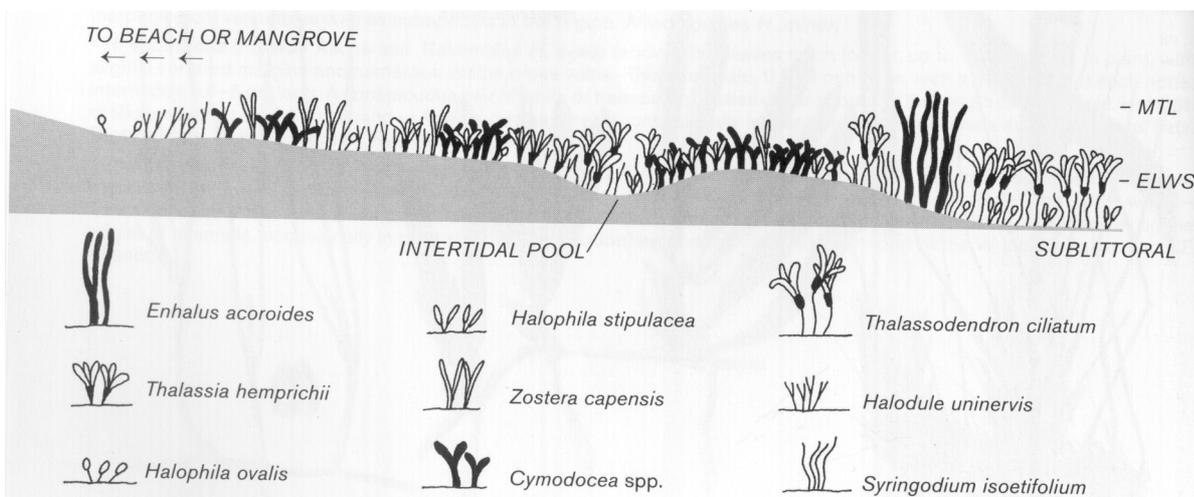


Figure 6. Seagrass species and zonation on Eastern African shores  
(Source: *A Guide to Seashores of Eastern Africa and the Western Indian Ocean Islands*)

Seagrass beds, or meadows, are highly productive. They also have a high rate of species diversity and they support a variety of marine fauna. In Tanzania, seagrass beds are widely distributed from high intertidal to shallow subtidal areas. They are found in sheltered areas of the coast around Kilwa, Rufiji, Ruvu and Moa. They also occur on the west side of Pemba, Unguja and Mafia Islands.

Twelve types of seagrass have been identified in the country. These include *Enhalus acoroides*, *Cymodocea rotundata*, *Cymodocea serrulata*, *Cymodocea* sp., *Halodule uninervis*, *Halodule wrightii*, *Halophila minor*, *Halophila ovata*, *Halophila stipulacea*, *Syringodium isoetifolium*, *Thalassia hemprichii* and *Thalassodendron ciliatum*. The most dominant species are *Thalassodendron ciliatum*, *Thalassia hemprichii* and *Syringodium isoetifolium*. There is a significant difference in above-ground biomass for the different types of seagrasses within

each site and also among the sites. However, they show little seasonality in biomass. The stems of *Thalassodendron ciliatum* support many algal and faunal epiphytes. The biomass of macrofauna found in various types of seagrass beds are different depending on the density and morphology of the supporting seagrass and the associated macroalgae and other environmental factors.

Unlike the coral reefs, which have an intrinsic aesthetic value, seagrass beds are not usually regarded as needing protection and may even be considered as a nuisance to swimmers and boat users. However, seagrass beds are highly productive and serve many ecological functions. These include providing breeding, nursery and feeding areas for many invertebrates and vertebrate species including commercially important species of finfish and shellfish and shelter and refuge for resident and transient adult animals such as shrimps (*Penaeus* spp.). Seagrass is an important food source for herbivorous invertebrates, fish, dugong and green and hawksbill turtles. Furthermore, certain species of sea urchins derive their nutrition from direct consumption of detrital seagrasses.

Additional ecological functions of seagrass include filtering sediments and, therefore, reducing sedimentation over coral reefs and providing protection to shorelines (by dissipating wave energy).

In Tanzania, no records of seagrass harvesting have been reported and the direct uses of seagrass by man are limited. In Tanga, most villagers know two or three different kinds of seagrass; are aware that it is a food source for fish and they associate particular species of fish with the seagrass.

Because seagrass beds are mainly found in shallow water close to shore and human activities, they are very vulnerable to pressure from those activities. Major threats to the survival of seagrass beds come from excessive sedimentation of coastal waters resulting from different activities. Increased turbidity tends to cut down light penetration. Inshore prawn trawling and seine nets also destroy seagrass beds.



Seagrasses

## Seaweeds

The term 'seaweed' (locally known as 'mwani') embraces a very heterogeneous assemblage of marine plants, known as the algae. The plants grow attached to rocks or other stable objects at various depths in the sea. Traditionally, seaweeds include only macroscopic, multicellular marine red, green and brown algae, which are also referred to as macroalgae. However, at some stage of their life cycles, seaweeds are unicellular as spores and zygotes. Seaweeds possess pigments such as chlorophylls, carotenoids, phycobilins, as well as other accessory pigments, which may mask chlorophyll-a and produce the diagnostic colour of different groups. Seaweeds differ from flowering plants in having a holdfast instead of roots, a stipe instead of a stem and a blade or thallus instead of leaves. They depend on water movement to continuously provide nutrients, which they take up through the surface of the blade.

In Tanzania there are over 300 species of red, green and brown intertidal seaweeds. The species diversity of red seaweeds is higher than the other two groups but the brown algae dominate in terms of biomass. Over 100 species of phytoplanktonic algae have also been reported. However, information on the distribution of seaweeds in Tanzania is limited.

Economically important seaweed genera such as *Eucheuma*, *Kappaphycus*, *Gracilaria* and *Sargassum* are exploited or farmed. These have great potential for exploitation as a source of industrial gums: carageenan, agar and alginate which have a wide range of applications as gelling, thickening and emulsifying agents in the manufacture of textiles, milk products, lotions and pharmaceutical extracts. Already *Eucheuma* is exploited for commercial purposes in Tanzania. Many have antimicrobial substances; others contain a great amount of vitamins, protein and trace minerals essential to the human body. Antimicrobial activity is found in 24 algae and strong activity was found in the red algae *Acanthophora spicifera* and *Gracilaria fergusonii*, brown alga *Cystoseira myrica* and a green alga *Valonia aegrophila*. These algae develop products for use as agrochemicals, in soaps, lotions, shampoos, creams, antiseptics, preservatives, pharmaceutical extracts and as inhibitory agents. Therefore, algal biodiversity has potential in solving future economic problems of the country, although majority have very limited biomass and the exploitation can only be achieved by increasing their biomass through mariculture as is now being practised for *Eucheuma*.

There are limited uses of seaweeds by the local communities. The alga species *Ulva fasciata* is used to cover fresh wounds. The algae *Enteromorpha* spp., *Laurencia papillosa*, *Acanthophora spicifera* and *Ulva* spp. are normally used as fish baits in traps ('madema') by artisanal fishermen. In Tanga, one village (Kipumbwi) uses a specific green alga which grows in mangrove areas as a vegetable and a mixture of seaweed, seagrasses and elephant dung is burned and the smoke is inhaled to cure high fever in children. Due to lack of extensive use of the seaweeds by local communities, all the algae are grouped under one local name, 'mwani', with only two local names for particular types. Thus, *Sargassum* (a large and abundant type) is known as 'mandarafa' and *Laurencia papillosa* (a common fish bait) as 'mashava'.

## CORAL REEFS

Coral reefs are made up of many animals and plants as well as corals. The growth forms of corals vary enormously and this results in irregular reef structures. Corals occur along shallow, tropical coastlines where the marine waters are clean, clear and warm. The growth of corals is controlled primarily by the availability of light, sediment load and wave action. The complex topography and the high retention of nutrients by coral communities make coral reefs one of the most productive ecosystems in the world.

The living coral organism or polyp is a tiny tube-shaped animal that extracts calcium compounds from seawater which it uses to build a protective skeleton. After one polyp establishes itself on a bare rock, it may divide by budding and establish a colony, which, given the right conditions, may continue to grow at the rate of a few millimetres or centimetres a year. Corals occur in shallow sunlit waters because the coral polyps rely on symbiotic algae (zooxanthellae),

which occur in the polyp tissues. These algae, being plants, need light to photosynthesise. They are vital to the polyps because they produce organic compounds, which provide the coral organism with as much as 98% of its total food requirements. The polyps also use their tentacles to trap microscopic animals and plants, floating past. However, food particles are rare in tropical waters, so the polyps depend mostly on the zooxanthellae.

Coral reefs are common along much of the Tanzanian coastline and well-developed barrier reefs occur along most of the ocean-facing eastern coastline of the islands. (Map 6) The reefs are located along about two-thirds of Tanzania's continental shelf. Fringing reefs (which form margins along the edge of the mainland or islands) and patch reefs (which are often extensions of fringing reefs) predominate, but they are restricted to a narrow strip along the coast, due to the narrowness of the continental shelf. The islands of Zanzibar, Pemba and Mafia, as well as numerous small islands all along the coast, are for the most part surrounded by fringing reefs. An outer fringing reef runs along the eastern side of both the Mafia and Songo Songo archipelagos.

The fringing reef system is broken by numerous and often extensive mangrove stands, particularly near rivers and streams. Fringing reefs are usually narrow and consist primarily of a reef flat, sometimes with a limited reef slope. Reefs on the landward sides of offshore islands and patch reefs are more developed, with the reef slope sometimes extending below 10 m. Reefs on the seaward sides of islands, patch reefs and the continental shelf have the most extensive reef slopes, where corals sometimes extend down to 25–30 m.

In Zanzibar, because of the differences in water quality, water depth and current and wave strength, the coral species composition and the coral growth forms differ between the eastern and western sides of the islands. While branched corals (*Acropora* and *Porites*) dominate the western sides of the islands, the eastern sides are comprised of a wider range of soft corals and massive and encrusting corals that can withstand strong currents and waves.

There are about 700 species of reef associated corals worldwide and 150 species of scleractinian corals have been reported in Tanzanian reefs. The reefs around Mafia, with 350 fish and 40 genera of corals are among the best on the East African coast. Misali, a small forested island of coral rag located some 10 km off the southwest of Pemba Island, has 9.4 km of exceptional coral growth extending to 64 m depth on the western side with diverse corals (40 genera) and fish (244 species). It should be noted however that many reefs in Tanzania are not well studied and some are yet to be described.

The coral reefs provide a range of resources to the adjacent coastal communities and to society as a whole. For example, the coral reefs contribute to terrestrial accretion by providing sand for beaches and low islands and they can provide protective barriers that shield coastal communities from high-energy seas. Since Tanzania has a very narrow continental shelf of only a few kilometres in some areas, much of the unprotected coastline faces the full brunt of oceanic weather conditions. However, the barrier reefs that have developed on the shelf provide invaluable protection to the coastline and the communities it supports.

The coral reefs are very high in diversity of animal life, which makes them important areas for fish breeding and shelter. Coral reefs in Tanzania support an intensive and mainly artisanal fishery that employs over 50,000 full-time fishermen. In terms of the total fisheries catch, virtually all of the demersal fish taken are from coral reefs and a significant part of the other components of the catch are also taken from coral reef areas. The most important fish families among the coral reef catch include the Lethrinidae, Lutjanidae, Siganidae, Scaridae, Labridae and Mullidae. The other important components of the coral reef catch include octopus, lobsters, squid, various shells for the curio trade and sea cucumbers. The export of sea cucumbers (beche-de-mer or trepang) is one of the more profitable areas of marine resource extraction from coral reefs (Table 9). In addition, seaweed cultivation is presently the most lucrative marine resource-related activity for many coastal communities. This is primarily farmed in the lagoons that exist behind much of the fringing reefs on Unguja Island and, to a lesser extent, on Pemba Island, so that the industry as a whole is dependent on the protection afforded by the reefs.

### Box 3. CORAL BLEACHING IN TANZANIA

Corals harbour photosynthetically active dinoflagellate algae called zooxanthellae in their endodermal cells. The zooxanthellae provide the coral with large quantities of organic materials, especially high calorific value lipids and carbohydrates which provide most of the energy for maintenance, tissue and skeletal growth, and possibly reproduction. Furthermore, the zooxanthellae pigmentation is responsible for the colour of the coral colony. In return, the coral provides space, protection, and nutrients to the zooxanthellae.

Coral bleaching refers to the loss of the zooxanthellae by the host (i.e. the coral), or the loss of photosynthetic pigments within the algae itself, which make the coral transparent. Consequently, coral colony appears white due to the underlying skeleton. Some bleaching events are reversible and do not kill corals, however, extensive bleaching can cause mass mortality of corals and local extinction of coral species.

A coral bleaching event may be evoked by various environmental factors, such as higher-than-normal sea temperatures, higher levels of ultraviolet radiation, fluctuations in salinity, increased sedimentation, bacterial infection, crown-of-thorn starfish predation and various anthropogenic toxicants.

In 1998 between the months of March and June, a widespread coral bleaching incidence was witnessed in the western Indian Ocean with coral mortalities ranging from 0 – 85% on shallow reefs (See Wilkinson et al., 1999).

In Tanzania, the severity of the bleaching and coral mortality differed among reef sites. The corals of Tutia, Juani and Mange reefs off Mafia Island, and Misali off Pemba Island suffered greater mortalities ranging from 60–90% and 30–65% respectively. Reefs in Mnazi Bay, Kunduchi and Songo Songo experienced medium to high coral mortalities. Reefs around Unguja Island were least affected, with coral mortality ranging from 10 to 25%. The onset of the coral bleaching corresponded with increased seawater surface temperatures at Unguja Island. The intrusion of a cold water mass, cooling the water around Unguja Island in mid-March could be the reason for a comparatively low coral mortality on these reefs. In all areas, corals were more affected in shallow waters and *Acropora* was the most affected genus. Preliminary observations indicate that coral recovery has started on some reefs. The unprecedented mortality of Tanzanian corals constitutes an additional degrading factor for reefs, which are already under pressure.



Assessment of coral bleaching at the permanent monitoring site at Bawe reef, Unguja

**Table 9. Sea Cucumber Export from Tanzania**

Year	Dry Weight (Kg)	Value (US\$)
1992	178,373	411,979
1993	326,620	481,098
1994	530,192	884,169
1995	263,870	353,919
1996	296,410	450,405

Major threats to coral reefs include: destruction by fishing with explosives, anchor damage, destruction for construction material, vessel grounding, trampling, destruction of linked habitats such as mangroves and over-harvesting of fish, octopus, sea cucumbers and shells. Others include sediment mainly brought in by rivers, sewage discharges and chemical pollution, poison fishing and dredging. Abnormal nutrient enrichment, particularly from sewage disposal, can alter the structure of coral reef ecosystems through the overgrowth of algae and shade from increased algae production.

Reef blasting has devastated most of Tanzania's coral reefs. This destructive fishing method has increased since the late 1960s. Dynamite fishing not only destroys fish in abundance but damages the ecological balance as well. It kills all fish within the radius of the blast and destroys the cover for the inhabitants that would populate the area. It is the lack of fishing gear that mostly forces fishermen to resort to this illegal fishing method. However, pure human greed by owners of motorised boats is another reason for the continual use of dynamite. The coastal people are aware of the ill effects of dynamite fishing and both the government and nongovernmental organisations have made some effort to combat this problem.

Corals are mined for building stone and for production of lime by the local construction industry. To produce lime, coral is burnt in a kiln. Coral is either mined from ancient fossilised coral reefs found inland and below ground, or from live and dead coral from the sea. Coral mining in the sea destroys the coral reef habitat with consequent reduction in ecosystem productivity.



Corals such as this *Montipora* sp. are common in Tanzania

#### Box 4: CORAL CULTURE FOR MANAGEMENT IN TANZANIA

The anthropogenic pressure on the coral reefs of Tanzania is high. Over-exploitation, destructive fishing practices, unplanned tourism and high sediment load are among the most evident contributing factors whilst the poor economy and increasing population density along the coast is an underlying problem. The 1998 coral bleaching event resulted in further deterioration of the coral reefs. In some areas natural regeneration or replenishment of the reef environment and its resources appears to be far less than the corresponding harvested stocks and destructive activities, resulting in a net loss or degradation of the reefs. There is a need for alternative sources of livelihood and effective ways to manage coral reef resources sustainably. Coral culture is one of the options in restoring degraded coral reefs and could become an income generating activity.

Experiments on coral culturing (transplantation) have been conducted on Chumbe and Bawe reefs in Zanzibar, on Kitutia reefs in Mafia and on Mbudya reefs in Dar es Salaam. The objectives of the experiments included assessing the possibility of culturing coral fragments of different sizes, assessing the effects of lesions on the upper surfaces on the fragment growth and survival and selecting species suitable for transplantation. Other experiments investigated appropriate coral fragment attachment techniques and procedures when restoring rock-, sand- or rubble-dominated reefs. The use of artificial structures as fragment attachment media was investigated in areas where biophysical factors prevented direct transplantation on the sea bottom. More than 14 species were tested. In these experiments, the guiding principal was to minimise damage to the donor colonies and to maximise survival and growth of transplanted coral fragments.

The results have indicated that having lesions on the upper surfaces did not inhibit the growth of coral fragments from *Acropora nasuta*, *Acropora auctera*, *Acropora tenuis*, *Galaxea clavus* and *Porites cylindrica*. Fragments as small as 2 cm survived and grew. The experiments revealed that larger fragments survived better than small fragments although they were relatively more difficult to attach. Fragment survival was better on rubble-dominated areas than on sand, implying that the use of artificial substrate is necessary to restore or expand coral reef distribution on sandy patches on the reef flat and on lower reef slope areas.

In other parts of the world, coral transplantation has been studied as a potential reef management option for many reasons. In the Philippines, transplantation was tried to aid coral recovery following dynamite fishing. In Guam, attempts were made to replace coral species killed by diseases, while in Singapore, transplantation was done to save species threatened by pollution or loss of habitat due to reclamation. In Hawaii, coral transplantation was done to reintroduce species of corals in an area polluted by sewage and in Florida, to aid reef recovery following the grounding of large boats. In the Gulf of Mexico, transplantation was done to enhance a tourist area. In Great Barrier Reef, coral transplantation was done to aid recovery of coral areas damaged by crown-of-thorns starfish, *Acanthaster planci*.

Coral reef management in Tanzania could benefit from the use of 'coral nurseries' or 'coral gardens' from which small branches can be harvested and subsequently transplanted to degraded reefs. Coral culture could be and should be used to restore degraded environments or species. It is the intention of the Institute of Marine Studies concerning various aspects of coral culturing in order to develop a sustainable industry of mariculture.



Coral culture experiments

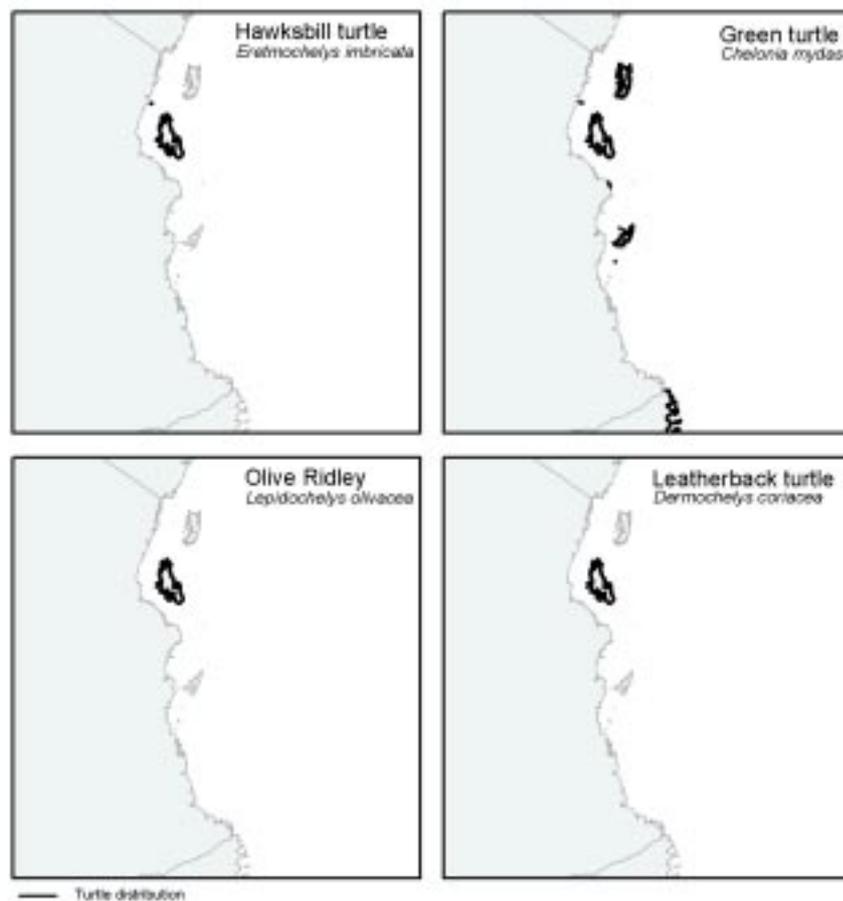
## MARINE TURTLES

The following five species of marine turtles are found in the waters of Tanzania: green turtle, *Chelonia mydas* (locally known as 'kasa' or 'nduvi'); hawksbill turtle, *Eretmochelys imbricata* ('ngamba'); leatherback turtle, *Dermochelys coriacea*; olive ridley turtle, *Lepidochelys olivacea* and loggerhead turtle, *Caretta caretta* ('mtumbwi', 'ranga'). The most common type is the green turtle followed by the hawksbill, which is smaller. The loggerhead and leathery turtles are less common, while the olive ridley is very rare.

Out of these, the green turtle is the only herbivore; it nests at night in large groups of several hundred. The hawksbill uses its pointed beak for feeding on invertebrates found on the coral reefs. It nests during the day, singly or in small groups. The loggerhead has strong jaws with which it crushes hard molluscs and nests in subtropical areas. The olive ridley turtle feeds on sessile and slow-moving invertebrates that live in the shallow, often muddy waters of estuaries; it nests in very large concentrations. The leathery turtle, one of the largest of living reptiles, feeds on jellyfish and other soft-bodied invertebrates.

Some of the nesting sites are the beaches between Jambiani and Makunduchi in Unguja Island, on Mnemba Island and on a small islet at Mwanamwana north of Tumbatu Island, Mafia, Latham and Misali Islands. Others are Kipumbwi, Kilwa Kisiwani and Pangani along the Tanzania Mainland coast (Map 7).

Turtle populations in Tanzania have declined, probably due to loss of the nesting sites. Maziwi Island for instance, was an important breeding site for the green, hawksbill and olive ridley turtles. The small island was submerged below the high spring tides in the early 1980s and is no longer suitable for nesting. The development of hotels along beaches is also another reason for the decline of nesting sites (e.g. in the east coast of Unguja Island there are now



Map 7. Marine turtles main distribution areas by species

22 hotels compared to none in 1988). Turtles are exploited for their meat and eggs and the hawksbill for the carapace, which is used for ornamental purposes. It is the epidermal plate material of this species that is inaccurately termed 'tortoise shell'. Fishermen using gill nets for fishing also catch the turtles incidentally.

Although turtles are officially protected, in Tanzania there is little effective policing and their status continues to be threatened through active hunting, egg collection, nesting disturbance and incidental catches in nets. In Zanzibar, marine turtles are protected by the 1993 fisheries regulations under the 1988 Fisheries Legislation. Although these regulations prohibit the capture of sea turtles, the law does not prohibit possession of turtle products or meat. Transporting turtle meat from rural to urban areas in Zanzibar was recently prohibited. This has somewhat curtailed the sale of turtle meat in urban areas.



Marine turtle amongst corals

## MARINE MAMMALS

Cetaceans, whales, dolphins and porpoises are among marine mammals which frequent the coastal waters of Tanzania. The dugong (*Dugong dugon*) (order Sirenia) are found particularly near Kilwa and Mafia. Dugongs are herbivores that feed on seagrasses, especially *Cymodocea* and *Syringodium* and can consume up to 30 kg (wet weight) daily. The dugong was once a common species in Tanzania, but is now almost decimated. They are killed for their flesh and oil. Further threats to dugong populations include habitat degradation (e.g. pollution and siltation) which might affect its food supply and dynamite fishing, which kills individuals and destroys the habitat.

Several species of dolphins have been reported in the waters of Tanzania and these include rough-toothed dolphin (*Steno bredanensis*), bottlenose and spinner dolphins (*Stenella longirostris*) and Indo-Pacific humpback. They have been observed in different places including the Rufiji Delta, Mtwara, Tanga, Saadani, Latham Island, Menai Bay, Nungwi and Matemwe.

Humpback whales (*Megaptera novaeanglia*) have also been sighted in Tanzanian waters, particularly near the coast of Zanzibar and Tanga.

## MIGRATORY AND OTHER BIRDS

Mangroves, intertidal flats and rocky cliffs provide habitats for a wide variety of birds. At low tide migrant birds are attracted to the intertidal flats to feed. Latham Island is an important breeding site for birds, such as the sooty tern (*Sterna fuscata*), noddy tern (*Anous stolidus*), crested tern (*Sterna bergii*) and masked booby (*Sula dactylatra*). Fairy tern, frigate birds and gannets are commonly found along the coast. The mangrove swamps and the coastal wetlands are a home to many birds such as egrets, fish eagle and plovers. The non-native Indian house crow, which was introduced in Zanzibar at the turn of the century, has expanded its range to the mainland and has had severe effects on local bird species. It is an aggressive predator of birds, their eggs and young and also a potential carrier of diseases to poultry and native species.



Lesser crested terns at Latham Island

## SPECIES AT RISK

Dugongs and turtles are considered endangered in Tanzania. The dugong species *Dugong dugon* (status unknown) and the turtle species *Caretta caretta* are considered vulnerable while the sea turtles *Chelonia mydas*, *Eretmochelys imbricata*, *Lepidochelys olivacea* and *Demochelys coriacea* are all endangered. Dugong populations used to inhabit the seagrass beds surrounding Kilwa and Mafia and off the Tanga region coast. However, there have been no recent sightings by local populations who enjoyed their meat as a delicacy, or by researchers. The nesting populations of turtles have also been declining rapidly. This is due to increase in incidental catches of these species, hunting as well as degradation of their environment—feeding grounds for the dugongs (seagrass beds) and nesting beaches for the turtles. The huge decline in populations of sea turtles may result in their extinction unless effective protective measures are taken.

Several shore birds depend upon small undisturbed islands for their nesting. Latham Island is particularly critical as a sanctuary requiring specific protection. The island is a famous seabird colony for sooty terns, noddy terns, fairy terns, frigate birds and gannets.

**Table 10. Rare, Vulnerable and Threatened Species**

Type	Common Name	Species Name	Status
Plants		<i>Encephalartos hildebrandtii</i>	CITES Appendix 1
Mammals	African elephant	<i>Loxodonta africana</i>	CITES Appendix 1; IUCN Vulnerable
	Leopard	<i>Panthera pardus</i>	CITES Appendix 1; IUCN Threatened
	Black-and-rufous elephant shrew	<i>Rhynchocyon petersi petersi</i>	IUCN Rare
	Black-and-rufous elephant shrew	<i>Rhynchocyon petersi adersi</i>	IUCN Threatened
	Zanzibar galago	<i>Galagoides zanzibaricus</i>	IUCN Vulnerable
	Lesser pouched rat	<i>Beamys hindei</i>	
	Mongoose	<i>Bdeogale crassicauda</i>	
	Cyclops leaf-nosed bat	<i>Hipposideros cyclops</i>	Rare
Reptiles	Nile crocodile	<i>Crocodylus niloticus</i>	CITES Appendix 1
Birds	Purple-throated cuckoo shrike		Rare
	Sokoke scops owl	<i>Otus sokokensis</i>	
	Clarke's weaver	<i>Ploceus gollandi</i>	
	Reichenow's batis	<i>Batis reichenowi</i>	
	Sokoke pipit	<i>Anthus sokokensis</i>	
	Little yellow flycatcher	<i>Erthrocercus holochlorus</i>	

## THE HUMAN DIMENSION

### Population

Tanzania has conducted three official censuses since independence, in 1967, 1978 and 1988. Another census was to be conducted in 1998 but it was not possible due to the impact of El Niño rains, which disrupted the country's railway and road network. The population of Tanzania has tripled from 7.7 million in 1948 to 23.1 million in 1988. Table 11 shows the population trend of coastal regions since 1967. The total population of coastal regions, which was 2.95 million in 1967, is estimated to rise to 7.61 million by the year 2000. The percentage of coastal population to the country population was 23.6% in 1988, but it is estimated at 24.2% in the year 2000. The population growth rate of the city of Dar es Salaam is very high but it had declined over the previous two inter-census periods (7.8% and 4.8% per annum for the years 1967–1978 and 1978–1988, respectively). By the year 2000, an estimated 7.7% of the Tanzanian population was living in Dar es Salaam. At the time of the 1988 census, this figure was only 5.9%.

Based on land area of 883,749 km<sup>2</sup>, the population density for the country is estimated at 36 persons/km<sup>2</sup> by the year 2000 (Table 12). In Dar es Salaam, the density would reach 1745 persons/km<sup>2</sup>, almost double that of 1988 (977 persons/km<sup>2</sup>). However, in other coastal regions

**Table 11. Population of Coastal Regions in Tanzania**

Region	Total Population				% Growth Rate (1988)
	1967	1978	1988	2000*	
Coast	428,041	516,586	638,015	813,444	2.1
Dar es Salaam	356,286	843,090	1,360,850	2,430,500	4.8
Lindi	419,853	527,624	646,550	800,038	2.0
Mtwara	621,293	771,818	889,494	1,023,134	1.4
Tanga	771,060	1,037,767	1,283,636	1,671,027	2.1
Zanzibar	354,815	476,111	642,578	867,473	3.0
Total (Tanzania)	12,313,469	17,512,610	23,174,336	31,400,138	2.8

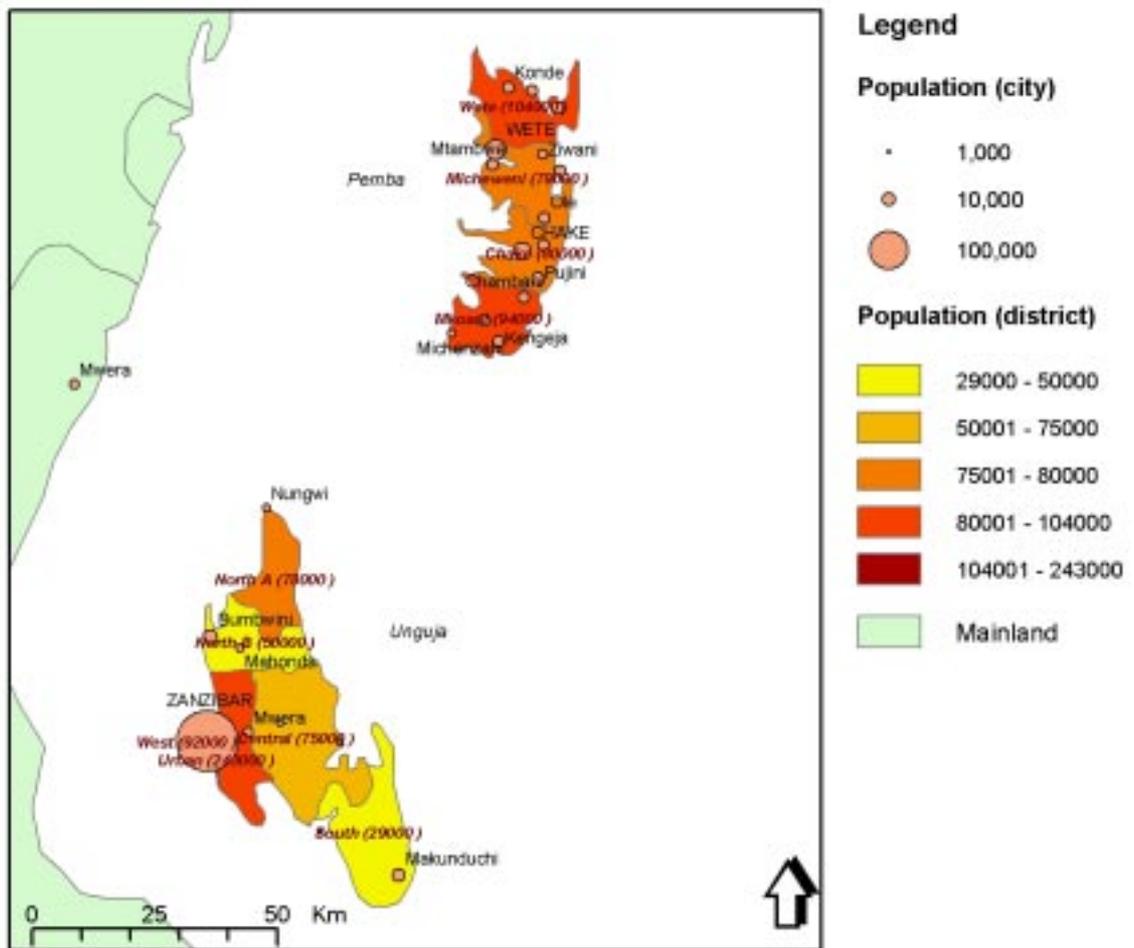
\*Estimates based on various population growth rates.

Region	Land Area (km <sup>2</sup> )	Population Density			
		1967	1978	1988	2000*
Coast	32,407	13	16	20	25
Dar es Salaam	1393	256	605	977	1745
Lindi	66,046	6	8	10	12
Mtwara	16,707	37	46	53	61
Tanga	26,808	29	39	48	62
Zanzibar	2460	149	201	260	353
TANZANIA	881,300	14	20	26	36

\*Estimates based on various population growth rates.

such as Lindi and Coast, the population density in 2000 would be less than the average figure for the country of 36 persons/km<sup>2</sup>. (Map 8)

With the exception of Dar es Salaam, the rate of population density increase for all other coastal regions from 1967 to 1988 was less than that of the country (86%). However, the populations for other coastal regions apart from Dar es Salaam include both urban and rural areas, with the urban areas having higher densities than the rural areas. This explosive urban growth, especially in Dar es Salaam, has not matched the level of surveyed plots for construction of homes and extension of sanitation services. The trend has therefore led to an increase in squatter settlements and environmental degradation.



Map 8. Population projections (estimates) for settlements and districts in Zanzibar for the year 2000



Cleaning fish at Kilwa

Poverty, lack of livelihood opportunities and poor performance of agriculture and fishing are among the main contributing factors to the rural-urban migration. Availability of arable agricultural land is also an issue in coastal areas, because, thanks to customary law, only a few families own the large expanses of land.

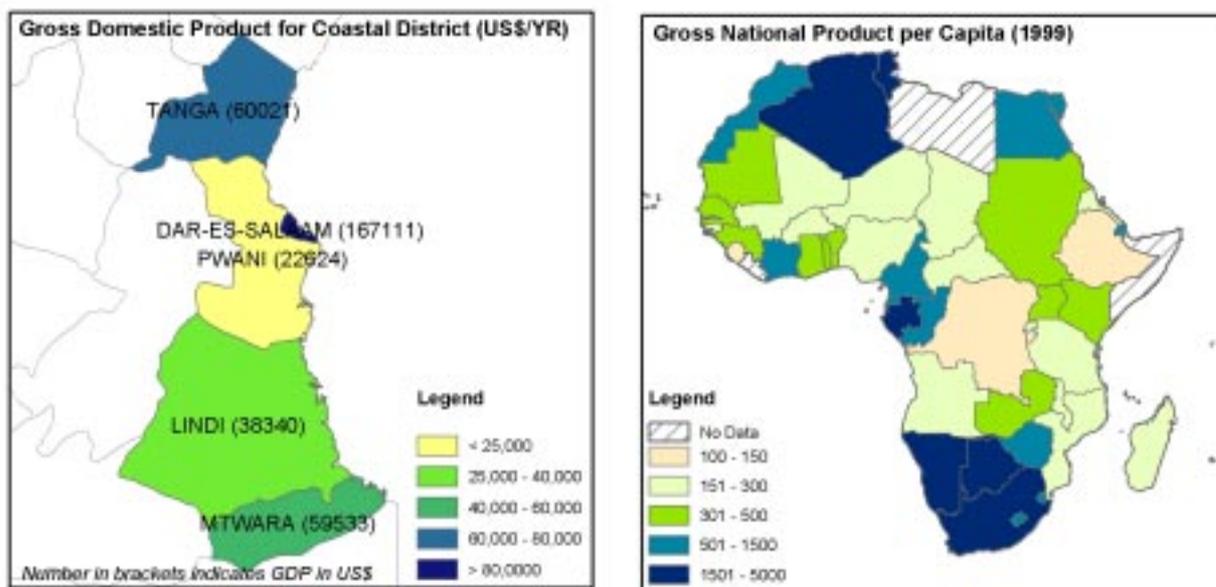
The rapid growth rates of human populations along the coast, which tend to congregate in the resource-rich areas, have a profound effect on the sustainability of the coastal zone resources. Coastal populations exploit these resources for food, building materials and firewood. As the population rises, so does the pressure of resource use until, without careful management, it becomes unsustainable due to over-exploitation.

## The Coastal Economy

Tanzania is one of the poorest countries in the world, with per capita income of about US\$ 150 per year. The economy is heavily dependent on agriculture (primarily coffee, cotton, tea, cashewnuts, sisal and tobacco), which accounts for 50% of the gross domestic product (GDP). Agriculture thus provides 85% of the country's exports and employs 90% of the work force. Industry accounts for some 15% of the GDP and is mainly limited to processing agricultural products and light consumer goods. Tourism is one of Tanzania's dynamic sectors and has shown significant growth in recent years.

Over the period of 1980–1994, the five coastal regions, which comprise 15% of the land area of Tanzania, contributed about one-third of the national GDP, with Dar es Salaam leading overall with 20% of the national GDP. However, Lindi and Coast regions are nationally ranked as the poorest (Map 9).

Economic activities in coastal areas include fishing, subsistence farming, trade and tourism. Smallscale trading occupation involves selling fish, mangrove poles, coconut, salt, lime, charcoal, firewood and retail trade. Although farming is the nation's most common occupation, agricultural activities are less important economically than fisheries to the coastal communities. In coastal communities, coconut is the most important cash crop in terms of land area in production and number of farms. The other major cash crops are cotton, sisal and cashews.



Map 9. Gross domestic product in coastal districts of Tanzania and the gross national product per capita in Africa

Livestock keeping in Mtwara, Lindi, Coast and Dar es Salaam has been low in comparison to other regions like Tanga and the rest of the country. Livestock keeping is predominantly traditional and is composed more-or-less of entirely indigenous stock.

Activities such as coastal tourism, mariculture and natural gas exploitation are seen as potential resources for national economic development. There is also a substantial potential for agriculture, fisheries, shipping, urban development, smallscale mining and manufacturing, which have been tapped.

## Infrastructure and Utilities

The coast is of critical importance to the development of the country. Tourism, fisheries, shipping, mariculture, salt production and urban development are viewed by the government as being important components to the socioeconomic development of not only the coastal communities but the whole country as well. This notwithstanding, much of the coastal areas remain relatively underdeveloped and with poor infrastructure, rendering the rural coastal communities poor.

### DOMESTIC WATER SUPPLY AND SEWAGE SERVICES

Water is one of the most important natural resources for human welfare and human existence. It plays an important role in industry and it is indispensable in food production. Relative to the country as a whole, water access is good in the coastal regions. For instance, while the national average of people in rural areas that have access to clean water is 22%, it is 87% in Mtwara, 61% in Lindi and 48% in Tanga.

Water demand in Dar es Salaam in 1993 was 409,500 m<sup>3</sup>/day, while the total production capacity stood at about 191,000 m<sup>3</sup>/day. There has always been a high demand for water resulting from growth in population and industry. About 33% of the households in Dar es Salaam have water connections. Other sources such as water harvesting and groundwater are also available. In the other regions, the main sources of water are groundwater and surface water.

Treatment of water is poor causing most coastal areas to experience occasional outbreaks of communicable diseases such as cholera due to shortage of safe water. Most of the households have toilets. Pit latrines are predominant and are commonly used by low-income households. Access to flush toilets is much higher in urban than in rural areas. In coastal communities there is a high percentage of households without any toilet facilities (Table 13).

**Table 13. Distribution Percentage of Private Households by Type of Toilet**

Region	Rural			Urban		
	Flush	Pit Latrine	None	Flush	Pit Latrine	None
Tanga	0.8	80.8	18.3	16.2	79.2	4.5
Coast	0.9	76.1	23.0	4.8	88.3	6.7
Dar es Salaam	3.8	80.9	15.2	15.9	83.1	1.0
Lindi	0.6	77.2	22.2	4.7	85.0	10.3
Mtwara	1.0	84.2	14.8	7.4	86.1	6.6

## ROADS

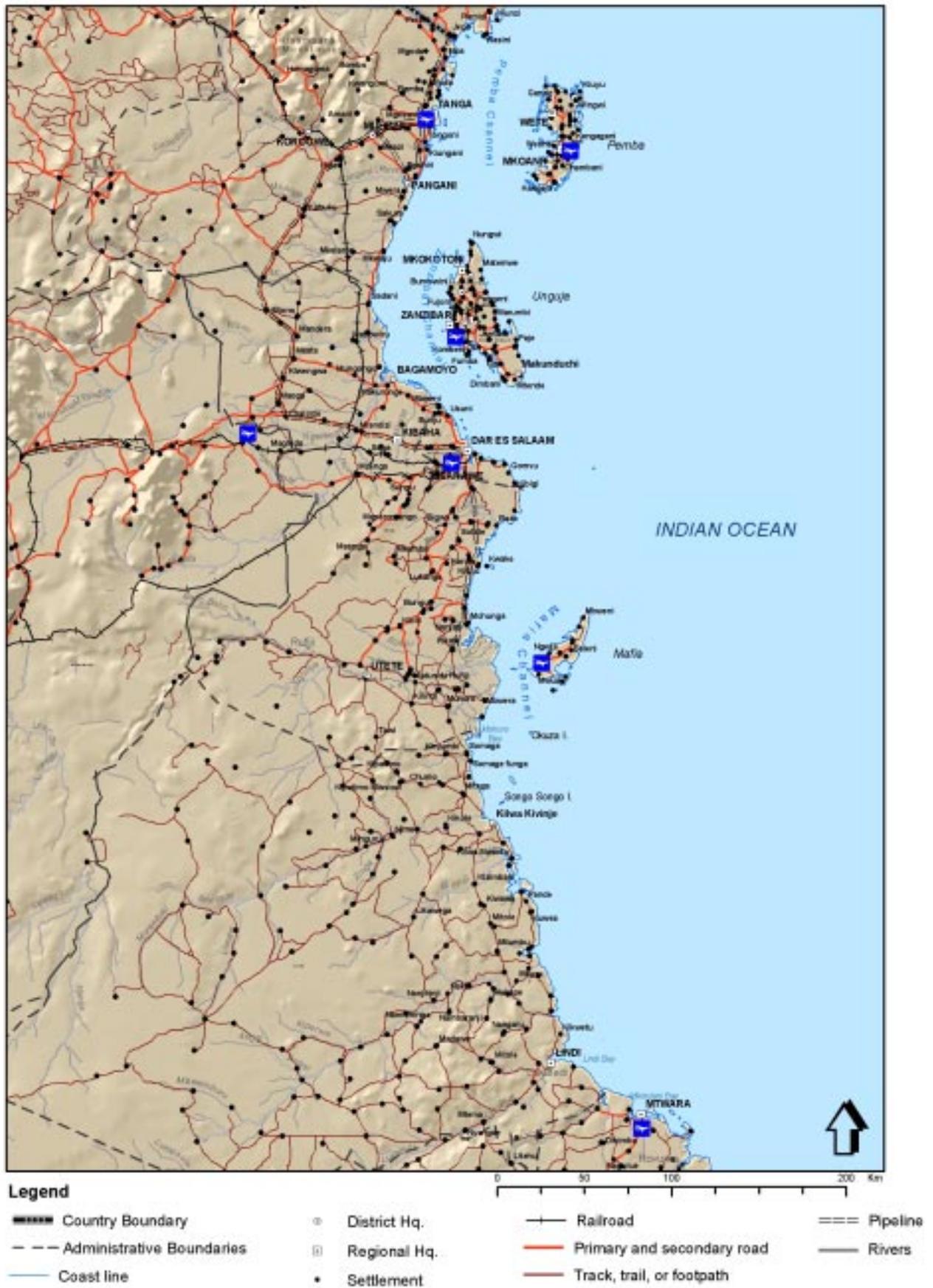
The road system is generally poor along the coast. However, Dar es Salaam City is well served with both tarmac and earth/gravel roads (Map 10). The road leading to Lindi and Mtwara via Rufiji River and the floodplain in the Coast region is seasonal and impassable during the long rains. Coast, Lindi and Mtwara regions have few tarmac surfaced roads. In Coast region, 89% of the roads are constructed of gravel and bare earth and are impassable during the rainy seasons. The 'truck' roads that connect other regions with the Coast region are about 85% hardtop. Connecting roads represent about 11% (407 km) of the total road length in the region. In Lindi, most of the roads are old and have not been repaired; 96.4% of them are built of earth, while 2% are tarmac, but full of potholes. In Tanga, about 304 km of the roads are tarmac; 1092 km are gravel and 1382 km are earth.



Ferry-crossing at Pangani river

## RAIL TRANSPORT

Tanzania has two railway systems, namely the Tanzania Railways Corporation (TRC) and the Tanzania Zambia Railways Authority (TAZARA). The two railway lines have different gauges (TAZARA: 1.067 m and TRC: 1.000 m) and meet at two points only. The first meeting point is at Dar es Salaam Port and the second is at Kidatu, about 300 km from Dar es Salaam. TAZARA operates 1860 km between Dar es Salaam and New Kapiri Mposhi in Zambia, of which 891 km are in Tanzania. TRC line is 1255 km long. It goes up to Kigoma, on the shores of Lake



Map 10. Infrastructure in the coastal areas of Tanzania

Tanganyika, linking Dar es Salaam with western Tanzania. The line branches at Tabora and goes to Mwanza on Lake Victoria. Before reaching Mwanza, at Isaka, TRC has built a modern depot to facilitate transshipment of cargo to Kigali in Rwanda some 500 km from Isaka. At Ruvu, some 60 km from Dar es Salaam, the line branches to Tanga where it stretches further to Moshi and Arusha in Tanzania and Taveta in Kenya where it connects to the Kenyan railway system. Construction of a transshipment station between TAZARA and TRC is underway at Kidatu to enable goods to be railed from the Republic of South Africa to Kenya and Uganda.

#### AIR TRANSPORT

Tanzania has three international airports: Dar es Salaam and Zanzibar along the coast and Kilimanjaro inland. Dar es Salaam International Airport (DIA) is the largest, handling both passengers and freight cargo. There are also 60 airstrips spread across the country. These are served mainly by local airlines, Air Tanzania being the national airline. Mtwara region has three landing facilities, that is, one major airport, one minor airport and one airstrip. The major airport, located in Mtwara town, is capable of handling large aircraft and regular commercial traffic. There is one minor airport in Masasi, while Newala has a small airstrip for use by light, non-commercial aircraft at irregular intervals.

Air transportation is not common in the Coast region. There are airstrips on Mafia Island and in Rufiji, while, in Bagamoyo, an airstrip is under construction. In Lindi, there are three airports located in Lindi town, Nachingwea and Kilwa. Tanga has the fifth-largest airport on Tanzania Mainland; it also has several airstrips.

# PART 2

## Coastal Resources and Their Use

C. MUHANDO, Y. MGAYA AND J. DAFFA



Stone Town Cultural Centre, famous by its former name "Old Dispensary"

### HISTORICAL AND CULTURAL RESOURCES

The Tanzanian coastal zone is rich in historical and archaeological sites reminiscent of its long history of Swahili culture. Several remnants of mosques, churches, palaces, slave forts, carved doors and other ancient structures depict different ensembles of Islamic, Christian, Persian, Arab and European architecture using lime, coral stone and timber. In most places there are monuments of mosques, groups of tombs inside and outside city walls, mounds and house walls representing the old city houses.

The most spectacular sites are the islands of Zanzibar and Pemba and Bagamoyo and Kilwa on the mainland's coastline. For centuries, Zanzibar was the principal emporium of the eastern seaboard of Africa. At one time the Zanzibar Empire stretched from Cape of Guardafui in Somalia to the Ruvuma River and inland beyond the Great Lakes. The remains of the imperial infrastructures have survived centuries in the Island. The house that Dr Livingstone lived in still stands at Ng'ambo by the Dhow Harbour and the old British consulate where his body

was kept before being sent to UK continues to be preserved. Other famous historical sites in Zanzibar are the Arab stone houses with their wooden balconies and magnificently carved doors. Also famous are the old Arab Fort with its round stone towers, the palace of the former sultan, the towering Beit el-ajab (the House of Wonders) — once the largest building in Zanzibar, and ruins of the haunted palace at Dunga. Others are the English cathedral, Maruhubi Palace ruins built by Sultan Sayyid Barghash between 1880 and 1882, Persian baths at Kidichi built in 1850 by Sayyid Said bin Sultan for his second wife and the Prison Island situated to the West of Zanzibar town.

Pemba, whose touristic attractions have earned it the popular name 'The Pearl of the Indian Ocean', is home to the remains of a Portuguese fort at Chake Chake and Pujini ruins, some 11 km north of the town. Other remains include Harun's Tomb, which is a traditional pillar tomb 15 feet high believed to be the memorial for a former Shirazi Prince and the 'Lonely Tomb' close to the village of Vitongoji, situated between the beach and the jungle. Similarly, Pemba has a tradition of bullfighting derived from the Portuguese occupation of the 16<sup>th</sup> and 17<sup>th</sup> centuries.

Bagamoyo, located about 72 km north of Dar es Salaam, was a major port of the ivory and slave trades. The first mainland Christian Mission was established in Bagamoyo in 1868; in 1888 the German East Africa Company made it the base of its operations. When the German East Africa colony was established in 1890, Bagamoyo briefly became the capital. The Germans shifted their administrative centre to Dar es Salaam in 1891. A number of Arab and German buildings are preserved in Bagamoyo, as well as a small guardhouse which was built in 1889. Its location is believed to be the site where the old caravan route from the interior entered Bagamoyo.

Kilwa is a small coastal township in Lindi region, which contains some magnificent ruins, regarded as the most spectacular on the East African coast. The focal point is Kilwa Kisiwani (Kilwa Island), where in the 12<sup>th</sup> century, Shirazi merchant rulers settled to build a wealthy dynasty. Kilwa grew as a gold trade terminus with its own sultan and even minted its own coinage. Near to this place are the historic sites of Mtitimira, Songo Mnara, Sanje ya Kati and Sanje Majoma.



Historical building constructed by the Portuguese in 1905



Dema—a traditional fish trap used in Unguja

Other historical remains reminiscent of the coastal ancient past are the Kunduchi, Mbweni and Mzizima ruins in Dar es Salaam; Amboni Caves and Tongoni, Toten Island and Ndumi ruins in Tanga region and Kimbiji, Kisiju, Koma Island, Chole, Kua, Jibondo and Kisimani Mafia ruins in Coast region.

## FISHERIES AND AQUACULTURE

### Artisanal Fisheries

The contribution of fishery to Tanzania's GDP varies between 2.1–5% in Tanzania mainland and 2.2–10.4% in Zanzibar, mostly from export of fishery products. Tanzania exports marine fishery products to the tune of around US\$ 7,652,700 for the mainland part and US\$ 598,203 for Zanzibar. These products are shrimp, beche-de-mer, shells, lobster, crabs, squid, octopus, sardines, fish offal and aquarium fish.

In Tanzania marine fisheries are still mainly artisanal. Marine fish output contributes about 15% of the total fish production in the country with the rest coming from freshwater fisheries. In Tanzania Mainland, marine fish catches fluctuated between 35,000–60,000 metric tonnes annually between 1990 and 1996 (Table 14) of which more than 95% was contributed by smallscale fisheries. From 1992 to 1997, the artisanal fishery production in Zanzibar remained steady at around 10 metric tonnes. The number of artisanal fishermen in Tanzania Mainland in 1996 was estimated to be 13,822 and the number of fishing vessels were 3768.

Artisanal fishermen use traditional crafts (mostly non-motorised) and simple fishing gear. Most of the fishing vessels in Tanzania Mainland and Zanzibar are locally made and range in size from 4–10 m. The most common fishing vessels are dugout canoes. Dugout canoes with outriggers are known locally as 'ngalawa' and those without are known as 'mitumbwi'. The most common means of propulsion is by oar, pole or sail. The larger dhow and 'mashua' are usually wooden planked and sometimes motorised. The most common vessel used in Tanzania is the 'ngalawa' because it is cheaper than the 'mashua' and relatively more efficient than the dhow or 'mtumbwi'. The fishing gears commonly used are lines (troll line, handline and

**Table 14. Summary of Artisanal Fishery Production**

Year	Tanzania Mainland		Zanzibar	
	Number of Fishermen	Fishing Vessels	Weight of Fish (Kg)	Weight of Fish (Kg)
1990	16,178	4354	54,527	8851
1991	16,361	4401	52,381	7842
1992	15,027	3514	43,886	11,740
1993	15,027	3232	34,227	9884
1994	15,027	3232	37,286	11,329
1995	13,822	3768	48,762	9789
1996	13,822	3768	58,780	11,214
1997				10,062

longline), traps (fixed and moveable), nets (purse seine, scoop, drift gillnets, demersal gillnets with small and large mesh, shark nets and surrounding gill nets), spear guns and iron harpoons.

The main groups of fish caught by artisanal fishermen in Tanzania are the demersal fish (i.e. bream, parrotfish, snappers, mullet, emperors, groupers, etc.), which are caught with lines, traps and nets. The small pelagic fish (sardines, mackerel, anchovies, etc.) are caught with purse seine nets, surrounding nets and scoop nets, while the large pelagic fish (tuna, kingfish, sailfish, marlin, shark and ray) are caught with lines, drift gillnets, demersal gillnets and shark nets. Other species caught include octopus, squid, prawn and lobster.

Fishing communities (with the exception of urban centres) exist in many small villages scattered along the entire Tanzania Mainland coastline. Fishing takes place almost entirely within the nearshore waters to depths of 40 m, although sometimes there is handlining to 60 m depth on the upper edge of the continental shelf. The area along the Tanzania Mainland coast available to the artisanal fishery is estimated to be around 12,000 km<sup>2</sup>, regionally divided into Tanga (2200 km<sup>2</sup>), Coast including Dar es Salaam (8100 km<sup>2</sup>), Lindi (1550 km<sup>2</sup>) and Mtwara (310 km<sup>2</sup>).



Dhow building yard in Unguja

In Zanzibar artisanal fishing is undertaken along the entire coastline of both islands (Unguja and Pemba) within 2 km of the shore, where the areas are protected by coral reef barriers and the water depths are not more than 20 m. Some fishing occurs in depths of 100 m and more in the case of drift gillnetting and large pelagic fishing, although this is on a small scale and is undertaken by the larger boats such as dhows. Since the main propulsion for the fishing boats is wind, the fishing areas protected by the coral reef barriers are the only places where it is possible to fish all the year round. However, because of the limitation of tides, fishermen can only operate for 12 hours a day. The total area available for artisanal fishermen in Zanzibar is estimated at 4001 km<sup>2</sup>, divided into 1279 km<sup>2</sup> for Unguja Island and 2722 km<sup>2</sup> for Pemba Island.

## Industrial Fisheries

Several semi-commercial fishing companies operate in Tanzanian waters, particularly off the Bagamoyo-Saadani area and the Rufiji Delta (prawn fishing). Some of these companies are government-owned, such as Tanzania Fisheries Corporation (TAFICO) and others are privately owned. In 1995, there were 19 commercial trawlers and three commercial purse seines operating along the Tanzania Mainland coast (Table 15).

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998
No. Vessels	16	19	15	13	16	19	13	16	17
Catch (Mt)	2015	1510	1119	1223	1787	1933	1377	1206	1533

The majority of the commercial vessels are foreign-owned. The prawn fishing season lasts for 9 months from March to the end of November and trawling is permitted from 6.00 am to 6.00 pm every day. The prawn trawling grounds are divided into three zones as follows: Zone 1 - Bagamoyo and North; Zone 2 - Shunga Bay to Ras Twana; Zone 3 - Bwejuu Island and South. Due to the Rufiji River, Zone 2 produces the highest prawn yields (up to 80% of the total catch) for the trawlers. To avoid over-exploitation of Zone 2, the Fisheries Division allocates zones to trawlers (Map 11) on a rotational basis.

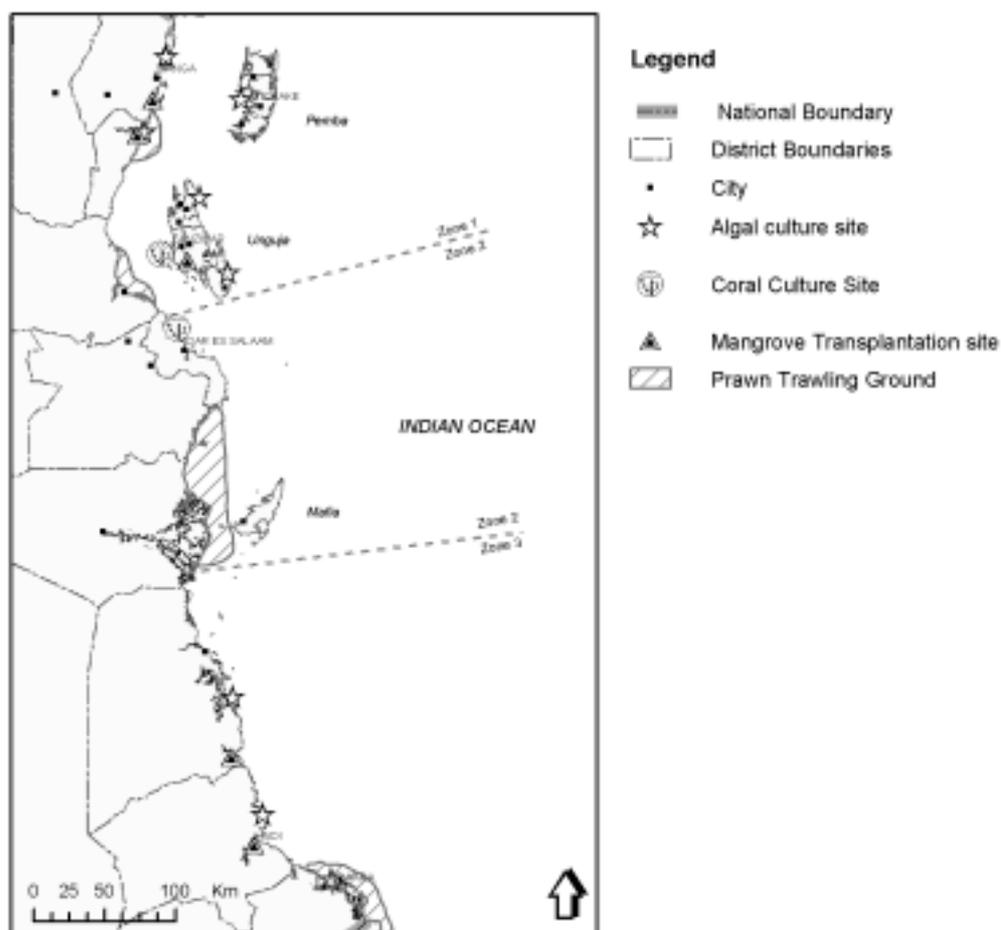
There are no commercial fishing trawlers registered in Zanzibar and foreign fishing vessels have not used Zanzibar port for over five years.

## Mariculture

The coastline of Tanzania consists of mangrove areas, salt marshes, fringing coral reefs, intertidal floods, estuaries, lagoons and bays, within which there are potential sites for mariculture.

Aquaculture production in coastal areas includes species grown in both brackish and marine environments. It is strongly believed that Tanzania's numerous deltas, estuaries and mangrove swamps hold great potential for mariculture, especially prawn culture. However, to date there have been only limited attempts to culture a number of species, such as rabbitfish (*Siganus* sp.), prawns (*Penaeus* sp.), oysters (*Saccostrea cucullata*) and seaweeds (*Euचेuma* sp.) (Table 16). The culture of rabbitfish (*Siganus* sp.) and cockles (*Anadara antiquata*) was successful at the experimental level but has not been adopted by local communities because it is an expensive project and also people lack awareness of its potential.

Although significant development has been realised in seaweed farming in Zanzibar and now to a lesser extent in Mainland Tanzania, the mariculture industry in Tanzania is still at its infancy. Only few mariculture attempts have been made by researchers and with the exception of algal culture, all other culture species have not developed further to a pilot scale or model farm for adoption by the local communities. It is interesting to note that private companies



Map 11. Mariculture sites and prawn trawling grounds and zones

Year	Experiment	Place	Technology
1982	Finfish <i>Siganus</i>	Unguja, Zanzibar	Cages
1983	Seaweed farming	Tanga, Zanzibar	Rafts
1985	Seaweed farming	Unguja, Zanzibar	Cages
1989	Seaweed farming	Unguja, Zanzibar	Pegs and ropes – extensive
1991	Shellfish <i>Anadara</i>	Mji Mwema, Dar es Salaam	Direct sowing in the sediment
1992	Seaweed farming	Pemba, Zanzibar	Floating method
1994	Finfish polyculture	Pete, Zanzibar	Ponds
1995	Seaweed farming	Mtwara, Lindi, Tanga	Pegs and ropes
1996	Oysters	Muheza, Tanga	Racks and rafts
1998	Finfish, shellfish and seaweed	Unguja, Zanzibar	Integrated pond model

are initiating mariculture operations and one of them has already established a commercial pilot farm for prawns at Bagamoyo. The proposed Rufiji Delta Prawn Project would be the largest such project in the world if developed as planned. The proposed farm would cover about 6000 ha of surface water growout ponds on 10,000 ha of land. It would consist of production ponds plus water pumping stations, supply and drainage canals. Staff quarters for operating personnel, storage facilities for materials and supplies would be built close to the farm. The targeted species for prawn culture is *Penaeus monodon*. The developer, African Fishing Company Limited (AFC), plans to employ semi-intensive production methods at farm level management.

The farming of the seaweed *Eucheuma* was introduced in Zanzibar in 1989. The production of cultivated *Eucheuma* in metric tonnes dry weight from Tanzania has been increasing yearly (Table 17).

### **Box 5. THE RUFJI DELTA PRAWN FARM PROJECT**

The Rufiji River Delta is the largest delta in eastern Africa and contains the largest estuarine mangrove forest on the eastern seaboard of the African continent. It also contains numerous other features of conservation and socioeconomic importance. More importantly, the delta region is home to over 30,000 people who live, farm and fish in its rich fishing grounds. The delta's waters produce over 80% of Tanzania's prawn exports, consisting entirely of wild prawns.

In 1996, the African Fishing Company, a Dar es Salaam based company owned by a foreign investor, applied to be allocated some 10,000 hectares in the Rufiji River Delta to undertake industrial prawn farming. According to the project document, this project would be financed under a credit facility extended by the European Investments Bank (EIB) and European Development Fund (EDF) to the tune of US\$ 180 million.

The Prawn Project, the biggest in the world, has attracted widespread controversy. In May 1996, AFC submitted an Environmental Impact Assessment (EIA) but it was found to be too demanding and raised even more controversy. As a result AFC was required to undertake a more thorough EIA, a report of which was submitted in April 1997.

Prepared by a team of high level experts of various disciplines and from various institutions, the EIA report detailed various social and economic benefits to be derived by the local communities and the nation at large. The chief benefit was foreign exchange earnings, which were projected at between US\$ 200 and 300 million annually throughout the entire life of the project. The EIA report also identified several negative 'externalities' that will ensue from the implementation of the project. These included clearing of mangroves, pollution arising from the disposal of wastewater effluents, contamination of fresh water sources and agricultural land from the saline seawater, possible outbreak of infectious diseases, and so on. The report, therefore, proposed mitigation measures such as replanting of cleared mangroves, the use of solid waste for construction of roads and for earthwork repairs and close project monitoring to avoid negative impacts.

In June 1997 the Government directed the National Environment Management Council (NEMC) to coordinate the review of the EIA report and submit recommendations to the Government. NEMC was required to draft experts from various Government departments and elsewhere for this task and to take into account laws and policies that regulate the sector. NEMC submitted its report in August 1997.

NEMC's review report found that the EIA report submitted by AFC contained, among other things, a far higher danger of socioeconomic and ecological damage than AFC had indicated in its EIA report. Furthermore, the review report found that the Rufiji Delta region was far more economically productive without the Prawn Project and its attendant dangers. On legal and policy issues, the review report found that serious abrogation of the law would occur if the project was approved for implementation as conceived. The review report also examined land tenure issues and found that serious land use conflicts will ensue as a result of the implementation of the Project. The conclusion that the review team reached in its report was that the Project should not be approved for implementation until such time as the land use master plan for the Rufiji Delta has been completed and land use conflicts had been resolved. NEMC also advised that commercial prawn farming should not be allowed in Tanzania until rules and guidelines to regulate the industry have been promulgated, and that these activities should not be undertaken in ecologically sensitive areas such as mangroves.

Both the Ministry of Energy and Minerals and the Tanzania Petroleum Development Corporation (TPDC) had also taken positions against the implementation of the Project. The objections were founded on the fact that the Rufiji Delta has been designated as an oil exploration block which has already been allocated to two foreign oil prospecting companies for that purpose. Granting a large chunk of the Delta area to AFC would therefore lead to future land use conflicts.

The Ministry of Natural Resources and Tourism (MNRT) on its part also agreed with the review report. It furthermore suggested that the project should not be implemented in the controversial five out of six sites identified by AFC which have conservation status. It set out a rigorous monitoring regime to ensure ecological destruction in the remaining site was avoided. It proposed the adoption of semi-intensive prawn culture technologies rather than intensive ones, as well as payment of compensation and cost of resettlement of the people who would be affected by the Project.

The review report was submitted to the Vice President in August 1997. The Government reached its decision—to approve the Project—in late November 1997. In the aftermath of the Government's decision, local communities in the Delta decided to file a constitutional suit in the High Court to challenge the Government's decision.

Due to its anticipated negative impacts, the Project has been opposed by the majority of the local population in the Rufiji area, including academicians, nongovernmental organisations and journalists. The review process also involved a public hearing—the first of its kind in the history of the country.

**Table 17. *Eucheuma* Export in Zanzibar**

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
(Mt Dry Weight)	119	1218	2177	2245	3382	6452	7200	–	5770	5212

In 1996 the farms covered 570 ha. Seaweed farming is mainly carried out by women who have very few other opportunities to earn money. Seaweed accounted for about 15 and 27% of total export earnings of Zanzibar in 1993 and 1994, respectively. In 1994, the total seaweed export amounted to US\$ 793,548 compared to US\$ 466,129 from tourism. The species cultivated include imported *Eucheuma spinosum* and naturally occurring *Eucheuma cottonii* (*Kappaphycus alvarezii*). So far two Philippines varieties are grown because they have a higher growth rate of 6–7% per day while local varieties grow at 4.5% per day.

Seaweed farming has several important advantages that make it an important activity for the future. For example, it does not compete with traditional crops for land, it does not require freshwater and the addition of fertilisers and pesticides is usually not necessary. Seaweed growth requires habitats with clear seawater, away from freshwater estuaries and where the seawater salinity does not normally fall below 30‰. However, cultivation in the sea is in many ways similar to cultivation on land. There are problems of grazers, epiphytes, diseases and some sites do not support the growth of certain seaweeds. In seaweed farms, potential grazers include sea urchins and herbivorous fishes. Also, processing and handling capabilities are still below desirable levels and marketing difficulties have started to emerge.

Coastal management initiatives in some parts of Tanzania have involved the culture of marine organisms with the aim of restoring habitat quality after human-induced degradation. Mangrove transplantation projects have been successfully attempted in Tanga, Lindi, Kilwa and Mtwara. Restoring of degraded coral reefs through transplantation of coral fragments is now being attempted in Zanzibar and Dar es Salaam.



Seaweed

## MINERALS AND ENERGY RESOURCES

Tanzania is endowed with a wealth of minerals and energy resources, including the following: hydropower potential, tin, phosphates, iron ore, coal, diamonds, gemstones, gold, natural gas and nickel. Officially, mining accounts for less than 2% of the national GDP, but the actual potential for expansion is considered to be enormous. Smallscale mining is growing, but inadequate management, poor physical infrastructure and poor exploration, extraction and processing technologies have limited largescale mining performance. At the coast, smallscale mining offers an opportunity for income generation.

### Salt Production

There are four main methods for salt production in Tanzania, namely: thermal evaporation, vacuum evaporation, solar evaporation and foothills salt collection. Among these solar evaporation is the most widely used method and the one that is the least capital-intensive. There are about 197 salt works in Tanzania and 193 of them are coastal salt works. In 1991 the total salt produced was 87,567 tonnes, comprising 66,615 tonnes of solar salt, 7182 tonnes of vacuum salt and 13,770 tonnes of thermal salt (Figure 7).



Solar salt pans at Mitengo Village, Mtwara

Relatively big companies such as Coastal Salt Works and H.J. Stanley and Sons in Bagamoyo and Kibo Match in Tanga conduct the largest salt mining business using solar evaporation. Solar evaporation is normally carried out during the dry season.

Salt is also produced through boiling by smallscale miners. This method entails the availability of large amount of firewood, which is obtained by cutting down mangrove forests and neighbouring terrestrial trees. It is estimated that it takes two truckloads of wood to produce 1.4 tonnes of salt using a boiling pan. Almost all the salt produced along the coast is sold to the internal market.

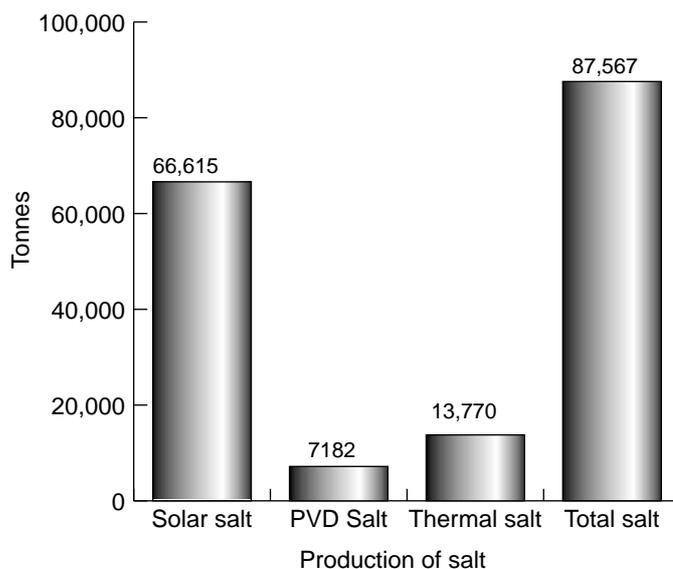


Figure 7. Production of salt

## Limestone and Cement

Limestone is widely available all along the Tanzanian coast and small miners exploit many areas in their day to day construction activities. Tanzania Portland Cement Company and Tanga Cement Company officially exploit limestone at Wazo Hill in Dar es Salaam and Amboni in Tanga, respectively. These two cement plants are the biggest in Tanzania. At Kigamboni in Dar es Salaam, a private company known as Cvamico mines limestone for lime making. Gypsum for the manufacture of cement is obtained from gypsum mines at Mkomazi in Lushoto District, Tanga Region and Kilimanjaro. Weathered shale, iron ore, pozzolana, coal and heavy fuel, the other ingredients for the manufacture of cement are imported.

## Other Minerals

A number of minerals have been identified along the coastal zone (Table 18). Some of the minerals are of economic significance and are being actively exploited (Map 12). In Dar es Salaam and Coast regions, they include kaolin at Pugu, stone in Kunduchi, Boko and Mlolwa, granite in Lugoba and Msolwa, calcite in Miono Mkongwe and Manda, dolomite in Mboga, clay in Pugu and sand in several areas. Kaolin is mined by Pugu Kaolin Company, while stone quarrying is done by Tanzania Sand and Stone Company, Varson Ramji Dewji Patel, MECCO and by small miners. Granite is extracted by Konoike Construction Company, Skanpihl Colas, NOREMCO and ADUCO. Dolomite is mined by Tanzania Sheet Glass, clay by M/s Kisarawe Bricks, sand by Universal Electronics & Hardware and calcite which is found in different colours such as white, black, pink and red is exploited by Pugu Kaolin company and small miners.

Tanga and Mtwara are rich in such minerals as amethyst, garnets, tourmaline, kyanite, gypsum, feldspar, kornepine, zircon, bauxite, ruby, turquoise, rhodolite, sapphire, graphite, marble, chrysoberyl and alexandrite. There is similarly a great potential of gold mining in Nachingwea, Lindi region.

## Hydrocarbons

The history of oil and gas exploration in Tanzania falls into three phases, with the first phase beginning in 1952. The second exploration phase coincided with the formation of TPDC (Tanzania Petroleum Development Corporation) in 1969. From 1973 to 1982 Agip were joined by AMOCO and drilled three onshore and three offshore wells resulting in the discovery of Songo Songo and Mnazi Bay gas fields in 1974 and 1982, respectively. Although the Songo Songo gas is methane-rich, ethane and higher hydrocarbons are ubiquitous. Gas ratios are characteristic of gases associated with oils. At Mnazi Bay, the Discovery well was drilled in 1981 in 8 m of water close to the shore and tested gas from two zones. A review of the

**Table 18. Sites of Current and Potential Mineral Exploitation and Quarrying in Coastal Areas**

Deposit	Location	Use/Product
Rock salt	Lindi	Common salt
Limestone	Wazo Hill	Dimension stone, cement
Kaolin	Pugu Hills	Crockery, glossy paper, paint and chemical products
Gravel	all coast	Construction
Sand	all coast	Construction
Limestone	all coast	Construction
Rutile	all coast	Diamond stimulant, industrial constituent, source of titanium, gems, white pigment
Solar/pan salt	Dar es Salaam/ Bagamoyo/ Tanga/ Lindi/Mtwara	Common salt
Calcite	Miono, Mkonge and Mandera (Coast)	Marbles, chicken feed, glass making
Clay	Kisarawe	Construction bricks
Dolomite	Mboga (Coast)	Emulsion paints
Amethyst	Tanga/Mtwara	Precious stone
Garnet	Tanga/Mtwara	Gemstone, abrasive material
Tourmaline, kornerupine, ruby, chrisoberyl, alexandrite, sapphire, turquoise	Tanga/Mtwara	Gemstones
Kyanite	Tanga/Mtwara	Non-fusion cast tank blocks
Gypsum	Tanga/Mtwara	'Sheetrock' or wallboard
Gold	Nachingwea	Dentistry and medicine, jewelry and art, medallions and ingots, intricate circuitry, electroplating
Feldspar	Tanga/Mtwara	Glass, ceramics, enamelware and soaps
Zircon	Tanga/Mtwara	Radioactive age determination
Bauxite	Tanga/Mtwara	Cans, airplanes, sporting, electronic equipment and home appliances
Graphite		Coatings and other industrial uses
Rhodolite		Ornamental stone
Marble		Building construction and decorative items (pillars, bath tiles, table tops)

geological, geophysical and well database indicates a substantial reserve of good quality gas. No appraisal wells have been drilled but the gas is almost entirely composed of methane and is thought to be mainly biogenic in origin. The third exploration phase was stimulated by high oil prices during the early eighties.

The capacity of gas reserves at Songo Songo is estimated at 212 billion cubic metres of gas and is equivalent to commercial energy consumption for about 30 years. Gas from Songo Songo is planned for production of ammonia and urea (mainly for export) and generation of electricity for local consumption. TPDC has already entered into an agreement with potential investors to start production.

A number of oil seeps indicate that liquid as well as gaseous hydrocarbons have been generated in the sedimentary basins of Tanzania. A live oil seep site has been found at Wingayongo, on the flank of the Rufiji Trough. Nearby at Kipatimu, beds are stained with bitumen, which may be all that remains of a breached palaeo-accumulation. Bitumen also cements sands on the island of Msimbati on the northern side of the Ruvuma River estuary. The petroliferous nature of this seepage, which is the most significant of several hydrocarbon occurrences in the Ruvuma Basin and has a strong sulphuric-bituminous odour, has been confirmed by various analyses. A verified crude oil seep also occurs in the mangroves on the west coast of Pemba Island. Access is difficult but a thin film of oil floating on the water and areas with sparse vegetation around the seep can be seen clearly from the air.

#### SONGO SONGO GAS-TO-ELECTRICITY PROJECT

In October 1995, Ocelot International (Tanzania) Ltd and TCPL Tanzania Limited, in partnership with the Government of Tanzania, Tanzania Electric Supply Company Limited (TANESCO) and Tanzania Petroleum Development Corporation (TPDC), set out to create a company called SONGAS to implement the Songo Songo Gas-to-Electricity Project. In so doing, SONGAS will develop the Songo Songo gas field, construct gas processing facilities on Songo Songo Island and transport natural gas to Dar es Salaam via pipeline where it will be used as the principal fuel supply for five gas turbine electricity generators. The pipeline will then continue northward to supply the Wazo Hill Cement Plant.

The Project will service two onshore and three offshore natural gas wells at Songo Songo Island. Natural gas from the wells will then be piped to a gas plant on Songo Songo Island. Two 35 million cubic feet per day processing units (dehydration and refrigeration) on Songo Songo Island will be built to process the natural gas from the wells. Any hydrocarbon liquids removed will be shipped to Dar es Salaam or consumed on-site as fuel. The gas plant will lead to improvements in the island's infrastructure including potable water and power supply, an airstrip and wharves.

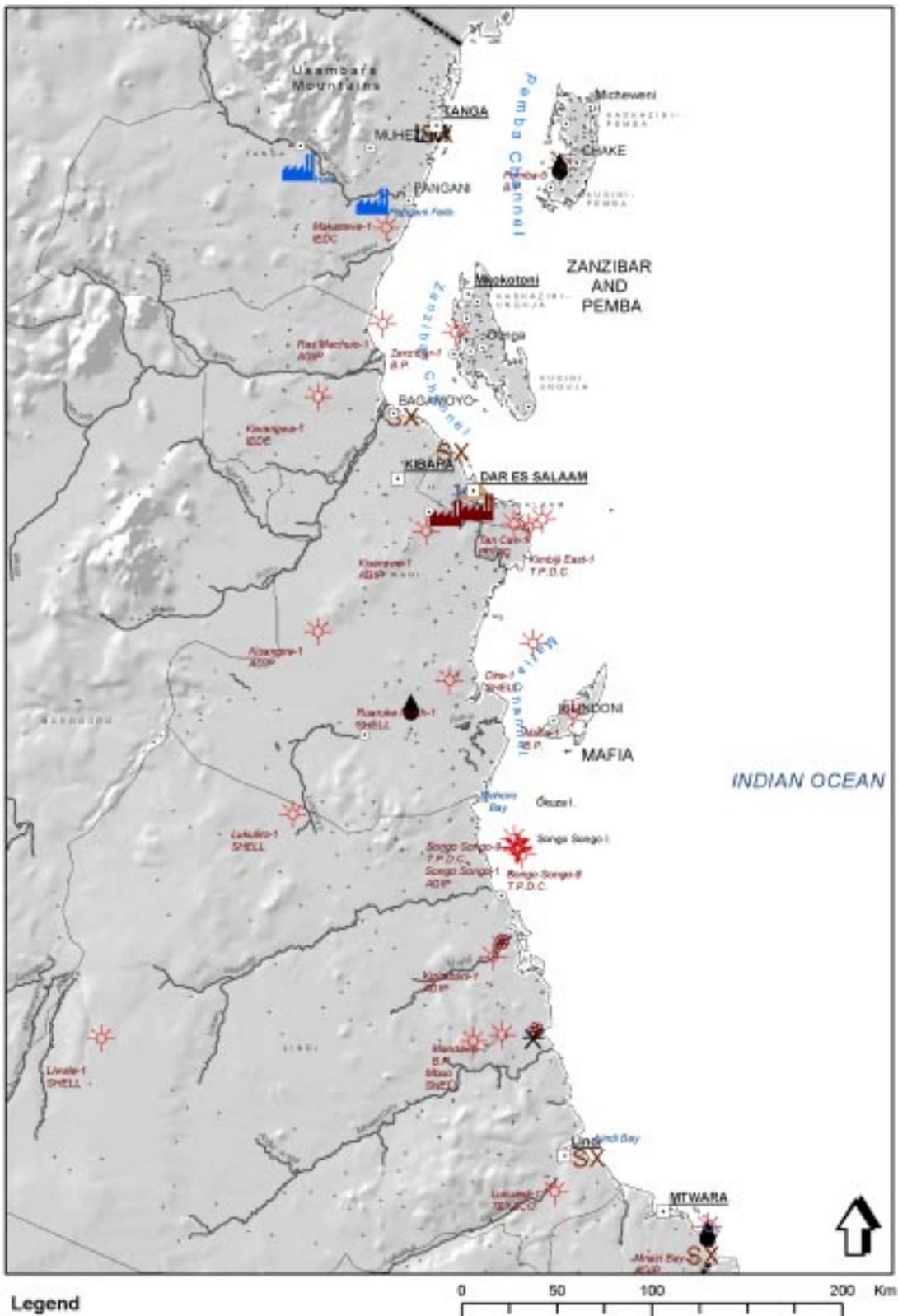
Underwater and underground pipelines will transport natural gas from Songo Songo Island to Dar es Salaam to provide fuel for power generation plants and other industrial uses. The underwater pipeline will extend from Songo Songo Island to Somanga. The underground pipeline will begin at Somanga and extend north to the Ubungo Power Plant in Dar es Salaam and the Wazo Hill Cement Plant. The route selected will minimise resettlement of residents, stream and river crossings, tree and brush removal and avoid unstable steep slopes and wet areas.

The power plant located at Ubungo will produce up to 112 MW of electricity. Four gas turbine-driven generators will be connected to the national power grid at Ubungo. All turbines will be converted from liquid fuel to natural gas and SONGAS will assume ownership of all gas turbines. A portion of the SONGAS power plant, the Emergency Power Plant (EPP), is already supplying power to the national grid. Acting as project managers for TANESCO, OTC fast-tracked the construction of the EPP in less than five months and was generating 75 MW of power within 165 days of signing the contract.

An Environmental Impact Assessment (EIA) study commissioned by the Ministry of Water Energy and Minerals in 1994 reported that, with proper planning and implementation, this project would have minimal or neutral impacts on the biophysical and human environment.

#### MNAZI BAY GAS-TO-ELECTRICITY PROJECT

The TULLOW oil company, in a joint venture with the US power company CINERGY, has with the Ministry of Energy and Minerals of the United Republic of Tanzania undertaken responsibility for the provision of electricity in the southern region of Mtwara. There are plans to drill a well adjacent to the Discovery well drilled in 1981 and to produce gas initially to meet the requirements of a dedicated local power station.



Map 12. Location of hydrocarbon exploration wells, mining of minerals and powerplants in coastal Tanzania

In addition to the development of the Mnazi Bay gas field, the fully integrated project entails gas processing and transportation to a power generating facility, upgrading the facility and expanding its electrical transmission and distribution system and the responsibility for supply to its customers. In its integrated approach to infrastructure development, this is a unique project to the region and it is expected to expand the industrial user base for both gas and electricity.

With this proposed development in the near future, there is concern regarding the environmental impacts of such a project on the local environment. Further studies are therefore necessary within the Mnazi Bay to assess such impacts.

#### HYDROELECTRIC POWER

Although gas and coal are abundant in Tanzania, it was only recently that they were considered for development. Other potential energy sources in Tanzania include solar and renewable bio-energy. So far, however, energy generation in Tanzania has mainly focused on hydropower development. Several dams have therefore been constructed in the rivers that empty into the Indian Ocean for hydroelectric power generation. These hydropower plants generate about 85–90% of the electrical energy consumed in the country. The largest dams are on the Great Ruaha (Rufiji tributary) and Pangani rivers (Table 19). These dams are mainly for production of electricity and to a lesser extent irrigation and fisheries. The other potential sites in the Rufiji river basin include Stiegler's Gorge (1400 MW), Kingenenas (150 MW) and Shuguri Falls (400 MW). Others are Kihansi, Ikondo and Ruhudji. The total hydropower potential in the Rufiji is approximately 4000 MW.

Dam	River	Energy Capacity (MW)
Nyumba ya Mungu	Pangani	8
Pangani Falls	Pangani	66
Hale	Pangani	17
Kidatu	Great Ruaha	204
Mtera	Great Ruaha	80

Although great economic benefits accrue from these impoundments, they are not without negative consequences. The major concerns of upstream damming on the coastal environment are mainly related to the regulated discharges, which alter the flow characteristics of these rivers. In the Rufiji Delta for instance, the eroding force of coastal wave action and currents has been found to exceed the deposition of silt in the Delta, leading to shoreline erosion. One possible reason for this reduced sedimentation is that dams upstream are trapping silt transported by the Rufiji River.

Another environmental impact of upstream damming is the reduction in volume of freshwater and the associated flow of nutrients of terrestrial origin into the marine system, often resulting in increased salinity and reduced productivity of the system. The productivity of the Mafia channel and associated fisheries (prawns and fish), for instance, are highly dependent on the Rufiji for supply of nutrients.

#### PORTS AND SHIPPING

The major ports on the Tanzanian coast are Dar es Salaam, Zanzibar, Tanga and Mtwara. There are also four other small ports on the coast, namely Pemba, Lindi, Kilwa and Mafia. With the exception of Zanzibar Port which handles only Tanzanian cargo, the other major ports handle Tanzanian goods as well as transit goods for neighbouring landlocked countries. Major import commodities include machinery, chemicals, food grains, fertiliser, sugar, motor vehicles, spare parts, crude oil, petroleum products, plastic materials and textile products. The major exports are: coffee and tea (to Europe, Japan, USA), cotton lint (Europe, Southeast Asia), cashewnuts (India, Japan), seed beans, tobacco and sugar (Europe), oilseeds and peas (India) and copper (Europe and Southeast Asia).

The four major ports handle around 4 million tonnes of cargo a year, with imports accounting for more than 75% of the cargo. The net registered tonnage handled by the three mainland ports of Dar es Salaam, Tanga and Mtwara decreased from 4.4 million tons in 1997 to 4.0 million tons in 1998. In 1997, the port of Dar es Salaam accounted for 92.7% of all cargo handled by the four major ports, followed by Mtwara (3.02%), Tanga (2.94%) and lastly Zanzibar (1.33%). Within the same year, the port of Dar es Salaam accounted for 95.4% of all goods imported through the four coastal ports (Table 20).

Port	Product	1994	1995	1996	1997	1998
Dar es Salaam	Imports	3,119,140	3,564,420	2,770,699	3,395,900	2,871,241
	Exports	856,791	870,457	764,755	716,376	682,958
	<b>Subtotal</b>	<b>3,975,931</b>	<b>4,434,877</b>	<b>3,535,454</b>	<b>4,112,276</b>	<b>3,554,198</b>
Tanga	Imports	49,316	46,320	55,493	54,692	94,726
	Exports	78,136	70,722	82,708	75,936	88,100
	<b>Subtotal</b>	<b>127,452</b>	<b>117,042</b>	<b>138,201</b>	<b>130,628</b>	<b>182,826</b>
Mtwara	Imports	29,793	50,853	42,200	56,998	81,084
	Exports	62,365	57,202	62,892	76,907	133,888
	<b>Subtotal</b>	<b>92,158</b>	<b>108,055</b>	<b>105,092</b>	<b>133,905</b>	<b>214,972</b>
Zanzibar	Imports	28,711	52,811	52,509	52,053	
	Exports	1798	5452	2774	6779	
	<b>Subtotal</b>	<b>30,509</b>	<b>58,263</b>	<b>55,283</b>	<b>58,832</b>	
<b>Tanzania</b>	Imports	3,226,960	3,714,404	2,920,901	3,559,643	3,047,051
	Exports	799,090	1,003,833	913,129	875,998	904,946
	<b>Total</b>	<b>4,226,050</b>	<b>4,718,237</b>	<b>3,834,030</b>	<b>4,435,641</b>	<b>3,951,997</b>

## Port of Dar es Salaam

The port of Dar es Salaam is linked to its hinterland by the country's two railway systems, the Tanzania Railways Corporation (TRC) and the Tanzania Zambia Railways Authority (TAZARA). It is the principal port of Tanzania and a major sea outlet for the Republic of Zambia, Burundi, Malawi, Rwanda, Uganda, Zimbabwe and eastern parts of the Democratic Republic of the Congo. About 50% of the cargo handled in Dar es Salaam is in transit to these countries. The port has a container terminal, a general cargo terminal and a grain terminal. Passengers from coastal vessels embark/disembark at Malindi wharf. The general cargo terminal also handles cruise vessels, as the port has no dedicated terminal for cruise vessels as yet.

In 1998 Dar es Salaam Harbour alone handled a total tonnage of 3.55 million, down from 4.1 million tonnes in 1997. The Dar es Salaam Harbour generates over 90% of the Tanzania Harbours Authority's revenue from charges on various services provided such as navigation, mooring, port dues, wharfage, stevedoring as well as other cargo handling services. The port is linked worldwide by major shipping lines such as those shown in Table 21.

Bulk liquid handled by the port at its specialised installations of Single Bouy Mooring (SBM) and Kurasini Oil Jetty (KOJ) is largely comprised of petroleum products. During 1998, the port handled a total of 1.66 million tonnes of bulk oils, which had decreased from 2.2 million the previous year. The total cargo handled by the port as an export component was 682,958 metric tonnes, which had decreased from 716,376 metric tonnes in 1997. Of all cargo handled by the port in 1998, the dry cargo transit traffic was 236,228 metric tonnes. The largest destination for transit goods handled by the port was Democratic Republic of Congo, which accounted for 26% of the total throughput. The dry cargo handled by the Dar es Salaam port on transit to the neighbouring countries generally fell by 31% between 1997 and 1998. The quantity of transshipment dry cargo increased to 103,162 metric tonnes in 1998 from 1812 metric tonnes in 1997, with Kenya accounting for 87% of this cargo.

Shipping Line	Area of Service
Bank Line	South Africa, Canada, Persian Gulf and Indian subcontinent
CMBT	South and East Africa, Gulf and Europe
CGM SUD	Madagascar, Reunion, UK and Europe
D.O.A.L.	North Western Europe
DSR Line	Europe with transhipment to Scandinavia
Ellerman Lines	Europe with transhipment to USA, Canada
Global Container Line	Gulf, India and Far East
Gold Star Line	West and South Africa, Far East
Harrison Line	Europe
Holbud Ltd. London	Gulf and Europe
Ignazio Messina & Co.	South and East Africa, Gulf, India and Europe
Jadroplov	South and East Africa, Adriatic Port
Lloyd Triestino Line	Europe, East and South Africa with transhipment to West Africa
Lykes Lines	US East Coast, South and East Africa
Maersk Line	Worldwide
Mediterranean Shipping Co.	USA East Coast, Europe, Mediterranean, Persian Gulf, Far East
Mitsui O.S.K. Lines	Indian Ocean, Far East with transhipment at Singapore to Australia
N.Y.K.	Far East
Nedlloyd Line B.V.	Gulf, India, Far East
P & O Containers Ltd	Europe with transhipment to Scandinavia
Unicorn – CMBT	South and East Africa, Gulf and India
West European Container (WEC)	Europe
Pacific International Lines (Pte) Ltd	Gulf, Far East with transhipment at Singapore

## Port of Tanga

Tanga Port, the second-largest sea port, lies northeast of Tanzania almost 568 km from Dar es Salaam. The port is closer to the port of Mombasa in Kenya than to Dar es Salaam. In the year 1995/96 the ship arrivals were 183. Of the vessels calling at Tanga 62 were deep-sea ships and 121 were coastal ships. During 1998 the Tanga Port, handled 397,798 metric tonnes, an



The harbour at Tanga

increase of 33.5% from the previous year. Of this throughput, 94,726 metric tonnes were imported cargo and 88,100 metric tonnes were export cargo.

## Port of Mtwara

Mtwara port is situated in the southern part of the coast of Tanzania and in 1998, 108 ships called at the port. Of these, 22 were deep-sea ships, 72 general cargo coasters and 14 coastal tankers. During 1998 the port handled a total cargo of 214,972 metric tonnes against 133,905 metric tonnes in the previous year. Imported cargo shot up from 56,998 metric tonnes in 1997 to 81,084 metric tonnes in the year 1998. A similar trend was seen for exports, which were 76,907 metric tonnes in 1997 and 133,888 metric tonnes in 1998.

## Port of Zanzibar

In recent years, the Zanzibar Port has experienced an increase in containers and passenger traffic. The imported cargo landing at Zanzibar mainly comes from the Gulf States and the Far East. About 80% of the cargo is then transported to the mainland. Passenger traffic has also increased significantly since 1987. Zanzibar is in the process of being established as a free port; free economic zones have been established at three places in Unguja and Pemba Islands.

## RECREATION AND TOURISM

Tanzania's touristic attractions encompass its rich and diverse wildlife resources, spectacular landscape and scenery, water bodies and beaches, a diversity of cultures and numerous historical sites. During the colonial period, most tourists visiting Tanzania were big game hunters. Since World War II, an increasing number of tourists have come to see Tanzania's varied flora and fauna. In the years following independence in 1961, little effort was made to encourage foreign tourism. The policy was changed in 1977 and a campaign was launched to attract foreign visitors. The government's recent decision to open tourism to private companies and investors has also helped to revive existing tourist facilities and attract international hotel chains. The current Tourism Master Plan aims at creating a quality product, generating high-



Tourists cycling in Paje, Unguja

yield visitors and preventing mass tourism. Tanzania's tourism sector is among those with great economic growth potential. Over the last decade, the country has registered an average growth of 6% per annum in tourism.

Tourist attractions may be divided into two major regions. The more popular northern region comprises Mount Kilimanjaro (the highest mountain in Africa), Serengeti National Park, Ngorongoro Crater, Selous Game Reserve, Lake Manyara National Park and some 20 lesser parks and reserves. Over 80% of the tourists coming to Tanzania visit the northern region where tourists can enjoy hunting, fishing, game viewing, photography and other recreational activities. The coastal tourist region, which accounts for less than 10% of tourists, includes Dar es Salaam, Zanzibar, Mafia Island, Mikumi National Park and the Tanzania Mainland coastline. The Kilimanjaro International Airport in Moshi/Arusha links these areas. Other tourist attractions include the Rift Valley, Lake Victoria and Lake Tanganyika.

Tanzania's coastal region is endowed with historical attractions such as historical buildings, ruins and monuments, particularly in Zanzibar, Bagamoyo and Kilwa Kisiwani; cultural attractions mainly related to people's values, customs and traditions; and natural scenery such as of beaches, coastal forest reserves, coral reefs and caves. However, the coastal tourism sector has gradually started to attract more tourists in recent years. About 93% of the tourists visiting Tanzania are from Europe and North America. Of these, 60% are tourists from Germany, Britain and France. In 1998, Tanzania earned US\$ 640 million compared to US\$ 394 million in 1997—a remarkable growth of 62% (Table 22).

**Table 22. International Tourism Trend in Tanzania: 1990–1998**

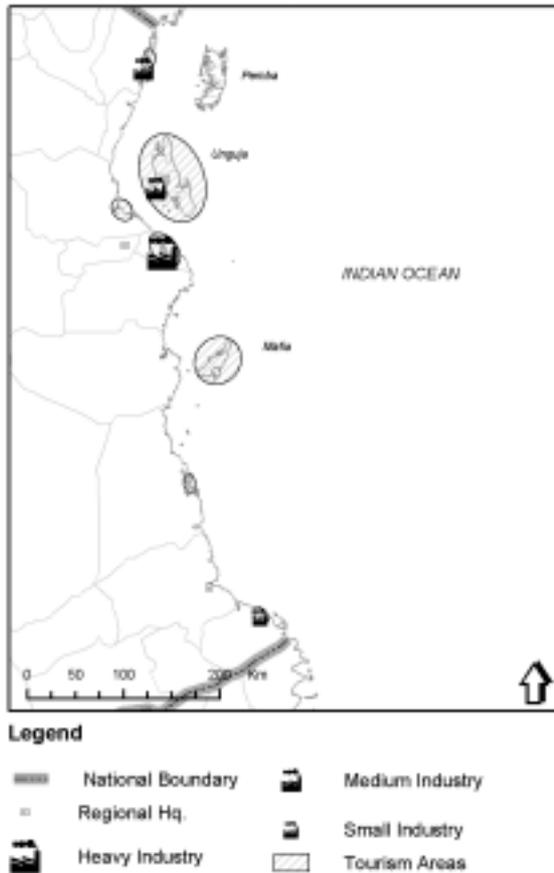
Year	Number of Tourists		Foreign Currency Earnings (US \$ Million)	
	Tanzania Mainland	Zanzibar	Tanzania Mainland	Zanzibar
1990	153,000	42,141	65.00	0.49
1991	186,800	50,827	94.73	0.69
1992	201,744	59,747	120.04	0.86
1993	230,166	46,133	146.84	0.81
1994	261,595	41,533	192.10	0.75
1995	293,834	56,415	259.44	
1996	326,194	69,159	322.37	1.31
1997	360,000	86,495	393.39	0.89
1998	456,080		640.00	

## Tourist Accommodation

Tourist hotels in Tanzania were for a long time concentrated in the Northern Wildlife Circuit consisting of Arusha, Mara and Kilimanjaro regions. However, tourist hotels and other facilities are now widespread in the coast (Map 13). Most of these coastal tourist hotels are concentrated in Dar es Salaam, Coast and Zanzibar. It is estimated that there are 105 hotels on the Tanzanian coast with an average of 20 rooms and 80 beds each. Zanzibar alone has 10 hotels of international standard with a total of 600 beds. Most of these hotels contain modern tourist facilities such as swimming pools and conference rooms and are located directly adjacent to sandy beaches.

Some of these tourism centres have stimulated the development of support infrastructure, such as the improvement of the ports of Zanzibar and Dar es Salaam, the operation of high quality sea and air transport services between Dar es Salaam and Zanzibar, Mafia and Tanga. Furthermore, many of the roads leading to these hotels have been improved.

In some areas such as the coastal strip around Dar es Salaam and Zanzibar the development of tourism has put pressure on the sustainable use of coastal resources such as coral reefs. Demand for seafood, shells and coral souvenirs has risen sharply and as nearshore local supplies become depleted, the pressure on the coastal ecosystem extends farther and farther from the resorts, spreading the impact.



Map 13. Industry and tourism areas



Corals

## Diving, Snorkelling and Scuba

Diving facilities are available in most tourist centres of the Tanzania coast. Tanzania waters are attractive, warm all the year round, clear and teeming with marine life. There are a variety of diving sites along the coast. Most hotels built along the shoreline offer wind surfing, snorkelling, water skiing and scuba diving. Mafia and Zanzibar islands water sport centres and offshore areas in Dar es Salaam are very popular sites. The aquatic life within these waters is often very rich and one usually sees moray eels, scorpion fish, lionfish, large groupers, octopus, lobsters, rays, whales, sharks, dolphins, giant rock cod, marlin, tuna, barracuda and others.

## Big Game Fishing

Big game fisheries in Tanzania usually include black marlin, striped marlin, blue marlin, sailfish, yellowfin, broadbill, wahoo, barracuda, kingfish, karambesi, tuna, dorado, five fingered jack, red snapper and rock cod. The fishing usually takes place around Pemba Island, Unguja Island, Pemba Channel, local reefs and shoals, Pangani River, Mafia Island, Songo Songo archipelago, the deep sea crescent east of Mafia Island and the channel from Rufiji Delta south to Lindi. These areas are thought to be the best big game fishing grounds in East Africa. Fishing normally takes place between 0.5 and 30 km offshore in open waters.

The best areas for big game fishing are those around Pemba Island, in the vicinity of Mafia Island, off Ras Kankadya and Bongoyo Island and in Lindi Bay. The deep crescent off Mafia and the Songo Songo Archipelago is potentially one of the most exciting game fishing areas in the world, with expanses of virtually unfished waters that offer a keen challenge to sport fishermen. In the Mafia channel, there have been some fine catches, including 500-pound rock cod, 80-pound horse mackerel, 100-pound sailfish and American jack and marlin of up to 150 pounds.

The main fishing season is from August to March, but fishing for reef species is good all year round along the reefs and channels. The big migratory fish, the sailfish and swordfish are usually present between December and March. This is the time when Mafia Island is best for sailfish. July to November is the main tuna season with large yellowfin and bonito, but kingfish, wahoo, karambesi, cobia, rainbow runner and sharks are also available. At the deep waters of the Pemba Channel, game fishing runs all year round but tends to seasonal variation.

Big game fishing is operated by Msasani Slipway (Dar es Salaam), Ocean Safaris Ltd. (Mafia Island), Kingfisher Lodge (Tanga) and Mashoda Game Fishing Lodge Ltd. (Pangani). In 1995, a total of 21 vessels were registered and licensed with the Dar es Salaam district office for recreational sport fishing. The majority of these vessels were based at the Dar es Salaam Yacht Club and belonged to non-residents. In Zanzibar, there is a sport fishing community that caters for the demands of tourists that visit the islands.

## INDUSTRY

Industry accounts for 17% of the gross domestic product (GDP). The industrial sector in the Mainland and Zanzibar is not strongly developed and has concentrated primarily on the processing of agricultural products, petroleum and light consumer goods both for export and for local consumption. Most of these industries (Map 13) are located in Dar es Salaam (75% of the country's industries) and to a lesser extent in other coastal towns. These industries include: cement manufacture, steel rolling mills, oil refining, textiles, food and beverage industries, metal products and chemicals. Other industries include paints, plastic and rubber, and pulp and paper products.

The structure of the industries in Tanzania is characterised by the existence of a few large industrial plants, often with an input of foreign capital and a multitude of smallscale, low technology and family-managed artisan and commercial activities. There are few medium industries that rely only on local capital.

The performance of the sector has continued to decline over the years mainly due to shortage of industrial inputs due to inadequate working capital and stiff competition from imports.

Tanzania's food processing industries produce large quantities of organic wastes containing nitrogen and fermentable starches, fats and blood. These industries do not have treatment facilities and effluents are discharged directly into the Indian Ocean.

## AGRICULTURE

The Tanzanian economy relies heavily on agriculture, which employs about 90% of the work force for the production of food for domestic consumption and export as well as industrial raw materials. Topography and climate conditions, however, limit cultivated crops to only 5% of the land area.

Most of the land in the coastal area is of low agricultural potential. The major agricultural products in the coastal areas of Tanzania Mainland are sisal, cashewnuts, coconuts, cassava, rice, legumes, horticultural products (particularly vegetables and tropical fruits), sorghum and cattle. Of these, the first three are major cash crops. Sisal, introduced by the Germans in 1903, is an important cash crop. Sisal is grown in large estates owned by individuals or the state. However, production has been affected by price fluctuations and this has resulted in the abandonment of many estates. However, as external markets become more favourable the estates are being revived. In Zanzibar, clove is the major cash crop while rice production is encouraged under agricultural reforms instituted in 1964. Other major crops in Zanzibar include maize, citrus fruits and coconuts. However, the majority of the coconut trees all over the Tanzanian coast are old and have low yields.

Coastal agriculture (with the exception of sisal estates that are mostly located in Tanga) is predominantly smallscale, labour intensive and requires little capital. There is very little extension service offered to improve varieties or husbandry practices. The inadequate use of farm



Clove plantation

inputs like fertilisers has contributed to the poor performance of the agricultural sector in the coastal area.

Given the characteristics of agricultural production currently in practice it is necessary to introduce measures that will intensify and diversify production in order to improve food security and reduce rural poverty and environmental problems. One recommendation is the improvement of soil through organic farming.

## ENVIRONMENTAL PRESSURES

Signs of environmental degradation, as well as the decline in natural resources and biodiversity, are becoming obvious in some parts of Tanzania. This is attributed to the combination of poverty, rapid population growth, as well as increasing land-based activities and sources of pollution such as industrial and agricultural activities. Of these problems, the main ones are:

- declining harvests of marine and coastal living resources
- loss of coastal and marine biodiversity
- coastal pollution
- beach (coastal) erosion.

## Declining Marine and Coastal Living Resources

The artisanal and industrial coastal fisheries in Tanzania have been falling consistently in recent years. The artisanal fish landings have decreased from 54,527 tonnes in 1990 to 32,286 tonnes in 1994. Furthermore, there is evidence that increased commercialisation of octopus, sea cucumber and seashell harvest has resulted in declines of these species in a number of areas in Tanzania.

Most coral reefs in Zanzibar are showing signs of over-fishing. Though the reefs appear to be relatively healthy, only few small sized fish are found in them. The inshore fishery of Zanzibar of late has been declining. The total annual catch in Zanzibar was about 20,000 tonnes in 1988. Currently, it has dropped to less than 13,000 tonnes per annum. This reduction in fish catch can also be observed in some localised areas such as in Chwaka Bay. Likewise for the

small pelagic fisheries, the catch has also seen a drastic decline from 600 tonnes in 1986 by the Zanzibar Fisheries Corporation vessels to 91 tonnes in 1997.

Shark fin trade has also declined and some fish species are now rarely seen in Tanzanian waters. Both shark and ray catches have declined significantly, particularly at Mafia and Songo Songo islands.

The demand for fish has increased due to the increase in the population. The demand is further intensified by the increase in the number of tourists visiting Tanzania, most of whom prefer seafood. This has resulted in an increase in the price of fish and consequently an increase in the pressure on the reefs by fishermen.

The demands for beche-de-mer in the Far East markets are responsible for the over-fishing of this resource in Tanzania.

**Box 6. THREE TYPES OF OVER-FISHING**

1. Growth over-fishing — young fish are caught before reaching a reasonable size.
  2. Recruitment over-fishing — the parent stock is reduced so much that not enough young fish are produced for the fishery to maintain itself.
  3. Ecosystem over-fishing — species distribution is drastically changed, altering the efficiency of the system.
- (Source: Lowe-McConnell, 1987)

## Loss of Coastal Zone Habitats and Biodiversity

Degradation of critical habitats such as mangroves, seagrass beds and coral reefs and their water quality can result from a number of practices, most of which are common to the eastern African countries. These include:

### DESTRUCTIVE FISHING GEARS AND METHODS

Fishing methods such as dynamite fishing, beach seines and fish poisoning are destructive to the environment to which they are applied, regardless of how limited their operations are. Other fishing methods such as trawling are destructive because of their mode of operation. Nevertheless, trawling is less destructive when operated in shallow waters.

Dynamite fishing is regarded as an effective but extremely destructive fishing method used mainly in shallow waters of less than 10 m depth. This method destroys the basis for reef fish productivity by indiscriminately killing juveniles and adult fish alike and at the same time reducing the reef to rubble. Despite the government efforts to stop the practice, dynamite continues to be used in some parts along the Tanzanian coastline, from Tanga in the north to Mtwara in the south.

A survey in Tanga has shown that dynamite fishing is responsible for the damage beyond repair of 10% of coral reefs in the region and 70% shows significant amounts of damage but could recover if appropriate measures are taken in time. Now that many reef areas close to large cities are partly destroyed, the fishermen are searching for new grounds further ashore.

Another destructive fishing method is known locally as 'kigumi'. This method involves the use of encircling nets in open waters around patch reefs followed by breaking of coral heads to scare fish into the net.

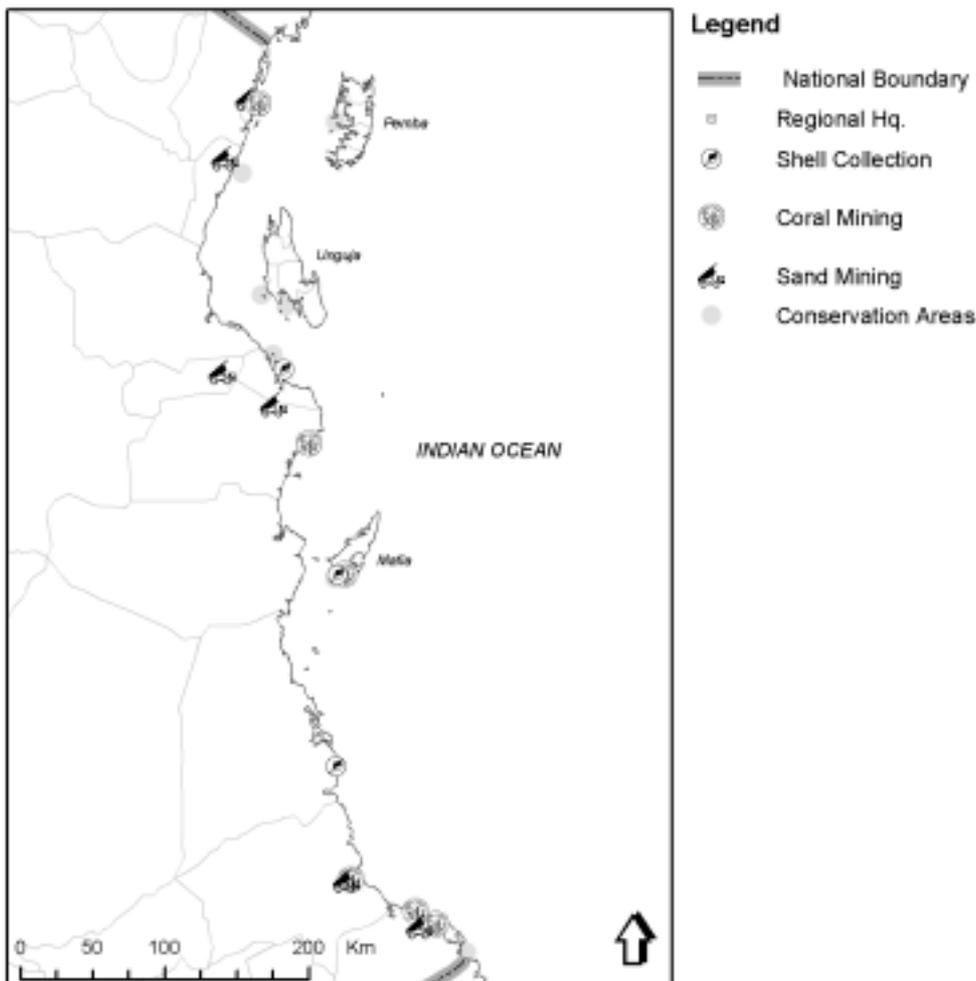
The use of beach seines (locally known as 'juya' and 'kavogo') over coral reefs is also contributing to significant destruction of coral reefs in Tanzania.

Commercial and semi-commercial fishing vessels have been operating their vessels off Bagamoyo and Rufiji Delta, at depths of less than 20 m. This is not only harmful to seagrass beds and soft benthic communities but also disturbs microhabitats and sediment structure.

#### CORAL MINING

Large quantities of living coral are mined for use as construction material and for lime production, produced by burning of the coral rock (Map 14). Coral mining results in direct damage to reef structures and may lead to increased beach erosion and sedimentation due to disruption of water circulation pattern around the reefs.

In some areas such as Mafia Island and southern Tanzania coast, living corals are mined to produce lime or for use as building materials. In 1998, it is estimated that 80,000 tonnes of live and dead corals were mined and used for lime production in Lindi and Mtwara alone.



Map 14. Coral mining, sand mining and shell collection on the Tanzania coast

#### LOSS OF FORESTS

In recent years, the rate and variety of human influences on the mangroves have increased to the extent that they are threatened with destruction in some areas. One of the most pressing issues in the mangrove forests is their loss for conversion to commercial purposes. Examples are the conversion to agricultural lands (e.g. clearing of mangroves for rice farms in Rufiji Delta), conversion to salt pans, conversion to aquaculture ponds (i.e. prawn farming) and clearance for urban and industrial development. Other threats include: alteration of the hydrological conditions (dams upstream of rivers); pollution through using mangrove forests as rubbish dumps; and over-exploitation of resources, mainly through clearing of mangroves for fuel and construction purposes.



Lime making at Mitengo Village, Mtwara



Lime sacks at Mikindani Village, Mtwara

Loss of coastal forests is also significant. Coastal forests are threatened by unsustainable human activities including logging of canopy trees for timber and fuel, removal of hardwood poles to build houses, burning of woody plants to produce charcoal, clearance of forests for farmland (e.g., Mlola Forest Reserve in Mafia Island and Kazimzumbwi in the Coast region) and uncontrolled fires (e.g. in Chitoo Forest Reserve and Rondo Forest).

#### DEPLETION OF LIVING RESOURCES

Turtle populations have probably declined in recent years due to loss of their nesting sites. Maziwi Island for instance, was an important breeding site for the green, hawksbill and olive



Timber for export from Kilwa Masoko Port

ridley turtles. The small island submerged below the high spring tides in the early 1980s and is no longer suitable for nesting. The development of hotels along beaches is also another reason for the decrease of nesting sites (e.g. in the east coast of Unguja Island where there are now 22 hotels compared to none in 1988).

Dugong populations used to inhabit the seagrass beds surrounding Kilwa and Mafia and off the Tanga region coast. However, there have been very few recent sightings by local populations or by researchers.

## Coastal Pollution

In comparison with other parts of the world, the overall levels of marine pollution in Tanzania are relatively low. This is attributed to the low levels of urbanisation and industrial development. However, there are localised areas of intense pollution associated with coastal cities. All coastal cities are experiencing high population and rural-urban migration growth, limited town planning and infrastructure development.

In general, the main sources of marine pollution in Tanzania come from land-based activities related to coastal urbanisation and coastal development, industries, tourism, agriculture and mineral exploitation. However, further assessment of the problem has shown that sewage, especially that emanating from municipal sources, is the principal source of pollution threatening human health and ecosystems.

### SEWAGE POLLUTION

Sewage pollution is attributed to the presence of organic compounds, nutrients, pathogens and toxic substances in the effluents. The potential for sewage to cause impact depends on the volume of the waste, treatment processes employed and the manner in which it is disposed.

The amount of organic material in effluents is quantified by measuring its biological oxygen demand (BOD), while phosphates and nitrates are indicative of the amount of nutrients in the

effluent. Pathogens are indicated by the presence of coliform bacteria and the risk of contamination is estimated by measuring the faecal coliform levels.

In Dar es Salaam, 80% of the population is served by on-site sanitation systems: septic tanks, soak-away pit and traditional and ventilated pit latrines. This high percentage, however, conceals major deficiencies in the city's sanitation. Soak-away pits and septic tanks have severe problems with overflows particularly during the rainy seasons. The other systems are also deficient and inappropriate, with the consequence that individual sewerage systems constitute a significant source of water pollution. Only 15% of the total population of the city is served by the central sewage system. Some few areas such as Mikocheni, Regent Estate and University of Dar es Salaam have waste stabilisation pond systems. The sewage collected is discharged through a 1.6 km long sea outfall near Ocean Road Hospital. The outfall is exposed during low tide and leaks at several points due to lack of maintenance.

Different surveys have shown that both surface water sources as well as coastal waters in the Dar es Salaam area are heavily polluted. With more than 118,822 tonnes of polluted water being discharged into the ground each day, the majority of ground-water sources within the built up area are contaminated as a result of poor sanitary arrangements (Tables 23 and 24).

Type	Industrial Effluent	Pit Latrines	Septic Tanks	Without Facilities	Total
BOD	28,330	15,282	3275	9897	56,784
COD	29,904	16,131	3457	10,447	49,776
Suspended solids	47,216	25,470	5458	16,495	78,429
Dissolved solids	83,940	45,280	9830	29,325	138,923
Total N	4145	2236	479	1448	6859
Total P	787	425	91	275	1302

Type	Without Facilities	Pit Latrines	Septic Tanks	Sewer Domestic	Losses Industry	Total (Tonnes)
BOD	1100	15,282	7641	1221	1899	27
COD	1161	16,131	8068	1289	11,994	29
Suspended solids	1833	6116	3832	2035	3148	18
Dissolved solids	3258	97,857	61,128	3618	5596	196
Total N	120	4,829	3018	3618	5596	10
Total P	23	915	572	34	52	2

Various studies conducted in the region have shown that untreated municipal sewage has caused eutrophication of coastal waters and destruction of important habitats such as coral reefs. For example, eutrophication that is associated with the release of inorganic nutrients into coastal waters from domestic sewage around Zanzibar has been identified as the possible cause of the decreased cover of coral reef-building algae. Furthermore, it has been shown that calcified algae are sensitive to phosphate and they disappear from phosphate-rich areas.

According to a number of studies, there appears to be a significant increase in the levels of pollution along the coastal waters of Tanzania and Zanzibar Island during the past few years. A baseline study on heavy metal contents in seaweeds that were collected from different parts of Zanzibar and Dar es Salaam, close and away from the source of waste effluents, found that in some algal species the heavy metal contents have increased tenfold since 1989. High levels of nitrates, ammonium and phosphate on coralline algae have been observed in areas close to the sources of waste effluents from Zanzibar town. Furthermore, significant levels of aluminium and cadmium have been observed in the macroalgae collected from Chapwani and Changuu islands off Zanzibar.

In Zanzibar, both ground water and seawater in Zanzibar town area are contaminated with organic pollutants. Total and faecal levels of 1100+ and 1500+ cells per ml respectively have been recorded in the waters fronting the town area. Other pollution indicators, BOD and COD, are also high. High coliform levels are also found in surface streams running across the town area.

#### SOLID WASTE MANAGEMENT

As the pace of industrial development increases so will the volume of wastes generated by the different industries. The storage, collection and disposal of this increasing volume of solid wastes have become a major environmental issue for coastal urban centres. Solid wastes generated by municipal, industrial and commercial activities are not properly managed. The overall storage, collection and disposal activities are largely unsatisfactory (Table 25).

Town	Solid Waste Per Capita (Kg/Year) 1992–1997	% Population With Sewage Connection 1992–1997	% Waste Collected (Tonnes/Year) 1992–1997
Tanga	150	13	24
Dar es Salaam	150	13	23

Local authorities have traditionally collected solid wastes, but over time this system has broken down. During the last few years, however, the Dar es Salaam City Commission has entrusted some of the collection functions to private contractors. Waste disposal still remains a problem. One of the deficiencies in the existing solid waste management operations is the very low standard of waste disposal. Haphazard dumping of wastes in the absence of an overall disposal plan is environmentally and aesthetically unacceptable and poses possible health hazards.

#### Beach Erosion

Beach (coastal) erosion has been recognised as a global environmental problem. Shoreline change and associated coastal erosion is a natural process of evolution of coastal areas. It may occur on different scales of time, over a very short time of a few days, as long as a few decades or several centuries. Beach erosion is caused by a complex interaction of various natural



Beach erosion in Paje/Bwejuu (Unguja)

processes and in most cases is intensified by human activities. The natural processes include among others: the combined action of waves, tides, winds and current; variations in the sea level; land subsidence; and storms. Human activities that could intensify beach erosion include:

- manipulation of hydrological cycles mainly through dam construction
- construction of coastal structures such as jetties
- mining of beach sand and live coral
- destruction of protective coral reef systems
- destruction of coastal vegetation
- building on beaches.

The coastal areas of Tanzania are increasingly attracting a wide range of human activities such as the development of major settlement centres and tourism infrastructures. However, the instability of the coastline threatens the sustainability of this development.

Beach erosion has affected several areas along the Tanzania coast, causing significant social, economic and ecological impacts. These include the loss of beaches, arable land and construction sites; damage to coastal property or infrastructure; and destruction of ecologically important ecosystems. The most severely affected areas include Mikindani Bay (Mtwara), Lindi Bay and Kilwa Masoko (Lindi), Kunduchi (Dar es Salaam), Kigombe and Mwambani (Tanga) and Maruhubi and Nungwi (Zanzibar).



Sea wall at Jambini (Unguja)

# PART 3

## Management of the Coastal and Marine Environment: Legal and Institutional Framework

M.A.K. NGOILE AND J. FRANCIS



Good management practices make a difference: Illustration showing a healthy and a degraded coral reef environment

### INTRODUCTION

Legal and institutional frameworks are among the important mechanisms for preventing the degradation of the coastal and marine environment. Effective implementation of policies at the national level largely depends on effective institutional mechanisms.

Different responses have been (or are) undertaken in the management of coastal and marine resources in Tanzania. These include traditional management systems, enforcement of policies and laws through regulatory mechanisms, collaborative management arrangements and conservation initiatives by the private sector.

### TRADITIONAL MANAGEMENT SYSTEMS

It is now becoming recognised by authorities and scientists that fisherfolk in Tanzania (like their counterparts in other parts of the world) know much more about the coastal and marine environment than was previously acknowledged. Despite the fact that it was advocated a long time ago, marine scientists and decision makers are only recently starting to realise and seriously appreciate the value of this traditional knowledge base.

There has even been a misconception that fisherfolk do not plan their activities. Fishing activities depend on, among others, seasons, weather conditions and lunar/tidal effects. All these factors make fishing a very risky undertaking. In order to spread the risk of fishing, sharing systems based on labour and capital inputs as well as age and experience, are widely used in coastal communities. Such systems bring a sense of ownership and responsibility among the different groups which benefit from the sharing.

Traditional management systems impose both direct and indirect restrictions upon individuals for the benefits of a larger group. For example, Chwaka Bay mangroves in Zanzibar have been managed for many years through traditional and government-coordinated management systems. Michamvi villagers claim exclusive right over mangrove forest use and they have used the mangroves for subsistence only. Villagers of Ukongoroni in Chwaka Bay have a traditional closed season for octopus during the months of June to August. Also in Chwaka Bay, prawn fishing used to stop for two to three months at the time when prawns were hatching.

Many customs and traditions associated with fishing as well as traditional management systems in Tanzania have ceased to operate due to a number of reasons, including pressures from commercialisation, population growth, technological innovations and deterioration of the authority of elders as guardians of the management systems. While in several places, colonialism is regarded as one of the main contributing factors to the collapse of the traditional management systems in Tanzania that was less directly the case. During the German and the British rules and even after independence, fishing was not considered a priority by the authorities and therefore there were less interventions from the governments than, for instance, in cash-crop agriculture.

The traditional management systems in Tanzania have basically retained their mode of operations, which is based mainly on trust and respect of authority of elders. With emerging external challenges, pressure and opportunities they have become more vulnerable and thus failed to survive.



Makonde curving at Mitambo Village, Mtwara

Lack of legal recognition of the traditional systems of management in recent years has led to their decline. It is only the latest policies and legislation that do acknowledge the importance of reviving the traditional management systems. However, the mechanisms of their institutionalisation have not yet been specified.

The involvement of local communities and the integration of their traditional knowledge in the planning and implementation processes of resource management regimes are the foundation of any successful management regime. This is due to the fact that such a management system is based on sound knowledge (traditional and scientific) and is acceptable to resource users, as their needs have been incorporated.

## **POLICIES AND LEGISLATION**

Legislation and regulations are key elements in the protection of the marine environment. Their importance is dictated by the legal necessity to determine and define management structure and marine environmental quality standards. There is also necessity to determine major measures for the prevention and mitigation of pollution to ensure the standards, the legal liabilities resulting from violation of the marine environmental protection laws and regulation, and the rights and procedures for environmental management and enforcement of laws.

Tanzania lacks a coherent and harmonised coastal legislation for dealing with the marine and coastal environment. This is further complicated by the existence of two types of legislation for Zanzibar Islands and Tanzania Mainland. Although Tanzania is a federal state comprising Tanzania Mainland and Zanzibar, the latter maintains administrative independence in most of its government matters. The National Assembly, which includes members from Zanzibar, legislates on all matters and for the United Republic of Tanzania on issues such as foreign affairs, finance, defence, immigration and citizenship. All other matters concerning Zanzibar are within the exclusive jurisdiction of the Zanzibar government and its legislative body, that is, the House of Representatives.

For managing terrestrial development activities, the two types of legislation may not conflict. However, marine ecosystems do not recognise administrative or national boundaries and the situation as it exists in Tanzania needs a critical assessment and harmonisation of the two different types of legislation. For example, the Fisheries Act of 1970 does not cover the territorial waters of Zanzibar Island since Zanzibar has its own fisheries legislation. However, the Exclusive Economic Zone Act, 1989 and the Deep Sea Fishing Act, 1997 distinguished the separate rights that the Tanzania Mainland and Zanzibar have with respect to fisheries management.

### **Tanzania Mainland**

There are several sectoral legislations that have relevance for the management of marine and coastal resources on Tanzania Mainland (Table 26). These cover sectors such as fisheries, agriculture, forestry, industry and trade, land use planning, culture, marine transport, environment, energy and tourism.

Tanzania has adopted a wide range of approaches within their legal and regulatory framework aimed at the protection of the coastal and marine environment. These include:

- Setting out the environmental quality standards
- Protection of the key habitats such as coral reefs and mangroves
- Environmental impact assessment
- Pollutant discharge fee
- Monitoring, surveillance and inspection
- Penalties.

A number of environmental regulations exist in Tanzania. Such efforts notwithstanding, serious gaps remain in policy, law and practice. There is also a shortage of reliable information to

**Table 26. The Key Policies, Legislation and Plans Relevant to the Marine and Coastal Environment of Tanzania**

Aspect	Policies/Plans/Legislation
Natural Resources	<ul style="list-style-type: none"> <li>• National Fisheries Sector Policy and Strategy Statement, 1997</li> <li>• Fisheries Act, 1970</li> <li>• Marine Parks and Reserves Act, 1994</li> <li>• National Forest Policy, 1998</li> <li>• Forest Ordinance, 1957</li> <li>• National Forest Action Plan, 1990/91–2007/08</li> <li>• Management Plan for the Mangrove Ecosystem in Tanzania, 1991</li> <li>• The Territorial Sea and Exclusive Economic Zone, 1989 – Union Government</li> <li>• Deep Sea Fishing Authority Act, 1997</li> </ul>
Land Use	<ul style="list-style-type: none"> <li>• National Land Policy, 1995</li> <li>• Town &amp; Country Planning Ordinance, 1956, Cap. 378</li> <li>• The Town &amp; Country (Public beaches planning area) Order, 1991</li> <li>• Government Notice No. 76 reducing the Beach Protection Line from 200 m to 60 m, 1992</li> </ul>
Shipping	<ul style="list-style-type: none"> <li>• Merchant Shipping Act of 1967</li> </ul>
Cross-cutting	<ul style="list-style-type: none"> <li>• National Environmental Policy, 1997</li> <li>• Water Policy, 1991</li> <li>• Water Utilisation (Control &amp; Regulation) (Amendment) No. 10, 1980</li> <li>• National Land Policy, 1995</li> <li>• Land Act, 1998</li> <li>• Village Land Act, 1998</li> <li>• Local Government Reforms</li> <li>• Local Government (District &amp; Urban Authorities) Acts, 1982</li> <li>• Regional Administration Act, 1997</li> <li>• District &amp; Village by-laws</li> <li>• Public Health (Sewerage &amp; Drainage) Ordinance</li> <li>• Mining (Environmental Management &amp; Protection) Regulation, 1999</li> </ul>

guide implementation of both policy and legislation. However, previous experiences clearly show that while enacting environmental laws with the accompanying penalties is one thing, enforcing and implementing them is another. More often than not, the problem lies with enforcement. However, the main contributing factors for weak enforcement are limited financial and human resources, lack of technological capacity, insufficient political support, pressure on government from interest groups, lack of transparency, as well as the practical problems of administering environmental regulations.

Furthermore, there has been minimum translation of the national legislation dealing with coastal and marine environment to district and local levels. An attempt has been made in translating laws related to agriculture, land use planning and forestry. By-laws exist at district level in the named sectors but these are few.

In practice, when a legislation is enacted, the responsible ministry is required to develop its own strategy for implementing the legislation through development of regulations and management mechanisms. This is done sector by sector and without any consultation. This process requires resources and expertise. Lack of infrastructure, personnel and funding have resulted in the non-translation of the laws into regulations and management strategies as well as enforcement, which is generally very weak. Unilateral translations of the laws have in some instances developed conflicts. For example, whereas the Forestry Division has regulations that put all mangrove forests under the category of reserves, the Fisheries Division issues permits for the development of prawn farms and the Ministry of Industries and Trade issues permits for the extraction of salt in the same designated mangrove forest reserve areas.

Some areas are not covered by the existing regulation such as environmental impact assessment, emission standards, industrial waste standards and good practice guidelines to direct sustainable development activities along the coastal zone.

## Zanzibar Islands

Similar to Tanzania Mainland, there is a serious deficiency in legislation guiding development activities of marine and coastal areas in Zanzibar Islands (Table 27). There is an urgent need to review the legislation in order to address current and emerging issues as well as to increase the level of penalties. However, Fisheries legislation has been updated recently. The development of the Environmental Policy has increased the awareness of islanders because it was done in a truly participatory manner. This consultative process which was approved by the House of Representatives in February 1996 and acceded by the President in July 1996, has generated a comprehensive and effective Environmental Policy Legislation for Zanzibar.

<b>Table 27. The Key Legislation Relevant to Marine and Coastal Environment of Zanzibar Islands</b>	
Aspect	Policies/Plans/Legislation
Natural Resources	<ul style="list-style-type: none"> <li>• The Fisheries Legislation (Revised 1988)</li> <li>• The Forest Reserve Decree (Cap. 120) and Wood Cutting Decree (Cap. 121)</li> <li>• The Wild Animals Protection Decree (Cap. 128)</li> <li>• The Wild Birds Protection Decree (Cap. 129)</li> </ul>
Land Use	<ul style="list-style-type: none"> <li>• The Land (Distribution) Decree, 1966</li> <li>• The Town and Country Planning Decree (Cap. 85)</li> <li>• The Public Land Decree (Cap. 93) Removal of Natural Produce Rules</li> </ul>
Cross-cutting	<ul style="list-style-type: none"> <li>• The Commission of Lands and Environment Act, 1988</li> <li>• The Investment Promotion Act, 1986</li> <li>• The Administrative Authorities Act, 1981</li> <li>• The Local Government Act, 1986</li> <li>• The Public Health Act (Cap. 73)</li> <li>• The Dangerous Goods Act (Cap. 160)</li> <li>• The Petroleum Act, 1980</li> <li>• The Mining Act, 1979</li> </ul>

### **Box 7. ENVIRONMENTAL IMPACT ASSESSMENT**

Environmental Impact Assessment (EIA) is an important management tool and is a relatively new management tool in Tanzania. EIAs are widely used to ensure that development activities are environmentally, socially and economically sustainable.

The National Environment Management Council (NEMC) is the regulatory and supervisory agency in environmental management. The issuing of a development permit/licence is subject to provision of environmental approval by NEMC. An EIA Directorate was established at NEMC in 1996 to facilitate and implement the EIA process. The national EIA guidelines and procedures have been developed by NEMC since 1997 and they are currently awaiting formal government approval for them to be legally binding. In addition, the process of development of Mariculture Guidelines is almost complete.

A few legislations are currently requiring and taking into account EIA before approving development projects. These include:

- The Marine Parks and Reserves Act, 1994 includes provisions for Environmental Impact Assessment (EIA)
- The Tanzania Investment Act, 1997 requires and takes into account EIA
- The new Mining Act, 1998 provides for EIA.

Currently, some EIAs have been conducted mainly through the initiative of the donor community. Such development proposals have included, for instance, the proposed development of a prawn farm at Rufiji River Delta, and the production of electricity from natural gas at Songo Songo Island.

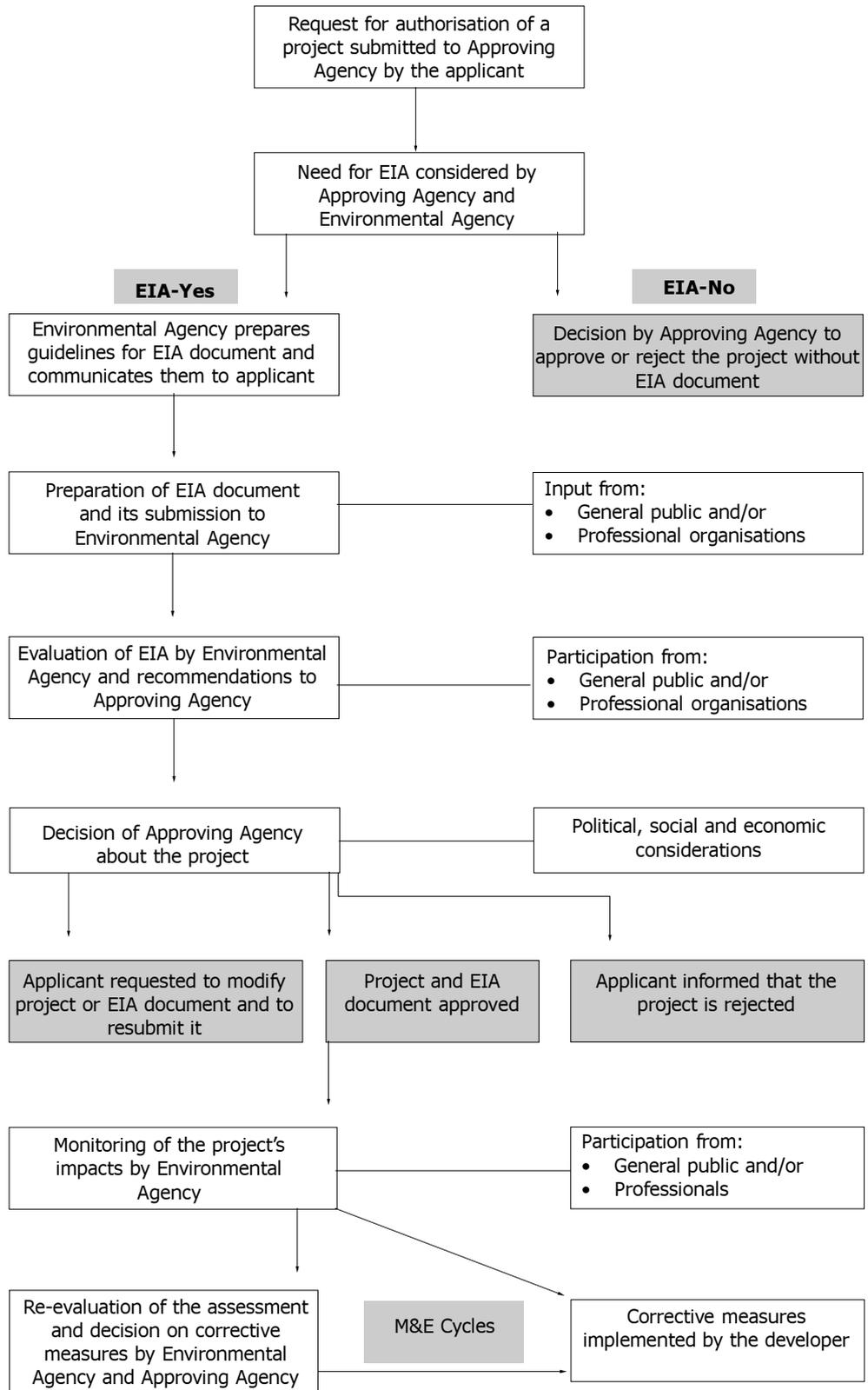


Figure 8. Simplified flow chart of EIA procedure

## COASTAL PLANNING

Coastal planning can only be truly effective once it starts looking at external cross-sectoral integration including the engagement of stakeholders. Since people have always been the root cause to problems, the key goal is to change their behaviour in the use of resources and environment from unsustainable practices to sustainability. For example, the over-population in many coastal zones, caused by an excessive migration from the hinterland and high birth rates (which are very difficult to control through our traditional governmental tools) provide continuous evidence of the impact people have. The weakness or lack of physical planning is evident in Tanzania's urban centres such as Dar es Salaam, Tanga and Zanzibar. The loss of natural resources in coastal areas such as mangroves, breeding and feeding grounds in the shallow waters is evident in many areas such as the Rufiji Delta. Also, the pollution introduced from industries, agriculture, household wastes and sewage show that people are a main source of the problem.

Although the use of marine and coastal resources and services including fisheries, forestry and beaches are under the mandate of the Division of Fisheries, Forestry and Tourism; coastal land use planning is the responsibility of the Commission of Land Use Planning. Land administration, land use planning and development are covered by three regulations: The 1923 Land Ordinance, Town and Country Planning Ordinance 1956, and the Local Government, District Authorities and Local Government Urban Authorities Act, 1982.

- The Land Ordinance gives powers to the President to grant and acquire land; some of the power is delegated to the Commissioner for Lands. However, this Ordinance does not regulate the management of land resources.
- The Town and Country Planning Ordinance empowers the Minister responsible for Town and Country Planning to declare planning areas and provide for establishment of planning committees within the urban authorities. The Ordinance prescribes the procedures for preparation approval and implementation of planning schemes; and for controlling development. As a tool for managing land resources, including coastal resources, the Town and Country Planning Ordinance has several inadequacies including insufficient emphasis on rural land planning; it does not address key conservation issues such as pollution, and it lacks provisions for effective public involvement in the planning process.

In addition to the above legislation, more recent legislation relevant to coastal land issues include:

- The Public Beaches Planning Areas Order, May 1992.
- The Public Recreation Grounds Allocation, Development Control, Management and Control Regulations, April 1994.
- The Urban Authorities and District Authorities Act which empowers municipal and district councils to make by-laws, including decrees to ensure environmental protection. However, as stated earlier, this opportunity has not been used sufficiently by these authorities because of lack of capacity and resources. A few district councils such as Lindi, Tanga, and Mafia have enacted by-laws.

**Table 28. Land Ownership as Reflected in the Policies/Legislation**

Policy/Legislation	Description
National Land Policy, 1995	<ul style="list-style-type: none"> <li>• Dual land tenure system</li> <li>• All land owned by State</li> <li>• Stipulates that all beaches are public</li> </ul>
Land Act, 1998	<ul style="list-style-type: none"> <li>• Statutory right of occupancy stipulates the right to use and occupy land through Title Deed</li> </ul>
Village Land Act, 1998	<ul style="list-style-type: none"> <li>• Customary right of occupancy gives the right to use and occupy land through Certificate of Customary Land issued by village councils and registered at District Land Registry</li> </ul>

In Zanzibar, the institution that has a leading role in both the planning and management of the coast is the Commission for Lands and Environment (COLE) which includes the Department of Environment (DoE) and the Department of Land and Surveys. COLE was established by decree in 1988 and it was originally located in the Chief Minister's Office, a position that was advantageous for inter-sectoral coordination. However, COLE was moved to the Ministry of Water, Construction, Energy, Land and Environment in 1990. Its mandate includes:

- coordinating sustainable use of both terrestrial and marine resources,
- facilitating implementation of policy,
- coordinating sectoral activities,
- monitoring the state of the environment, and
- acting as an advisory body to the government on all issues relating to environmental conservation.

It is through COLE that the government of Zanzibar has put considerable effort in collecting and compiling much of the information on the environmental situation in Zanzibar. An Environmental Policy and Programme have been prepared through a comprehensive participatory process and adopted by the government. This programme forms the basis for all the development activities on the islands.

#### **Box 8. COASTAL ZONE BOUNDARY**

Defining boundaries for integrated coastal management policies is a very thorny issue, that is, determining how far inland and offshore coastal management initiatives should extend. There is great diversity in the kind of boundaries set up by different countries for their coastal management initiatives. Some countries have determined their landward boundaries based on either the extent of local government jurisdiction or the extent of watershed. The seaward boundaries have been determined based on 12 nautical miles territorial water and arbitrary offshore distance from tidal mark, amongst others. Of recent, determining boundaries according to use has become a more preferred way of defining boundaries. However, most of the countries still do not have any defined boundary for their coastal management efforts.

Currently, there is no legislation that defines a coastal area in Tanzania. However, the Ministry of Lands established a development setback line in 1992, which is reserved for public use, and allowing only moveable and temporary structures. More specifically, the main purpose of the setback line is to ensure public access to coastal resources, protect structures against erosion and create a buffer zone where permanent structures are not allowed. The zone was first set at 200 m from high tide, then 100 m, and it is now 60 m.

The Integrated Coastal Management Policy, which is in preparation, recommends that an operational boundary be established to include existing administrative borders of coastal districts out to the seaward edge of territorial waters.

## **Coastal Management Plans/Projects/Programmes**

### **TANGA COASTAL ZONE CONSERVATION AND DEVELOPMENT PROGRAMME**

The Tanga Coastal Zone Conservation and Development Programme (TCZCDP) is constituted at the regional level and serves the coastal villages in the three districts of Muheza, Tanga and Pangani. The overall goal of the Programme is to develop sustainable use of Tanga Region coastal resources through:

- improvement of the institutional capacity up to the regional level to undertake integrated coastal management; and
- assisting coastal communities to use coastal resources in a sustainable manner.

The first phase of the Programme was from July 1994 to June 1997; the second phase started in July 1997 and was expected to end in June 2000. Technical assistance to the Programme

is provided by the International Union for the Conservation of Nature (IUCN) through its East Africa Regional Office (EARO) and funded by Irish Aid. The following are the objectives of the Programme.

- strengthen capacity of local institutions to undertake integrated coastal management
- work with local communities to implement effective management of coral reefs, mangroves, coastal forests and wildlife
- three coastal districts with established programmes of collaborative resource management (communities and government together) improve the well being of the coastal communities and their environment in the Programme villages.

The first two objectives were covered during Phase I, while the third objective was implemented in Phase II.

The major coastal management issues facing the Tanga region when the Programme started were:

- institutional framework for coastal management was inadequate
- coral reefs were being destroyed by destructive fishing methods such as dynamite fishing
- fish catches were declining due to over-fishing and critical habitat destruction
- mangroves and coastal forests were being destroyed by excessive cutting and encroachment
- beach erosion.

The Programme activities have led to some changes in attitude and behaviour on the part of both villagers and government officers. The Programme has been able to introduce a participatory, bottom-up, community-based and community-led process for establishing coastal resource management. Many government staff now have an appreciation of the issues and practice of coastal management, as well as participatory approaches to decision-making. Gender awareness, participation and motivation are high.



Mangrove replanting

More specifically, the Programme has succeeded in the following key areas:

- *Fisheries conservation and management.* Dynamite fishing has to a large extent been eliminated due to regular enforcement patrols and effective prosecution of offenders.
- *Promotion of the role of women.* Women are involved in the decision-making process and well represented in the gender balanced multi-stakeholder committees associated with the Programme at the village level.
- *Participatory process.* Participatory processes have been used by the Programme in socioeconomic and resource assessments, issue identification and analysis, prioritising, decision-making, and evaluation and monitoring.
- *Improvement of environmental awareness.* Many government staff at the regional and district levels as well as fishermen and local community at large, have a good appreciation and understanding of the issues and practice of coastal management as well as participatory approaches to decision-making.

#### RURAL INTEGRATED PROJECT SUPPORT PROGRAMME (RIPS)

The Government of Finland has been supporting the two southern regions of Lindi and Mtwara for the past 25 years. The Rural Integrated Project Support (RIPS), which started in 1988, represents the latest in a long series of rural development projects covering regional planning, rural water supply and rural road projects. The programme's objective is to provide a framework for supporting local initiatives and projects for sustainable livelihoods.

RIPS is implemented through the district and regional councils. It has a marine protection component, the Marine Environment Protection Project (MEPP), which started in 1994 with strong community participation. The MEPP evolved from the concern of fishing communities on the use of dynamite fishing and its impacts on the marine environment.

The aim of the MEPP is to initiate a process of community empowerment in managing the marine environment using participatory approaches. The implementation of the project enables local communities particularly the fishermen to collaborate with the government officers and project staff to reduce dynamite fishing and raise awareness about the importance of coastal resources.

A number of activities have been implemented by MEPP. These include:

- Patrolling and awareness campaigns. A film *Bahari Yetu Hututaki* was produced and shown to villagers and district and regional leaders
- Establishment of a village level revolving fund for purchasing fishing gear
- Introduction of seaweed farming as alternative source of income
- Formation of a fisherfolk's interest organisation, the Southern Zone Confederation for the Conservation of the Marine Environment (*Shirikisho la Kuhifadhi Mazingira ya Bahari Kanda ya Kusini*). The confederation has already been registered as a local NGO.

#### MANGROVE MANAGEMENT PROGRAMME

This project is implemented by the Forestry and Bee-keeping Division of the Ministry of Natural Resources and Tourism through district and regional councils, with funding from the Norwegian Agency for Research Cooperation with Developing Countries (NORAD). It is designed to protect mangrove areas along the whole coast of Tanzania. The Project's main goal is to enhance the sustainable socioeconomic contribution of mangrove resources by improving the management of the mangrove ecosystem. Administratively, the Project is subdivided into three zones, namely: Northern zone covering mainly the Tanga region; Central zone consisting of Dar es Salaam and Coast regions and Southern zone which covers Lindi and Mtwara regions.

The Programme has succeeded in implementing a number of activities. These include:

- *Integration of village communities in mangrove management through formation of Village Natural Resources Committee.* Through these committees, the villagers are involved in

patrolling and monitoring for illegal activities and in replanting of mangroves in degraded areas.

- *Collaboration with other projects* such as Tanga Coastal Zone Conservation and Development Programme and Mafia Island Marine Park. For example, formulation of Kipumbwi-Sange (KISA) collaborative mangrove management agreement between Kipumbwi and Sange villages, Pangani District Council and the Ministry of Natural Resources and Tourism.
- *Improvement of environmental awareness.* 60 teachers from 20 primary schools in Tanga have trained on coastal ecology.
- *Continuation of community-based mangrove replanting in degraded areas.* Replanting of 245 ha of mangroves in Tanga region alone has been achieved.

#### RUFJI ENVIRONMENT MANAGEMENT PROJECT (REMP)

Rufiji delta is an extremely important habitat and breeding area, with an extensive mangrove forest and a rich biodiversity. REMP was established in 1998 with the objective of promoting long-term conservation through wise resource use in the lower Rufiji forests, woodlands and wetlands such that biodiversity is conserved, critical ecological functions are maintained and renewable resources are used sustainably.

The project plans to undertake the following activities:

- establish a knowledge base to support environmental planning and sustainable development
- raise awareness of key stakeholders of environmental values, lessons learned, and using information to improve management.
- improve capacity of key stakeholders and local institutions in natural resources management and conservation
- develop environmental planning and monitoring established and an initial environmental plan
- research, develop, pilot and test wise use activities.

#### CONSERVATION OF LOWLAND COASTAL FORESTS PROJECT

In response to growing threats to the lowland coastal forests of Tanzania, the World Wide Fund for Nature (WWF) under the ODA Joint Funding Scheme began a project in 1991 to conserve a representative sample of these forests identified as conservation priorities by the Forestry Department. This project concentrates on five of 39 main coastal forests: Vikindu, Zaraninge, Kiwengoma, Namakutwa and Mlola forest reserves.

The two main aims of the project are to protect the forests for threatened habitats and provide an alternative resource base to the local communities. The project uses various approaches to ensure that communities are fully involved in developing and implementing a set of viable alternatives that they think could minimise pressure on the existing coastal forests. The strategies used by this project therefore include:

- participatory project planning
- establishment of tree nurseries at village level within the project sites
- tree planting and agroforestry scheme
- training and employment of local people
- establishment and support of community conservation committees
- conservation and sustainable utilisation of woodlands outside forest reserves.

#### THE CHWAKA BAY-PAJE AREA, ZANZIBAR

This pilot coastal management initiative was started for the purpose of building momentum towards national ICAM (Integrated Coastal Area Management) and to develop necessary experience in coastal management. This modest experience encompasses the Chwaka Bay and Paje coastline, lying about 50 km southwest of Zanzibar town. The area includes the

villages of Chwaka, Uroa, Michamvi, Bwejuu, Paje, Ukongoroni, Maruhubi and Charawe. It was chosen as a demonstration area for a number of reasons:

- The area's resources are important both at the local and national level for fisheries, tourism, seaweed farming, and coastal thicket and mangrove forests.
- The area is confronted by the most critical coastal issue that is found in many other areas of Zanzibar—incorporating a rapidly expanding international tourism industry within an area comprised of traditional villages in a manner that benefits the people of the place and the nation. Management approaches and techniques developed here will be useful in other locations.
- There was local demand for the project. One major impetus in the selection of the area was that eminent local people recognised that changes were occurring and envisaged problems unless necessary actions, defined in full consultation with local people, were taken.

The management objectives of the project were defined as follows:

- maintain the coastal resource base on which the economy depends
- sustain and enhance village economies
- encourage environmentally and culturally sensitive tourism development within the area which benefits both the local residents and the nation
- foster harmonious relationships between and among non-traditional and traditional activities
- acquire and use the best possible information for management decisions
- utilise and build upon existing laws, policies, regulations, institutions and experience to achieve ICAM goals and objectives.

#### SUSTAINABLE DAR ES SALAAM PROJECT

The Sustainable Dar es Salaam Project (SDP) is part of the global Sustainable Cities Programme (SCP) which is a joint programme of United Nations Centre for Human Settlements (Habitat) and UNEP. SCP provides municipal authorities and their partners in public, private and community sectors with an improved environmental planning and management capacity. The SCP is undertaking demonstration projects in 15 cities worldwide which will result in the formulation of local Agenda 21 which include environmental management strategies, action plans and priority technical cooperation and capital investment projects for the cities concerned. The SDP is the first demonstration project and was launched in 1992.

SDP focuses on substantive participation of all stakeholders in the urban development process. Although the project is currently confined to Dar es Salaam City, the ultimate goal is to gradually transfer and adapt the experiences from SDP to other towns in Tanzania. Presently, the SDP is concentrating on nine (priority) environmental issues. These are:

- improving solid waste management
- upgrading unserved settlements
- servicing city expansion & coastal resource management
- managing surface water and liquid wastes
- air quality management and urban transportation
- managing open spaces, recreational areas, hazard lands, green belts and urban agriculture
- managing the economy and integrating petty trading
- coordinating city centre renewal
- managing coastal resources.

The primary goal of SDP is to improve the local (municipality and community) capacities to foster sustainable environmental planning and management. The ultimate aim is to ensure that Dar es Salaam City is able to effectively meet the needs of its booming population by gradually improving the living and working environment.

### **Box 9. TANZANIA COASTAL MANAGEMENT PARTNERSHIP (TCMP)**

The Tanzania Coastal Management Partnership (TCMP) is a joint initiative involving the Tanzania Government's National Environment Management Council (NEMC), the United States Agency for International Development (USAID) and the University of Rhode Island Coastal Resources Centre (URI/CRC). Established in May 1997, TCMP is part of the USAID-Tanzania Strategic Objective that aims to establish a foundation for the adoption of environmentally sustainable natural resources management. The lifespan of the Project is five years, from 1997 to 2001.

The goal of TCMP is to establish the foundation for effective coastal governance, which is an essential precondition for the improvement of the quality of coastal environment, sustainable coastal development, and improvement of the quality of life of coastal residents. The partnership is working to achieve the following results:

- formulation of integrated coastal management (ICM) policy that is applicable to coastal problems at both the national and local levels,
- establishment of intersectoral mechanisms for addressing emerging coastal economic opportunities such as mariculture and coastal tourism,
- development of mechanisms to facilitate national support for ICM,
- increasing institutional and human capacity for ICM, and
- sharing of Tanzania's coastal management experience regionally and globally.

During Phase I (1997–1999), the programme's focus is on learning from existing experience, policy articulation, development and testing of sustainable practices. It also focuses on the building of the process, support and structure which are necessary for a sustainable ICM programme. In Phase II (2000–2001), emphasis will be on the application and refinement of articulated policy for the whole coastline of Tanzania.

In principle, TCMP aims at uniting the government and community, science and management, as well as sectoral and public interests to conserve and develop the coastal and marine environment and resources. The work plan of the TCMP is organised by Life of Partnership Results (LOPR). It is the forward-looking results that the TCMP is seeking to achieve during the lifespan of the project. Each result is supported by a list of tasks and outputs, which provide the framework for implementation. The tasks are carried out by multidisciplinary cross-sectoral working groups and in some cases by consultancy teams made up of interdisciplinary experts.

The institutional structure for management of the project includes the Permanent Secretary in the Vice President's Office, National Environmental Management Council, TCMP-Support Unit, working groups, a network of existing demonstration projects and external technical support.

The TCMP-Support Unit, established under NEMC, is coordinating and ensuring that the results of the project are brought to the attention of appropriate institutions for necessary actions.

The Support Unit is responsible for the coordination and day-to-day activities of the project such as secretariat support to the Core Working Group and other working groups, and providing logistical, administrative and technical support to the policy development process.

The Core Working Group and the Mariculture Working Group are composed of experts representing different disciplines and sectors. The Groups have been established for the purpose of conducting a consultative and collaborative process with the relevant stakeholders to identify issues and problems, and recommend solutions.

Therefore the main objectives of the SDP are to:

- enhance the local capacity to jointly plan, coordinate and manage environmental interaction;
- promote substantive participation of all stakeholders (residents) in the plan generation, implementation programmes and projects;
- prepare a long-term dynamic and integrated development plan and investment strategy where partners in urban development cooperate in a synergistic manner.

Working groups generate action plans, which are delivered from ideas based on specific environmental problems. Some examples of action plans which are now under implementation or which are going to be implemented very soon are: the upgrading of Hanna Nassif, Kijitonyama and Tabata areas; privatisation of solid waste collection; rehabilitation of the city horticultural gardens; pit emptying in Sinza area; planting of trees, and others.

#### KINONDONI COASTAL AREA MANAGEMENT PROGRAMME (KICAMP)

This new programme is based on the earlier proposed Kunduchi Integrated Coastal Area Management Programme (KICAMP) that was developed by the National Environment Management Council, in collaboration with the Institute of Marine Sciences (IMS), the University of Dar es Salaam and a number of stakeholders of Kunduchi from 1994–1996.

The focus of the new programme is the Kinondoni District and not Kunduchi area as was the case for the previous proposal. The overall objective of the new programme is to improve understanding and management of marine and coastal resources in the District of Kinondoni. Through the programme, Kinondoni will be provided with technical assistance in coastal planning, resource management and environment protection.

During the preparatory phase which started in July 1995 with a series of three awareness workshops, a number of issues and problems were highlighted. In January 1996, working groups formed at the awareness workshops presented their findings to a Logical Framework Analysis (LFA) workshop. The workshop identified a number of environmental problems. These include: decline in fishery resources, beach erosion, indiscriminate mangrove cutting, degradation of coral reefs, uncontrolled mining and unsightly quarries, dynamite fishing, pollution and conflict over plots and haphazard building.

Discussions held with different stakeholders during the planning of the new KICAMP broadly categorised the main environmental problems facing the Kinondoni District into:

- highly degraded coastline and the hinterland
- depleted fishery and other key resources
- high prevalence of communicable diseases
- very low income levels
- absence of planned basic infrastructure and environmental profile.

The new programme will have four components:

- coastal land and water use planning
- coastal community development
- coastal surveys, assessment and monitoring
- education, information and communication.

## MARINE PROTECTED AREAS AND RESERVES

Marine and coastal protected areas (MPAs) are widely recognised as an important component of any management strategy for the sustainable development of the coastal and marine environment. In this regard, MPAs take into consideration both conservation and developmental interests.

**Table 29. Development Process of the Marine Parks in Tanzania**

Time	Milestone	Framework
Late 1960	Ray Carleton proposes the establishment of marine parks and reserves in Tanzania	
1975	Eight small marine reserves established	The Fisheries Act, 1970 – The Fisheries (Marine Reserves) Regulations, 1975
Late 1970	Maziwi Island, one of the designated marine parks, is submerged	
1994	Marine Parks and Reserves Act passed by Parliament Marine Parks and Reserves Unit (MPRU) established	
1995	Mafia Island Marine Park established (incorporating Tutia Island and Chole Bay Marine Reserves)	Marine Parks and Reserves Act
1999	Formal transfer of management of marine reserves from Fisheries Act to Marine Parks and Reserves Act  Introduction of the Marine Parks (user fees) Regulations	
May 2000	Recruitment of Marine Parks and Reserves staff	
June 2000	Establishment of Mnazi Bay Marine Park in Mtwara	Marine Parks and Reserves Act

The development of marine parks and reserves in Tanzania dates back to the late 1960s when surveys of the reefs were conducted and several sites were proposed as having the potential for marine protected areas (Table 29).

## Marine Reserves

Several areas were designated as Marine Reserves in 1975, and became subject to the regulations laid down in the Fisheries Act of 1970, Government Notice No. 1370, 1975. Under this Act, the recommended marine reserve policy was the 'no-take or non-consumptive use'. Thus, the policy encouraged aesthetic, recreation, education and research activities in these reserves. These areas (Map 15), which were administered by the Fisheries Division of the Ministry of Natural Resources and Tourism, are as follows:

- *Dar es Salaam area:* The islands of Mbudya, Bongoyo, Pangavini and Fungu Yasini
- *Tanga Region:* Maziwi Island (off Pangani)
- *Mafia Island:* Chole Bay and Tutia Reef.

However, only two of the Mafia Island sites have been implemented as MPAs. The rest of the sites have deteriorated. Maziwi Island submerged in 1978, probably due to the rise of the sea level and the Dar es Salaam reserves are all in poor condition. The gazetted reserves are subjected to continued fishing pressure, intense blast fishing, shell and coral collection, anchor damage, and human trampling. Lack of financial and technical resources has contributed to the reserves being left unmanaged.

Despite their damaged condition at present, some sites could recover if effective management was implemented. Furthermore, the gazetted but unprotected marine reserves still have potential as marine protected areas (MPAs) due to the persistence of species and reef structure. Reduced fishing effort, elimination of destructive gear (dynamite and beach seines), protection



of vulnerable species and, in some cases, sea urchin reduction could rectify the problems of over-fishing.

**MAFIA ISLAND MARINE PARK**

Discussions on marine parks in the Mafia Island (Map 16) region have been held at various levels for many years since 1968. The Mafia Island Marine Park (MIMP), encompassing the two reserves of Chole Bay and Tutia Reef, was officially gazetted in April 1995, following the approval of the Marine Parks and Reserves Act of 1995.

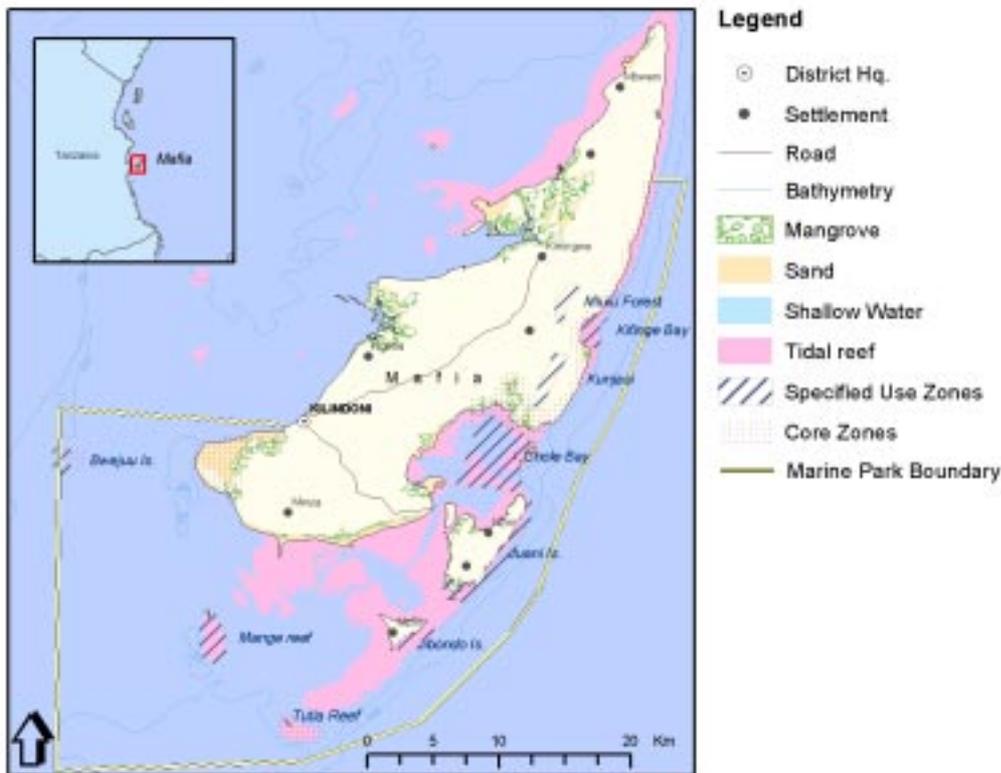
The park area forms part of the Mafia Island/Rufiji Delta system that has a total area of 1500 km<sup>2</sup>. The park occupies an area of 822 km<sup>2</sup>, which includes, among others, estuarine, mangrove, coral reef and seagrass ecosystems. The Park also includes critical habitats for dugong and sea turtles.

The management goals of MIMP, which reflect the integration of development, environmental protection and sustainable resource use, are as follows:

- to protect ecosystem processes and areas of high species and genetic diversity;
- to stimulate the rational development of non-utilised natural resources and tourism;
- to promote sustainability of existing resource use incorporating recovery strategies for over-utilised resources;
- to involve marine park users, especially the Mafia community, in planning, development and management of the park, and to give them priority of resource use and economic opportunity.

The Park has been experiencing a number of threats including:

- increasing exploitation of natural resources such as finfish, octopus, shellfish, sea cucumber and crayfish;



Map 16. Zoning of the Mafia Island Marine Park

- uncontrolled clearance of mangrove and coastal forests for building materials and agricultural activities;
- use of destructive fishing gear/methods such as dynamiting and small mesh nets;
- live coral mining for lime making.

The Park has made significant achievements in reducing the impacts of these threats. With assistance of local communities, the Park has succeeded in:

- Eradicating dynamite fishing and beach seines ('juya'). To some fishermen, 'juya' is the only available fishing gear, and The Park is working towards finding alternative fishing gear to replace 'juya'.
- Reducing mining of live corals. For small islands such as Juani, Chole, Jibondo, and Bwejuu, lime from live corals is the building material available. The Park is experimenting on land-based fossil corals and clay bricks as alternative building materials.
- Reducing exploitation of high-value stocks such as octopus, sea cucumber and lobsters. This has been possible through the implementation of a permit system based on available scientific information. The minimum allowable mantle length of octopus is 10 cm, the number of fishermen extracting octopus is limited to 350 and octopus processing plants to only two. The Park has also banned the collection of sea cucumber by scuba diving.
- Introducing entrance and fishing permit fees.
- Development, through a participatory process involving all key stakeholders, of a General Management Plan of the Park. The Plan contains the zoning scheme that divides the Park into three use-zones, namely core zones, specified-use zones and general use zones.

#### CORE ZONES

Within core zones all biological resources, non-biological resources and ecosystem processes are, as far as practicable, protected from the direct adverse effects of human activity. Accordingly, extractive resource use is prohibited entirely. Controlled tourism and scientific research are permitted.

#### SPECIFIED-USE ZONES

The strategy in specified-use zones is to prohibit activities likely to cause significant alterations to the environment. Extractive resource-use in specified-use zones is restricted to residents of the marine park. This may be defined as:

- significant change or damage to benthic or terrestrial habitats not likely to self-regenerate from year to year;
- significant depletion of the abundance or biodiversity of representative species assemblages
- significant depletion over time of species that are considered locally rare or threatened.

#### GENERAL-USE ZONES

Extractive resource-use is permitted in general-use zones. The objective of regulation in general-use is to ensure that fish catches and other resource exploitation is sustainable from year to year, notwithstanding natural variations in breeding and recruitment. A certain level of permanent habitat alteration is acceptable only provided that the overall productivity of the environment is not significantly undermined and that adjacent areas with a higher protection status do not deteriorate significantly.

#### MNAZI BAY MARINE PARK

The Mnazi Bay Marine Park, which includes Mnazi Bay and Ruvuma Estuary, is located at the southern end of the Tanzanian coast bordering Mozambique. Seven villages surround the Bay and these include Msimbati, Mngoji, Mnazi, Nalingu, Mnete, Kubilu and Msangamkuu.

Several islands are located within the Bay and the main islands are Mmongo, Namponda and Membelwa. Mnazi Bay and Ruvuma Estuary have extensive mangrove forests, which are breeding and nursery grounds for prawns and other species, including commercial fish. Fisheries

resources include fish, lobsters, prawns, seacucumber, bivalves and gastropods. Seagrass beds occur in shallow water areas in the Bay.

Coral reefs occur as patch reefs in the Bay and continuous fringing reefs outside the Bay. These reefs were in pristine conditions until recently; dynamite fishing now threatens the health of the reefs. A number of rare and endangered species such as turtles, dugong, seashore fish and nudibranchs occur in the Bay. The biological diversity is considered to be the highest in southern Tanzania.

Mnazi Bay has attractive and pristine beaches and some of the islands can accommodate day visitors. Several investors have identified the Bay as a site for hotel development. Although the Bay has no historical sites, it lies close to Mikindani settlement which is an old slave town containing the slave market and a German Fort.

The local communities depend mainly on artisanal fishing, subsistence farming and utilisation of mangroves for timber, poles and fuel wood. Recently, seaweed farming has been introduced. Kingsway International Company is the main seaweed trading company in Mtwara region. Cashewnut production was a reliable source of income but due to lack of market and low production, it is no longer a dependable income-generating cash crop.

The planned exploitation of natural gas by Tanzania Petroleum Development Corporation, when commissioned, will be the main economic activity within the Park.

The Park was officially gazetted in June 2000 by Parliament.

#### MENAI BAY CONSERVATION AREA (MBCA), ZANZIBAR

Menai Bay is located in the southwest side of Unguja Island (Map 17). It is a traditional fishing ground with extensive coral reefs. The Government of Zanzibar officially gazetted it as a conservation area in August 1997. The gazetted area covers an area of 470 km<sup>2</sup> inclusive of islets. The area had remained relatively undisturbed until recently, when fishing pressures combined with destructive fishing techniques became a serious environmental concern. This has been partly due to high demand for fish from the ever-growing populations of Dar es Salaam and Zanzibar cities. The decline of fish resources in other fishing grounds has resulted in the influx of fishermen from outside the area. The traditional 'dago' system, referring to seasonal visits by fishermen camping in the area, has been replaced by permanent settlement on some of the bay area islets.

The main goal of MBCA is to conserve the biological diversity, ecological processes and productivity of the area so as to ensure that resources suffice the needs of local people. The project is designed to provide a framework for the local communities of Menai Bay to participate fully in planning, managing and monitoring the resources.

The MBCA falls under the Commission of Natural Resources and Tourism in the Ministry of Agriculture, Livestock and Natural Resources, with WWF providing both technical and financial support to the activities in the conservation area.

A district environmental committee composed of members from villages and other stakeholders within the district, has been formed. This committee provides a link between the project and the communities as well as with the government agencies. At the village level, Village Conservation Committees have been established. These committees have been very instrumental in surveillance and law enforcement system, educating villagers on environmental conservation and monitoring project activities. There has been a significant reduction in the use of destructive fishing methods, particularly dynamite fishing. This is attributed to increased surveillance by the villages, fisheries officers and the Navy.

#### MISALI ISLAND CONSERVATION AREA, PEMBA

The forested coral rag island of Misali, occupying a land area of 90 ha, is located 10 km off the western coast of Pemba. The total area gazetted is 22 km<sup>2</sup>, with a 9.4-km ring of coral growth



Map 17. Menai Bay conservation area

varying from extensive reef formations to areas with patches bommies. Misali Island is renowned in diving circles for its rich coral communities. It has a high biodiversity with 42 hard coral genera and over 244 fish species from 43 families. The forest on the Island is relatively undisturbed and contains endemic species such as the Pemba sunbird, the Pemba white-eye, and the Pemba flying-fox, a rare fruit bat species.

There is no permanent human habitation on Misali Island. Fishermen from various parts of Pemba camp on the Island for two to three weeks per year.

The marine environment and fishery resources of Misali Island are threatened by a number of activities, including the use of destructive fishing methods such as dynamite, 'kigumi' and the use of small mesh nets.

The Misali Island Marine Conservation Area (MICA) was established on 22 May 1998 under the Misali Order, based on both the Fisheries Act and the Forest Resources Management and Conservation Act. The Misali Order allows for the formulation of controls of the area by a Management Committee made up of resource users and government. The main goal of MICA is to conserve biodiversity and maintain productivity of marine ecosystems, as well as permitting for the sustainable use of the resources. Social and economic development of the Misali user communities is promoted by zoning, multiple-use mechanism, appropriate tourism development and the sharing of tourism revenue.

The conservation area covers 22 km<sup>2</sup> in total, including a terrestrial area of about 1 km<sup>2</sup>. The marine part of the area is divided into two zones, a non-extractive-use zone (core protected area) and an extractive-use zone. The non-extractive-use zone is 1.4 km<sup>2</sup> in area on the west side of the island and includes important turtle nesting beaches and coral reefs. This area makes up 8.5% of the total and is meant to allow fish stocks to replenish. No extractive uses are allowed in this zone. However, activities such as diving, snorkelling, swimming, boating and scientific research are permitted.

In the extractive use zone all legal fishing techniques are permitted. The main aim of the patrol effort since the beginning of the project has been to control illegal fishing within the area.

#### CHUMBE ISLAND CORAL PARK, ZANZIBAR

The Chumbe Island Coral Park is a private nature reserve developed and managed by the Chumbe Island Coral Park Ltd. (CHICOP). Chumbe Island which occupies an area of 16 ha, is situated southwest of Unguja Island. It is a rare example of a still pristine coral island ecosystem in an otherwise heavily overfished and over-exploited area. The reserve includes a reef sanctuary and a forest reserve. The fringing reef west of Chumbe Island was officially closed in October 1992. On the 24th of December 1994 the Zanzibar Government also gazetted the reef as the 'Chumbe Reef Sanctuary'. Zanzibar Fisheries Legislation of 1988 provides for the declaration of marine sanctuaries and territorial marine parks. CHICOP holds a 33-year-old lease of 2.5 ha of cleared land and a management contract of 10 years for the Chumbe Reef Sanctuary.

The main goal of the project is the conservation of the reef and island. Ecotourism is promoted as an activity that can sustain and finance the project.

Since 1992, former fishermen from adjacent villages have been trained as park rangers and posted on the island. They now cooperate closely with the management, and they have taken full responsibility for protecting the area. They produce weekly reports on any incidents and observations on the Reef Sanctuary and the forest. Nature trails and educational material are open to both ecotourists and local people.

Biological surveys reveal that the protection of the reef west of Chumbe Island from 1992 by CHICOP has already shown good results. Coral growth and diversity are among the highest in the region, and Chumbe has at least 90% of all the species that have ever been recorded from eastern Africa reefs. Fish diversity and populations have also increased; nearly 380



Corals in the Chumbe Island Coral Park

species of fish belonging to 50 families have been recorded, including giant groupers *Epinephelus lanceolatus* of up to 1 m in length, a rare occurrence in shallow reefs. The rich fish life has attracted seabirds, such as the rare roseate tern *Sterna dougalli*, which bred successfully on Chumbe in mid-1994. The rare robber or coconut crab *Birgus latro* is common on Chumbe while it is threatened elsewhere in the Indian Ocean as it is widely eaten and used in fish traps.

## INTERNATIONAL PERSPECTIVE

Tanzania has signed and ratified several regional and international conventions and agreements relevant to the marine and coastal management. These include:

- The African Convention on the Conservation of Nature and Natural Resources, Algiers, 1968. Tanzania ratified this Convention in 1974.
- The Convention on International Trade in Endangered Species on Wild Fauna and Flora (CITES or Washington Convention), Washington, DC, 1973. Tanzania ratified this convention in 1980.
- The International Convention for the Prevention of Pollution from Ships (MARPOL), London, 1973. Tanzania is signatory since 1978.
- United Nations Convention on the Law of the Sea, 1982. This is the only convention for which Tanzania has a corresponding national legislation— the Territorial Sea and Exclusive Economic Zone Act of 1989. This act reduces the territorial waters from the former 50 nautical miles to 12 nautical miles and extended the EEZ to 200 nautical miles.
- The Nairobi Convention on Protection, Management and Development of Marine and Coastal Environment in the Eastern Africa Region and Related Protocols, 1985. Tanzania ratified it in 1996.
- The International Convention on Climate Change. Tanzania is signatory since 1996.
- The Convention on Biological Diversity was ratified by Tanzania in 1996. Tanzania is now developing a National Strategy for the Conservation of Biological Diversity including compliance to the Jakarta Mandate.

Major International Agreements into which Tanzania has entered include:

- The Kenya and Tanzania agreement of 1995 concerning delimitation of territorial waters boundary. This agreement also gives guidance on matters related to fisheries.

- Fishing agreement between Tanzania and the European Union, which was adopted in 1990. This agreement requires the parties to coordinate their activities to ensure the sustainable management and conservation of living resources in the Indian Ocean particularly with respect to migratory species. This agreement is in force despite the fact that Tanzania is not party to the UN agreement on straddling fish stocks and highly migratory fish stocks.
- Tanzania is also Member to some of the international and regional organisations such as the Intergovernmental Oceanographic Commission of UNESCO (IOC), Regional Committee for Cooperative Investigations in the North and Central Western Indian Ocean (IOCINCWIO); International Maritime Organisation (IMO); and the Indian Ocean Marine Affairs Commission (IOMAC).

As stated above, almost none of these conventions and agreements (except the Territorial Sea and EEZ Act) have been translated into corresponding national legislation.

Zanzibar has had little involvement in these conventions although it has ratified some of them indirectly by virtue of being in the Union Government. It is anticipated that the Environmental Policy Programme will create a mechanism of sensitisation which will lead to increased international cooperation, and in turn lead to government interest in the international conventions of most relevance to it.

## ADMINISTRATION: INSTITUTIONAL AND GOVERNANCE STRUCTURES

### Local Level

Tanzania's coastal zone is served by five administrative regions, namely Tanga, Coast, Dar es Salaam, Lindi and Mtwara on Tanzania Mainland and five regions on the Islands of Zanzibar, that is, Unguja North, Unguja Town/West and Unguja South, Pemba North and Pemba South. The regions in the Mainland are sub-divided into districts, wards, villages and 10 cell units. As such the structure of government is well established up to the local level. The sub-division of administrative hierarchy is somewhat different in Zanzibar Islands. The districts are sub-divided into constituencies, wards and then 'shehias'.

The large urban centres such as Tanga, Zanzibar, Lindi and Mtwara are municipalities. Effective September 1999, Dar es Salaam was divided into three municipalities, namely Kinondoni, Temeke, and Ilala. Municipalities and districts are served by councils made of democratically elected representatives. Urban centres do not have the sub-division of a village. However, there is lack of a clear mandate between the regional authorities and municipal/town councils of these urban centres.

Municipal Councils have powers to make by-laws to facilitate the implementation of their functions. The Councils implement central government policy decisions through these by-laws. The by-laws have to be approved by the Minister responsible for Local Government.

Regional and municipal administration is under the Ministry responsible for local government in the Prime Minister's Office. However, at the regional and district levels there are civil servants of all central government ministries and these have dual reporting roles—a more direct reporting to the mother ministry as well as an indirect reporting role to the sector ministries. For example, the District Fisheries Officer reports to the District Development Director and District Commissioner on a day-to-day basis but is also responsible for compiling fisheries catch statistical data in the district and submitting these to the Regional Fisheries Officer for onward transmission to the Division of Fisheries.

Lack of capacity and resources, duplication of responsibility and limited sectoral coordination has interfered with the proper management of resources. The ministry responsible for local administration operates and functions as just another line/sector ministry and this situation raises a lot of confusion and in some instances, conflicts.

Tanzania has now realised the importance of strengthening district authorities and is already taking steps to review the structure, roles and responsibilities between regional and district authorities as well as the different sectoral ministry functions at the district level. Regional and district development committees have been phased out and district councils are being strengthened. With the devolution of authority to the local level, local administrations have received increased responsibility for managing development. Although they have the authority to establish and enforce by-laws, many local administrations lack the capacity and institutional structure to adequately carry out this function. Regional authorities are now responsible for coordinating development activities while districts are the main implementers of government policies and development activities. This is an opportune time to engage cross-sectoral integration that is required for Integrated Coastal Management (ICM) in the maritime districts. Considering that marine and coastal resources know no boundaries and that the users of these resources have open access, inter-district cooperation and collaboration should be emphasised in the reorganisation process. The district authorities should also have a strong linkage to the central government institutions.

### National Level

There are more than 10 national ministries and offices that are mandated to manage some components of marine and coastal resources and environmental issues. The main ones are:

- the Vice President’s Office which is responsible for environment
- Prime Minister’s Office which is responsible for Local Government
- the National Planning Commission which is responsible for national planning
- the Ministry of Natural Resources and Tourism
- Ministry of Transport
- Ministry of Agriculture
- Ministry of Industries and Trade
- the Ministry of Judiciary, Attorney General’s Office and the National Assembly are responsible for law enforcement.

A similar structure exists for the Zanzibar Government (Table 30). Governance for Tanzania’s coastal zone is complicated by the existence of two national jurisdictions—the Zanzibar Government and the Union Government. Whereas certain issues such as home affairs (law enforcement) and foreign affairs are under joint responsibility of the Union Government, most of the coastal and marine management issues are non-union matters. Most of the ministries are not coordinated and do not create a viable system for managing coastal and marine resources. Authority is fragmented and often overlaps between different departments,

**Table 30. Government Institutions Dealing With Different Aspects of Coastal and Marine Environment in Zanzibar**

Ministry	Institution	Specific Responsibilities
Ministry of Water, Construction, Energy, Lands and Environment	Department of Environment	Environmental law and setting of environmental standards
	Department of Lands	Land management, administration and control
	Department of Urban Planning and Surveying	Urban planning, land use planning, development control and physical standards
Ministry of State for Regional Administration		Coordinates all aspects related to regional and district administration and local government (municipal councils, wards and 'shehias')
Ministry of Agriculture, Resources, Livestock and Fisheries		Agriculture, livestock, natural resources fisheries and forestry

thus causing unnecessary competition. Both the Zanzibar and Union governments need to develop sound institutional linkages in order to optimise the use of limited financial resources and support facilities.

The lack of a comprehensive institutional framework, which could act as a focal point in co-ordinating all activities related to marine and coastal areas, is a major drawback in the formulation of integrated coastal zone management. For example, as pointed above, fisheries officers at the regional and district levels administratively report to two different ministries (Prime Minister's Office and Ministry of Local Government) while technically, they belong to the Ministry of Natural Resources and Tourism. This poses a major constraint to the efficient implementation and administration of the government's fisheries development projects. The adoption of the Territorial Sea and Exclusive Economic Zone Act of 1989 vested substantial powers for the control of coastal resources in the Ministry of Foreign Affairs. The Ministry is responsible for the development of the necessary framework for an integrated marine policy, but due to the diverse nature of the coastal zone, progress is slow. However, it should be pointed out that the preparation of this policy and related legislation should involve local and international interest groups to ensure the adoption of sound and acceptable management practices.

In an attempt to coordinate environmental management Tanzania has restructured the former Ministry of Tourism, Natural Resources and Environment and has moved the functions of Environment and associated institutions (National Environment Management Council and Division of Environment) to the Vice President's Office. The Minister of State responsible for the Environment heads these functions. However, to date, the Vice President's Office has not issued guidelines on the way in which sector ministries and parastatals will be engaged in a coordinated manner in addressing environmental issues.

## Service Parastatals

### MARINE PARKS AND RESERVES UNIT

Within the framework of the Marine Parks and Reserves Act of 1994, the Board of Trustees (BOT) for Marine Parks and Reserves was established in 1996 as a semi-autonomous governing body responsible for the management and administration of marine protected areas in the country. The Board was established as a trusteeship and its functions include, amongst others:

- To formulate policies on MPA-related facilities and activities
- To advise the Minister of Natural Resources and Tourism on the approval, revision and amendment of management plans
- To oversee the use of the Marine Parks and Reserves Conservation and Development Trust Fund (CDTF).

### THE NATIONAL ENVIRONMENTAL MANAGEMENT COUNCIL (NEMC)

NEMC, which was enacted in 1983 and became operational in 1986, is responsible for the formulation, coordination and evaluation of policies and legislation related to the environment. The Council is also responsible for monitoring and assessing the state of the environment in relation to development activities. NEMC has actively commissioned several coastal and marine environmental studies and the information has been used in the preparation of the relevant chapters of the National Conservation Strategy for Sustainable Development (NCSSD), National Environment Action Plan (NEAP), and Environmental Policy and Legislation.

### COMMISSION FOR SCIENCE AND TECHNOLOGY (COSTECH)

COSTECH was established in 1986. It is the main advisory institution to the government on all matters relating to scientific research and technology development.

The work of the Commission is carried out in four directorates, namely the Directorate of Research Coordination and Promotion, which coordinates both sectoral and institutional research in the country; the Directorate of Technology Development, which maintains links with technology development centres; the Directorate of Information and Documentation, which

is responsible for collection, dissemination, and processing of scientific and technical information for use by the local scientists; and the Directorate of Finance and Administration.

The Commission for Science and Technology is responsible for the development of a National Research Policy and Strategy. Its activities, however, have not been sufficiently directed towards marine and coastal issues, and this task is yet to be accomplished.

#### TANZANIA PETROLEUM DEVELOPMENT CORPORATION (TPDC)

TPDC is the Government parastatal through which the Ministry of Energy and Minerals implements its petroleum exploration and development activities. The Corporation participates in and monitors production sharing agreements and joint ventures in all facets of the petroleum industry— from exploration to distribution.

The Directorate of Exploration and Production maintains a petroleum exploration database consisting of wide-ranging geological and geochemical studies. The database also consists of geological and drilling records from about one hundred boreholes and 28 deep wells as well as extensive data from gravity, airborne magnetometer and seismic surveys.

#### TANZANIA HARBOURS AUTHORITY (THA)

THA was established in 1977 by an Act of Parliament to oversee the development and management of the mainland coastal ports (Dar es Salaam, Tanga, Mtwara, Lindi, Mafia and Kilwa), control navigation and provide port-related services including the provision of ferry services and warehousing.

#### THE COMMISSION OF LANDS AND ENVIRONMENT (COLE)

COLE was established in 1988 within the Chief Minister's Office. In 1990 it was moved to the Ministry of Water, Construction, Energy, Lands and Environment. COLE's mandate includes the coordination of the sustainable use of both terrestrial and marine resources; more specifically, the facilitation of the implementation of land use and environmental policies, coordination of sectoral activities and monitoring of the state of environment.

#### THE SUB-COMMISSION OF FISHERIES (SCF)

The SCF was established in 1978 as part of the Ministry of Agriculture, Livestock and Natural Resources. The Commission is responsible for the development of the artisanal fisheries, formulation of fisheries policies for the Zanzibar government, training of fishermen and fisheries officers, collection of fishery statistics and enforcement of the fisheries legislation. The Commission is coordinating the implementation of the WWF-funded Menai Bay Conservation Area Project.

#### ZANZIBAR PORT AUTHORITY (ZPA)

Established in 1997, ZPA is responsible for overseeing the development and management of ports in Zanzibar Islands. More specifically, it is responsible for cargo handling, maintenance of superstructures, pilot guidance, control of vessels and berthing allocation to vessel.

## RESEARCH AND TRAINING INSTITUTIONS

Policy and management of coastal resources and environment in Tanzania is informed and advised by several research and training institutions. The role and functions of these institutions are specified in the Acts establishing them.

### Training Institutions

There are several institutions in the country offering training relevant to coastal and marine related issues, at levels ranging from certificate to MSc/PhD degrees. These institutions include: University of Dar es Salaam, training institutions under the Division of Fisheries (the Mbegani Fisheries Development Centre and Kunduchi Fisheries Training Institute) and Dar es Salaam Maritime Institute.

**Table 31. Selected Training Institutions Relevant to Coastal Management**

Institution	Field of Specification	Award
University of DSM through the Institute of Marine Sciences, Zanzibar; Faculty of Science; the Institute of Resource Assessment; and Faculty of Law	Marine Biology/Sciences: Environmental Science (Course: Marine Ecology) Marine Geology Natural Resources Law of the Sea Civil Engineering (Course: Port Engineering)	BSc, MSc and PhD
Kunduchi Fisheries Training and Research Institute	Fisheries Biology Food Technology Marine Engineering Nautical Science Fisheries Management Administration	Diploma and Certificate
Mbegani Fisheries Development Centre	Fisheries Science	Diploma and Certificate

#### UNIVERSITY OF DAR ES SALAAM

There are several departments from different faculties of the University involved in coastal and marine studies. These include departments of Zoology and Marine Biology, Botany and Geology within the Faculty of Science, the Department of Civil Engineering of the Faculty of Engineering, as well as the Faculty of Law. Table 31 lists the courses related to coastal and marine issues offered by different departments. These courses are part of the general BSc degree.

The Faculty also offers MSc studies in Fisheries and Aquatic Sciences and in Environmental Sciences, by course work and dissertation. The faculty also offers MSc and PhD degrees by thesis only. The MSc in Fisheries and Aquatic Sciences has been suspended for several years now due to a lack of qualified lecturers.

#### DIVISION OF FISHERIES

There are two training institutes under the Division of Fisheries which offer courses related to the coastal and marine environment. These are Kunduchi Fisheries Institute and Mbegani Fisheries Development Centre.

##### *Kunduchi Fisheries Institute*

The Institute has three main objectives:

- to train fisheries personnel to diploma level in fisheries science
- to carry out applied fisheries research in all aspects of the fishing industry
- to provide consultancy services in all aspects of the fishing industry, that is, stock assessment, fish processing, fisheries management and export of fisheries products.

The Institute has five departments namely; Nautical Sciences, Engineering, Fisheries Biology, Food Technology and Management.

##### *Mbegani Fisheries Development Centre*

The Centre has six departments: Finance and Administration, Maintenance, Marine Engineering, Nautical Sciences, Boat Building and Fish Processing. It offers professional training in Nautical and Marine Engineering, Applied Fisheries, as well as providing extension services for fishermen.

#### DAR ES SALAAM MARITIME INSTITUTE

The Institute has two training departments: Navigation and Engineering.

The Institute offers long-term courses such as Engineering Class 3, 4 and 5 and Marine Cadet Course Engineering for deck officers of Class 5, 4, and 3 and cadets. The following Short courses are also offered: Survival at Sea, Fire Fighting, First Aid at Sea, Efficient Deck Hand, Electronic Navigation Systems, Radio Telephone, Advanced Fire Fighting, Navigational Control, and Ship Captain Medical Guide.

## Research Institutions

### UNIVERSITY OF DAR ES SALAAM (UDSM)

The two Institutes within UDSM concerned with research on coastal and marine resources are the Institute of Resource Assessment (IRA) and Institute of Marine Sciences (IMS).

#### *Institute of Resource Assessment (IRA)*

The Institute was established to address a range of issues related to resource use in Tanzania. The Institute has, among others, the following objectives:

- to carry out research projects pertinent to the social, cultural, environmental and economic development of Tanzania, and develop research capacities in these fields.
- to cooperate with government, public authorities and other organisations on special issues of interest.
- to offer advisory services to government, public and other organisations.
- to arrange conferences, seminars or postgraduate courses on resources and land use planning matters.

#### *Institute of Marine Science (IMS)*

IMS was established in 1979 with the following main objectives:

- to undertake research in all aspects of marine sciences.
- to provide postgraduate training and establish undergraduate training in accordance with the manpower requirements of Tanzania.
- to provide advisory and consultancy services in marine affairs.

The research programme of the Institute is mainly based on projects undertaken by its staff as well as collaborative activities with different institutions in the country, overseas universities and international research, education and development organisations. The type of research undertaken covers most of the spectrum of marine science.

The Institute has four sections: Living Resources and Ecology, Chemical and Environmental Marine Sciences, Physical and Applied Marine Sciences and Marine Affairs. The Institute has 16 scientists and 51 support staff.

### DIVISION OF FISHERIES

#### *Tanzania Fisheries Research Institute (TAFIRI)*

TAFIRI was established in 1980 with the aim of promoting, conducting and coordinating fisheries research in the country and disseminating research findings to government agencies, public institutions and private companies engaged in the fishing industry. Its research priorities are fisheries statistics and fish stock assessment, fish biology, fish diseases, fishery management, fish processing and marketing, water pollution and aquaculture.

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# Annex I: The EAF/I4 Database in Tanzania

The overall objective of the EAF/14 project of UNEP was to provide decision makers, and general public alike, with a planning and management tool for developing their coastal resources. The main task was to collate existing information on the coastal environment from institutes, government departments, agencies and other research bodies and to summarise the same in country map sheets, at a scale of 1:250,000 (and 1:50,000 for island states). The next task was to organise the data and information in such a way that it would be readily available and useful for planning and decision-making.

Although the Institute of Marine Sciences was leading in the process of data collection and development of the database, several other institutions were also involved. The type of data collected followed a UNEP-proposed format which included data on climate, hydrology, oceanography, coastal types, natural hazards, mineral and energy resources, cultural and recreational resources, socioeconomic environment (population, administration, economy, utilities), tourism, industry, important marine and coastal ecosystems (mangroves, coral reefs, estuaries and wetlands) and marine protected areas. It was envisaged that when the database was complete, it would be possible to support most of the requests for coastal area resource maps.

## AVAILABLE INFORMATION AND STRUCTURE OF THE DATABASE

Different types of data and information have been collected, collated, synthesised and stored in the database. The information collected so far has been categorised into five data types:

- a) spatial (maps) data (Arc-Info or ArcView point, line or polygon coverage;
- b) attribute data in spreadsheet tables (lookup tables) with information that could or could not be geo-referenced/linked with spatial data;
- c) reference text (defining and describing sources and other information relevant to available data and information)
- d) pictures and other types of illustrations
- e) projects (spatial displays that make use of a combination of data types a, b, c and d).

### Spatial Data

Available spatial data covers some themes in Africa, East Africa, Tanzania (as a country), the coastal areas of Tanzania, coastal regions, coastal districts, marine protected areas and special area data (e.g. study sites such as Makoba, Kunduchi, etc). Themes covered include: administrative boundaries, settlements (major urban centres), road networks, railway lines, major rivers, important coastal ecosystems (e.g. mangroves, sandy beaches, rocky shores, coral reefs, estuaries and wetlands), historical and archaeological sites, recreational, and touristic sites, etc.

### Attribute Data

Most of the attribute data is contained within the Arc-info or ArcView tables. Some of the attribute data is, however, stored in spreadsheet files (e.g. population, fisheries statistics, rainfall data, seawater temperature, etc.) depending on the nature and amount of the data involved.

### Reference Text

All reference materials or information that defines or clarifies data and information in the database are contained in this part of the database. To make the database easily manageable and ready for use a database manual is now being finalised after which any user needing to

extract information from the database should be able to do so, and furthermore, be able to know from where the original information included in the database came.

Some of the text files contain information about the spatial coverage, data tables, sources of information, and other relevant information that would inform and help people to decide whether to use the information or not and allow them to obtain additional information if they wanted to. This section will also be an indicator of correctness and level of detail of the included data.

Information on different activities carried out by scientists at different institutions dealing with coastal and marine research or management is contained in a separate meta-database accompanying the main database. The accompanying meta-database also contains some information and maps on marine protected areas of Tanzania, main ecosystems of coastal districts and information regarding oceanographic datasets held at the Institute of Marine Sciences, Zanzibar.

## Pictures and Other Forms of Illustrations

Pictures, graphs, sketches and other forms of illustrations have been stored in this part of the database. The intention was to have a picture library to illustrate some of the important events taking place along the Tanzania coast.

## Projects

Most maps are produced as a combination of several separate map features such as roads, settlement, rivers, mangroves, etc. In ArcView a *project* is the term given to such a combination of separate map features. Completed thematic maps in the database are stored in a separate directory in the database. A project's manual and a map display file (in MS PowerPoint) are now being prepared to give a quick view of the themes in the database.

## ACHIEVEMENTS AND PROBLEMS

The establishment and utilisation of the database have positively influenced the planning and management of initiation of coastal zone programmes. The database has also acted as a reference site where different kinds of data and information may be obtained. Information in the database was used by scientists in surveys and production of marine protected area habitat maps of the following places: Misali Conservation Area in Pemba, Menai Bay Conservation Area in Zanzibar, Mafia Island Marine Park, Mnazi Bay, Mnazi Bay Marine Park and in the Dar es Salaam Marine Reserves. The database has been used to provide information on the marine environment and resources as well as assisting in the mapping of resources as requested. In-house training and demonstrations involving IMS staff, Fisheries officers, officers from the Environment Division, and other research institutions (e.g. TAFIRI) were carried out regularly in 1998 and 1999. Many individuals have shown interest in this facility.

However, the development of the database was not an easy process. The first and probably the most serious problem encountered was lack of cooperation from different institutions to share information. This problem is hindering the process of updating the database. Unless the information is updated, the usefulness of the database may soon decline. The volume of requests for information and maps has increased rapidly since 1999. The sustainability of the project activities will require more investment on capacity building as well as the creation of a conducive environment for the exchange of data and information.