Coastal Profile for Tanzania Mainland 2014
Thematic Volume I
Including Threats Prioritisation

Investment Prioritisation for Resilient Livelihoods and Ecosystems in Coastal Zones of Tanzania

NORDIC DEVELOPMENT FUND

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Acronyms[1]

Addax	International oil and gas exploration and production company
AEWA	African-Eurasian Waterbird Agreement
AGIP	Azienda Generale Italiana Petroli (General Italian Oil Company)
BG	British Gas
BMU	Beach Management Units
BoE	Barrels of oil Equivalent
CAMARTEC	Center for Agricultural Mechanization and Rural Technology
CARE	Cooperative for Assistance and Relief Everywhere
CBNRM	Community Based Natural Resource Management
CC	Carrying Capacity
CFMA	Collaborative Fisheries Management Areas
CFMU	Collaborative Fisheries Management Units
CITES	Convention on International Trade in Endangered Species
CMCA	Community Marine Conservation Areas
CMIP	Coupled Model Intercomparison Project
CNPC	China National Petroleum Corporation
CPTDC	China Petroleum and Technology Development Company
CPUE	Catch per Unit Effort
CPUF	Catch per Unit Fisher
CPUFV	Catch per Unit Fishing Vessel
CRIAM	Coastal Rapid Impact Assessment Matrix
CRIF	Coral Reef Information System
CSAG	Climate Systems Analysis Group (University of Cape Town)
CTI	Confederation of Tanzania Industries
DCCFF	Department of Commercial Crops, Fruits and Forestry
DDT	dichlorodiphenyltrichloroethane
DED	District Executive Director
DEM	Digital Elevation Model
DFMP	Department of Fisheries and Marine Products
DoE	Department of Environment
DSFA	Deep Sea Fishing Authority
DSS	Decision Support System
DWT	Dead Weight Tonnage
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMA	Environmental Management Act
Engen	Energy company focusing on the downstream refined petroleum products
EPZ	Economic Promotion Zone
EPZA	Export Processing Zones Authority
ERA-Interim	Model for near real time reanalysis used by the European Centre for Medium-Range Weather Forecasts
ESRF	Economic and Social Research Foundation
EV	Evaluation Value calculated in CRIAM
EWURA	Energy and Water Utilities Authority
EximBank	China Export-Import Bank

[1] The list of abbreviations and acronyms covers both thematic volumes, i.e. for Mainland Tanzania and for Zanzibar

FDD	Fisheries Development Division
FMP	Fisheries Management Plans
FYDP	National Fisheries Development Plan
GapCo	Gulf Africa Petroleum Corporation
GapOil	Retailers and marketer of petroleum products (GapCo subsidiary)
GCAP	Global Climate Adaptation Partnership
GCM	General Circulation Model
GDP	Gross Domestic Product
GHG	Green House Gasses
GIS	Geographical Information System
GoT	Government of Tanzania
GOZ	Government of Zanzibar
GPS	Global Positioning System
GSM	Global System for Mobile communication
HAT	Hotel Association of Tanzania
HEP	Hydro Electric Power
HIMA	Hifadhi Misitu ya Asili
HIV/AIDS	Human Immunodeficiency Virus/Acquired ImmunoDeficiency Syndrome
IBA	Important Bird Areas
ICM	Integrated Coastal Management
ICT	Information and Communication Technology
ICZM	Integrated Coastal Zone Management
IDD	Iodine Deficiency Disorder
IIDS	Integrated Industrial Development Strategy
IMS	Institute of Marine Sciences
IOD	Indian Ocean Dipole
IPCC	Intergovernmental Panel on Climate Change
ISCP	Innovation Systems and Cluster Programme
IUCN	International Union for Conservation of Nature
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
KNMI	Koninklijk Nederlands Meteorologisch Instituut (Royal Dutch Meteorological Institute)
LEAT	Lawyers' Environmental Action Team
LGA	Local Government Authority
LNG	Liquefied Natural Gas
LUP	Land Use Plans
MACEMP	Marine and Coastal Environmental Management Project
MAFSC	Ministry of Agriculture, Food Security and Cooperatives
MALE	Ministry of Agriculture, Livestock and Environment, Zanzibar
MANREC	Ministry of Agriculture, Natural Resources, Environment and Cooperatives
MARUHUBI	Zanzibar Institute of Tourism
MCS	Marine Control and Surveillance
MCU	Marine Conservation Unit
MIC	Ministry of Infrastructure and Communications
MIMCA	Mnemba Island Marine Conservation Area
MIT	Ministry of Industry and Trade
MKURABITA	Property and Business Formalization Program
MKUZA II	Zanzibar Strategy for Growth and Poverty Reduction
MLFD	Ministry of Livestock and Fisheries Development
MNRT	Ministry of Natural Resources and Tourism

MoT	Ministry of Transport
MOW	Ministry of Water
MoW	Ministry of Works
MPA	Marine Protected Area
MRPU	Marine Reserves and Park Unit
MSME	Micro, Small and Medium Enterprises
MSY	Maximum Sustainable Yield
MUKUTA	National Strategy for Growth and Reduction of Poverty (NSGRP)
MVIWATA	Mtandaowa Vikundivya Wakulimawa Tanzania (farmers network)
NAPA	National Adaptation Programme of Action
NAWAPO	National Water Policy
NAWESCO	National Sustainable Wetlands Management Steering Committee
NBS	National Bureau of Statistics
NDC	National Development Corporation
NEMC	National Environmental Management Council
NFP	National Forest Programme
NGO	Non-Government Organisation
NICEMS	National Integrated Coastal Environment Management Strategy
NSGRP	National Strategy for Growth and Reduction of Poverty
PCB	Polychlorinated Biphenyl
PMO-RALG	Prime Minister's Office for Regional and Local Government
PSA	Production Sharing Agreement
Ramsar	International convention on wetlands management
REDD	Reducing Emissions from Deforestation and forest Degradation
RIAM	Rapid Impact Assessment Matrix
RV	Range Value calculated in CRIAM
SACCOS	Savings and Credit Cooperative Organizations
SAGCOT	Southern Agriculture Corridor of Tanzania
SCUBA	Self-Contained Underwater Breathing Apparatus
SEC	South Equatorial Current
SESIA	Strategic Environmental and Social Impact Assessment
SEZ	Special Economic Zone
SIDO	Small Industries Development Organization
SIDP	Sustainable Industrial Development Policy
SME	Small and Medium sized Enterprises
SMOLE	Sustainable Management of Land and Environment
SPM	Single Point Mooring
SSHS	Saffir-Simpson Hurricane Scale
SST	Sea Surface Temperature
STCDA	Stone Town Conservation and Development Authority
SUMATRA	Surface and Marine Transport Regulatory Authority
SWMP	Sustainable Wetlands Management
TAA	Tanzania Airports Authority
TAFORI	Tanzania Forestry Research Institute
TAMPA	Tanzania Milk Processors Association
TAMPRODA	Tanzania Milk Producers Association
TANESCO	Tanzania Electric Supply Company Limited
TASONABI	Tanzania Specialist Organisation on Community Natural Resources and Biodiversity Conservation
TASPA	Tanzania Salt Producers Association
TATO	Tanzanian Association of Tour Operators

TAWA	Tanzania Wildlife Authority
TAZARA	Tanzania-Zambia Railway
TCAA	Tanzania Civil Aviation Authority
TCCIA	Tanzania Chamber of Commerce, Industries and Agriculture
TCF	Trillion Cubic Feet
TCMP	Tanzania Coastal Management Partnership
TCPL	Trans Canada Pipeline Limited
TD	Tropical Depression
TEMDO	Tanzania Engineering and Manufacturing Design Organization
TEU	Twenty-foot Equivalent Units
TFCG	Tanzania Forest Conservation Group
TFNC	Tanzania Food and Nutrition Centre
TFS	Tanzania Forest Services
TGFA	Tanzania Government Flight Agency
TIPER	Tanzania Italian Petroleum Oil Refinery
TIRDO	Tanzania Industrial Research Development Organization
TLU	Total Livestock Units
TMA	Tanzania Meteorological Agency
TNBC	Tanzanian National Business Council
TNRF	Tanzania Natural Resources Forum
TPA	Tanzania Ports Authority
TPCC	Tanzania Portland Cement Company
TPDC	Tanzania Petroleum Development Corporation
TPSF	Tanzania Private Sector Foundation
TRAFFIC	The Wildlife Trade Monitoring Network
TS	Tropical Storm
TSH	Tanzania Currency Unit
TTB	Tanzania Tourist Board
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFPA	United Nations Population Fund
URT	United Republic of Tanzania
USD	United States Currency Unit
USDM	University of Dar es Salaam
VAT	Value Added Tax
VICOBA	Village Community Banks
VLFR	Village Land Forest Reserves
VPO	Vice President's Office
WB	World Bank
WCST	Wildlife Conservation Society of Tanzania
WRIAM	Water Resources Impact Assessment Matrix
WWF	World Wildlife Fund
ZATI	Zanzibar Association of Tourism Investors
ZATO	Zanzibar Association of Tour Operators
ZAWA	Zanzibar Water Authority
ZCT	Zanzibar Commission for Tourism
ZECO	Zanzibar Electricity Corporation
ZIPA	Zanzibar Investment Promotion Authority
ZNCCIA	Zanzibar National Chamber of Commerce, Industry and Agriculture
ZPC	Zanzibar Port Corporation
ZPRP	Zanzibar Poverty Reduction Plan

Table of Units

BoE	Barrels of oil Equivalent
ft	feet
ha	hectare
km	kilometre
km^2	square kilometre
m	meter
m^2	square meter
m^3	cubic meter
Mm^3	Million cubic metres
mmscf	million standard cubic feet
MV	Mega Volt
MW	Mega Watt
s	second
TCF	Trillion Cubic Feet
TEU	Twenty-foot Equivalent Units

1 INTRODUCTION

Coastal Areas

Vulnerable Areas under Pressure

Coastal areas represent complex and dynamic systems both in terms of human activities and in terms of their biophysical conditions. Today, a significant proportion of the global population lives in coastal areas and the proportion is growing. The effects of the increased pressure are degradation of the environment through pollution and unsustainable exploitation of coastal living and non-living resources. Increasing population density, industrial development, and economic growth have given rise to a variety of additional economic activities, the combined effects of which increase the pressure on coastal areas and their resources. This frequently results in cumulative and complex impacts on the environment, depletion of resources and intensified conflict between competing user groups.

There is a limit to the capacity of coastal environments to sustain human activities without deterioration, and many coastal areas today show signs of severe degradation. One example is exploitation of coastal fish stocks, providing most of worldwide marine fish harvests, which has exceeded sustainable levels in many areas. Another is the loss at an alarming rate of coastal wetlands due to amongst others, interference with hydraulic patterns, conversion to aquaculture and other land uses, pollution, coastal erosion, land reclamation and harbour development. Coastal wetlands such as mangrove swamps, sea grass meadows and lagoons and estuaries are critically important as nursery grounds for a number of coastal fish and shrimp species, they assist in shore protection, and their high biological productivity plays a significant role in impairing or diminishing the effects of organic and nutrient pollution.

Coastal areas are particularly vulnerable to climate variability and climate change, with low lying areas exposed to inundation through sea level rise and to flooding due to surges during extreme events. Shoreline dynamics will be influenced by changes in wave climates and currents and by alterations in catchment hydraulics. Coastal ecosystems will be impacted by changes in temperatures and in sea water acidity.

Tanzania

Tanzania relies on the rich natural resources of its coastal areas. The coastal environments and their valuable resources of water, fisheries, estuaries, mangroves, coral reefs, seagrass beds, recreational areas and arable land are increasingly under pressure as the country develops. Economic growth and industrialisation are exerting pressure on the sensitive coastal ecosystems.

Some of the dominant sectors in Tanzania are the oil and gas sector, the fisheries sector, the agriculture sector, the forestry sector and the tourism sector. Fisheries are predominantly artisan in the near-shore waters where stocks are exploited near or above sustainable yield levels. Coral reefs are suffering from the effects of unsustainable fishing methods such as the use of explosives, whereas offshore fisheries are only carried out to little extent offering some possibilities for further development. Coastal aquaculture offers some potential, particularly within shrimp farming, sea weed farming and cage culture. Whereas coastal tourism is prominent for Zanzibar, coastal areas in the mainland offer significant unexploited potential for tourism development. Land and water resources use activities inland represent potential threats to the coastal areas due to the risk of disturbing hydraulics and siltation patterns on which coastal ecosystems rely. The oil and gas exploration and production activities cause a potential threat to the coastal zone, both in relation to shipping and to offshore activities. Urbanisation and the increasing population pressure in general exert pressure on the environmental quality along the coasts.

The coastlines in some areas suffer from coastal erosion, which may be further worsened by sand mining.

The present coastal zone management is characterised by insufficient integration, co-ordination and co-operation among relevant government agencies at state and local levels and other parties with vested interests in the coastal areas.

There is awareness in Tanzania of the need to strike a balance between competing coastal activities and uses of coastal resources in ways which recognise commercial and strategic interests, potential coastal hazard and the need to conserve important natural resources to ensure sustained food yields. Conventional sector planning and management has shortcomings in addressing the many conflicting interests in the coastal zone and in a long term perspective an integrated multi-sector approach is required to ensure sustainable future development of the coastal zone.

In order to address these management challenges the Government of Tanzania with World Bank assistance has through the project "Investment Prioritisation for Resilient Livelihoods and Ecosystems in Coastal Zones of Tanzania" embarked on identifying and prioritising threats with the view of developing fundable adaptation measures to address the most pertinent threats.

The Project

Partners

The study is financed by the World Bank (WB) with trust funds provided by Nordic Development Fund (NDF).

The client for the project is Fisheries Department at the Ministry for Livestock and Fisheries Development (MLFD) in Dar es Salaam and the Department of Fisheries and Marine Resources at the Ministry of Agriculture, Livestock and Environment (MALE) in Zanzibar.

The consultants carrying out the study are DHI from Denmark and SAMAKI Consultants from Tanzania.

Objectives

The objective of the study is to prioritise geographically and thematically the actions to promote sustainable coastal livelihoods and ecosystems in Tanzania (both Mainland and Zanzibar). The results will comprise proposals for measures for coastal management and climate change adaptation in Tanzania, which the Government of Tanzania, NGOs, and donors can use to guide their support and investments over a five year period.

The specific objectives are to:

1. Conduct a review of current coastal management and climate change adaptation studies and planning activities in Tanzania Mainland and Zanzibar, including an inventory of data and information available;
2. Identify, analyse and geographically locate the most important livelihood sources of Tanzania's coastal communities, and the ecosystems on which they depend;
3. Assess the economic costs of climate change on coastal communities and analyse the adaptive capacity of these communities;
4. Identify and geographically locate a gross list of major climate-related threats to sustain these livelihood sources and the ecosystems they depend on;
5. Evaluate the gross list of threats in terms of probability of occurrence, prediction confidence, and consequences if a 'business as usual' scenario is applied;

6. Identify possible adaptation measures to mitigate the threats and evaluate these measures in terms of cost-benefit efficiency and reasonability to implement;
7. Analyse the characteristics of the threats and adaptation measures to prioritise them and identify the most urgent and important investments for sustainable coastal livelihoods and ecosystems;
8. Identify on-going and planned projects supporting coastal management and climate change initiatives in coastal areas, and recognise overlaps with the above found priorities;
9. Identify data monitoring and research needs that should be addressed to augment the implementation and sustainability of the recommended investments;
10. Establish a GIS data base to document the results from the above objectives to the extent possible. The data base should be used as the basis upon which to undertake spatial analysis and thereby assist in prioritizing adaptation investments, based in large part on the characteristics and geographic locations of the major threats to sustainable livelihood sources.;
11. Develop an action plan for priority investment in the short-term (next five years) under multiple funding scenarios. The action plan should consider the prioritisation results, total estimated costs compared to assumed available funds, and possible overlaps with existing initiatives. It should be specified whether the investments are targeted for Tanzania Mainland or Zanzibar.

Phases and Activities

The study proceeds in three phases:

- **Extended Inception Phase** during which systematic efforts are made to identify and acquire and review as recent information on the situation in the coastal areas. This phase was completed with two workshops in Dar es Salaam and Stone Town where feedback was given from key stakeholders on the results achieved during the inception period.

  These results were described in the inception report containing a consolidated description of the coastal areas, their resources, socio-economic characteristics and current management, as well as major challenges from both increased anthropogenic pressure and climate change. The report also provided an overview of data and information identified as pertinent for coastal zone management, including a description of the geographical information system (GIS) built as part of the study. This overview has been compiled as a database of documents and a meta-description of the GIS. The inception report also gave a preliminary list of major threats to coastal areas and presented a method to analyse these threats in regard to relevance and adaptation possibilities.

  The inception report was presented in the form of a coastal profile for Tanzania with three volumes as further described below.

  The inception report has been distributed in soft copy after the workshops with the feedback from stakeholders on the identified threats.

  A series of posters was displayed at the workshop presenting selected themes and providing a district level overview. These posters have been compiled into an A4 booklet also widely distributed as soft copy.

  Objectives achieved during the extended inception phase are: 1, 2, 3, 4, 8 and 10.

  Objectives contributed to during this phase are: 5, 7 and 9.

- **Prioritisation Study** through which the threats identified in the extended inception phase are examined in more detail to prepare a ranked list of threats and to examine adaptation measures addressing these threats.

  The ranked list of threats and adaptation measures is reviewed against already existing or planned adaptation projects to avoid overlapping and duplication in the development of a package of adaptation measures for a 5 year period that can contribute to building resilience of coastal livelihoods and ecosystem.

  Objectives achieved during this phase are 5, 6, 7, 9 and 11.

- **Reporting and Dissemination** is the final activity under the study and will include a validation among major stakeholders through final workshops in Dar es Salaam and Stone Town. The final report from the study will describe the list of threats and adaptation measures, the method and results of the multi-criterion analysis, the investment prioritisation and propose adaptation measures.

Schedule

The project activities started in November 2013. The extended inception period was completed by mid-April 2014. The study was completed by end January 2015.

Coastal Profile

Presentation of the Coastal Profile

The coastal profile is based primarily on secondary data, acquired from key stakeholders during the extended inception period. A database has been established listing all relevant documents identified and linkages to soft copies have been included as available.

A Geographical Information Systems (GIS) has been established to contain acquired themes. The GIS is used to examine inundation and flooding consequences of various Sea Level Rise scenarios. These analyses have been based on a Digital Elevation Model (DEM) developed for the coastal areas of the country. The GIS has also been used to produce district level statistical information.

The coastal profile is presented in three volumes:

Volume I: Coastal Themes, presenting the situation in the coastal zone thematically, i.e. from the perspective of various sectors and other country wide themes. Further details are provided in the presentation of the volume below.

Volume II: Coastal Districts, offering an overview of the situation in the coastal zone of each district, localising and adding detail to the information in Volume I.

Volume III: Maps and Tables, presenting thematic and district maps in A3 format and offering tabulated information, collected from documents consulted or generated from the GIS.

A key requirement for all themes and all district presentation has been to identify threats to coastal communities and ecosystems as has an assessment of vulnerability to climate variability and climate change.

Threats Prioritisation

Process

The coastal profiles were presented in detail for key stakeholders at the Inception Workshops in Dar es Salaam and Zanzibar in April 2014 together with a tool for prioritising the threats to local communities and ecosystems that had been identified in the coastal profiles. The participants in the inception workshops are listed in Annex 6.

Full details on the prioritisation tool, the Coastal Rapid Impact Assessment Matrix (CRIAM), are provided in Annex 3 to this version of the coastal profile. CRIAM is particularly useful in developing consensus on management issues among multiple stakeholders in situations where baseline information is scarce and or out of date. It is as the name indicates a rapid tool relying substantially on the knowledge, experience and perception among the group of people using the tool.

The participants at the inception workshops engaged in rapid sessions using the tool to assess the relative importance of the threats identified in the coastal profiles, while also allowing additional threats to be included in the assessment.

To consolidate the CRIAM assessments two smaller working groups were formed in Dar es Salaam and Zanzibar to systematically review and assess all identified threats and to outline broad measures that could be undertaken to address these threats. These measures provide guidance for further detailing of actions in the form of project sheets.

These working groups of around 10 to 15 members were composed of key actors with particular and recent knowledge about the coastal situation and challenges in mainland Tanzania and Zanzibar. The composition of the working groups is attached this report as Annex 7.

Two full day working sessions took place in June 2014 in each group. The results of their work has since then been further processed and included in the current Version 1 of the Coastal Profile. Details are presented as new subsections in each of the thematic chapters. These are:

- CRIAM Ranking of Threats to Local Communities associated with the theme covered in the chapter
- Outline of Broad Measures to Address Threats to Local Communities associated with the theme covered in the chapter

The working groups were also requested to consider and evaluate the threats identified in the District/Regional Coastal Profiles using the CRIAM methodology and these documents have been updated accordingly.

Threats Prioritisation Methodology Brief

All threats identified in the coastal profiles have been systematically assessed using five criteria:

Criterion A_1 - Importance of condition[2], which is a measure of the importance of the threat, which is assessed against the spatial boundaries or human interests it will affect. Values can be allocated between 4 and 0 as follows:

$A_1 = 0$: No importance
$A_1 = 1$: Important only to local condition
$A_1 = 2$: Important to areas immediately outside local condition
$A_1 = 3$: Important to regional/national interests
$A_1 = 4$: Important to national/international interests

Criterion A_2 - Magnitude of change / effect, which is a measure of the scale of the threat. Values can be allocated between 3 and 0 as follows:

$A_2 = 0$: No change / status quo
$A_2 = 1$: Negative change to status quo
$A_2 = 2$: Significant negative dis-benefit or change
$A_2 = 3$: Major dis-benefit or change

Criterion B_1 – Permanence, which considers whether the threat is temporary or permanent. Values can be allocated between 3 and 1 as follows:

$B_1 = 1$: No change / not applicable
$B_1 = 2$: Temporary
$B_1 = 3$: Permanent

Criterion B_2 – Reversibility, which considers whether the threat can be changed and is a measure of the control over the effect of the condition. Values can be allocated between 3 and 1 as follows:

$B_2 = 1$: No change / not applicable
$B_2 = 2$: Reversible
$B_2 = 3$: Irreversible

Criterion B_3 – Cumulative character, which considers whether the threat has a single direct impact or whether there will be a cumulative effect over time, or a synergistic effect with other threats. Values can be allocated between 3 and 1 as follows:

$B_3 = 1$: No change / not applicable
$B_3 = 2$: Non-cumulative / single
$B_3 = 3$: Cumulative / synergistic

The overall assessment of each threat is calculated using the following formula:

$$Evaluation\ Score\ (ES) = A_1 \times A_2 \times (B_1 + B_2 + B_3)$$

According to the severity of threats the evaluation scores can reach values between 0 and 108. For a simpler overview these scores are translated into problem classes as follows:

[2] The CRIAM methodology has been used to rank threats both in the thematic and in the district/regional volumes of the coastal profile. The resulting evaluation scores cannot be compared directly between these dimensions as the A_1 values differ. In the thematic volume the value 3 is allocated for a threat distributed throughout the coast, whereas the value 3 in the district/regional volume is allocated for a threat distributed throughout the district/region.

Table 1: Translation of Evaluation Scores into Range Values / Problem Classes

Score (ES)	Range value (RV)	Problem Class
0	0	No importance / Not applicable
1 to 9	1	Slight Problem
10 to 18	2	Problem
19 to 35	3	Important Problem
36 to 71	4	Very Important Problem
72 to 108	5	Major Problem

Full details on the prioritisation methodology has been attached as Annex 3: Coastal Rapid Impact Assessment Matrix (CRIAM).

Overall Threats Prioritisation Outcome

Altogether 120 of the threats to coastal communities and ecosystems identified in thematic coastal profile for mainland Tanzania have been prioritised. Out of these 6 were considered to constitute major problems, 41 very important problems, 24 important problems, 28 problems and 21 light problems. The thematic grouping of the problems are presented in Table 2 below and illustrated in Figure 1 also below.

Table 2: Overview of threat severity distribution within themes considered in the coastal profile for mainland Tanzania. For each theme numbers of threats identified within each range of threat severity is provided.

MAINLAND	Light Problem	Problem	Important Problem	Very Important Problem	Major Problem	Total
Agriculture	1	2	2	7		12
Fisheries	1	3	1	3	3	11
Forestry		3	1	5	2	11
Freshwater Resources	2		2	3	1	8
Hydrocarbons		1	1	2		4
Industry	1	1		3		5
Infrastructure				3		3
Management Framework for CZM		1	1	5		7
Natural Resources	9	5	2	2		18
Ports and Harbours	2	3				5
Salt Production	2	1	3			6
Sand and Rock Mining	3	3	4	1		11
Tourism		4	4	5		13
Urbanisation		1	3	2		6
Grand Total	21	28	24	41	6	120

The details of the ranking of threats within each sector are presented in the sector chapters under a separate CRIAM heading. A brief overview of threats within each problem class is tabulated in Table 3 to Table 7 and briefly commented below.

Major problems (Table 3)

Fisheries theme

All threats within this level have been considered widespread along the coast and of national importance and causing major dis-benefits. All threats cause permanent problems which accumulate if un-addressed.

Destructive fisheries and illegal fisheries scores highest as the impact has been considered irreversible and action needs to be taken in order not to permanently lose habitats and resources that local communities rely on to sustain livelihood. Deforestation in upstream catchments is of major concern related to fisheries at the coast as it leads to changes in river flows which again causes flooding, sedimentation and erosion and poor mangrove management is outspread increasing erosion and estuarine siltation.

Forestry theme

Coastal forest reserves are threatened by expanding aquaculture and settlements and from unsustainable use particularly for firewood.

Freshwater resources theme

Freshwater resources are threatened from the increasing demand imposed by an increasing coastal population and associated economic growth.

Very important problems (Table 4)

Agriculture theme

Widespread and of major concern to local communities are dependence on rain-fed agriculture, insufficient water for irrigation and lack of forecasting and early warning related to climate and agro-meteorological information.

Widespread and of important concern are inadequate government support related to agriculture technology (e.g. seeds to resist pest) and a reduction in soil fertility and structure.

Scattered but of major concern is poor land management leading to conflicts between agriculture and livestock raising.

Fisheries theme

Widespread and of important concern to local communities are poverty, lack of education and lack of alternative livelihoods contributing to unsustainable practises of fishermen and poor fisheries resource management allowing open access and leading to conflicts between different stakeholders (tourism, fisheries, sea weed farmers).

Scattered but of major concern are conflicts arising over use of fishing gears some of which may be illegal.

Forestry theme

Widespread and of major concern to local communities is inadequate enforcement of forestry regulations resulting in illegal clearing and overharvesting of coastal forests and mangroves.

Widespread and of important concern are decreases in freshwater flows due to upstream land and water uses, uncontrolled fires exacerbated by long dry seasons, ineffective coastal land use planning resulting in destructive mining practises (limestone), clearing of coastal forests and encroachment from amongst others tourism and salt works and the unreserved status for more than 60% of forests and woodlands..

Freshwater resources theme

Widespread and of major concern to local communities are the degradation in catchments due to land use changes and grazing and inefficient environmental management of wetlands and water resources (removal of riverine vegetation causing erosion, pollution from solid and liquid waste dumping, agriculture and mining and over extraction of water).

Widespread and of important concern is the general lack of information on patterns of climate change and the impact on the hydrology of the river systems draining to the coast.

Hydrocarbon theme

Widespread and of important concern are piracy attacks against offshore operations and degradation of marine and coastal habitats from exploration activities.

Industry theme

Widespread and of major concern is the shortage of infrastructure to promote and sustain development (electricity, transport, water supply).

Scattered but of major concern is the inability to monitor and control solid and liquid waste leading to pollution of water ways, ground water and open ground.

Infrastructure theme

Widespread and of major concern is inadequate infrastructure management unable to maintain supply of services (electricity, transport, water supply, health and education services and ICT) to coastal regions, resulting in a deterioration of living standards, business development and prosperity, and weak implementation of environmental legislation.

Management Framework for CZM theme

Widespread and of major concern to local communities are the inability to stop dynamite (and other illegal) fishing, which threaten coastal habitats and their productivity, the lack of financial capacity to address management issues, the low capacity and motivation at local government (district) level to implement and enforce existing legislation and poor coordination between different sectors leading to ineffective governance and failures in enforcement.

Widespread and of important concern is the corruption at diverse management levels associated with extractive activities, particularly within fisheries.

Natural Resources theme

Widespread and of major concern to local communities is the illegal fisheries damaging seaweed, sea grass beds and coral reefs (shallow water trawling, beach seining and dynamite fishing).

Widespread and of important concern is the poor management of shores and lack of understanding of coastal erosion processes.

Sand and Rock Mining theme

Scattered and of major concern to local communities is the poor management of shores and lack of understanding of coastal erosion processes.

Tourism theme

Widespread and of major concern to local communities are the inconsistency of job opportunities (ad-hoc, as need basis, seasonal), the risk of erosion of local traditions and culture (language, dress code, manners and habits), and increase in prostitution, crime and alcohol abuse, and inadequate sewage infrastructure and waste management causing pollution.

Widespread and of important concern to local communities are the increase in living costs in areas where prices on fish and agriculture have gone up due to tourism and that profits from tourism only to limited degree is captured locally.

Urbanisation theme

Widespread and of major concern is the unemployment rate for youth in urban areas.

Widespread and of important concern is the inadequate solid waste management leading to pollution and degradation of the landscape, the watersheds and the coast.

Important problems (Table 5)

Agriculture theme

Widespread and of important concern is in encroachment onto water catchment areas which may lead to drying up and contamination of ground and surface waters.

Scattered and of important concern I slack of skills among producers and suppliers to ensure adequate distribution.

Fisheries theme

Widespread and of some concern is pollution into catchments which may impact on marine productivity by degrading nursery areas in the coastal zone.

Forestry theme

Widespread and of some concern is land tenure uncertainty discouraging long-term investment in village land and protection of sensitive areas as water catchment areas and forests.

Freshwater Resources theme

Widespread and of some concern is the absence of information on river discharges.

Scattered and of some concern is the deterioration of river flows reducing productivity in estuarine and marine environments.

Hydrocarbons theme

Scattered and of some concern is potential social unrest associated with government and other stakeholder behaviour.

Management Framework for CZM theme

Wide spread and of some concern is the poor coordination in addressing catchment degradation.

Natural Resources theme

Widespread and of some concern is coral bleaching caused by increasing temperatures in sea surface waters.

Scattered and of some concern is poor upstream agriculture practises leading to increased sediment loads in coastal waters.

Salt Production theme

Scattered and of some concern is the lack of government support to the industry, sea level rise threatening enterprise infrastructure and unsustainable industry practises resulting in mangrove degradation.

Sand and Rock Mining theme

Scattered and of some concern is lack of enforcement of government policies, coastal erosion due to anarchistic extraction of sand and rock, loss of turtle nesting sites associated with beach sand mining and loss of river basin habitats from unregulated sand extraction.

Tourism theme

Scattered and of some concern are the reduction in iconic marine life lowering tourist attraction potential and lack of trained personnel for conservation and cultural heritage management.

Locally but of important concern is the increasing costs of land in areas with high tourit potential and ecosystem fragmentation due to tourism development.

Urbanisation theme

Scattered and of some concern is encroachment of coastal habitats due to urban expansion.

Locally but of important concern is poor urban management resulting in overcrowded informal settlements ad poor vehicular management causing congestion, conflicts and air pollution.

Problems (Table 6)

Agriculture theme

Widespread and of concern is quality deterioration and post-harvest losses of produce due to poor marketing.

Scattered and of concern is salt water intrusion in coastal areas.

Fisheries theme

Locally and of some concern are changed sediment loads to estuaries due to upstream damming and agriculture practises and unsustainable mining of sand, coral lime, and salt.

Forestry theme

Scattered and of concern are erosion and pollution of mangroves and inadequate enforcement of hunting regulations.

Hydrocarbons theme

Locally and of some concern is damage to infrastructure and environment associated with design failure.

Industry theme

Scattered and of concern lack of coordination behind choice of location of new industries.

Management Framework for CZM theme

Locally and of some concern pollution of beaches and coastal waters due to poor coordination in addressing solid waste disposal.

Natural Resources theme

Locally and of some concern are solid and liquid waste disposal, invasion of the Indian house crow, coral mining and seismic surveying.

Scattered and of concern is habitat alteration.

Ports and Harbours theme

Locally and of important concern is inefficient operation of Dar es Salaam port and inadequate environmental mitigation during port expansion at Mtwara , Mwamabni and Bagamoyo.

Locally and of some concern is the inadequate compensation for land for port expansion.

Salt Production theme

Locally and of some concern is completion for land from unplanned urbanization.

Sand and Rock Mining theme

Locally and of some concern are reduced coastal sand recharge from rivers due to over-extraction of river sand, removal of live coral threatening reef protection services and increase in water borne diseases due to stagnant waters in quarries.

Tourism theme

Locally and of some concern are anarchistic tourism development threatening cultural heritage sites, loss of employment opportunities for locals due to competition from other areas of

Tanzania and Kenya, destruction of marine environments from unsustainable and illegal fishing practises and alteration of the shoreline.

Urbanisation theme

Inadequate housing for youth and children exposing these to various threats.

Light problems (Table 7

Agriculture theme

Locally and of some concern to coastal communities is the reduction in duration of fallow period for coral rag bush farming to 1-2 years as compared to customary 10-15 years.

Fisheries theme

Locally and of some concern to coastal communities are social conflicts over access to fisheries resources.

Freshwater Resources theme

Locally and of some concern to coastal communities are pesticide pollution from poor agriculture practises and corruption leading to waste of water and revenues from water usage.

Industry theme

Locally and of some concern to coastal communities is failure to industry air emission leading to air pollution.

Natural Resources theme

Locally and of some concern to coastal communities are gill netting imposing threats to dugongs, turtles and whales; shrimp trawling threatening turtles; introduction of invasive species; pollution of local watersheds; nutrient enrichment leading to overgrowth of coral reefs; sedimentation of coral reefs from river discharges, sewerage discharges and dredging; and tourism activities destroying sea grass beds and coral reefs.

Ports and Harbours theme

Locally and of some concern to coastal communities are eroding shorelines adjacent to secondary ports and pollution arising from port activities and traffic.

Salt Production theme

Locally and of some concern to coastal communities are lack of suitable land for artisanal and industrial systems and IDD hazard from low iodisation of salt from small scale producers.

Sand and Rock Mining theme

Locally and of some concern to coastal communities are shallow water table contamination, loss of coastal aesthetics and tourism appeal from poor siting of rock quarries.

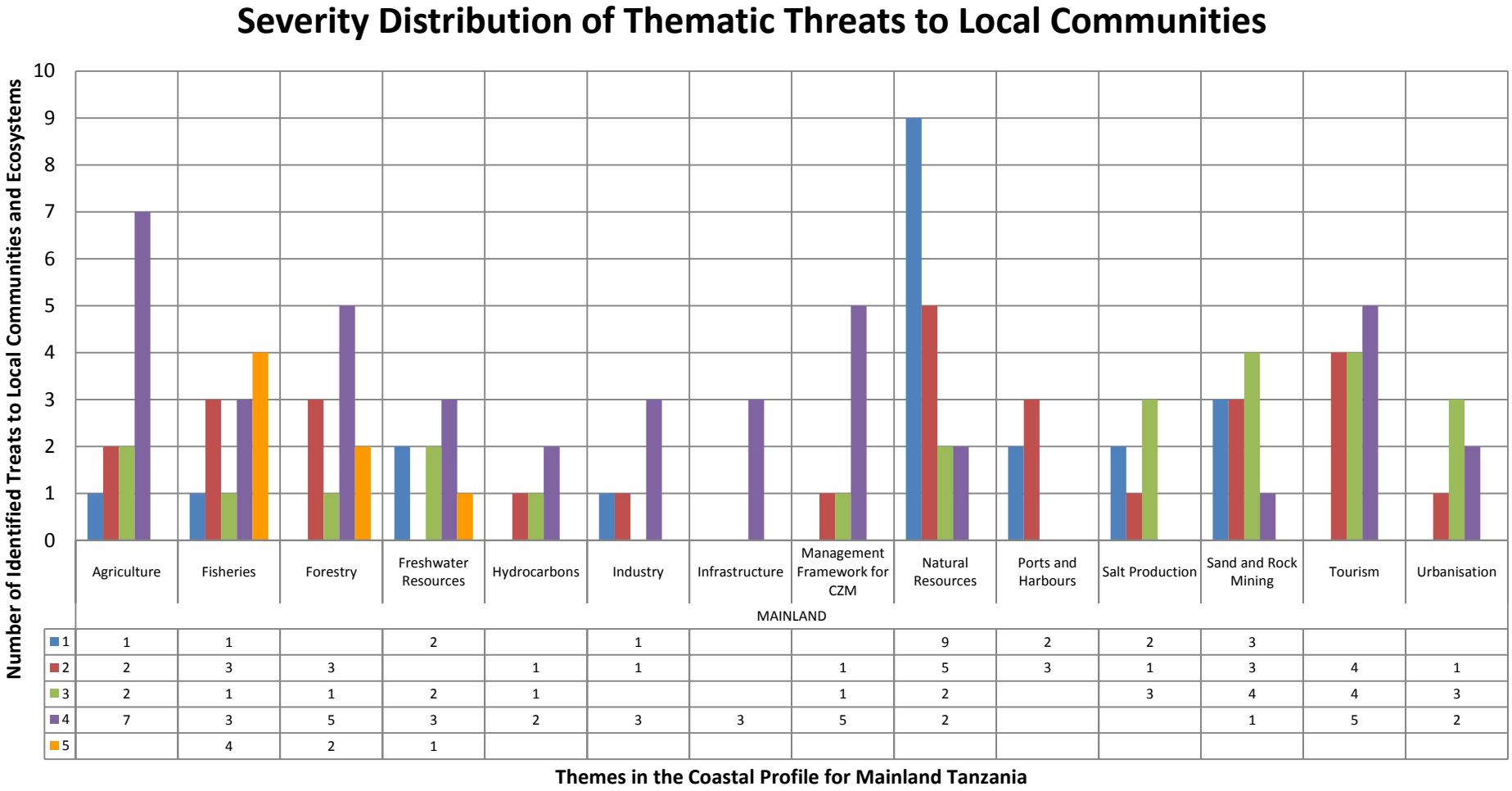

Figure 1: Severity distribution of thematic threats to coastal communities in mainland Tanzania. Light Blue (1) = Light Problem, Brown (2) = Problem, Green (3) = Important Problem, Dark Blue (4) = Very Important Problem, Orange (5) = Major Problem. The bars display the number of threats identified within each of these problem ranges. These results arise from a participatory identification and prioritisation of threats using a rapid assessment tool (CRIAM) presented in detail in Annex 3. Further details on the assessment are provided in the thematic chapters.

Table 3: Threats assessed to impose major problems to local communities and ecosystems. The assessment has been made using the Coastal Rapid Impact Assessment Matrix (CRIAM) approach, described in detail in Annex 3.

Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
Destructive and illegal fishing - causing decline in productivity due to habitat destruction through beach seine, spear guns and dragnets, and dynamite, adversely affecting the fisher community livelihoods.	Fisheries	3	3	3	3	3	81	5					
Catchment deforestation in major basins – causing changes in river flows, leading to excessive run-off, flooding, erosion and siltation.	Fisheries	3	3	3	2	3	72	5					
Encroachment of expanding agriculture and settlements into coastal forest reserves e.g. South Ruvu forest reserve and widespread in Msubugwe and Gendagenda FRs in Tanga region, Vikindu FR near Dar es salaam and near major centres e.g. Bagamoyo.	Forestry	3	3	3	2	3	72	5					
Inefficient use of biomass fuel production (e.g. charcoal) and consumption is extremely inefficient, exacerbating the demand.	Forestry	3	3	3	2	3	72	5					
Poor mangrove resource management – allowing over harvesting of mangrove and wetland or riverine trees leading to erosion and estuarine siltation.	Fisheries	3	3	3	2	3	72	5					
Population and economic growth leading to ever increasing need for freshwater.	Freshwater Resources	3	3	3	2	3	72	5					

Table 4: Threats assessed to impose very important problems to local communities and ecosystems. The assessment has been made using the Coastal Rapid Impact Assessment Matrix (CRIAM) approach, described in detail in Annex 3.

Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
Continued inability to stop "dynamite" fishing, threatening the productive quality of coastal marine habitats.	Management Framework for CZM	3	3	2	2	3	63	4					
Degradation of catchments due to land use changes and livestock keeping.	Freshwater Resources	3	3	3	2	2	63	4					
Dependence on rain-fed agriculture and insufficient water for irrigation	Agriculture	3	3	3	2	2	63	4					
Erosion of local traditions and culture due to influences from tourists and non-locals in the industry (e.g. from language, dress code, manners and habits); loss of village elder authority to preside over disputes; increases in prostitution, robbery and alcohol abuse; goods and services offered freely in the past (e.g. land, thatch (roofing materials) and assistance to the elderly or during times of hardship), are eroded by the 'money economy' of wage employment.	Tourism	3	3	3	2	2	63	4					
Illegal (destructive) fishing (shallow water prawn trawling, beach seining and dynamite fishing), damaging seaweed, seagrass beds and coral reefs.	Natural Resources	3	3	3	2	2	63	4					
Inadequate enforcement of forest management regulations resulting in illegal clearing and over-harvesting of mangrove forests and coastal forests for various reasons: charcoal (Bagamoyo and close to large urban areas) and domestic firewood (most districts), for lime burning (in Rufiji, Mafia and Lindi), conversion to agricultural land (Rufiji for rice), tourist developments (e.g. Bagamoyo) and salt farms. Lack of effective enforcement, low penalties, and a long and cumbersome procedure to pass by-laws, dilutes the process.	Forestry	3	3	3	2	2	63	4					
Inadequate infrastructure management unable to maintain supply of services (electricity, transport, water supply) to coastal regions, resulting in a disincentive for industry to be attracted to the coast and develop.	Industry	3	3	3	2	2	63	4					
Inadequate sewage infrastructure and waste management resulting in pollution of the coastal zone, from some developments illegally dumping waste and litter.	Tourism	3	3	3	2	2	63	4					
Inefficient environmental management of wetlands leading to removal of riverine vegetation, erosion of riverbanks, pollution of water bodies from municipal waste	Freshwater Resources	3	3	3	2	2	63	4					

Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
dumping, agricultural practices or mining (minerals and river sand), abstraction for water for agriculture (or livestock) or hydropower generation.													
Uncertainty of tourism jobs with most being ad-hoc, or 'as needed' basis and does not offer steady employment, or seasonal in nature.	Tourism	3	3	3	3	1	63	4					
Youth Unemployment (Inception Meeting Addition)	Urbanisation	3	3	3	2	2	63	4					
Inadequate infrastructure management unable to maintain supply of services (electricity, transport, water supply, health and education services and ICT) to coastal regions, resulting in a deterioration of living standards, business development and prosperity.	Infrastructure	3	3	2	2	2	54	4					
Poor land tenure.	Agriculture	3	3	3	2	1	54	4					
Weak Implementation of Environmental Legislation (Inception Meeting Addition)	Infrastructure	3	3	2	2	2	54	4					
Inadequate solid waste management causing pollution of the landscape, watersheds and the coast.	Urbanisation	2	3	3	2	3	48	4					
Increased cost of living due to tourism industry where prices of fish and agricultural foodstuff have gone up, to the detriment of the local consumers who risk loss of valuable protein inputs to their diets.	Tourism	3	2	3	3	2	48	4					
Invasion of water catchments areas and upstream changes in river courses (springs, small seasonal streams, ponds and wetlands) by farmers, leads to decreases in freshwater flows affecting coastal and mangrove forests (e.g. Pangani River estuary).	Forestry	3	2	3	2	3	48	4					
Uncontrolled fires escaping from plot clearing destroys forests, killing wildlife and other living organisms and are a long term threat to coastal forests, exacerbated by long dry seasons experienced over recent years have caused the coastal forests to dry up and prone to forest fires.	Forestry	3	2	3	2	3	48	4					
Absence of financial capacity to address management issues related to coastal and marine resources.	Management Framework for CZM	3	3	2	2	1	45	4					
Lack of early warning systems strengthening climate information and agro-meteorological services and seasonal forecasting, and strengthened early warning	Agriculture	3	3	2	2	1	45	4					

Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
systems (including communication) and enhanced disaster risk management (VPO 2012).													
Poor capacity and motivation at local district authority level to implement legal mandates governing natural resource use, resulting in continued deterioration of productivity.	Management Framework for CZM	3	3	2	2	1	45	4					
Poor coordination and monitoring between different sectors leading to ineffective governance and failing of enforcement in coastal and marine areas.	Management Framework for CZM	3	3	2	2	1	45	4					
Poor infrastructure management leading to poor or biased choices for development, for example, promoting road transport at the expenses of developing railways.	Infrastructure	3	3	2	2	1	45	4					
Inadequate Government support for continued or expanded production, e.g. with new seeds to resist new pest.	Agriculture	3	2	3	2	2	42	4					
Ineffective implementation of land use planning resulting in destructive mining practices such as of limestone is widespread along coastal areas of Wazo Hill in Dar es Salaam and Amboni in Tanga, clearing forests while the Songo gas project pipeline extending from Lindi to Dar es Salaam, with extensive damage to coastal forests, or over exploitation of coast forests for salt works or tourism.	Forestry	3	2	3	2	2	42	4					
Poor fishery resource management – allowing open access fishery, thus increasing fishing pressure and stock depletion is difficult to manage; leading to conflicts with tourists over coral reefs to dive and to snorkel, fish landing sites and tourist hotels; to seaweed farming conflict with boat users and tourists;	Fisheries	3	2	2	2	3	42	4					
Poor freshwater resources management leading to scarcity and irregular supply.	Agriculture	3	2	3	2	2	42	4					
Poverty and lack of education – combine with absence of alternatives or investment, are all attributed as the causes for the current behaviour of fishers.	Fisheries	3	2	3	2	2	42	4					
Profits not captured locally, thus not benefitting the local population (e.g. package tours sold overseas).	Tourism	3	2	3	2	2	42	4					
Unreserved status in more than 60% of forest and woodlands leaving these areas with insufficient management instruments.	Forestry	3	2	3	2	2	42	4					
Piracy attacks against offshore operations.	Hydrocarbons	4	2	2	2	1	40	4					

Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
Corruption at diverse management levels associated with extractive activity related to marine resources, particularly in the fisheries sector, leading to deterioration of the productivity of the resource.	Management Framework for CZM	2	3	2	2	2	36	4					
Degradation of the natural marine and coastal environment and thus impact on livelihoods, from failure of exploration companies to adhere to environmental and socio-economic safeguards, partly due to weakness in the oversight provided by The National Environment management Council (NEMC) is responsible for issuing licences and monitoring the operations that have been subjected to EIAs.	Hydrocarbons	3	2	2	2	2	36	4					
Failure to monitor industry liquid waste leading to pollution of waterways and ground water.	Industry	2	3	3	2	1	36	4					
Failure to monitor industry solid waste leading to pollution of waterways and open ground.	Industry	2	3	3	2	1	36	4					
General lack of information on the patterns of climate change and their impacts on the hydrology of the Tanzanian river systems draining into the coast.	Freshwater Resources	3	2	2	2	2	36	4					
Poor land management leading to social conflicts over land between agriculture and livestock grazing.	Agriculture	2	3	2	2	2	36	4					
Poor management of shores (e.g. coastal developments) and river basins, lack of understanding of coastal erosion causative factors and sustainable mitigation/adaptation measures leading to loss of shoreline due to coastal erosion.	Sand & Rock Mining	2	3	2	2	2	36	4					
Poor management of the shores (e.g. coastal developments) and lack of understanding of coastal erosion causative factors and sustainable mitigation/adaptation measures leading to loss of shoreline due to coastal erosion.	Natural Resources	3	2	2	2	2	36	4					
Reduction in soil fertility and structure.	Agriculture	3	2	2	2	2	36	4					
Social conflicts over fishing gears - where local fishers use gears or methods (some of which are illegal) that are not acceptable by neighbouring villages.	Fisheries	2	3	2	2	2	36	4					

Table 5: Threats assessed to impose important problems to local communities and ecosystems. The assessment has been made using the Coastal Rapid Impact Assessment Matrix (CRIAM) approach, described in detail in Annex 3.

Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
Encroachment into coastal habitats from urban expansion	Urbanisation	2	2	3	3	2	32	3					
Absence of updated data on current river discharges leading to failure to comprehensively monitor river discharges.	Freshwater Resources	3	2	2	2	1	30	3					
Coral bleaching from El Nino sea surface temperature rise damaging coral reefs	Natural Resources	3	2	2	2	1	30	3					
Invasion of water catchments areas (springs, small seasonal streams, ponds and wetlands) by farmers, leads to drying up and contamination of ground and surfaces waters, with periodic outbreak water borne diseases.	Agriculture	3	2	2	2	1	30	3					
Poor coordination to combat river basin and catchment degradation, resulting in loss of productivity in the coastal zone through reduced seasonal freshwater and nutrient inputs, as well as reduced river sand contribution to the coast; and/or overload of the sediments and freshwater from flash floods.	Management Framework for CZM	3	2	2	2	1	30	3					
Lack of business/financial management skills of producers and suppliers, limits the success of timely distribution.	Agriculture	2	2	3	2	2	28	3					
Anarchistic sand and rock extraction from coastal zone resulting in increased erosion.	Sand & Rock Mining	2	2	2	2	2	24	3					
Corrupt and uncoordinated institutional enforcement of mining policy to protect the natural environment, particularly rivers and coastline.	Sand & Rock Mining	2	2	2	2	2	24	3					
Deterioration of river flows leading to reduced estuarine and marine productivity, especially of delta prawn and small pelagic species (e.g. sardines).	Freshwater Resources	2	2	2	2	2	24	3					
Increasing cost of land in high tourism potential areas are targeted by speculators or developers and competition for land can drive prices high, such local populous cannot afford land.	Tourism	1	3	3	3	2	24	3					
Pollution into catchments and coastal zone - by dumping or leaching of domestic, urban, mining and industrial wastes, sewage, solids, agricultural pesticides into catchments or direct disposal in wetlands, draining to estuaries and coastal zone, affecting marine productivity.	Fisheries	3	1	3	2	3	24	3					

Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
Poor upstream agriculture increases sediment loads, increased turbidity and reduced photosynthesis, affecting seaweed and seagrass productivity.	Natural Resources	2	2	2	2	2	24	3					
Poor urban management leading to overcrowding informal settlements that lack clean water and adequate sanitation, leading to increase health and well-being problems from contaminated water and from mosquitos and other pests that thrive in unsanitary environments.	Urbanisation	1	3	3	2	3	24	3					
Poor vehicular management leading to increasing vehicular/pedestrian congestion, conflicts and air pollution.	Urbanisation	1	3	3	2	3	24	3					
Reduction in iconic marine life with illegal killing of whale sharks, dolphins, dugongs, turtles and other exotic marine animals that are tourist attractions degrading the value of the experience and creating a poor image of Tanzania as an eco-friendly destination.	Tourism	2	2	3	2	1	24	3					
Sea level rise threatening infrastructure (dykes and buildings, etc.).	Salt Production	2	2	2	3	1	24	3					
Ecosystem fragmentation due to encroachment of corridors and protected areas, is affecting migratory species, exacerbated by over utilization of forest resources and conflicts between agriculture and wildlife, due to failure of management to address encroachment and resource over-utilisation, especially forests.	Tourism	1	3	3	2	2	21	3					
Land tenure uncertainty discourages long-term investment in village land and protection of sensitive areas as water catchment areas and forests.	Forestry	3	1	3	2	2	21	3					
Lack of government support with infrastructure (e.g. roads) and land ownership, and corruption.	Salt Production	2	2	2	2	1	20	3					
Lack of trained personnel for conservation and management of cultural heritage (TCMP 2001).	Tourism	2	2	2	2	1	20	3					
Loss of beach habitats for turtle nesting.	Sand & Rock Mining	2	2	2	2	1	20	3					
Loss of river basin habitat from un-regulated sand extraction.	Sand & Rock Mining	2	2	2	2	1	20	3					
Social and/or political unrest related to behaviour of the Government and stakeholders.	Hydrocarbons	2	2	2	2	1	20	3					
Unsustainable practices resulting in degradation of mangrove forests for ponds and timber (for boiling salt water), causing losses to the wider environment with respect to shelter from wave action to fisheries production.	Salt Production	2	2	2	2	1	20	3					

Table 6: Threats assessed to impose problems to local communities and ecosystems. The assessment has been made using the Coastal Rapid Impact Assessment Matrix (CRIAM) approach, described in detail in Annex 3.

Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
Poor marketing resulting in quality deterioration and huge post-harvest losses.	Agriculture	3	1	2	2	2	18	2					
Erosion of mangrove stands from sea level changes and storms.	Forestry	2	1	3	3	2	16	2					
Inadequate enforcement of hunting regulations resulting in loss of wildlife from many coastal forests (the demand for bush meat is ever increasing in coastal forest communities, notably Gendagenda forest reserve in Handeni district and Noto/Chitoa Plateau forests in Lindi region).	Forestry	2	1	3	2	3	16	2					
Pollution from fertilizers, pesticides, and other toxic chemicals and solid wastes including from up-stream sources. DDT and Thiodan are widely used to control crabs in the rice farms in the Rufiji delta, can poison mangroves.	Forestry	2	1	3	2	3	16	2					
River damming - for reservoirs for domestic water, irrigation and/or hydro-electric power (HEP) changing sediment loads, affecting estuaries.	Fisheries	1	2	3	2	3	16	2					
Salt water intrusion seen in many of the coastal areas with good soils for agriculture (Rufiji, Mkuranga, Bagamoyo, Pangani, Lindi) which are now frequently flooded by sea water during spring tides. The actual cause could be multiple, over-abstraction for domestic and agriculture irrigation, sea level rise, damage to coral reef and mangroves reducing the dampening effect on sea surges during storms or increased incidence of storms (VPO 2012).	Agriculture	2	1	3	2	3	16	2					
Inadequate environmental mitigation during port expansion at Mtwara, Mwamabni (Tanga) and Bagamoyo, leading to environmental degradation e.g. siltation of reefs.	Ports and Harbours	1	3	2	2	1	15	2					
Inefficient operation at Dar es Salaam port leading to loss of economic competitiveness (compared to other ports e.g. Mombasa) by increasing the costs of import/export to/from global markets.	Ports and Harbours	1	3	2	2	1	15	2					
Destruction of reef protection services from removal of live coral, threatening coastal infrastructure, farmland, villages and fisheries resources.	Sand & Rock Mining	1	2	2	2	3	14	2					

Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
Drainage changes - re-claiming areas for agriculture, to build roads, houses and cities or mosquito control, or diversion or in-efficient use of water for irrigation, mining, industry, livestock or domestic and urban needs alters flows, changes estuarine sediment loads.	Fisheries	1	2	3	2	2	14	2					
Habitat alteration such as the filling of marshes and tidal flats, and reconstruction of shorelines to accommodate the needs of development, transportation, and agriculture, can degrade estuaries.	Natural Resources	2	1	3	2	2	14	2					
Increased beach erosion due to tourism alteration of the shoreline, with obstruction of sediment supply by modification of the beach hydrodynamics due to the construction of inappropriate engineering structures like sea walls, jetties and salt pans and removal of beach material for road or hotel or beach construction, and of protective mangroves enhancing aggressive wave action on the beach, leading to sand loss (e.g. Northern Bagamoyo Beach Hotels have cleared their mangrove frontage, resulting in erosion rates of up to 3m/year.). Poor planning by beach hotels and residential houses built directly on or very close to the beach are threatened by erosion (e.g. in Dar es Salaam area Hotel Africana built on a dune lost more than 50% of its residential huts by the late 1980s.	Tourism	1	2	3	2	2	14	2					
Invasive Indian house crow causing loss of bird diversity through ferocious predation on eggs of local bird species thus threatening indigenous populations.	Natural Resources	1	2	3	2	2	14	2					
Lack of coordination of the choice of location of new industries underlines the need for integrated planning.	Industry	2	1	3	2	2	14	2					
Reduced coastal sand recharge from rivers due to over-extraction of river sand.	Sand & Rock Mining	1	2	2	2	3	14	2					
Waste disposal, in solid and liquid form causing harm to seagrass beds and estuaries where marine debris enters from storm sewers, or especially after heavy rains. Debris comes from many sources, including improper disposal of trash on land, storm water runoff and combined sewer overflows to rivers and streams, ships and other vessels.	Natural Resources	1	2	3	2	2	14	2					

Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
Anarchistic tourist development destroying cultural heritage sites (TCMP 2001) where urban development planning and control fail to intervene.	Tourism	1	2	2	2	2	12	2					
Coral mining for the lime industry significantly destructive to reef ecosystems, especially in Kilwa, Lindi and Mtwara districts.	Natural Resources	1	2	2	2	2	12	2					
Failure of housing for the youth and children exposing them to human predators, violence, abuse and sexual assault that increase their risk of HIV infection.	Urbanisation	1	2	2	2	2	12	2					
Increase in water borne diseases from quarries that fill with rainwater.	Sand & Rock Mining	1	2	2	2	2	12	2					
Poor coordination to address solid waste disposal leading to pollution of beaches and coastal waters.	Management Framework for CZM	1	2	2	2	2	12	2					
Seismic surveys by oil and gas companies deterring whales, especially migrating Humpback whales with calves.	Natural Resources	1	2	2	2	2	12	2					
Unplanned urbanization and land availability into which to expand (in some areas).	Salt Production	1	2	3	2	1	12	2					
Unsustainable mining - salt, sand, coral lime, fossil coral limestone, etc. mined with damage to physical properties of shorelines and river basins.	Fisheries	1	2	2	2	2	12	2					
Damage to infrastructure and environment from engineering design failure.	Hydrocarbons	1	2	2	2	1	10	2					
Deterioration of marine environment resulting in loss of biodiversity and other marine tourist attractions from destructive fishing practices (e.g. dynamite fishing) due to failures in marine resource management to cope with the increased pressure on marine resources due to the demand for seafood from the tourism sector and urban centres, also threatening the sport fishing industry.	Tourism	1	2	2	2	1	10	2					
Inadequate compensation for land for port expansion at Dar es Salaam, Mtwara, Mwamabni (Tanga) and Bagamoyo.	Ports and Harbours	1	2	2	2	1	10	2					
Loss of employment opportunities by locals to more qualified and better trained staff from other parts of mainland Tanzania and Kenya.	Tourism	1	2	2	2	1	10	2					

Table 7: Threats assessed to impose light problems to local communities and ecosystems. The assessment has been made using the Coastal Rapid Impact Assessment Matrix (CRIAM) approach, described in detail in Annex 3.

Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
Erosion of shorelines adjacent to some secondary ports: Kilindoni (Mafia), Lindi, Rushungi, Kilwa Kivinje and Kilwa Masoko ports.	Ports and Harbours	1	1	3	2	3	8	1					
Due to poor farming practice on limited land, the coral rag bush fallow system has been progressively reduced in extremes, to 1-2 years instead of the customary 10-15. Also, availability, timing, price, variety and quality of essential seed varieties and chemicals hinder optimal production, thus limiting output and returns. Also, Poor agricultural and soil management techniques have resulted in loss of topsoil, erosion, structural deterioration and declining fertility.	Agriculture	1	1	3	2	2	7	1					
Loss of suitable habitat for artisanal (non-pump) and industrial systems into which to expand/adapt, particularly with respect to land and availability of clay to construct dykes.	Salt Production	1	1	3	2	2	7	1					
Pollution arising from port activities and traffic.	Ports and Harbours	1	1	2	2	3	7	1					
Failure to monitor industry air emission leading to air pollution.	Industry	1	1	3	2	1	6	1					
Gillnetting possess the greatest threat to dugongs.	Natural Resources	1	1	3	2	1	6	1					
Gillnetting threatening turtles (adults and sub adults).	Natural Resources	1	1	3	2	1	6	1					
Gillnetting threatening whales, especially migrating Humpback whales.	Natural Resources	1	1	3	2	1	6	1					
Intentional or accidental introduction of invasive species can often result in unexpected ecological, economic, and social impacts on the estuarine environment.	Natural Resources	1	1	3	2	1	6	1					
Pesticide pollution of river deltas from poor agricultural practices resulting in reduced crustacean and fisheries productivity and poisoning of edible marine life.	Freshwater Resources	1	1	2	2	2	6	1					

Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
Pollution of coastal watersheds poses a threat to estuaries, entering waterways through storm drains, industrial discharges, runoff from farmlands, discharges from sewage treatment plants, being toxic or harmful to biological systems with long lasting effects, as well as having a negative visual impacts on estuarine environment.	Natural Resources	1	1	2	2	2	6	1					
Pollution through 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.	Natural Resources	1	1	2	2	2	6	1					
Sedimentation of coral reefs from river discharges, sewage discharges and dredging.	Natural Resources	1	1	2	2	2	6	1					
Shallow water table contamination from poor citing of rock quarries.	Sand & Rock Mining	1	1	2	2	2	6	1					
Shrimp trawling threatening turtles.	Natural Resources	1	1	2	2	2	6	1					
Social conflicts over access to resource – where cultural and historical rivalry over "traditional" fishing grounds increases as pressure on the resource increases; also includes increasing resentment of migratory fishing groups of "dago" fishers during seasonal visits, using gears considered destructive or conflict with local traditions.	Fisheries	1	1	2	2	2	6	1					
Tourist activities destroying seagrass beds and coral reefs (e.g. trampling when wading, boat anchorage).	Natural Resources	1	1	2	2	2	6	1					
Corruption with the management sectors leading to waste of water or revenues from water usage.	Freshwater Resources	1	1	2	2	1	5	1					
Economic losses through tourist abandonment	Sand & Rock Mining	1	1	2	2	1	5	1					
Local population IDD hazard from low iodisation of salt from small-scale producers in Mtwara and Lindi.	Salt Production	1	1	2	2	1	5	1					
Loss of coastal aesthetics	Sand & Rock Mining	1	1	2	2	1	5	1					

2 COASTAL COMMUNITIES

Introduction:

Coastal livelihoods in mainland Tanzania are comprised of complex, diversified systems of activities and circumstances, which on one side relies directly on the natural resources, while at the same time may impose significant impact on the capacities of the same coastal environment to sustain such livelihoods. The assessment of coastal livelihoods in mainland Tanzania has considered the basic gender and socio-economic characteristics of the different population categories resident along and/or dependent on the coastal and marine environment for a living. A consideration of the key livelihood assets, particularly education and skills, infrastructure [markets], and the institutional set up that support livelihoods, allow for diversification or alternatives. The natural resource endowment and the issues surrounding their use for a livelihood is also a key consideration.

This thematic section outlines the context within which coastal communities' livelihoods are pursued and the threats that coastal people face in these pursuits, but also how the livelihood challenges that they face expose them to vulnerability to the implications of climate change.

The context

Settlements and administrative description

Administratively, mainland Tanzanian coastal area is made up of five regions which from the north to south are Tanga, Dar es Salaam, Coast, Lindi and Mtwara. The five regions have altogether 16 coastal districts[3]. The important port city of Dar es Salaam, which is also the hub of the national economy, dominates the coastal zone, in terms of population size and economic activities. It is made up of the three Municipalities of Kinondoni, Ilala and Temeke, each of which has a densely populated urban sector and peri-urban/rural sectors. Other urban centres of less significance along the coast include Tanga, Pangani, Bagamoyo, Lindi (urban), and Mtwara (urban).

The rest of the coastal settlements include a few peri-urban concentrations (Kilwa Kivinje, Kilindoni) and a plethora of rural villages some of which are relatively isolated, and significantly less endowed in terms of access to quality infrastructure, such as roads, communications, electricity, and other services. Poor infrastructure has affected the socio-economic situation of the local people, constraining their capacities to take advantage of many economic opportunities, and being competitive in the fisheries-related sector.

Rapid urbanisation, particularly within Dar es Salaam, is occurring at a pace that does not enjoy commensurate urban spatial planning systems and basic service availability. The growth of Dar es Salaam in terms of population density (Table 8 below) has become characterised by the extensive urban sprawl of the city of Dar es Salaam, largely into slums and squatter settlements, unplanned and partly into planned residential areas and mini-satellite towns (Bunju, Mbagala, Kigamboni). Changes in land-use patterns due to urbanisation along the coastal area has also led to the decline in traditional coastal fishing settlements as has been the case with Kunduchi and Ununio settlements (Kinondoni District, Dar es Salaam region).

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[3] Tanga (Mkinga, Tanga (u), Muheza, Pangani); Pwani (Bagamoyo, Mkuranga, Rufiji, Mafia); Dar es Salaam (Kinondoni, Ilala, Temeke); Lindi (Lindi (M) Lindi (rural) Kilwa) and Mtwara (Mtwara (M), Mikindani).

The economy

Tanzania is one of the 49 Least Developed Countries (LDCs) in the world and about 35% of the total population lives below the poverty line (World Bank, 2013). In 2012, the country reached a record high of GDP of 28.25 Billion US$, a rise from 11.35 Billion USD in 2005. GDP per capita was 483.48 US$ (World Bank, 2010). The country's economy is heavily dependent on agriculture (including livestock), which accounts for 27.1% of the GDP, employs about 80% of the work force, and provides 60% of export earnings[4]. Other socio-economic sectors include manufacturing industry, mining industry, fisheries, tourism and forestry, water, marine and coastal resources, energy, construction and communications/transportation.

Seventy-five percent (75%) of the country's industries are also located in the urban coastal areas, with a large concentration in Dar es Salaam. The industrial sector and the ports constitute a significant sector in the national economy. The coastal ports of Dar es Salaam, Tanga and Mtwara do not only handle the nation's cargo but also transit goods to some land-locked countries of Eastern and South-central countries in the Africa region. The Dar es Salaam port in 2011 handled 475,000 twenty-foot equivalent units (TEUs) compared to 415,000 TEUs of previous year, due to increasing container berths at the port to allow for six containers ships to discharge at the same time, up from five. Dar es Salaam is also the centre of the administrative and service sector which provides employment for many of its urban residents. The same can be mentioned of Tanga, Mtwara and Lindi urban. Those in the urban peripheries are dependent on fisheries and related trades, small-scale-farming and businesses.

Population and other demographic aspects

The coastal regions of mainland Tanzania encompass about 15% of the country's land area, and are home to approximately 25 percent of the country's population (about 8 million people)[5]. The population density for mainland coastal Tanzania has been relatively stable for the past 10 years. However, the rapid rate of population growth in mainland Tanzania and especially the coastal urban areas poses a big threat to coastal livelihoods. According to the 2012 National Census, the population of the United Republic of Tanzania (URT) is 44,928,923 people, of which females are 23,058,933 and males 21,869,990. Of this population, Tanzania mainland has 43,625,354 with 22,386,041 females and 21,239,313. The inter-censual annual average population growth rate for the mainland is 2.7% similar to the total URT growth rate. Mainland Tanzania has a total of 9,109,150 households.

On average the population density (2012) was estimated at 49 persons per km^2, which is slightly lower than the national average of 51 people per km^2 for the URT as a whole. Yet, although smaller in land surface area, Dar es Salaam region had about 4.36 million people in 2012, which is 10% of the total mainland population and a population density of 3,133 per km^2, the highest for the whole of Tanzania (URT, 2013).

[4] CIA 2013 World Fact Book

[5] According to World Bank estimates in 2000, Tanzania's population was approximately 34.1 million with an annual growth rate of 2.54%. This has increased to over 43.7 million people and annual growth rate of 2.91% in 2009 (World Bank, 2010). The 2012 National census

Table 8: Population estimates and density – Tanzania mainland coast

Region	Population Census count 2002	Population census count 2012	Annual inter-census growth rate	Population density 2002	Population density 2012
Tanga	1,636,280	2,045,205	2.2	61	77
Pwani	885,017	1,098,668	2.2	27	34
Dar es Salaam	2,487,288	4,364,541	5.6	1793	3,133
Mtwara	1,124,481	1,270,854	1.2	68	76
Lindi	787,624	864,652	0.9	12	13
Tanzania mainland	33,461,849	43,625,35	2.7	38	49
Tanzania	34,443,603	44,928,923	2.7	39.1	50.4
Source: National population and household census, URT 2013					

Increased population densities in the coastal urban settlements is putting pressure on the natural resource endowment – pushing residences to delicate coastal marginal lands which are vulnerable to erosion, but also the over use of natural aquifers, and hence affecting clean water supply.

Household well-being and access to basic amenities

An analysis of household well-being in the mainland indicates that coastal regions are comparatively well-served in terms of access to certain basic social services in relation to other regions in the country. Yet in reality, diversity in household economic standards means that a large percentage of coastal households are relatively deprived.

Table 9: Selected indicators of hh well-being in the mainland coastal regions (2000-01). Source: HBS 2000/01 (summary report)[6]

Households (hh)	Tanga	Pwani	Dsm	Lindi	Mtwara	Mainland
% of hh headed by women	24	18	21	20	20	23
% of hh using toilets	81	98	94	98	93	93
% hh connected to electricity grid	7	6	59	5	5	10
Mean distance to fuel wood sources (rural)	3.2	1.7	Na	1.6	3.2	3.1
Education						
% of adult without education	31	39	8	44	28	25
% of women without education	38	52	11	52	36	32
Primary education net enrolment	50	56	71	44	59	59
Mean distance to Primary School	2.3	1.7	0.8	1.2	1.1	1.8
Mean distance to Secondary School	18.8	13.1	2.5	25.1	16.6	12.6
Health						
% of hh within 6 km of dispensary/ Health centre	62	74	98	67	87	75
Water						
% of hh with piped or protected water	46	35	94	19	52	55
% of hh within 1km of drinking water (dry season	41	56	84	47	41	55
Economy						
% of children (2-14) employed	80	57	28	40	46	62
Consumption and poverty						
Expenditure	9.3	10.5	21.9	9.5	12.4	10.1
Basic needs poverty	36	46	18	53	38	36

[6] http://www.povertymonitoring.go.tz/surveyroutinereport/HBS_2000_contents_of_summary.pdf

Dar es Salaam city is comparatively well-endowed in terms of infrastructure and access to basic amenities, while the rest of the coastal areas remain relatively underdeveloped, with inadequate social service infrastructure, inadequate marketing structures which are affecting opportunities for livelihood enhancement. Major trunk roads connecting the 4 coastal regions to Dar es Salaam have tarmac. This includes the 556 km Dar es Salaam-Mtwara road that is almost completely tarmacked and the construction of the Mkapa Bridge. The PHDR (2011) reports that at the national level, the percentage of trunk and regional roads in good and fair condition increased from 51% (good 14%; fair 37%) in 2002 to 90% in 2010 (good 58%; fair 32%). The road network within the more interior settlements is however generally undeveloped.

Extensive urbanisation and population pressure exert pressure on water availability and supply. Inadequate infrastructure (especially piped water) denies many rural and urban households access to reliable sources. Through government and CBOs support the drilling of boreholes has therefore been encouraged. Studies conducted in Dar es Salaam (Mtoni, Yohana & Kristine Walraevens, 2010) and in Pangani district[7] indicate sea water intrusion in sites close to the coastline. A study on the relationship between Dar es Salaam's growth and its vulnerability to climate change indicates that urban sprawl due to migration and population growth questions the sustainability of water supply – especially for those households forced into marginal lands having to depend on ground water supply (Silva M., Ricci, L, Congedo, L. and Faldi, G., 2013).

Access to reliable energy sources poses another threat to livelihoods and to the state of the environment. Although the number of customers connected to the national grid between 2002 and 2010 rose from around 450,000 to 790,000 (an increase of 75%), and connections to off-grid supply of electricity more than doubled over the same period from 32,000 to 72,000 at the national level (PHDR, 2011), only 14.2% of households in mainland Tanzania are connected to electricity, with an extremely large disparity in coverage between urban areas (45.4%) and rural areas (3.4%) (PHDR, 2011). The situation for coastal regions illustrates this difference and the overwhelming concentration in Dar es Salaam city (ref Table 2.0 above). The constraints to improve the supply of electricity which include limited generating capacity and reserve margins; ageing infrastructure and inadequate investment in maintenance, rehabilitation and upgrading of systems (PHDR, 2011) imply that the use of alternative, more environmentally destructive sources including charcoal and fuel wood will continue.

Infrastructural challenges have also limited access to markets for local produce.

Livelihood activities

Coastal households in mainland Tanzania depend on a diversified livelihood pattern that include, small-scale fisheries, small-holder farming, subsistence forestry, seaweed production, artisanal/small-scale mining (sand, lime and salt production), petty trades, small livestock husbandry, trade in handicrafts, stone quarrying and to some extent, tourism support services.

Fisheries

The fisheries sector has remained among the top six major economic sectors but with the smallest contribution to GDP over a period of 10 years that is between 2001 and 2010, going from 1.7% in 2001 to 6.7% in 2004 to a decline to 1.4% in 2010 (PHDR, 2011)[8] Poor growth in this sector is attributed to

[7] Water samples taken by researchers from the Pangani Basin Water Board show that the total soluble salt levels downstream of the Pangani River are far beyond acceptable standards at 2,000 mg/L.

[8] The six major sectors of the mainland economy include agriculture, mining, services, construction, manufacturing and fishing (PHDR, 2011).

illegal fishing and trafficking of fish and fisheries products across the nation's borders, and a poorly equipped artisanal/small scale fishing sector (PHDR, 2011). The fishery does not, however, make a significant contribution to foreign exchange earnings and revenue in the country. The artisanal fishery (marine and freshwater) contributed about 99.15% of total fish harvested (MLDF, 2007). At the community level, small-scale/artisanal fisheries are an important part of the livelihoods of many households. In 2009, it was estimated that there are 172,090 fishers in the marine and freshwater artisanal fishery composed of 135,769 freshwater fishers and 36,321 marine fishers (MLDF, 2009). In addition more than five hundred thousand (500,000) coastal habitants derive their economic livelihood from the sector in one way or another in fisheries related activities (Marine fisheries Report 2008 in MLDF 2009). It is also a source of recreation, tourism and foreign earnings.

Fishing provides some insurance for the poor as a fall-back source of food and income in between crops or in bad crop years, and during times of economic crisis and instability. In coastal households fish accounts for almost 60% of the animal protein consumed and in 2007, the marine artisanal fishery contributed 13% of the total artisanal fish production (MLDF, 2007).

The fisheries environment is open access, and is based on common property rights. According to Fisheries regulations, fishing vessels must be licensed and fishers can access any fishing ground as long as they have a fishing license and a permit from the local authority. This open-access system has provided both opportunities for livelihood enhancement to coastal fishing households, but at the same time exposed the marine environment to the 'tragedy of the commons' syndrome due to weak governance systems, low motivation and corruption among stakeholders which have facilitated the use of destructive fishing methods including dynamite fishing and the unregulated use of the beach seine (*kokoro*). Studies on the prevalence and persistence of dynamite fishing indicate that it is driven by the demand for quick returns [even more than poverty], in the absence of more profitable alternatives. This has eroded many people's willingness to comply with sustainable fishing, and the ready availability of dynamite or material to make the desired explosives locally has made it persist. The consequent habitat destruction and overexploitation of resources has in turn affected the well-being of the same communities. This has led to the continued destruction of the marine environment. Innovative fishers have capitalised on new technologies – crudely designed 'FADS' (Bagamoyo) to enhance their profit margins at least a few times of the seasons.

The coastal fisheries are multi-species and many fishers target the coral reef fishes because they are easily accessible by fishers with rudimentary gear. Other important species include the octopus, squid and other estuarine and mangrove organisms, which are usually gathered on foot in the littoral zone by women, children and older men. Much of the catch is immediately sold at landing sites, and traders distribute it to fish markets (especially at Kigamboni Ferry which receives marine products from almost the entire coast of Tanzania), or as processed fish into the interior.

Many fishers target products for export (including lobster, octopus, squid, and prawns/shrimp) which have for some time stimulated intensive fishing. Poor fishing technologies, including small-sized, largely non-mechanised vessels have affected the level of catch-per-effort for individual fishers. Most coastal fishers are thus limited to the inshore waters. Although exact numbers are not yet possible, with support from organisations such as MACEMP, deep-sea fishing has also become possible with mechanised small vessels especially in Mafia and the Pemba Channel (the 2400 feet deep channel separating the island from the mainland).

Most of the fishing by small-scale/artisanal fishers is largely market oriented, although it is still significant to household subsistence. Market linkages therefore form the most important part of mainland fishing livelihoods and contribute a significant percentage of local incomes. This is however limited by poor mechanisms for transportation including preservation for fresh produce (fish and other marine products). Fish and marine products are collected at landing sites by

fishmongers, middle-persons or agents and sent to the market by sea or road to Kigamboni market which serves as the hub of fresh fish from as far as Lindi (Kilwa in the south) to Mafia island and Bagamoyo, or to processors in the various processing plants in mainland Tanzania (e.g. TANPESCA processing factory, Mafia). This pattern is restrictive or too expensive to be handled by many fishers, and has therefore created dependency on middle-persons some of whom maintain a patron-client relationship or bond, often exploitative and hence lowering local incomes. Only a few fishers had been able to take advantage of MACEMP support to establish their own marketing links. The increasing availability of micro-credit facilities (SACCOS, VICOBA) and money transfer facilities may provide opportunities for improving people's access to more efficient production equipment to enhance their livelihoods but this is yet to become evident for the larger population. The fishing is largely targeted for the market and the Kigamboni market.

Mariculture: Mariculture in mainland Tanzania is steadily growing. There is an increasing engagement in fish farming (milk fish, mullet, tilapia, and prawn) in the coastal districts and the potential is there to expand, contributing to food security, income generation and employment in coastal communities. The development of mariculture is also regarded as an ideal measure to lessen pressure on capture fisheries and its association to resource and habitat degradation.

The potential for the development of mariculture however high faces a number of challenges which include uncertain legal ownership for sites suitable for aquaculture, damage to the mangrove ecosystem, and infrastructural inadequacies at local level to establish viable and affordable mariculture establishments and limited extension services.

Seaweed farming: Seaweed production plays an important role in the sustenance of coastal households particularly in Bagamoyo, Tanga, Kilwa and Pangani. Commercial cultivation of seaweed in mainland Tanzania began in 1994 spreading from Zanzibar whose people had started production in 1989. Strategies for value-addition to enhance producers' livelihoods have allowed small-scale production of seaweed soap [Mlingotini, Bagamoyo] which is sold locally to residents or tourists (Msuya *et al*, 2013:5). This has been possible through the Innovation Systems and Cluster Programme (ISCP-Tz) and Seaweed Cluster Initiative (Msuya, 2011). Value addition has raised the economic benefits of the farmers and particularly for women who are the main producers. The significance of seaweed production as a potential income earner has however, suffered from extensive die-offs [linked to environmental changes]; and low prices for the crop, which are between TSH 300-500 (=USD 0.2 - 0.35) per kg for *cottonii* species and TSH 200 (=USD 0.18) for *spinosum,* and which are grossly not commensurate to the intensive labour input.

Agriculture: crops and livestock keeping

Small-scale subsistence farming is an important source of livelihood for many rural coastal households, and in some communities it provides a significant percentage of household food security. For example, 90% of the households in Coast and Mtwara Region depend on small-scale agriculture (URT, 2007; URT, 1997). Major crops include rice, cassava, cashew nuts, legumes and greens. Small animal keeping is also common, although the coastal landscape has greatly changed because of the influx of livestock from the north.

Agricultural production is basically rain-fed, with a limited use of traditional irrigation techniques (e.g.: along the Ruvu in Bagamoyo). Of late, weather variability has affected productivity and extended dry periods have reduced dependence on traditional systems of crop cultivation. New technologies [green technologies] are minutely making their entry [Bagamoyo] and provide opportunities for less environmentally dependent and destructive production systems, but inadequate extension support, poor rural infrastructure including roads, and currently increasingly declining access to adequate land for household–based production are still a challenge. In addition, the high pressure on coastal land from population increases, urbanisation and large-scale

investments are also affecting agriculture's capacity as a viable livelihood source to many households. Only in a few communities along the coast, there is less dependence on agriculture due to the lack of suitable soils for farming which is characteristic of certain areas where coral rag soils dominate the terrain as is the case with Mafia district.

Traditional farming techniques such as forest clearing for agricultural land are also still common. In addition cultivation along river valleys and deltas is extensive, given the potentials of these areas to preserve moisture for a large part of the year. Along the Rufiji River, rice can be cultivated twice a year (REMP, 2001). River valley farming however may cause sedimentation downstream, and therefore affecting other livelihood systems.

Tourism

Tourism constitutes a substantial part of the services sector (contributing over 17% to GDP and nearly 40% of total export earnings), making it one of the lead contributors to the national economy. Tanzania earned USD 1,291.5 billion (about TSH 1.901 trillion) from travel and related activities during the year ending November 2010, according to the Bank of Tanzania report. This achievement puts Tanzania on the right path to reach its target of generating about 1.7 billion from tourism and related activities by the end of this year. However, tourism's contribution to local employment generation is limited despite the existence of tourism training institutions that are currently generating many professionals. A limited infrastructure, low level of domestic demand and insufficient skills of workers and businesses in the industry are the biggest challenges (PHDR, 2011).

Incomes are obtained through servicing the tourist ventures through direct employment; by providing transportation facilities [travel and car hire services]; selling of traditional artefacts and curios (e.g. Mwenge tourist market); or through selling fish or other marine products directly to hotels.

The Marine Reserves and Parks Unit (MRPU) under the Ministry of Livestock Development and Fisheries has also supported the development of community-based tourism enterprises, some of which operate around the Dar es Salaam Marine Reserves. However, lack of skills and initiative (MIMP) and the competitive edge are limiting the profits for small community-based tourism operators. The beach hotels and the few recreational activities therefore offer a small amount of employment to local people, but in general, although tourism is a reliable source of national revenue, it is yet to become a reliable source of income or livelihoods for the local coastal population. The local tourist support activities also do not fetch much income to the people.

In addition, extensive constructions of tourist facilities such as beach hotels, some of which are poorly protected from erosion by concrete structures are at risk of erosion. This is not only threatening the economic investments but also local employment.

Coastal Mining:

Coastal mining at community level is dominated by sand and gravel mining, salt production and coral mining. Sand and stone quarrying are important livelihood activities, and un-regulated sand mining has become a big local industry. This is conducted along beaches, coastal streams/rivers, and other areas leading to localised accelerated/ severe coastal erosion and enormous environmental degradation and threat to coastal properties (Masalu, 2002). Employment is also attained in the more established salt-works companies (Bagamoyo) which produce salt using solar evaporation. Salt production by small producers entails an intensive use of fuel wood, often 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. 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. Other mining ventures of lesser significance in terms of community engagement include kaolin mining (Pugu), granite, calcite, and dolomite in several localised areas. Precious stone and minerals including amethyst, granite and others, plus some gold is found in Lindi region and along the upper Ruvu River.

Coastal mining activities in the mainland have proceeded un-regulated, and being 'a poor person's refuge' the pressure on entry has surpassed the capacities of management authorities. Hence they are associated with erosion (Kunduchi) which has affected the state of residential areas; and significant pollution to fresh water sources.

Other sectors supporting coastal livelihoods

Land and land use patterns

Land ownership in the mainland is based on a complex, multi-layered system that has combined traditional customary rights, acquisition through the local land market, and state-led acquisition which has supported both plot allocation through land planning development such as for settlement development supporting the rapid rate of urbanisation, or for state-led investments such as the designation of huge lands for the Economic Promotion Zone (EPZ in Bagamoyo district) or large-scale farming/plantations. In the rural coastal communities land ownership is on average 1-3 ha (ASCLME, 2012) and much of the land plots are utilised for crop production and to smaller extent, individually owned wood lots. It is also customary to support usufruct rights to agricultural use and for landless coastal migrants; the system has continuously supported significant coastal populations.

Land use and subsequently local ownership along the coastal areas has over the past decade undergone rapid and significant changes, with the potential to reach higher levels. This has brought to the fore the insecurity in 'customary rights of land', caused by inefficient governance systems and lack of local awareness on alternative measures to secure land, consequently causing the decline in livelihoods. Large-scale land acquisition for investment such as in rice production (Rufiji River basin) biofuel production in Tanzania by foreign companies e.g.: for the production of Jatropha (Kilwa, Kisarawe, Bagamoyo); Sugar cane (Bagamoyo, Rufiji); Oil palm (Bagamoyo); white sorghum (Bagamoyo) is impacting directly on coastal livelihoods by this land acquisition. The proposed EPZA planning area in coastal Bagamoyo district is expected to occupy 5860 ha, much of which is already populated and includes traditional farm land. Women, many of them landless and who had been dependent on usufruct access to production land are expected to be the most affected by such land acquisition.

Coastal forests and mangroves

Coastal forests and mangroves provide a number of dependable items for the households including fuel wood for home consumption or sale, wood for charcoal making, poles for house construction, and timber for boat building. Other products include fishing gear and herbal medicines, edible fruits, mushrooms, plant-derived oils, leaves and beverages, bamboo, gums, fodder, fibre, thatch grass, honey, candles, dyes, ornamental plants, wild meat and handicrafts (Kaale, 2003; Semesi, 2000). In some communities certain traditional activities are performed in these areas, such as ritual cleansing, collection of molluscs or fishing bait within mangrove areas. At the community level, the value of freely collected non-marketed and marketed products from coastal forests to the local communities is significant and provides income opportunities even to women (Kaale, 2003).

Coastal forests, in addition to supporting livelihoods directly, also generate significant revenue for local governments. Government royalties are collected from sales of forest goods that are obtained

from forests on the public lands and from the selected district forest reserves. Rufiji district has the highest reported collections compared to other districts. This was attributed to its proximity to Dar es Salaam where there is high demand of wood based products including charcoal. Moreover, the district has a good roads network that is providing for easy transportation of the forest products. Large portions of Coastal Forest Reserves in Tanzania mainland have also been cleared and turned to agriculture or wasteland of which Kazimzumbwi FR and Pande Game Reserve provides a good example (Kaale, 2003; MNRT, 2001).

Mangrove areas are increasingly threatened with unsustainable extraction for charcoal, poles, timber and firewood, and clearance for expanding agriculture. Leading factors include rapid population growth, poverty, market failures, absence of proper definition of property rights and security of tenure, trade liberalisation and general policy failures. Other factors include: unavailability of alternative sources of products and services from the forests for subsistence livelihoods to the majority of users; use of inefficient utilisation technologies on wood products; and poor enforcement of laws related to woodland management (Kaale, 2003). Illegal trading of mangrove forest products, including charcoal and fuel wood is also common, sometimes crossing over to Zanzibar unregulated and thus unaccounted for but have contributed significantly to coastal forest depletion. Inadequacies in the forest regulatory system, weak enforcement caused by corruption is threatening the health of mangrove and coastal forests even to higher rates than human pressure for settlement and household items.

Amidst these threats, alternative sources of livelihood are being promoted in order to conserve the natural forests and at the same time support local livelihoods. Such activities include butterfly farming for export (East Usambaras, Tanga); and modern beekeeping (Rufiji, Mafia, Bagamoyo).

The extractive industry

The recent increasing activities in oil and gas production in mainland Tanzania are potential sources for local employment. Currently, limited employment is secured at the natural gas production site at Songo reaching 70 mcf in 2008, and production at Mnazi Bay reaching 1 mcf in 2008 (ASCLME, 2012) The country also has strong hydrocarbon potential and numerous companies are currently exploring for oil, with 13 offshore blocks expected to be conceded in the near future. Although the refinery in Dar es Salaam was closed in 1999, the region still remains a centre for downstream activity, as it handles imports of LPG, stores oil products, receives gas from the 230 km pipeline connected to Songo, supplies Burundi, Uganda, Rwanda and Eastern DRC, and transports crude oil through a pipeline to the Indeni refinery in Zambia. Despite all this activity, it is estimated that only 0.1% of the population is employed in the electricity and gas sectors (ASCLME, 2012) Employment opportunities for local people are limited by low levels of education and the requisite technical training in this sector.

Another threat to local livelihoods is the disturbance and limited access to the marine environment caused by activities such as gas mining. Experiences from Songo Songo indicate that traditional fisheries around the island have been restricted and this may be indicative of the outcomes from the expanding sector. Alternatives to local livelihood enhancement are currently being seen in terms of the industry availing opportunities for stimulating and supporting local development such as by improving the service infrastructure or providing a market for local goods.

Women and gender issues

Because of the lack of viable alternatives, female-headed households are in many coastal communities the poorest and most dependent on near shore resources as an important source of food and income. Ascription to gender roles has influenced what women do. In those communities largely dependent on the fisheries, women are mainly involved in agriculture, gleaning, collection

of shellfish, sea cucumber, and octopus, and catching small shrimp or sardines in the near shore using nets or pieces of cloth. Only a few women have been able to transcend traditional norms defined by patriarchy to become engaged in small-scale fishing using small canoes around the shore waters unlike their male counterparts who go to the deep waters (Chando, 2002). A number also are engaged in fish-farming.

The bulk of the women in fishing communities are involved in the processing and marketing of fish. Long-distance retail trade of dried or fried fish is prominent by female traders and includes trade in sardines. But this is competitive and often restrictive due to family responsibilities.

Seaweed farming along coastal Tanzania is an important income generation activity dominated by women, but as mentioned above, it is labour intensive and the prices are very low because of the value-chain inequities.

Management programmes impacting on livelihoods

A number of interventions for coastal and marine resource management have enhanced the livelihood status of coastal communities, especially through community-focused resource management initiatives (ref. other Thematic sections). These include comprehensive programmes addressing sustainable use of marine resources and livelihood improvement programmes, such as the MACEMP and RUMAKI Seascape programme, that adopt a multi-dimensional livelihood approach; the more localised TCMP (Bagamoyo), TCZCDP (Tanga), and the Collaborative Fisheries Management Areas (CFMA, Bagamoyo).

The TCZCDP – introduced the Collaborative Management Areas CMAs which are based on resource use, specifically on shared fishing grounds, and therefore involve several villages in each CMA. This has helped reduce conflicts and address the difficulties of managing common pool resources.

Community-based management structures such as the Village Environmental Committees (VEC) and Beach Management Units (BMU) promote collaborative resources management and enforcement, which are crucial for livelihood sustenance. Other livelihood opportunities can be garnered through larger-scale management systems such as Mafia Island Marine Park (1995), which include regulation of the fisheries. These are supported through the enactment of village and district by-laws for enforcement or general management (Silva, 2006). Women's representation is currently a key requirement in these governance structures and coastal and marine management institutions, including the Beach Management Units (BMU).

Lack of political will to address and confront the factors leading to destructive resource use/extraction (e.g.: dynamite fisheries, mangrove depletion) is however limiting management efficiency, hence affecting livelihood enhancement opportunities. Limited mechanisms to avail livelihood alternatives to coastal people are also a major factor in the failure of management performances.

At the local level, although there is a plethora of management structures and institutions, these do not work in harmony although responsibilities may over-lap. Corruption and inadequate capacity for coordination between institutions concerned with coastal and marine areas is a major issue.

Implications to Climate Change effects

Coastal livelihood pursuits, accompanied by socio-economic changes in terms of rapid population growth, urbanisation, and spatial population distribution and associated economic growth including coastal land-use changes have both the potential to stimulate environmental changes and at the same time increase the vulnerability of the coastal communities to vagaries of extreme weather changes.

Summary of climate change impacts

Extracted from Chapters 15 and 16 (in this Volume), the summary of changes that can be expected in the future based on models - themselves with assumptions based on historic events with very little known about feedbacks, additive, antagonistic and synergistic effects as well as thresholds above which the trends change – reveal the following:

- Temperatures are likely to increase in air and water, with average yearly temperatures at the end of the century likely to be 2 to 2.5°C higher than today. Scleractinian corals would be particularly vulnerable.
- Precipitation in future scenarios are not conclusive but could indicate longer mid-year dryer conditions and (shorter) but wetter wet seasons.
- Increasing problems related to incidences of extreme winds that will affect coastal areas with significant impacts on coastal infrastructure, agriculture biodiversity, and ground water.

The effects of these changes and the possible interacting factors and adaptation approaches to physical impacts include the following:

Natural system effect	Possible interacting factors	Possible adaptation approaches
Erosion of low-lying sand/mud beaches	Sediment supply Dam construction, construction in coastal areas	Nourishment, land-use planning, managed realignment
Wetland/mangrove loss	Sediment supply, Filling, construction in coastal zone	Nourishment, land-use planning, managed realignment, replantation of wetland vegetation
Inundation/flooding	Waves/storms, sediment supply	Dikes, surge barriers, closure of dams, dune management, building codes, set-back lines
Saltwater intrusion	Runoff/rainfall, catchment/water extraction management	Salt water intrusion barriers, change water extraction, freshwater injection
Coral reef loss	Destructive fishing methods, bleaching, sedimentation	Managed fishing, coral replantation, provision of hard substrates for natural coral recruitment

Vulnerability and mitigation

The vulnerability of the coastal communities of Tanzania depends on physical exposure (determined mainly by geology and topography) and susceptibility, which is related to the types of coastal structures and their predisposition to being affected by the physical or socio-economic change (for example loss of fisheries production). Vulnerability leads to estimation of loss or damage, and thus to costs. Financing adaptation to the physical or socio-economic consequences of changes brought about by the above-listed natural system effects depends on the approach. Four management options are widely recognised: no action, or "do nothing", protection of shoreline from physical changes, accommodation of changes to shorelines through regulation and physical adaptation, and, a strategy of landward retreat away from the risk. In practice, for a given length of coast a combination of these options is likely, proportionate to the values of the coastal assets at risk.

Economic costs of climate change

Coastal communities are aware of the hazards associated with erosion, as these have been witnessed for some time. Other impacts are less well known, such as the often less-visible impacts on productivity of marine habitats, sediment supply and salt-water intrusion. The latter is a distinct possibility for many coastal areas, especially following storm surges whose likelihood of increased frequency and scale may not be appreciated, especially along the creeks and inlets that are common in most districts, with resulting impacts extending inland several kilometres. Based on the inundation modelling presented in Volume II, the following summarises the impacts for each district:

District	Significant local impacts from sea level rise scenarios
Mkinga	For rises > 10 m, affecting over 8% of land, since much of district sufficiently raised. Mangrove creeks at Kwale and Moa and other smaller inlets are vulnerable.
Tanga Urban	For rises levels > 4 m, approximately 5 % of district will be flooded, and 15% of the district will be inundated with a 10 m rise (or surge). Built-up areas will generally not suffer, even with a 10 m rise (or surge).
Muheza	The raised shore and short length of coastline (46 km) preclude any significant impacts from sea level rise, even for the 10 m rise scenario.
Pangani	For a rise of 10 m whereby 27.5 % of land would be flooded, since much of the district is low-lying and thus vulnerable to inundation. Although there is very little build-up area, it is vulnerable to inundation, with over 8 % likely to be inundated with a 2 m rise. Storm surges resulting in rises equivalent to 7 m, will likely flood almost 18 % of the district.
Bagamoyo	For level rises only > 10 m (surges), since much of the district is sufficiently raised to avoid inundation, except for impacts further inland, along much of the length of the various rivers and creeks.
Kinondoni	For rise levels only > 10 m, since much of district sufficiently raised to avoid inundation. However, even a 1 m rise will significantly impact seafront properties and infrastructure, already witnessed at Kunduchi where many groynes have been haphazardly constructed to protect residences and hotels.
Ilala	For sea level rises > 5 m, however, even a 1 m rise will significantly impact seafront at both beach areas (Selander Bridge and Ocean Road), with flooding of built-up areas (especially road infrastructure) very likely. At Msimbazi Creek and the Mtoni River creeks, likely significant impacts further inland.
Temeke	For level rises > 10 m, since much of the district is sufficiently raised to avoid inundation, with ca. 9 % of agricultural land inundated. Significant impacts further inland, along much of the length of creeks.
Mkuranga	Only for rise levels > 10 m, whereby over 4 % of the total land area will be inundated. Most of district is sufficiently raised to avoid inundation even at 5 m level, inundating approximately 0.6 %. Virtually all infrastructures is set 15-20 km from the coast.
Rufiji	Only rise levels > 10 m will ca. 5 % of total land area be inundated, since most of district is sufficiently raised, even at 5 m level, and virtually all infrastructures is set 15-20 km from the coast. However, surges that coincide with spring high tides are likely to have significant impacts on fishing camps in the Rufiji Delta.
Mafia	For rise levels > 5 m, inundating ca. 3 % of the district.
Kilwa	A rise level of 10 m, inundating ca. 4 % of the district.
Lindi Rural	For rise levels > 10 m, since much of district is sufficiently raised.
Lindi Urban	For rise levels > 10 m, since much of district sufficiently raised. However, most of the infrastructure is around Lindi town, thus a 10 m rise equivalent storm surge (inundating about 5 % of built-up areas), is likely to have more significant impact on infrastructure.
Mtwara Urban	For rises > 10 m, since much of Mtwara Urban districts is sufficiently raised, despite about 9 % of the land area becoming inundated with such a rise. However, most infrastructure is around Mtwara town and Mikindani town, thus a 10 m rise equivalent storm surge (inundating about 2.5 % of built-up areas), likely to have more significant impact on infrastructure.
Mtwara Rural	For rises > 10 m, since much of the Mtwara Urban is sufficiently raised to avoid inundation, despite about 9 % of the land area becoming inundated with such a rise.

The overall picture is that most of the coastline will experience very little flooding from rises in sea level, should this occur. For most districts, only rises above 10 m will have significant impacts on land flooding, though creeks and groundwater are vulnerable especially to storm surges and lower rise scenarios. Within the higher population density districts, such as the Dar es Salaam region, significant impacts will directly affect coastal communities where there is significant infrastructure close to the shore, even with level rises of just 1 metre. This is confirmed by the detailed study by Kebede et al (2010) for example who note that "it is predicted that on average about 400 m of landward retreat would occur due to erosion in Dar es Salaam under a 1 m sea-level rise. A total land loss estimated at 247 km^2 and 494 km^2 is expected for a 0.5 and 1 meter rise of sea level, which makes "infrastructure worth USD 48 and USD 82 million are vulnerable to a 0.5 m and 1 m sea-level rise, respectively" (2010:13). Infrastructural developments, including port expansion and development of tourist hotels along the shoreline with less considerations of the delicate nature of the ecosystem, expose these structures to risk of destruction in the event of extreme weather changes or shoreline erosion.

Though unlikely to be of the same scale of cost, the urban areas of Pangani Town, Lindi Town, Mtwara and Mikindani are likely to be impacted by rises of less than 5 m. Numerous small, scattered villages are located very close to the shore, for example in the Rufiji Delta, on smaller islands around Mafia (e.g. Juani, Bwejuu) and Kilwa (e.g. Songo Songo), and around Mnazi Bay (e.g. Msimbati). These are presently experiencing consequences of coastal erosion, a phenomenon that is likely to increase in intensity, if not from sea level rise *per se*, from increases in severe weather and storm surges.

Calculating the costs associated with the losses to homes and businesses requires a considerable and detailed effort, beyond the scope of the present study. However, using the Kebede et al (2010) estimate as a measure, and extrapolating to other areas on the mainland coast, a crude overall cost would range from between USD 96 million and USD 164 million. In addition to the loss of infrastructure such as roads, housing and businesses, included in the latter figures, there are other costs to coastal communities associated with climate change. These include reduced fishing yields from coral reefs impacted by sea water temperature increase and from shrinking mangroves that are retreating into smaller inland spaces, and from reduced freshwater due to saline intrusion into coastal aquifers. Quantifying these costs can only roughly be approached, but they are likely to be of the order of tens of millions of dollars.

Adaptive capacity of communities

The adaptive capacity of the artisanal fisher or farmer from the villages exposed to highest risk is generally low. For much of the poorer areas of the coastline, there are limited 'viable' livelihood alternatives, low human capital and a challenged governance system in most respects that may limit the people's adaptive capabilities in cases of extreme weather, as Kebede et al. (2010) describe. Worse still, the low productivity in the fisheries mainly due to habitat destruction and stock depletion, which may worsen from climate change impacts (described above) is encouraging the use of destructive methods which are attractive because of their quick returns. Low capacities for livelihood enhancement among the local communities also indicate that destructive resource extraction for a living may persist. Considerable awareness raising, education for alternative livelihood development and assistance will be required to prevent the situation from worsening.

Issues Emerging

The assessment of coastal livelihoods in mainland Tanzania/Zanzibar has considered the basic gender and socio-economic characteristics of the different population categories resident along and/or dependent on the coastal and marine environment for a living. A consideration of the key

livelihood assets, particularly education and skills, infrastructure [markets], and the institutional set up that support livelihoods, allow for diversification or alternatives. The natural resource endowment and the issues surrounding their use for a livelihood is also a key consideration. Finally, environmental and climate change implications are discussed in relation to livelihoods.

- Socio-economic diversity and the income gap[9] among coastal dwellers illustrates that livelihoods vary, and pockets of poverty are evident, between coastal communities or population categories in these communities and which have an implication on the use of coastal and marine resources. Poor households have fewer options than direct dependence on coastal resources or the activities related to their exploitation – including fish processing, cleansing, daily labour.
- Decisions and developments associated with economic growth, such as tourism along the coast, ports and harbours and related infrastructure likewise generates changes in lives of urban populations.
- Increased population densities in the coastal urban settlements is putting pressure on the natural resource endowment – pushing residences to delicate coastal marginal lands which are vulnerable to erosion, but also over use of natural aquifers, and hence affecting clean water supply. The noted sea water intrusion in sites close to the coastline will be aggravated by increasing population growth and densities especially in the absence of the desired infrastructure to provide the coastal population with reliable and safe water sources.
- Urban development and redefined land use plans (Ununio, Bagamoyo EPZ, Kigamboni Satellite City plan) is leading to the decline in traditional fishing settlements. The implication is not only relocation but sometimes leading to loss of livelihood opportunities and hence poverty to some.
- Undeveloped infrastructure is limiting service delivery, access to markets (e.g. fish markets by poor fishers) making them dependable on middle-persons and hence limiting the levels of their incomes.
- Fishing: the open-access/common property marine resource base has provided both opportunities for livelihood enhancement to coastal fishing households, but also challenges due to weak governance systems, low motivation and corruption among stakeholders which have facilitated the use of destructive fishing methods including dynamite fishing and the use of beach seine.
- Demand for quick returns [even more than poverty], in the absence of more viable alternatives and a weak management/enforcement structure has pushed people into destructive fishing and hence the continued destruction of the marine environment.
- Tourism: lack of skills and the competitive edge [Dar es Salaam Marine Reserves, Mafia Marine Park] are limiting the profits for small tourism ventures [community-based tourism operators]
- Agriculture: poor technologies, limited land space and dependence on rain-fed agriculture limits the capacities to attain household food security in coastal villages. Weather variability has aggravated dependence on traditional systems of crop cultivation. New technologies [green

[9] Research needs to be conducted to establish income and livelihood differences along the coastal area.

technologies] are minutely making their entry [Bagamoyo] and provide an opportunity for less environmentally dependent and destructive production systems.

- Lack of [limited access to expensive] alternative energy sources for household usage [and to a limited extent house and vessel construction material] for both rural and urban coastal communities is putting pressure on the coastal forests and mangrove, through unregulated cutting and destruction of mangrove ecosystems. The availability of a ready market for forest products both within the mainland and the islands is another major factor leading to resource destruction.
- Inadequate access and sometimes limited awareness of non-timber alternatives and other products is constraining efforts to control over exploitation of coastal forests and mangroves.
- Coastal mining and the extractive industry: poverty and lack of more viable alternatives is pushing people into mining, leading to degradation of the coastal environment and affecting livelihood sources. At the same time limited requisite skills in the more advanced extractive industry does not permit extensive direct engagement in professional positions in the industry.
- Women's traditional livelihood pursuits are gradually being eroded because of the degradation of coastal ecosystems e.g. mangrove depletion [collection of shellfish - chaza; beekeeping], and the intensification of exploitation in the fisheries [gleaning, small shrimp catching; octopus harvesting]. The alternatives are competitive, labour intensive, arduous and less paying.
- Lack of political will to address and confront the factors leading to destructive resource use/extraction (fisheries, mangroves) is limiting management efficiency, hence affecting livelihood enhancement opportunities. Limited mechanisms to supply alternatives to coastal people are a major factor.
- Inadequate capacity for coordination between institutions concerned with coastal and marine areas is also affecting management capacities and hence livelihoods.

3 COASTAL FISHERY

Introduction

The fisheries sector is an important contributor to the Tanzania mainland economy, contributing between 1-3 % to GDP, with the bulk of landings (85%) originating from the large inland lakes (MACEMP, 2012a). Coastal fisheries is nevertheless important for generating income and employment locally, the latter mostly artisanal with a small semi-industrial component. The farming of fish, invertebrates and seaweed are also included in the fishery sector.

Most fishing takes place near the mainland coast and around the islands of Mafia and those within the Songo Archipelago, all within internal and territorial water. There are two principal focus areas in the finfish fishery of mainland Tanzania: the inshore demersal fishery and the pelagic fishery (both inshore and offshore). The freshwater fishery provides a much smaller contribution to coastal fish production, but is important in some districts, notably Rufiji.

Tanzania's numerous deltas, estuaries and mangrove swamps hold potential for mariculture, especially prawns, however, to date there have been only limited (pilot study) attempts. The private sector is initiating mariculture operations with commercial pilot farms for prawns at Bagamoyo and Mafia. A tilapia farm is under development in Mafia.

Management of the Fishery Sector

The Ministry of Livestock and Fisheries Development (MLFD) has overall management of fisheries policies and regulatory frameworks, assisted by the Fisheries Development Division (FDD) responsible for coordinating fisheries through several zonal/offices. The Prime Minister's Office for Regional and Local Government (PMO-RALG), coordinate devolved management by districts under the Fisheries Act (2003). The Deep Sea Fishing Authority (DSFA) under the Deep Sea Fishing Authority Act (2007) regulates international fishing vessels using the 223,000 km^2 Exclusive Economic Zone (EEZ) in a 60:40 fee sharing structure with Zanzibar.

National policies and legislation governing fisheries, include the National Fisheries Policy and Strategy Statement (1997) and supportive Fisheries Act No. 22 (2003) and Fisheries Regulations (2009) of which a key sector policy given the artisanal nature of the fishery is the emphasis on Community Based Natural Resource Management (CBNRM) which establishes user rights to fisheries through Beach Management Units (BMU) and Collaborative Fisheries Management Units (CFMU) (WWF, 2010; MLDF, 2013). There are over 700 BMUs, mostly in Lake Victoria and 200 coastal BMUs. Of the latter 63 have Fishery Management Plans (FMPs), 36 have by-laws and 65% have been trained in CFM (MACEMP, 2012 b). While most marine fisheries are open access, or regulated by local institutions (such as BMUs), the industrial prawn fishery is managed by the FDD, through a rotating monthly access per vessel to the three prawn fishing zones, with a six month closed season, as of 1st September each year. Since 2010 the industrial fishery has been closed, through a self-imposed moratorium by the fleet of 20-30 vessels due to reduced catches. In contrast, the artisanal fishery for prawns is un-regulated.

Some key fisheries programs include the National Strategy for Growth and Reduction of Poverty (MKUKUTA), National Strategy for Urgent Actions on Conservation of Coastal, Marine, Lakes, Rivers, And Dams Environment (2008), Strategy for Urgent Action on Land Degradation and Protection of Water Catchment (2006) and the National Integrated Coastal Environment Management Strategy (NICEMS). The NICEMS combines administrative and issue based boundaries by involving various sectors linked to coastal resources based on seven strategies that need to be implemented by the year 2025, including ICZM, environmentally friendly approaches, conserve and restore critical habitats and areas of high biodiversity.

Coastal wetlands are important sources of fishery products, and, like Ramsar Sites, are managed under the Wildlife Policy (2007) and Wildlife Regulations (2009), which together with ICZM, are regulated by the Environment Management Act (EMA) (2004) as "state property". The Local Government (District Authorities) Act (1982) provides the platform for districts to implement the Fisheries Master Plan (2002) and Integrated Coastal Management (ICM) Policy (2000) and recent regulations on the Integrated Coastal Zone and Environment Management (ICZM) Regulation (URT in draft 2013).

The National Fisheries Development Plan (URT, 2011) includes various development indicators for mainland fisheries, with approximate percentage targets increase by 2015/16 as follows: sector growth (31%), contribution to GDP (83%), revenue collection (36%), exports (24%), full-time fisher employment (23%), fisheries establishments (41%), seaweed production (25%), aquaculture production (166%) and incidents of illegal fishing reduced (by 50%). The budget allocation for this over the next five years amounts to TSH 171 billion (USD 107,000), with 30% allocated to standards and marketing, 19 % to extension and training, 13% to resource management, 13% to research and minor contributions to environmental aspects and 3% to legal and institutional, aquaculture, management information and other cross-cutting costs.

Description of the Fishery Resource and its Use

Fishery Types and Fishing Grounds

The main shallow demersal fishing grounds of mainland Tanzania and associated islands lie within the 20 meter contour, an area that includes mangroves, rocky tidal zones, coral reefs, sea grass beds, estuaries and intermediate habitats (Muhando, C. and Rumisha, C.K., 2008). More than two-thirds of the 1,340 km mainland coastline has barrier coral reefs (i.e. Mafia, Mkinga, Tanga, Mafia, Kilwa and Mtwara) interrupted only near major rivers, a total area of 3,580 km^2. Some deeper waters are also fished, to 100 meter contour, though little data is available on this fishery.

Multiple fishing gears are used in the demersal fishery, both traditional as well as modern (e.g. basket fish-trap, stakes tidal fish-trap, hand-lines, gillnets, and seine net (Muhando, C. and Rumisha, C.K., 2008). The artisanal vessels include ngalawa (outrigger dug-out boat), mtumbwi (dug-out canoe), dau and mashua (planked boats), and motorisation (only 12%).

The principal small pelagic fishing grounds are fished by large semi-industrial scale purse seine netting vessels, involving light attraction at night (Muhando, C. and Rumisha, C.K., 2008). This activity is concentrated over sheltered, moderately deep waters, mostly along the shores of Tanga region, off Dar es Salaam, in the Songo Archipelago and around Mtwara.

The large pelagic species (mainly inshore tuna), are fished within 5-10 km of the coast, are targeted by a local fleet of 9-12 m boats, with large meshed gill nets. Weather conditions are the major constraint to covering that distance, usually operating from Tanga, Dar es Salaam, Kilwa and Mtwara, where a total of 200-300 boats are distributed. The fishing usually only takes place on darker nights, for 12-15 days consecutive, followed by 5-8 days off.

Prawns are associated with muddy environments, and their fishing grounds are associated with shallow, brackish and mangrove ecosystems, adjacent to major rivers and estuaries (namely Rufiji delta, Wami, Ruvu, Pangani and Ruvuma estuaries). Prawns migrate to breed in deeper waters and the juveniles undergo several stages before moving back into the deltas, estuaries and creeks where they feed and grow to maturity. The fishery is predominately for export, trawling in less than 20m, with catches of the white shrimp comprising almost 66% of landings, the bulk of white originates from the Rufiji Delta area.

Muhando, C. and Rumisha, C.K. (2008) note prawn catches have remained relatively static between 1988 to to-day, ranging from 1,000 to 2,000 t/year, from 13 trawlers in 1998 to 23 in 2008, suggesting over-fishing.

The industrial fishery for tuna and other large pelagic species comprises purse seiners and long-liners that are licensed by the Deep Sea Fishing Authority to fish within the Tanzania EEZ. Currently there are around 70-80 vessels licensed. These vessels usually operate beyond the Territorial Sea (12 nm), mostly in the wider EEZ. There may also be 4-5 deep-water trawlers licensed to trawl at depths of 300-500 m.

With five major rivers draining into the coast, notably Pangani, Wami, Ruvu, Rufiji and Ruvuma, together with associated freshwater/brackish interfaces at the respective deltas and associated wetlands, there is a minor freshwater fishery in some coastal districts, but species sizes and catch are not reported.

Seaweed farming was first introduced in Zanzibar in 1984 where commercial production started in 1990. It was encouraged at numerous mainland Tanzania locations and became established in Mafia, Mtwara and Tanga in 2005, locations where the suitable clear-water, shallow sheltered lagoons exist. The species cultured are *Eucheuma cotonii* and *E. Spinosium*, attached to lines anchored in shallow sandy lagoons.

Fishing Effort and Yields

In 2009 there was a total of 36,321 full time fishers (including foot fishers), using 7,342 relatively small fishing dugout canoes, and nearly 56% who operate on foot without gear or crafts using spears, hand traps and small nets operating from 257 landing sites (Fisheries Frame Survey report 2009). Numbers of fishers have increased from 19,071 in 2001. Gillnets have increased from 5,136 in 2001 to 22,666 units in 2009.

On the 36,321 full time fishers, based on MLFD (2010), the greatest numbers are operating from the following regions: Coast (12,417), Dar es Salaam (7,430), Mtwara (5,792), Tanga (5,410) and Lindi (5,272). The districts with the greatest number of fishers are Mtwara Rural (4,739), Rufiji (4,247) Mafia (4,200), Temeke (3,586) and Kilwa (3,500). The distribution of the 7,342 vessels estimated during the 2009 Frame Survey reflects the concentration of effort, with the Coast Region supplying 2,726 vessels, twice as many as any other region, Mafia and Mtwara having the highest number.

About 50% of landings are from the artisanal demersal fisheries sector, with the artisanal and semi-industrial small pelagic fishery contributing 25% of total landings (Muhando, C. and Rumisha, C.K., 2008). The remainder is comprised of miscellaneous invertebrate fisheries, such as lobsters, octopus, prawns and molluscs, including small-scale exploitation of pelagic species offshore (deep-sea waters), producing about 1,300 t/year. Muhando, C. and Rumisha, C.K. (2008) report lobster catches averaging 80 t/year from artisanal fishers (in Tanga, Dar es Salaam, Kilwa and Mafia) and sold to tourist hotels and for export purposes.

Seaweed is farmed in 11 coastal districts on the mainland, employing 5,579 people. Kilwa District engages the largest number (2,649 seaweed farmers), while 1,001 farmers are based in Lindi Rural, 971 in Lindi Urban, and the other seaweed farming districts engaging between 15 and 210 farmers (MLFD, 2010). It is sold as a food source, medicine and for the production of agar and carrageenan, to export markets in Asia, Europe and United States of America at a price in 2004 of 350-450 USD/t of dried *Eucheuma cottonii* and 180-220 USD/t for *E. spinosum*, but prices fluctuate, mostly going down (MACEMP, 2009).

Status of the Fishery

Catches have been static at around 50,000t/year, despite the potential estimated as high as 100,000 t/year (Haule, 2013). An analysis of both catch per unit fisher (CPUF) and Catch per Unit

Fishing Vessel (CPUFV) by NEMC (2009), shows a continuous declining trend, with CPUF declining much faster than CPUFV suggesting there has been a rapid increase of people joining the fishing industry. That is substantiated by the increase in the numbers of fishers, from 14,000 in 1995 to nearly three times that in 2009 (NEMC, 2009), despite a decline in foot fishers, hand lines, gill nets, scoop nets and trawl nets. Over that period the illegal gears (i.e. beach seines and use of explosives) has increased in numbers in some districts despite enforcement.

Major issues

The growing demand for fish has increased with population growth and tourism expansion, causing increases in fish prices, increased fishing pressure and, the use of gears that are destructive (i.e. beach seine, spears, and *juya la kigumi* - a dragged purse-seine net used around reefs). The latter is one of the more difficult to control because the net used is not illegal but the way it is used (involving smashing corals to force fish out) is destructive and illegal.

Damage to habitats cause loss of spawning and nursery grounds, biodiversity and habitat resilience. Reduction in fisheries productivity due to habitat destruction can takes years, even centuries to recover. Haule, (2013) reports a loss in capital, notably reef habitat and fish stocks that would perpetuate production (estimated USD 33,900-306,800/km2 of coral reef) where there is a low and high potential value of tourism and coastal protection), and loss in tourism "attractiveness of the coral reef for recreational angling, snorkelling and diving, and damage to Tanzania's conservation image as a biodiversity tourism destination. MACEMP (2013) estimates reef recovery from severe storm damage at 40-70 years (quoting Dollar and Tribble, 1993), and recovery is likely to extend to centuries**.** NEMC (2009) considers that any threats on sea grasses, seaweeds, coral reefs and the mangroves (from global warming or physical degradation) would greatly impinge on the fishery, adversely affecting the fisher community livelihoods. Damage to habitats cause loss of spawning and nursery grounds, biodiversity and habitat resilience.

Economic Importance of the Fishery

The fisheries sub-sector contributes between 1-3 % to GDP, based on direct fish value generation as well as exports, though much of this comes from Lake Victoria Nile perch fishery, with the coastal marine fisheries contributing only a small percentage.

Finfish Fishery Revenue

Based on total landings of around 50,000 t/year, the value of the marine fisheries can be estimated as of the order of USD 70 million. The greatest regional contributions are from Dar es Salaam (50%), followed by the Coast (Mafia, Rufiji, Mkuranga and Bagamoyo districts) with 25%, and Tanga, Mtwara and Lindi all contributing 5-10% ((Muhando, C. and Rumisha, C.K., 2008). Estimates on the offshore tuna fishery in the EEZ are vague and from few data sources.

Overall Fishery and Seaweed Exports

MACEMP (2009) reporting on value and royalties from marine products (i.e. prawn, sea cucumber, shells, lobster, crabs, squids, octopus, sardines and aquarium fish), show a decline from a 5,000 t/year high in 2003, earning USD 17.2 million, to 2,000 t/year in 2011, earning USD 10.2 million. According to MACEMP (2012 a) a weak trend is seen that shows a peak in the years 2002-2003, declining and stabilising at around USD 10 million per year. The total marine products export value is estimated by (MLFD, 2013) as USD 35 million (2005).

Socio-economic Importance of Fisheries

Finfish and Invertebrate Fisheries

Tanzania's marine resources are critical to economic and social development, and underpin the livelihoods of coastal communities, who rely on the sea for their food and income. In addition to the 36,321 individuals reported for 2009, who derive their living from fishing, to coastal communities, fishing is the primary source of protein and a crucial source of revenue in allied industries.

The artisanal fishery (small scale) sector is the most important, historically providing the economic base for the majority of coastal communities, contributing significantly to poverty reduction, economic growth and food security, employment, local incomes and some foreign exchange. Most reef fish, sardines and other species are caught for domestic markets.

The national per capita animal protein from fish has shown a gradual decline from 13 kg/capita in 1993 to 8.2 kg/capita in 2007, and 7.6 kg/capita in 2012, a feature of a stable total fish catch but a growing population (MLFD, 2013). Fish consumption averages 25-30kg/capita/year at the coast, supports livelihoods in associated sectors (i.e. boat building and repair, gear sale and repair, and marketing of fishery products).

Muhando, C. and Rumisha, C.K. (2008) noted that molluscs and bivalves are not commercially important, but they make up an important component in the dishes of many coastal households. Octopus, squids, oysters, cockles, mussels and gastropods are exploited for food or sold to tourist hotels, collected mostly from the inter-tidal flats and within the mangrove ecosystems. The collection of molluscs from the marine environment in Tanzania is not controlled so it is difficult to determine levels of exploitation (NEMC, 2009).

Sea Weed Farming

With a workforce of 5,579 (MACEMP, 2009), mostly women, the seaweed farming industry makes a significant contribution to the local economy and livelihoods, especially in some of the poorest districts along the coast, such as Kilwa and Lindi Rural.

Mariculture

Mariculture has to date been limited to pilot trials but thanks to private sector operations with commercial farms for prawns at Bagamoyo and Mafia, several hundred employment opportunities are being realised. A tilapia farm is under development in Mafia. At present, employment and socio-economic significance remains low.

Threats to Coastal Communities Relying on Fisheries for their Livelihoods

The following list summarises specific threats to livelihoods related to fisheries and aquaculture, and the natural environment, many of which are human-induced (see MNRT, 2013):

- **Social conflicts over fishing gears** - where local fishers use gears or methods (some of which are illegal) that are not acceptable by neighbouring villages.
- **Social conflicts over access to resource** – where cultural and historical rivalry over "traditional" fishing grounds increases as pressure on the resource increases; also includes increasing resentment of migratory fishing groups of "dago" fishers during seasonal visits, using gears considered destructive or conflict with local traditions.
- **Destructive and illegal fishing** - causing decline in productivity due to habitat destruction through beach seine, spear guns and dragnets, and dynamite, adversely affecting the fisher community livelihoods.

- **Poor fishery resource management –** allowing open access fishery, thus increasing fishing pressure and stock depletion is difficult to manage; leading to conflicts with tourists over coral reefs to dive and to snorkel, fish landing sites and tourist hotels; to seaweed farming conflict with boat users and tourists;
- **Poverty and lack of education –** combine with absence of alternatives or investment, are all attributed as the causes for the current behaviour of fishers.
- **Pollution into catchments and coastal zone** - by dumping or leaching of domestic, urban, mining and industrial wastes, sewage, solids, agricultural pesticides into catchments or direct disposal in wetlands, draining to estuaries and coastal zone, affecting marine productivity.
- **Drainage changes** - re-claiming areas for agriculture, to build roads, houses and cities or mosquito control, or diversion or in-efficient use of water for irrigation, mining, industry, livestock or domestic and urban needs alters flows, changes estuarine sediment loads.
- **Unsustainable mining** - salt, sand, coral lime, fossil coral limestone, etc. mined with damage to physical properties of shorelines and river basins.
- **River damming -** for reservoirs for domestic water, irrigation and/or hydro-electric power (HEP) changing sediment loads, affecting estuaries.
- **Poor mangrove resource management –** allowing over harvesting of mangrove and wetland or riverine trees leading to erosion and estuarine siltation.
- **Catchment deforestation in major basins –** causing changes in river flows, leading to excessive run-off, flooding, erosion and siltation.

CRIAM Ranking of Threats to Local Communities associated with Fisheries

Table 10: Prioritisation of threats to local communities and ecosystems associated with fisheries. The assessment has been made using the Coastal Rapid Impact Assessment Matrix (CRIAM) approach, described in detail in Annex 3.

ThemeID	Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
M_Fish-03	Destructive and illegal fishing - causing decline in productivity due to habitat destruction through beach seine, spear guns and dragnets, and dynamite, adversely affecting the fisher community livelihoods.	Fisheries	3	3	3	3	3	81	5					
M_Fish-10	Poor mangrove resource management – allowing over harvesting of mangrove and wetland or riverine trees leading to erosion and estuarine siltation.	Fisheries	3	3	3	2	3	72	5					
M_Fish-11	Catchment deforestation in major basins – causing changes in river flows, leading to excessive run-off, flooding, erosion and siltation.	Fisheries	3	3	3	2	3	72	5					
M_Fish-04	Poor fishery resource management – allowing open access fishery, thus increasing fishing pressure and stock depletion is difficult to manage; leading to conflicts with tourists over coral reefs to dive and to snorkel, fish landing sites and tourist hotels; to seaweed farming conflict with boat users and tourists;	Fisheries	3	2	2	2	3	42	4					
M_Fish-05	Poverty and lack of education – combine with absence of alternatives or investment, are all attributed as the causes for the current behaviour of fishers.	Fisheries	3	2	3	2	2	42	4					
M_Fish-01	Social conflicts over fishing gears - where local fishers use gears or methods (some of which are illegal) that are not acceptable by neighbouring villages.	Fisheries	2	3	2	2	2	36	4					

ThemeID	Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
M_Fish-06	Pollution into catchments and coastal zone - by dumping or leaching of domestic, urban, mining and industrial wastes, sewage, solids, agricultural pesticides into catchments or direct disposal in wetlands, draining to estuaries and coastal zone, affecting marine productivity.	Fisheries	2	1	3	2	3	16	2					
M_Fish-09	River damming - for reservoirs for domestic water, irrigation and/or hydro-electric power (HEP) changing sediment loads, affecting estuaries.	Fisheries	1	2	3	2	3	16	2					
M_Fish-07	Drainage changes - re-claiming areas for agriculture, to build roads, houses and cities or mosquito control, or diversion or in-efficient use of water for irrigation, mining, industry, livestock or domestic and urban needs alters flows, changes estuarine sediment loads.	Fisheries	1	2	3	2	2	14	2					
M_Fish-08	Unsustainable mining - salt, sand, coral lime, fossil coral limestone, etc. mined with damage to physical properties of shorelines and river basins.	Fisheries	1	2	2	2	2	12	2					
M_Fish-02	Social conflicts over access to resource – where cultural and historical rivalry over "traditional" fishing grounds increases as pressure on the resource increases; also includes increasing resentment of migratory fishing groups of "dago" fishers during seasonal visits, using gears considered destructive or conflict with local traditions.	Fisheries	1	1	2	2	2	6	1					

Vulnerability to Climate, Climate Variability and Climate Change

The Tanzania mainland coastal economy is very dependent on the climate and a large proportion of GDP, employment and livelihoods are associated with climate sensitive activities such as fishing, and farming. MACEMP (2009) or GCAP (2012) note the climate of Zanzibar is changing, with recent decades seeing rising temperatures, increased rainfall variability, higher wind speeds and high-tide levels, and an increase in extreme events (climate variability), notably droughts and floods which have had major economic costs in terms of impacts on GDP. A similar situation is likely on the mainland coast and coastal livelihoods are therefore extremely sensitive to climate change. Based on assessments made by MACEMP (2009), SMOLE (2010) and GCAP (2012), the specific vulnerabilities can be summarised under the principle climate change areas:

Changes in Weather Patterns (precipitation, and water availability)

- Run-off and river flows affecting salinity and siltation and thus fisheries productivity in estuarine, mangrove, seagrass and coral reef habitats and feeding and breeding grounds.
- Unseasonal precipitation affecting various activities e.g. sea-weed farming and drying (affect quality of the dried product).
- Changes in wind pattern will thus change fishing behaviour.

Extreme Weather Events

- Fishing effort reduced due to limited access to fishing grounds in small vessels, e.g. form increase in wind speeds (and ocean swells).
- Boats moorings and fisheries infrastructure (fish landing sites, coastal villages) affected by erosion.

Sea-Level Rise

- Retreating mangroves with no space to occupy because of land-based activities and/or infrastructure.
- Combined with extreme weather events (above) sea level rise will increase beach erosion, threatening coastal infrastructure and near shore marine habitats (from smothering from suspended particles in the water column, as well as from reduced light penetration).

Seawater Temperature Rise

- Alteration of marine biodiversity, possibly resulting in extinctions and/or species migration, potentially affecting coastal fisheries.
- Warmer waters can favour plankton transition and enhance fish growth rates.
- Coral bleaching is temperature related and in turn affects fisheries.
- Farmed sea-weed die-off along the coast has been attributed to sea surface temperature as the most likely cause, leading to movement of sea weed farming to deeper water (where possible).

Seawater Acidification

- Increasingly acidic as CO2 is absorbed by water to become carbonic acid, resultant drop in pH, is expected to have major effects on shell-forming organisms (notable corals and molluscs) but will also enhance primary production. Combined with bleaching impacts on corals, coral reefs (physically important in coastal surge protection, nurturing fisheries and protecting shoreline fisheries infrastructure) are vulnerable to degradation.

Outlook for Fisheries

The pragmatic outlook on the fisheries sector along mainland Tanzania's coast is that there is little room for expansion and the current pressure is damaging the productivity and catches are unlikely to increase with more fishing effort. NEMC (2009) considers that over-fishing pressure and destructive fishing methods have contributed greatly in undermining the marine ecology changing species compositions in the same localities. Distance travelled for search of good fishing ground averages half to one hour except for three Tanga districts, where fishers tend to cover longer distances, implies a local decline the inshore fishery quality, again signs of overexploitation. Some potential increase may be gained from deeper water operations, improvements in efficiency and/or value-added in the small pelagic fishery and from coastal aquaculture.

4 TOURISM

Introduction

Tourism is one of the fast growing sectors of Tanzania's economy, ranking top in foreign exchange earnings, overtaking agriculture in GDP terms, generating significant amounts of hard currency and providing a range of employment, service and product opportunities for other sectors of the economy. The attraction of mainland Tanzania to international tourists is very strong, being based on the well-established and in places exceptional wildlife reserves and parks, the landscapes, history cultural identity and generally peaceful status. Four interest groups among those visiting the coastal districts can be identified: wildlife tourism (focused on Saadani National Park and water birds); marine-based tourism (focused on marine parks, for diving, snorkelling, deep sea fishing, etc.); cultural tourism (historical, heritage and cultural sites); and beach tourism (beaches, hotels, restaurants, shops, handicrafts, etc.). There is considerable overlap within these interest groups, but the bulk of present interest is the coastal beach experience.

Of the 850,000 international tourist arrivals in 2010, only a small proportion visited the coastal districts, while many more travelled on to stay in Zanzibar. Coastal tourism on the mainland is however growing rapidly (e.g. in 2011, Mafia Island received 4,500 tourists, while Dar es Salaam Marine Reserves catered for 20,000 visitors, and visitors to Tanga and Mtwara region are growing annually). Beach hotels are scattered along the entire coastline, and is a more recent development than the traditional, land based nature tourism, for which Tanzania is internationally known.

It is difficult to disaggregate the contribution of the mainland coastal tourism sector from overall industry figures, where direct expenditures from international visitors account for 5.8% of the economy, at USD 1.35 billion (in 2011). Of that total, 20% is attributed to coastal tourism (but including Zanzibar). The economic impact of tourism however, is a multiple of this in terms of employment and services through the value chain.

Management of the Sector

The National Tourism Policy (1999) recognises the potential and establishes the basis for a well-developed and ecologically balanced coastal tourism, described as a priority area in the Integrated Tourism Master Plan. Whereas the Wildlife Policy (2007) and Wildlife Regulations (2009) govern wilderness areas like Saadani National Park, the Ancient Monuments Preservation Decree (1927, Amended 1971 and 2002), protects and conserves cultural tourism such as historical sites and monuments. The Marine Parks and Reserves Act (1994) establishes and manages Marine Protected Areas (MPAs) which are also popular tourist sites. The Ministry of Natural Resources and Tourism (MNRT) is the tourism policy oversight body with sectors represented by the Wildlife Division, Department of Tourism and the Antiquities Department.

The Tanzania Tourist Board (TTB) spearheads the marketing and promotion. In addition, several private sector associations such as Tourism Confederation of Tanzania (TCT) Tanzanian Association of Tour Operators (TATO) and the Hotel Association of Tanzania (HAT) represent tour operators and hotel owners respectively. There are about 10 more sector specific (hunting) or regional tourism associations.

Description of Tourism and Resource Use

Despite a coastline of natural beauty with sand beaches, numerous islands, safe bathing, cultural and historical sites and a ready and diverse seafood supply, (NEMC, 2009) notes that coastal tourism is still not very popular on the mainland. Most of the 100 or so facilities (many around Dar es Salaam) contain modern tourist facilities: dining areas, bars, swimming pools and

conference rooms and are located directly adjacent to sandy beaches or prime SCUBA dive locations. These tourism centres have stimulated the local development of support infrastructure, and the development of high quality air transport services between Dar es Salaam and Mafia, Tanga and Mtwara. In addition to beach access, there are two main interest areas of coastal tourism on mainland Tanzania:

Historical and Cultural attractions

The Tanzanian coastal zone is rich in historical and archaeological sites reminiscent of its long history of Swahili culture. Excluding Zanzibar, the most spectacular sites are Bagamoyo, Kilwa and Tanga, with some sites dating to at least 800 AD and of global significance. Muhando and Rumisha (2008) note that cultural tourism along the mainland coast and islands is growing, in part thanks to efforts to restore historical sites and monuments with the purpose of conserving history and tourist related income.

Marine attractions

The marine environment along the 650 km of mainland Tanzania includes marine protected areas (MPAs) many of which are important tourist sites of interest, providing snorkelling or SCUBA and deep sea fishing opportunities. The MPAs of Tanzania are Mafia Island Marine Park and Mnazi Bay Marine Estuary Marine Park, Saadani National Park (Tanzania's only wildlife area extending to the sea) and 11 Marine Reserves (Maziwe located off Pangani; Fungu Yasin, Mbudya, Pangavini and Bongoyo; Inner and Outer Makatombe, Kendwa and Inner and Outer Sinda; and Nyororo, Shungi Mbili and Mbarakuni). In addition, ten Community Marine Conservation Areas (CMCAs) exist (six in Tanga and four at Bagamoyo) that at times provide opportunities for tourists. The Rufiji-Mafia-Kilwa Ramsar Site is the largest internationally recognised marine protected area along mainland Tanzania. Within or adjacent to these sites are several well-known recreational SCUBA dive locations and deep sea fishing grounds.

Trends in entrances to marine parks have shown consistent growth with a slight decline during the 2008 economic crisis. Annual growth rates averaged around 18% between 2000 and 2011 when 24,367 visitors paid entrance to an MPA (MACEMP, 2012a).

Issues

The Tourism Master Plan 2002 notes the following shortcomings applicable to coastal tourism which could influence its growth: generally poor access (mainly internal flights), poor infrastructure (especially roads) and high costs of internal transport, leading to overpriced product and poor service standards with poor quality guides in comparison with competitor destinations, low quality tour operators and a general lack of quality accommodation (URT, 2002).

Economic Importance of Tourism

Annual revenue generated from the nationwide tourism industry is estimated at USD 100 million in taxes, plus protected areas fees of over USD 50 million and the VAT (18%) contribution, produces a direct annual tourism revenue of USD 1.3 billion (Fig. 1) (MACEMP 2012a). Tourism has been growing at a moderate rate of 5.2% since 2001 and has recovered from the 2009 slump with growth of around 9-10% for the last two years (Fig. 1). The portion of these gross amounts that is generated from coastal tourism in mainland Tanzania, is however very low. With a total of 105 hotels on the 650 km coastline, averaging 80 beds each, the contribution to national revenues from this sector IS small, with small additional contributions from the MPAs and Saadani National Park.

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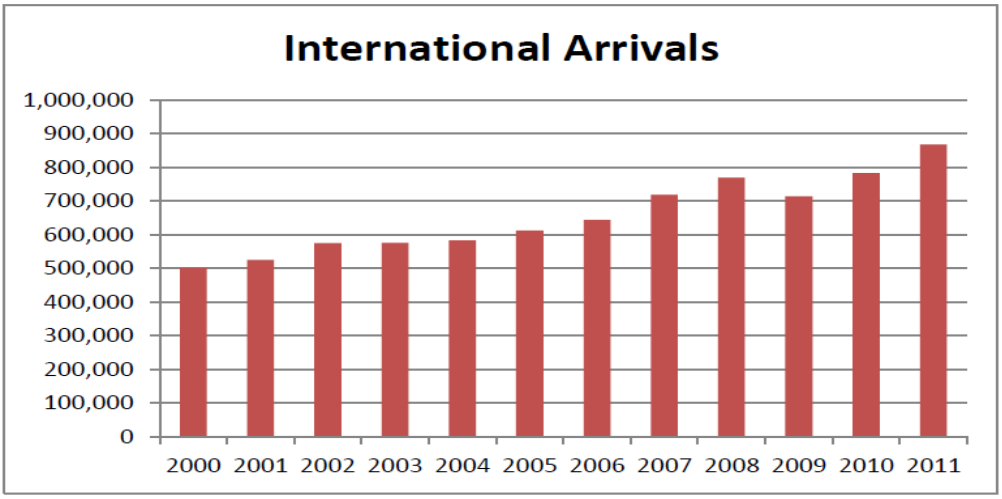

Figure 8 International tourism arrivals (data from Tanzania Tourism Bulletin

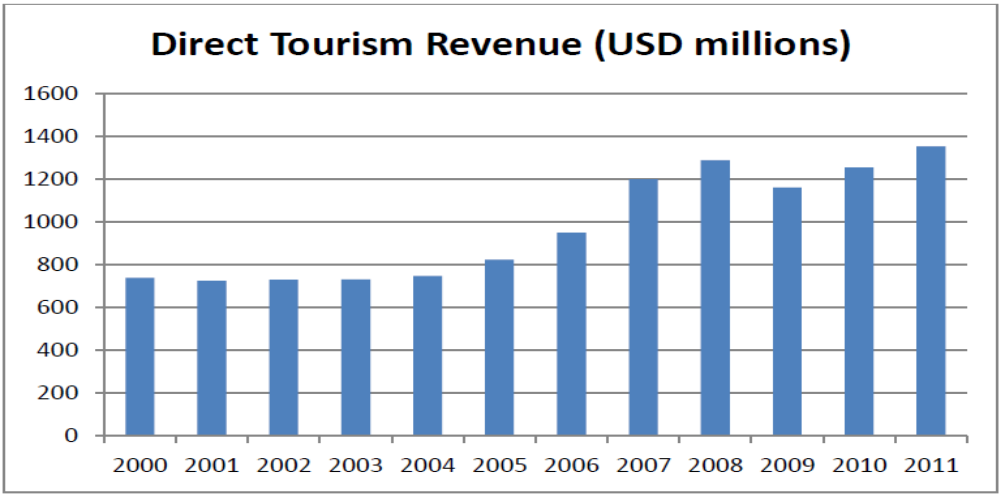

Figure 2: Growth in tourist arrivals and tourism revenue in Tanzania (MACEMP 2012).

Socio-economic Importance of Tourism

The economic benefits from coastal tourism are listed by TCMP (2012) as both positive and negative in terms of the local and national economies. Direct employment from operation of the 105 hotels along Tanzania's coast probably generates some 5,000 jobs to local communities in addition to those engaged in the supporting services and businesses (i.e. restaurants, tour agencies, etc.) that benefit local entrepreneurs. These visitors benefit local government development funds through taxes and other revenues. Though temporary, additional employment opportunities are in the construction industry (i.e. masons, carpenters, etc.), material supplies (i.e. cement, rock, sand, brick, wood, etc.) and allied building services provide opportunities in the sector with manufactured hotel goods (i.e. furniture, linen, art, kitchen units, cutlery, etc.).

Threats to Coastal Communities Relying on Tourism for Livelihoods

The largest concern to the tourism industry of Tanzania is the failure of tourist to visit. This may come about for a myriad of reasons, including better options elsewhere, cost of international flights, or reduction in the quality of the experience. The latter can arise due to many reasons.

The principle threats to the quality of the local experience, to those engaged in the tourism sector and to the wider environment are described below:

- **Anarchistic tourist development** destroying cultural heritage sites where urban development planning and control fail to intervene.
- **Lack of trained personnel** for conservation and management of cultural heritage.
- **Profits not benefitting the local population**.
- **Increased cost of living due to tourism industry[10].**
- **Increasing cost of land in high tourism potential areas[11]**.
- **Uncertainty of tourism jobs[12]**
- **Loss of employment opportunities** by locals to more qualified and better trained staff[13]
- **Erosion of local traditions and culture** due to influences from tourists and non-locals in the industry[14].
- **Deterioration of marine environment** resulting in loss of biodiversity and other marine tourist attractions[15].
- **Reduction in iconic marine life**[16]
- **Ecosystem fragmentation** due to encroachment of corridors and protected areas[17].
- **Inadequate sewage infrastructure and waste management** leading to pollution of the coastal zone, from some developments illegally dumping waste and litter.
- **Increased beach erosion** due to alternation of the shoreline[18]

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[10] Prices of fish and agricultural foodstuff have gone up, to the detriment of the local consumers who risk loss of valuable protein inputs to their diets.

[11] Coastal land is targeted by speculators or developers and competition for land can drive prices to levels where the local populous cannot afford land.

[12] Most being ad-hoc, or 'as needed' basis or seasonal in nature and do not offer steady employment.

[13] From other parts of mainland Tanzania and Kenya.

[14] e.g. from language, dress code, manners and habits; loss of village elder authority to preside over disputes; rise in prostitution, robbery and alcohol abuse; **g**oods and services offered freely in the past (e.g. land, thatch (roofing materials) and assistance to the elderly or during times of hardship), are eroded by the 'money economy' of wage employment.

[15] From destructive fishing practices (e.g. dynamite fishing) due to failures in marine resource management to cope with the increased pressure on marine resources due to the demand for seafood from the tourism sector and urban centres, also threatening the sport fishing industry.

[16] Illegal killing of whale sharks, dolphins, dugongs, turtles and other exotic marine animals that are tourist attractions thereby creating a poor image of Tanzania as an eco-friendly destination.

[17] Affects migratory species and is exacerbated by overutilization of forest resources. Failure of management to address encroachment and resource over-utilisation, especially forests.

[18] Obstruction of sediment supply by modification of the beach hydrodynamics due to the construction of inappropriate engineering structures like sea walls, jetties and salt pans and removal of beach material for road or hotel or beach construction, and of protective mangroves enhancing aggressive wave action on the beach, leading to sand loss. Poor planning by beach hotels and residential houses built directly on or very close to the beach are threatened by erosion (eg in Dar es Salaam area Hotel Africana built on a dune lost more than 50% of its residential huts by the late 1980s).

CRIAM Ranking of Threats to Local Communities associated with Tourism

Table 11: Prioritisation of threats to local communities and ecosystems associated with tourism. The assessment has been made using the Coastal Rapid Impact Assessment Matrix (CRIAM) approach, described in detail in Annex 3.

ThemeID	Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
M-Tour_06	Uncertainty of tourism jobs with most being ad-hoc, or 'as needed' basis and does not offer steady employment, or seasonal in nature.	Tourism	3	3	3	3	1	63	4					
M-Tour_08	Erosion of local traditions and culture due to influences from tourists and non-locals in the industry (e.g. from language, dress code, manners and habits); loss of village elder authority to preside over disputes; increases in prostitution, robbery and alcohol abuse; goods and services offered freely in the past (e.g. land, thatch (roofing materials) and assistance to the elderly or during times of hardship), are eroded by the 'money economy' of wage employment.	Tourism	3	3	3	2	2	63	4					
M-Tour_12	Inadequate sewage infrastructure and waste management resulting in pollution of the coastal zone, from some developments illegally dumping waste and litter.	Tourism	3	3	3	2	2	63	4					
M-Tour_04	Increased cost of living due to tourism industry where prices of fish and agricultural foodstuff have gone up, to the detriment of the local consumers who risk loss of valuable protein inputs to their diets.	Tourism	3	2	3	3	2	48	4					
M-Tour_03	Profits not captured locally, thus not benefitting the local population (e.g. package tours sold overseas).	Tourism	3	2	3	2	2	42	4					
M-Tour_05	Increasing cost of land in high tourism potential areas are targeted by speculators or developers and competition for land can drive prices high, such local populous cannot afford land.	Tourism	1	3	3	3	2	24	3					
M-Tour_10	Reduction in iconic marine life with illegal killing of whale sharks, dolphins, dugongs, turtles and other exotic marine animals that are tourist attractions degrading the value of the experience and creating a poor image of Tanzania as an eco-friendly destination.	Tourism	2	2	3	2	1	24	3					

ThemeID	Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
M-Tour_11	Ecosystem fragmentation due to encroachment of corridors and protected areas, is affecting migratory species, exacerbated by over utilization of forest resources and conflicts between agriculture and wildlife, due to failure of management to address encroachment and resource over-utilisation, especially forests.	Tourism	1	3	3	2	2	21	3					
M-Tour_02	Lack of trained personnel for conservation and management of cultural heritage (TCMP 2001).	Tourism	2	2	2	2	1	20	3					
M-Tour_13	Increased beach erosion due to tourism alteration of the shoreline, with obstruction of sediment supply by modification of the beach hydrodynamics due to the construction of inappropriate engineering structures like sea walls, jetties and salt pans and removal of beach material for road or hotel or beach construction, and of protective mangroves enhancing aggressive wave action on the beach, leading to sand loss (e.g. northern Bagamoyo Beach Hotels have cleared their mangrove frontage, resulting in erosion rates of up to 3m/year.). Poor planning by beach hotels and residential houses built directly on or very close to the beach are threatened by erosion (e.g. in Dar es Salaam area Hotel Africana built on a dune lost more than 50% of its residential huts by the late 1980s.	Tourism	1	2	3	2	2	14	2					
M-Tour_01	Anarchistic tourist development destroying cultural heritage sites (TCMP 2001) where urban development planning and control fail to intervene.	Tourism	1	2	2	2	2	12	2					
M-Tour_07	Loss of employment opportunities by locals to more qualified and better trained staff from other parts of mainland Tanzania and Kenya.	Tourism	1	2	2	2	1	10	2					
M-Tour_09	Deterioration of marine environment resulting in loss of biodiversity and other marine tourist attractions from destructive fishing practices (e.g. dynamite fishing) due to failures in marine resource management to cope with the increased pressure on marine resources due to the demand for seafood from the tourism sector and urban centres, also threatening the sport fishing industry.	Tourism	1	2	2	2	1	10	2					

Vulnerability of Tourism to Climate, Climate Variability & Climate Change

There are many potential threats from climate change on a number of sectors that are linked to tourism, including fisheries, health, infrastructure, water resources and ecosystem services. NAPA, (2007) GCAP (2011) considers tourism has been largely unaffected by climate variability and extremes, because tourist numbers are low in the rainy season, and the sector is generally protected in food production and water availability. Based on assessments made by VPO (2012), GCAP (2012) and SMOLE (2010) the specific vulnerabilities can be summarised under the principle climate change areas:

Changes in Weather Patterns (precipitation, and water availability)

- Shift in the preference of tourist destinations due to unfavourable climatic conditions affecting attractiveness of the mainland coastal destinations.
- Retreat of the ice cap at Mt. Kilimanjaro affecting downstream seasonality of flows (e.g. Pangani River in Pangani District) affecting beach sedimentation and erosion.
- Fire risk to coastal wildlife-based tourism may result in the loss of endemic biodiversity (flora and fauna).
- Less frequent but more intense precipitation will cause more surface runoff and erosion and less recharge of ground water. Longer dry periods between rains can lead to deficiency of soil water affecting plant growth in hotel garden landscapes and lower the water table.
- Decline in agricultural production due to changes in weather, would create problems for hotel supply chains.
- More frequent flooding especially in urban areas can increase frequency of food and water borne diseases, necessitating better hygiene with food and vegetables.
- Unpredictable climate that alter biodiversity as species struggle to adapt to changing conditions (Lovett et al., 2005) resulting in major extinctions, while invasive species, with high fertility and dispersal capabilities are highly adaptive to variable climatic conditions (Malcolm et al., 2002), negatively affecting the tourism experience.

Extreme Weather Events

- Inundation of coastal areas affecting hotel foreshores and hotel landscapes.
- Recreational tourism, notably diving, snorkelling and deep sea fishing activities, adversely affected by rougher sea conditions.

Sea-Level Rise

- Degradation of coral reefs which are crucial for coastal protection and tourism, leading to increased erosion.
- Saltwater intrusion in wells near the coast due to rising sea level and over abstraction.
- Threats to tourism hotels and infrastructure from coastal erosion, flooding and storm surges and sea level rise, and in the longer-term, to key tourist areas such as Mafia and Kilwa[19].

[19] The Kilwa Monuments continue to be vulnerable to coastal inundation and erosion, a process that has been affecting the ruins for the last fifty years. Tourist facilities such as hotels and roads are perhaps the most vulnerable structures to inundation and the consequences of sea level rise and enhanced risk of

Seawater and Air Temperature Rise

- Rising sea temperatures and ocean acidification (below), will impact on marine ecosystems, particularly through coral bleaching, adversely affecting marine recreational activities (snorkelling and diving)[20].
- Warming temperatures negatively affecting some fisheries, reducing fish supplies to hotels and degrading the sport fishing potential of the area.

Seawater Acidification

- Negatively impacting coral reef development and structures, leading to greatest exposure of beach hotels to wave surges.

Outlook

Coastal tourism shows a promising future as evidenced by the number, variety and diversity of accommodation facilities that have been constructed or are planned. They range from ecologically friendly lodges, stylish to classic type of hotels, a diverse range of accommodation to target different market segments of eco-tourists, local and international holiday makers.

Recommendations in the Tourism Master Plan (URT, 2002) that look at factors that will enhance coastal tourism, include diversification from Northern Circuit, and extension of the north coast arc of Tanga/Pangani, development of a strong Southern Circuit comprising the coastal areas beach resort tourism including Mafia, offshore islands, Bagamoyo, Saadani Game Reserve and Kilwa, and enhancement of Dar es Salaam and environs with emphasis on the urban waterfront.

damage from sea surges and the like. In Dar es Salaam, a large number are partly protected from erosion by groynes and a seawall. The cost for building seawalls to protect important vulnerable areas of the city against a 1m rise in sea level has been estimated at USD 337 million (GCAP, 2011 citing Mwaipopo, 2000). They estimate with proper adaptation measures, area lost, erosion, submergence, and flooding can be minimised at a cost of US$27 million per year in 2030.

[20] IPCC (2007) reports that the coral bleaching occurring in 1998 led to reduced tourist revenue for Mombasa and Zanzibar of USD 12 to 18 million

5 LIVESTOCK AND AGRICULTURE

Introduction

Agriculture (including livestock) is the dominant sector in Tanzanian economy, providing livelihood, income and employment to over 80% of the population and it accounted for 56% of GDP and about 60% of export earnings in 2008 (NBS 2008/9). Agriculture is the main stay of the livelihoods of the majority of the coastal population; however it is difficult to disaggregate data specifically for the coastal belt. Urban and rural agriculture/livestock keeping are practiced, with farming, both small and large scale. Most of the land in the coastal area is of low agricultural potential, with an over-reliance on rain-fed agriculture and investment in the sector, in coastal districts, has remained low.

Tanzania has a high potential for producing horticultural crops but this has yet to be fully exploited. Tanzania has about 88.6 million hectares of land suitable for agricultural production, including 60 million hectares of rangelands suitable for livestock grazing. Major cash crops include maize, citrus fruits and coconuts. At a national level food security has not been achieved yet due to regional variations in supply and demand, and market inefficiencies. Large amounts of wheat are imported each year. Major export crops are cotton, coffee and tobacco, each achieving around USD 100 million in export value in 2009.

The livestock sub-sector is an integral part of Tanzania's economy and cattle dominate the livestock industry. The contribution of the livestock sector to agriculture is 30% and 6.1% to the GDP, with the livestock value chain (meat trade, butcheries, and restaurants) more significant than official statistics reflect (MNRT 2013). The potential to increase both livestock production and productivity and its contribution to GDP exists as the carrying capacity of up to 20 million Livestock Units has not been fully utilised, but there is increasing conflict in land use between pastoralist and crop farmers.

The agriculture sector in Tanzania is dominated by small-scale holders who use very low-key technologies and as a result, the sector has exhibited very low productivity and food insecurity. This makes producers vulnerable to the effects of periodic droughts and occasional floods from climate variability (GCAP, 2011).

Management of the Agriculture Sector

The institutions responsible for agriculture in Tanzania are the Ministry of Agriculture, Food Security and Cooperatives (MAFSC) and the Ministry of Livestock and Fisheries Development (MLFD) who respectively manage crop and livestock policy implementation, while the Ministry of Water (MOW) has a role in irrigated crops. The legal instruments that guide agriculture development, are many, as detailed by ERM (2013) including the Centre for Agricultural Mechanisation and Rural Technology Act (1981); Agricultural Irrigation Development Fund (Establishment Management) Act (1984); Food Security Act (1991); Agricultural Inputs Trust Fund Act (1994); Plant Protection Act (1997); Seeds Act (2003); Fertilisers Act (2009); Grazing-Land and Animal Feed Resources Act (2010); Plant Breeder's Rights Act (2012); and crop-specific laws, including for Cotton (2001), Cashew Nuts (1984), Pyrethrum (1997), Sisal (1997), Sugar (2001), Tea (1997), and Wattle (CAP. 158, RE 2002).

The policy instruments that guide mainland agriculture, include Vision 2025 outlined in a strategy known as and *Kilimo Kwanza*, for the transformation of Tanzania's agricultural sector to achieve food self-sufficiency to achieve the goals in National Strategy for Growth and Reduction of Poverty (NSGRP II or MUKUTA II). More specific to the coast is the National Integrated Coastal Environment Management Strategy (NICEMS) which builds on food security as in the Agricultural Sector Policy (1997) and elaborated as part of the Southern Agriculture Corridor of

Tanzania (SAGCOT). Commercial agri-business is targeted in the southern belt, mostly the Rufiji and Wami Rivers, to benefit local community and food security. The policy focus is to promote local and foreign investments towards commercial farming, increase crop production, livestock keeping, availability of inputs, improved extension, credit and improved markets, with a drive to promote bio-fuels.

Description of Agriculture and Land Use

Agro-ecological Zones

Tanzania mainland is divided into seven agro-ecological zones categorised by altitude, precipitation pattern, dependable growing seasons and average water holding capacity of the soils and physiographic features (VPO, 2007). Most of the coastal districts fall under the lowland coastal agro-ecological zone, typified by moderately fertile to low fertility soils, high temperatures with generally low and unreliable rainfall. There are slight differences within the coastal agro-ecological zone, which is further divided into the following five sub-zones, which are present with varying coverage in many of the coastal districts of Tanzania:

- **Coastal Plains** - between 0 - 150 m altitude with temperatures ranging between 24 - 32^{o}C, receives moderate rains with annual averages from 800 - 1,400 mm. Major soil types are sand and sandy-clay, generally of low fertility. Crops include sisal, coconuts, cashew nuts, maize, cassava and paddy.
- **Dry Plains -** ranges from 200 m to 600 m altitude, an average annual rainfall between 500 – 800 mm and temperatures from 21 - 24^{o}C. Soils are brown-sandy and major crops include sisal, cotton, tobacco, paddy, maize, cassava, millet and beans.
- **Wet Plains -** predominantly low, with altitude ranging between 500 and 600 m, with rainfall between 800 - 1,000 mm and high temperatures between 24 - 31^{o}C. Soils are of low fertility with medium moisture retaining capacity. Major crops include sisal, coconuts, cashew nuts, cotton, maize, cassava, paddy, beans, tropical fruits and vegetables.
- **Highland plateau** - is mainly loam and sand clay. This type of soil is fertile for growing pulses and vegetables of various species.
- **Lowland riverine** - along the river valleys of Rufiji, Ruvu and Wami are fertile for planting varieties of various crops. The leading crops in such areas are maize, paddy, pulses, vegetables and pineapples.

Livestock Production

For many Tanzanians, livestock plays a crucial role in household food security as they indirectly support crop production through draught power and manure. Livestock is the most significant source of income and store of wealth for smallholders and thereby provides a reliable source of access to food and overall household food security. The links between the livestock sub-sector and other sectors are also important. Livestock plays an important role in providing income and employment opportunities, mostly in the rural economy, but increasingly in the commercial sector.

No data was obtained on the value of the coastal herd, however, extrapolating from MNRT (2011b) who notes national livestock carrying capacity (CC) is estimated to be 2.49 ha/TLU (Total Livestock Units). Coastal regions have 10% of land suitable for livestock, but only 3% of the TLU, with the lowest national CC of 136.26 ha/TLU is found in Lindi region. This implies the coast has under-utilisation of forage resources.

The current herd is in a large number of cases undernourished, especially in the coastal belt which is of low carrying capacity and therefore not that well suited to pastoralism. Animals are often stressed with low resilience to sudden climate variations. Carcass dress-out weight may be as low as 50%, leading to lower yields and market values.

Table 12: Livestock units by coastal region (MNRT, 2011b).

Region	Total Livestock Units (TLU)	Suitable land (ha)	Carrying capacity (ha/TLU)	Composition and comments
Tanga	386,734	1,588,935	4.11	Chicken occupy the largest share (58.3%) of all livestock, followed by cattle (18.6%), goats (16.2%), sheep (5.9%), pigs (0.5%) and donkeys (0.3%)
Coast	132,483	566,540	4.28	Cattle dominate (37.7% and 27.1%) in Bagamoyo and Rufiji (respectively) but smallest (1.4%) in Kisarawe.
Lindi	17,044	2,322,466	136.26	Indigenous cattle 2,019 (65.5 % of the herd), 110,506 goats (mostly Lindi Rural), sheep 11,905 animals, mostly Lindi Rural pigs and chickens ??
Mtwara	49,961	398,375	7.97	Standard of livestock keeping in Mtwara region is very low and the region experiences great deficiency of animal protein of livestock origin.
Coastal district total (excluding Dar es Salaam)	586,222	4,876,316	-	
National total	**20,057,671**	**49,979,875**	**2.49**	

Crop Production

In general, there are few crops well suited to this zone of the coastal belt, and farming is constrained by lack of appropriate technologies, reliable low-cost implements, extension service support, and supply of inputs (fertilisers, fuel and seeds). Major food crops, in order of production are maize, cassava, sweet potatoes, legumes, bananas, sorghum, rice and other horticultural products (particularly vegetables and tropical fruits), with major cash crops of the coastal zone being sisal, cashew nuts and coconuts. Sisal was introduced by the Germans in 1903, and is grown in large estates (private and publicly owned), mostly in Tanga, but also in the southern region.

VPO (2003) notes that coastal agriculture is dominated by smallholders who form the core of the economy. The majority of these smallholder farms are located in areas with poor infrastructure - limiting market opportunities, with poor extension support and with limited access to critical inputs such as fertiliser and credit. Few crops are well suited to the agro-ecological climate of the lowland coastal villages. Much of the coastal agricultural land has been planted with coconuts and is held in a tangle of inheritance rights. In the more remote villages where crops are left unguarded, wild animals may devastate an entire crop. Because of the pressure from vermin, farming is very risky in those villages. Lack of diversification in agriculture has further contributed to food insecurity.

Table 13 below provides an overview of crop production for coastal regions.

Table 13: Crop production by coastal region.

Region	Total area (ha) available (% farmed)	Main food crops and cash crops	Dominant crops (by area cultivated);
Tanga (NBS/TRCO, 2008)	825,000 (400,000)	Maize, paddy, sorghum cassava, sweet potatoes and legumes/pulses; cash crops sisal, tea, cashew nuts, coffee, coconuts, oranges, mangoes, temperate fruits (on higher ground), cotton, betel nuts, spices, cocoa and tobacco	Maize dominant (48.8%), cassava (24.6%), pulses /legumes (17.6%), paddy (7.2%), others (1.5%). Maize made 30.4% of all crop harvested, contributing to most of the food harvested in the Region. followed by cassava (24.7%), legumes (24.1%), paddy (10.1%), banana (8.9%), sweet potatoes (1.6% and sorghum (0.16 %).17,500 ha (in 2002) under traditional irrigation and 360 ha of formal irrigation, and according to 2006 estimations, Tanga Region has utilised only 20,010 out of 67,030 hectares, which is only 29.9% of its land capable of being irrigated.
Coast (NBS/CRCO, 2007):	Xxxxx (19 %?)	Cassava, Maize, paddy, sorghum, sweet potatoes, legumes, pulses and bananas, sorghum. Cash crops cashew nut, coconut, sesame, mixed fruits (mostly oranges and mangoes)	Up to 60% of Coast GDP is derived from agricultural sector, however, the available arable land is not fully utilised. Most of the districts except Mafia do not fully utilise their farm land, Bagamoyo uses 6.7%, Rufiji 20.7% and Kisarawe 27.1%. Coast region potential for irrigation is high due to Wami, Ruvu and Rufiji rivers, with 274,200ha potential, however, only 1822 ha. or 0.2% is currently under irrigation.
Lindi **2006 Agriculture census**	340,000 (12%)	Cashew trees (67.5% of area), pigeon peas (17.1%), coconut (10.2%), other fruits (4%)	Mostly Nachingwea and Lindi Rural; the number of agricultural households in were 153,173 out of which 138,034 (90.1%) were involved in growing only crops, 15,139 (10%) were rearing livestock and crops. About 62.7% of the total planted area was planted with cereals (mostly Maize), followed by roots and tubers (24.1%), oil seeds and oil nuts (9.6%), pulses, 6,016 ha (3.1%), fruits and vegetables (0.5%). Area under irrigation was 4,066 ha representing 0.4% of the total area planted, mostly located Ruangwa 31%, Lindi Rural24% and Nachingwea (18.5%)
Mtwara **(NBS/MRCO, 200?)**	85% of total area is arable land, however less than 20%	Cassava and sorghum emphasised due to drought resistance; paddy and Maize limited, also millet and legumes. Cash Crops cashew nut the most important, with sesame and groundnuts also contributing to the cash income of farmers.	92% people farm; region providing 40% of national cashew production Irrigation in Mtwara is feasible and would greatly make up for the loss on agricultural production caused by seasonal and unpredictable rainfall, however, currently very little development has taken place. Potential exists in: Ruvuma river in Mtwara, Newala and Masasi districts, Mbangala and Mtesei in Masasi, Mambi in Mtwara and Newala districts and Mbuo in Mtwara.

Issues

About 60% of the total rangeland for livestock is infested by the tsetse fly making it unsuitable for livestock pastures and human settlements. Surveys show that the existing numbers of cattle in certain districts have already surpassed the normal carrying capacity. As a result, most livestock keepers are shifting their herd towards southern Tanzania wetlands in search for pastures. In recent decades, ERM (2013) note that a combination of active government relocation programmes and reduced availability of rangeland associated with a variety of government policies, development schemes, the commercialisation of agriculture and establishment of large protected areas has resulted in a movement of cattle-owning groups to the centre and south of Tanzania, including entry into the coastal belt wetlands (e.g. Bagamoyo and Rufiji). This large scale movement has been accompanied by significant resource degradation and pastoralist-farmer conflicts. NEMC (2009) noted recently that livestock keepers from Ihefu had shifted to some of the coastal regions/districts like Lindi, Mtwara and Coast and if care is not taken there is a danger that as herd populations increase, more pressure will be put on the fragile coastal environment.

A new economic growth area is described in NEMC (2009) who note that the coastal belt has been most preferred by biofuel production investors and quite a large tract of land has been or are in the process of being set aside with the purpose of growing crops such as sugarcane, oil palm, jatropha, or sorghum for ethanol production. Legislation on biofuels initiatives is currently

lacking and NEMC fears there will be a rush to secure adequate land and calls for careful planning and sound decision making to prevent conflicts among different coastal land users and avoid potential shortage of food, should biofuels development jeopardise food crop production.

Economic Importance of Agriculture

Value of Livestock

Livestock contribution in 2007 was 4.7 % of the national GDP, with 40% from beef, 30% from milk and 30% from poultry (SOER, 2008). Production is largely subsistence, mostly for local markets and wealth is limited to livestock ownership. The annual turnover is over 2 million heads of cattle and as many goats, over 300,000 t/year of meat and 75,000 t/year poultry, 138,000 t/year milk, and 4 million hides. About 95% of the total livestock population is not reflected in the GDP and the true economic value is hard to define (Mdoe and Mnenwa, 2007, in NIRAS, 2009).

The 2006 Livestock Policy estimates there are 1 million draught animals that reduce workload of ploughing, planting, weeding and transportation by 75%. In addition, the fertiliser value of dung and its potential for bio-gas production and the use of slaughter effluent add to the economic value of the herds, and that is also a significant, but un-measured economic contribution.

MNRT (2011) notes TNRF studies show that livestock trade and value added chain contribute USD 1.3 billion through the informal meat vendor and local tourism industry, implying a greater importance than official statistics reflect, potentially an industry with as big a turn-over as the tourism sector.

Value of Agricultural Crops

Being the main source of employment and livelihood for more than 66% of the population, agriculture is also an important economic sector in terms of food production, production of raw materials for industries and generation of foreign exchange. Including livestock, agriculture accounted for 56% of GDP and about 60% of export earnings in 2008 (NBS 2008/9). In real terms agriculture's contribution to GDP grew by 6.8 % in 2005, however it is susceptible to droughts often leading to food insecurity (VPO 2007).

Socio-economic Importance of Agriculture

Livestock

Compared to other parts of the country coastal livestock is not very developed. This may be due to access to inexpensive dietary proteins from coastal fisheries.

Crop Production

In the coastal regions 80-90% of people's livelihood depends on agriculture, largely subsistence, but with some surplus cash crops. More recently, several large bio-fuel projects have targeted the coast where there is available land and agro-climatic conditions and soils suitable for these crops.

Threats to Coastal Communities Relying on Agriculture for its Livelihood

The following list summarises specific threats to livelihoods related to agriculture and livestock keeping, and the natural environment (MOAFS, 2002):

- **Poor land management leading to social conflicts** over land between agriculture and livestock grazing.
- **Poor land tenure**.
- **Inadequate Government support** for continued or expanded production[21].
- **Poor marketing** resulting in quality deterioration and huge post-harvest losses.
- **Reduction in soil fertility and structure.**
- **Invasion of water catchments areas by farmers** leads to drying up and contamination of ground and surfaces waters, with periodic outbreak water borne diseases[22].
- **Poor freshwater resources management** leading to scarcity and irregular supply.
- **Poor farming practice** due to shortage of land[23], access to products[24] and farming techniques[25].
- **Dependence on rain-fed agriculture and insufficient water for irrigation**
- **Lack of business/financial management training** of producers and suppliers, limits the success of timely distribution.
- **Salt water intrusion** seen in many of the coastal areas with good soils for agriculture[26].
- **Lack of early warning systems** strengthening climate information and agro-meteorological services and seasonal forecasting, and strengthened early warning systems (including communication) and enhanced disaster risk management (VPO 2012).

[21] e.g. with new seeds to resist new pest and other extension elements

[22] For example springs, small seasonal streams, ponds and wetlands

[23] The coral rag bush fallow system has been progressively reduced in extremes, to 1-2 years instead of the customary 10-15

[24] Non-availability, timing, price, variety and quality of essential seed varieties and chemicals hinder optimal production, thus limiting output and returns

[25] Poor agricultural and soil management techniques have resulted in loss of topsoil, erosion, structural deterioration and declining fertility.

[26] For example Pemba, e.g. at Tumbe, Jiondeni, Mkoani and Makoongwe Island and Kisiwapanza which are now frequently flooded by sea water during spring tides and identified at 150 such sites. The actual cause could be multiple, over-abstraction for domestic and agriculture irrigation, sea level rise, damage to coral reef and mangroves reducing the dampening effect on sea surges during storms or increased incidence of storms (SMOLE 2010; CARE 2011; VPO 2012).

CRIAM Ranking of Threats to Local Communities associated with Livestock and Agriculture

Table 14: Prioritisation of threats to local communities and ecosystems associated with livestock and agriculture. The assessment has been made using the Coastal Rapid Impact Assessment Matrix (CRIAM) approach, described in detail in Annex 3.

	Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
M_Agr_09	Dependence on rain-fed agriculture and insufficient water for irrigation	Agriculture	3	3	3	2	2	63	4					
M_Agr_02	Poor land tenure.	Agriculture	3	3	3	2	1	54	4					
M_Agr_12	Lack of early warning systems strengthening climate information and agro-meteorological services and seasonal forecasting, and strengthened early warning systems (including communication) and enhanced disaster risk management (VPO 2012).	Agriculture	3	3	2	2	1	45	4					
M_Agr_03	Inadequate Government support for continued or expanded production, e.g. with new seeds to resist new pest.	Agriculture	3	2	3	2	2	42	4					
M_Agr_07	Poor freshwater resources management leading to scarcity and irregular supply.	Agriculture	3	2	3	2	2	42	4					
M_Agr_01	Poor land management leading to social conflicts over land between agriculture and livestock grazing.	Agriculture	2	3	2	2	2	36	4					
M_Agr_05	Reduction in soil fertility and structure.	Agriculture	3	2	2	2	2	36	4					
M_Agr_06	Invasion of water catchments areas (springs, small seasonal streams, ponds and wetlands) by farmers, leads to drying up and contamination of ground and surfaces waters, with periodic outbreak water borne diseases.	Agriculture	3	2	2	2	1	30	3					
M_Agr_10	Lack of business/financial management skills of producers and suppliers, limits the success of timely distribution.	Agriculture	2	2	3	2	2	28	3					

	Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
M_Agr_04	Poor marketing resulting in quality deterioration and huge post-harvest losses.	Agriculture	3	1	2	2	2	18	2					
M_Agr_11	Salt water intrusion seen in many of the coastal areas with good soils for agriculture (Rufiji, Mkuranga, Bagamoyo, Pangani, Lindi) which are now frequently flooded by sea water during spring tides. The actual cause could be multiple, over-abstraction for domestic and agriculture irrigation, sea level rise, damage to coral reef and mangroves reducing the dampening effect on sea surges during storms or increased incidence of storms (VPO 2012).	Agriculture	2	1	3	2	3	16	2					
M_Agr_08	Due to poor farming practice on limited land, the coral rag bush fallow system has been progressively reduced in extremes, to 1-2 years instead of the customary 10-15. Also, availability, timing, price, variety and quality of essential seed varieties and chemicals hinder optimal production, thus limiting output and returns. Also, Poor agricultural and soil management techniques have resulted in loss of topsoil, erosion, structural deterioration and declining fertility.	Agriculture	1	1	3	2	2	7	1					

Vulnerability of Agriculture to Climate, Climate Variability & Climate Change

As GCAP (2011), VPO (2012) and others note, the potential impacts of climate change on agriculture involve a range of complex factors, which will affect crops and farming systems differently, including potential positive as well as negative impacts. Based on assessments made by MACEMP (2009), SMOLE (2010) and GCAP (2011) the specific vulnerabilities can be summarised under the principal climate change areas:

Changes in Weather Patterns (precipitation, and water availability)

- Unseasonal rain affecting various farming activities, potentially shift agro-zones[27].
- Invasive species and weeds[28].
- More intense rain allowing more aggressive surface runoff and increased soil erosion.
- New/more severe crop diseases from changing environment e.g. temperature.
- Annual flow reductions of Pangani and Ruvu rivers could affect electricity generation and Dar es Salaam freshwater supplies, putting pumped irrigation at risk (VPO-URT).
- Changes in plant species composition, affecting quality of pasture.
- Unseasonal precipitation affecting livestock water supply.

Extreme Weather Events

- Damaging crops, through strong winds, or inundation of coastal farm lands[29].

Sea-Level Rise

- Flooding of farmland with seawater due to rising sea water and stronger wave action.
- Warm sea surface temperatures, more extreme weather events, and sea-level rise will lead to destruction of coral reefs and mangroves, crucial for protection of coastal farms.
- Saltwater intrusion (also affected by changes in precipitation) in wells near the coast due to rising sea level or over abstraction for irrigation.
- Wind burn from salt spray onto farmland.

Seawater and Air Temperature Rise

- Higher temperature stress will increase livestock disease and affect pasture/milk production.
- Decline of Maize yields due to temperature rise[30].
- Accelerated reduction in soil fertility and structure due to warmer temperatures affecting composting rates.

Seawater Acidification

- No impact.

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[27] Sensitivity evident from poor/erratic rains in 2006/7 significantly reducing agricultural production, affecting GDP. Farmers uncertain when to prepare, plant, sow, harvest etc., also affecting land management and transport of supplies.

[28] Species with high fertility and dispersal capabilities have been shown to be highly adaptive to variable climatic conditions and may invade farms.

[29] e.g. tree crops (cashew an export crop), or coconuts vulnerable to increased storm and high winds.

[30] In coastal areas of between 10% and 20% by 2030 and between 20% and 40% by 2050 (GCAP 2011).

Outlook

It is widely documented that agriculture in much Tanzania is in need of measures to improve production, processing, including post-harvest, and marketing. The expectations are that production can only increase with better fertilizer use, improved irrigation, and crop selection. There are a large number of initiatives, led by NGOs and donors that support agriculture at local levels, and investments in the sector at the industrial levels, mainly for biofuel or rice and sugar projects.

6 FORESTRY

Introduction

Forests and woodlands are key elements in the livelihoods of hundreds of thousands of households across Tanzania and cover an estimated 35 million hectares or 33% of the total land coverage, of which a very small portion is coastal (only 70,000 ha are coastal forests, plus 111,817 ha of mangrove forests (GCAP, 2011, quoting Munishi et al, 2007). The estimated standing timber value is USD 228 trillion. Tanzania's forests provide employment opportunities to between 1 million and 10 million people, while forest products contribute approx. USD 14 million (10-15%) of the country's recorded export earnings (DPG, 2006).

Forests resources on Tanzania's mainland coastal districts are of three sorts: coastal forest reserves (high bio-diversity, some as protected sites), coastal forest and thickets on general land (used for timber, charcoal), and mangrove forest (protected under law, but used amongst others for timber, poles, charcoal). Fruit and cultivated plantations are briefly discussed under agriculture (page 59).

Forests provide a wide range of benefits both directly in the form of timber, forage, fruits, fuel wood and charcoal (providing 95% of Tanzania's energy supply), traditional medicines, and gums and resins, and indirectly through their ecosystem functions including regulating water-catchment, erosion control, nutrient cycling, maintaining local climates, and in supporting a rich biodiversity (DPG 2006). Despite their importance, about two-thirds of the forests and woodlands are currently unreserved and lack any effective management. Extensive deforestation pressures since the 1990s has resulted in the loss of an average of forest cover of 412,000 ha/year, totalling a national loss of 15% in the period between 1990 and 2005, at about 1.2 %/year (GCAP, 2012 citing UN-REDD, 2009).

Management of the Sector

The institutional framework governing coastal forests and mangroves include the Ministry of Natural Resources and Tourism (MNRT) of which the Wildlife Division (soon to be Tanzania Wildlife Authority (TAWA) and Forestry and Beekeeping (now Tanzania Forest Services - TFS), are custodians of forests and wooded and wildlife reserved areas. All mangrove forests in Mainland Tanzania are gazetted as forest reserves, whereby conservation and management are guided by Forestry Policy and Forestry Act of 2003. The Vice President's Office (VPO) Department of Environment is responsible for overall environment policy including forests and wetlands (i.e. mangroves), and the Prime Minister's Office for Regional Administration and Local Government (PMO-RALG) is responsible for Local Government Reforms devolved to the District Councils and their role in state and community forest management. Tanzania Forestry Research Institute (TAFORI) supports the sector with research.

The policies and legislation governing forests are included in the National Forest Policy (1998), as the framework and the National Beekeeping Policy (1998), which is more focused. The key instruments available for forest management are the Land Act (1999), the Village Land Act (1999) and the Forest Act (2002), which is supported by the National Forest Programme (NFP, 2001-2010). There are four types of forests recognised in the 2002 Forest Act: National forests, Local Authority forests, Village forests and Private forests. Within this categorisation, forests may be either forest reserves/national park forests or non-reserved forest land; about 60% of the total forest area is currently non-reserved.

Related sector policies are National Energy Policy (2003), given the significance of biomass fuels and the Wildlife Policy (2007), protecting faunal biodiversity. Associated with forests are several NGOs, many focused on sustainable conservation of forests, generally through CBNRM.

Examples include WWF, TRAFFIC, LEAT, CARE-Tanzania, TFCG, WCST, TCMP and TASONABI. Other coastal forest stakeholders include the private sector, or which Dallu (2004) lists sawmills, notable in the coastal districts are Badr E.A Enterprise Ltd, Mahmood International Ltd and Portfolio Investment Company Ltd (Ikwiriri, Rufiji), and Sikh Sawmills/MASCO (Tanga district).

Core development programs that are coastal forest or mangrove oriented are the National Forest Programme (NFP) which initiated Participatory Forest Management (PFM), the National Adaptation Programme of Action (NAPA, 2007) and the National Strategy for Growth and Reduction of Poverty (NSGRP) 2005 with environment, and forestry as integral to the strategy, and the basis for the implementation of the REDD Strategy (2012). Policy reforms in the National Forest Policy in 1998 and the subsequent Forest Act of 2002 facilitated community engagement in PFM over 15 years ago with support from Danida, the Finnish Government and the World Bank. Over 3,000 Village Land Forest Reserves (VLFR) are under development.

Description of the Forest Resource and its Use

Coastal Forests

Natural coastal forests cover around 70,000 ha, including the evergreen tree cover and occur in 83 sites, of which the coastal sites are in Tanga region (25), Lindi (19), Coast (14), Mtwara (6) and Dar es salaam (2) (see Dallu 2004).

Tanzania has 40% of the remnant Coastal Forests of Eastern Africa whose main features are that they are small, and highly fragmented, consisting of many (over 150) separate forest patches, most of which are less than 500 ha in size. MACEMP (2012) considers coastal forests and thickets to cover about 350 km^2 (much in inland districts) and harbouring many endemic species, with over 50% in the animal taxa of restricted mobility, and approaching 25% in the woody plants. These species are highly threatened and of great potential value. Some remaining coastal forests can be found on the coastal islands and are considered especially important for ecological, evolutionary and economic reasons, but details are scarce.

Coastal forests are used as a source of fuel wood, medicinal plants, building materials and food and they help to maintain a regular water supply for towns and villages. They play an important role in reducing soil erosion, maintaining ecological cycles and micro-climates and in carbon sequestration.

Mangrove Forests

Mangrove ecosystems are found in all coastal districts of Tanzania, in sheltered shores of deltas, river estuaries, and creeks where there is an abundance of fine-grained sediment (silt and clay) in the upper part of the inter-tidal zone. These forests cover an area of approximately 108,138 ha, and when the area covered by the salt crust is included, this totals 111,817 hectares. The districts of Rufiji supports 48,030 ha, Kilwa 21,755 ha, Tanga and Muheza 9,313 ha and the remaining districts each with between 2,000 and 4,000 ha (Wang et al. 2003).

Tanzanian mangrove forests comprise up to ten tree species, and provide permanent or temporary habitats for many aquatic organisms which move in and out with the tide. They are important feeding and nursery grounds for many economically valuable marine species (Muhando and Rumisha, 2008, quoting Y. Wang et al. 2003*).* The Rufiji Delta is the most important prawn fishing grounds in Tanzania, from which about 80% of the total commercial prawn catch is obtained (Annual Fisheries Statistics Reports 1996; Semesi 2000, quoted by Muhando and Rumisha (2008)).

Mangroves are extremely productive ecosystems, generating about 600 t/year/km^2 plant mass (Muhando and Rumisha, 2008) from detritus and recycling of nutrients and trapping land-based

debris, sediments, and suspended particulate matter carried to the coast by rivers. Mangroves grow between the estuary and the surrounding land, and provide a number of important ecosystem services. TCMP (2003) showed a small decrease in the overall mangrove coverage between 1990 and 2000, notably in the Rufiji, Kilwa, and Mkuranga districts.

The largest continuous mangrove areas are to be found on the coast of Tanga district in the north, in the delta of the Rufiji River (40%), in Kilwa and Lindi districts, Muheza, Bagamoyo, Kisarawe and in Mtwara, where the Ruvuma River forms an estuary close to the Mozambique border in the south and are well represented on the coastal islands and Mafia. The greatest damaged areas are near urban centres like Temeke (where more than 50% of the forest is degraded), Kinondoni, Bagamoyo, Kilwa, Tanga and Lindi, while Mtwara and Mkinga showed no significant degradation (NEMC, 2009). The coast has 22 AEWA classified Important Bird Areas (IBA) (see Natural Resources, page 133), of which six are mangrove wetland sites (Baker and Baker, 2002).

Issues

VPO (2003) notes that the only remnants of the once extensive ancient forests of East Africa remain as isolated patches on hilltops and the offshore islands of Zanzibar. The biodiversity value of these forests lies in the fact that they contain about 190 forest species, of which 92 are endemic (Dallu, 2004), plus other species of animals and plants, many of which are also endemic (i.e. birds of global significance, rare mammals, reptiles, amphibians and invertebrates).

Economic importance

At national level, forestry accounts for more than 10% of foreign exchange earnings, from exports of timber (sawn wood, softwood pulp, paper and round wood), timber products, honey, beeswax, mushrooms and other non-wood forest products (Dallu, 2004 citing MNRT, 1998a). In 2003 it was estimated that the forestry sector contributed 3.0-3.4% of GDP, and considered that the Coastal Forests play a major part, though specific quantitative contributions are not available (Dallu 2004). More recent estimates, that also include the illegal use of forest products, as well as tourism-related income, suggest that the forest sector's total annual contribution may be as high as 10%-15% of total GDP (DPG, 2006).

Fuel wood remains the most important use of wood and accounts for at least 92% of the country's energy use and 95% of the total wood products consumed in the country. Per capita consumption of wood fuel is estimated at 1 m^3 per year (MNRT, 1998a). Charcoal is the most important energy source for millions of urban dwellers with annual consumption of 1.6 million tons, corresponding to approximately 15 million m^3 of wood. Dar es Salaam, alone, the main target market for coastal forest charcoal production, is valued at approximately USD 350 million/year (CGAP, 2011). Charcoal contributes to degradation of forest land of 100,000 – 125,000 ha/year (WB, 2010), with impacts on biodiversity and ecosystem services. In terms of fuel wood for household use, country-wide consumption at 22 million m^3 exceeds the sustainable yield of 13 million m^3, with projections of reaching 52 million m^3 by the year 2020.

Mangrove forests have substantial commercial value primarily in terms of timber but also from other non-wood products such as firewood, charcoal, building and construction materials, dyes and as a recreational and fishing area (Muhando and Rumisha, 2008; Semesi, 1993).

Socio-economic Importance of Forests

The forestry sector employs about 3% of paid labour and over three million people in the informal sector (nationwide), including those trading forest products (e.g. charcoal). Specifically in the coastal districts, 150,000 people are making their living directly from mangrove forests MACEMP (2012).

Forests provide over 90% of the national energy supply through fuel wood and charcoal, and 75% of construction materials, and the demand for energy in particular is a key factor in deforestation. In addition to timber products and boat building materials from mangroves, Dallu (2004) lists other products provided by coastal forests (including mangroves) that contributes to community livelihood, including herbal medicines, edible fruits, mushrooms, plant-derived oils, eaves and beverages, bamboo, gums, fodder, fibre, honey, candles, dyes, ornamental plants, household utensils and handicrafts. The value of these non-marketed forest products to communities is immense (citing IUCN, 2001; MNRT, 2001a; Mogaka et. al., 2001) and it is estimated that about 70% of Tanzanians use medicinal plants for curing illnesses (Dallu, 2004, citing Marshall, 1998; MNRT, 2001a). A total of around 1,000 species are used in traditional medicine, with 98 traded in urban centres (citing Mariki et al., 2003).

Dallu (2004) notes there is a substantial, but unknown value, in informal investment by traders on activities associated with timber, through purchase of working tools like: saws, axes, bicycles etc., and construction of selling points. The impact of informal trade on the coastal forests is high, but data on its volume and investment levels are scarce.

Threats to Coastal Communities Relying on Forests for Livelihoods

The following list summarises specific threats to livelihoods related to coastal and mangrove forests, and the natural environment, after NEMC (2009), TCMP (2003), (Francis et al. 2002), Dallu (2004):

- **Invasion of water catchments areas and upstream changes in river courses** (springs, small seasonal streams, ponds and wetlands) by farmers, leads to decreases in freshwater flows affecting coastal and mangrove forests (e.g. Pangani River estuary).
- **Inadequate enforcement of forest management regulations** resulting in illegal clearing and over-harvesting of mangrove forests and coastal forests[31].
- **Pollution** from fertilisers, pesticides, and other toxic chemicals and solid wastes including from up-stream sources[32].
- **Erosion** of mangrove stands from sea level changes and storms.
- **Inadequate enforcement of hunting regulations** resulting in loss of wildlife from many coastal forests[33].
- **Encroachment of expanding agriculture and settlements** into coastal forest reserves[34].
- **Uncontrolled fires** escaping from plot clearing destroys forests[35].

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[31] Charcoal (Bagamoyo and close to large urban areas) and domestic firewood (most districts), for lime burning (in Rufiji, Mafia and Lindi), conversion to agricultural land (Rufiji for rice), tourist developments (e.g. Bagamoyo) and salt farms. Lack of effective enforcement, low penalties, and a long and cumbersome procedure to pass by-laws, dilutes the process.

[32] DDT and Thiodan which are widely used to control crabs in the rice farms in the Rufiji delta, can poison mangroves

[33] The demand for bush meat is ever increasing in coastal forest communities, notably Gendagenda forest reserve in Handeni district and Noto/Chitoa Plateau forests in Lindi region.

[34] e.g. South Ruvu forest reserve and widespread in Msubugwe and Gendagenda FRs in Tanga region, Vikindu FR near Dar es salaam and near major centres e.g. Bagamoyo

[35] Long dry seasons experienced over recent years have caused the coastal forests to dry up and rendering them prone to forest fires.

- **Ineffective land use planning**[36].
- **Land tenure uncertainty** discourages long-term investment in village land and protection of sensitive areas as water catchment areas and forests.
- **Inefficient use of biomass** fuel production (e.g. charcoal) and consumption is extremely inefficient, exacerbating the demand.
- **Unreserved status in more than 60% of forest and woodlands leaving these areas with insufficient management instruments.**

[36] Examples include destructive mining practices such as for limestone which is widespread along coastal areas of Wazo Hill in Dar es Salaam and Amboni in Tanga; clearing forests while the Songo Songo gas project pipeline extending from Lindi to Dar es Salaam, with extensive damage to coastal forests; and overexploitation of coast forests for salt works or tourism

CRIAM Ranking of Threats to Local Communities associated with Forestry

Table 15: Prioritisation of threats to local communities and ecosystems associated with forestry. The assessment has been made using the Coastal Rapid Impact Assessment Matrix (CRIAM) approach, described in detail in Annex 3.

ThemeID	Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
M_Forest_06	Encroachment of expanding agriculture and settlements into coastal forest reserves e.g. South Ruvu forest reserve and widespread in Msubugwe and Gendagenda FRs in Tanga region, Vikindu FR near Dar es salaam and near major centres e.g. Bagamoyo.	Forestry	3	3	3	2	3	72	5					
M_Forest_10	Inefficient use of biomass fuel production (e.g. charcoal) and consumption is extremely inefficient, exacerbating the demand.	Forestry	3	3	3	2	3	72	5					
M_Forest_02	Inadequate enforcement of forest management regulations resulting in illegal clearing and over-harvesting of mangrove forests and coastal forests for various reasons: charcoal (Bagamoyo and close to large urban areas) and domestic firewood (most districts), for lime burning (in Rufiji, Mafia and Lindi), conversion to agricultural land (Rufiji for rice), tourist developments (e.g. Bagamoyo) and salt farms. Lack of effective enforcement, low penalties, and a long and cumbersome procedure to pass by-laws, dilutes the process.	Forestry	3	3	3	2	2	63	4					
M_Forest_01	Invasion of water catchments areas and upstream changes in river courses (springs, small seasonal streams, ponds and wetlands) by farmers, leads to decreases in freshwater flows affecting coastal and mangrove forests (e.g. Pangani River estuary).	Forestry	3	2	3	2	3	48	4					
M_Forest_07	Uncontrolled fires escaping from plot clearing destroys forests, killing wildlife and other living organisms and are a long term threat to coastal forests, exacerbated by long dry seasons experienced over recent years have caused the coastal forests to dry up and prone to forest fires.	Forestry	3	2	3	2	3	48	4					

ThemeID	Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
M_Forest_08	Ineffective implementation of land use planning resulting in destructive mining practices such as of limestone is widespread along coastal areas of Wazo Hill in Dar es Salaam and Amboni in Tanga, clearing forests while the Songo Songo gas project pipeline extending from Lindi to Dar es Salaam, with extensive damage to coastal forests, or over exploitation of coast forests for salt works or tourism.	Forestry	3	2	3	2	2	42	4					
M_Forest_11	Unreserved status in more than 60% of forest and woodlands leaving these areas with insufficient management instruments.	Forestry	3	2	3	2	2	42	4					
M_Forest_09	Land tenure uncertainty discourages long-term investment in village land and protection of sensitive areas as water catchment areas and forests.	Forestry	3	1	3	2	2	21	3					
M_Forest_03	Pollution from fertilizers, pesticides, and other toxic chemicals and solid wastes including from up-stream sources. DDT and Thiodan are widely used to control crabs in the rice farms in the Rufiji delta, can poison mangroves.	Forestry	2	1	3	2	3	16	2					
M_Forest_04	Erosion of mangrove stands from sea level changes and storms.	Forestry	2	1	3	3	2	16	2					
M_Forest_05	Inadequate enforcement of hunting regulations resulting in loss of wildlife from many coastal forests (the demand for bush meat is ever increasing in coastal forest communities, notably Gendagenda forest reserve in Handeni district and Noto/Chitoa Plateau forests in Lindi region).	Forestry	2	1	3	2	3	16	2					

Vulnerability of Forests to Climate, Climate Variability & Climate Change

As GCAP (2011), and others note, forests are very vulnerable to climate change with potential impacts involving a range of complex factors, which will affect forests differently, with positive as well as negative impacts. For example, tree growth may be enhanced by some processes related to climate change (including CO_2 fertilisation and longer growing seasons), while certain losses and impacts, may be irreversible. Any negative impacts on forests will have wider deleterious effects on forest reliant biodiversity and human communities, as well as wider consequences on ecosystem services that forests provide (e.g. soil protection, flood prevention, natural resources, water catchment, etc.). Particularly vulnerable areas in Tanzania include arid lands (from water scarcity and heat stress), notably the coastal zones a potential decoupling of coevolved interactions, such as plant–pollinator relationships. The specific vulnerabilities can be summarised under the principle climate change areas:

Changes in Weather Patterns (precipitation, and water availability)

- Unseasonal precipitation affecting various forest and related activities[37].
- Invasive species and weeds with high fertility and dispersal capabilities[38].
- More intense rain leading to more aggressive surface runoff and increased soil erosion.
- New or more severe forest diseases[39].
- Increased risk of forest fires[40].

Extreme Weather Events

- Damaging forests, through strong winds, or inundation of coastal forests or flooding of mangroves.

Sea-Level Rise

- Salt water intrusion in low-lying forest areas near the coast due to rising sea level or over abstraction for irrigation.
- Wind burn from salt spray onto coastal forests.

Seawater and Air Temperature Rise

- Accelerated reduction in soil fertility and structure due to warmer temperatures affecting composting rates in forest soils.
- Forests are prone to extreme events such as drought.
- Increase in risk of forest fires

Seawater Acidification

- No impact.

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[37] Potentially with changes in plant species composition and shifting forest zones, though trees are not very resilient to change

[38] Species more adaptive to variable climatic conditions will invade forests

[39] Resulting from changing environmental conditions like increased temperature

[40] As a consequence of increase in temperatures and decline in precipitation and resultant desiccation of forests.

Outlook

It is well-documented that most forests in Tanzania are subject to increasing over-exploitation, and varying degrees of degradation, whether they are protected forest, village forest or open access woodland. In the coastal districts of Tanzania, mangrove forests are subjected to similar misuse, in many cases for the same reasons. Regardless of climate change, the deforestation rate was estimated in 2005 to be 1.2%/year, ranking Tanzania 6th globally for forest loss (GCAP, 2011). This is likely to increase as demand for forest products grow in the absence of alternatives. Meanwhile, the ability of the management institutions to contain or reduce the degradation is questionable, despite the large number of initiatives, NGOs and donors that support forest conservation programs.

Other Matters Specific to Forest Sector or of Particular Importance

The REDD Strategy 2012, addresses the current use of forest resources, proposing strategies to halt forest deforestation and degradation, so as to raise significant carbon financing through the 'Reducing Emissions from Deforestation and forest Degradation (REDD+) scheme.

7 INDUSTRY

Introduction

Industry accounts for 17% of the GDP and is mainly limited to processing agricultural products and light consumer goods. Industries producing agricultural inputs (fertilizer and farm tools) and agricultural outputs (cigarettes, canned meats, beer, pyrethrum, and shelled cashews) are important for the economy. The principal exports are coffee, cotton, cashew nuts, minerals, tea, sisal, tobacco, and pyrethrum (UN-HABITAT 2009a). Meanwhile Tanzania's manufacturing sector shows signs of recovery after the difficult years of the 1980's and 1990's and there is evidence of accelerating growth during the 2000's. For 2008 the manufacturing sector contributed 8.5% of GDP, reflecting an impressive recovery (UN Statistics Division, 2010).

Recent statistics show that since 2007, the value of manufactured goods exports has grown to become the second largest item only after the mining sector, surpassing traditional agricultural exports. This growth has been brought about by foreign direct investment (FDI) which entered the country after the introduction of structural adjustment policies (URT, 2011).

The National Development Vision 2025 (VISION 2025) recognizes the leading role of the industrial sector in the process of transforming Tanzania's economy from a weather and market dependent agricultural economy to a self-sustainable semi-industrial one by 2025. Sustainable Industrial Development Policy 1996-2020 (SIDP) declared the government's decision to phase the public sector out of productive activities and allow the private sector to become the principal vehicle for economic growth. Though the shift from the public to private sector has been successfully accomplished under SIDP, Tanzania's industrial sector is still in the infancy stage (URT 2011).

Management of the Industry Sector

The Ministry of Industry and Trade (MIT) is responsible for promotion, support, regulation and many other roles associated with the development on industries and trade in the country. In order to execute its mandate and core functions, the Ministry has a number of support organizations and agencies as listed below:

- National Development Corporation (NDC)
- Tanzania Industrial Research Development Organization (TIRDO)
- Tanzania Engineering and Manufacturing Design Organization (TEMDO)
- Centre for Agricultural Mechanization and Rural Technology (CAMARTEC)
- Export Processing Zones Authority (EPZA)
- Small Industries Development Organization (SIDO)

In addition, Tanzania has established an institutional framework to cater for private sector led industrialization. Nationwide institutions such as the Tanzanian National Business Council (TNBC), Confederation of Tanzania Industries (CTI), Tanzania Chamber of Commerce, Industries and Agriculture (TCCIA) and Tanzania Private Sector Foundation (TPSF) have been established. Through these organizations, channels of public/private dialogue have been secured to share views and understanding on common concerns including policy directions.

Locations of new industry are addressed by the National Development Corporation (NDC) and other autonomous industrial corporations under the MIT. The Ministry of Transport (MoT) in 2011, charged with the responsibility for development of transport (and meteorology) and to

ensure that the services provided in these sectors are efficient and meet the needs of the population, including industry.

The Sustainable Industrial Development Policy (SIDP) 1996 was adopted with the objective of implementing the government's decision of withdrawing the public sector from engagement in production activities and enabling the private sector to become the principal vehicle for economic growth. Under the guidance of this policy, shifting the engine of growth from public to private sector has been successfully accomplished. An enabling environment, including the provision of fiscal incentives, transparency, stable and simple regularly framework is being created. Consequently, the industrial sector started growing steadily from the end of 1990's with accelerated growth being achieved in the 2000's. The SIDP also refers to sound environmental management as a means of promoting environmentally friendly and ecologically sustainable industrial development in Tanzania. For example, the policy underscores the importance of carrying out EIA for new projects.

In accordance with the National Development Vision 2025, the goal of the Trade Policy 2003 is that of raising efficiency and widening linkages in domestic production and building a diversified competitive export sector as the means of stimulating higher rates of growth and development. The Integrated Industrial Development Strategy (IIDS) 2025 identifies and provides the direction of policy instruments available to steer the process of industrialization.

Description of Industry and Manufacturing of the Coast

Within the coastal districts, and indeed true for much of the country. During the 2007-2008 business survey there were 9,354 manufacturing enterprises in Dar es Salaam (equivalent to 60%) and 15,625 in the other regions, (URT 2011).

Small scale industry concentrates in domestic production sectors scattered throughout the City and located mostly in residential areas. Large-scale industries, located in the designated industrial areas, include textiles, chemical, food processing, light manufacturing, aluminium and glass, plastic, products, rubber products, cement, etc. (URT 2004). Currently 35 of the large factories in Dar es Salaam (e.g. breweries, glass manufacture, paper mills, cement factory, bottling plants) have been connected to the gas distribution pipeline owned by Songas Ltd., thereby reducing power costs and more importantly, improving reliability of power. Despite the large volume of industry and manufacturing, the regional GDP growth for Dar es Salaam is only 12%.

Industrial support outside Dar es Salaam is very weak. However, of all the coastal regions outside Dar es Salaam, Tanga enjoys the fastest growth speed in regional GDP (18%) among all the regions of the country, with impressive accumulation of factories such as textile mills, food processing, leather goods, handcrafts, cosmetics and construction materials (URT 2011). Mtwara and Lindi reflect an 8% and 12% GDP contribution growth respectively, and the Coast (Pwani) 12%. The major industrial and manufacturing sub-sectors present within the coastal regions are described in more detail below:

Limestone and Cement

Limestone is widely available all along the Tanzanian coast and small miners exploit many areas in their daily construction activities (see Sand and Rock Mining theme, page 121). Tanzania Portland Cement Company (TPCC) 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, the other ingredients for the manufacture of cement are imported.

From 1997 to 2002, Tanzania's cement consumption increased to nearly 1.14 Mt from 0.54 Mt (NBS 2003). Tanzania's other major cement producer is Mbeya Cement Co. Ltd. TPCC which had a total cement production capacity of 1.25 Mt/year and a total clinker production capacity of 1.55 Mt/year produced 0.5 Mt of cement in 2002. By September 2004, TPCC planned to increase its capacity to as much as 0.7 Mt/year (Mwamunyange, 2002; Kenge, 2003). In addition a major new player, Lake Cement from India is building a cement factory at Kimbiji (Temeke district), expected to be completed during 2014, with 0.5 Mt/year capacity, combined with a 10 MW power plant. While a major Nigerian cement manufacturer, Dangote Industries Ltd, is planning to enter the market with a new cement plant at Mtwara using local limestone and natural gas resources.

Textiles

Tanzania is one of the largest cotton producers in Africa, with around 500,000 farmers growing cotton in farmlands of 412,000 hectares in 13 regions. Nevertheless, it is estimated that 70% of the cotton produced is currently exported as cotton lint without processing. There are five major textile mills in Dar es Salaam.

Since 2000, the industry has shown gradual recovery and now employs 69,000 workers (13 % of manufacturing sector workers) and produced 25% of manufacturing sector GDP in 2008, but remains in a fragile condition.

Agro-processing

Cashew nuts production is well suited to the Tanzanian environment and is the main source of cash income for 250,000 small farmers in the poorest southern regions, where Mtwara, Lindi and Ruvuma accounts for 80% to 90% of Tanzania's cashew production. Local processing has considerably increased from 1,274 t in 2000 to 23,219 t in 2008 (weight in cashew nuts with shell), yet more than 70% of cashew nuts are exported without processing.

According to 2008 TRA Trade Data, cashew-nuts exports earned USD 42.9 million from 52,743 t of raw cashew exports and USD 26.5 million was earned from 7,725 t of processed cashew-nuts export. If the whole lot had been exported in processed form, it would have earned an additional USD 40 -50 million.

Horticultural (fruits) post-harvest losses are as high as 60% due to lack of proper collection and storage systems and processing, packing and preservation facilities. The agro-processing sub-sector contributes a constant proportion of 55% of manufacturing value addition to the manufacturing sector, in a situation where the beverage and tobacco industries have increased their shares. The activities of agro-processing industries are spread over all regions and maintain the dominant position.

Bakhresa Food Products Ltd. started operation of fresh fruit juice making in Dar es Salaam from July 2008 with an imported modern processing unit. The operation started successfully collecting fruits from farms along the central corridor. It processes oranges from July through August to September, mangoes from November to January, pineapples from December to February, and tomatoes between March and May. A similar juice producer in Bagamoyo, Travocs Produce Ltd is engaged in the same industry. Allied companies also based in Dar es Salaam include two industrial bakeries, grain milling and

Milk and allied products are produced in Tanzania but only 4% of local milk produced is properly processed and marketed. The milk market is dominated by imported products from 37 countries. Supported by the Dutch government, the first regional dairy stockholder organization, the Tanga Dairy Co-operative Union was established in 1995 in Tanga, and the establishment of Tanzania Milk Processors Association (TAMPA) and Tanzania Milk Producers Association

(TAMPRODA) followed in 2004. Tanga is the major producer with the coastal belt and one dairy producer exists in Dar es Salaam.

Beverage production (beer and soft drinks) are represented in Dar es Salaam by five major companies, with steadily increasing production. The most recent entry to the market was a subsidiary of Bakhresa Food Products Ltd. making bottled soft drinks. One other agro-processing industry, also in Dar es Salaam, is a cigarette production factory.

Others

Dar es Salaam has also the highest concentration of other industries, including pharmaceutical, chemical, plastics and rubber, glass, metal works, soaps and detergents.

Issues

It is argued that poor and low agricultural production yield has prevented industrialization in Tanzania in many ways. For instance, unstable supply and inferior quality of agricultural products has prevented the growth of sound and competitive agro-processing and food processing industries. The weak agro-processing industrial sub-sector does not provide the market and motivation for farmers to invest in improved farming. Agricultural development and industrialization have to be promoted simultaneously and in unison (URT 2011).

One of the weaknesses of Tanzania's industrial scene is the geographical spread or dispersion of industries and factories. Apart from Dar es Salaam, and parts of Tanga, the rest of the coast lacks any form of industrial cluster. Clustering offers unique opportunities for firms not only to take advantage of a wide array of domestic links but also to create both competition and collaboration which stimulates the potential for learning and innovation (URT 2011).

According to research undertaken by MKURABITA (Property and Business Formalization Program) program, more than 90% of all businesses in Tanzania operate extra-legally due to insurmountable regulatory and administrative obstacles that impede micro and small firms from operational in the legal system. Although industrial statistics are the basic information necessary for making policy or assessing risks for policy makers as well as for investors, the volume and quality of data collected and disclosed in Tanzania is very poor. Available industrial statistics are not continuous and therefore not very much reliable.

Economic Importance

In 2008, manufacturing and industrial contributions combined reached 25.5% of GDP, with construction contributing 5%. The Dar es Salaam region GDP has nearly tripled in the last nine years but its average annual growth rate of 12 % is lower than the national average, and its GDP share has dropped from 17.9% in 1998 to 15.6% in 2007. The relatively high growth of the other regions in Tanzania could be explained by the rapid growth of mining and tourism sectors mainly observed in up-country regions. The manufacturing sector also contributed to push up the performance of Tanga, Mbeya and Kigoma regions based on the recovery of the Textile industry and Cement industry. On the other hand, the GDP share of Singida and Mtwara dropped considerably.

The Government budget for the manufacturing sector represented 0.4% throughout the first decade of 2000's. To accelerate growth of the manufacturing into the leader of the economic sector, as foreseen in Vision 2025, it is necessary to allocate an adequate budget of not less than 2% to the ministry. It has been suggested that the MIT should establish an Industrial Development Fund to promote the growth of strategic key business sub-sectors (URT 2011).

Manufactured goods export of Tanzania shows hyper growth with annual growth rate of 28.3% over the last 10 years up from USD 58.4 million in 2001 to USD 707.5 million in 2010. The manufactured goods exports, which had played a minor position in terms of foreign currency

earning, started to grow sharply since 2003 when a considerable number of ex-state owned factories resumed operation after completing privatization and re-investment process.

In the year of 2007, for the first time in the history of Tanzania, the amount that manufactured goods earned from exports exceeded that of traditional agricultural export standing at USD 325.3 million. The momentum of the growth did not stop and keep increasing with accelerated speed. Similarly, the annual growth rate of manufacturing activities has shown a remarkable improvement, from 4.8 % in 1996 to 7.9% in 2010, despite the world financial crisis in the preceding year. Exporting value of manufactured goods has remarkably increased from USD 30.1 million in 1999 to USD 707 million in 2010 (UNCTAD statistic based SITC code). The contribution of manufacturing sector to GDP has however not increased much, rising from 7.4% in 1996 to 9.0% in 2010, with the perceived low increase being a result of improvements in diversification in favour of other sectors including tourism, mining, construction, telecommunications, transportation and the estate sectors.

Socio-Economic Importance

The social and economic importance of the industrial and manufacturing sector in the coastal regions varies significantly with Dar es Salaam-based companies employing hundreds of thousands of workers, compared to regions like Mtwara and Lindi where very few are employed in these sectors.

Threats to coastal communities relying on Industry sub-sectors for livelihoods

The principle threats to those dependent on industry and to the wider coastal environment are described below:

- **Inadequate infrastructure management** unable to maintain supply of services (electricity, transport, water supply) to coastal regions, resulting in a disincentive for industry to be attracted to the coast and develop.
- **Lack of coordination** of the choice of location of new industries underlines the need for integrated planning.
- **Failure to monitor industry liquid waste** leading to pollution of waterways and ground water.
- **Failure to monitor industry solid waste** leading to pollution of waterways and open ground.
- **Failure to monitor industry air emission** leading to air pollution.

CRIAM Ranking of Threats to Local Communities associated with Industry

Table 16: Prioritisation of threats to local communities and ecosystems associated with infrastructure. The assessment has been made using the Coastal Rapid Impact Assessment Matrix (CRIAM) approach, described in detail in Annex 3.

ThemeID	Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
M_Industry_01	Inadequate infrastructure management unable to maintain supply of services (electricity, transport, water supply) to coastal regions, resulting in a disincentive for industry to be attracted to the coast and develop.	Industry	3	3	3	2	2	63	4					
M_Industry_03	Failure to monitor industry liquid waste leading to pollution of waterways and ground water.	Industry	2	3	3	2	1	36	4					
M_Industry_04	Failure to monitor industry solid waste leading to pollution of waterways and open ground.	Industry	2	3	3	2	1	36	4					
M_Industry_02	Lack of coordination of the choice of location of new industries underlines the need for integrated planning.	Industry	2	1	3	2	2	14	2					
M_Industry_05	Failure to monitor industry air emission leading to air pollution.	Industry	1	1	3	2	1	6	1					

Vulnerability to Climate, Climate Variability and Climate Change

A number of specific vulnerabilities of industry and those that engage in it are summarised under the principle climate change areas:

Changes in Weather Patterns (precipitation, and water availability)

- Increased rainfall volumes water leading to faster deterioration of roads.
- Greater standing water increases contamination risk for drink water supplies leading to increased diseases such as cholera etc. affecting work force at industries.
- Flood damage to transport, communication and electricity supply infrastructure.

Extreme Weather Events

- Damage to power infrastructure from fallen trees, or from direct impacts of weather affecting industry power supply.
- Damage to ICT infrastructure from direct impacts of weather, affecting industry.

Sea-Level Rise

- Coastal inundation on in low-lying coastal areas affecting roads and affecting supply chain of products to factories and exports.
- Possible elevated salinization of coastal aquifers affecting safe water supplies to coastal industries.

Seawater and Air Temperature Rise

- Drought increases vulnerability of crops that provide the supplies to coastal drinks and food processing factories.
- Increased damage to roads affecting supply chain of products to factories and exports.
- Greater cooling costs for generators and other industry machinery.

Seawater Acidification

- No impact.

Outlook

The coastal zone will witness considerable industrial development in the coming 5-10 years. Oil and gas development is accelerating in Mtwara, Lindi and Kilwa and has the potential to benefit livelihoods through creating opportunities for business (e.g. fertilizer plants, cement factories, processing plants) that require large amounts of power. By doing so, employments opportunities will expand. Industry in these traditionally poor regions has a better chance of accompanying economic development if some of profits from the activities are retained in the regions.

Linked to the "development corridors" promoted by the National Development Corporation one major coastal development instrument includes the accumulation and concentration of industrial firms through cluster development, supported by Special Economic Zones (SEZ). Three waterfront SEZs are planned: one for Dar es Salaam linked with the Central Railway Line to constitute the "Logistics Corridor" and TAZARA to constitute the "Agricultural Corridor"; Mtwara SEZ which is being developed as the "Minerals Corridor" and the Tanga corridor to serve the areas of northern and north-western Tanzania up to and including Rwanda. At the regional and district level, these corridors will link Regional SEZs and Micro Industrial Parks at the district level with the domestic and regional markets. The "Logistics Corridor" also requires a new port to be built at Bagamoyo as a supplementary port to Dar es Salaam, by 2020, and

promote the twin ports as the gateway port for East and Central Africa with next generation facilities. Certainly the opportunities are there; what remains to be seen is whether these can be transformed into viable realities that benefit the socio-economic status of the coastal communities without degrading the natural resources on which many currently depend.

8 PORTS AND HARBOURS

Introduction

Tanzania mainland has three major ports, namely Dar es Salaam, Mtwara and Tanga. These ports are responsible for handling 90% of all inputs and exports. From the ports to the consumers, road and rail transportation infrastructure are responsible for delivery and movement on land to and from the coastal districts. Harbours are thus integrally dependent on roads or rail to move goods and people.

Dar es Salaam port is by far the largest port, serving all major economic centres in the country as well as the transit countries (Zambia and DRC). All major existing infrastructure corridors in Tanzania lead to Dar es Salaam, and it is the only place where both railway systems (TAZARA and TRL) join. The port has shown a strong growth over the past years, especially in the container sector, but due the resulting congestion in the port area, search is on-going for additional land area in or near the port (TPA 2009).

Management of the Sector

Tanzania Ports Authority was established on 15th April 2005 following the repeal of THA Act No. 12/77 and enactment of TPA Act No. 17/2004. Under the Port Act of 2004, Tanzania Ports Authority was formed as a landlord port authority, implying that port operations are handed over to private terminal operators (e.g. TICTS). AT present, the TPA operates ten coastal ports and ten manned inland ports, plus several other unmanned ports mostly located on the lakes. Of the coastal ports, only five have any form of mechanised handling equipment on the quay side, i.e. Dar es Salaam, Tanga and Mtwara. In the other ports cargo is loaded and unloaded using manual labour.

Description of Ports and Harbours and their Use

The Tanzanian mainland ports system comprises one large international port, Dar es Salaam, with a throughput of 13.5 million tonnes for the period 2012-13; two medium sized coastal ports, Tanga and Mtwara, with throughputs of 380,000 and 295,000 tonnes respectively for the period 2012-13 (see Table 1); and the secondary coastal ports with current throughputs of less than 50,000 tonnes per annum (for 2007), namely Pangani, Kilindoni (Mafia), Kilwa Masoko and Kilwa Kivinje, Rushungi, Lindi and Mikindani (Mtwara).

Dar es Salaam

Dar es Salaam is the country's largest city and is the commercial centre. Its port is the country's principal port, handling about 93% of Tanzania's port traffic. All types of commodities are handled in the port. In addition to cargo, Dar es Salaam port handled 732,000 passengers in 2007. Currently the port has eight deep-water berths for general cargo, three berths for container vessels, eight anchorages, a grain terminal, an oil jetty and offshore mooring for super tankers.

Between 2001 and 2007 the average growth rate for coastal ports was 9.2% per annum (8.5% per annum for imports and 9.1% per annum for exports) (TPA 2009). Container traffic has been growing even faster, at around 13.5% per annum, and there has also been strong growth in dry bulk cargoes such as wheat, fertilisers and cement. Liquid bulk traffic (mainly oil) has been growing at an average rate of 5.4% per annum, but break-bulk traffic has been static. Transit traffic to the land-locked countries (Burundi, Rwanda, Uganda, Malawi and Zambia) makes up a growing proportion of Dar es Salaam's traffic, increasing from 10% to 41% of liquid bulks, and from 25% to 39% of containers between 2001 and 2007.

Tanga

Tanga is the second largest seaport with a handling capacity of 500,000 tonnes of cargo a year, and presently handling 380,000 tonnes. The port handles mostly cargo (copper concentrates from the Kahama mines, bulk wheat, cement, fish fillets/octopus and hide and skins). Sisal and coffee are also exported to European and Asian markets.

Tanga port is located near the city centre, and does not have enough space for expansion. A new site, at Mwambani t the south, is being considered for future port development. However, this new port would be located at the center of the Tanga Coelacanth Marine Park and thus meet with environmental concerns.

Mtwara

Tanga is the third largest seaport with a handling capacity of 400,000 tonnes of cargo a year, and presently handling 290,000 tonnes, mainly of conventional cargo. The export of un-processed cashew nuts has traditionally been Mtwara Port's main export.

The forecasts for Mtwara depend largely on the viability, form and timing of several large projects in the Mtwara Corridor. These include compressed natural gas, bio-diesel, woodchips, hardwood timber, cement, urea, coal and iron ore. Some of the projects could involve substantially larger ships than those using the port at present. The Corridor project includes the construction of a railway from Mtwara to Mbamba Bay. Although intended primarily to facilitate coal exports, this would also allow Mtwara to become a natural gateway to Malawi and parts of Zambia. Mtwara has also been selected as the site for an EDZ.

Issues

All Tanzania's coastal ports are located close to their city centres, where their operation contributes to traffic congestion and other adverse environmental effects, especially in the largest port of Dar es Salaam. Difficulties in acquiring land have led to cramped and inefficient port layouts, and imposed serious constraints on port expansion plans.

The short-term plan for Dar es Salaam (existing footprint) provides sufficient capacity to handle the expected traffic up to 2016 in the high forecast case, and 2020 in the low forecast case. After that, a completely new area will have to be opened up for port development. Three suitable locations for handling Dar es Salaam overspill traffic are Kigamboni (on the other side of the creek to the existing port), Bagamoyo and Mwambani Bay (near Tanga). Economic analyses and comparison of non-monetary aspects show these two sites offer the preferred development alternatives.

Table 17: Approximate throughput volumes, vessel movements and facilities for Tanzania's three main coastal ports (TPA statistics 2013).

Parameter	Dar es Salaam	Tanga	Mtwara
Total throughput **(million tonnes)**	13.50	0.38	0.29
Imports	11.30	0.29	0.16
Exports	1.90	0.06	0.13
Transhipment	0.20	0.0	0.00
Global vessels **(number)**			
Dry cargo	677	81	60
Liquid cargo	134	0	0
Other vessels **(deep sea, navy, surveys) (number)**	17	0	1
Coastal vessels **(number)**			
Passenger/dry cargo	408	60	2
Liquid cargo	62	0	0
Passenger	3,030	8	0
Scooners/dhows	913	469	21
Fishing/others/tugs	165	1	495
Berths, Wharves, Jetty etc.			
Deep Water Berths No.	11	-	2
-Total Length (m)	2,018	-	385
Depth Dredged	10	-	10
Bulk Oil Jetty (Tanker Berth) No.	1	-	-
Single Buoy Mooring (SBM) No.	1	-	-
Grain Silo (30,000 Tons)	1	-	-
Lighterage & Dhow Wharves No.	4	2	-
-Total Length (m)	588	381	-
Stream Handling Points No.	5	9	-
Sheds			
Main Quay Transit Shed No.	6	-	3
-Total Floor Area(m2)	46,439	-	7,322
Passenger, Baggage Hall and Shed No.	2	-	-
-Total Floor Area	532	-	-
Back of Port Transit Shed No.	2	-	1
-Total Floor Area(m2)	6,290	-	9,160
10 day Cargo Shed No.	1	-	-
-Total Floor Area(m2)	1,560	-	-
Lighterage Area Transit Shed No.	3	7	-
-Total Floor Area(m2)	8,692	34,692	-
Transit Depots No.	2	-	-
-Total Floor Area (Ubungo) (m2)	28,060	-	-
-Total Floor Area (Kurasini) (m2)	28,300	-	-
Customs Warehouse No.	1	-	-
-Total Floor Area (m2)	3,800		
Stacking Grounds			
Total Floor Area - main Port (m2)	129,794	28,210	15000
- Container Terminal (m2)	104,500		
- AMI Area (m2)	22,800		
Transit Depots - (Ubungo) (m2)	29,745	-	
- (Kurasini) (m2)	40,385	-	

Economic importance

Tanzania's three major ports (Dar es Salaam, Tanga and Mtwara) handle over 95% of all import and exports. In 2012, Dar es Salaam port cleared USD 15 billion of merchandise (a sum equivalent to 60% of Tanzania's GDP (World Bank 2013). Furthermore, transit trade counts for as much as 50 % of exports and 32 % of imports, making Dar es Salaam port the second most important gateway for regional trade in East Africa after Mombasa (World Bank Databank).

As the World Bank (2013) explains, while there is no doubt that Dar es Salaam port is an important source of revenue, it is difficult to determine who benefits from its current state of inefficiency and institutional set-up. Their analysis suggests that a number of parties stand to gain significantly from the current state of inefficiency as a result of: (a) the distorted incentive structure at the port; (b) the prevalence of corruption; and (c) the extra protection for local producers. The report goes on to highlight that the total revenue from additional storage collected by the TPA and TICTS reached a value of around USD 14.5 million, and that additional revenue generated by container traffic for the TPA was estimated to reach a value of around USD 36.5 million in 2011.

The World Bank (2013) concludes that achieving a level of efficiency in Dar es Salaam's port equivalent to that of Mombasa's, which is of average standard for African ports, could generate an estimated USD 1.7 billion in additional revenues for Tanzania, and about USD 800 million for its neighbours in the region.

Socio-economic importance

TPA employed 3,163 permanent staff in 2003, of which 10% are based at the headquarters in Dar es Salaam. The activities of the port and harbour are a dependable source of employment for local populations since they offer casual labour opportunities and subsidiary jobs such as food vending during periods of peak activities. An additional 3,000 individuals are employed by the nine main private companies that provide services to the coastal port and the number of stevedores and causal labourers may bring the overall total job associated with the Dar es Salaam port (including the TPA) to some 8,000. In addition to those directly employed by TPA and the support companies, the ports (including Mtwara and Tanga and the seven secondary ports) have spawned a wide range of economic support activities nearby that also create livelihood opportunities.

Threats to coastal communities relying on sector for livelihoods

The largest threat to the port industry of Tanzania is simply the failure of the ports to continue to function as a gateway for goods and passengers or that goods and passengers fail to require the facilities because they are either not utilizing Tanzania or there is no demand. The principle threats to those engaged in the port sector and to the wider environment are described below:

- **Inefficient operation at Dar es Salaam port** leading to loss of economic competitiveness (compared to other ports e.g. Mombasa) by increasing the costs of import/export to/from global markets.
- **Inadequate compensation for land** for port expansion at Dar es Salaam, Mtwara, Mwamabni (Tanga) and Bagamoyo.
- **Legal concerns about the ongoing eviction of several villages in Mwambani Bay** (Ndumi, Magaoni) as an ESIA has not yet been conducted for the new port (See: http://www.tnrf.org/files/E_INFO_MWAMBANI_DOSSIER_November.pdf)
- **Inadequate environmental mitigation** during port expansion at Mtwara, Mwamabni (Tanga) and Bagamoyo, leading to environmental degradation e.g. siltation of reefs.
- **Erosion of shorelines** adjacent to some secondary ports: Kilindoni (Mafia), Lindi, Rushungi, Kilwa Kivinje and Kilwa Masoko ports.
- **Pollution** arising from port activities and traffic.

CRIAM Ranking of Threats to Local Communities associated with Ports and Harbours

Table 18: Prioritisation of threats to local communities and ecosystems associated with ports and harbours. The assessment has been made using the Coastal Rapid Impact Assessment Matrix (CRIAM) approach, described in detail in Annex 3.

ThemeID	Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
M_P&H_01	Inefficient operation at Dar es Salaam port leading to loss of economic competitiveness (compared to other ports e.g. Mombasa) by increasing the costs of import/export to/from global markets.	Ports and Harbours	1	3	2	2	1	15	2					
M_P&H_02	Inadequate compensation for land for port expansion at Dar es Salaam, Mtwara, Mwamabni (Tanga) and Bagamoyo.	Ports and Harbours	1	2	2	2	1	10	2					
M_P&H_03	Inadequate environmental mitigation during port expansion at Mtwara, Mwamabni (Tanga) and Bagamoyo, leading to environmental degradation e.g. siltation of reefs.	Ports and Harbours	1	3	2	2	1	15	2					
M_P&H_04	Erosion of shorelines adjacent to some secondary ports: Kilindoni (Mafia), Lindi, Rushungi, Kilwa Kivinje and Kilwa Masoko ports.	Ports and Harbours	1	1	3	2	3	8	1					
M_P&H_05	Pollution arising from port activities and traffic.	Ports and Harbours	1	1	2	2	3	7	1					

Vulnerability to Climate, Climate Variability and Climate Change

Changes in Weather Patterns (precipitation, and water availability)

- No impact expected for Dar es Salaam port, but not known for other **ports**.

Extreme Weather Events

- Possible flooding from storm drains blockages due to poor maintenance at Dar es Salaam port; not known for other ports.
- Erosion of shorelines adjacent to some secondary ports (see above).

Sea-Level Rise

- No impact to Dar es Salaam port, but not known for other ports.

Seawater and Air Temperature Rise

- No impact.

Seawater Acidification

- No impact.

Outlook

Since approximately 90% of Tanzania's international transactions transit through the port of Dar es Salaam, improvements to this facility (especially efficiency) should be prioritised. For example, it is estimated that it takes on average seven days to transport goods from Dar es Salaam to the Zambian border (counting for the poor infrastructure and administrative delays). By comparison, the waiting time, including anchorage and dwell time, at the port of Dar es Salaam was generally higher than 20 days (as of mid- 2012).

9 INFRASTRUCTURE

Introduction

Tanzania has a vast rural population (70%), with most people living in villages, far removed from urban life. Supplying infrastructure to all Tanzania's remains a major challenge. Tanzania's economic growth is healthy and presently averaged around 7%, up from 3.7% in 1990. The infrastructure sector contributed 1.4% to annual GDP over the recent decade, primarily due to very strong developments in the information and communication technology (ICT) sector. The power sector has also had a positive impact on growth. However, the cost to provide infrastructure is presently equivalent to 17% of the country's GDP (Shkaratan 2012).

Management of the Infrastructure Sector

There are various ministries and departments responsible for legislating and oversight of the sub-sectors related to infrastructure. The most visible of these is the transport division of the now defunct Ministry of Infrastructure Development that was recently developed into the Ministry of Transport (MoT) in 2011, charged with the responsibility for development of transport and meteorology and to ensure that the services provided in these sectors are efficient and meet the needs of the population. In addition to road, airport and railways, the MoT is also responsible for the oil and gas pipeline systems, consists of 1,750 km used to transport crude oil products from Dar es Salaam to Ndola refinery in Zambia, and 232 km used to transport natural gas from Songo to Dar es Salaam, while the 500 km gas pipeline from Mtwara to Dar es Salaam is still under construction (see hydrocarbons, page 111).

Operational, semi-autonomous agencies within the MoT are Tanzania Airports Authority (TAA), Tanzania Meteorological Agency (TMA), Tanzania Government Flight Agency (TGFA), and two transport regulatory authorities, the Surface and Marine Transport Regulatory Authority (SUMATRA) and the Tanzania Civil Aviation Authority (TCAA).

Specifically focused on roads is the Ministry of Works (MoW), instituted in 2010. Through TANROADS it is managing the national road network of about 33,891 km comprising 12,786 km of Trunk and 21,105 km of Regional roads. The remaining network of about 53,460 km of Urban, District and Feeder Roads is under the responsibility of the Prime Minister's Office Regional Administration and Local Government (PMO-RALG).

The Urban Development Division (in the Ministry of Lands Housing and Urban Development) is responsible for preparation of Master Plans for cities. The Ministry of Natural Resources and Tourism (MNRT) also has a management role in so far as environmental and social issues are concerned.

The current emphasis is for the above functions to be assigned to and undertaken by the local government, although most of the funding still comes from the central government or donors. For example, some 30% of the Road Fund Collection is allocated to local authorities for the maintenance of district roads. The same applies to other sub-sectors, notably the health delivery and education systems. The responsibilities for each sub-sector are elaborated further in the sections that follow.

Description of Infrastructure of the Coast

The proportion of people living in urban areas has increased from less than 10% in 1975 to 33% in 2003. The annual urban growth rate for Tanzania was estimated at 2.8 %, indicating that it is among one of the most rapidly urbanising countries in the region (UN-HABITAT 2009a). This trend is positive with respect to delivery of infrastructure services since delivery of certain

infrastructure directly to the public is usually easier and more cost effective when targeted people are grouped in urban centres rather than scattered in small villages across wide areas of the country. This is especially true for power supply, water supply and sanitation, education and health services, and ICT networks. A summary of the status of the various sub-sectors is presented below.

Power and Energy

Tanzania's rural communities are about 70% of the total population though less than 2% have access to electricity. Coastal regions are particularly poorly served, and people rely on different sources of energy, including kerosene, charcoal, firewood and solar. The main source of power in urban centres, used for lighting, business and industry, is electricity. This is transmitted and supplied by a sole utility agent - Tanzania Electric Supply Company Limited (TANESCO), who also generates much of their electricity. However, there are number of cases where private sector power generation companies supply electricity to TANESCO. One example from coast is the Mtwara gas –powered generation station that supplies electricity to Mtwara and Lindi.

All coastal regions and districts are now connected to the national grid, though there are large areas of the districts that have no electricity infrastructure, and reliable availability of electricity in most parts of coastal region of Tanzania is still a challenge. In 2006 the peak demand was well below installed capacity resulting in frequent power shortages due to a prolonged drought which led to outages whose economic cost has been estimated as high as 4% of GDP (Shkaratan 2012).

Tanzania has a peak demand (in 2009) of 760 MW. Thermal power stations, which made up 54% of installed capacity, account for 55% of power production, and hydroelectric installations provided for 40%. Hydroelectric power stations include Kidatu, with a capacity of 204 MW; Kihansi, 180 MW; Mtera, 80 MW; Pangani Falls, 68 MW; and Hale, 21 MW. Of these, the Pangani Falls is the only one located in a coastal district. Three gas-powered stations exist in the coastal zone of Tanzania, at Mtwara (18 MW), Somanga (near Kilwa) 4.5 MW, and in Dar es Salaam at Ubungo 100 MW. Fuel driven power plants exist at numerous places across the country and supply most of the deficit, though in most cases the peak demand is not met.

Lack of alternative energy for cooking, especially in rural areas has imposed severe demands on forest resources due to unsustainable harvesting of wood for cooking. Fuel wood and charcoal are the main sources of energy for most people in the coastal regions. To alleviate the resulting deforestation, TANESCO promoted rural electrification and the development of renewable energy (Business Council for Sustainable Energy, 2003). Renewable energy components are currently exempt from import duty and are VAT exempt.

TANESCO's Power Sector Master Plan has proposed the addition of 1,440 MW of new capacity by 2021. The company planned to build new gas-fired power plants and substitute diesel for natural gas in other plants (Yager 2002).

Transportation

Transportation is an extremely important infrastructure sector in the economy of the country in general and also the economy of the coastal regions. Transportation includes movement of goods and people from place to place as well as the importation and export of goods to and from the coastal districts.

Tanzania's ports and airports are integrally dependent on roads or rail to move goods and people. Of note is that the port of Dar es Salaam suffers from performance problems as rapid traffic growth increasingly exposes deficiencies in storage and access to the port, at great cost to the users. Because of the importance of ports and harbours and their specific interaction with the

marine environment, this sub-sector is treated in a separate theme (Ports and Harbours, page 87). The remaining transportation sub-sectors are described below:

Roads

The national trunk road network has undergone substantial improvements across Tanzania and the coastal zone in particular over the last 15 years. There is now a complete north to south coast road. On the southern portion, the T7 trunk road extends from Dar es Salaam to Mtwara passing first through the interior of Mkuranga District and into Rufiji District, where in the last ten years the Mkapa Bridge across the Rufiji River was completed, and now only a small section (ca. 15 km) remains to be paved (in the Rufiji District) before paved surfaces continue to coastal cities of Kilwa, Lindi, Mikindani and Mtwara. To cross into north Mozambique the road extends westward for 300 km to the Unity Bridge across the Ruvuma River, completed in 2010.

North, from Dar es Salaam to Tanga, the new trunk road roads through Bagamoyo then detours west around Saadani National Park, onto the main T2 trunk road through the interior of Pangani and via Segera then the T13 to Tanga city on the coast, and the new trunk road north to the Kenya border at Horo. For the first time, all the coastal cities are interconnected with a good road network that extends to neighbouring countries. However, from the trunk road to the small towns and villages, there are virtually no paved roads, consequently there are much greater distances of unpaved road than paved (see Table 19) and, the regions along Mtwara corridor (west to Songea, Mbeya and Malawi) have remained the least developed in Tanzania due to poor infrastructure, including lack of railway system and poor road conditions (URT 2011).

Table 19: Distances of paved and unpaved roads in coastal regions of Tanzania (TANROADS 2008).

	Paved (km)	Unpaved (km)	Total (km)
Coast	314.60	644.10	958.70
Tanga	485.10	1,135.46	1,620.56
Dar es Salaam	123.43	339.70	463.13
Mtwara	161.80	916.64	1,078.44
Lindi	362.04	821.00	1,183.04

Railways

Tanzania has two main railway systems with different gauges, i.e. the Tanzania-Zambia Railway Authority (TAZARA) with connections to Zambia Railway system, and the Tanzania Railway Limited with links to Uganda, DRC Congo, and Kenya. These lines link Dar es Salaam with the interior and do not directly benefit coastal districts. The railway sector has performed badly during the last ten years; infrastructure has deteriorated, services are below standard and there is a shortage of locomotives and wagons. Improvements to rail infrastructure and availability of rolling stock (locomotives and wagons) are urgently required (TPA 2013).

Between 2001 and 2007, TRL's share of dry cargo imports through Dar es Salaam fell from 22% to 3%, whilst TAZARA's crept up slightly from 2.5% to 4.5%. Rail is generally recommended for cargo movements exceeding 400-600 km, so even allowing for the limited extent of the rail network, there is scope for increasing rail's share of port traffic (excluding oil) from around 7.5% today to a target of 30-35% in 10-15 years' time. This would lead to a significant reduction in inland transport costs, environmental improvements, and more efficient port operations (Shkaratan 2012). Any railway improvements would benefit industry, agriculture, trade and passenger movement from the coast to the interior.

Air Transport

Julius Nyerere International airport in Dar es Salaam is the only international airport in the coastal zone, also handling local flights (ASCLME 2012). Other coastal regions have secondary airports catering for domestic transport. These include a paved airports at Tanga, at Mafia in Pwani Region and Lindi (both un-paved), and at Mtwara (paved and capable of handling Boeing 737s). In addition there are numerous small un-paved airstrips that cater for private needs and small charter planes, such as at Mnazi Bay, Utete (Rifiji), Saadani National Park and two at Kimbiji (Temeke). The coverage and standards are general good, in part due to its immense tourism demand.

Water supply and sanitation

About 30% of the coastal population, especially in rural areas, still have no access to safe drinking water (ASCLME 2012). With the exception of the major urban centres (Tanga, Pangani, Bagamoyo, Dar es Salaam, Utete, Kilwa, Lindi, Mikindani and Mtwara) the rest of the population do not have access to piped water to their homes, and either share a public stand pipe or well, or have their own well. Where available, river water is frequently abstracted for drinking, cooking and bathing.

The challenge to safe water supply is exacerbated by poor budget execution in the sector requiring equivalent of 10-20% of the national GDP to fund uniform supply nationwide. Despite reforms and increased financing, performance has remained poor and access to clean and safe water has fallen significantly since 2000 in both urban and rural areas (Shkaratan 2012). The water utilities continue to record low revenue collection, low cost recovery and high distribution losses.

Health Services

People in rural areas rely heavily on government health facilities compared to urban residents (URT 2007a, 2007b), since the majority of private health facilitate are in urban areas. The use of traditional healers has reduced significantly in the recent past (URT 2007b), reflecting increased confidence in medical facilities. Health status is a big challenge in most of the coastal region of Tanzania (ASCLME 2012) though most households are generally not far from primary health care facilities, even in rural areas. The distance to the nearest hospitals appeared to have decreased since 2000/01, particularly in rural areas. The 2007 Household Budget Survey indicated that 68% of households are less than 6 km away from a primary health facility and over 84% of households are within 10 km of a dispensary (URT 2007b). In most areas in the coastal region of Tanzania, malaria are the most commonly reported diseases being reported by 62% of adults and almost 77 % of children (NEMC 2009).

Education Services

At the district level, power and authority to make decisions rests with District Councils as well as School Boards and Committees. The District Councils are responsible for effective management of funds; discussing and endorsing district education plans. At the district level there are established District Education Committee with membership from various departments at the District Council, NGOs/CBOs, religious institutions and private individuals who own schools. The committees provide technical advice to the District Council on all matters pertaining to education to development of education and EFA plans, in particular.

The Government is the main funding agency of basic education. In 1990, the total recurrent educational expenditure allocated to primary education was 46% after dropping from 58% in 1982/83. The figure has now been recovered to 65% (1998) following Government determination to improve the resourcing of basic education.

Across the country, enrolment rates of children aged 7 years in Standard 1 vary significantly, with the coastal regions of Mtwara and Lindi having the lowest net intake rates of the whole county (45.1% and 48.1%, respectively), compared to the highest in Iringa (98.6%). Dar es Salaam ranked quite high (84.1%) but Tanga only attained an enrolment rate of 64.7% (NBS).

Information and Communication Technology (ICT)

The country has also seen significant gains in ICT networks, with substantial progress in modernising its institutional framework for ICT. There are now seven wireless operators, achieving one of the most competitive mobile markets in Africa. However, at 28%, mobile tax rates are among the highest in Africa and Tanzania is lagging behind its neighbours in extending mobile coverage to rural areas (Shkaratan 2012). Only around 75% of the population lives within range of a GSM signal, compared with more than 90% in neighbouring Kenya and Uganda (albeit both countries significantly smaller in area than Tanzania).

Issues

The speed of population growth, urbanisation and the need for infrastructure is taking place in many parts of the coast place enormous pressure on the local authorities to match the provision of basic services (clean water supply, power and energy, transportation, health, education, etc.). Some of the sub-sector fare better than others, for example the ICT developments over recent years are far more impressive than the development in provision of safe drinking water.

Evidence from enterprise surveys suggests that infrastructure constraints are responsible for about 34% of the productivity handicap faced by the private sector in Tanzania over the period 2002-2006, with the remainder being due to governance, red tape, and financing constraints. Transportation is reportedly the infrastructure constraint that weighs most heavily on businesses followed closely by water supply (Shkaratan 2012).

Economic Importance

In Tanzania, the spending on infrastructure was USD 1.2 billion per year or 17% of the country's GDP (Shkaratan 2012), noticeably higher than the average for Sub-Saharan Africa. The public sector, the largest source of finance for infrastructure in Tanzania, accounts for 56% of total spending. Official development assistance and the private sector are also important financiers, respectively contributing 25% and 18% of total expenditures. At present, the transport and power sectors each receive nearly one-third of total spending, while the ICT and water sectors each receive a further 18%. On the per capita basis, annual spending on infrastructure is USD 30, on par with Uganda and Ethiopia but just one-fifth of what is spent by Kenya and only one-twelfth of what is spent by South Africa (Shkaratan 2012).

The power sector poses Tanzania's most serious infrastructure challenge, despite significant improvements in pricing and operational performance in recent years. Inefficiency still absorbs about 1.4% of GDP. Moreover, due to heavy reliance on hydroelectricity the sector remains vulnerable to climate variability (Yager 2002). Numerous constraints have been identified in the energy sector, including weak petroleum regulations, lack of financial, operational and human resources capacity and law enforcement in the sector (particularly at lower-levels of administration) (Shkaratan 2012). The second largest source of inefficiency is under-collection of the fuel levy for road maintenance, which represents a loss on the order of USD 100 million a year.

Socio-Economic Importance

The social and economic importance of the various sub-sectors under the broad term of infrastructure, in some cases a basic human right (e.g. access to education, safe water supply,

and health services) cannot be overstated. The percentage of the coastal population employed in the various sub-sectors is not significant.

Threats to coastal communities relying on infrastructure sub-sectors for livelihoods

The principle threats to those relying on infrastructure and to the wider coastal environment are described below:

- **Poor infrastructure management** leading to poor or biased choices for development, for example, promoting road transport at the expenses of developing railways.
- **Inadequate infrastructure management** unable to maintain supply of services (electricity, transport, water supply, health and education services and ICT) to coastal regions, resulting in a deterioration of living standards, business development and prosperity.

CRIAM Ranking of Threats to Local Communities associated with Infrastructure

Table 20: Prioritisation of threats to local communities and ecosystems associated with infrastructure. The assessment has been made using the Coastal Rapid Impact Assessment Matrix (CRIAM) approach, described in detail in Annex 3.

ThemeID	Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
M_Infra_01	Poor infrastructure management leading to poor or biased choices for development, for example, promoting road transport at the expenses of developing railways.	Infrastructure	3	3	2	2	1	45	4					
M_Infra_02	Inadequate infrastructure management unable to maintain supply of services (electricity, transport, water supply, health and education services and ICT) to coastal regions, resulting in a deterioration of living standards, business development and prosperity.	Infrastructure	3	3	2	2	2	54	4					
M_Infra_03	Weak Implementation of Environmental Legislation (Inception Meeting Addition)	Infrastructure	3	3	2	2	2	54	4					

Vulnerability to Climate, Climate Variability and Climate Change

A number of specific vulnerabilities of infrastructure and those that utilise it were identified by Hepworth (2010), combined with additional ones, summarised under the principle climate change areas:

Changes in Weather Patterns (precipitation, and water availability)

- Increased rainfall volumes water leading to faster deterioration of roads.
- Increased rainfall volumes water leading to failure of road drains and accumulation of standing water resulting in water borne diseases.
- Greater standing water increases contamination risk for drink water supplies leading to increased diseases such as cholera etc.
- Flood damage to transport, communication and electricity supply infrastructure

Extreme Weather Events

- Damage to power supplies from fallen trees, or from direct impacts of weather.
- Damage to ICT infrastructure from direct impacts of weather.

Sea-Level Rise

- Coastal inundation on in low-lying coastal areas affecting roads.
- Possible elevated salinization of coastal aquifers affecting safe water supplies.

Seawater and Air Temperature Rise

- Drought increases vulnerability of hydro-electric power supply from Pangani Falls and other stations.
- Increased damage to roads.
- Greater cooling costs for generators and other infrastructure machinery.

Seawater Acidification

- No impact.

Outlook

The coastal zone will witness considerable development in business and trade in the coming 5-10 years. Oil and gas development is accelerating in Mtwara, Lindi and Kilwa and has the potential to benefit livelihoods through employment, while companies in the sector are likely to further engage in the community and support local development. Infrastructure in these traditionally poor regions has a better chance of accompanying economic development if some of profits from the activities are retained in the regions. Agricultural output, tourism development and general trade are likely to witness accelerated growth in the near future, especially in the southern coastal region, but also to the north. Tanga and Pangani are already witnessing growth in the tourism sector, largely due to better roads and infrastructure, and the trend is likely to continue. The challenge will be for the responsible ministries and local authorities to implement and maintain the infrastructure sub-sectors that need developing.

Other Matters

Tanzania has recently embarked on the concept of "development corridors" with the National Development Corporation charged with their implementation, whereby large public

investments in energy and transport will support and boost private sector investment in mining and agriculture along four corridors, thus ensuring balanced regional growth, running from the coast inland, as described below:

Tanga Corridor

The Tanga Corridor study has identified several large agricultural and mining projects, but these are less well-defined than in the other corridor studies. Targets include boosting manufacturing activity in Tanga and Arusha, and building a new rail link from Tanga to Musoma via Arusha, providing Uganda with a more direct route to the sea than via Dar es Salaam. This corridor is likely to meet international opposition as it would cut across the Serengeti National Park.

Central Corridor

The principal investment projects in the Central Corridor are in mining and agriculture, supported by large public investments in energy and transport. The additional traffic which they generate will go mainly to Dar es Salaam.

Southern Agricultural Growth Corridor (SAGCOT)

SAGCOT is already showing the way forward, taking advantage of the Tanzania-Zambia Railway (TAZARA) which passes through Tanzania's leading three agricultural regions i.e. Morogoro, Iringa and Mbeya and provides international access to the other two i.e. Ruvuma and Sumbawanga. The strategy is to develop integrated agricultural production systems that include modern and commercialized agricultural production, backward linkages to production and supply of inputs and forward linkages to agro-processing, packaging and marketing. Stakeholders include domestic smallholder producers linked with large international firms through contract farming procedures that ensure access to state of the art production technologies, integration of domestic markets and linkages to international markets (URT 2011).

Mtwara (or Ruvuma) Corridor

Work on the Mtwara Corridor is the most advanced, and seems likely to generate substantial volumes of port traffic, mainly for Mtwara but also for ports on Lake Nyasa.

10 URBANISATION

Introduction

Tanzania is a predominantly rural country within a largely rural population (70%), with most living in villages, far removed from urban life. The post-independence model fostered by President Julius Nyerere in the 1960s accelerated the clustering of people into main villages, mainly to preserve the country's rural character and counter a trend whereby migration from villages to the then budding cities where urban growth rates soared. Resettlement policies were supported by state ownership and allocation of land, and from 1967 to 1973 Ujamaa villages were created to promote the utilisation of modern agricultural techniques in collective production, as well as to expand the provision of drinking water, healthcare and other services to the previously dispersed rural population (UNICEF 2012). In 1974 'villagisation' or the grouping of population into centrally planned rural clusters, became the official, state mandated development policy, leading to the resettlement of a large portion of rural communities into designated areas. From the 1980s, the growth of some villages into small town and towns in large cities has been transforming the physical and social landscape.

Presently, one of every four Tanzanian children lives in an urban area, and one of every three babies born this year is likely to live in a city before reaching the age of 20 (UNICEF 2012). The population of Tanzania is estimated at over 45 million, of which 30% now live in urban areas. Cities like Dar es Salaam growing at a rate of between 7% and 11% per annum.

Urbanisation is the physical growth of the urban areas due to the global change. It is closely linked to industrialisation and modernisation and the process of rationalisation. Urbanisation occurs naturally from the individual and other corporate efforts to reduce time and expense in commuting and to improve jobs and education.

Management of the Sector

Local government is organised into rural and urban authorities. The Local Government (Urban Authorities) Act 1982 establishes their composition, functions and legislative powers. Urban government authorities with legal and autonomous status include cities, municipalities and town councils which, for administrative and electoral purposes, are divided into wards and 2,600 sub-wards ("mitaa"). From a politico-administrative perspective, the Local Government Act defines the role that PMO-RALG is expected to play in urban areas and provides for the establishment of an urban authority in any area of mainland Tanzania. In parallel, the Ministry of Lands and Human Settlements Development (MoLHSD) guides the implementation of the National Human Settlements Development Policy 2000 (NHSDP), which provides a classification of human settlements. The Urban Development Division (in the Ministry of Lands Housing and Urban Development) is responsible for preparation of Master Plans for cities. The Ministry of Natural Resources & Tourism (MNRT) also have a management roles in so far as environmental and social issues are concerned.

The Town and Country Planning Act of 1956 (revised in 1961), the Physical Planning Act of 2003, and the Land Act of 1999 (No. 4 and No. 5) each empower the local government's ability to plan, guide, implement, and monitor land management activities in the city. The National Land Policy of 1995, the Human Settlement Development Policy of 2000, the Housing Programme of 2000, and other government orders strengthen the above acts, ensuring effective land management, poverty reduction, and sustainable development toward the Millennium Development Goals.

The National Human Settlements Policy 2000 recognises that clearing unplanned settlements is not a viable option, and establishes a government policy of progressive upgrading. The Land Act makes provisions for validating urban land acquired in the absence of a right of occupancy, by

issuing residential licences that confer temporary land entitlements (UNICEF 2012).

Urban Local Government Authorities (LGAs) levy from residents nearly five times as much revenue as rural LGAs, and also generate more of their own revenue. In 2006-07, intergovernmental transfers to urban LGAs accounted for 18%, compared to 82% for rural LGAs. Urban taxpayers contribute a substantial share of national revenues. Tanzania's redistributive intergovernmental transfer system, relying on a heavy urban composition of the national tax base, aims to redistribute resources from urban to rural areas (UNICEF 2012).

Description of Urbanisation of the Coast

The proportion of people living in urban areas has increased from less than 10% in 1975 to 33% in 2003. The annual urban growth rate for Tanzania was estimated at 2.8 %, indicating that it is among one of the most rapidly urbanising countries in the region (UN-HABITAT 2009a). This growth rate is typical of most of principle coastal urban centres. Despite this rapid urbanisation, there has been a threefold increase in the rural population, adding to pressure on land and other resources in rural areas (Wenban-Smith 2014). Urbanisation rates vary across the country, depending on region, with some regions losing up to a third of their expected population while others gain substantially, the former usually also experiencing high rural out-migration. However, urban in-migration patterns are more varied (Wenban-Smith, 2014).

The advantages of urban life are many, the most obvious being access to facilities, services, infrastructure and amenities, more options for jobs and education. Though traditionally the rural areas have been worse off compared to urban centres, Tanzania's rural areas are catching up with cities, where the provision of social services and infrastructure has not kept pace with the growing demand generated by rapid urban growth. Examples include the availability of basic services, expected to be higher in urban centres, has been declining and now many indicators in education, health, nutrition, water and sanitation are higher in rural areas; meanwhile as urban performance stagnates and even declines, it is likely that poor, under-serviced communities are being hit hardest, with poor urban children often faring worse than their rural peers (UNICEF 2012).

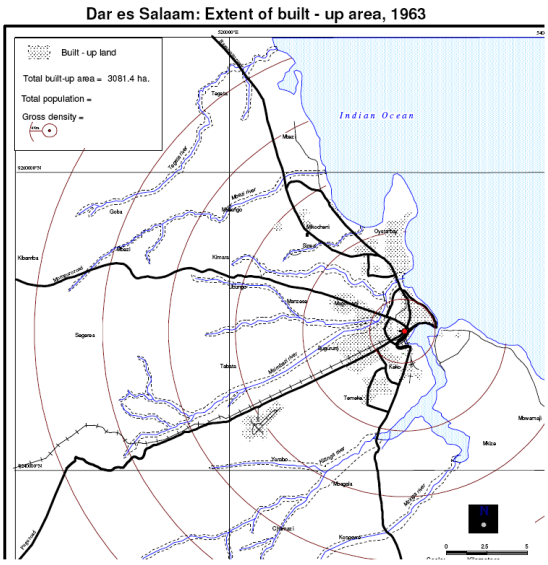
Among the fifteen coastal districts there are seven centres that are considered urban, Tanga city, Muheza, Bagamoyo, Dar es Salaam, Utete (Rufiji), Lindi and Mtwara. Of these, Dar es Salaam is by far the largest, as described below.

The example of Dar es Salaam

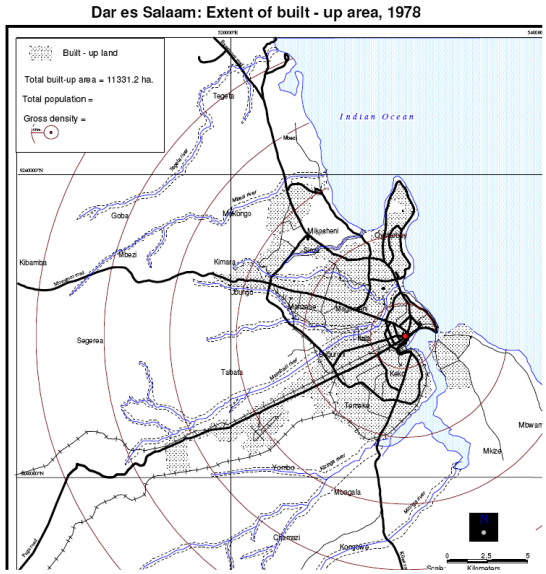
The largest city in Tanzania, Dar es Salaam had a population of about 150,969 in 1963 but had increased to 2.5 million by 2001 (Figure 3) and to 4.4 million by 2012 (Wenban-Smith, 2014). It now hosts 8% of the national population and generates over 70% of the national GDP. It has a land area of 565 km^2 from 30 km^2 in 1963. Much of the urban growth of Dar es Salaam has been informal and unregulated.

Dar es Salaam remains the centre for the permanent central government bureaucracy and continues to serve as the capital for the surrounding Dar es Salaam region. The city falls under the jurisdiction of one administrative body but is divided into three municipalities: Ilala, Kinondoni, and Temeke (each with a District Commissioner), with a total of 73 wards. Each ward is divided into a number of sub-wards of which there are possibly 246. The city has a mayor and an executive director/city director head the Dar es Salaam City Council.

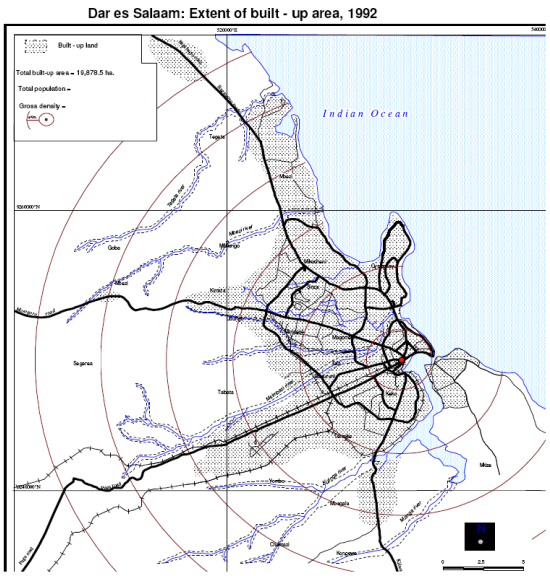
For Dar es Salaam, over 25 policies, by-laws, and regulations supplement the implementation of principle acts and ordinances, including the Town and Country Planning Act of 1956 (revised in 1961), the Land Act of 1999, the 2004 Environmental Law, and the Human Settlement Development Policy of 2000.



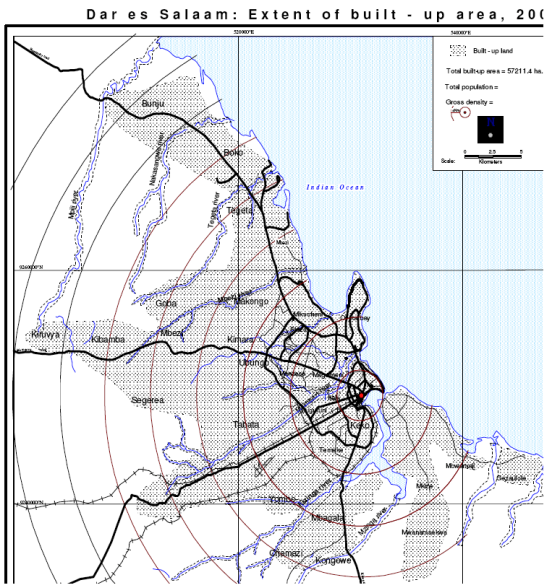
DAR ES SALAAM 1963
Spatial Extent: 6KM Radius
Urbanised Area: 3081 HA
Population150,969 People
Pop. Density: 49 PPH



DAR ES SALAAM 1978
Spatial Extent: 14KM Radius
Urbanised Area: 11,331 HA
Population 843,090 People
Pop. Density: 74 PPH



DAR ES SALAAM 1991
Spatial Extent: 18KM Radius
Urbanised Area:19879 HA
Population 1,550,000 People
Pop. Density: 78 PPH



DAR ES SALAAM 2001
Spatial Extent: 30 KM Radius
Urbanised Area: 57,211 HA
Population 2,497,940 People
Pop. Density: 52 PPH

Figure 3: Spatial growth trends for Dar es Salaam from 1963 to 2001 (Lupala 2002).

Issues

The speed at which urbanisation is taking place in Dar es Salaam (as well as some of the other major coastal cities) places enormous pressure on the city authorities to match the provision of basic services (clean water supply, sewage and waste management, transportation, health, education, etc.). With respect to transport, Kanyama et al (2004) identified a number of shortcomings in Dar es Salaam, ranging from lack of a well-defined authority and administrative system that has the responsibility for formulation and implementation of a coordinated strategy for public transportation, to inadequate enforcement of traffic regulations and application of out-of date legal and administrative framework in traffic management.

An additional significant environmental problem in Dar es Salaam City is unguided urban growth, characterised by informal settlements and un-serviced housing areas and a growing informal sector (UN-HABITAT 2004). In Bagamoyo, 65% of the urban population live in unplanned and unserviced settlements (UN-HABITAT 2009c) .Poor land ownership is an issue related to financial stability, resulting in households with insecure land tenure being less likely to invest in that land, and also less able to access formal finance, since land titles can be used as collateral for loans (Collin, 2014).

The population living below subsistence level (food poverty) ranges from 7.4% in Dar es Salaam to 12.9% in other cities, meaning that between one in eight and one in 14 urban households are destitute. Due to population growth and reclassification of formerly rural areas, the number of poor urban residents has kept growing. Around the year 2000 just over 12% of Tanzania's poor lived in urban areas; today the figure is closer to 20%, reflecting an increasing urbanisation of poverty.

Economic Importance

The proximity and economies of scale present in urban centres permit cities to become engines of growth. Urban centres offer more options for jobs and economic resources (and political visibility) enhance the scope for investments in critical services and infrastructure that can make service provision less costly and more widely available than in the sparsely populated hinterland (UNICEF 2012). Urban areas are also hubs of technological innovation. Though Tanzania's urban centres are home to only 25% of the population, these areas contribute 50% of Tanzania's GDP (UNICEF 2012).

Socio-Economic Importance

Most of the urban population of the coastal cities engages in informal activities and micro-enterprises. According to the 2005 Property and Business Formalisation Programme, popularly known as Mkurabita, it was revealed that about 98% of businesses in Dar es Salaam are informal and operate outside of the legal system; in other words, the private sector is largely a part of the informal sector (UN-HABITAT 2010).

Threats to coastal communities associated with urbanisation

The principle threats to those living in urban centres and to the wider coastal environment are described below:

- **Poor urban management** leading to overcrowding informal settlements that lack clean water and adequate sanitation, leading to increase health and well-being problems from contaminated water and from mosquitos and other pests that thrive in unsanitary environments.
- **Inadequate solid waste management** causing pollution of the landscape, watersheds and the coast.

- **Failure of housing for the youth and children** exposing them to human predators, violence, abuse and sexual assault that increase their risk of HIV infection.
- **Encroachment into coastal habitats** from urban expansion
- **Poor vehicular management** leading to increasing vehicular/pedestrian congestion, conflicts and air pollution.
- **Poor vehicular management** leading to increasing vehicular congestion resulting in loss of working hours and fatigue among the workforce.

CRIAM Ranking of Threats to Local Communities associated with Urbanisation

Table 21: Prioritisation of threats to local communities and ecosystems associated with urbanisation. The assessment has been made using the Coastal Rapid Impact Assessment Matrix (CRIAM) approach, described in detail in Annex 3.

ThemeID	Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
M_Urban_06	Youth Unemployment (Inception Meeting Addition)	Urbanisation	3	3	3	2	2	63	4					
M_Urban_02	Inadequate solid waste management causing pollution of the landscape, watersheds and the coast.	Urbanisation	2	3	3	2	3	48	4					
M_Urban_04	Encroachment into coastal habitats from urban expansion	Urbanisation	2	2	3	3	2	32	3					
M_Urban_01	Poor urban management leading to overcrowding informal settlements that lack clean water and adequate sanitation, leading to increase health and well-being problems from contaminated water and from mosquitos and other pests that thrive in unsanitary environments.	Urbanisation	1	3	3	2	3	24	3					
M_Urban_05	Poor vehicular management leading to increasing vehicular/pedestrian congestion, conflicts and air pollution.	Urbanisation	1	3	3	2	3	24	3					
M_Urban_03	Failure of housing for the youth and children exposing them to human predators, violence, abuse and sexual assault that increase their risk of HIV infection.	Urbanisation	1	2	2	2	2	12	2					

Vulnerability to Climate, Climate Variability and Climate Change

The specific vulnerabilities of the urban environment and those that utilise it, were identified by UNICEF (2012) and can be summarised under the principle climate change areas:

Changes in Weather Patterns (precipitation, and water availability)

- Increased standing water leading to greater risk of water-borne diseases (e.g. malaria, dengue fever, etc.)
- Greater standing water increases contamination risk for drink water supplies leading to increased diseases such as cholera etc.
- Increased rainfall likely to impact on the poor quality housing of the urban informal settlements.
- Urban poor less able to respond to unpredictable changes in the weather, being less informed and less able to mobilise finances to adapt.

Extreme Weather Events

- Severe flooding likely to impact more significantly on the urban poor settlements where the majority of urban dwellers live.

Sea-Level Rise

- High water table leading to drainage problems, sewage disposal problems and disease.

Seawater and Air Temperature Rise

- Drought increases vulnerability in urban areas by reducing the availability of safe drinking water and contributing to food scarcity and higher food prices.
- Power cuts during droughts have an overall adverse effect on urban populations by restricting formal, informal and household-based livelihood activities, thus reducing household incomes.

Seawater Acidification

- No impact.

Outlook

Urban growth in Tanzania is projected to continue in the coming decades. If the current predicaments faced in urban centres are not addressed soon, conditions will likely deteriorate. As density increases and unplanned settlements become more congested, investments in facilities, services and infrastructure are likely to become costlier, both financially and socially. Already Dar es Salaam has one of the highest proportions of urban residents living in unplanned settlements in all of sub-Saharan Africa (UNICEF 2012). If present trends continue unabated, Tanzania could then find itself facing a daunting scenario: not only are today's urban children exposed to one of the most hazardous environments imaginable, but climate change is poised to further increase their vulnerability (UNICEF 2012). The current approaches to improving the lives and working conditions of people living in informal settlements as well as urban housing development in general, in the city of Dar es Salaam, have focussed on regularisation and provision of newly surveyed and (partly) serviced sites (UN-HABITAT 2010).

11 NON-RENEWABLE EXTRACTIVE INDUSTRY

Hydrocarbons

Introduction

Tanzania was not, until recently, known for hydrocarbons, but oil and gas reserves are certainly present, in the coastal zone, beneath the seabed and within the East African rift system. The exploration for and development of oil and gas resources have been going on for some time, but have only recently begun to contribute towards economic development in the country. One of several recently-discovered East African basins is an area off the coast of southern Tanzania, now referred to as the *Mafia Deep Offshore Basin*, of about 75,000 km^2 in size with depths of 500 to 3,300 m. This is believed by some experts in the industry to provide one of the few remaining significant offshore exploration opportunities in Africa, with world-class hydrocarbon potential, possibly comparable with those recently made in West Africa.

By 2004 the gas from Songo gas field was piped 232 km to generate electricity in Dar es Salaam, and by 2007 Mnazi Bay gas was used to produce electricity in Mtwara and in Lindi by 2009. Offshore exploration drilling continues with now enough proven reserves of methane discovered by BG and Statoil in three general locations (in 2012), of significant size to justify investment in the construction of a Liquefied Natural Gas (LNG) plant at Lindi, with construction expected to begin by 2015. Meanwhile a 500 km gas pipeline is presently being constructed to supply surplus gas from Mnazi Bay (and expected new discoveries) to Dar es Salaam, with completion expected in 2015.

While a great success has been recorded on natural gas front, "exploration of oil has not shown much success as the search is still on" (TPDC, 2010). The search for oil has intensified. A number of exploration fields are visible in the coast and offshore, and in the inland basins. According to TPDC (2010) "the outcome has been mixed and no discovery has been made to assert the availability of reserves that could be termed as viable for economic extraction. The geology suggests that we should continue to explore, which is what we are doing." This suggests, therefore, drilling of oil exploration wells is a work in progress.

In addition to the upstream exploration results, this section also includes the mid-stream and downstream sectors, namely the importation, storage and transportation of oil (and gas) and the refining, marketing and sale of the products (mainly methane, diesel, petrol and kerosene).

Management

The Tanzania Petroleum Development Corporation (TPDC) is the Tanzanian State Corporation through which the Ministry of Energy and Minerals implements its petroleum exploration and development policies. TPCD was established under the Public Corporations Act No. 17 through the Government Notice No.140 of 30 May 1969, and began operations in 1973. TPDC is a wholly owned Government parastatal, with all the shares held by the Treasury Registrar.

Petroleum exploration and development in Tanzania is regulated under the Petroleum (Exploration and Production) Act 1980. This Act vests powers to oversee exploration and extraction of petroleum deposits in the United Republic of Tanzania in the hands of the state. The Act, amongst others, is designed to create and facilitate a favourable legal environment to the oil exploratory and extractive companies. The Act expressly permits the Government to enter into petroleum agreements under which an oil company may be granted exclusive rights to explore for and produce petroleum. Under the Production Sharing Agreements arrangements, TPDC is permitted to enter into such agreement with the oil companies on behalf of the

Government. The terms of these agreements form the basis of the licences and are negotiable (PWYP-Tanzania, 2011).

Following the discovery of the Songo Songo gas field, and subsequent relinquishment by AGIP, TPDC undertook the confirmation of the gas field, and eventual appraisal. It is now geared to the development of the field as well as exploration in other basins in the country. TPDC holds shares in the Songo Songo Gas-to-Electricity and Mnazi Bay gas development projects. The mandate of the corporation is to spearhead, facilitate and undertake oil exploration and development in Tanzania. Exploration blocks exist in various parts of the country (

Figure 4) including in deep waters offshore where in 2000, TPDC launched exploration activities. Under a recent agreement between the mainland and Zanzibar governments exploration in and around Pemba and Unguja islands, and northernmost offshore blocks (numbers 9 to 12), will be managed by the Department of Energy on Zanzibar.

There are also various substantive and subsidiary laws that affect performances and activities of petroleum development, starting with the Constitution of the United Republic of Tanzania, though Tanzania (mainland) did not have an explicit national petroleum exploration and development policy (ESRF , 2009) until recently, when the Natural Gas Policy (2013) was formulated, aimed at rectifying the shortcomings and provide guidance to the increasing mid- and down-stream activities in the natural gas industry in Tanzania. The main objective of the Policy is to provide guidance for the sustainable development and utilisation of the natural gas resource and maximisation of the benefits there from and contribute to the transformation and diversification of the Tanzanian economy. For that reason, natural gas will be exported when domestic market has been satisfied. The Constitution states that matters of natural resources such as oil and gas are under the management of the United Republic of Tanzania, and there is provision providing that for the purposes of the efficient conduct of public affairs in the United Republic and for the allocation of powers among the organs specified in this Article. The government of URT has a National Energy Policy (1992 and 2003) and several other national development policies facilitating the promotion of the development of the petroleum industry in Tanzania. For example, the Energy and Water Utilities Regulatory Act of 2001 empowers Energy and Water Utilities Authority (EWURA) to regulate transmission and distribution of petroleum and natural gas. The Authority is obliged to monitor the performance of licensees and to take measures necessary to improve that performance. These policies are very clear on matters related with investments, production, private sector participation and development in a liberalised market environment, though they do not guarantee the position, interests and rights of indigenous Tanzanians with respect to petroleum resources. Hence it is assumed that government will represent people's interests when dealing with petroleum exploration and development firms.

Management of environmental and social aspects are the responsibility of the proponent, under the guidance and supervision of the National Environment Management Council (NEMC) who is responsible for issuing licences and monitoring the operations that have been subjected to environmental impact assessments (EIAs). The NEMC has also recently commissioned a Strategic Environmental and Social Impact Assessment (SESIA) for the upstream oil and natural gas development. The Surface and Marine Transport Regulatory Authority (SUMATRA) is finalizing the National Oil Spill Contingency Plan.

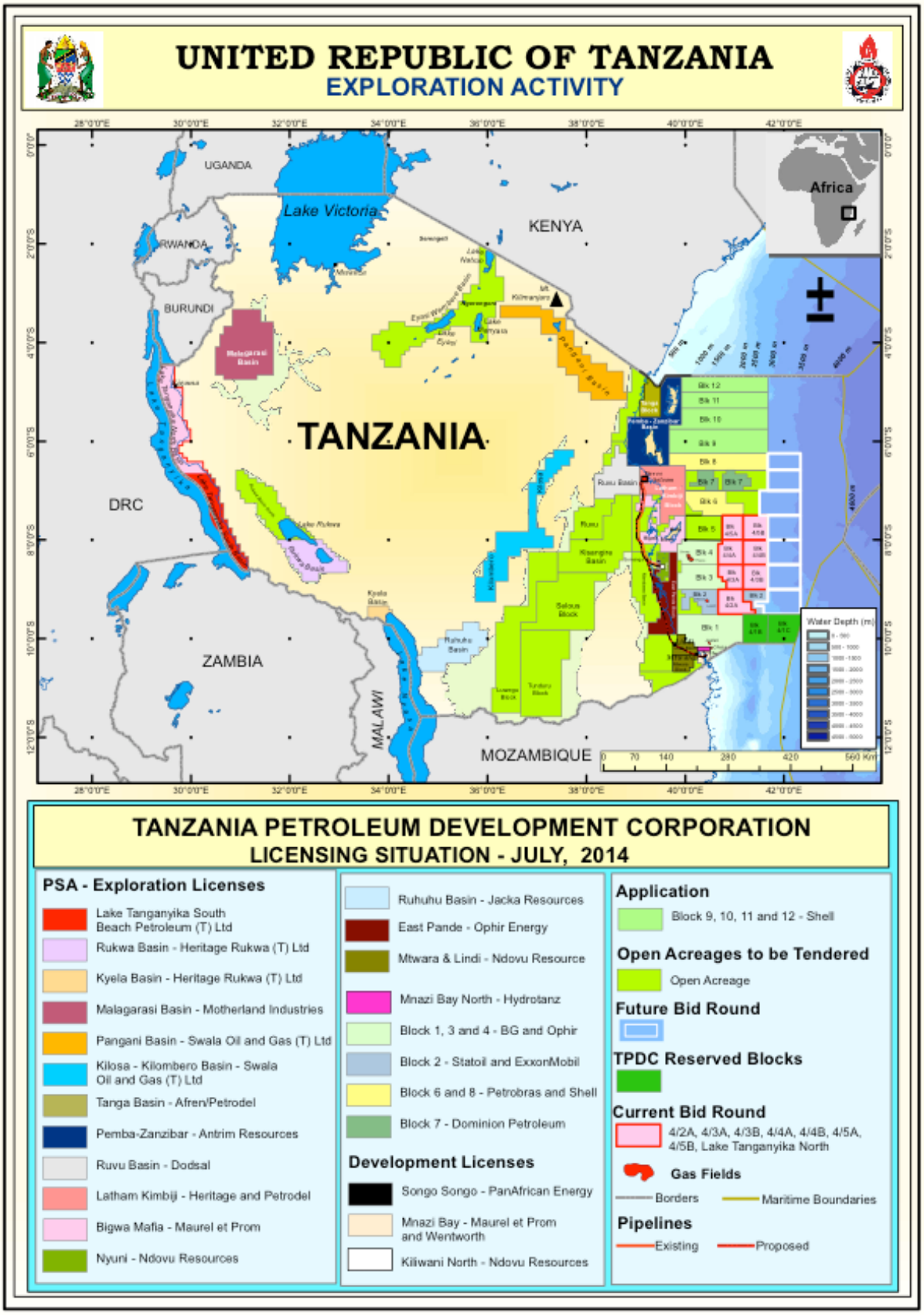


Figure 4: Tanzania Exploration blocks (TPDC, 2014)*http://www.tpdc-tz.com/tpdc/ (visited February 2015).*

Description of Hydrocarbons and their Use

Hydrocarbons are organic compounds consisting of hydrogen and carbon that may occur in three forms: solid, like coal; liquid such as crude oil or diesel; or gas (e.g. methane or propane). These compounds are predominantly used as fuel, for generation of electricity, combusted as a fuel in cars, trucks, planes or ships; or refined into diverse products and mixed with other chemicals to make plastics and related products.

In some places, due to the lack of traps, or of breached traps, hydrocarbons may leek to the surface. The presence is a clear indication of hydrocarbon generation but is not proof that deeper traps or pools exist. Geologists say that such oil is proof of a working hydrocarbon system, possibly of biogenic origin, thus not necessarily implying the presence of significant hydrocarbon reserves. On the west coast of Pemba Island off Tanzania there is one such natural oil seep. Bubbles of methane periodically emerge from the seabed around Songo Songo Island.

In Tanzania, exploration drilling started in the 1950s but initially found little reason to be enthusiastic. After extensive geological and geophysical surveys plus a few exploratory wells, no hydrocarbons were found in sufficient quantities to justify further drilling at a time when better opportunities were available in the Middle East. By 1964, exploration in Tanzania had stopped. Apart from some exploratory well drilling close to shore in the 1970s and early 1980s, with the discovery of viable methane gas reserves in southern and central Tanzania, not much happened for another 40 years. This was also partly due to local government policy, price of oil, global markets and lack of local infrastructure. By the year 2000, only 21 wells had been drilled in Tanzania but things began to change rapidly thereafter.

Stimulated by high global oil prices, support from local governments and favourable investment conditions, as well as support from international banks and even donor agencies, well-known oil companies started to explore in Tanzania. Investment in development and production of the few methane reserves already discovered, namely, in central and southern Tanzania, at Songo Songo and Mnazi Bay, took place at the start of the new millennium. There are now 17 companies with PSAs in Tanzania and over 46 new well have been drilled since 2004, bringing the total exploration wells in Tanzania to 67, of which 14 are in offshore basins. As of June, 2013 natural gas discoveries of about 42.7 TCF (7.5 billion barrels of oil equivalent – BoE) have been made from both on- and off-shore basins (URT 2013). Exploration efforts are on-going, especially focused in the deep sea, and expectations in the sector are of further discoveries. There is a general expectation that Tanzania's gas reserves could at least double within the next 10 years.

The oil and gas industry is usually divided into three major sectors: upstream, midstream and downstream.

Upstream – This sector includes the exploration and production phases, that includes the search for potential underground or underwater crude oil and natural gas fields, drilling exploratory wells, subsequently drilling and operating wells that recover and bring the crude oil and/or raw natural gas to the surface (the production phase), and corresponding developments in liquefied natural gas (LNG) processing.

The coastal districts of Mtwara, Kilwa and Mkuranga now have gas wells with viable reserves, while offshore exploration drilling in blocks number 1, 2, 3 and 4 (off the coast of Mtwara, Lindi and Kilwa) have similarly been successful. Offshore drilling has been conducted since 2010, from a shore base utilizing Mtwara Port.

Midstream – This sector involves transportation, storage and marketing of various oil and gas products. Transportation options can vary from small connector pipelines to massive cargo ships making trans-ocean crossings, depending on the commodity and distances involved. Most oil is transported in its current state, though natural gas must be either compressed or liquefied for transport.

Gas pipeline infrastructure has been installed in four locations in the coast on Tanzania, as described below:

- **Songo Songo gas and pipeline from Kilwa to Dar es Salaam.** In 1995, Ocelot Tanzania Inc. and Trans Canada Pipeline Limited (TCPL Tanzania Inc.), in partnership with the Government of Tanzania (GoT), Tanzania Electric Supply Company Limited (TANESCO) and Tanzania Petroleum Development Corporation (TPDC), created a company called Songas to implement the Songo Songo Gas to Electricity Project. The project consisted of refurbishment and operation of five natural gas wells in Songo Songo, the construction and operation of a 65 mmscf/day gas processing plant and related facilities and the construction of a 230 km marine and land pipeline from the gas plant to Ubungo in Dar es Salaam, where it drives a 310 MW gas-fired station producing electricity for the national grid. A 16 km 8-in pipeline has been extended northwards to provide natural gas to the Wazo Hill cement plant where gas has replaced fuel oil as feedstock in the manufacture of cement, and to various industrial centres in the city. The project attained commercial operations in July 2004. The majority of Songo Songo gas has been treated as accounted for by use in Dar es Salaam, with at least 60% going to power generation, and the remainder to industrial and other uses.
- **Mnazi Bay gas and pipeline to Mtwara.** This gas field 25 km southeast of Mtwara is still being developed and its output will depend to a large extent on identifying appropriate uses for the gas. At present it is used primarily to fuel a 12 MW power station supplying the local area. There are plans to considerably expand power production (up to 300 MW). Four wells have been drilled which are not fully utilised as there is no immediate demand for the gas. The Tanzanian Government is anxious to maximise the local value-added that can be obtained from the gas by using it as energy source for the manufacture of commodities such as a large cement plant, and production of urea and caustic soda, which are deemed essential for the transformation of the local economy.
- **Mtwara to Dar es Salaam pipeline.** The most significant development in this sector is the 500 km gas pipeline from Mtwara to Dar es Salaam, funded by China Export-Import Bank (EximBank), and jointly implemented by the China Petroleum and Technology Development Company (CPTDC), a unit of China National Petroleum Corporation (CNPC), and TPDC. The project is being fast-tracked to ensure construction of the pipeline is completed during 2015, which will allow for a significant increase in the production and sales of Mnazi Bay gas.
- **TAZAMA Pipeline from Dar es Salaam to Zambia.** The TAZAMA Pipeline Limited is jointly owned by the Government of Zambia (66.7%) and the United Republic of Tanzania (33.3%). The pipeline is 1,710 km in length from Dar es Salaam (Tanzania) to the Indeni Refinery in Ndola (Zambia). It was commissioned in 1968 and was originally designed for a throughput of 1.1 million tonnes per year. Currently it is capable of handling approximately 600,000 tonnes per year.

The pipeline is supported by equipment and infrastructure owned by the Tanzania Ports Authority (TPA) comprising of a 36 inch diameter sub-sea from a single point mooring buoy (SPM) located south-east of the port entrance in open sea, about 3 km offshore in Mjimwema Bay, and on land pipeline to the TAZAMA tank farm. The tank farm has six onshore tanks at Dar es Salaam comprising of three 36,000m3 capacity tanks and three 41,000m3 capacity tanks. There are seven pump stations between Dar es Salaam and Ndola; five stations are located in Tanzania and two in Zambia.

Downstream – Refining and processing (and purifying) of raw natural gas and oil (e.g. into usable products such as gasoline, jet fuel and diesel) are downstream activities. The marketing and distribution of products derived from crude oil is included in this sector. TPDC, which is presently the sole importer of oil, refines it at the TIPER refinery and then delivers the product to the marketing companies. Refined products are also imported as the refinery does not process

enough to supply the demand in Tanzania. Distribution and marketing of fuels and lubricants is carried out by Addax, Mobil, Total, BP, GapCo, GapOil, Engen and others. Most of the imported product is transported by road. There are currently 37 storage depots with a total capacity of 305,000 tonnes (Mbendi 2014).

Services and Consulting– This "sub-sector" is an increasingly important part of the oil and gas industry, assisting effectiveness and efficiency in all three major streams. Typically companies specialising in repairs, maintenance, troubleshooting, construction and operation of projects (including drilling, water filtration, engineering design), project design, implementation and environmental management, which can help with project economics, staffing, financing, risk management, geological assessment and community outreach, for example.

Major Issues

As explained by ESRF (2009), the TPDC is the major regulator on petroleum matters but the laws have empowered EWURA to execute function of TPDC as the regulatory body for the petroleum sector. Thus both have the status of regulatory body in the petroleum sector and TPDC is a very strong and strategic partner in petroleum exploration and development.

However, in practice, there are problems of TPDC assuming different and multiple roles as a player, coach and referee and its capacity is very limited. Further, consultations with people in Zanzibar suggest that TPDC has been neglecting the role and importance of the Government of Zanzibar in participating in determining petroleum activities in Zanzibar and TDPC has ignored the need to establish an office and operate in Zanzibar.

Economic Importance

Since 2004, Tanzania has been utilising the gas resources from Songo Songo and Mnazi Bay for one purpose only - to generate electricity. In Dar es Salaam, the gas supplies the Ubungu Power Station, but is also piped as fuel for industry generators (examples including the Wazo Hill cement factory, and a range of other industries from breweries to glass manufacturing). Since 2006 the cities of Mtwara, Lindi and Kilwa are supplied with electricity generated from combustion of natural gas.

The importance of the natural gas to generate power can be calculated by considering the alternative power supply options that would have to be used to generate the same electricity that has been utilised in Mtwara, Lindi, Kilwa and Dar es Salaam over the past 5-10 years. Given the general shortfall in supply from the hydroelectric supplies in the country, the alternative would be combustion of imported heavy fuels for generators. The cost of obtaining alternative fuel to provide for this electricity demand, since 2004, is of the order of several million dollars per year.

Socio-Economic Importance

Employment in the oil and gas sector is split over the three main streams discussed above, and the consulting services sub-sector. Upstream activities presently restrict local employment due to the highly specialist skills required by drilling teams, with very little opportunity for local participation in the exploration through lack of skilled personnel. The five main companies (BG, Statoil, Petrobras, Morel et Prom and Ophir East Africa Ventures) have headquarters in Dar es Salaam where some 50-100 local staff are employed. Specialist consulting services, at present mainly in environmental and social advisory roles, based in Dar es Salaam, generate income for another 20-30 local professionals. The regulatory TPDC currently has a manpower of about 130 staff.

Support services at Mtwara Port employs local contractors mainly to supply and transport materials, plus staff working in residences and offices, in security, as drivers, etc. totalling some

300-500 personnel. The two gas processing plants operating in Tanzania (Mnazi Bay and Songo Songo), employ 40-50 nationals each, while the power generation plants at Ubungo, Kilwa and Mtwara, create at least 200 jobs. The construction of the Mtwara to Dar es Salaam pipeline probably employs 200-300 permanent staff plus many hundred casual labourers. Many of these opportunities are in the least developed parts of Tanzania, districts of Mtwara, Lindi and Kilwa.

Indirect employment, through supply of foodstuffs, water, and other goods to the Mtwara-based operations base, increases the personnel involved by a further 500. Hence the upstream sector is likely to provide incomes to some 1,500 nationals. Downstream operations, mainly storage, distribution and sale of hydrocarbon products, working at petrol stations and depots, within the coastal districts of mainland Tanzania, probably generates employment for over 3,000 personnel.

The future of the oil and gas industry for Tanzania, especially in the coastal zone, can be considered likely to grow considerably. By 2015, when the LNG plant will begin to be constructed, the employment in the sector will increase significantly, to over 5,000 Tanzanians.

Threats to Sustainable Livelihoods of Coastal Communities

The baseline study by ESRF (2009) found that there are an increasing number of complex primary and secondary constraints and risks affecting the performance in oil and petroleum exploration in Tanzania. One risk of international consequence is that the operational currency is the US dollar, and that a major portion of the operational expenses, and a significant portion of investments are denominated in that currency. Similarly, the international demand and hence world market prices for oil and gas may threaten development of the sector in Tanzania.

More local threats are:

- **Degradation of the natural marine and coastal environment** and thus impact on livelihoods, from failure of exploration companies to adhere to environmental and socio-economic safeguards[41].
- **Piracy** attacks against offshore operations.
- **Damage to infrastructure and environment** from engineering design failure.
- **Social and/or political unrest** related to behaviour of the Government and stakeholders.

[41] Partly due to weakness in the oversight provided by the National Environment management Council (NEMC) which is responsible for issuing licences and monitoring the operations that have been subjected to EIAs

CRIAM Ranking of Threats to Local Communities associated with Hydrocarbons

Table 22: Prioritisation of threats to local communities and ecosystems associated with hydrocarbons. The assessment has been made using the Coastal Rapid Impact Assessment Matrix (CRIAM) approach, described in detail in Annex 3.

ThemeID	Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
M_HydroC_03	Piracy attacks against offshore operations.	Hydrocarbons	4	2	2	2	1	40	4					
M_HydroC_01	Degradation of the natural marine and coastal environment and thus impact on livelihoods, from failure of exploration companies to adhere to environmental and socio-economic safeguards, partly due to weakness in the oversight provided by The National Environment management Council (NEMC) is responsible for issuing licenses and monitoring the operations that have been subjected to EIAs.	Hydrocarbons	3	2	2	2	2	36	4					
M_HydroC_05	Social and/or political unrest related to behaviour of the Government and stakeholders.	Hydrocarbons	2	2	2	2	1	20	3					
M_HydroC_04	Damage to infrastructure and environment from engineering design failure.	Hydrocarbons	1	2	2	2	1	10	2					

Vulnerability to Climate, Climate Variability and Climate Change

Climate change is unlikely to have any impact on the resource itself, though any change to maritime conditions (including coastal weather) may impact the oil and gas sector, from exploration to mid-stream LNG plants and power generation, especially to pipelines, sites and infrastructure located in the sea or close to the shore.

Changes in Weather Patterns (precipitation, and water availability)

- No impact.

Extreme Weather Events

- Extreme sea conditions and winds may lead to leaks or worse with secondary impacts on the wider natural environment and livelihoods.

Sea-Level Rise

- No short-term impact; possible long-term need to strengthen infrastructure.

Seawater Temperature Rise

- No significant impact.

Seawater Acidification

- No impact.

Outlook

The outlook for the oil and gas industry in Tanzania, from upstream to downstream operations is likely to witness significant increase in volumes extracted and traded, income generated and employment created.

Tanzania Coastal Sand and Rock Mining

Introduction

Being Africa's third largest gold producer, the world's sole producer of the gemstone tanzanite, and a producer of cement, diamonds and other gemstones, Tanzania has an extensive and diverse mining sector (ASCLME, 2012). However, most of the mining takes place in the interior and west of the county. The coastal zone does however have mining operations focused on cement, coral and lime, with both lime and cement being produced for export throughout East Africa. The coast also provides rock and sand for the construction industry.

This sub-section describes sand extraction from east-flowing rivers and their catchments and from beaches and the mining of onshore coastal rock and live coral rock from the shallow waters. Sand extraction is also known as 'sand mining'. In Tanzania sand is indispensable for many economic development activities, such as road building and concrete production, as well as other uses such as in glass-making, and glazing for pottery. Good quality sand is sourced primarily from relatively limited sources, mainly around Lake Victoria (Yager, 2002), while marine and terrestrial deposits are the two main sources of sand for building in the coastal zone.

The mining of rock in the coastal districts produces a range of grades from chipping to aggregate and larger boulders used for foundations of homes. Most of the rock is of limestone origin though in some districts sandstones may be present. Mining is usually in open quarries that may be on village or private land. Mining of live coral, usually the boulder genus *Porites*, extracted off the seabed in shallow lagoons, takes places along the mainland coast at a number of sites, mainly in southern districts. The coral is dried and then baked to produce lime, for use in the building industry.

The Tanzania mining sector contributes nearly 4% to GDP and it formally employs 8,000 people, with an estimated 500,000 artisanal miners also active throughout the country (ASCLME, 2012). The sector also contributes 42.9% of total foreign exchange earnings. From the coastal districts, the sand, rock and coral (as rock or lime) that are mined for the building industry are usually sold by volume, in a trade that is mostly not regulated, with little if any royalties or taxes accrued to the government, other than fees to the quarry owner. Supplies to the cement factories are more regulated.

Management of the Sector

The Ministry of Energy and Minerals are responsible for issuance of mining permits while the NEMC is responsible for issuing licences and monitoring the operations that have been subjected to environmental impact assessments. The Mining Act 2010 is the over-riding legislation that governs the issuance and rights to mine in Tanzania. Mining of sand from rivers without a licence is illegal. Though sand and rock are being extracted at extremely high rates, sand is classified as a 'low value' resource and also a 'minor' mineral resource even in legislation in many countries such as India (MAC, 2007).

Mineral Policy 2009 describes medium and large scale mining operations require an environmental and social impact assessment (ESIA), as regulated by the NEMC, as well as a "Mining Closure Plan". The policy also notes that the enforcement of environmental management regulations in mining activities has been limited by lack of coordination, insufficient operational funds and inadequate experts, and that there is a need to increase environmental awareness and promote environmentally-friendly practices among small-scale miners.

Minerals defined in the policy include, beach sand under industrial minerals and stone aggregate and sand under building materials. However, live coral is not included under the mining legislation but is covered by the Ministry of Livestock and Fisheries Development assisted by the Fisheries Development Division, the institution responsible for coastal resources (particularly fisheries, but also other marine life, including corals and other marine life).

With respect to rivers and beaches, coastal wetlands, like Ramsar Sites, are managed under the Wildlife Policy (2007) and Wildlife Regulations (2009), which together with ICZM, are regulated by the Environment Management Act (EMA) (2004) as "state property".

Description of Sand and Rock Resources of the Coast and their Use

Sands

The sand excavated from river beds (usually during the dry season) is often of silica origin and suitable for the construction industry, being of too low grade for glass manufacture. The vicinity of large urban centres with an active construction sector has a high demand for sand, some of which is extracted from river beds. The volumes and locations are not well documented, yet evidence of river bed sand mining is easily seen along the coastal zone of Tanzania, usually undertaken by small-scale operators.

River sand extraction requires little equipment or expertise and is mainly undertaken by groups of youth who pile the sand up the banks onto the nearest access sites for trucks to collect and transport to the building site or a middleman re-seller. Illegal sand mining is presently a big industry in Tanzania, employing many youths, and has become a social, economic, and environmental problem - thus, it is a sensitive issue (Masalu, D.C.P., 2002). In the Ruangwa District of Lindi, sand mining is carried along Ruangwa River valley and almost all the sand that is used to build houses in Ruangwa urban comes from this river valley (http://www.lindi.go.tz/ruangwa.html).

The Kunduchi beach area north of Dar es Salaam is a well-documented example of sand mining. The majority of people who manufacture concrete blocks in Dar es Salaam obtain sand by buying lorry loads dug from local stream beds, and sand digging from stream beds employs many people.

The studies of beach erosion at Kunduchi had concluded that the erosion has been increased by certain human activities conducted in the vicinity (Masalu, D.C.P., 2002).

Rock

Rock mined from quarries in coastal districts in Tanzania, is generally either for use in the construction industry or for the two major cement producers, Portland Cement in Tanga, and Twiga Cement at Wazo Hill (Kinondoni District, Dar es Salaam). At these sites, limestone deposits have been developed for use in the cement industry. Other substantial limestone deposits are present in Lindi (Yager, 2002). Numerous small-scale crushed stone operations exist in rural areas that use labour intensive production processes. According to official statistics, about 108,000 t/year of stone and aggregate were produced in the area of Dar es Salaam; other estimates run as high as three times this figure.

Live coral rock

Coral mining is increasing to supply building material for construction along the coast (VPO, 2003). In 1998, in just two southern regions, 80,000 tonnes of live and dead coral were estimated to be mined and used for lime production. Still common in certain parts of the country, such as Songo Songo and Mtwara (Darwall & Guard, 2000), and several communities in Mikindani Bay,

Mtwara were almost entirely dependent upon coral mining for their income (Solandt & Ball 1999). Near Mikindani Bay, all *Porites* above a depth of 2 m have been removed (Wagner 2004).

Issues

Several factors, including sea level rise, geology, and rapid coastal population growth accompanied by rapid increase of human activities that interfere with natural processes, have been linked to coastal erosion in Tanzania, but one human activity in particular that is believed to have a strong linkage to the problem of coastal erosion is illegal sand mining along beaches, coastal streams/rivers, and other restricted areas (Masalu, D.C.P., 2002). This causes localised severe coastal erosion and enormous environmental degradation and threat to coastal properties, to the environment, infrastructure, and local residences through the diversion of streams and rivers (Menda, 2002).

Illegal sand mining is presently a big industry in Tanzania, employing many youths, and has become a social, economic, and environmental problem. Sand extraction also poses a threat to critical infrastructure such as bridges, roads and railway tracks (Kondolf et al., 2001). Other macroeconomic impacts have also been observed such as changes in land use patterns (Myers 2002) and increased public health costs (Myers & Muhajir I997, Mensah, 1997).

Removal of live coral results in loss of reef habitat, loss of natural breakwaters with concomitant indirect loss of adjacent coastal habitats, and loss of the aesthetic value of the reefs for tourism (Dulvy et al., 1995; Darwall & Guard, 2000). Moreover, since coral mining simplifies the surface topography of reefs, there is also a reduction in microhabitat diversity that, in turn, results in a decrease in biodiversity (Wagner 2004).

Economic Importance

The mining sector overall, has seen an average growth rate of 10.2% since 2000, and contributes 4% to GDP (ASCLME, 2012), though most of this is derived from the mining of more valuable minerals and gems. The contribution from mining of sand and rock in the coastal districts is minimal.

The Twiga and Tanga cement projects have produced over USD 125 million in tax revenue, and recent investments in these two operations are expected to generate more employment and training for employees in the coastal region. The development of new cement projects on the coast (at Kimbiji, Temeke District) and in Mtwara (planned) highlights the potential for further sustainable growth in the sector. Despite some of the environmental issues surrounding the mining sector on the coast, the incentive to invest in the region remains high (ASCLME, 2012).

Socio-Economic Importance

Overall the mining sector employs just 1% of total labour force, yet the livelihoods associated with beach and river sand extraction operations is likely to involve several thousand casual workers and in some cases women and children. Since much of the excavation of sand, rock and aggregate and mining of live coral is undertaken in the informal sector, with no regulation or management, figures of those involved are scarce.

Threats to coastal communities relying on mining sector for livelihoods

The principle threats to those engaged in the exploitation of the coastal sand and rock (including live coral mining) and to the wider coastal environment are described below:

- **Poor management** of shores (e.g. coastal developments) and river basins, lack of understanding of coastal erosion causative factors and sustainable mitigation/adaptation measures leading to loss of shoreline due to coastal erosion**.**
- **Destruction of reef protection services** from removal of live coral, threatening coastal infrastructure, farmland, villages and fisheries resources.
- **Reduced coastal sand recharge from rivers** due to over-extraction of river sand.
- **Corrupt and uncoordinated institutional enforcement** of mining policy to protect the natural environment, particularly rivers and coastline.
- **Anarchistic sand and rock extraction** from coastal zone resulting in increased erosion.
- **Loss of river basin habitat** from un-regulated sand extraction.
- **Loss of beach habitats for turtle nesting**.
- **Economic losses** through tourist abandonment
- **Loss of coastal aesthetics**
- **Increase in water borne diseases** from quarries that fill with rainwater.
- **Shallow water table contamination** from poor citing of rock quarries.

CRIAM Ranking of Threats to Local Communities associated with Coastal Sand and Rock Mining

Table 23: Prioritisation of threats to local communities and ecosystems associated with coastal sand and rock mining. The assessment has been made using the Coastal Rapid Impact Assessment Matrix (CRIAM) approach, described in detail in Annex 3.

ThemeID	Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
M_SandR_01	Poor management of shores (e.g. coastal developments) and river basins, lack of understanding of coastal erosion causative factors and sustainable mitigation/adaptation measures leading to loss of shoreline due to coastal erosion.	Sand & Rock Mining	2	3	2	2	2	36	4					
M_SandR_04	Corrupt and uncoordinated institutional enforcement of mining policy to protect the natural environment, particularly rivers and coastline.	Sand & Rock Mining	2	2	2	2	2	24	3					
M_SandR_05	Anarchistic sand and rock extraction from coastal zone resulting in increased erosion.	Sand & Rock Mining	2	2	2	2	2	24	3					
M_SandR_06	Loss of river basin habitat from un-regulated sand extraction.	Sand & Rock Mining	2	2	2	2	1	20	3					
M_SandR_07	Loss of beach habitats for turtle nesting.	Sand & Rock Mining	2	2	2	2	1	20	3					
M_SandR_02	Destruction of reef protection services from removal of live coral, threatening coastal infrastructure, farmland, villages and fisheries resources.	Sand & Rock Mining	1	2	2	2	3	14	2					
M_SandR_03	Reduced coastal sand recharge from rivers due to over-extraction of river sand.	Sand & Rock Mining	1	2	2	2	3	14	2					
M_SandR_10	Increase in water borne diseases from quarries that fill with rainwater.	Sand & Rock Mining	1	2	2	2	2	12	2					
M_SandR_11	Shallow water table contamination from poor citing of rock quarries.	Sand & Rock Mining	1	1	2	2	2	6	1					
M_SandR_08	Economic losses through tourist abandonment	Sand & Rock Mining	1	1	2	2	1	5	1					
M_SandR_09	Loss of coastal aesthetics	Sand & Rock Mining	1	1	2	2	1	5	1					

Vulnerability to Climate, Climate Variability and Climate Change

The specific vulnerabilities of the coastal sand and rock resources and those that utilise them, can be summarised under the principle climate change areas:

Changes in Weather Patterns (precipitation, and water availability)

- Run-off increased from deforested and damaged river banks due to unregulated sand extraction.

Extreme Weather Events

- Destruction of shoreline infrastructure and natural habitat from increased erosion due to loss of beach sand and live coral.

Sea-Level Rise

- **Increased erosion due to loss of beach sand and live coral.**

Seawater and Air Temperature Rise

- **No impact.**

Seawater Acidification

- **No impact.**

Outlook

With Tanzania's GDP growth rate reaching 6-7%, similar rates of growth are expected in the construction industry, thus requiring construction materials, such as bricks, limestone, sand and gravel. The extraction and mining of these materials and resulting impacts could increase substantially (Yager 2002). Given the rapid rate of urbanisation along parts of the mainland coast (especially Dar es Salaam, Tanga and Mtwara) the accompanying rates of sand and rock extraction are likely to continue rise. The outlook for east-flowing river sand extraction in Tanzania, is likely to witness significant increase in volumes traded, income generated and employment created if left un-regulated.

While financial resources are limited and environmental management remains uncoordinated, NGO involvement in coastal zone management and the development of new cement projects on the coast suggest further growth in the mining sector. Despite some of the environmental issues surrounding the mining sector on the coast, the incentive to invest in the region also remains high.

Salt Production from Evaporation of Sea Water

Introduction

This section provides an overview of the industry that produces salt (sodium chloride) from the evaporation of seawater. One litre of seawater contains approximately 36 g of salt. The majority of salt production in Africa, including Tanzania, is based on solar salt works situated in the upper intertidal zone, usually inland of mangrove forests. The main use of solar salt is for human consumption, as a vital component in diets, particularly when iodised. Other uses of lower grade, non-iodised salt, include livestock feed, use in food preservation (slated fish) and in industry.

Global demand for salt currently exceeds 230 million tonnes. Around 40% of global salt production is by the solar evaporation of seawater. Until the 1960s, China and India dominated the production of solar salt worldwide, and they still remain major producers.

Production of salt per hectares varies due to weather (e.g. rain and cloud cover, dryness and wind). The procedures used in making salt vary by geographic region, resources locally available and quantity desired by the producer and local population. The process may involve techniques such as leaching, extraction and filtering, the final step in salt production invariably required evaporation of water from brine to precipitate salt crystals (Akridge, 2008).

Based on satellite imagery analysis, along the Tanzania mainland coastline there are an estimated 3,697 hectares (ca. 37 km^2) of salt pans (www.tansea.org 2014). Most of the industry is unregulated and does not contribute to the national GDP, and there are expected to be several hundred operators.

Management of the Solar Salt Production Sector

Along mainland coast, The Ministry of Energy and Minerals regulates the salt production industry, from which permits for the construction of salt farms are supposed to be issued after consultation with the local village and district authorities. In accordance with the Environmental Management Act of 1996, which specifies that projects involving reclamation of land requires environmental impact assessments, the NEMC are supposed to approve a project. However, some farmers begin construction prior to receiving permission.

Relevant legislation include The Salt Act (1994), The Mining Act (1979), The Mining (Salt Production and Iodation) Regulations 1994, The Food (Control of Quality) Act 1978, regulations made under section 161, 2 16 (1) and (2), and The Food (Iodated salt) Regulation (1992).

Representation of the industry is achieved through the Tanzania Salt Producers Association (TASPA) and additional regional associations, such as the Mtwara Region Miners Association (MTWAREMA) which also covers other mining operations.

Description of Solar Salt Production

Types of Salt Production Systems

Mainland Tanzania has more rain than ideal for solar salt production. Despite that, solar evaporation is the most widely used method and the one that is the least capital-intensive. Others include thermal evaporation, vacuum evaporation and foothills salt collection. Solar evaporation is normally carried out during the dry seasons, with very little production during the rainy season.

Salt works usually consists of a series of evaporation ponds from the seawater intake point to the crystallizing ponds. Pond walls are constructed using impermeable clay soils available on site, hence local availability of clay is critical. The only machinery required for commercial pond

systems is water pumps. Ditches and gate structures between ponds and pipes under roads are also needed. Salt is also produced at very small-scales through boiling seawater in pans, whereby two truckloads of wood are needed to produce 1.4 tonne of salt (Muhando et al, 2010).

Production Rates

Production rates vary significantly depending on the intensity and industrialisation of the process. On Pemba, small-holders produced 28.8t/ha/year (Wolchok, 2006), whereas a large-scale, commercial salt works at full efficiency in Bagamoyo should produce at least 100 t/ha/year, though most salt works are probably producing under 50 t/ha/year (Stanley, *pers. comm.*).

In 1991, the total solar salt produced was 66,615 t, of a total of 87,567 t for Tanzania (Rahman, 1994). Based on an approximate figure of 40,000 ha of salt pans in 2013, the current national production of sea salt, using an average production figure of 50t/ha/year (see above) should be 2,000,000, but given that many of the small-scale operations are working at lower efficiencies, the annual production for coastal Tanzania is probably between 1.0-1.5 million tonnes of salt per year.

Salt Production Distribution

There are about 197 salt works in Tanzania and 193 of them are coastal salt works. Production takes place to differing degrees of industrialisation (mechanised inputs and power) in 12 of the 16 coastal districts in mainland Tanzania. There are five relatively big companies that produce the bulk of salt in Tanzania, such as Coastal Salt Works and H.J. Stanley and Sons in Bagamoyo, Kibo Match in Tanga and Sea Salt in Saadani, each with several hundred hectares of salt works. Some 180 other small-scale producers operate small-holdings with a few hectares each, selling to local markets.

Bagamoyo district supports the greatest coverage of salt works along the mainland coast, with approximately 10 km² (see Table 1). Other major contributors to the production are Mtwara Rural (6 km²) and Kilwa (4 km²).

Table 24: Solar salt works per district (TanSEA 2013)

Mainland Tanzania	Saltpan area (h)
Tanga	286.44
Mkinga (2007)	364.54
Temeke	63.62
Kinondoni	86.89
Rufiji	48.53
Mkuranga	116.52
Bagamoyo	1,106.01
Lindi Rural	199.95
Lindi Urban	269.5
Kilwa	417.03
Mtwara Rural	607.74
Mtwara Urban	130.7
Total	3,697.47

Salt Prices and Taxes

Prices vary depending on whether salt is iodised and the quality. A small-scale salt producer on Pemba retails sale in 50 kg bags at equivalent to USD 17/t (Wolchok, 2006), whereas large-scale producers in Tanzania expect to receive closer to the world price solar salt, between USD 50-60/t.

Salt for human consumption

Healthy humans require iodine, an essential component of the thyroid hormones, thyroxin and triiodothyronine. Failure to have adequate iodine leads to insufficient production of these

hormones, which adversely affects many different parts of the body, particularly muscle, heart, liver, kidney, and the developing brain, resulting in the disease states known collectively as the iodine deficiency disorders (IDD). Consequences include mental retardation and other defects in development of the nervous system, goitre (enlarged thyroid), physical sluggishness, growth retardation, reproductive failure, increased childhood mortality. The most devastating of these consequences are on the developing human brain (Mannar & Dunn, 1995). To prevent IDD, humans need around 140 micrograms of iodine a day and it is usually consumed through fish, sea vegetables and other foods of marine origin.

In Tanzania, effort to combat IDD started in the 1950s, but due to lack expertise were not successful until 1970's when the Tanzania Food and Nutrition Centre (TFNC) was formed. Surveys to determine the prevalence of goitre were conducted nationwide to establish the magnitude of the problem. The survey report showed that 41% of the population was at risk while 25% (equivalent to 5.6 million people at the time) were already suffering from iodine deficiency. Nowadays, every salt producer is required to mix the mineral with a specified amount of iodine. One kilogramme of potassium iodate costs approximately USD 44, enough for around 19t.

The TDHS 2004/05 surveys also recorded a high coverage of iodated salt; 74% of households had salt which had been iodated. However, the survey revealed a lack of adequately iodated salt in several regions; for example, Zanzibar, Mtwara and Lindi have much lower percentages of households with iodated salt than other parts of the country. To increase coverage, greater monitoring of salt trading is required, as well as stronger measures to support small-scale salt producers, especially in areas identified with low iodation. The small-scale salt producers in Tanzania are largely responsible for the non-iodated salt in the market (Leach & Kilama 2009).

Major Issues

The solar salt industry in Tanzania continues to suffer from inconsistent iodisation, with southern regions of Mtwara and Lindi having the poorest levels of iodised salt consumption. Local producers claim that as a result of high prices for iodine, hardly 18 % of produced salt in Mtwara region is iodised, unlike the past, when government subsidies for salt producers, increased iodisation to over 90%.

Since 2003, the Government has set out to do more intensive monitoring of the salt production sites and enforcement of salt iodation regulations in partnership with the Tanzania Salt Producers' Association. However, salt producers stated that in most cases, no serious legal action has been taken against non-compliant facilities, resulting in a market flooded with non-iodated or inadequately iodated salt, which was observed selling at a lower price than adequately iodated salt (Assey et al 2009).

There are grave concerns in the industry on the taxes and levies which salt producers are required to pay, increasing operation costs. The levies include rent, village and mining taxes as well as a levy which is paid to the Ministry of Natural Resources and Tourism - collectively these levies as known as "nuisance" taxes. In addition, producers are obliged to charge VAT (18%) on the saleable product which makes it more expensive to the consumer. VAT is not charged on other food products. The financial burdens are a disincentive to development of the sector.

Small scale salt producers usually have limited financial means and lack access to technical assistance. As a result, the salt produced is of poor quality. Inputs identified to improve production are improvements to technology and product quality, to health hazards among workers; better organisation of supply chains from small-scale producers to industrial plants and private consumers; and need for training programs and strengthening of the cooperation with public institutions.

Economic Importance

Production Revenues

Trends in the industry suggest that on the mainland coast there is an increase in production, with availability of suitable land not being an issue. Recent new industries include Sawa Salts in Kibaha and Sea Salt Saadani. A new development has been the development of refined salt plants as a new business opportunity, where raw sea salt is purchased and refined industrially.

Contribution to national GDP is low, based only on taxes and levies paid by the few larger companies who produce 60-80% of the total solar salt.

Overall Exports

In general, the Tanzania solar salt produced is of low quality which is not suitable for export.

Socio-Economic Importance

Though of low GDP significance, salt production is more significant with respect to the vital importance of salt for human nutrition acting as the main conduit of introducing iodine into the diet of Tanzanians, hence local salt production is extremely important since it should be cheaper than importation.

Employment on salt works is based on a core staff to run and maintain the operations plus an additional input of personnel recruited specifically for harvesting. Though employment figures are difficult to find, estimates based on commercial operations and small-scale salt works (UNICEF, 2007), suggest that between 3,500-5,000 people may be employed in the sector along mainland Tanzania's coast.

For example, UNICEF (2007) suggests that for Tanzania as a whole, over 6,500 people, mainly women, are involved in this type of small-scale salt production.

Threats to Coastal Communities Relying on Solar Salt for Livelihoods

No threat exists to the availability of salty seawater, though the following are noted threats that could affect livelihoods of those involved or the wider environment:

- **Loss of suitable habitat** for artisanal (non-pump) and industrial systems into which to expand/adapt, particularly with respect to land and availability of clay for dykes.
- **Lack of government support** with infrastructure (e.g. roads) and land ownership.
- **Unplanned urbanization** in some areas reduces land availability into which to expand
- **Unsustainable practices** resulting in degradation of mangrove forests for ponds and timber (for boiling salt water), causing losses to the wider environment with respect to shelter from wave action to fisheries production.
- **Sea level rise** threatening infrastructure (dykes and buildings, etc.).
- **Local population IDD hazard from low iodisation of salt** from small-scale producers in Mtwara and Lindi.

CRIAM Ranking of Threats to Local Communities associated with Salt Production from Evaporation of Sea Water

Table 25: Prioritisation of threats to local communities and ecosystems associated with salt production from evaporation of sea water. The assessment has been made using the Coastal Rapid Impact Assessment Matrix (CRIAM) approach, described in detail in Annex 3.

ThemeID	Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
M_Salt_05	Sea level rise threatening infrastructure (dykes and buildings, etc.).	Salt Production	2	2	2	3	1	24	3					
M_Salt_02	Lack of government support with infrastructure (e.g. roads) and land ownership, and corruption.	Salt Production	2	2	2	2	1	20	3					
M_Salt_04	Unsustainable practices resulting in degradation of mangrove forests for ponds and timber (for boiling salt water), causing losses to the wider environment with respect to shelter from wave action to fisheries production.	Salt Production	2	2	2	2	1	20	3					
M_Salt_03	Unplanned urbanization and land availability into which to expand (in some areas).	Salt Production	1	2	3	2	1	12	2					
M_Salt_01	Loss of suitable habitat for artisanal (non-pump) and industrial systems into which to expand/adapt, particularly with respect to land and availability of clay to construct dykes.	Salt Production	1	1	3	2	2	7	1					
M_Salt_06	Local population IDD hazard from low iodisation of salt from small-scale producers in Mtwara and Lindi.	Salt Production	1	1	2	2	1	5	1					

Vulnerability to Climate, Climate Variability and Climate Change

Based on assessments made by MACEMP (2009), SMOLE (2010) and GCAP (2012) the specific vulnerabilities can be summarised under the principle climate change areas:

Changes in Weather Patterns (precipitation, and water availability)

- Unseasonal precipitation affecting evaporation and production.
- Changes in wind pattern causing changes in evaporation rates.

Extreme Weather Events

- Extreme rainfall significantly damages the salt work structure (dykes).

Sea-Level Rise

- The need for salt works to retreat may result in unavailability of adequate space and/or clay soils needed to build salt pan dykes.

Seawater Temperature Rise

- No significant impact, possibly beneficial to evaporation, thus boosting production.

Seawater Acidification

- No impact.

Outlook of the Solar Salt Production Industry

Based on the information uncovered, it seems that the solar salt industry has room for expansion in coastal Tanzania, to the benefit of the wider economy and population, and the livelihoods of those involved.

12 NATURAL RESOURCES

Introduction

The coast of Tanzania stretches over a distance of 650 km, with an orientation approximately north-south, extending from latitude 4°49'S at the border with Kenya to the border with Mozambique at latitude 10°28'S. The coast is exposed to the Southern Indian Ocean and is subject to incoming waves generated by the monsoon winds and local storms. There are a large number of islands that shelters the mainland from the waves, some of these islands are very large (notably Zanzibar, Pemba and Mafia) with length of 50-100 km and lies at a distance of several tens of kilometres offshore. There are also a large number of smaller islands lying almost as fringes close to the mainland. 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 (Francis et al. 2001).

About two thirds of the coastline has fringing reefs, often close to the shoreline, broken by river outlets such as the Rufiji, Pangani, Ruvuma, Wami and Ruvu (Dubi 2000). Features of interest within the coastal zone include the coastline, continental shelf, corals, mangroves, and seagrass beds. These are characterised by high marine biodiversity and rich marine and coastal resources (Francis and Bryceson, 2001). Rivers such as Pangani, Wami, Ruvu, Rufiji, Matandu, Mbemkuru, Lukuledi and Ruvuma all flow to the Indian Ocean and to a certain extent influence the coastal environment through creation of productive brackish water environments in estuaries, maintenance of deltas, tidal flats and shorelines and nourishment of mangroves and seagrass beds (Francis and Bryceson, 2001). These coastal ecosystems subsequently interact with each other and together sustain a tremendous diversity of marine life, which supports the livelihood of coastal communities. A wide range of important and valued species are found along the coast, including an estimated 150 species of corals in 13 families; 8,000 species of invertebrates; 1,000 species of fish; five species of marine turtles, at least 20 species of marine mammal and many seabirds (Francis and Bryceson, 2001).

This section presents in brief an overview of the coastal features of mainland Tanzania, followed by a description of the marine or coastal resources, grouped as follows: coral reefs, seagrass beds, coastal birds, coastal wildlife (marine mammals, turtles). Mangrove forests are included under the theme on forestry (page 69).

Management of the Sector

The institution responsible for coastal resources (particularly fisheries, but also other marine life, including corals and turtle) is the Ministry of Livestock and Fisheries Development assisted by the Fisheries Development Division. The Fisheries Act (2003), the National Fisheries Policy and Strategy Statement (NFPSS) (1997) and supportive Fisheries Act No. 22 (2003) and Fisheries Regulations (2009) address various marine issues and species, with the Fisheries Act specifically covering turtles, and Sections 43 and 44 prohibiting the use of explosives to kill fish or destroying aquatic flora; and possession of poison within the vicinity of any water body containing fish, respectively.

The overall goal of the National Fisheries Policy is to promote conservation, development and sustainable management of fisheries resources for the benefit of present and future generations. On fisheries resources and aquatic environmental protection, the policy mentions the requirement to integrate conservation and sustainable utilisation of the fisheries resources into the socio-economic programs of the community, encourage and support all initiatives leading to the protection and sustainable use of fish stock and aquatic resources and to protect the productivity and biological diversity of coastal and aquatic ecosystems through prevention of

habitat destruction, pollution and over exploitation. Among the strategies stated by the policy as a means to achieve that objective is promoting protection of fragile ecosystems, ecosystem processes and throughout their life. The policy specifically addresses protection of coral reefs, and adopting relevant regional and international protocols and treaties for protection and conservation of fisheries resources and aquatic environment.

Some key fisheries programs include the National Strategy for Growth and Reduction of Poverty (MKUKUTA), National Strategy for Urgent Actions on Conservation of Coastal, Marine, Lakes, Rivers, And Dams Environment (2008), Strategy for Urgent Action on Land Degradation and Protection of Water Catchment (2006) and the National Integrated Coastal Environment Management Strategy (NICEMS). The NICEMS combines administrative and issue based boundaries by involving various sectors linked to coastal resources based on seven strategies that need to be implemented by the year 2025, including ICZM, environmentally friendly approaches, conserve and restore critical habitats and areas of high biodiversity.

In addition to Fisheries legislation, the Marine Parks and Reserves Act No. 29 of 1994 provides for the establishment of marine protected areas and the protection and conservation of coastal and marine life including turtles and other species of special significance or considered endangered or threatened under international conventions or agreements. However, coastal birds are not covered in the implementation of the Fisheries policy and unless the species are of global significance in any way, there status remains unprotected in Tanzania.

Coastal wetlands are important sources of fishery products, and, like Ramsar Sites, are managed under the Wildlife Policy (2007) and Wildlife Regulations (2009), which together with ICZM, are regulated by the Environment Management Act (EMA) (2004) as "state property". The Local Government (District Authorities) Act (1982) provides the platform for districts to implement the Fisheries Master Plan (2002) and Integrated Coastal Management (ICM) Policy (2000) and recent regulations on the Integrated Coastal Zone and Environment Management (ICZM) Regulation (URT in draft 2013).

The EMA 2004 provides for the legal and institutional framework for the sustainable management of the environment, outlines principles of environmental management, environmental impact and risk assessment, prevention and control of pollution, waste management, environmental quality standards, public participation in environmental decision making and planning; and environmental compliance and enforcement implementation of international instruments on environment. Furthermore, the EMA also provides a mechanism for prevention and control of pollution (Part VIII), whereby it is an offense to allow poisonous or noxious liquid from manufactory processes to flow into a stream or to discharge any hazardous substances, chemical or oil or their mixture into a water body or other environment.

Pollution is also addressed in the National Environmental Policy (1997) which emphasises on the application of the "polluter-pays" principle which shall be adopted and implemented as a deterrent. In principle, it shall be the responsibility of those who pollute to repair and bear the costs of pollution caused and rehabilitation, where appropriate. National Science and Technology Policy (1996) includes pursuit of strategies to monitor the status of the environment, promoting knowledge and awareness on environmental issues, preserve biodiversity on land and in the sea, and prevent pollution of water resources. Meanwhile the Merchant Shipping Act No.21 of 2003 provides for, among others, pollution prevention and protection of marine environment and marine security. Section 369 of the Act prohibits discharge of oil or oily mixture anywhere at sea unless under special circumstances.

The Local Government (Urban Authorities) Act No 8 (1982) and Local Government (District Authorities) Act No. 7 (1982) state that the respective authorities may perform (among others) the following functions in respect of water supply and sanitation: prevent the pollution of water in any river, stream, water course, well or other water supply in the area, and for this purpose

prohibit, regulate or control the use of such water supply. Finally, the Water Resources Management Act, 2009 (Act No. 11/ 2009) also creates offenses and stipulates severe penalties against water pollution in rivers, streams or watercourses or in any body of surface water.

Description of Natural Resources of the Coast and their Use

The coast of Tanzania includes a narrow coastal belt varying in width from 20 to 150 km on the Tanzania mainland, the offshore waters and the associated islands (Kent et al., 1971). The narrow coastal belt along the Tanzania mainland runs more or less in a northerly direction for 800 km. This narrow belt is characterised by low-lying coastal plains that rise towards the hinterland to an elevation of about 200 m at the border with the inland plateau (Macmillan 2008). The coastal belt is widest along the Dar es Salaam embayment where it extends 150 km inland (Kent et al. 1971, Kapilima 1984). However, it is relatively narrow north and south of the Dar es Salaam embayment where its width is about 20 km (Kent et al. 1971). Low-lying coastal plains are also a characteristic feature for the offshore islands, but the highest altitudes on the islands are generally lower than those on the mainland (Kent et al. 1971).

The major offshore islands, Pemba, Unguja and Mafia, are all located within 100 km of the mainland. Pemba is separated from the mainland by a deep channel (800 m), while Unguja and Mafia are separated by a relatively shallow channel whose depth is less than 65 m. Both Unguja and Mafia islands are situated on the continental shelf, while Pemba is located off the continental shelf. There is also a small oceanic island, Latham Island (or Fungu Mubarak) that is under the jurisdiction of Zanzibar.

Mafia Island is a coral limestone island established on the continental shelf and was probably part of a Pleistocene inshore coral reef system which is now separated from the mainland by relatively shallow (30-50 m deep) channel (McClanahan 1988). The continental shelf, covering an area estimated to range between 17,500 and 17,900 km^2 (up to a depth of 200 m) is generally narrow with the narrowest point being 2 km and the widest 80 km. The shelf drops sharply after a depth of 60 m.

The mainland coast also contains numerous small islands; some are raised fossil coral platforms and others sandbanks. They include Yambe and Karange (off Tanga), Songo Songo and Fanjove (off the Kilwa coast) and Mbudya and Bongoyo off Dar es Salaam. 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.

Coastline types

Francis et al (2001) broadly categorise the mainland coastline into four shoreline types, as follows:

Cliffed Shorelines

Limestone cliffs predominate on headlands, along large lengths of the shoreline in the southern districts of mainland Tanzania (especially Lindi and Kilwa), as well as on the east coast of Mafia Island, Temeke and Tanga districts. The limestone (of Pleistocene age or earlier) is 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

Parts of the mainland coast in the north of the country are 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.

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, notable in Saadani and Pangani districts. Dunes are limited and only found in two locations southern Tanzania (south of Mtwara town near Msimbati) and south of Rushungi and Kiswere Harbour in Kilwa. Both areas are covered by sparse vegetation.

Deltaic Shorelines

This type is characteristic of low-lying coastal areas that receive a large supply of terrestrial sediments. They are associated with river as well as tidal deltas or creeks. There are at least 15 rivers of over 25 km in length that discharge their waters, sediments and nutrients into the coastal waters of Tanzania, though only five or six are perennial rivers, the remainder flowing only during the wetter months from December to May. The mouths of the rivers are characterised by the presence of deltas, estuaries (some with sandy spits and mangrove forests (see Forestry theme, page 69).

Coral reefs

More than two-thirds of the coastline has fringing reefs (i.e. Mafia, Mkinga, Tanga, Mafia, Kilwa and Mtwara) totalling 3,580 km^2 in area, interrupted only near estuaries. Due to the narrowness of the continental shelf, reefs are generally situated close to shore, within a distance of 1-5 km (ASCLME, 2012). Tanzania's reefs support about 150 species of scleractinian corals and are one of the most productive and diverse marine ecosystems in Tanzania waters with over 500 species of commercially important fish and numerous invertebrates (e.g. sea cucumbers, lobsters, and octopus), providing fishing grounds to 95% of artisanal fishing (ASCLME 2012).

Coral reefs provide shelter as well as feeding, breeding and nursery grounds, are natural barriers that restrain beach erosion by holding back the cruising oceanic waves, preventing beach erosion. Their well-being affects the surrounding seagrass beds, intertidal zones and mangrove forests as well as other marine life, and support 70% of the artisanal fish yield.

Overall reef health is probably good in most parts especially in less accessible and deeper areas i.e. the Mafia, Songo Songo and Kilwa (Saada 2005). The most degraded coral reefs arethose found in shallow waters (1-10 m), especially near urban centres of Tanga, Dar es Salaam and Mtwara (Mohammed et al. 2002). Over the past few decades, a number of factors have contributed to the degradation of coral reefs. The closeness of the reefs to land make them particularly prone to human impact, either from exploitation or from indirect terrestrial influence such as sedimentation and pollution. Many of the reefs were severely affected by the coral bleaching event of 1997-1998 that reduced the average live coral cover from 52% before bleaching to about 27% after the event (Wells et al., 2004). Follow-up assessments and monitoring indicated that although the impacts were not uniform, generally recovery has been very slow (Mohammed et al., 2002).

Seagrass and algal beds

Over 300 species of seaweed and 12 species of sea grasses are found in Tanzania, playing an important ecological role as habitat for micro-organisms and fish. Seaweed farming is important in Zanzibar, but to a lesser extent on the mainland (see Fisheries theme, page 37). Seagrass in mainland waters, typically found in the coastal fringing reefs and bays act as binding elements for sediments and as fish habitat and substrate provision for nursery, spawning, refugia, food and foraging areas as well as nutrient recycling, dampen strong wave actions and slowing water currents (NEMC, 2009). Through their root base, sea grasses filter and bind sediments and thus prevent sedimentation over coral reefs hence protecting the shoreline from erosion (Saada 2005). They also enhance primary productivity, are important fishing ground and a vital food source for turtles and dugong.

The most extensive seagrass beds are found in Tanga coast, deltas of Ruvu, Wami and Rufiji rivers, Mafia and Songo Songo archipelago and around Kilwa. The precise areas covered by seagrass beds and the relative species densities in Tanzania are not well known (Whitney *et al.* 2003).

Birds life

The avifauna of Tanzania includes a total of 1,108 species of which 23 are endemic, 4 have been introduced by humans, and 43 are rare or accidental, with 36 species which are globally threatened (Wikipedia, 2014). A wide variety of coastal birds and seabirds are found particularly in mangrove forests, intertidal flats and on rocky cliffs. Waders and shorebirds visit Tanzania in large numbers each year between August and May to feed on intertidal flats during low tides. There are 17 Important Bird Areas (IBAs) designated by Birdlife International in the coastal districts on mainland Tanzania (Baker, N.E. and Baker, E.M, 2002). Coastal villagers occasionally harvest eggs and chicks from shorebirds (e.g. nesting reef herons), thought the impact on numbers is very low.

Marine mammals

Whales, dolphins and dugongs are some of the marine mammals that frequently occur in the marine coastal waters of Tanzania. There are at least 33 species of marine mammals reported from the wider Western Indian Ocean (Berggren, 2009). The following are the species most likely to be present at any time: Sperm whale, Humpback whale, Indo-Pacific bottlenose dolphin, Indo-Pacific humpback dolphin, Spinner dolphin and Spotted dolphin. Humpback whales are regularly observed near the coast during their migration season between July and November.

Prior to the mid-1970s, dugongs were both abundant and widely distributed along the Tanzania coast. Ray (1968) identified Rufiji and Kilwa as the last remaining refuges for dugongs along the Tanzania coast and until recently, dugongs were thought to have disappeared from northern Tanzania - their former stronghold. Recent studies of dugong distribution and migration along the Tanzania coast show that they are associated with areas of extensive seagrass beds particularly in the Rufiji delta and Mafia-Kilwa area which has a viable dugong population. Dugong is one of the most endangered species on the African continent and is on the IUCN Red list. In Tanzania, dugong numbers are estimated to be no more than 100 individuals (Ngusaru *et al.,* 2001) and populations have declined significantly in recent decades possibly to the point where they cannot recover.

Marine turtles

Five species of marine turtles occur in Tanzania's coastal waters. These are the green, hawksbill, loggerhead, olive ridley and leatherback turtles. The first studies on the status, distribution, uses of and threats to turtles in Tanzaniawere conducted by Frazier (1976, 1980). However, it was not until the early 1990s that more widespread efforts to conserve turtles were made, and it was only recently that more comprehensive surveys were conducted in Mafia, Pemba, Unguja, Saadani, Temeke and Mtwara.

The green turtle is the most common nesting species in Tanzania, with population size estimates from the mid-1970s putting the total number in the whole of Tanzania at approximately 300**.** Maziwe Island south of Tanga was considered the most important breeding ground for turtles in Tanzania and East Africa as a whole, but in the 1980s, Maziwe Island submerged as a result of erosion and now exists as a shifting tidal sandbank on top of Maziwe reef (Howell and Mbindo, 1996)**.** Concentrated nesting activity occurs on Mafia Island (Juani Island and Kungwi), in Saadani (Madete) and Mtwara (Msimbati and Litokoto and Kingumi Islands) (Khatib, 1998a, 1998b; Pharaoh *et al,* 2003; Muir 2005).

The main nesting season is between February and July. Evidence from tag returns indicate that some green turtles are probably resident while others are highly migratory, moving to other nesting and feeding grounds in Kenya, Seychelles, Comoros, Mayotte, Europa Island and South Africa. It is estimated that the annual nesting population of green turtles in Tanzania is about 150 (Muir, 2005).

Hawksbills are also widely distributed but are less abundant, with few records from small remote islands off Dar es Salaam, Shungumbili Island and Juani Islands in Mafia and the Songo Songo archipelago. No nests have been recorded on the mainland coast (Muir, 2005). The main nesting season is during the North East monsoon between December and April. Hawksbill is a migratory species and Tanzania coast harbours both residents and migrants (Muir, 2005).

The three other species are present in far fewer numbers. Olive Ridley turtles were observed nesting on Maziwe Island south of Tanga in the mid-1970s but after submerged ad no further nesting records for this species have been made (Muir, 2005), though local fishermen note that they are occasionally accidentally caught in gillnets along the Mtwara, and Mnazi Bay Ruvuma Estuary Marine Park. Loggerhead turtles are relatively rare in Tanzania, though the Mafia area may be an important foraging grounds for this species, based on three tagged animals were caught in southern Tanzania in 1976, from tagging at their nesting grounds in Tongaland and Natal in South Africa (Muir, 2003). The leatherback turtle used to nest in Zanzibar in the 1970s (Frazier, 1976), but few specimens have been seen since, and those that are present may be migrating to nesting sites in Natal, South Africa.

Tanzania has extensive seagrass beds and coral reefs which can support considerable numbers of turtles (Howell & Mbindo, 1996), particularly off the southern Rufiji Delta (Kichinja Mbuzi and Toshi) including Mohoro Bay (Fungu ya Kasa) and around Mafia Island. In Mtwara, important turtle foraging habitats exist in Mnazi Bay and off Msimbati (Guard, 1998; Muir, 2003).

Issues

Increasing degradation of the ecosystems due to various anthropogenic activities including destructive fishing methods and over-exploitation are evident, especially where there has been rapid increase in coastal populations. High pressure on finite coastal natural resources has resulted in degradation of critical coastal ecosystems with the potential to reduce the ecosystem goods and services offered (e.g. from coral reefs and seagrass beds). This has the potential to affect the socio-economic livelihoods of the local communities in Tanzania.

In addition to intensity of resource extraction, water and coastal pollution are increasing along the mainland shores. Increased economic activities and expanding populations in coastal towns of Tanzania have resulted in production of large amount of waste including sewage and industrial effluent. High levels of PCBs and organochlorine pesticide residues have been detected in Dar es Salaam harbour (Machiwa, 1992; Mwevura et al. 2002). Raw sewage and industrial effluents produced in all coastal towns are directly released into estuaries and other coastal habitats, notably in Dar es Salaam, Tanga, Kilwa and Mtwara. Away from coastal towns, pollution of coastal waters is caused by fertiliser residue contained in run-off from agricultural areas, with evidence of nutrient enrichment (ASCLME, 2012).

Economic importance

The coastal and marine resources of mainland Tanzania provide an extremely valuable source of food and other commodities to the local populations and those inland. The economic importance of fish, seafood, farmed seaweed, harvested mangrove products and the value of these ecosystems to the tourism sector have been described in other themes.

Less simple to define in economic terms but often clear to envisage are the value of estuaries, fringing corals reefs and seagrass beds, the presence of marine mammals, turtles and coastal birds. However, estuaries are clearly critical to the survival of tens of thousands of birds, mammals and fish. Many different habitat types are found in and around estuaries, including shallow open waters, freshwater and salt marshes, sandy beaches, mud and sand flats, rocky shores, oyster reefs, mangrove forests, river deltas, tidal pools, sea grass beds, and wooded swamps (Muhando, C. and Rumisha, C.K., 2008). Being protected from strong waves and currents, they are function as recreational and educational sites. Estuaries serve as nursery grounds for many commercial fish and shellfish. Estuaries are also home to all the ports and harbours of Tanzania mainland that support shipping and other industrial and commercial activities.

Coral reefs and associated seagrass beds support over 70% of the artisanal fish production in Tanzania (Saada, 2005) thus employing over 50,000 full time fishermen, with a sustainable yield estimated at 15 tonnes of fish per km^2 (Munro and Williams, 1985). Coral reefs also provide a natural barrier to waves and storm surges that protect the shores from erosion. Corals have been a source of lime and building rocks for centuries, though the excavation of living coral is now forbidden as it conflicts with the protection of reef for their productivity and shoreline protection services.

The diversity and abundance of coastal bird life, marine mammals and turtles, and rare and iconic fish such as whale sharks and coelacanths for example, though without direct monetary value are important in focusing international attention of the Tanzania coast, thus a potential boost to the tourism sector, but also to the role and duty of Tanzania towards international obligations related to biodiversity and endangered species conservation.

Socio-economic importance

The coastal habitats described above (coral reefs, seagrass beds, estuaries, beaches and rocky shores) provide the environment from which diverse resources are harvested by a large number of the coastal population. These have been described in other themes.

Coastal communities have consumed marine mammals for centuries, though they have rarely been the target of any specific fishery. Recently, a more focused fishery for dugongs, whales, dolphins and turtles has been reported, albeit in low numbers, using gill-nets, mainly for food. The local trade in turtle meat in Mtwara district was an important and lucrative business in the past, and despite being a signatory to the CITES, and Tanzania successfully reducing export markets for turtle products, the trade in tortoiseshell and other products continues to be noted in Mtwara, Rufiji district (Muir, 2005) and along Lindi and Kilwa coasts. In Tanga, turtle oil is used mainly as a cure for earache and in Mtwara turtle oil is applied to the skin to heal burns and rashes. In other parts of Tanzania, turtle oil is used to treat asthma, hernias and muscle ache and is occasionally used to waterproof traditional wooden dhows (Clark and Khatib, 1993).

Threats to coastal communities relying on sector for livelihoods

The principle threats to those engaged in the exploitation of the coastal resources and to the wider coastal environment are described below:

- **Poor management** of the shores (e.g. coastal developments) and lack of understanding of coastal erosion leading to loss of shoreline.
- **Illegal (destructive) fishing** damaging seaweed, seagrass beds and coral reefs[42].

[42] e.g. beach seining, dynamite fishing

- **Tourist activities** damaging seagrass beds and coral reefs[43].
- **Poor upstream agriculture on Pemba** affecting seaweed and seagrass productivity[44].
- **Waste disposal**, in solid and liquid form causing harm to seagrass beds and estuaries[45].
- **Coral bleaching** from El Nino sea surface temperature rise damaging coral reefs
- **Coral mining** for the lime industry significantly destructive to reef ecosystems, especially in Kilwa, Lindi and Mtwara districts.
- **Pollution of coastal watersheds** poses a threat to estuaries[46].
- **Pollution through nutrient enrichment**, particularly from sewage disposal, altering the structure of coral reef ecosystems[47].
- **Sedimentation of coral reefs** from river discharges, sewage discharges and dredging.
- **Habitat alteration** from land use changes[48].
- **Introduction of invasive species** can often result in unexpected ecological, economic, and social impacts on the estuarine environment.
- **Invasive Indian house crow** causing loss of bird diversity through ferocious predation on eggs of local bird species thus threatening indigenous populations.
- **Gillnetting** possess the greatest threat to dugongs.
- **Shrimp trawling** threatening turtles.
- **Gillnetting** threatening turtles (adults and sub adults).
- **Gillnetting** threatening whales, especially migrating Humpback whales.
- **Seismic surveys** by oil and gas companies deterring whales, especially migrating Humpback whales with calves.

[43] e.g. trampling when wading, boat anchorage

[44] Agriculture practises increase sediment loads, and turbidity thus reducing photosynthesis, especially during the west season.

[45] Debris comes from many sources, including improper disposal of trash on land, storm water runoff and combined sewer overflows to rivers and streams, ships and other vessels.

[46] Entering waterways through storm drains, industrial discharges, runoff from farmlands, discharges from sewage treatment plants, being toxic or harmful to biological systems with long lasting effects, as well as having a negative visual impacts on estuarine environment

[47] Through the overgrowth of algae and shading from increased algae production in the water column.

[48] Filling of marshes and tidal flats (e.g. conversion to salt works), and reconstruction of shorelines to accommodate the needs of development, transportation, and agriculture, can degrade estuaries and creeks.

CRIAM Ranking of Threats to Local Communities associated with Natural Resources

Table 26: Prioritisation of threats to local communities and ecosystems associated with salt production from evaporation of natural resources. The assessment has been made using the Coastal Rapid Impact Assessment Matrix (CRIAM) approach, described in detail in Annex 3.

ThemeID	Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
M_NatRes_02	Illegal (destructive) fishing (shallow water prawn trawling, beach seining and dynamite fishing), damaging seaweed, seagrass beds and coral reefs.	Natural Resources	3	3	3	2	2	63	4					
M_NatRes_01	Poor management of the shores (e.g. coastal developments) and lack of understanding of coastal erosion causative factors and sustainable mitigation/adaptation measures leading to loss of shoreline due to coastal erosion.	Natural Resources	3	2	2	2	2	36	4					
M_NatRes_06	Coral bleaching from El Nino sea surface temperature rise damaging coral reefs	Natural Resources	3	2	2	2	1	30	3					
M_NatRes_04	Poor upstream agriculture increases sediment loads, increased turbidity and reduced photosynthesis, affecting seaweed and seagrass productivity.	Natural Resources	2	2	2	2	2	24	3					
M_NatRes_05	Waste disposal, in solid and liquid form causing harm to seagrass beds and estuaries where marine debris enters from storm sewers, or especially after heavy rains. Debris comes from many sources, including improper disposal of trash on land, storm water runoff and combined sewer overflows to rivers and streams, ships and other vessels.	Natural Resources	1	2	3	2	2	14	2					
M_NatRes_11	Habitat alteration such as the filling of marshes and tidal flats, and reconstruction of shorelines to accommodate the needs of development, transportation, and agriculture, can degrade estuaries.	Natural Resources	2	1	3	2	2	14	2					
M_NatRes_13	Invasive Indian house crow causing loss of bird diversity through ferocious predation on eggs of local bird species thus threatening indigenous populations.	Natural Resources	1	2	3	2	2	14	2					
M_NatRes_07	Coral mining for the lime industry significantly destructive to reef ecosystems, especially in Kilwa, Lindi and Mtwara districts.	Natural Resources	1	2	2	2	2	12	2					

ThemeID	Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
M_NatRes_18	Seismic surveys by oil and gas companies deterring whales, especially migrating Humpback whales with calves.	Natural Resources	1	2	2	2	2	12	2					
M_NatRes_03	Tourist activities destroying seagrass beds and coral reefs (e.g. trampling when wading, boat anchorage).	Natural Resources	1	1	2	2	2	6	1					
M_NatRes_08	Pollution of coastal watersheds poses a threat to estuaries, entering waterways through storm drains, industrial discharges, runoff from farmlands, discharges from sewage treatment plants, being toxic or harmful to biological systems with long lasting effects, as well as having a negative visual impacts on estuarine environment.	Natural Resources	1	1	2	2	2	6	1					
M_NatRes_09	Pollution through 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.	Natural Resources	1	1	2	2	2	6	1					
M_NatRes_10	Sedimentation of coral reefs from river discharges, sewage discharges and dredging.	Natural Resources	1	1	2	2	2	6	1					
M_NatRes_12	Intentional or accidental introduction of invasive species can often result in unexpected ecological, economic, and social impacts on the estuarine environment.	Natural Resources	1	1	3	2	1	6	1					
M_NatRes_14	Gillnetting possess the greatest threat to dugongs.	Natural Resources	1	1	3	2	1	6	1					
M_NatRes_15	Shrimp trawling threatening turtles.	Natural Resources	1	1	2	2	2	6	1					
M_NatRes_16	Gillnetting threatening turtles (adults and sub adults).	Natural Resources	1	1	3	2	1	6	1					
M_NatRes_17	Gillnetting threatening whales, especially migrating Humpback whales.	Natural Resources	1	1	3	2	1	6	1					

Vulnerability to Climate, Climate Variability and Climate Change

The Tanzania mainland coastal economy is very dependent on the climate and a large proportion of GDP, employment and livelihoods are associated with climate sensitive activities such as fishing, and farming. The specific vulnerabilities of the coastal ecosystems and species described above and those that utilise them, can be summarised under the principle climate change areas:

Changes in Weather Patterns (precipitation, and water availability)

- Run-off and river flows affecting salinity and siltation and thus fisheries productivity in coastal ecosystems (coral reefs and seagrass beds), including breeding grounds.
- Unseasonal precipitation affecting various activities[49].
- Changes in wind pattern will thus change fishing behaviour.

Extreme Weather Events

- Fishing effort reduced due to limited access to fishing grounds in small vessels.
- Moorings and fisheries infrastructure (landing sites, coastal villages) affected by erosion.

Sea-Level Rise

- Combined with extreme weather events (above) sea level rise will increase beach erosion, threatening coastal infrastructure.
- Erosion of beaches threatening turtle nesting sites.
- Erosion threatening near shore marine habitats (from smothering from suspended particles in the water column, as well as from reduced light penetration).

Seawater and Air Temperature Rise

- Alteration of marine biodiversity, possibly resulting in extinctions and/or species migration, potentially affecting coastal fisheries.
- Warmer waters can favour plankton transition and enhance fish growth rates.
- Coral bleaching is temperature related and in turn affects fisheries.

Seawater Acidification

- Increasingly acidic will have major effects on shell-forming organisms[50].

Outlook

The outlook on coastal ecosystems along mainland Tanzania's coast is that the areas close to large urban centres (particularly Tanga, Dar es Salaam, Kilwa, Lindi and Mtwara) will continue to experience degradation from various anthropogenic impacts, with current pressure damaging their integrity and productivity. These areas represent a relatively small portion of the total coverage of the coastal ecosystems, some 20-30%, consequently, at present, most of the natural coastal environment is not damaged from over-harvested, destructive fishing gears, riverine, urban or agricultural pollution, because of distance from severe anthropogenic influences. There remains considerable opportunity to conserve the productive status of much of the coastline.

[49] e.g. seaweed farming and drying (affect quality of the dried product)

[50] CO_2 is absorbed by water to become carbonic acid, causing pH to drop, is expected to have major effects on shell-forming organisms (notable corals and molluscs).

13 FRESHWATER RESOURCES

Introduction

With a few small exceptions, Tanzania is virtually surrounded by water. The Indian Ocean borders to the east while a series of small lakes and dams lead the northern perimeter to Lake Victoria. The western border comprises Lake Tanganyika, with Lake Rukwa close by, while the south-west corner fringes Lake Malawi. Much of the southern border is the Ruvuma River. Nine watersheds, including wetlands, lakes and rivers, cover most of the landscape, though some central areas are extremely dry with little surface water and overall, Tanzania is challenged by a high degree of water resource variability both spatially and temporally. National mean annual rainfall is 1,071 mm but the Lake Tanganyika basin and the southern highlands can receive up to 3,000 mm annually while about half the country receives less than 762 mm annually. Coastal districts receive around 1,000 mm per year.

Water resources are critical to Tanzania's population, its economy (key to the agricultural sector and for industrial production). Water in Tanzania's rivers and reservoirs generate over half of the country's grid electricity through hydropower installations; and water flows nurture the ecosystems, provide numerous provisioning services while also supporting the tourism sector.

Management of the Sector

The Ministry of Water is entrusted with the responsibility of developing and managing water resources of the country. In order to manage the water resources in a sustainable manner, the Ministry has adopted a river basin as a planning unit. The objective of the river basin approach is to manage water resources in an integrated and comprehensive manner, which ensures equitable, efficient and sustainable development of the resources. In 1989, through the Water Utilisation ((Control and Regulation) Act No. 42 of 1974, Amendment No. 10 of 1981) the Minister for Water gazetted nine water basins for the purposes of water resources administration and management. Six of these basins are international drainage basins. The Government established Water Basin Offices in the Pangani River Basin (1991), Rufiji River Basin (1993), Lake Victoria (2000), Wami-Ruvu (2001), Lake Nyasa (2001), Lake Rukwa (2001), Internal Drainage Basin to Lake Eyasi, Manyara and Bubu depression (2004), Lake Tanganyika (2004), Ruvuma and Southern Coast (2004). There are nineteen urban water authorities charged with regulating the resource and resulting sewerage.

According to the current water laws in Tanzania, water belongs to the state and all water abstracted from a river or stream must be accompanied by a "water right" obtained from the water officer. Water right defines the amount of water to be abstracted, its purpose, and the duration of the right and also the source of the water. A water right, or part of it, can be transferred along with land. There is no other provision in the current legislation for sale or other types of direct transfers of water rights (Lein, H and Tagseth, M., 2009). Customary or traditional rights to water have coexisted with the statutory water licences since their inception. In communities with a long-standing practice of traditional irrigation, rightful access to water is seen as a matter of usufruct, inheritance or local custom.

The National Water Policy (NAWAPO) 2002 provides a comprehensive framework for sustainable development of water sources. It gives a direction for proper development, management and utilisation of these sources. For the implementation of the NAWAPO, the Ministry has developed a National Water Sector Development Strategy 2006 – 2015 and a Water Sector Development Programme 2006 – 2025. The National Water Sector Development Strategy defines roles and responsibilities of all stakeholders and priorities of the sector reforms in the implementation of the National Water Policy.

The NAWAPO emphasises river basin as the administrative unit and the vision of integrated water resources management. Human needs are defined as a first priority before environmental flow, while water allocation for "other uses will be subject to social and economic criteria, which will be reviewed from time to time". Furthermore, the policy states that "in order to realise the objectives of water resources management, all water uses, especially water use for economic purposes, will be charged for". The principle that "water has a value in all its competing uses" and the volumetric pricing of water in order to increase efficiency, are also recognised. Trading of water rights is to be introduced as a means of demand management and water conservation.

With respect to wetlands, the Environment Management Act, Section 47, specifically singles out wetlands, by empowering the Minister to declare any area which is ecologically fragile or sensitive to be an Environmental Protected Area; take into account the natural features and beauty of the area, flora and fauna, unique or special geographical, physiographical, ecological or historic and cultural features, or any special scientific feature or biological diversity; consider the interests of the local communities; and, comply with any international obligation under any agreement to which Tanzania is a member (e.g. Ramsar). Under Section 51 any area can be declared and protected, and under Section 52, this includes swamps and wetlands. Section 54 allows, in consultation with Sector Ministry, this to be extended to a river, river bank, lake or lakeshore as a protected area and impose any restrictions as he considers necessary for its protection from environmental degradation. The National Environment Regulations state that "Each Local Government shall after the recommendation of the appropriate local environmental committee make by-laws. a) Identifying river banks and lake shores within their jurisdiction which are at risk from environmental degradation; b) Promoting soil conservation measures along river banks and lake shores..."

In 2000, Tanzania joined the international convention on wetlands management known as the Ramsar Convention of 1971. Accordingly, Tanzania produced its first National Wetlands Strategic Plan (2003-5). This plan was revised in 2006-8 and has become popularly known as the national "Sustainable Wetlands Management Program" (SWMP) based on a draft National Wetlands Strategy. SWMP is managed by a National Sustainable Wetlands Management Steering Committee (NAWESCO), which is made up of nine Ministries at Permanent Secretary level. NAWESCO is the oversight body of SWMP, and is chaired by Ministry of Natural Resources and Tourism (MNRT) and is assisted by a technical body - the National Wetlands Working Group which is made up of 35 institutions. The Wildlife Division in the MNRT is the Secretariat to these bodies, through the Wetlands Unit.

Description of Freshwater Resources and their Use

Wetlands can be categorised by several biotomes, from open water (a true aquatic environment that is permanently inundated), to periodically flooded (an intertidal or inter-flood zone) where seasonally water rises to inundate the area, to periodically saturated but on higher ground, with water logging for a small part of the season. In Tanzania, the Wildlife Policy (2007) estimated that 10% of the country surface area, is wetlands, 7% are natural freshwater wetlands (79,450 km^2), 3% of freshwater wetlands (27,000 km^2) are freshwater swamps, marshes, deltas and seasonal floodplain, and 3% is coastal shoreline, salt marshes, intertidal zones, estuaries, and mangrove forests.

Wetlands hold water on land and in intertidal zones where "wetland ecosystem services" become life support functions available for plants and animals, of which several are consumed by humans. Wetlands are so diverse in nature and function, that they perhaps contain and support almost 60-70% of all biodiversity in Tanzania.

Coastal River Basins

The coast of Tanzania has four river basins that discharge into the Indian Ocean, the Pangani, Ruvu-Wami, Rufiji and Ruvuma (**Error! Reference source not found.**). The Rufiji is the largest iver in Tanzania, with a mean annual discharge estimated to range between 900 and 1,133 m^3/s and contributing 50% of Tanzania's total freshwater discharges to the sea (Welcomme, 1972; Hafslund 1980; Francis *et al.*, 2001). The mouths of most of these rivers are characterised by the presence of deltas, estuaries and mangrove forests. These estuary areas, and inshore water beyond, are extremely productive to fisheries thanks to the freshwater inputs that are accompanied by dissolved nutrients and sediment.

The Rufiji delta covering an area of about 1,200 km^2 is the largest estuarine mangrove forest in East Africa, with an estimated surface area of 53,200 ha. Other important rivers include the Ruvuma with a mean annual discharge of 475 m^3/s, the Wami and the Ruvu, both with mean annual discharges of 63 m^3/s, and the Pangani with a mean annual discharge of 27 m^3/s (see Table 27). The remaining rivers such as the Matandu (Kilwa), Mbwemkuru and Lukuledi (Lindi) are strongly seasonal and considered relatively less important in terms of freshwater discharges to the Indian Ocean.

The flow pattern of all the rivers is directly related to the general rainfall pattern. Relatively higher river discharges occur during the period November- May (peak flow in March-April) and lower discharges occur during the dry season from June to October.

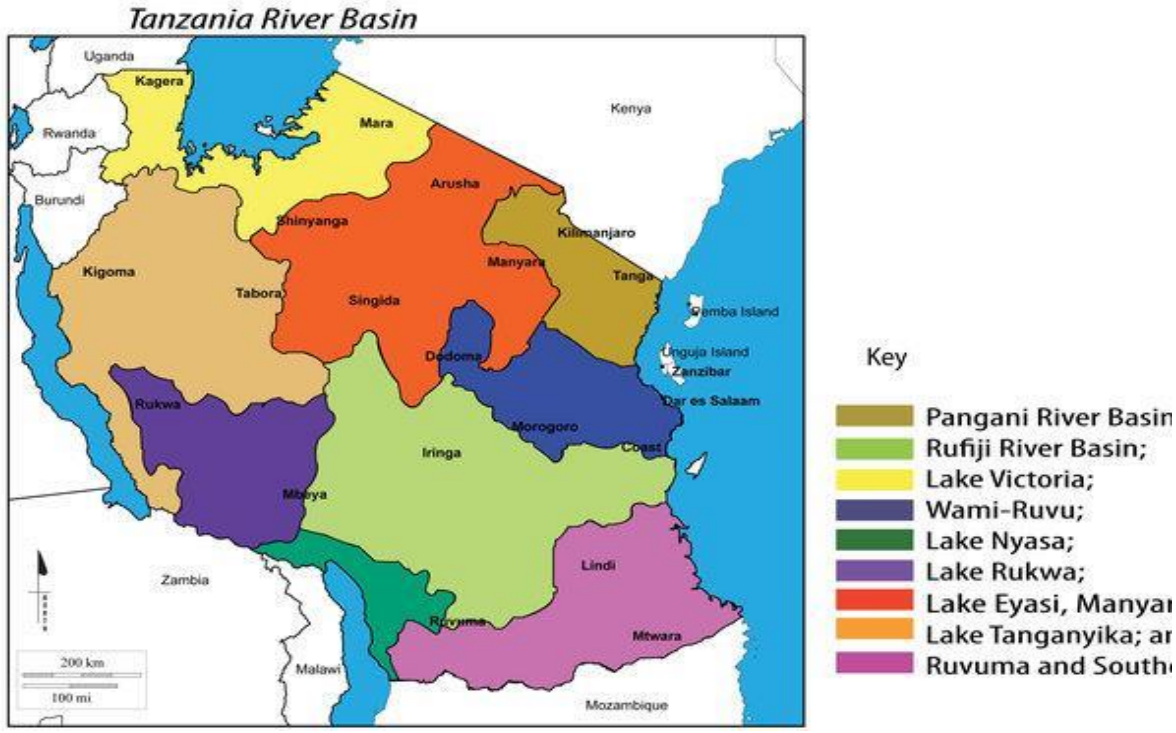


Figure 5: Tanzania coastal river basins (north to south): Pangani, Wami-Ruvu, Rufiji and Ruvuma.

Source: http://www.tpsftz.org/eac-article/river-basin

Aquifers

When water sits on land, in a wetland, it will also percolate (or seep) through the soil and ends up stored in underground aquifers or groundwater reservoirs. Underground aquifers store around 97% of the world's unfrozen fresh water and provide safe drinking water for between 25-50% of the global population who tap this through wells and boreholes – and they play an important role in irrigated agriculture.

Table 27: Major and minor rivers of the Tanzania coastline (modified from Welcomme 1972; Francis et al. 2001).

River	Length (km)	Catchment area ('000 km^2)	Mean annual discharge (m^3/s)
Rufiji	640	177.4	900-1,133
Ruvuma	640	52.1 (in Tanzania)	475
Wami	490	46.4	63
Ruvu	270	18	63
Pangani	395	42.1	27
Matandu	-	18.6	-
Mbwemkuru	-	16.3	-
Likuledi	-	13.0	-

There is not much detailed information on the shape and size of Tanzania's aquifers (IWMI 2010), despite their use for extraction of water via boreholes, in some cases hundreds of metres deep. The IWMI 2010 study concludes that considering that groundwater in Tanzania is likely to be the key resource to improve the water supply coverage in many areas under the changing climate, the development of groundwater should be carefully managed to make full benefit of its potential, to protect its quality and to guard against over-exploitation of the aquifers.

Using historical information from hydrocarbon prospecting and traditional geological information Ruden (2007) has demonstrated the existence of a new and sizeable freshwater aquifer system in coastal Tanzania, called the Kimbiji Aquifer, situated along the coast south of Dar es Salaam. Results from geophysical well logging, groundwater sampling, aquifer testing, combined with regional seismic information from historical oil surveys and oil exploration well logs, reveal the existence of a significant and hitherto unknown coastal aquifer system which extends over an area of some 1000 km^2 and is approximately 1000 m deep on average. The volume estimate of this aquifer system is on the order of 1000 km^3 of water of acceptable quality, and subject to further study and definition has the potential to meet Dar es Salaam's future water demands. Early results indicate that the aquifer system is susceptible to cross-flow between aquifer units and surface pollution unless stringent protective measures are taken during future well construction and installations.

Issues

Anthropogenic activities related to demand for water for irrigation, livestock, land use changes and hydropower developments have contributed to degradation of the river basins and significantly reduced the fresh water discharges of Tanzania's east flowing rivers, at least during the last five decades (Shaghude, 2006, 2008; Sosovele, 2007; Duvail and Hammerlynck, 2007). Land use changes within the upper catchments of the rivers have contributed to the degradation of the river basins with corresponding reduction in the freshwater discharges (Shaghude, 2008). In some of the rivers such as the Pangani, Wami and Ruvu, the situation is considered to be critical with multiple socio-economic conflicts and potential ecological and environmental impacts at the coast (Mwandosya *et al.*, 1998; Shaghude, 2006; Yanda and Munishi, 2007).

In the Rufiji River Basin for instance, the total annual discharge is estimated at 28,382 Mm^3 (million cubic metres), which are contributed by the three tributaries and flows from the Lower Rufiji. Of this total flow, the irrigation developments on the Great Ruaha River consumes about 1,490 Mm^3, while the evaporative losses from the Mtera dam are estimated at 1,277 Mm^3, making a total reduced flow of about 2,747 Mm^3, which is also approximately 10% of the Rufiji Basin annual discharge. The reduced flow may have profound effects on the dry season fresh water

discharges to the sea by the Rufiji, which is estimated at 300 m^3/s (Shaghude, 2008).

The management of wetlands is the responsibility of many institutions in Tanzania, but lack of coordination between institutions has in the past resulted in poor management, lack of accountability, inability to respond to changes in wetlands, and failure to partition responsibilities between institutions (Bakobi, 1991). From 2004 developments involving works or operations in the bed/banks of a river or stream are required to undertake Environmental and Social Impact Assessments (regulated by the NEMC, Dept Environment, VPO), in consultation with the Ministry of Water and Livestock Development and the local authority concerned.

Economic importance

The importance of Tanzania's freshwater resources cannot be underestimated. In monetary terms it is difficult to quantify, yet it provides drinking water for the entire population, for industrial production, and is critical for agriculture. In addition, hydropower provides 55% of the country's power generation. Adequate water flows support Tanzania's forests, grasslands, and coastal resources, which provide provisioning services (such as food, fodder, fuel wood, timber and other products) and other services (water purification, climate regulation, cultural and supporting services). Water flows in national parks and protected areas support the tourism sector, a key foreign exchange earner.

Socio-economic importance

The freshwater supplies of Tanzania are possibly the single most valuable resource to the population. Millions of livelihoods depend on it, particularly agriculture that employs some 80% of the population. Several thousand jobs are related to the management of the water, typically in the various urban and river basin authorities, as well as in NGOs engaged in water conservation.

Threats to coastal communities relying on freshwater for livelihoods

The principle threats to those reliant on freshwater systems and to the wider wetland environment are described below:

- **Inefficient environmental management of wetlands** leading to removal of riverine vegetation, erosion of riverbanks, pollution of water bodies from municipal waste dumping, agricultural practices or mining (minerals and river sand), abstraction for water for agriculture (or livestock) or hydropower generation.
- **Corruption with the management sectors** wasting water or revenues from water usage.
- **Degradation of catchments** due to land use changes and livestock keeping.
- **Population and economic growth** leading to ever increasing demand for freshwater.
- **Deterioration of river flows** leading to reduced estuarine and marine productivity, especially of delta prawn and small pelagic species (e.g. sardines).
- **Pesticide pollution of river deltas** from poor agricultural practices resulting in reduced crustacean and fisheries productivity and poisoning of edible marine life.
- **General lack of information** on the patterns of climate change and their impacts on the hydrology of the Tanzanian river systems draining into the coast.
- **Lack of updated data on current river discharges** leading to failure to comprehensively monitor river discharges.

CRIAM Ranking of Threats to Local Communities associated with Freshwater Resources

Table 28: Prioritisation of threats to local communities and ecosystems associated with salt production from evaporation of freshwater resources. The assessment has been made using the Coastal Rapid Impact Assessment Matrix (CRIAM) approach, described in detail in Annex 3.

ThemeID	Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
M_Fresh_04	Population and economic growth leading to ever increasing need for freshwater.	Freshwater Resources	3	3	3	2	3	72	5					
M_Fresh_01	Inefficient environmental management of wetlands leading to removal of riverine vegetation, erosion of riverbanks, pollution of water bodies from municipal waste dumping, agricultural practices or mining (minerals and river sand), abstraction for water for agriculture (or livestock) or hydropower generation.	Freshwater Resources	3	3	3	2	2	63	4					
M_Fresh_03	Degradation of catchments due to land use changes and livestock keeping.	Freshwater Resources	3	3	3	2	2	63	4					
M_Fresh_07	General lack of information on the patterns of climate change and their impacts on the hydrology of the Tanzanian river systems draining into the coast.	Freshwater Resources	3	2	2	2	2	36	4					
M_Fresh_08	Absence of updated data on current river discharges leading to failure to comprehensively monitor river discharges.	Freshwater Resources	3	2	2	2	1	30	3					
M_Fresh_05	Deterioration of river flows leading to reduced estuarine and marine productivity, especially of delta prawn and small pelagic species (e.g. sardines).	Freshwater Resources	2	2	2	2	2	24	3					
M_Fresh_06	Pesticide pollution of river deltas from poor agricultural practices resulting in reduced crustacean and fisheries productivity and poisoning of edible marine life.	Freshwater Resources	1	1	2	2	2	6	1					
M_Fresh_02	Corruption with the management sectors leading to waste of water or revenues from water usage.	Freshwater Resources	1	1	2	2	1	5	1					

Vulnerability to Climate, Climate Variability and Climate Change

The analysis of impacts is challenging due to the high uncertainty from the climate models in terms of average, seasonal and daily trends of future precipitation. Rainfall patterns and water flows projection vary widely, including both spatially and temporally within seasons. The potential future impacts of climate change include:

Changes in Weather Patterns (precipitation, and water availability)

- Unpredictable rainfall affecting water supply and water balance, thus affecting surface water and groundwater recharge and likely to exacerbate water supply problems.
- Increased pressure on water resources due to the potential decreases in rainfall during the dry season, when tourist demand is highest.
- Changes in flows affecting water quality and wastewater treatment.
- Unpredictable rainfall affecting water supply and water balance, thus affecting surface water and estuarine discharges and ecological and sediment processes.

Extreme Weather Events

- Affecting surface water and estuarine discharges and ecological and sediment processes, potentially exacerbating erosion of catchments, riverbanks, estuaries and nearby shorelines.

Sea-Level Rise

- Saltwater intrusion of wells and aquifers close to the shore or estuaries.

Seawater and Air Temperature Rise

- Household and tourism water demand increases with higher temperatures.[51]
- Agricultural water demand increases with higher temperatures, due to the combination of evaporation and plant transpiration rates.

Seawater Acidification

- No impact.

Outlook

In 2007, Tanzania's renewable water resources per capita was 2,291 m^3 (WRI, 2010), which is not classified as water scarce according to the Falkenmark Water Stress Indicator. However, the country's population has grown rapidly in the last 50 years, going from 10 million in 1960 to approximately 45 million in 2010 (UNESA 2010). The projected population for 2015 is 52 million, at which point the country's per capita water resources will fall below 1,700 m^3 per person, the definition of water scarcity. By 2030 the population is expected to be around 75 million and by 2050 it is projected to reach 109 million, further lowering per capita water resources. Based on the above, the future outlook is clearly one of insufficient water to meet the needs of the population, particularly the large urban centres on the coast as well as in the north of the country, areas where local water supplies are least abundant.

[51] Higher consumption, use in shower, garden irrigation, evaporation from swimming pools, etc.

14 MANAGEMENT FRAMEWORK FOR COASTAL ZONE MANAGMENT

Introduction

This overview provides a summary of the institutions, principle laws and technical/research facilities charged with the responsibility for management of the coastal zone of mainland Tanzania. The present population within Tanzania's coastal zone is approaching 10 million (URT, 2011). There are myriad ways in which these citizens interact with the marine environment – the challenge is the means to management these interactions so as to promote sustainability and prosperity.

Management of the Sector

There are over thirty national legislation documents with particular relevance to coastal and marine resources and environment management. As described in the preceding thematic overviews, these, relate to natural resources, maritime transport, waste management and pollution, water resources, forestry and agriculture, urbanisation, infrastructure, industry and others. An additional twenty to thirty international conventions to which Tanzania is signatory are also relevant to the coastal zone. Although financial and human resources have constrained the effective implementation of the diverse legislative mechanisms from operating at their full capacity, they do generally complement each other.

It is hoped that in the long run the implementing agents of these laws and policies will be allocated sufficient funds to enable them to improve enforcement operations. Tanzania is still in the process of implementing reforms in its legal sector; old and outdated laws are repealed and replaced by new ones, while the current trend in the enactment of new laws indicates a great likelihood that there will eventually be a strong enforcement machinery (ASCLME, 2012).

One piece of legislation that embraces most development activities in the coastal zone is the Environmental Management Act (EMA) 2004. This Act provides a legal and institutional framework for the sustainable management of the environment. All project activities, especially oil and gas exploration, industrial aquaculture, ports and harbours must be planned and comply with its relevant provisions, particularly the need to undertake an environmental and social impact assessment (ESIA) depending on the type of activity and scale. The implementation of the EMA 2004 is the responsibility of the National Environment Management Council (NEMC), under the Division of Environment.

The implementation of the legal instruments related to the coastal districts (and relevant hinterland areas, typically watersheds) begins with central government authorities, directed to regional authorities and further devolved to the district authorities for implementation. At various stages along this process, additional stakeholders may become involved, from international funding agencies interacting with central government ministries, and security services, to local non-governmental organisations and private sector groups working on the ground with local authorities.

Description of Management Framework

As with all parts of the country, the livelihoods and natural environment within the coastal districts of Tanzania are managed by laws and policies under diverse ministries. Five regions (Mtwara, Kilwa, Coast, Dar es Salaam, and Tanga) are coordinated by their regional administrations, overseeing a total of 15 districts. Of these, six are urban districts or municipalities (Mtwara Urban, Lindi Urban, and Tanga Municipality) plus the three

municipalities in the Dar es Salaam region. Each district (or municipality) is run from a district or municipal council. District and urban councils have autonomy in their geographic area, their councils coordinate the activities of the township authorities and village councils, which are accountable to the district for all revenues received for day to day administration. The village and township councils have the responsibility for formulating plans for their areas.

The head of the paid service is the District Executive Director (DED) in the district authorities and the Town/Municipal/City Director in the urban authorities. Typically, below the Director there are a number of Heads of Department. The Departments are many and may include: personnel and administration; planning and finance; engineering or works; education and culture; trade and economic affairs; urban planning; health and social welfare; cooperative, agriculture and livestock development; forestry, fisheries and community development. With respect to coastal zone management, the most important district staff are forestry and fisheries, though because of the multi-sectoral involvement in the coastal zone, many of the district departments are likely to be involved. Consequently, the implementation of the national legislation relevant to the coastal zone is shared between the various tiers of government, and other institutions (Table 29).

Table 29; Institutional arrangement, roles and responsibilities relevant to coastal zone management.

Institution	Roles and Responsibilities
Sectoral ministries (Energy and Minerals; Fisheries and Livestock Development,	• Issue policy guidance and provision of legal frameworks • Issue licenses, provisions of certificates of compliance • Enforce laws and regulations • Set operation standards for sector projects
Vice President's Office (NEMC)	• General supervision and coordinating over all matters related to environmental management. • Conduct environmental audit and environmental monitoring • Conduct surveys to assist proper management and conservation • Review/recommend for approval of environment impact statements • Enforce/ensure compliance of national environmental quality standards • Initiate/develop procedures and safeguards for the prevention of accidents which may cause environmental degradation and evolve remedial measures where accidents occur • Provide advice/technical support where possible to all stakeholders
Vice President's Office - Division of Environment	• Coordinate various environment management activities in country • Advise the Government on legislative and other measures for the management of the environment • Advise Government on international environmental agreements • Monitor and assess activities, being carried out by relevant agencies in order to ensure that the environment is not degraded • Coordinate implementation of the National Environmental Policy
Ministry of Livestock Development and Fisheries	• Manage marine parks through Marine Parks and Reserves Unit (including Mnazi Bay-Ruvuma Estuary Marine Park, and Mafia Island Marine Park) and other Marine Protected Areas (MPAs) • Manage RAMSAR Convention sites (Kilwa-Mafia-Rufiji)
Tanzania Petroleum Development Council (TPDC)	• Facilitate oil and gas exploration and development in Tanzania. • Provide basic information on hydrocarbon exploration/ prospects • Set quality/safety standards to protect people, property/environment
SUMATRA	• Enforce maritime safety and pollution prevention
Regional Secretariat Offices	• Oversee/advise implementation of national policies • Oversee enforcement of laws and regulations • Advise on implementation of development projects/activities
District Executive Directors	• Head executive officer for all development activities at District level
District Planning/ Natural Resource/Fisheries/Health/Community Development Departments/Forestry etc.	• Plan and coordinate activities on community-based natural resource and environment management • Enforce laws and regulations • Provide baseline data on social and economic conditions • Extension services
District Environmental Committee	• Coordinate environmental matters at the District level
Wards Development Committee: Ward Councillors, WEO, Ward Extensionists, Ward Environment Committees)	• Oversee general development plans for the Ward • Provide information on local situation extension services • Provide technical support and advice

Institution	Roles and Responsibilities
Assorted leaders (religious, teachers, traditional chiefs, elders etc.); Communities groups (farmers, fishers, women, youth, etc.), including Beach Management Units (BMUs).	• Provide information on local social, economic, environmental situation • View on socio-economic value of proposed drilling operations • Acting as watchdog for the environment, ensure well-being of residents and participate in development activities.
WWF and IUCN East Africa Regional Office Mangrove Management Project Local NGO/CBO	• Support, monitoring and management of the MBREMP and MIMP • Mangrove Forest/environment conservation • Socio-economic development in the area • Safeguard of natural environment

National and sector plans and strategies

There a numerous plans and strategies within Tanzania's ministries that are directly relevant to the livelihoods and environment of the coastal zone, most of which are described in the individual sectoral overviews. One strategy that is perhaps the most relevant is the Urgent Strategy to Conserve Ocean Environment, Coastal Zone, Lakes, Rivers and Dams: Vice President's Office, June 2008. The strategy was formulated by the Division of Environment, Vice President's Office in 2008 in response to President Kikwete's call for urgent strategies to preserve the Tanzanian environment. The strategy (section 2) recognizes the ocean and coastal zone as important areas both economically and socially.

Current exploitation of marine gas reserves at Songo Songo (Kilwa district) and Mnazi Bay (Mtwara district) and explorations of oil are recognized as among the main resources found in the ocean. Degradation and pollution of coastal zone and marine environment is identified among the main challenges. Section 3, subsection (vi) of the strategy matrix points out gas and oil exploration activities particularly at Songo Songo and Mnazi Bay area as among the potentially main causes of pollution of coastal zone and marine environments. The proposed long-term implementation mechanisms include identification of affected areas and overseeing implementation of management plans of gas/oil exploration and exploitation areas by government ministries responsible for environment, energy and Regional Administration and Local Governments.

Natural Resource Research and Non-Governmental Organisations

A diverse range of institutions plays important parts in the preservation of the coastal environment on which millions of Tanzanian livelihoods depend.

Sector Specific Research Institutes

The government has established three institutes with an overall mandate of providing scientific information and advice to government on matters relating to the sustainable management of natural resources. These include Tanzania Fisheries Research Institute (TAFIRI), Tanzania Forestry Research Institute (TAFORI), and Tanzania Wildlife Research Institute (TAWIRI).

Institute of Marine Sciences, University of Dar es Salaam

The Institute of Marine Sciences is a research and education department of the University of Dar es Salaam, with the mandate to conduct research and offer postgraduate and undergraduate training and consultancy services in all aspects of marine sciences. The IMS vision is to become a centre of excellence in the advancement of knowledge in marine science. The Institute is also the National Oceanographic Data Centre and holds various coastal and ocean data and information.

Tanzania Coastal Management Partnership (TCMP)

The TCMP established the Science and Technical Working Group (STWG) in July 1999. TCMP is a joint initiative between the Government of Tanzania, the National Environmental Management Council (NEMC), the United States Agency for International Development (USAID) and the Coastal Resources Centre (CRC) of the University of Rhode Island (URI). The main goal of TCMP is to establish the foundation for effective coastal management in Tanzania. TCMP is committed to working with the existing network of Integrated Coastal Management (ICM) programme and practitioners to facilitate a participatory transparent process to unite the Government and the community, science and management, sectoral and public interests with a primary goal of conservation and development of coastal ecosystems and resource. STWG is intended to provide the primary bridge between coastal managers and the science community studying coastal marine issues at the local and national level. More specifically, STWG provides a clearinghouse mechanism for the integration of science and better coastal management. The Institute of Marine Sciences (IMS) of the University of Dar es Salaam provides the Secretariat to the STWG and the IMS Director is the Chairperson of the Group.

WWF Tanzania

WWF, one of the world's largest independent conservation organizations has been actively involved in conservation work in eastern Africa since 1962. As part of an ongoing global structuring, the geographical concentration will be in coastal East Africa focusing at the coast from Kenya to Mozambique. This programme has combined conservation and climate change issues, including coastal zone management in Tanzania where the focus area has been the Rufiji-Mafia-Kilwa Seascape (a recognized Eastern Africa Marine Ecoregion of global importance) (EAME 2004). Mafia Island Marine Park has been a beneficiary of Norwegian aid support for the first few years of its existence, implemented through WWF.

The International Union for Conservation of Nature (IUCN)

The world's largest and oldest global environmental network with more than 1,000 government and NGO members. IUCN's mission is to influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable. Between 2000 and 2009 the IUCN was actively engaged in support for natural resource management programmes (with different funding sources) in the districts of Rufiji (Netherlands grant), Tanga (Irish Aid) and Mtwara's new marine park (French government support through the GEF).

Sea Sense

Sea Sense is a local NGO that works closely with coastal communities in Tanzania over much of the mainland coast to conserve and protect endangered marine species including sea turtles, dugongs, whales, dolphins and whale sharks. Sea Sense started as the Tanzania Turtle & Dugong Conservation Programme in 2001. The project was established in Mafia Island in response to disturbing levels of sea turtle slaughter and nest poaching. The project expanded to the mainland in 2004 and now operates in six coastal districts, covering approximately a third of the Tanzanian coastline. A network of community Conservation Officers are conserving and protecting endangered marine species in Mafia, Rufiji, Kilwa, Pangani, Temeke and Mkuranga Districts. Sea Sense funding is generated mainly donations and grants (e.g. DfID, Born Free Foundation) as well as individual donations from hotel and revenue from sale of educational and awareness materials.

Western Indian Ocean Marine Science Association (WIOMSA)

WIOMSA is a regional professional, non-governmental, non-profit, membership organization, registered in Zanzibar, Tanzania. The organization is dedicated to promoting the educational, scientific and technological development of all aspects of marine sciences throughout the region

of Western Indian Ocean (Somalia, Kenya, Tanzania, Mozambique, South Africa, Comoros, Madagascar, Seychelles, Mauritius, Reunion (France)), with a view toward sustaining the use and conservation of its marine resources. The Association has about 1,000 individual members as well as about 50 institutional members from within and outside the region.

The organization's inter-disciplinary membership consists of marine scientists, coastal practitioners, and institutions involved in the advancement of marine science research and development. The Association: (1) provides a forum for communication and exchange of information amongst its members that promotes and fosters inter-institutional linkages within and beyond the region; (2) supports marine research by offering research grants; (3) implements programs to build the capacity of marine scientists and coastal management practitioners; and (4) works to promote policy dialogue on key topics by organizing meetings and seminars on the findings and policy implications of science.

The Nairobi Convention

The Eastern Africa Region's ten participating states (Somalia, Kenya, Tanzania, Mozambique, South Africa, Madagascar, Mauritius, Seychelles, the Comoros, and France (Réunion and Mayotte). Adopted the Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region (known as the Nairobi Convention) in 1985. The Protocol concerning Protected Areas and Wild Fauna and Flora in the Eastern African Region was adopted at the same time and, in 2002, a Group of Experts on Marine Protected Areas in Eastern Africa (GEMPA-EA) was set up, hosted by UNEP (based in Nairobi, Kenya) and the Western Indian Ocean Marine Science Association (WIOMSA), to oversee implementation.

Mainland Coastal Conservation or High Biodiversity Areas

Tanzania's coastline presently includes six marine protected areas (MPAs), managed under the Marine Parks and Reserves Unit (Fisheries), one Ramsar Site (under Division of Environment), ten Important Bird Areas (IBAs), plus a system of collaborative fishery management areas with closed reefs on the northernmost mainland coast and all the mangrove forests (gazetted as Forest Reserves under Division of Forestry).

The estimated total coverage of the Marine Protected Areas (MPAs) in Tanzania is 1,932 km^2. At the Fifth World Parks Congress in Durban in 2003, Tanzania declared its intention to increase protection of its seas to 10% by 2012 and 20% by 2025. This led to preliminary steps being taken under the World Bank funded Marine and Coastal Environment Management Project (MACEMP) to develop a national MPA system (Ruitenbeek et al., 2005). The Marine Parks and Reserves Act No. 29 of 1994 is the main legal instrument for the establishment of marine protected areas in Tanzania mainland. The following are the coastal or marine areas that are presently under some form of conservation management:

- Tanga Region: A system of collaborative fishery management areas with closed reefs had been introduced by the Tanga Coastal Zone Conservation and Development Project on the northernmost mainland coast, but is not operative anymore after the end of the project in 2006.
- Tanga Coelacanth Marine Park, covering 552 km2, established in 2009.
- Saadani National Park, with a marine component.
- Dar es Salaam-Bagamoyo: Existing Dar es Salaam Marine Reserves and a District level ICM programme in place.

- Kinondoni Integrated Coastal Area Management Programme (KICAMP) North of Dar es Salaam – from Msasani to Mbweni Mafia Island Marine Park. Has a total area of about 822 km2 of which 75% is marine waters. It is a multiple use marine park with zoning.
- South Dar es Salaam Marine Reserves System - comprises: Inner and Outer Makatombe Islands, Kendwa Island and Inner and Outer Sinda Islands. Is a new marine reserve system declared in 2007.
- Nyororo, Shungi Mbili and Mbarakuni Islands Marine Reserves. It is a new marine reserve system declared in 2007.
- Rufiji, Mafia, Kilwa Seascape Programme (RUMAKI) – a large programme covering the entire delta, and Mafia Channel to include the Mafia Island Marine Park. Rufiji, Kilwa Mafia Ramsar Site – The only Ramsar site that protect the marine component covering the entire delta, and Mafia Channel overlapping RUMAKI Seascape.
- Mnazi Bay-Ruvuma Estuary Marine Park (total area = 650 km2). Potentially to be developed as a trans-boundary conservation area with Mozambique.

Issues

Despite positive signs that Tanzania is improving management on natural coastal resource in general, especially with respect to climate change issues (Hepworth 2010), and has consistently increased the area of the coast that is governed by some form of management system, there remains much to do. The spectacular failure of the authorities (Fisheries, Mining, security, judiciary) to eliminate the use of explosives in fishing ("dynamite" fishing), a practice that dates back to the mid-1970s, is testimony that there is not the will to implement change. No other country in the region permits such a practice, yet Tanzania consistently fails to deliver a complete ban, despite support and funding from diverse sources (NGOs, World Bank, Embassies, private sector). Root cause assessments, interactive community dialogues, focus for Beach Management Units (BMUs), military interventions, international web-based petitions and more have all been tried. Yet the rampant destruction of coral reefs and other resources, mainly at specific and well-known locations (often close to large urban centres like Dar es Salaam, Lindi, Tanga), continues with little regard for the laws of the land or the ability of those with authority to halt the practice. Such a situation does not reflect well on the interest and motivation of the authorities for implementing further improvements to the management of the resources of the coast and the livelihoods of those who rely on them. Other examples include extraction of live coral for lime and the use of illegal fishing mesh for certain reef fisheries, both of which continue, openly and in defiance of the laws.

Economic Importance

The cost of implementing coastal zone management initiatives are built in to the budgets of the relevant ministries, and/or district authorities, in many cases with support from international NGOs or donors, as described above for WWF and IUCN. The management framework for conservation of the coastal resources and preservation of the associated livelihoods cannot be achieved with cost. However, the incomes obtained from licensing legal businesses related to mangroves, prawn fishery, deep sea fishery, natural gas, marine transport, etc., to a large extent are all and always directed to the central government with less or non to the local government or community directly. It is important if the distribution of these incomes can be adjusted to enable the local governments to cope with rising management challenges at local level (ASCLME 2012). The importance of balancing the budgets for implementing management efforts and income generated from the resource needs to be undertaken in an open and transparent form.

Socio-Economic Importance

Without a management framework for conservation of the coastal resources the livelihoods of the hundreds of thousands of people that rely directly on these resources would be more threatened and unreliable than they are at present. Hence the importance of management is vital.

Threats to coastal communities relying on Management Framework for livelihoods

In a situation where an ever-increasing extractive effort is failing to yield greater returns, the need for management cannot be over-stated. The principle threats to those relying on the management framework and to the wider coastal environment are described below:

- **Poor coordination and monitoring** between different sectors leading to ineffective governance and failing of enforcement in coastal and marine areas.
- **Poor capacity and motivation** at local district authority level to implement legal mandates governing natural resource use, resulting in continued deterioration of productivity.
- **Absence of financial capacity** to address management issues related to coastal and marine resources.
- **Corruption** at diverse management levels associated with extractive activity related to marine resources, particularly in the fisheries sector, leading to deterioration of the productivity of the resource.
- **Continued inability to stop "dynamite" fishing,** threatening the productive quality of coastal marine habitats.
- **Poor coordination** to address solid waste disposal leading to pollution of beaches and coastal waters.
- **Poor coordination to combat** river basin and catchment degradation, resulting in loss of productivity in the coastal zone through reduced seasonal freshwater and nutrient inputs, as well as reduced river sand contribution to the coast; and/or overload of the sediments and freshwater from flash floods.

CRIAM Ranking of Threats to Local Communities associated with Management Framework for Coastal Zone Management

Table 30: Prioritisation of threats to local communities and ecosystems associated with management framework for coastal zone management. The assessment has been made using the Coastal Rapid Impact Assessment Matrix (CRIAM) approach, described in detail in Annex 3.

ThemeID	Threat as stated in Coastal Profile	Themes	A1 : Extent of issue	A2 : Seriousness of issue	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative character	Evaluation Score (ES)	Range Value (RV)	Light problem	Problem	Important problem	Very important problem	Major problem
M_MFCZM_05	Continued inability to stop "dynamite" fishing, threatening the productive quality of coastal marine habitats.	Management Framework for CZM	3	3	2	2	3	63	4					
M_MFCZM_01	Poor coordination and monitoring between different sectors leading to ineffective governance and failing of enforcement in coastal and marine areas.	Management Framework for CZM	3	3	2	2	1	45	4					
M_MFCZM_02	Poor capacity and motivation at local district authority level to implement legal mandates governing natural resource use, resulting in continued deterioration of productivity.	Management Framework for CZM	3	3	2	2	1	45	4					
M_MFCZM_03	Absence of financial capacity to address management issues related to coastal and marine resources.	Management Framework for CZM	3	3	2	2	1	45	4					
M_MFCZM_04	Corruption at diverse management levels associated with extractive activity related to marine resources, particularly in the fisheries sector, leading to deterioration of the productivity of the resource.	Management Framework for CZM	2	3	2	2	2	36	4					
M_MFCZM_07	Poor coordination to combat river basin and catchment degradation, resulting in loss of productivity in the coastal zone through reduced seasonal freshwater and nutrient inputs, as well as reduced river sand contribution to the coast; and/or overload of the sediments and freshwater from flash floods.	Management Framework for CZM	3	2	2	2	1	30	3					
M_MFCZM_06	Poor coordination to address solid waste disposal leading to pollution of beaches and coastal waters.	Management Framework for CZM	1	2	2	2	2	12	2					

Outlook

Government coordination on climate change issues, and on marine resource management, suffers from a lack of authority, capacity and ability to influence across sectors. The reach and efficacy of government in supporting the most vulnerable communities is weak, irrespective of climate change and there are systemic problems with governance, public sector functionality and the efficacy of aid which must be negotiated and learnt from within efforts to prepare Tanzania for the challenges of climate change (Hepworth 2010) as well as coastal zone management.

One clear link between the sectors is the constraint of governance and capacity. In the small-scale fisheries, the lack of institutional infrastructure to monitor the sector has led to destructive fishing practices going unchecked. In agriculture and forestry, community capacity is too weak to sustainably manage their resources, while government ownership in ports and shipping sector continues to weaken capacity and service delivery. Likewise, in the energy sector, capacity to manage and enforce laws has been highlighted as a weakness, particularly at lower-levels of government. Despite these constrictions, progress is being seen. For example, decentralization and microfinance has the potential to further empower local communities in the small-scale fisheries, while NGO's continue to provide technical support in the development of the mariculture sector. Likewise, concessions to the private sector in the ports and shipping sector, as well as strong regulation in the mining sector, highlight progress in development of governance capacity in the coastal zone (ACLME 2012).

15 CLIMATE CHANGE IN COASTAL TANZANIA

Introduction

The oceans are under multiple and often interconnected threats unprecedented in modern human history. Sea levels are rising, the water is warming and the pH is dropping and the oxygen is consumed by degrading processes in many areas. Particularly the shallow seas are being polluted and fishing is far too intensive, which leads not only to decreasing stocks of many species but also to effects on the ecosystem level. To be able to deal with the problems of ocean degradation in order to secure the goods and services provided by the sea, it is necessary to develop a holistic view of how anthropogenic actions impact the ocean environment. As humans are the dominant drivers of ocean change a framework for management is needed. Although much research has been carried out on the different issues affecting the oceans little knowledge exists on the extent to which the different threats interact with and feedback on each other. Questions that largely remain unanswered at this stage are, what are the possible feedback processes of these different individual threats? Do any of the problems amplify or are reduced by other issues? How do local, regional, and global stressors interact? What sort of policy and management strategies do we need to account for multiple, interacting stressors?

Developments in climate science research are regularly reviewed and assessed by the Intergovernmental Panel on Climate Change (IPCC). The IPCC Working Group 1 published the most recent report about the physical science in September 2013 (IPCC., 2013). In 2014 further reports from IPCC will follow: in end of March 2014 on impacts, adaptation and vulnerabilities, and in April 2014 on mitigation of climate change. The recent report about the physical science is based on many independent scientific analyses from observations of the climate system, investigations of paleo-climate archives, and of theoretical studies of climate processes including simulations using various climate models.

In East Africa several national reviews of the state of climate change and discussions of the possible future development have been carried out recently. In Tanzania the GCAP studies are examples of this (The Economics of Climate Change in Tanzania (mainland) (2011), The Implications of Climate Change and Sea-Level Rise in Tanzania, (2011), and The Economics of Climate Change in Zanzibar – Vulnerability, Impacts and Adaptation (2012). These reports provide an analysis of the present situation, forecasts for the future and discuss vulnerability and adaptation as well as economic impacts.

The Increasing Temperature of the Atmosphere and Oceans

Global warming is caused by the increased emissions of greenhouse gases (GHG) (carbon dioxide CO_2, methane CH_4, nitrous oxides N_20). The concentrations of all these gases have increased in the atmosphere since 1750 due to human activities. In December 2013 the carbon dioxide levels were 396.8 ppm, in 2011 methane concentrations 1803 ppb, and nitrous oxide 324 ppb, meaning an increase from pre-industrial concentrations by about 40%, 150% and 20% respectively. The concentrations of these gases are now higher than in at least 800,000 years (IPCC., 2013).

The effects of the increasing emissions on the earth's atmospheric and oceanic temperatures are projected using models that currently are valid primarily on the global level. The global climate models are the only information available for decisions about the response at the local level, which is a major problem as local conditions may very significantly affect the degrees of impacts at local and regional levels. On a global level the IPCC (2013) concludes that the global surface temperature (land and sea) has increased during the last 60 years by 0.5-0.84°C. Furthermore

IPCC (2013) forecasts, based on the available models that the average global temperature by 2100 will be more than 1.5°C higher than today and probably more than 2.0°C.

As the atmosphere warms so will the oceans. Warming of the world oceans due to increasing GHGs was first identified in a report by Revelle et al. (1965). Estimates for the increasing heat content for the upper 300 and 700 m layers and pentadal estimates for the upper 3000 m of the world ocean are shown in Figure 6 (after Levitus et al., 2005). For the world ocean the linear trend of heat content (0-3000 m layer for 1955-1998) is 0.33×10^{22} J/year representing an increase in the heat content of 14.5×10^{22} J corresponding to a mean temperature increase of 0.037°C. From the surface down to 700 m the ocean temperature has increased by 0.2°C during the last 50 years (Bindoff N.L. et al., 2007). For the Atlantic, Pacific and Indian Ocean the increases of heat content (linear trends) are 7.7, 3.3, and 3.5×10^{22} J respectively (Figure 7) (Levitus S., J. Antonov, and T. Boyer, 2005).

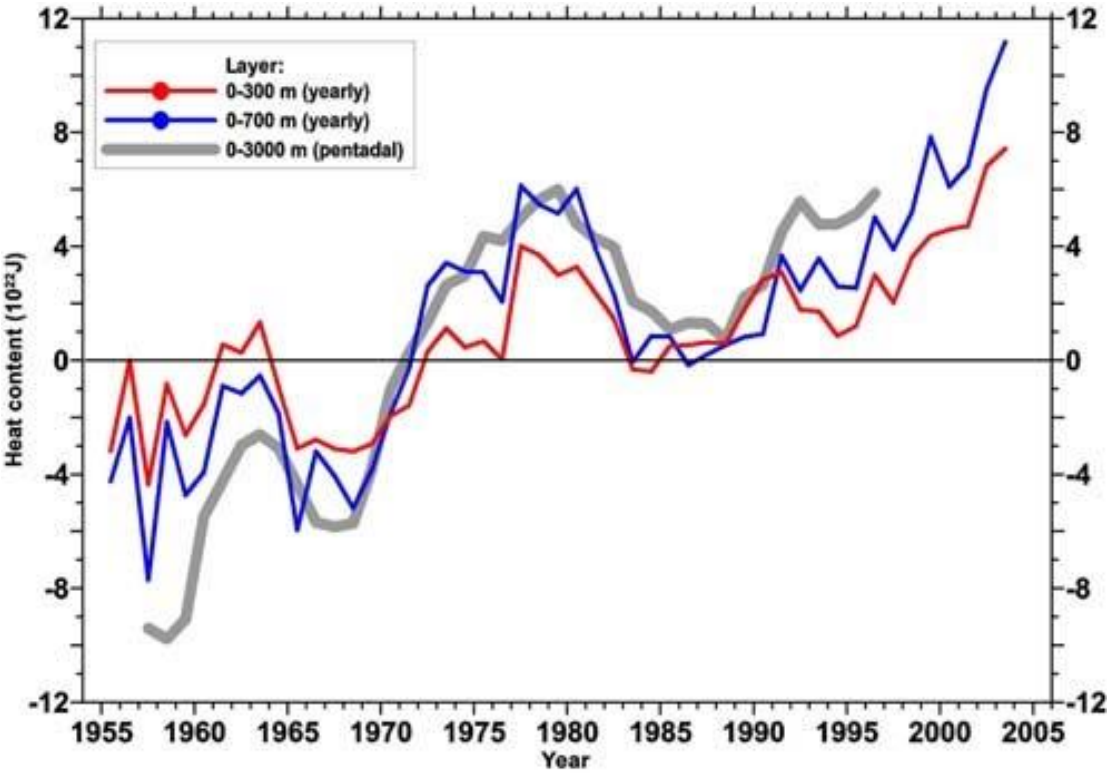


Figure 6: The heat content of the global ocean for the layers 0-300, 0-700 and 0-3000 m. From Levitus S., J. Antonov, and T. Boyer, 2005. For further information see the text above.

As the oceans warm, the amount of water vapour in the atmosphere at a given relative humidity increases. The increase is exponential and as the temperature increases the amount of water vapour at a given relative humidity increases very rapidly. Such changes in the amount of water vapour will affect the hydrological cycle and result in increases in the intensity of precipitation both over the oceans and over terrestrial areas.

The warming of the atmosphere and particularly the oceans has resulted in changes in extreme weather and climate events. Hence, on global scale IPCC states that it is very likely that the number of warm days and nights has increased and that the number of cold days and nights has decreased. Overall the frequency of heat waves has increased over large parts of the world, and there are more land areas where the number of heavy rainfalls has increased than where such rains have decreased in numbers.

On a global scale sea surface water temperature (down to 75 m) has increased by more than 0.1 degrees in the last 40 years. Also deeper waters have warmed, and it is likely that the ocean

warmed from 3000m to the bottom, with the largest warming observed in the Southern Ocean (IPCC., 2013). In addition, during the last 40 years, more than 60% of the net energy increase in the climate system is stored in the upper ocean (0-700 m) and about 30% is stored in deeper waters. As a consequence the increase in upper ocean heat content during this period is likely to be in the range of 15 to 19 x 10^{22} J. Other general ocean observations related to climate change show that it is very likely that regions of high salinity where evaporation dominates have become fresher since 1950s.

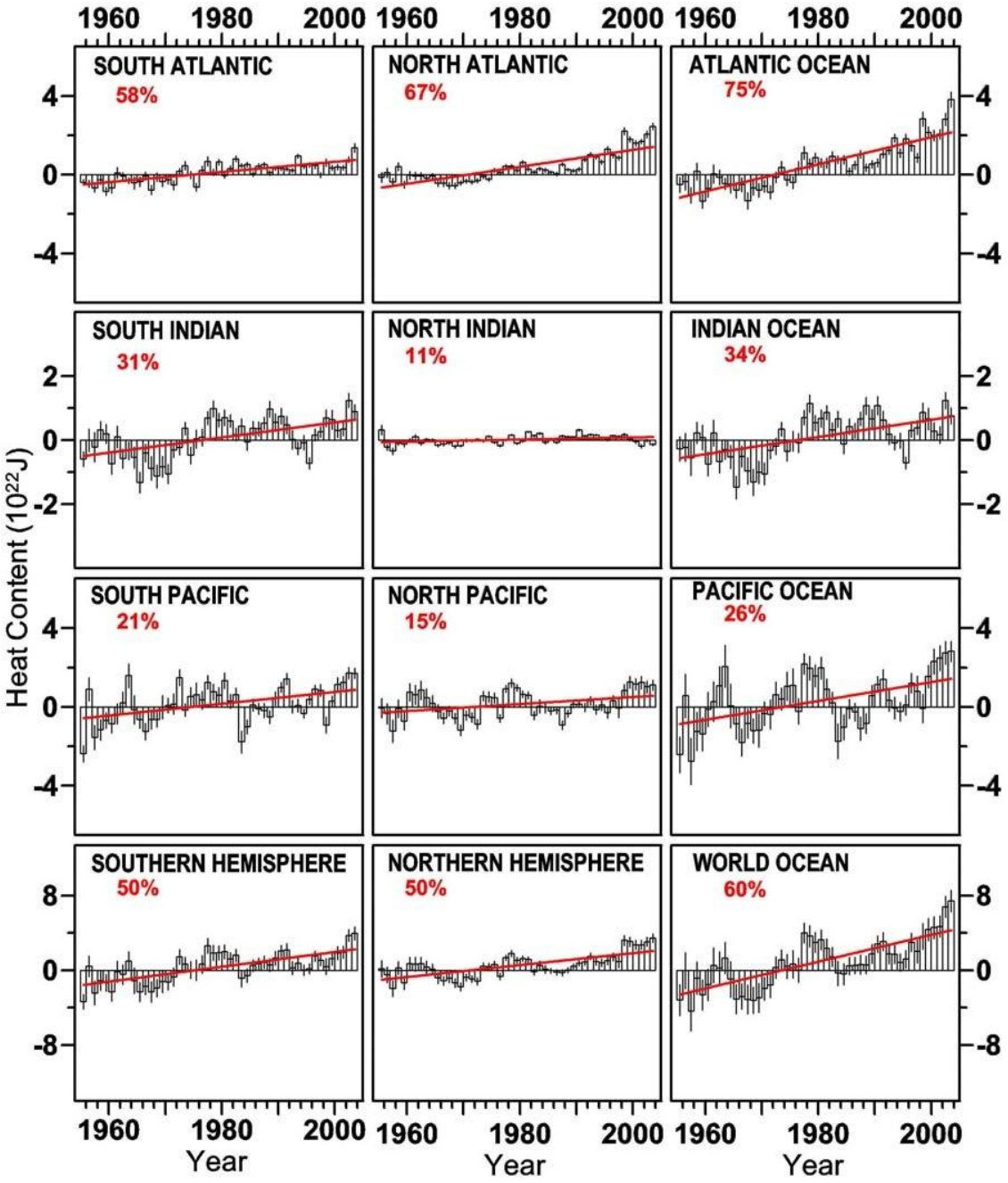


Figure 7: Time series of the yearly increase in the heat content for the 0-300 m layer of the world ocean and individual ocean basins. Vertical lines through each yearly estimate represent plus and minus one standard error of the estimate of heat content. The linear trend is plotted as a red line. The percent variance accounted for by this trend is given on the upper left corner of each diagram (from Levitus S., J. Antonov, and T. Boyer, 2005).

Sea level rise will impact all coastal areas, but to differing extents. Small islands may disappear entirely even with very modest increases in the sea levels. It has been estimated that about 145 million people would be directly affected by a 1 m sea level rise, 268 and 397 million by 5 and 10 m rise respectively (Anthoff D., R. Nicholls, R.S.J. Toi and A. Vafeidis, 2006).

Changes of the sea level at any given location are due to a combination of a number of different factors and processes and may be very different from the global average. Several hundred-year-old records of sea level fluctuations are available for many sites around the world. However, the quality of data that was collected 400 years ago may be questioned. Observations from different locations show different degrees of variability and different overall trends. Most sites around the world show clear upward trends (Boon, J.D., 2012), (Sallenger A.H., K.S. Doran and P.A. Howd, 2012), (Permanent Service for Mean Sea Level, 2014), but many sites show a fair amount of inter-annual variability. Global causes of sea level rise are the warming of the ocean which causes thermal expansion, and the melting of the glaciers and ice caps. However, at the regional and local levels a number of local phenomena play important roles, such as changes in the ocean and atmospheric circulations, uplift or subsidence due to tectonic movements or the abstraction of ground water or oil.

According to the IPCC (2013), the sea level rise during the last 60 years has been larger than the mean rate of change in sea levels, during the previous 2 million years. Globally the mean sea level has increased by 0.17 to 0.21 m between 1900 and 2010. Since 1970 global mean sea level rose by about 1.8 mm/year, which doubled to 3.1 mm/year in the 1990's and was 2.5mm/y since 2000.

Table 31: Summary of the sources of Sea Level Rise (mm/year) for three different time periods (modified after Noone K.J., 2013).

Source	42 years (1961-2003)	10 years (1993-2003)	4 years (2003-2007)
Observed Change	1.8	3.1	2.5
Thermal expansion	0.4	1.6	0.35
Melting glaciers	0.5	0.8	1.1
Melting ice sheets	0.2	0.4	1
Land storage (liquid water)	-	0	-
Residual	0.7	0.3	0.1

As can be seen from Table 31 most of the rise in sea levels has been caused by the combination of warming of seawater (thermal expansion) and as a result of adding water to the oceans from continents through melting, or transport of ice from glaciers. The residual fraction is the difference between the actual (observed) sea level rise and the sum of the different identified sources. This "unexplained" fraction is believed to originate from melting of ice sheets in Greenland and Antarctica (Steffen et al. 2010). It is important to observe that the relative contribution from the different sources vary with time, and also that the residual fraction has decreased as the techniques of quantifying the different contributions has improved. Thermal expansion (warming) of the upper 700 meters of the oceans shows clear variability on 5-10 year time scales, and can also be linked to volcanic eruptions. The contribution from water from terrestrial sources (groundwater, lakes and wetlands) is variable but averages out to be roughly zero over the period in question (1960-2010). Glaciers and icecaps have been the dominant source of sea level rise since about the late 1970's. However, as pointed out earlier, at the local level changes in mean sea level are a combination of a number of global processes and natural or human-induced subsidence due to tectonic movements or related to removal of ground water.

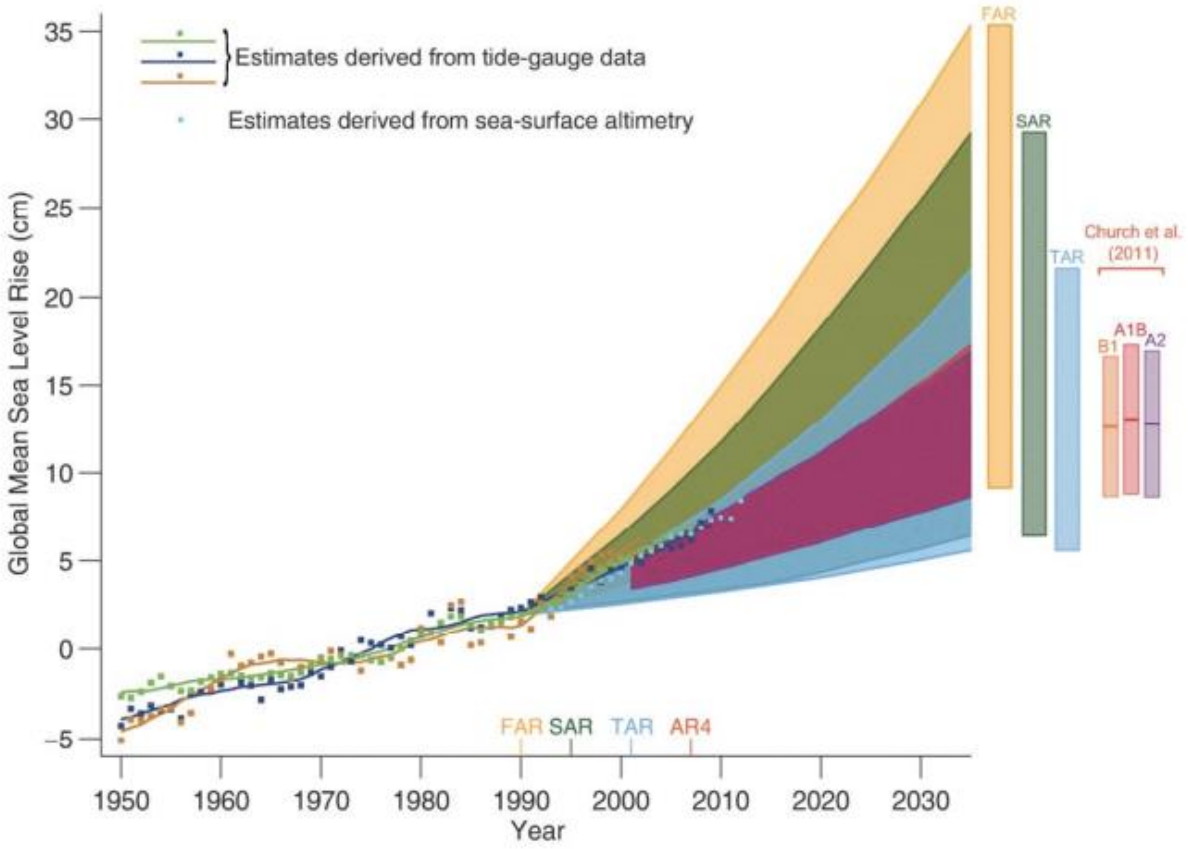


Figure 8: Sea level rise since 1950 and prediction for the future according to the different scenarios (from IPCC 2013).

Ocean Acidification

As atmospheric carbon dioxide is taken up by ocean water and transformed into carbonic acid the acidity of the water will increase. The oceans presently have taken up about 25% of the CO_2 emitted from human activities. Without ocean uptake the atmospheric concentrations of CO_2 would be about 460 ppm (instead of about 395 at present). The carbonic acid increases the ocean acidity, shifting the partitioning of inorganic carbon species towards increased CO_2 and dissolved inorganic carbon, and decreased concentration of carbonate ion. As a result the pH is decreasing (Figure 9). The degree of future ocean acidification will depend on carbon dioxide emission concentrations and rates, and if these are known, the corresponding degree of acidification is highly predictable. According to model projections burning of fossil fuels at similar rates as during the last 100 years, will result in a decline of the pH in ocean surface waters of 0.77 from preindustrial levels of 8.2, with a pH decline of 0.3-0.4 occurring during this century (Caldeira, K. and M.E. Wickett, 2003); (Orr J.C., V.J. Fabry, O. Aumont and 24 others, 2005); (Royal Society., 2005). The solubility of $CaCO_3$ depends on its crystalline form and varies with temperature and pressure, being more soluble in cold water than in warm water.

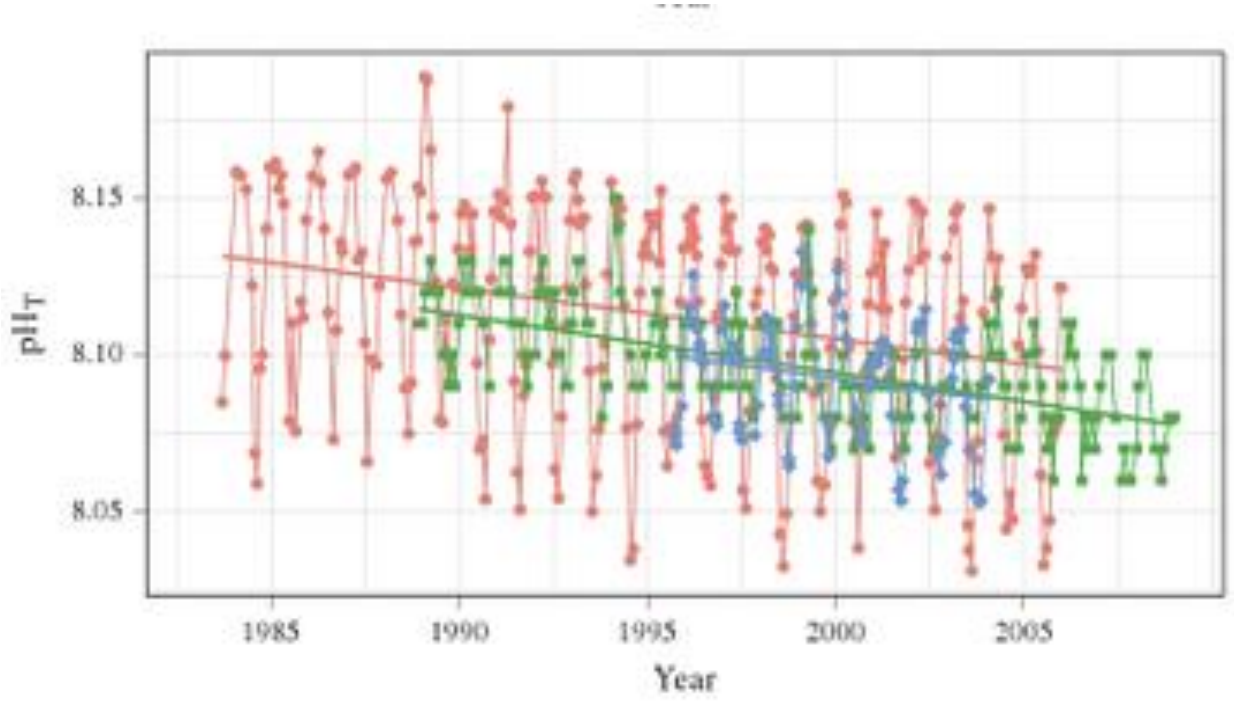


Figure 9: The diagram showing time series of pH at three ocean stations (from Orr J.C., 2011).

Climate Change and the Indian Ocean – the Larger Picture

Oceans are determining and moderating the climate on the planet. Ocean phenomena such as sea surface temperatures, surface and vertical currents, and salinities are all drivers influencing the climate as well as shorter time scale changes. Through increasing emissions of GHGs, human activities are causing increasing atmospheric temperatures which increase the sea surface temperatures. In order to comprehend how climate change will affect Zanzibar, Pemba and the coastal regions of Tanzania, it is necessary to understand the basic oceanic features of the western Indian Ocean.

Oceanographic Phenomena Influence the Local Scene

The major driving force influencing the weather and climate in Tanzania and along the East African coast is the Equatorial Current flowing from eastern Indian Ocean towards the west. Particularly the South Equatorial Current (SEC), which is a broad and shallow current that flows at a speed of 2 to 5 knots, 10 – 15 degrees south of the equator, is of importance to coastal East Africa. This current is feed by water from the South Indian Tropical Gyre. Some of its water comes from the Pacific via the Indonesian Seas. The flow through the Indonesian Seas is affected by the El Nino/La Ninja phenomena (see below). The SEC reaches the coast of East Africa at the latitude of southern Tanzania. A part of the SEC bends off to the north forming the East African Coastal Current and the South Indian Ocean Tropical Gyre (see Figure 10). During the North-East Monsoon (November-March) the East African Coastal Current/Somali Current is pushed to the east at the latitude of southern Somalia, in a clockwise movement and is starting to flow east along the equator forming the Equatorial Counter Current (see

Figure 11). During June to September the South East Monsoon usually dominates and during this period the East African Coastal Current continues northward along the Somali coast to the Gulf of Aden.

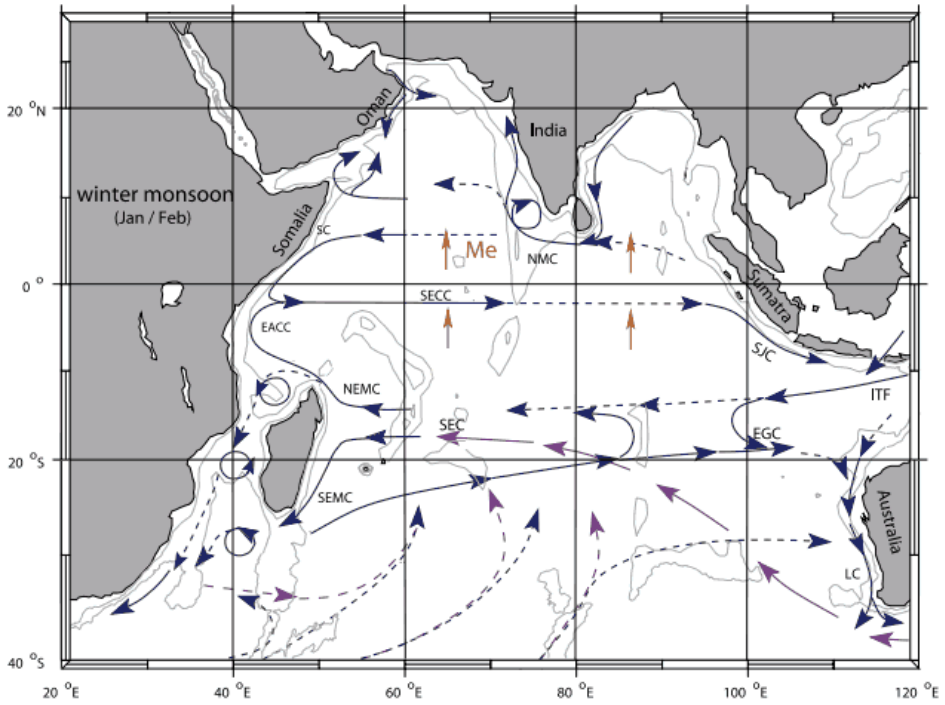


Figure 10: Major currents and branches of currents in the Indian Ocean during the winter monsoon (above) and summer monsoon (below). SEC = South Equatorial Current, SECC = South Equatorial Counter current, NEMC and SEMC = Northeast and Southeast Madagascar Current, EACC = East African Coastal Current, SC = Somali Current, SG = Southern Gyre, GW = Great Whirl, ITF = Indonesian Through flow. From Schott F.A., S.-P. Xie, and J.P. McCreary Jr., 2009.

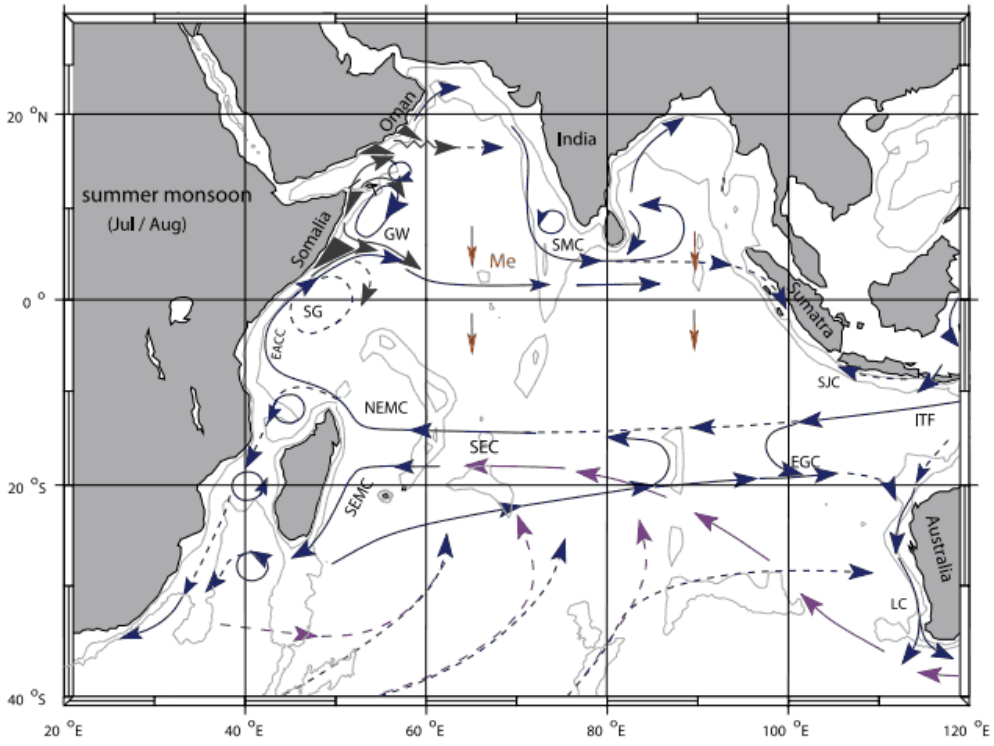


Figure 11: Major currents and branches of currents in the Indian Ocean during the summer monsoon. For further explanation and conditions during the winter monsoon see Figure 5. From Schott F.A., S.-P. Xie, and J.P. McCreary Jr., 2009.

A major portion of the Equatorial Counter Current bends off to the south, forming the Madagascar Current along the eastern Madagascar and the Mozambique Current along the Mozambique coast. These two south flowing currents merge between southern Madagascar and Mozambique roughly at the latitude of Inhambane, to form eddies and the western boundary current of Indian Ocean Subtropical Gyre (the Agulhas). The Agulhas runs south along the east coast of southern Africa and due to wind stress it does not usually form a complete gyre back into the Indian Ocean but rather shrinks as it moves poleward and westward or eastward.

Certain intra-annual global ocean phenomena exert at times very pronounced influence on the local conditions in the western Indian Ocean. Examples of such phenomena are the Indian Ocean Dipole (IOD) and the El Nino and connected La Nina modes. The Indian Ocean Dipole or the Zonal Mode is an indicator of the east-west temperature gradient across the tropical Indian Ocean. Years of extreme September-November rainfalls in tropical East Africa are associated with this phenomenon (Black E., J. Slingo and K.R. Sperber., 2003). During positive Indian Ocean Dipole mode (+IOD) strong easterly winds push warm surface water towards the western Indian Ocean resulting in unusually high sea surface temperature (SST) along the East African coast (see also Figure 12 and Figure 13 below). Hence under +IOD conditions the water in the eastern tropical Indian Ocean is cooler than normal. On the other hand, during negative Indian Ocean Dipole mode (–IOD), surface waters warms in the eastern tropical Indian Ocean while a corresponding cooling occurs along East Africa.

El Nino and La Nina modes are closely correlated to the Pacific Ocean Southern Oscillation. Even though these events are Pacific Ocean phenomena, their influence on surface water and the climate/weather in the western Indian Ocean through the Indonesian Seas is very significant, which was noted for example in 1983 and 1998. Even though El Nino/La Nina and IOD are largely natural phenomena, observations related to these phenomena must be carefully assessed in relation to increasing GHG concentrations. El Nino and La Nina events are related to changes in the coupled atmosphere-ocean system over the tropical Pacific. During El Nino conditions air pressure anomalies measured as the air pressure difference between eastern and western Pacific show below normal pressure over Tahiti and above normal over Darwin. This results in weak easterlies (trade winds) which result in the transport of warm surface water towards the east along the equator from the western Pacific to the east. On the other hand strong easterly equatorial winds over the eastern tropical Pacific Ocean results in shallow thermoclines in this region causing La Nina events. These events impact the ocean and land climate in all major ocean basins.

The relationship between the intensities of the different currents in the western Indian Ocean is intimately linked to the intensity of the South Equatorial Current (SEC). Several hypotheses exist related to these linkages (Palastranga V., P.J. van Leeuwen and W.P.M. de Ruijter, 2006); (Gordon A.L., 2005); (Schott F.A., S.-P. Xie, and J.P. McCreary Jr., 2009); (Ridderinkhof, H., P.M. van der Werf, J.E. Ullgren, H.M. van Aken, P.J. van Leeuwen, and W.P.M. De Ruijter., 2010). During El Nino conditions, the transport of water through the Indonesian Seas weakens and the SEC is reduced as a consequence. The Sea Surface Temperature anomalies over the Indonesian Seas and the Eastern Indian Ocean are negative during El Nino conditions. This causes high pressures, cools the air and generates easterly wind, which gives rise to planetary waves propagating towards the South Western Indian Ocean. Down-welling waves in the region of northern Madagascar deepens the thermocline of the sea water, leading to SST going up and the formation of a pressure difference between east and west. An extreme such event happened in 1998 when SST increased 3 to 5°C over large parts of the south and central western Indian Ocean (Wilkinson C., O. Linden, H. Cesar, G. Hodgson, J. Rubens & A. Strong., 1999).

During La Nina conditions in the Pacific Ocean, the low pressure conditions over the tropical western Pacific induce a stronger flux through the Indonesian Seas, creating conditions in the Indian Ocean that leads to a relatively stronger Southern Equatorial Current, a southward

displacement of the current and the intensification of the Tropical Gyre (dr Ruijter, W.P.M., H.M. van Aken, E.J. Beier, J.R.E. Lutjeharms, R.P. Matano and M.W., 2004); (Gordon A.L., 2005), (Ridderinkhof, H., P.M. van der Werf, J.E. Ullgren, H.M. van Aken, P.J. van Leeuwen, and W.P.M. De Ruijter., 2010); (Palastranga V., P.J. van Leeuwen and W.P.M. de Ruijter, 2006). The more intensive than normal Tropical Gyre induces upwelling of cooler deep water along the East African coast, with cooler sea surface temperatures as a result (Schott F.A., S.-P. Xie, and J.P. McCreary Jr., 2009).

Observed Climate Changes in Coastal Tanzania

Air Temperatures

The climate of coastal Tanzania is characterised by a tropical hot and humid climate driven by two distinct seasonal monsoon winds. Over the last 50+ years air temperatures typically has ranged between 22 and 30°C. The Northeast Monsoon ("kaskazi") (November-March) is the hottest period. This traditionally has been considered the mild season with calmer seas and gentle winds typically 1-8 m/s. In contrast the Southeast Monsoon ("kusi") (May-October) typically is characterised by stronger winds, 5-15 m/s and rougher seas. During the inter-monsoon, the winds are variable but calm. The rainy seasons coincide with the end of the Southeast Monsoon (March-May), and a shorter rainy season during November-December. Annual rainfall in coastal Tanzania averages 800-1000 mm/year with the highest levels recorded in Pemba (1500 mm/year) and lowest in Mtwara (<500 mm/year).

The description above reflects the normal situation as it has been experienced during the last 5 to 10 decades. However, during the last couple of decades temperatures, rainfall and humidity show tendencies to change. Particularly the air temperatures have changed. Metrological data from the Metrological Office in Dar es Salaam and from the Zanzibar Weather Service has been analysed (see Annex 4 and Annex 5). Data on maximum and minimum average monthly temperatures are shown for coastal sites in Tanzania including Zanzibar and Pemba. The data show significant changes in the air temperatures over the last 25 years in coastal Tanzania. Hence monthly average maximum and minimum temperatures in Dar es Salaam have increased 0.5 to 1.5 °C during the 25 year period from1985 to 2012 (Annex 5). A detailed analysis of the data from Dar es Salaam show an average decadal increase of 0.24°C. The ERAInterim values are about 50% of these figures (Annex 4). The reason for the lower values is that ERAInterim data refers to monthly means of the full diurnal cycle and gives less weight to extreme values.

In other coastal locations such as Mtwara there is no significant increase in average maximum temperature. However there is a clear tendency for increased minimum temperatures. In Pemba there is a very pronounced increase in the average minimum temperatures for the period 1985 to 2012. The corresponding figures for Zanzibar shows an increase of about 1 °C for average minimum temperatures and 0.5-1.5 °C increase in the average maximum monthly temperatures.

As mentioned above, the global average decadal temperature increase during the last 60 years is 0.08-0.14 °C (IPCC., 2013). This is the average land and sea surface temperature increase and the increase over land is significantly higher. Compared to the global average the figures reported here for Dar es Salaam and Zanzibar are significantly higher. However, IPCC points out that short record series such as those presented here are very sensitive to beginning and end dates and may therefore not reflect long-term climate trends.

Ocean Temperature

Even though there is a distinct warming trend for the Indian Ocean as a whole (see above), the warming of the ocean basin is not homogenous. The warming exhibits geographical differences with quite different patterns of warming and even cooling in some areas. The cooling is important to discuss as it is particularly relevant to Tanzania. The explanation for the trends of warming and cooling in the Indian Ocean are due to atmospheric and oceanographic processes primarily in the Southern Hemisphere and the understanding of these processes has gained much ground in the last decade based on large amounts of data and modelling (Schott F.A., S.-P. Xie, and J.P. McCreary Jr., 2009); (Ridderinkhof, H., P.M. van der Werf, J.E. Ullgren, H.M. van Aken, P.J. van Leeuwen, and W.P.M. De Ruijter., 2010); (Ridgway K.R. and R.J. Dunn., 2007); (Speich S., B. Blanke and W. Cai., 2007). During normal conditions the South Equatorial Current is bringing water from the eastern Indian Ocean towards East Africa. The current reaches the African continent at the level of north-eastern Madagascar where it bifurcates into a northern branch which becomes the East African Coastal Current flowing north along the coast of Tanzania (Figure 12). During El Nino mode the flow of warm Pacific water through the Indonesian Seas decreases in intensity and the South Equatorial Current moves southward as it is flowing across the Indian Ocean. When it reaches East Africa at the level of central Madagascar it bifurcates into a northern and a southern branch (Figure 12). The northern branch of warm water is flowing along the Tanzanian coast.

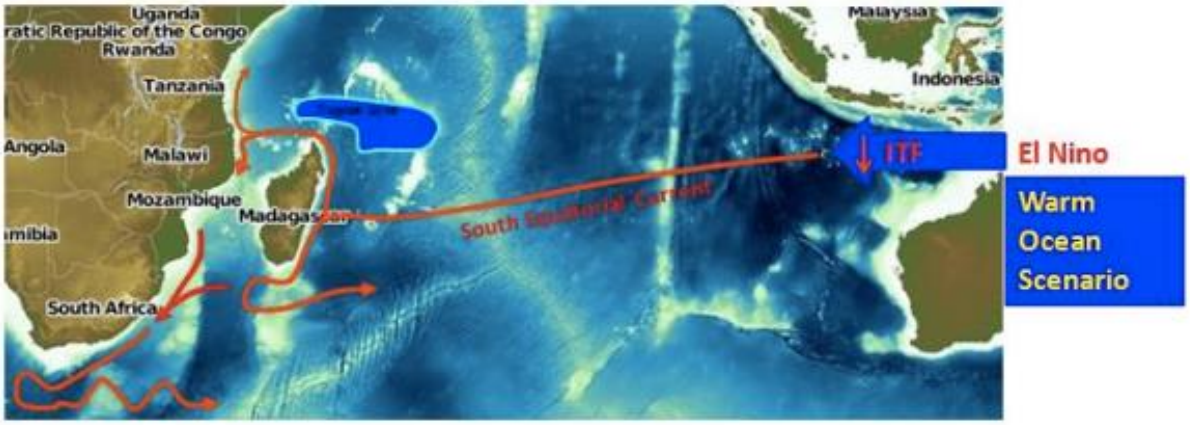


Figure 12. The warm water scenario is based on the South Equatorial Current bringing warm subtropical waters from east to west where on arrival to Madagascar it divides into two currents, one flowing north and one to the south. See also Figure 13. From "Responding to climate change in Mozambique" Synthesis Report (2012).

However, during La Nina modes the flow of the current through the Indonesian Seas intensifies and is displaced to the south by the Indian Ocean Tropical Gyre. This leads to extensive but temporary upwelling in the Mozambique Channel and along the Tanzanian coast (Figure 13)

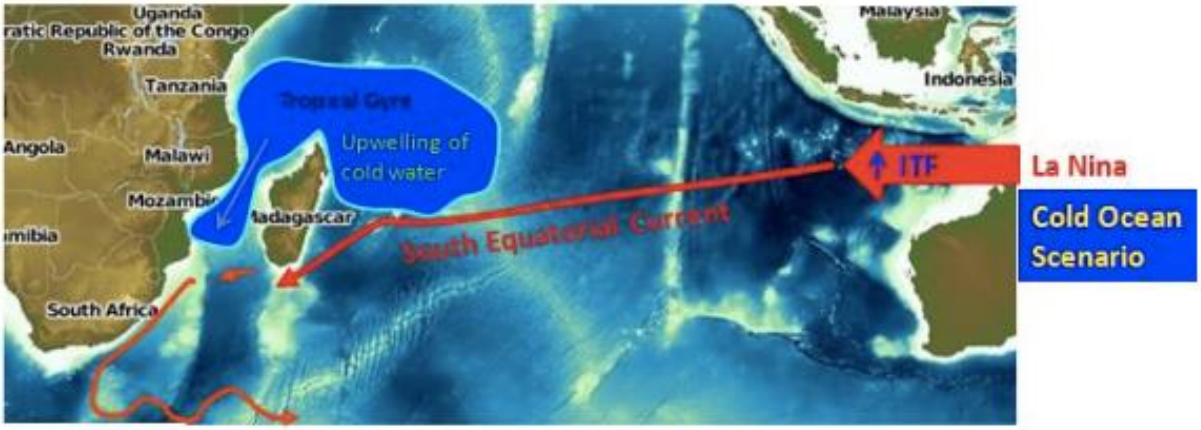


Figure 13: The cool water scenario (figure above) is based on a southward displacement of the South Equatorial Current, pushed down by a large south Indian Ocean tropical gyre. This situation results in large upwelling of deep cold water along the coast of Tanzania. From "Responding to climate change in Mozambique" Synthesis Report (2012).

Wind Speed / Intensity and Frequency of Storms

The available data on wind speeds from coastal Tanzania seem to indicate that wind speeds and the frequency and intensity of tropical storms has generally been increasing during the last three decades for four coastal stations (Tanga, Zanzibar, Dar es Salaam, and Mtwara (Mahongo S., and Y. Shaghude, 2013)(see Figure 14 and Figure 15). The authors also found a clear relation between past erosion events along the coast and the intensity of winds and occurrence of extreme wind speeds and tropical storms. These observations are in accordance of what would be expected as in warmer and moister conditions with higher sea surface temperatures changes in tropical storm and cyclone characteristics should be expected (Anthes, R. A., Corell, R. W., Holland, G., Hurrell, J. W., MacCracken, M. C., & Trenberth, K. E., 2006); (IPCC, 2007). There is a growing understanding of the correlations between anthropogenic warming, sea surface temperatures, and high wind/cyclone/hurricane intensity (Emanuel, K., 2005); (Emanuel, K., Sundararajan, R., & Williams, J., 2008). However, this does not necessarily mean that the frequency of events will increase, but rather that the intensity will.

Traditionally experts have been of the opinion that there is a functional relationship between storm intensity and the impacts on human infrastructure. Based on physical principles the power exerted by strong winds and the damage it causes should be proportional to the cube of maximum wind speed. However, with more real world cases of such events, experts now are of the opinion that the relationship is non-linear, since coastal structures typically survive up to a breaking point at which there are abrupt large losses. Also, experts generally agrees that impacts of climate change on coastal communities as a result of storm surges will be the most significant threat in the short term. It is the combination of increasing human populations and infrastructures along the coastlines with extreme winds (related to climate change) and spring-tides where the water table is superimposed by increasing sea levels (climate change) that will cause the greatest damage. This is discussed further below.

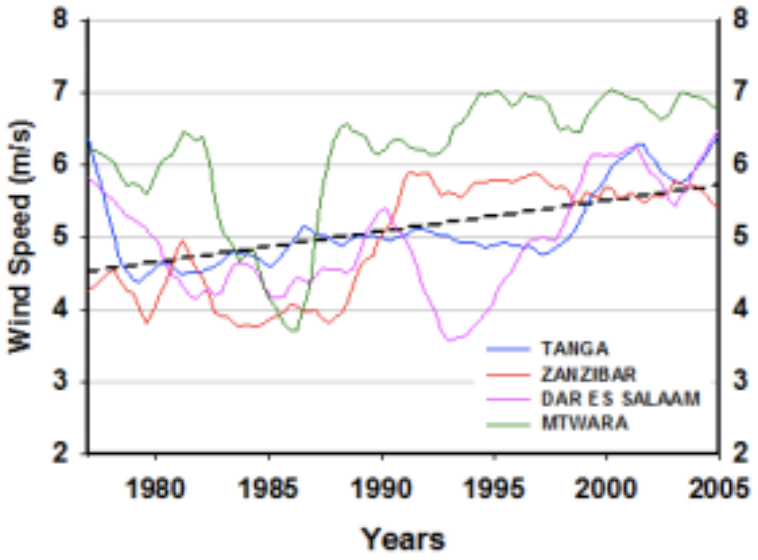


Figure 14: Monthly mean wind speeds (in the morning). The dotted line represents the combined linear regression line for all the four stations.

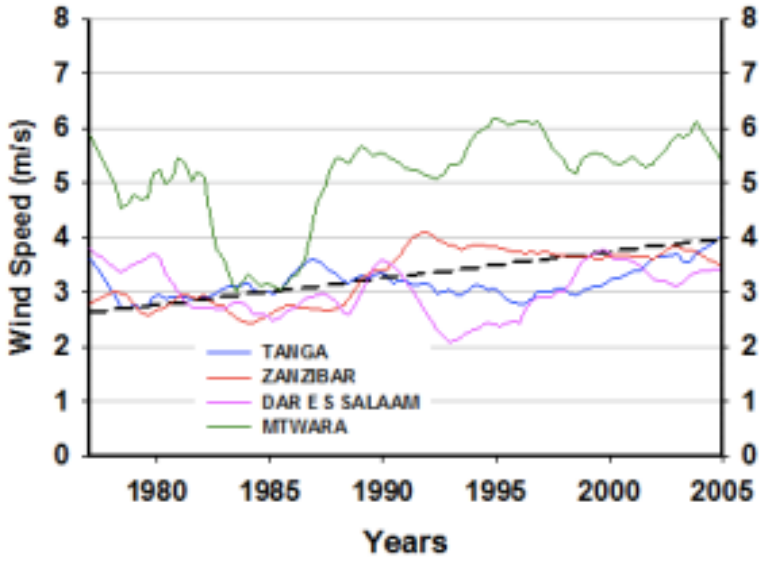


Figure 15: Monthly mean wind speeds (in the afternoon). The dotted line represents the combined linear regression line for all the four stations.

Rainfall and humidity

Data on rainfall over coastal Tanzania has been assessed in order to find out if any trends can be identified. Rainfall data are available from almost 20 sites, most of them along the coast (see Table 32 and Annex 5). Records of monthly average rainfall data are available from 1970's and 1980's. It should be pointed out that this is rather short period for assessing trends. The patterns of rainfall are complex and it is difficult to detect any single trend from the data available although there seems to be a general trend towards dryer conditions. However from a few sites a clear downward trend seems to be present. One of these sites are Mafia Island during the period 1989 – 2013 where a downward trend seems to be present during the rainy season towards the end of the year. Also in Muheza (inland from Tanga) there is a clear downward trend during both the rainy seasons recorded from 1981 to 2010. Also from Utete in the Rufiji Delta there seem to be a downward trend during the rainy season since 1981.

Table 32: Trends in total monthly rainfall in coastal Tanzania. See also Annex

Location	Period of recording	Observation
Lindi Boma	1971 – 2011	No trend
Dar es Salaam	1989 – 2013	No trend
Chakechake	1998 - 2012	No trend
Utete (Rufiji)	1981 – 2010	Downward (rainy season)
Tanga	1987 - 2012	No trend
Muheza (inland Tanga)	1981 - 2010	Downward (rainy season)
Pangani	1980 - 2011	No trend
Mtwara	1987 - 2012	No trend
Zanzibar	1971 - 2011	No trend
Karume (Pemba)	1974 - 2011	No trend
Kizimbani (Kilwa)	1970 - 2011	Downward (dry season)

Similar results of variations in rainfall have been reported by (Francis J. and S.B. Mahongo, 2012). They report a general downward trend in the precipitation although the trends are not significant. When studying data from the last 50 years the authors saw a significant influence of the El-Nino Southern Oscillation, and less influence by the Pacific Decadal Oscillation and the Indian Ocean Dipole. In the seasonal timescale the effects of the large scale climatic phenomena are relatively smaller during the rains and the Northeast Monsoon seasons, but are significantly larger during the Southeast Monsoon.

Data for precipitation is available from Zanzibar for the period since 1975 (Annex) and these recordings seem to indicate a consistent trend towards increasing humidity. It seems logical that the humidity should increase as the temperature increases.

The Sea Level

As mentioned above the global sea level has risen during the past decades as a result of thermal expansion of the warming ocean water and due to addition of water from the melting glaciers. However, the sea level has not risen uniformly everywhere. Regionally the sea level is also affected by subsidence and uplift and of changes in atmospheric or oceanic circulation. Furthermore as the gravitation pull from the poles decrease due to the melting of the ice, there are indications this might lead to increased water levels elsewhere, particularly around the equator. In addition there are inter-annual and decadal fluctuations that makes interpretation difficult unless data are available for very long periods of time. Long-term observational records are scarce in the Indian Ocean and hence regional changes in sea level are poorly known.

Han et al. (2010) studied the spatial pattern of sea-level rise since 1960's in the Indian Ocean. The authors combine *in situ* and satellite observations of Indian Ocean sea level with climate-model simulations. The investigation indicates that the sea level has decreased substantially in the south tropical Indian Ocean whereas it has increased elsewhere (see Figure 16). This pattern is driven by changing surface winds associated with a combined invigoration of the Indian Ocean Hadley and Walker cells, patterns of atmospheric overturning circulation in the north-south and east-west direction, respectively, which is partly attributable to rising levels of atmospheric greenhouse gases (Han, W., Meehl, G. A., Rajagopalan, B., Fasullo, J. T., Hu, A., Lin, J., ... & Yeager, S., 2010). The authors conclude that—if ongoing anthropogenic warming dominates natural variability—the pattern detected is likely to persist and to increase the environmental stress on the tropical East African coast and islands such as Zanzibar.

Historic regional data reconstructed and reviewed by Mahongo (2009) indicates that sea levels in Tanga 1962-1966 and Dar es Salaam 1986 to 1990, and from Zanzibar 1984 – 2004, were falling. Furthermore Mohongo reports that about 60% of the 34 tide gauge stations in the Western Indian Ocean region with at least 4 years and up to 41 years of data, show rising sea levels, while 40% show falling trends. Data from the Sea Level Center (University of Hawaii) (Figure 17) show a downward trend from 1986 to 2000, but after that period a significant increase.

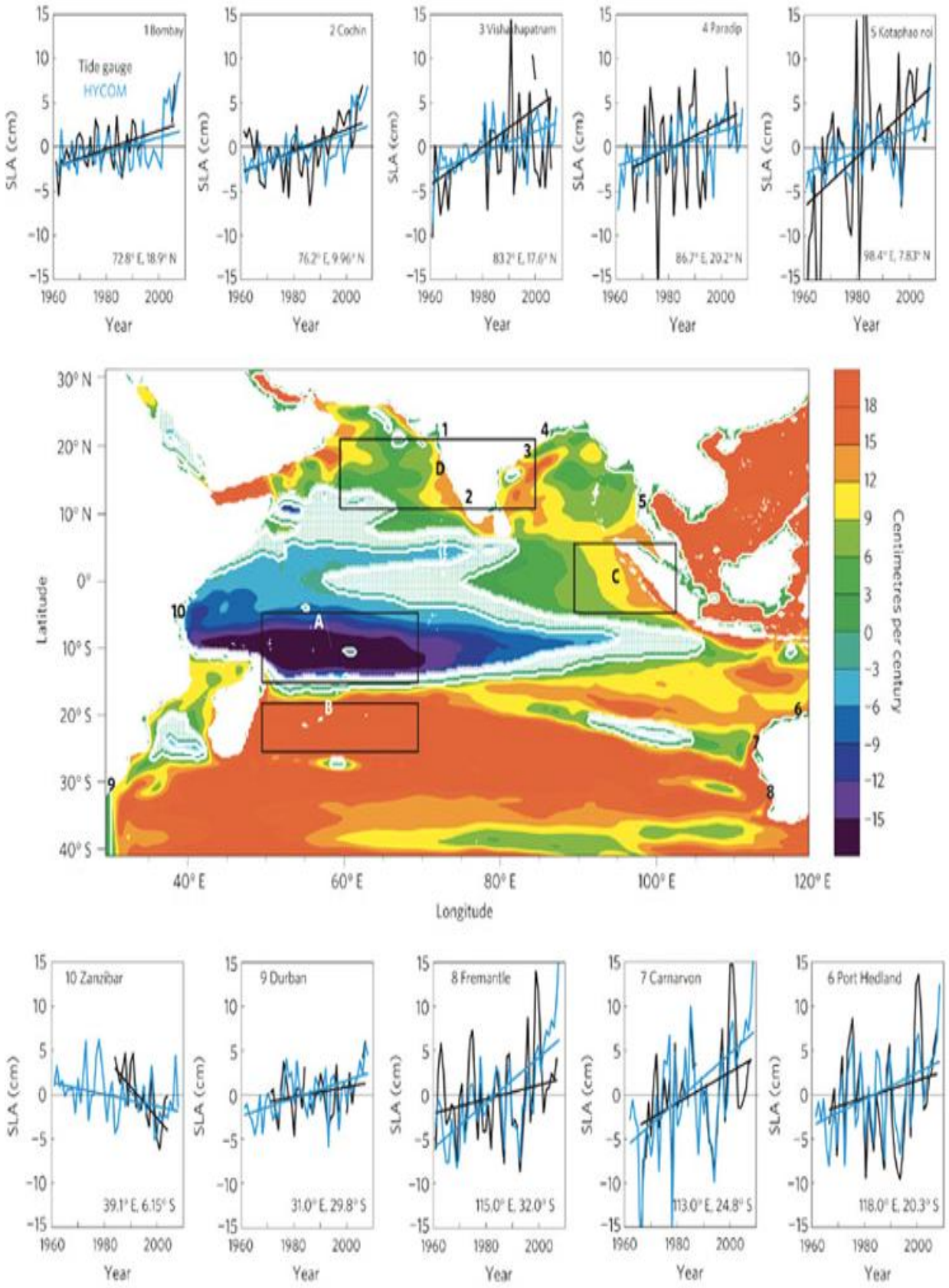


Figure 16: In situ (tide gauge) observed and model experiments (HYCOM) of mean sea level anomalies and their Kendall Theil trends during 1961 – 2008 in the Indian Ocean. The 10 tide gauge stations with records longer than 30 years (20 years for Zanzibar) are shown. The coloured map shows the Kendall Theil trend of HYCOM sea level anomaly for the same period. The blue/green regions are below and the rest are above 95% significance.

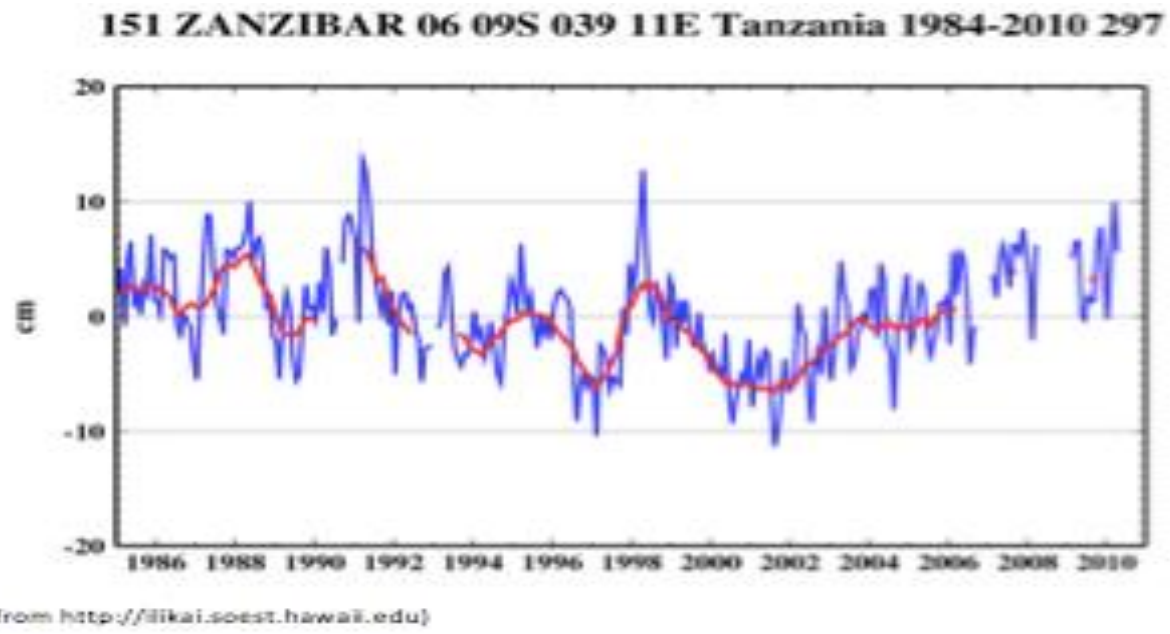


Figure 17: Sea level data from Zanzibar from 1985. A downward trend is apparent until about the year 2000 after which the sea level is rising. From Gloss/Clivar/NOAA Climate and Clobal Change Program, University of Hawaii Sea Level Center.

Impacts of Climate Change on Coastal Areas

Impacts of changing water levels: The physical impacts due to sea level rise include the disappearance of low-lying islands and coasts, erosion of coastal land, increasing incidents of flooding of coastal areas, saltwater intrusion of groundwater as well as surface water, and impacts in habitats such as reef ecosystems, marshes and mangroves as well as sandy beaches. The effects, interacting factors and possible adaptation approaches to these impacts have been summarised by Nicholls (2011) and are shown in the Table 33 below – modified to tropical East African conditions.

Table 33: Effects, interacting factors and possible adaptation approaches to physical impacts have been summarised by Nicholls (2011), but modified here to African conditions.

Natural system effect	Possible interacting factors	Possible adaptation approaches
Erosion of low-lying sand/mud beaches	Sediment supply/ Dam construction, construction in coastal areas	Nourishment, land-use planning, managed realignment
Wetland/mangrove loss	Sediment supply, Filling, construction in coastal zone	Nourishment, land-use planning, managed realignment, replantation of wetland vegetation
Inundation/flooding	Waves/storms, sediment supply	Dikes, surge barriers, closure of dams, dune management, building codes, set-back lines
Saltwater intrusion	Runoff/rainfall, catchment/water extraction management	Salt water intrusion barriers, change water extraction, freshwater injection
Coral reef loss	Destructive fishing methods, bleaching, sedimentation	Managed fishing, coral replantation, provision of hard substrates for natural coral recruitment

Impacts of increasing temperatures: Increasing temperatures of the ocean and coastal waters will affect the availability of dissolved oxygen which will impact temperature dependent respiration and metabolism. These factors will have a number of impacts on the local marine and shallow

water ecosystem. As part of US National Climate Assessment, Howard et al. (2013) summarised the impacts of increasing water temperatures that have been observed and will be increasing even more so in the future. Observed impacts include shifts in species distributions and ranges, effects (primarily negative) on survival, growth, reproduction, health, and alterations in species interactions. Impacts are occurring across a wide diversity of taxa and in all ocean regions. However, high latitude and tropical areas appear to be particularly affected. There is high variability in the vulnerability and responses of marine organisms to climate change, leading to "winners" (i.e. species positively impacted) and "losers" (i.e. species negatively affected). Species with high tolerance for changes in temperature and other environmental conditions will likely experience fewer climate-related impacts and may therefore outcompete less tolerant species. Corals and other calcifying organisms as well as other species that are highly vulnerable to climate change will continue to suffer and the diversity and abundance of these organisms will drop in tropical regions such as East Africa. Climate change effects on local ecosystems interacts with, and can exacerbate, the impacts of non-climate stressors such as pollution, the impacts of overfishing or the use of destructive fishing methods and the consequences of introductions of invasive species. Opportunities exist for ameliorating some of the impacts of climate change by reducing non-climate stressors at local and regional scales. The combined impacts of multiple stressors are difficult to predict considering the complexity in the physiological response and the ecological interactions among species. Past and current responses of marine organisms to climate variability and change are informative but extrapolations to future responses are difficult considering that future environmental conditions are likely to be unprecedented. It is clear however, that observed responses vary in magnitude across space and time. Phenomena such as threshold responses or tipping points resulting in rapid and more or less irrevocable ecosystem change are issues of great concern.

Impacts on fishing: Temperature is a very critical environmental factor in the embryonic development and growth of fish. Only a few degrees difference from the optimal will lead to declined growth and increased sensitivity to stress. Most research on these aspects has been carried out in the North Atlantic and few studies have been carried out in the Indian Ocean. What most studies seem to indicate is that it is not sufficient to study the impacts of the annual mean temperature on fish survival and growth. The seasonal pattern of temperatures and the food supply are also highly critical. Climate change is very likely to already have affected fisheries in the Indian Ocean. Following the massive coral bleaching and subsequent mortality of corals in 1998, many reefs in East Africa changed from being reefs dominated by corals to reefs dominated by algae. Typical coralivorous fish species disappeared and were replaced by herbivorous species (Linden, O., D. Souter, D. Wilhelmsson & D. Obura (Eds), 2002); (Souter, D. & O. Linden (Eds.), 2005). The IPCC (2007) considers that climate change is likely to have a greater impact on coastal than on pelagic species, but believes that the levels of fishing pressure are more likely to dominate reproductive success and abundance. Climate change is considered primarily as an additional pressure on fish stocks whose resilience may already be low due to anthropogenic impacts on stock and habitats.

Summary: Climate Changes in Coastal Tanzania

- The air temperatures in coastal Tanzania are increasing rapidly and there are indications the increase is accelerating.
- The temperature increase is particularly pronounced in Dar es Salaam, Zanzibar and Pemba.
- Increasing air temperatures are likely to affect patterns and intensity of precipitation. However, rainfall data from Tanzania does not indicate wetter conditions as might be expected from the increasing temperatures. In a few places along the coast a trend towards drier conditions can be seen.

- The ocean water off the coast is highly influenced by atmospheric processes including El Nino and La Nina phenomena which results in periods of very high temperatures interrupted by periods of relatively cold surface temperatures.
- Changes in wind speeds/directions and intensity of storm events have not yet been noticed in the area but increasing air and sea surface temperatures should be expected to result in higher wind/cyclone/hurricane intensities.
- Data on the changing sea levels that are available from the region show both rising and falling trends from up to 41 years. Data from Zanzibar since 1986 indicate an initial decrease in the water levels followed by an increase since about 2000.

Future Climate Change in Tanzania

Introduction

The report above presents the current state of the science regarding the causes and consequences of climate change as it has been recorded until now and from an Indian Ocean and Tanzania perspective. Several of the changes that have occurred may appear to have been gradual and relatively predictable. Year after year the air and ocean grow warmer, sea levels are rising, ocean water is acidifying and anoxic zones are spreading. The question is if the changes will continue to be gradual and predictable. If they are the most likely outcomes will be rather easy to forecast. However, gradual changes are not the whole story. Abrupt changes involving less likely and less predictable impacts are likely to occur. Many natural systems reach thresholds or tipping points after which the behaviour of the systems suddenly changes. In fact tipping points have been observed in numerous situations in the ocean before. Fisheries have collapsed as a result of warming waters in the northern Atlantic. Corals in the tropics live close to their maximum temperature tolerance limit and an increase of only a few degrees will cause bleaching and mortality. Ocean acidification will eventually lead to under-saturation of aragonite, at which point the oceans will become corrosive to calcifying organisms such as molluscs, crustaceans and many plankton species. When it comes to sea level rise science indicates that the melting of the ice sheets and glaciers on the planet are much faster than predicted in the earlier scenarios of the IPCC. The general opinion among climatologists today seems to be that there are two stable states for the planet: one with and one without ice sheets and glaciers. About 40 to 65 million years ago no major ice existed on Antarctica and Greenland. Concentrations of CO_2 in the atmosphere at that time were around 500 ppm. Today the CO_2 concentrations have increased to 400 ppm from 320 before industrialisation. Stable ice on Greenland was formed only 8 million years ago when the CO_2 concentrations were below 300 ppm. Most climatologists seem to agree that a complete loss of the Greenland ice sheet with a resulting sea level rise of 7 m is very likely with the development today.

Preparing for the impacts of future climate change is extremely difficult as the uncertainties are significant. Prediction of impacts and tipping points is difficult, in part because individual threats interact in complex and non-linear fashions. If coral reefs disappear because of warming of the ocean, fisheries will suffer and islands and low-lying coastal areas will be impacted by increasing erosion as the protective properties offered by the coral reefs will disappear. At the same time fisheries are generally suffering from overfishing and pollution. The combined impacts on the coastal livelihoods can be expected to be worse than the sum of the parts as feedbacks among the threats are frequent and inescapable. What this also means, and what a number of scientific studies have illustrated is that the management of local stressors has the potential of reducing the impacts of global stressor.

Below an attempt is made to forecast the future climate change impacts in coastal Tanzania. However, due to our limited understanding of feedbacks and interactions, forecasts are difficult and surprises should be expected.

Temperature

Based on the available climate data for Zanzibar and coastal Tanzania, feed into the global climate models which use the forecasted greenhouse gas emissions, it is possible to make predictions of the future development of the temperature in the air and coastal waters. As pointed out earlier, Regional Climate Models are not sufficiently developed at this stage to be useful in predicting local and regional weather and climate patterns. However, by downscaling empirical or statistical data from coastal Tanzania including the islands it is possible to approximate the regional temperatures over the near future. Such downscaled data were presented for Zanzibar based on CMIP3 archive GCMs using nine different simulations (done by University of Cape Town). The results were presented in the Zanzibar Climate Change Strategy presented early in 2014. The strategy considers future climate projections for the medium-long (2040-2060) and long-term (2080-2100). It uses meteorological data from the islands based on a baseline climate simulation of data from 1961 to 2000 and observed greenhouse gas concentrations. The Zanzibar Climate Strategy predicts a medium term (2040-2060) temperature increase of 1.5 to 2°C by 2050 (2045-2065) and 2 to 4°C by 2090 (2081-2100) (Figure 18). The prediction is for a fairly similar increase across the months of the year. Considering the close resemblance between the trends in temperature between Zanzibar, Pemba and the mainland coastal sites (see Annex 2), the predictions for Zanzibar are likely to be valid also for these other sites.

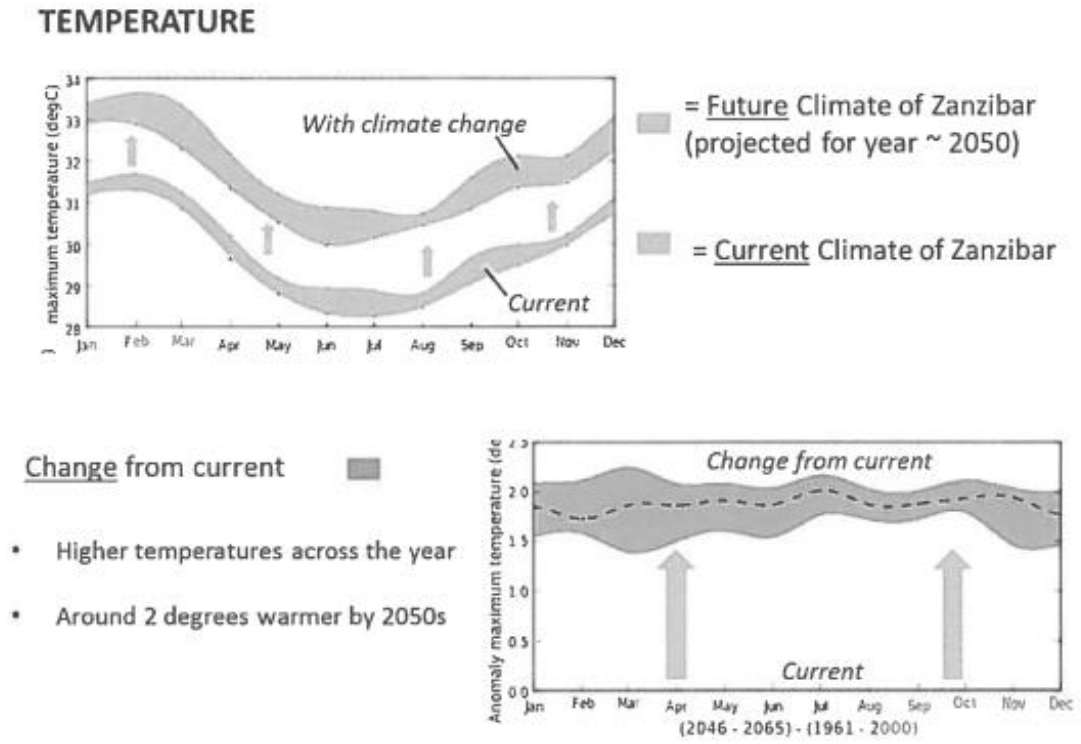


Figure 18: Forecast for future monthly daily maximum temperature (2045-2065) compared to the current situation in Zanzibar. From Zanzibar Climate Change Strategy/CSAG, Univ. Cape Town, SA (Figure 12 from the Zanzibar Climate Change Strategy).

Rainfall and Humidity

The future rainfall and humidity is more complex and difficult to predict. Increasing air temperatures could mean increasing humidity and indeed the data received from Zanzibar (see above) indicates that the humidity has increased significantly during the last decades. Whether this translates into more rainfall is questionable. In Zanzibar there was no corresponding increase in rainfall during the period in question.

The Zanzibar Climate Change Strategy forecasts increasing precipitation during the wet seasons and lower rainfall during the dry seasons (Zanzibar Climate Change Strategy). The size of the changes during the year varies dramatically across the models used (represented by the column height in the bottom panel), hence firm conclusions cannot be drawn.

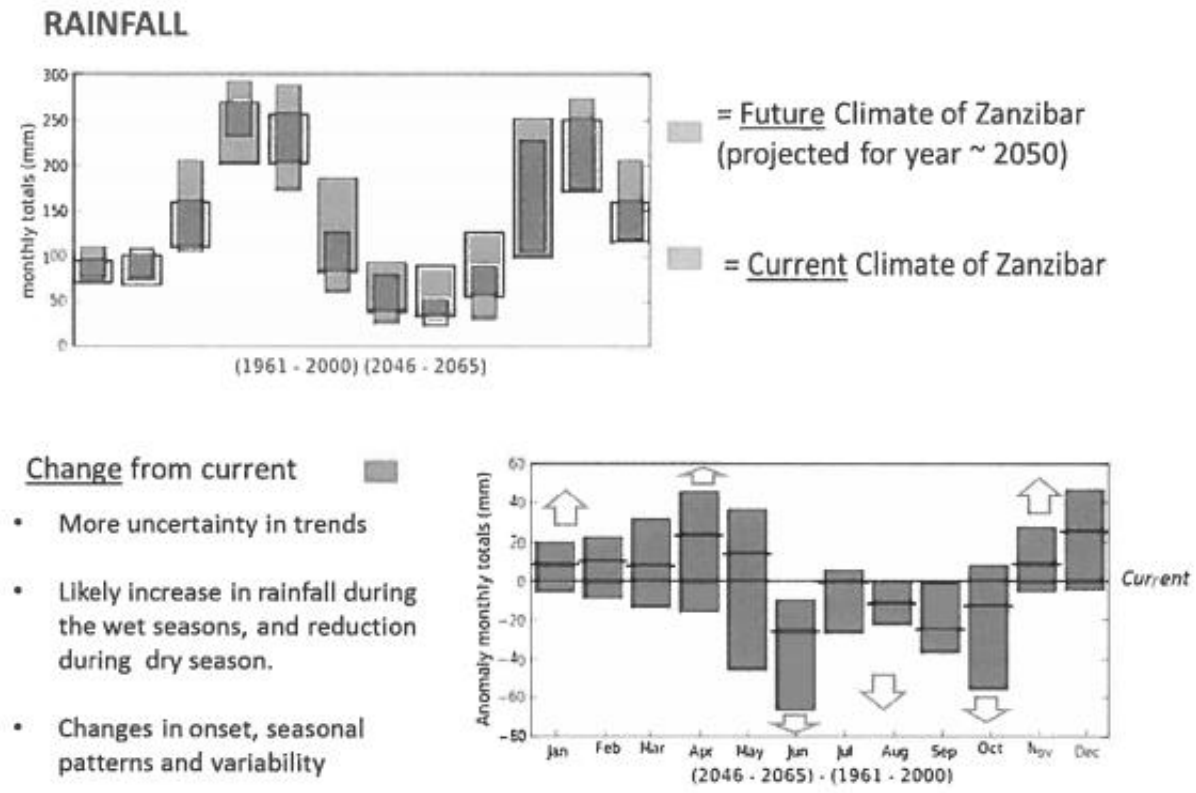


Figure 19: Forecast for future monthly rainfall (2045-2065) compared to the current situations in Zanzibar. From Zanzibar Climate Change Strategy/CSAG, Univ. Cape Town, SA.

The results of a modelling of the future monthly rainfall in Dar es Salaam was carried out by Besa (2013) based on CMIP5, a new set of climate model experiments coordinated between 20 modelling groups around the world. Also these results are rather inconclusive (Figure 20). The results indicate a decrease in the length of the long rainy season for the period 2020-2040 and 2040-2060 compared to 1958-2000. There are also indications that the short rainy season may change in its pattern (decrease in November, increase in January). As can be seen from the diagram there are few consistent trends. Additional projections were made as for the future number of heavy rains in Dar es Salaam for the period 2020-2040 (Figure 21). The results here are also not conclusive but the number of wet days (>20mm/day) from January to April may increase. Most models suggest increasing number of wet days in October – December. In the longer-term (2040-2060) there are no conclusive patterns.

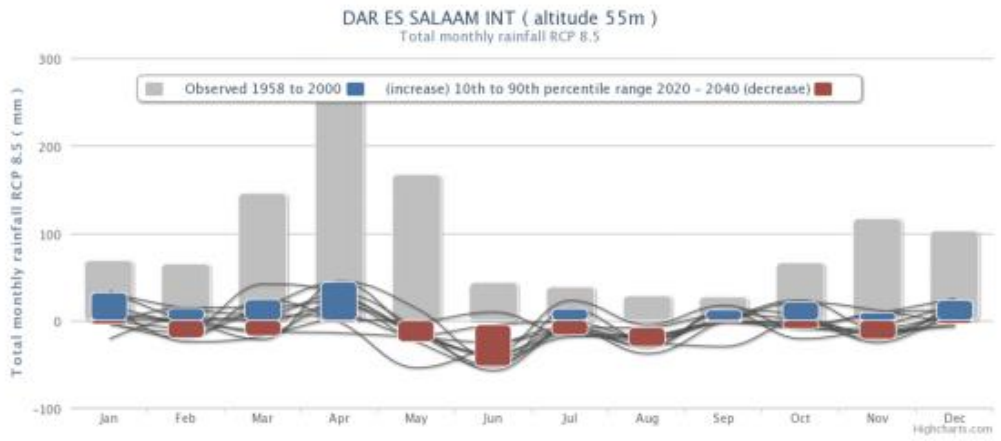


Figure 20: Projected changes in total monthly rainfall in Dar es Salaam (airport) 2020-2040, using the sing RCP8.5 scenario (high emission) (CMIP5). From Besa (2013).

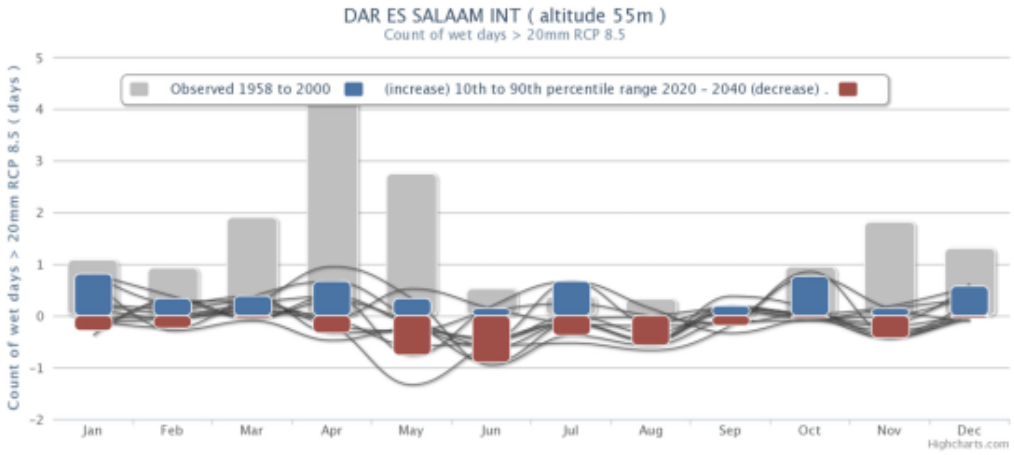


Figure 21: Projected changes in number of heavy rains in Dar es Salaam (airport) 2020-2040, using the sing RCP8.5 scenario (high emission) (CMIP5). From Besa (2013).

Besa (2013) further reported future forecasts regarding dry spells in Dar es Salaam based on CMIP5 (20 modelling groups around the world). Also here the models show mixed results (Figure 22). There is some agreement between several models that in the near to medium term there will be some decreases in the length of dry spells in the late and early parts of the year and a risk for increased length of dry spells in the middle of the year. However, in the longer term there are no conclusive picture and the models show different outcomes.

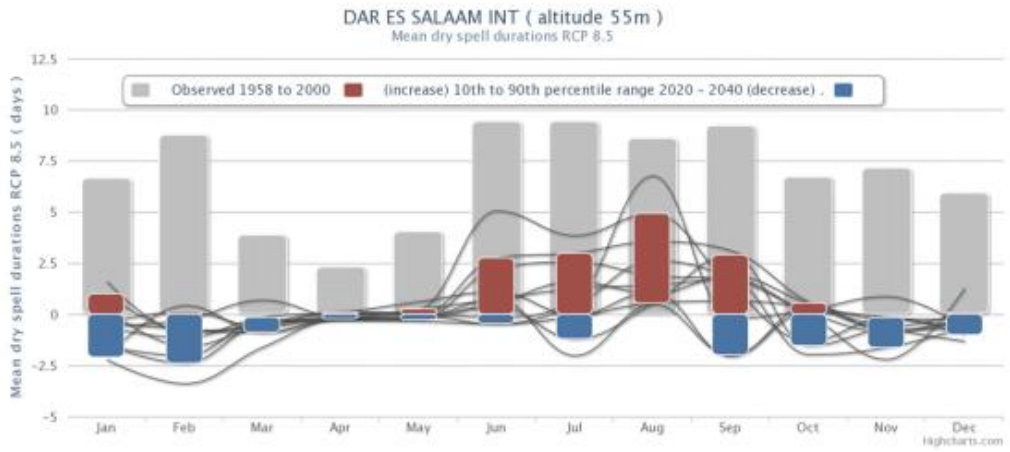


Figure 22: Projected changes in number of dry spells in Dar es Salaam (airport) 2020-2040 and 2040-2060, using the sing RCP8.5 scenario (high emission) (CMIP5). From Besa (2013).

Increasing Wind Speeds, Extreme Events and Multiple Stressors

Increasing intensity of winds in coastal Tanzania will affect coastal livelihoods in a number of ways. Coastal infrastructures will be affected, erosion is likely to increase, and traditional activities like fishing will be negatively affected.

Low-lying parts of Zanzibar and coastal Tanzania will be affected by extreme climate related events, most likely a combination of strong winds coinciding with spring tides and against a backdrop of sea level rise. A quite likely scenario is also changes in current and wind patterns as the air temperatures continue to increase. The result will be flooding of low laying areas, destruction of coastal infrastructures, salt-water intrusion into soils and groundwater, and erosion of the coastline. This kind of impacts has occurred with increasing impacts in parts of Zanzibar, Bagamoyo, Pangani, and Rufiji. In the near to medium term future such kind of impacts can only be expected to increase.

If our understanding of the impacts of the different aspects of climate change is limited, we have even less understanding of the extent of impacts of the climate change related stressors (of global origin) in combinations with other anthropogenic stressors of local origin. There are different types of responses from additive, antagonistic to synergistic. The additive response occurs when the impact of the multiple stressors is a direct addition of the stressors acting alone. An antagonistic is when the response is less than the addition of the stressors acting alone, and synergistic when the impact of the multiple stressors is greater than the additive impact. However, recent research (reviewed by Hall et al. 2013) seems to indicate that additive and synergistic reactions are far more common than antagonistic effects. This should indicate that improved coastal management at the local level would improve the situation in coastal Tanzania. Hence better management of reefs and mangroves and improved fisheries management would mean that the coastal environment would be in a better position as the climate is gradually changing.

Acidification

The problems with acidification of the coastal and ocean waters of Tanzania will depend on which CO_2 mitigation scenarios area is followed on a global level. There is a very clear and direct correlation with CO_2 emissions, the atmospheric concentrations of CO_2 and the uptake of CO_2 by the sea. However, it is important to consider the local variations across the oceans. Lower pH and carbonate ion concentrations will first affect high-latitude oceans, upwelling areas and the deep ocean. Cold waters absorb more CO_2 than warm water and the pH and the saturation of

carbon ions, aragonite and calcite are lower in polar seas than in tropical waters. Hence coastal East Africa is not expected to experience negative effects as a result of acidification during this century.

Summary: Changes that can be expected in the future

Our understanding of the likely future development of the climate is based on models that to a largely base their assumptions on historic events. It should be remembered that we know very little about feedbacks, additive, antagonistic and synergistic effects as well as thresholds above which the trends change. With this in mind, based on current knowledge and the different models that are used to predict the future climate we can say the following:

- All models show that temperatures are likely to increase in air and water. The average yearly temperatures at the end of the century is likely to be 2 to 2.5°C higher than today. Temperature increases of such magnitudes will have drastic effects on the ecosystem and very likely eliminate certain species almost totally (for example scleractinan corals);
- The models forecasting precipitation in future scenarios are not conclusive but could indicate dryer conditions during the non-rainy seasons and wetter during the wet seasons. There are also indications that we may expect changes in the pattern of the seasons, indicating possibly longer dry seasons and shorter but wetter rainy seasons;
- The models forecasting dry spells are not totally conclusive but there are indications that in the short to medium term dry spells during the beginning of the year and end of the year are decreasing and the mid-year dry spells increase in length;
- Models for the future wind speeds and intensity and frequency of strong winds/hurricanes indicates increasing trends. We can assume increasing problems related to incidences of extreme winds and that these will affect coastal areas with significant impacts on coastal infrastructures, agriculture biodiversity, and ground water;
- The issues related to acidification of the tropical Indian Ocean waters are not likely to seriously affect the conditions in Tanzania until towards the end of the century.

16 COASTAL EROSION CONDITIONS

Introduction

The coast of Tanzania stretches over a distance of 650 km. It has an orientation approximately north-south from latitude 4.7^0 south to 10.5^0 south. The coast is exposed to the Southern Indian Ocean and is subject to incoming waves generated by the monsoon winds and local storms. There are a large number of islands that shelters the mainland from the waves, some of these islands are very large (notably Zanzibar, Pemba and Mafia) with length of 50-100 km and lies at a distance of several tens of kilometres offshore. There are also a large number of smaller islands lying almost as fringes close to the mainland.

With its major islands the coastline of Tanzania has a total length of about 1,424 km (ASCLME, 2012).

Forcing

Coastal sediment transport and erosion is driven by waves, currents and tide. The waves are wind generated by local and regional wind fields, or they may be swell waves coming from storms at far distance.

Wind

The climate at the coast of Tanzania and in the entire Western Indian Ocean is dominated by the monsoons. The northeast monsoon season is from November to March and the southeast monsoon season is from April to October, see sketch in Figure 23.

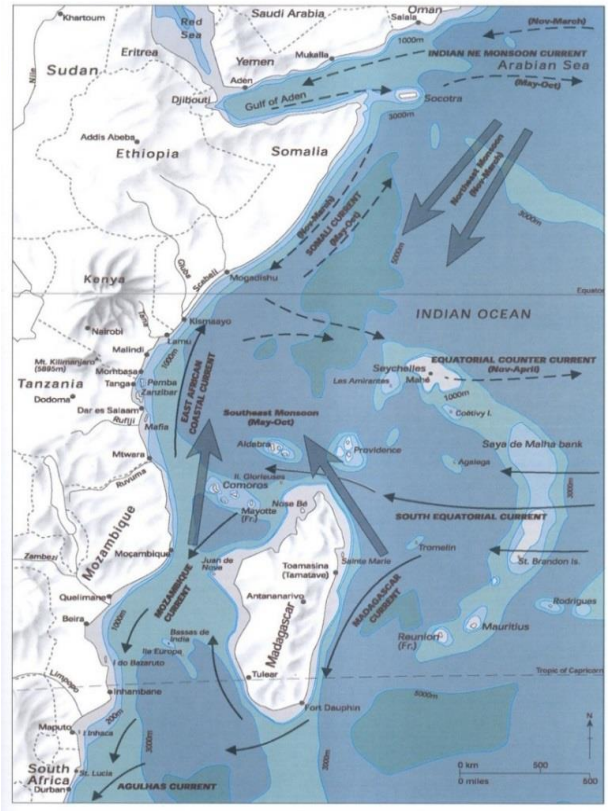


Figure 23: Monsoon winds and ocean currents, Western Indian Ocean (from Richmond, 2006).

In addition to the monsoon winds sea breezes may also affect the coast (ASCLME, 2012).

Tanzania is located in an area where cyclones and tropical storms are uncommon. Most heavy depressions that come from the Indian Ocean do not fall on land in Tanzania, and if it does happen the storms will have decayed and hardly ever have the strength of a tropical storm. Even though the south-eastern part of Tanzania may get hit by a cyclone the chances are very small. Figure 24 shows historical cyclone tracks in the western Indian Ocean. The cyclone season is from November till May.

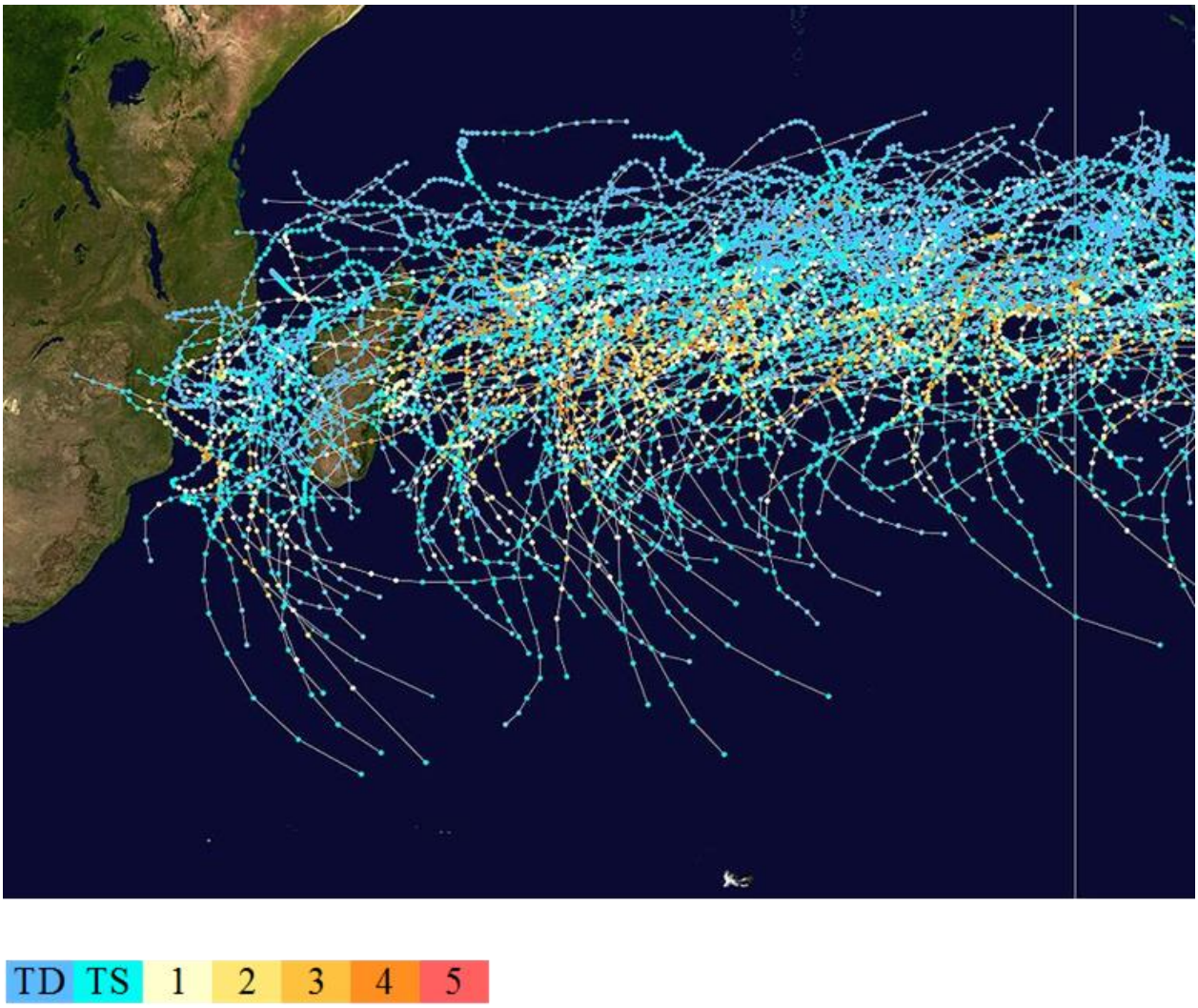


Figure 24: Tracks of all tropical cyclones in the South-western Indian Ocean between 1980 and 2005, Wikipedia, (Wikipedia, 2014). TD: Tropical Depression, TS: Tropical storm, 1-5: SSHS hurricane wind scale.

Waves

The offshore wave climate is to a large degree determined by the monsoon winds. There are no thorough studies of the wave conditions available, but the overall pattern is known. During the northeast monsoon the waves approach the coast from the northern sectors, with a wave height of approximately 0.9 m. During the southeast monsoon the waves approach from south-easterly directions and have heights of about 1.2 to 1.5 m, (ASCLME, 2012).

Almström, B. and L. Larsson (2008) present a wave statistics for the western Indian Ocean obtained from the KNMI/ERA-40 Wave Atlas, (Caires, S., A. Sterl, G. Komen and V. Swail, 2004). Statistics are given for waves coming from the four easterly directions between north and south, Table 34. It is seen that waves coming from east to south are much more frequent (84%) than waves coming from north to east (15%), and that the mean wave height of the former is also higher.

Table 34: Percentage of waves with a given wave height, Hs, and period Tm, coming from different directions in Western Indian Ocean, (Almström, B. and L. Larsson, 2008).

	Direction N - NE				Direction NE - E			
	H_s(m)							
T_m(s)	**0 -1**	**1 - 2**	**2 - 3**	**3 - 4**	**0-1**	**1 - 2**	**2 - 3**	**3 - 4**
3 – 4	0.00	0.01	0.00		0.12	0.08	0.00	
4 – 5	0.01	**0.76**	0.03		1.64	**5.66**	0.02	
5 – 6	0.00	0.15	0.05		1.85	2.59	0.05	
6 – 7	0.00	0.00	0.00		0.81	0.88	0.01	
7 – 8	0.00	0.00	0.00		0.11	0.16	0.00	
8 - 9	0.00	0.00	0.00		0.00	0.01	0.00	
All periods	0.01	0.92	0.07		4.53	9.38	0.08	
total		1.0				13.99		

	Direction E - SE				Direction SE - S			
	H_s(m)							
T_m(s)	**0 -1**	**1 - 2**	**2 - 3**	**3 - 4**	**0-1**	**1 - 2**	**2 - 3**	**3 - 4**
3 – 4	0.08	0.05	0.00	0.00	0.02	0.01	0.00	0.00
4 – 5	1.88	3.89	0.01	0.00	0.19	3.98	0.27	0.00
5 – 6	5.51	**12.25**	2.26	0.01	0.53	**8.79**	9.61	0.11
6 – 7	8.30	9.20	1.19	0.03	1.10	3.34	2.30	0.21
7 - 8	2.35	3.05	0.08	0.01	0.54	1.37	0.15	0.01
8 - 9	0.28	0.50	0.00	0.00	0.06	0.23	0.01	0.00
9 - 10	0.02	0.07	0.00	0.00	0.00	0.06	0.00	0.00
All periods	18.42	29.00	3.54	0.04	2.54	17.79	12.34	0.33
Total		51				33		

Tide

The tide at the coast of Tanzania is semidiurnal with a mean spring tidal range of approximately 3.5 m (Figure 25). This tidal range is large, especially when considering the offshore wave climate. The tide is therefore expected to important for the coastal morphology and the coast is characterised as 'macrotidal'.

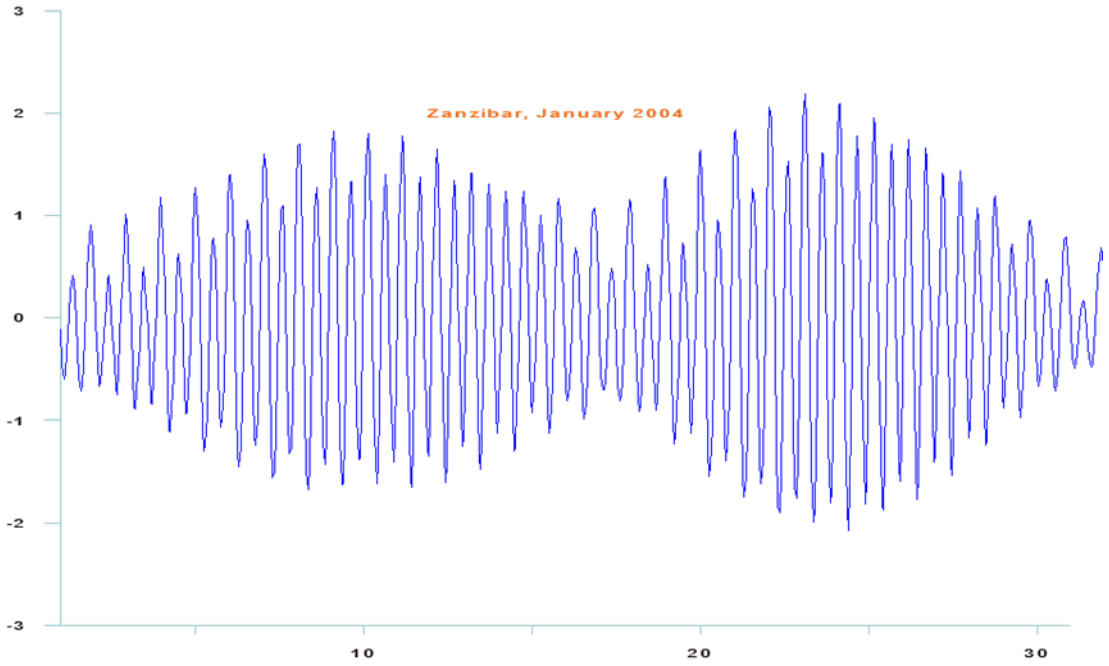


Figure 25: Example of predicted tide, Zanzibar, (Mahongo, 2006).

Currents

Tidal currents in creeks and estuaries can be important for the coastal erosion, but on the open coast tidal currents will often play a minor role compared to the wave action.

Ocean currents do not have sufficient velocity in the shallow coastal waters near the shoreline to play any role for the coastal erosion.

Characteristics of the Coastline

The morphology of a coastline is often dominated by longshore transport, littoral drift. The longshore transport is caused by waves approaching the coast at an angle, when breaking the waves will drive a current along the coast in the surf zone, and sand agitated by the breaking waves and the wave-driven current will transported along the coast. The transport direction changes with the direction of the wave incidence, and the coast will be characterised by the net transport, which is the mean transport on a long time scale of years, and the gross transport, which is the total of the transport going in both directions. The net transport thus represent the net drift of sand in one direction along the coastline, while the gross transport is a measure of the strength of the wave climate and how effective the waves are in distribution sand delivered to the coastline, for example by a river, on the coast.

The littoral drift thus depends on the direction of the wave incidence relative to the coastline and vice versa. The orientation of the coastline will change if the littoral drift is changed, for example if it is reduced by coastal protection structures or if the supply of sand from a river is changed due to mining of aggregates from the river or due to river regulation. Often it will be important to determine the 'equilibrium orientation' of a coastline, which is the local orientation of the shoreline for which the littoral transport is zero. The difference between the actual coastline orientation and the equilibrium orientation is an indication of how strongly the coastline will be affected by interference with the littoral drift.

An important concept is the littoral cells, which are coastal units for which well-defined sediment budgets can be established, and which either are isolated from the neighbouring cells, for example by headlands, or have a well-defined exchange of sand with the neighbouring cells.

It is characteristic for the coastline of Tanzania, that it is highly irregular with a large variation in the coastline orientation even over short distances. There are no large systems or littoral cells where the coastline is defined by the incoming waves and transport or redistribution of sand along the coast.

The reason for the absence of large littoral cells is to a large degree the presence of extensive coral reefs and the many islands along the coast. The coral reefs shelter the coast from the incoming waves except at high water, and the islands near the shoreline, which in some case are also parts of the coral reefs, give an effective local protection of the coastline and prevent any significant transport of sand in the lee zones.

The three large islands will also create lee for the waves coming in from the Indian Ocean. Taking a typical wave height of 1.5 m, this will be generated by winds with a speed of 7.5 m/s blowing over the sea over very large distances, Figure 26. In the lee of an island it would require a fetch of about 170 km to re-establish this wave height, and over a distance of 30-60 km, which is typical for the distance between the large islands and the mainland, it would only have regained 50-60 % of this height.

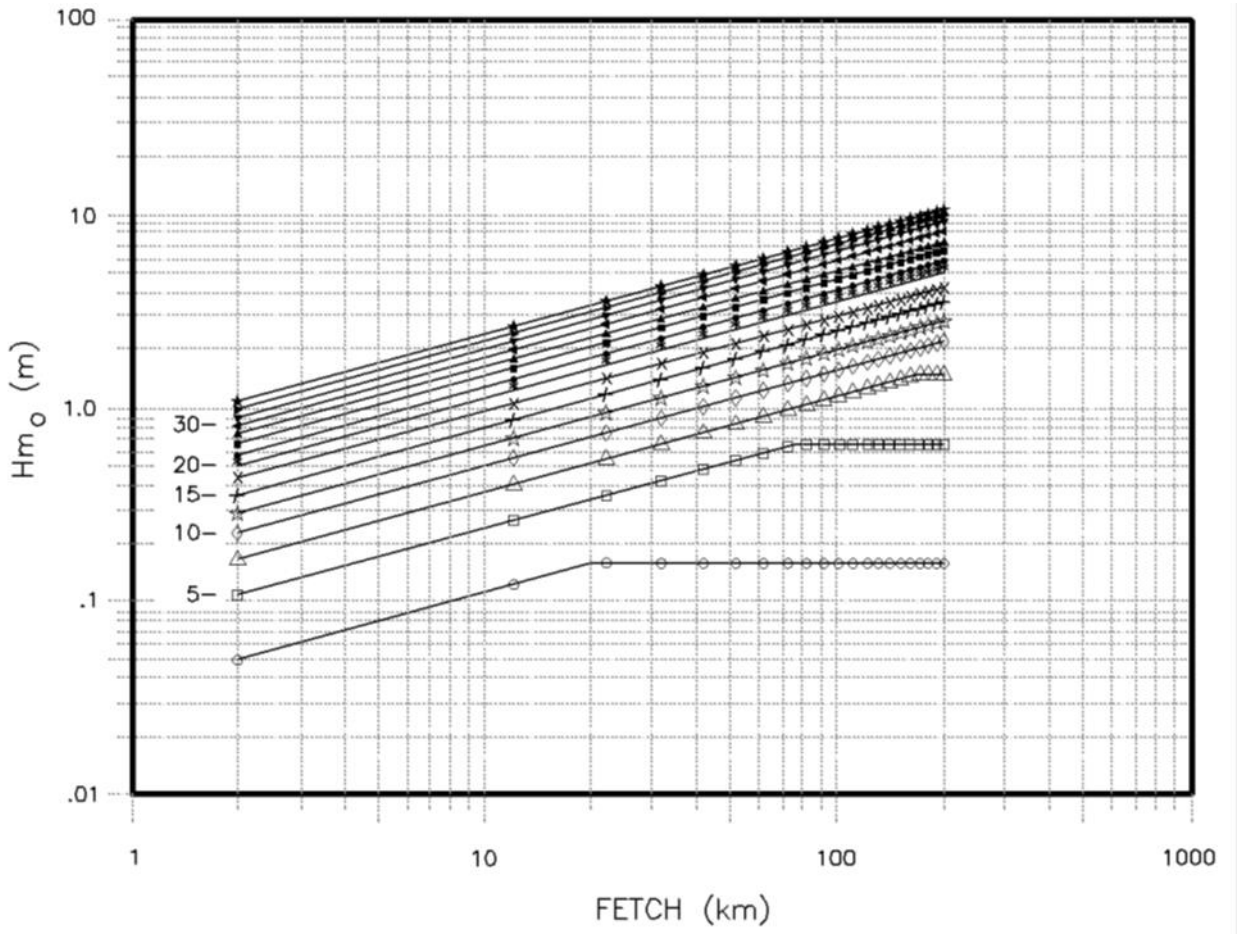


Figure 26: The relation between Wave height (Hm0), the distance the wind is blowing over (FETCH) and wind speed given next to the different curves (5 to 30 m/s).

At many locations the irregular coastline is also fixed by hard erosion resistant points. The hard point may be fossil reef terraces, (ASCLME, 2012). An example of an island formed as a reef terrace is shown in Figure 27.

Figure 27: Lighthouse on Ulenge Island, north of Tanga, Photo from Google Earth

Coral Reefs

As mentioned coral reefs play an important role for the coastal morphology. ASCLME (2012) estimates that coral reefs cover about two thirds of Tanzania's continental shelf. And fringing reefs forming margins along the edge of the mainland or the islands and patch reefs dominate the coastal waters of Tanzania.

ASCLME (2012) presents a classification of coastal types found along Tanzania's coast. The main types are Fringe reef coasts, patchy reef coasts and exposed low lying coasts, Figure 28.

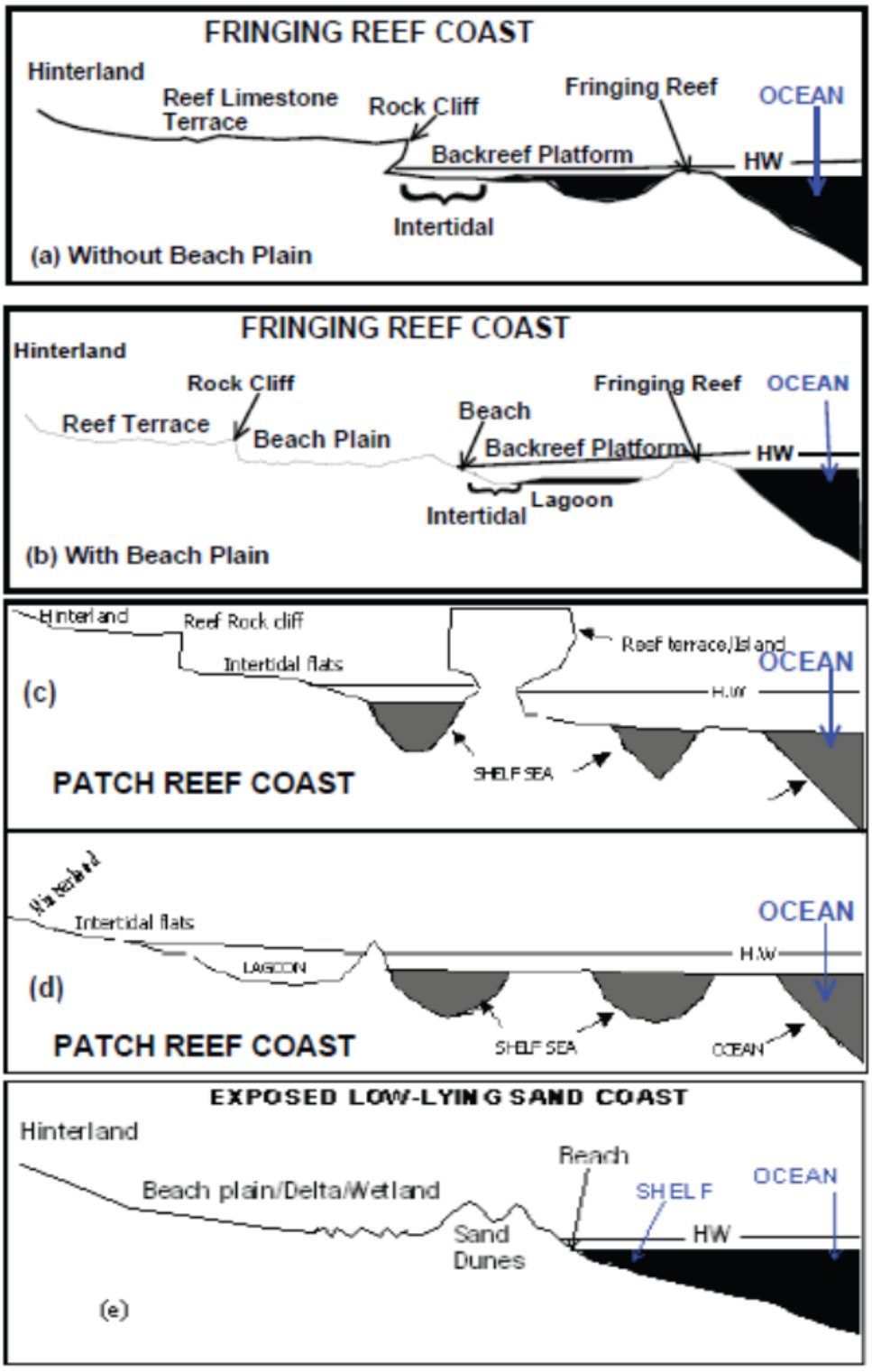


Figure 28: Cross sections of the most prominent coastal types in Tanzania, (ASCLME, 2012).

Tidal Inlets

The large tidal range have also caused the formation of numerous tidal inlets estuaries and creeks, which can be found in connection with all of the three major coastal types.

Mangrove

Extensive mangrove forests are found in the tidal inlets, estuaries and creeks, including where such locations are associated with urban and port development. Due to the gentle wave conditions sheltered by coral reefs mangroves can even be found on the open coast.

Rivers

Several rivers discharge to Indian Ocean on the Tanzanian coast, Figure 29. The river mouths are forming estuaries and deltas with extensive mangrove forests. The rivers are often significant as sediment sources for the coastline, especially for the low lying sandy shores. The rivers carry fine sediments, which are important for the sediment balance of estuaries end the formation of mangroves, but may also cause high turbidity in the coastal waters and have a negative effect on the corals.

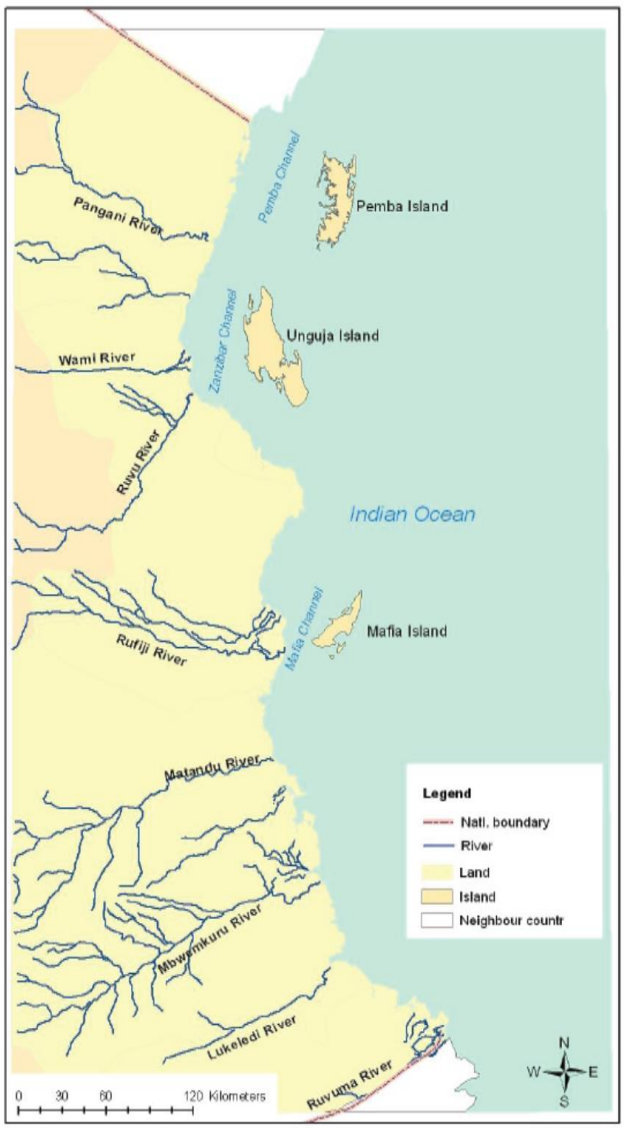


Figure 29: Rivers draining to the Tanzanian coast, (ASCLME, 2012).

Coastal Erosion Problems

The severity of coastal erosion problems depends of course on the persistence of the erosion, whether it is continuing year after year or whether it occurs in connection with single events and the beach is restored during the following more gentle wave and weather conditions. It is also important how developed the coastal front is: if the erosion threatens infrastructure such as roads or railways, of built up areas with hotels or houses.

The coastal types described above will often have a high resilience against erosion, and erosion problems will often be in the form of removal or shifting of an often sparse pool of sand lying in front of a more erosion-resistant backshore.

There are only few studied or reported examples of coastal erosion. Kairu, K. and N. Nyandwi, (2000) describes historical incidences of coastal erosion at locations from Pangani River and southward. The Mazewi Island and Kunduchi Beach are given as reference sites and is described in more detail in the following. Examples of damage to historical buildings are also given. An example, Kilwa Kisiwani, is illustrated in Figure 30 and Figure 31. In this case as in others, the erosion is not due to severe wave action, but rather shifting tidal channels.

Figure 32 and Figure 33 show a site in Lindi, which is not very exposed to waves from offshore, but where erosion seems to occur due to deterioration of a dead coral reef.

Figure 30: The location at Kilwa Kisiwani

Figure 31: Historical buildings damaged by erosion at Kilwa Kisiwani. Left: location 1. Center and Right: location 2.

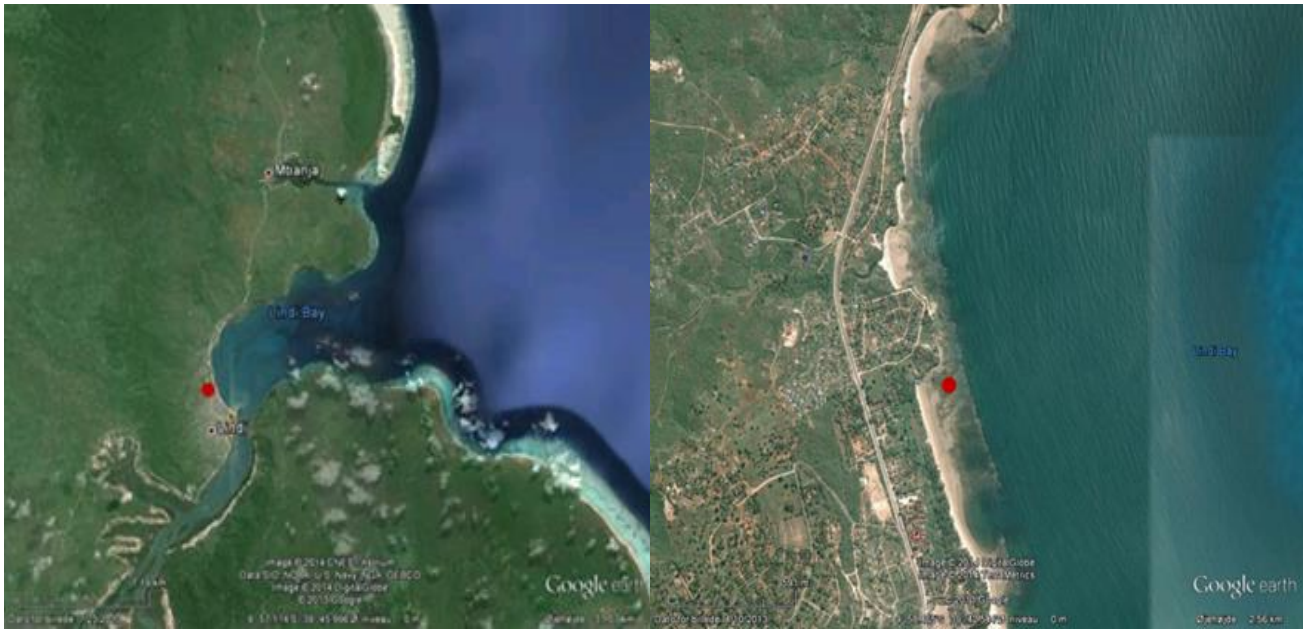


Figure 32: The location at Lindi.

Figure 33: Coastal erosion at Lindi.

Coastal Erosion Conditions at Selected Locations

The two cases, Maziwe Island and Kunduchi Beach, and the coasts at the three major coastal cities of Dar es Salaam, Tanga and Stonetown on Zanzibar are treated in more detail. The cities are of interest because the high level development makes the consequences of coastal erosion more severe, and makes it realistic to introduce costal protection measures.

Maziwe Island and Pangani Estuary

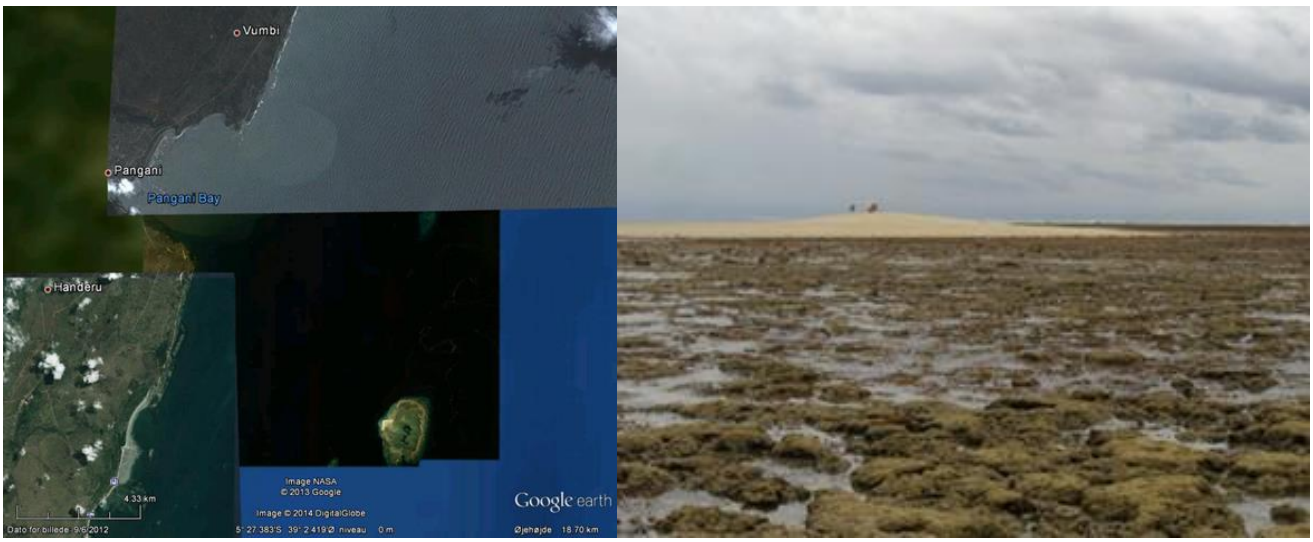


Figure 34: Pangani Bay and Maziwe Island, Google Earth, 2008, left: Maziwe Island today.

Shaghude, Y.W. (2004) and Ngusaro, A.S. (2000) describe the erosion of the island of Maziwe, which is situated off the mouth of the river Pangani, Figure 34. The erosion has been going on for as long as records are available. On charts from 1894 the island is shown as almost circular with a diameter of half a kilometre. The island was elevated about 2 m above the highest tidal level with a base 4 m lower at the reef flat surface. The Africa Pilot (Hydrographer of the Navy, 1980) describes the island as tree covered. By 1992 the main part of the remaining of the island was a reef flat at the level of neap high tide, (Ngusaru, 2000). Today the island is all but gone but according to (Shaghude, Y.W. (2004) the island was exposed at all tides until the 1960-ies and covered by casuarina trees. The disappearance of the island is attributed to the clearance of all trees from the island around 1980, (Shaghude, Y.W., 2004). Local sources claim this was done by the military for security reasons.

Shaghude, Y.W. (2004) and (Shaghude, 2004) also treats a coastal erosion problem on the mainland just north of the Pangani Estuary. The estuary is expected to be formed in a depression, (Shaghude, Y.W., 2004), Figure 35. The depression has been filled up with sediment brought by the river and shaped by the waves coming from offshore, which is clearly seen by a series of old shorelines, which are parallel with the present shoreline in the bay just north of the river mouth.

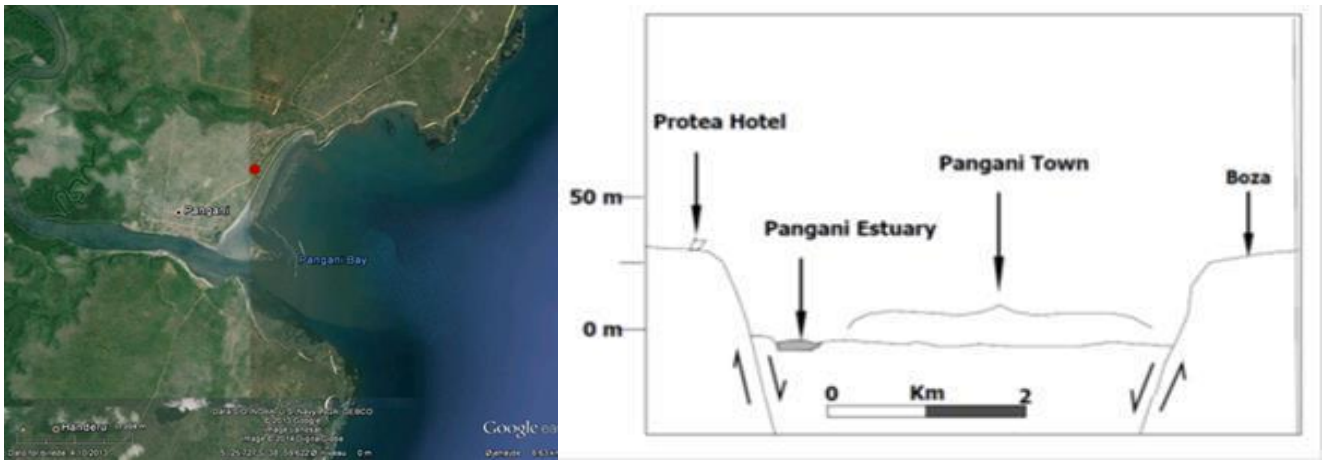


Figure 35: The Pangani estuary, right from Ref. /8/.

It has been reported that the shoreline in the bay recently has started to erode, and that the shoreline in the 1960-ies was almost a kilometre further offshore than today. Recent erosion rates of 20 m/year have been reported. However, there is no explanation for where large amounts of eroded sediment should have disappeared to, and inspection of Google Earth photos from 2008 and 2012 shows no signs of coastal erosion in the central parts of the Pangani bay, Figure 36. It should be noted that no Google Earth photos are available to look at the possible erosion further south closer to the river mouth.

Figure 36: Details of the shoreline north of Pangani River, location indicated by the red dot in Figure 1 14. Left: Oct. 30, 2008. Right: June 9, 2012. The length of the line from the buildings to the shoreline is 120 m.

Dar es Salaam and Kunduchi Beach

Dar es Salaam faces the Indian Ocean and has harbour facilities in a creek. The only location where coastal erosion has been reported and extensive protection measures have been taken is along the Kunduchi Beach. The conditions at Kunduchi Beach have been studied by Almström, B. and L. Larsson (2008), which also gives a review of other sources up to 2008.

Kunduchi Beach is situated north of Dar es Salaam, Figure 37, and is a coastal stretch of about 25 km length. Almström, B. and L. Larsson (2008) has analysed the shoreline movements by studying aerial photos and satellite images from 1953, 1981, 1992 and 2005 and recent GPS tracks made during a field campaign.

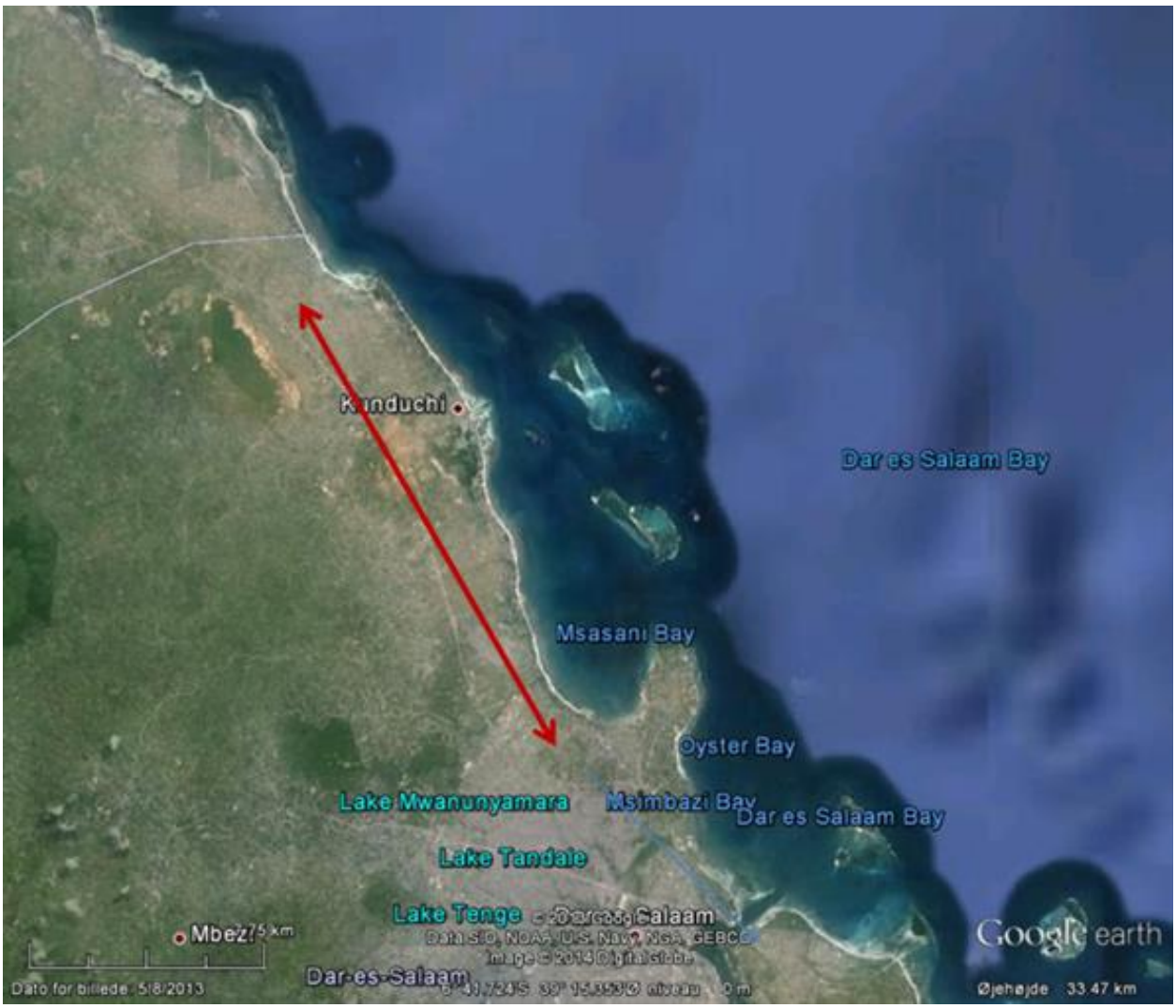


Figure 37: Kunduchi Beach.

Figure 38 shows the total shoreline change from 1953 to 2007. It shows both areas of erosion and accretion. The erosion has affected the many hotels situated on this section of the coast, and one is reported to have been destroyed.

The coast has been protected by groynes and sea walls often placed in front of an individual property, Figure 39, and there is no systematic protection, where the impact of a local protection measure on the adjacent coastline has been taken into account. Figure 40 shows a recent reclamation work, which is protected by extensive structures. This reclamation is of so large scale that it cannot avoid having an impact on the neighbouring shoreline. It will effectively block the longshore transport and can thereby cause erosion to the coastline north of it.

The main cause for the coastal erosion is expected to be alongshore gradients in the longshore sand transport, and there is a general trend for northward transport out of the area while only small amounts of sand are coming to this coastal cell from south.

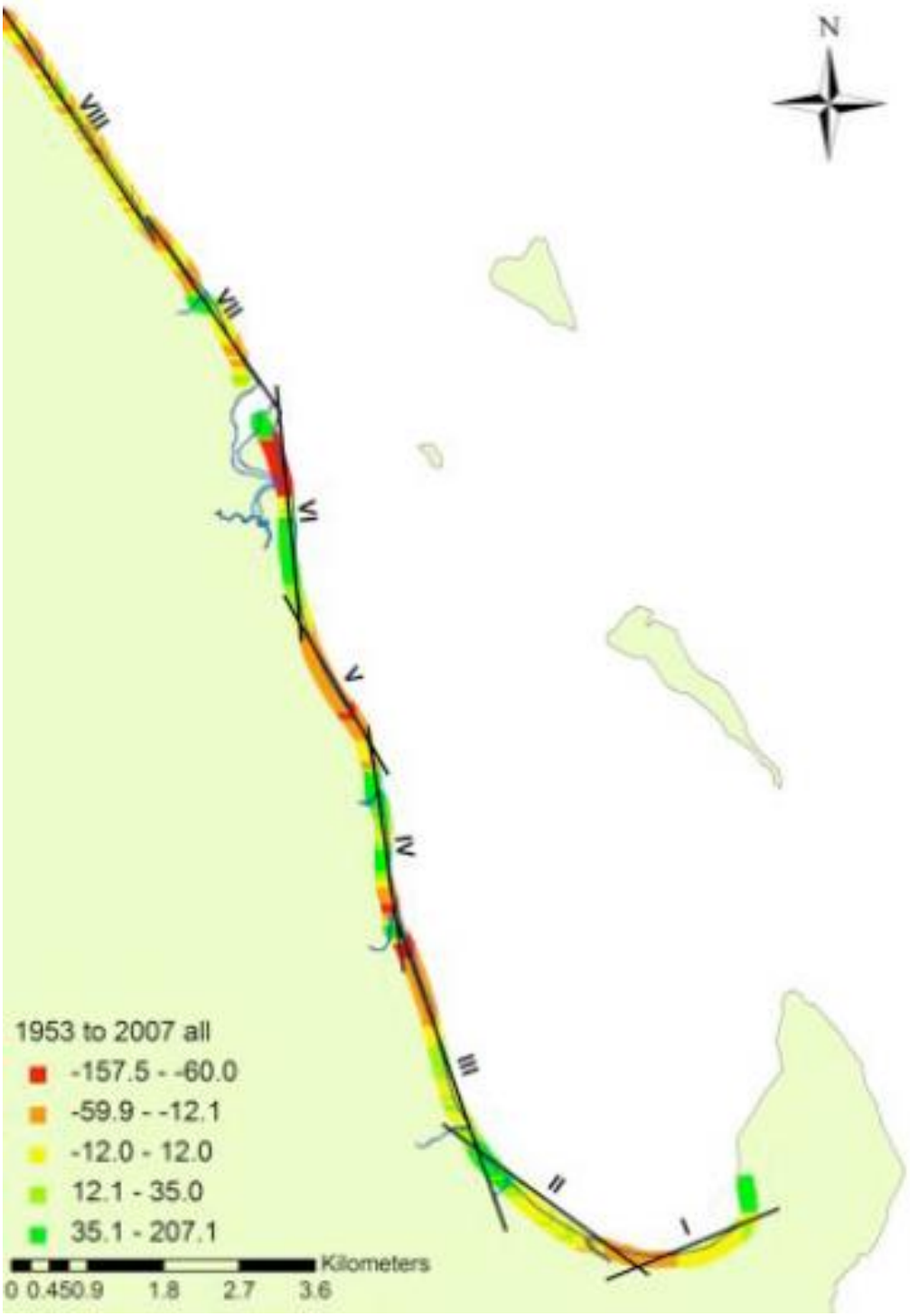


Figure 38: Erosion and accretion along the shoreline, (Almström, B. and L. Larsson, 2008).

On a shorter term erosion may also be caused by single storm events at high tide, where the large wave reaching the coastline will change the coastal profile with erosion of the upper part of the beach and deposition of the sand further out in the profile. This will be seen a pronounced coastal erosion, but the sand deposited off the shoreline will then gradually be transported back to the shoreline over a longer period by the more gentle wave conditions. No sand is lost from the system and over a long period it does not contribute to the erosion, but the changes in the profile and the shoreline position requires some space between the shoreline and developments, which can be damaged by the retreat of the shoreline. Almström, B. and L. Larsson (2008) found large spatial and temporal variations in the erosion and accretion patterns, for example the shoreline showed a clear tendency for accretion in the last years up to the time of the study (2007). A serious factor for the problems experienced is therefore also that the developments are placed much too close to the shoreline to absorb the natural variations in the shoreline position that are to be expected even if the coast were to be stable, cf. **Error! Reference source not found.**. Even if just the current setback line of 60 m from the high water ine had been respected this would have given a much more resilient development of the coast, (Almström, B. and L. Larsson, 2008).

Almström, B. and L. Larsson (2008) give the reasonable recommendation to use beach nourishment to mitigate the erosion and to develop a coordinated management of this stretch of shoreline.

Figure 39: Coastal protection works (groynes) at Kunduchi Beach.

Figure 40: Reclamation in the form of a headland at Kunduchi Beach. Left: May 8 2013. Right: December 20 2003.

Another example of coastal protection works is what appears as a small sea wall constructed along a road, which is located very close to the coastline, Figure 41.

Figure 41: Example of coastal protection works in Dar es Salaam: a sea wall protecting a road close to the coastline.

Tanga

The city of Tanga faces the Indian Ocean to the east and has its main harbour facilities in the sheltered Tanga Bay to the north. No erosion problems have been found to have been reported, and there are no visible signs of erosive action on the coast. To the east the coast is protected by a series of islands and reefs, and shows no sign of erosion. Rather, mangroves are found in front of the coastline. No signs of erosion are observed on the shoreline along the Tanga Bay.

Stonetown

The city of Stonetown is situated on the west coast of Zanzibar, and is therefore not attacked by waves coming from the Indian Ocean. The coast around the city shows very few signs of any erosive pressure. The only location that shows changes in the shoreline and some structures is at the promontory at Shagani, Figure 42. Even here the coastline variation is weak and not systematic and the structures have probably been found to be necessary because the buildings are placed too close to the beach.

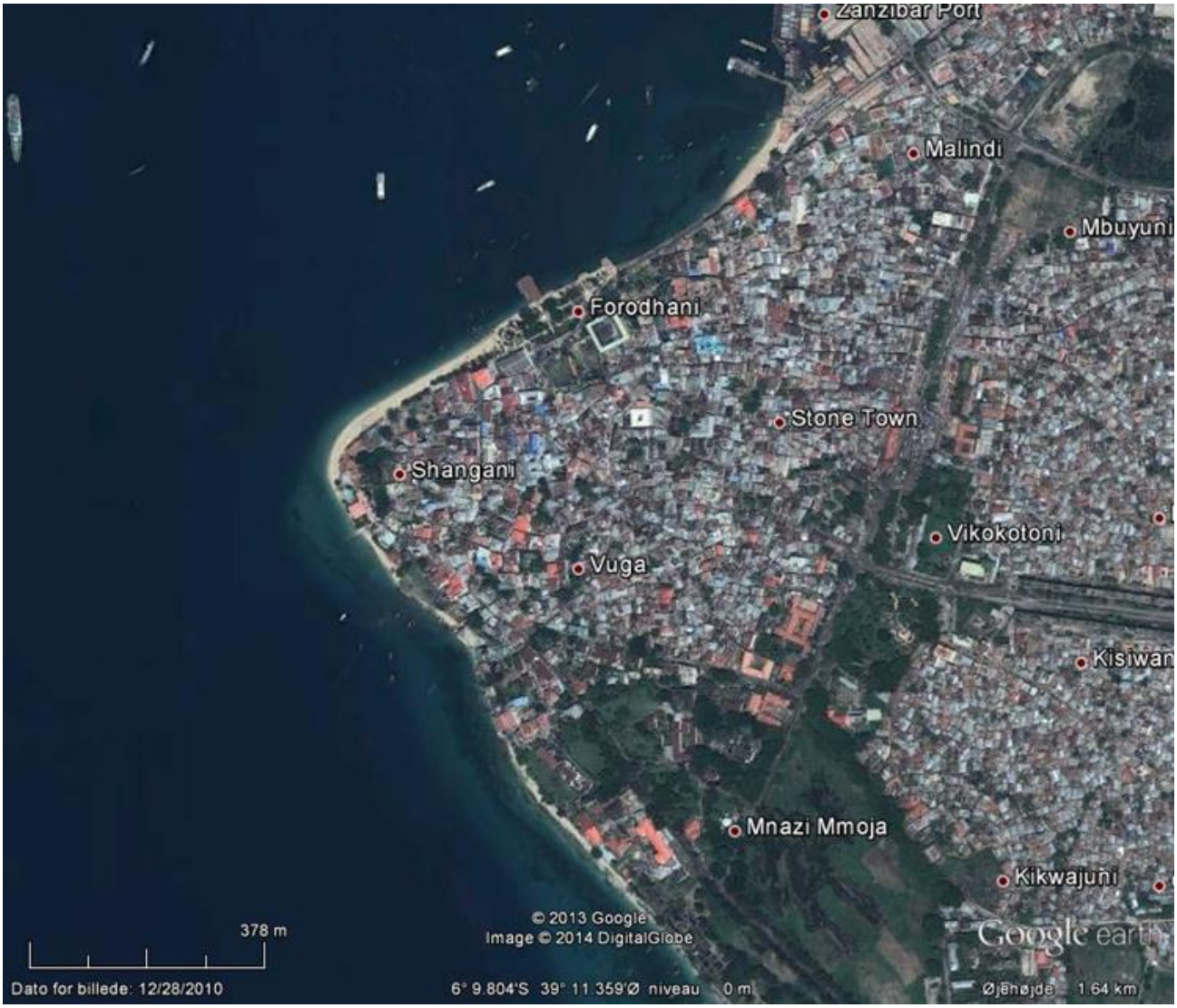


Figure 42: Shagram Promontory, Stonetown.

Future Erosion Pressures

The coastal erosion problems of Tanzania are manageable, but future conditions may cause more severe erosion problems and a deterioration of the quality of beaches used for fishing or recreation and water sports. The good beach conditions are to a high degree caused by the presence of coral reefs, which over large stretches protect the coastline against severe wave action but allow sufficient wave energy to propagate to the beaches to maintain a sandy beach of good quality without deposition of fine sediments, which would make the beach soft and wet.

Effects of Climate Change

The coral reefs may be affected by climate change. An increase in temperature may be detrimental to the corals.

The coastlines of Tanzania are also particularly sensitive to rapid variations in the sea level, if the coral reefs cannot keep up with the rising sea level the coasts will – in addition to the higher sea level

– be exposed to a harsher wave climate with higher maximum waves and a higher frequency of severe waves reaching the coastlines, which today are protected by corals.

Changing wind conditions will be reflected in a change in the wave conditions which will affect the coastal erosion.

Changes in the precipitation will affect the water and sediment discharge of rivers. An increase in the fine sediment load can result in an increase in the turbidity of the coastal waters, which may affect the coral reefs.

A change in the sand load delivered to the coast will affect the sediment budget for the coast. A decrease will increase the tendency for coastal erosion, while an increase will provide more sand to the coastal system.

Anthropogenic Effects

Sand mining directly from the coast, in the near shore or in rivers discharging to the coast will deprive the coast of the sediment and promote coastal erosion.

Coral reefs can be directly damaged by human action, which as described above can increase the coastal erosion. Coral reefs may be damaged or destroyed by collection of coral specimens, by mining of corals for construction material and by fishing by use of heavy equipment, by dynamite or by use of poison.

Cutting of mangroves can expose the coast and cause increased erosion.

River regulation, irrigation or changes in the land use in the drainage area may change the regime of the rivers discharging to the coast. The result may be changes in the load of fine sediments or sand with the consequences discussed above.

Coastal structures such as harbours will interfere with the coastal sediment transport and can cause coastal erosion. This should be taken into account when planning a project and is necessary remedial measures, as for example artificial bypass of sand past a harbour, should be considered (ZHTI, 2006).

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Annex 1: List of Documents

Table 35: Document Database at SAMAKI compiled for the Prioritisation Study

Title	Source	Year
Feasibility Study for New Port Project in Zanzibar -Phase I	REVOLUTIONARY GOVERNMENT OF ZANZIBAR, TANZANIA	2014
Perceptions of Rule-Breaking Related to Marine Ecosystem Health	Matthew J. Slater1, Yunus D. Mgaya, Selina M. Stead	2014
Alleviating Poverty & Countering Environmentally Unsustainable Practices.	Smallholder Empowerment and Economic Growth through Agribusiness & Association Development (SEEGAAD)	2014
Shipping Traffic At major Ports	Annual Statistics 2012-2013 TPA	2013
Economic Impacts of Dynamic Fishing in Tanzania	Wilson and Associates	2013
Marine and Coastal Environment Management Project (MACEMP): Implementation Completion and Results Report	World Bank	2013
Zanzibar Climate Change Strategy	THE REVOLUTIONARY GOVERNMENT OF ZANZIBAR THE FIRST VICE PRESIDENT'S OFFICE	2013
Zanzibar Environmental Policy	Department of Environment Zanzibar	2013
Management Plan For the Tanzanian Artisanal Fishery for Small and Medium Pelagic Fish Species	Ministry Of Livestock and Fisheries Development.	2013
Tanzania Tuna Fishery Management Strategy		2013
The Proposed Transboundary Conservation Area (TCA)	UNEP	2013
Tanzania Economic Update How the ports of Dar es salaam can transform	www.Worldbank.org/tanzania/economicupdste	2013
$200 - $350 bn a year needed for Africa-UN	wwwnewsdaily.com	2013
2012 Population and Housing census	National Bureau of Statistics	2013
Coastal and Marine Ecosystems in Changing Climate.	Prof. Pius Z. Yanda	2013
The Earth Security Index	Alejandro Litovsky, Founder & CEO, Earth Security Initiative	2013
Future habitat suitability for coral reef ecosystems under global warming and ocean acidification	Elena Couce,Andy Rdgwell and Erica J Hend	2013
Distribution and Marketing Networks within Dynamite Fishing in Tanzania.	Winfried Venant Haule	2013
Tanzania: marching toward sustainable IDD elimination	Idd Newsletter	2013
Anthropogenic Impacts On Coral Reefs and Their Effect on Fishery of Kilwa District ,Tanzania	Mbije ,N.E and Rinkevich,B.	2013
The Economic Impacts Of Dynamite Fishing in Tanzania	MANCEMP	2013
National Gas policy Of Tanzania	URT	2013
Report urges modern farming	www.theeastafrican.co.ke	2013
Situation analysis for Mangroves for the Future: Understanding the resilience of coastal systems	Melita Samoilys, George Waweru Maina, Julie Church, Brigid Mibei, Marta Mo njane, Abdulla Shah, Doris Mutta and Mine Pabari	2013
Action on Nutrition in Tanzania	WHO & URT	2013
Tanzania Initiatives on Coastal Ecosystem Management in The Context of Adaptation and Mitigation	Zainabu Shabani	2013
The Deloitte Guide to Oil and Gas in East Africa	Deloitte	2013
The Ecosystem, Livelihoods and Future Status of Mbegani	USAID/PWANI Project & http://www.crc.uri.edu	2013

Title	Source	Year
The Description of Ecologically or Biologically significant of Marine Areas.	UNEP/CBD/RW/EBSA/SIO/1/4	2013
Agriculture Lab Tanzania Development Vision 2025	URT	2013
Education NKRALab Report Tanzania Development Vision 2025	URT	2013
EnergyLab Final Report Tanzania Development Vision 2025		2013
Resources mobilization(NKRA)Report Tanzania Development Vision 2025		2013
Transport Lab (NKRA)Report Tanzania Development Vision 2025		2013
National Key Result Area (NKRA) Water Tanzania Development Vision 2025		2013
Environmental factors influencing whale shark occurrence & movements at Mafia Island, Tanzania	Christoph A. Rohner & Simon J. Pierce ,Michael Berumen,Jesse Cochran3 & Fernando Cagua, Mathias Igulu& Baraka Kuguru Jason Rubens6	2013
Economics of Climate Change in Zanzibar - Vulnerability, Impacts and Adaptation	Global Climate Adaptation Partnership	2012
Marine Legacy Funds of Tanzania	Meyers, D.	2012
Socio-economic Impact Assessment of MACEMP Supported Subprojects	Health and Environmental Concerns (HEC) Limited	2012
People, Nature and Research in Chwaka Bay, Zanzibar, Tanzania	de la Torre-Castro M. and Lyimo T.J. (eds)	2012
National Marine Ecosystem Diagnostic Analysis. Tanzania. Contribution to the Agulhas and Somali Current Large Marine Ecosystems Project	ASCLME	2012
The Economics of Climate Change in Zanzibar	Global Climate Adaptation Partnership	2012
Marine and Coastal Environment Management Project (MACEMP): The Marine Legacy Funds of Tanzania	MACEMP	2012
Implementation of Concrete Adaptation Measures to Reduce Vulnerability of Livelihoods and Economy of Coastal Communities of Tanzania	UNEP	2012
Rising tides threaten Tanzania's coastal towns	Kizito Makoye	2012
A Study of Working Conditions in the Zanzibar Seaweed Farming Industry	Flower E. Msuya	2012
The Revolutionary Government of Zanzibar NATIONAL SAMPLE CENSUS OF AGRICULTURE 2007/2008		2012
Chumbe_Island__Coral_Park__Governance_Analysis	Lina M.Nordlund,Ulrike Kloiber,Eleanor Carter and Sibylle Riedmiller.	2012
Coastal and Marine Tourism Development Plan for the Menai Bay Conservation Area (MBCA), Mnemba Island Marine Conservation Area (MIMCA), and the Pemba Channel Conservation Area (PECCA).	Enviro-Fish Africa (Pty) Ltd	2012
Octopus Fishery Management Plan		2012
Prawn Fishery Management Plan		2012
National Marine Ecosystem Diagnostic Analysis	ASCLME	2012
Deep Sea Coral Research and Technology	NOAA	2012
NATIONAL SAMPLE CENSUS OF AGRICULTURE 2007/2008		2012
2007/2008National Sample Census of Agriculture	URT	2012
Vulnerability, Impacts and Adaptation	SMZ	2012
Legal and Institutional Framework for Effective Management of Marine Managed Areas in Tanzania	Mwita M. Mangora Mwanahija S. Shalli Bernice McLean	2012

Title	Source	Year
Socio-Economic Profiles of Communities Adjacent to Tanga Marine Reserve Systems, Tanzania	Mwita M. Mangora and Mwanahija. S. Shalli Institute of Marine Sciences, University of Dar es Salaam, P.O. Box 668, Mizingani Rd., Zanzibar, Tanzania	2012
National Sample Census Of Agriculture 2007/2008 -Mtwara Region	URT	2012
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Pwani Region Report	URT	2012
Sea Sense Annual report	www.seasense.org	2012
Tanzania Environmental Threats and Opportunities Assessment	USAID	2012
Tanzania Ports Authority	TPA	2012
Impact Assessment (SESIA) for the Oil & Natural Gas Subsector	NEMC	2012
Legal and Institutional Framework for Effective Management of Marine Managed Areas in Tanzania	EcoAfrica Environmental Consultants	2012
Water Perfromance Report	ewura	2011
Economics of Climate Change in Tanzania (mainland) - The Implications of Climate Change and Sea Level Rise in Tanzania	Global Climate Adaptation Partnership	2011
Community-based Vulnerability Assessment and Adaptation Options in Coastal Villages: Bagamoyo District, Tanzania	TCMP (Tanzania Coastal Management Partnership)	2011
The Tanzania Five Year Development Plan 2011/2012 - 2015/2016	GOT: President's Office. Planning Commission	2011
The Economics of Climate Change in the United Republic of Tanzania	Global Climate Adaptation Partnership and partners	2011
Developing Core Capacity to Address Adaptation to Climate Change in Productive Coastal Zones of Tanzania	UNEP	2011
Sea Level Rise and Impacts in Africa 2000 - 2100	Sally Brown, Abiy S. Kebede and Robert J. Nicholls School of Civil Engineering and the Environment University of Southampton Southampton SO17 1BJ, UK	2011
Population and Assets Exposure to Coastal Flooding in Dar es Salaam (Tanzania) Vulnerability to Climate Extremes	Abiy S. Kebede and Robert J. Nicholls University of Southampton School of Civil Engineering and the Environment and Tyndall Centre for Climate Change Research Southampton, Highfield, SO17 1BJ United Kingdom	2011
Preparation of a Zoning Plan for Tanga Coelacanth Marine Park	Christopher A. Muhando	2011
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Impacts Of Climate Change In Zanzibar	Care International	2011
Local Economic Development Plan Kilwa Kisiwani, Kilwa, Tanzania	Eco Africa	2011

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To connect or not to connect? Floods, fisheries and livelihoods in the Lower Rufiji floodplain lakes, Tanzania	http://www.tandfonline.com/loi/thsj20	2011
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Integrated Industrial Development Strategy	URT	2011
State of Knowledge of Coastal and Marine Biodiversity of Indian Ocean Countries	Mohideen Wafar, Krishnamurthy Venkataraman, Baban Ingole, Syed Ajmal Khan, Ponnapakkam LokaBharathi	2011
The Formation and Establishment of the Jozani-Chwaka Bay National Park, Zanzibar, Tanzania	Fred Saunders School of Life Sciences, Södertörn University, Huddinge, Sweden	2011
Health Sector and Social Wlfare public Private Partnerships Policy Guidelines	Ministry of Health and Social Walfare	2011
The organisation Structure of the Ministry of Lands ,Housing and Human Settlements Development		2011
Tanzanian Food and Water Security Outlook	Aida Mliga	2011
Tourism Guide for the Tanga Region, Tanzania 2nd edition	Tanga City Council	2011
2011 TanSEA layers delivered	TanSea	2011
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WIOMSA Annual Report	WIOMSA	2011
Preparation of an Adaptation Programme of Action for Zanzibar (Zanzibar NAPA)	SMOLE	2010
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News of the Coast no 14	RECOMAP (Regional Programme for the Sustainable Management of the Coastal Zones of the Indian Ocean Countries)	2010
Annexes to Zanzibar NAPA	SMOLE	2010
Mapping of Mangroves in Jasini, Ndumbani, Mahandakini, Moa, Boma Kichakamiba and Boma Subutuni villages, Mkinga District, Tanga	Christopher A. Muhando	2010
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Mapping of Mangroves in Jasini, Ndumbani, Mahandakini, Moa, Boma Kichakamiba and Boma Subutuni villages, Mkinga District, Tanga	Dr. Christopher A. Muhando	2010
SMOLE II - Environmental Impact Assessment	KRISTINE KARPF, EIA Advisor, Environmental consultant with NIRAS	2010
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Policy misfits,climate change and cross scale vulnerability in Coastal Africa;How development projects undermine resilience	Matthew Brunce,Katrina Brown and Sergio Rosendo	2010
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Ecosystem-based Adaptation in Tanzania	Tahia Devisscher	2010
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Mnemba Island-Chwaka Bay Marine Conservation Area (MIMCA)	SMZ & MACEMP	2010
Zanzibar Strategy for Growth and Reduction of Poverty 2010-2015 (MKUZA II)	RGoZ	2010
Strengthening Co-Management (SccaFcoM) in Rufiji,Mafia,and Kilwa Districts	Dr Robert M. Otsyina Monitoring and Evaluation Expert Team Leader Development Associates Ltd Dr Benaiah L. Benno Expert in Fisheries Management University of Dar es Salaam Dr Jumanne M. Abdallah Socio-economist & Community Based Management Sokoine University of Agriculture	2010
An update on research on migratory routes and feeding destinations of Southwest Atlantic humpback whales	Alexandre N.Zerbini,Artur Andriolo,Daniel Danilewicz,Mads Peter Heide-Jorgensen,Nick Gales and Phillip J Clapham.	2010
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Habitats and Ecological Zone in Kicamp Area	Christopher A. Muhando, Mwanahija S. Shalli, Rukia A. Kitula ,Mwita M. Mangora	2009
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Documenting the global impacts of beach sand mining	R. Young and A. Griffith	2009
The Extractive Resource Industry in Tanzania	Society for International Development Regional Office for Eastern Africa P O Box 2404 – 00100 Nairobi Kenya Telephone: +254 - 20 - 2737991 Fax: +254 - 20 - 273 7992 Email: sidea@sidint.org Website: http://www.sidint.org	2009
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Country Wildlife Response Profiles	Sea Alarm	2009
Integrated Coastal Management Action Plan Bagamoyo District Council	The District Executive Director P.O. BOX 59 BAGAMOYO	2009
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Integrated Coastal Management Action Plan Kinondoni District Council		2009
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Integrated Coastal Management Action Plan Lindi District Council	Town Director Lindi Town Council P.O. Box 1070 LINDI Tel. 023 – 2202164 Fax: 023 – 2202116 E-mail: linditc@pmoralg.go.tz	2009
Integrated Coastal Management Action Plan Mkuranga District Council	District Executive Director Mkuranga District Council P.O. Box 10 Mkuranga Coastal Region	2009
2009 Integrated Coastal Management Action Plan Mtwara District Council	Municipal Director Mtwara-Mikindani Municipal Council P.O. Box 92, Mtwara. Te:+255 23 3333941 Fax: + 255 23 2334256 E-mail: Mtwaramikindani@yaoo.com	2009
2009 Mtwara District Council ICM Action Plan	District Executive Director Mtwara District Council P.O Box 528 MTWARA. Tel: 023-2333928 Fax: 023-2333293 Email: Mtwara rural@gmail.com	2009
2009 Integrated Coastal Management Action Plan Muheza District Council	District Executive Director Muheza District Council P.O.Box 20 Muheza TANGA	2009
Integrated Coastal Management Action Plan Pangani District Council.	District Executive Director Pangani District Council P.O. Box 89 Pangani Tanga Tel: 0272630058 Fax: 0272630315	2009
Mpango kazi wa Usimamizi Kamilifu wa Mazingira ya Pwani (ICM) Halmashauri jiji la Tanga	Mkurugenzi Halmashauri ya Jiji la Tanga S.L.P 178 TANGA Simu: 0272644530 Barua pepe: tmc@kaributanga.com	2009
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The Social Dimensions of Marine Protected Areas: A Case Study of the Mafi a Island Marine Park in Tanzania	Rosemarie Nyigulila Mwaipopo	2008
Distribution and Status of Coastal Habitats and Resources in Tanzania	Dr. Christopher A. Muhando, Institute of Marine Sciences and Mr. Chikambi K. Rumisha Ministry of Natural Resources and Tourism	2008
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Mapping research systems in developing countries	http://www.state.gov/r/pa/ei/bgn/2843.htm	2008
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Approaches to Coral Reef Monitoring in Tanzania	Christopher A. Muhando	2008
Interactive Governance Approach in Mariculture Activities In Tanzania	Mutatina Alieth	2008
A study of perceptions and impacts from different types of tourism in Mafia Island Marine Park, Tanzania.	Noragric Department of International Environment and Development Studies Norwegian University of Life Science (UMB) P.O. Box 5003 N-1432 Ås Norway Tel.: +47 64 96 52 00 Fax: +47 64 96 52 01 Internet: http://www.umb.no/noragric	2008
Natural resource dependence, livelihoods and development Perceptions from Tanga, Tanzania	Melita A. Samoilys and Nyaga W. Kanyange	2008
Method for calculating brine evaporation rates during salt production	D. Glen Arkridge	2008
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National and Regional Networks of Marine Protected Areas	UNEP World Conservation Monitoring Centre	2008
The Social Dimensions of Marine Protected Areas	Rosemarie Nyigulila Mwaipopo	2008
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Tanzania National Adaptation Program for Action (NAPA)	VPO-Division of Environment	2007
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National Report of the United Republic of Tanzania on Sea Level Measurements	Ignatious K. Nhnyete TANZANIA PORTS AUTHORITY and Shigalla B. Mahongo TANZANIA FISHERIES RESEARCH INSTITUTE	2007
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The Status Report On The Impact Of Dynamite Fishing In KICAMP Localities	Chikambi K. Rumisha and Christopher A. Muhando	2007
Effects Of Climate and Seawaters Variation on Coral Bleaching and Mortality.	TIMOTHY R. MCCLANAHAN,1,2,5 MEBRAHTU ATEWEBERHAN,2 CHRISTOPHER A. MUHANDO,3 JOSEPH MAINA,2 AND MOHAMMED S. MOHAMMED4	2007
Zanzibar Fisheries Frame Survey	Department of Fisheries and Marine Resources,Ministry of Agriculture,Livestock and environment,Zanzibar Institute of Marine Sciences ,University of Dar es salaam	2007
Sustainable universal salt iodization in low-income countries – time to re-think strategies?	VD Assey S Peterson and T Greiner	2007
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Land Suitability Mapping Lindi Rural	Steve Ball & Anne-Marie Gregory	2007
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Mtwara Region Socio - Economic Profile	The Planning Commission Dar es salaam and Regional Commissioner's Office Mtwara	2007
Tanga Region Agriculture Sample Census Report	URT	2007
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Mpango Kazi wa Usimamizi Kamilifu wa Mazingira ya Pwani Wilaya ya Rufiji	Mkurugenzi Mtendaji wa Wilaya, P.O Box 28 Tel. 0232010304 Fax. no.0232010317 Utete/Rufiji	2007
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City Profile for Dar es salaam	Dar es Salaam City Council,City Director Dar es Salaam City Council Morogoro/Sokoine Drive P.O. Box 9084 DAR ES SALAAM TEL.:255-22-2123551/6 FAX: 255-22-2125589 E-mail: cd@dcc.go.tz Website: www.dcc.go.tz	2004
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2003 Intitial National Communication Under The United Nations Framework convetion on climate change	United Republic of Tanzania(URT),Vice President's office	2003
Coral and fish distribution patterns in Mafia Island Marine Park, Tanzania: fish–habitat interactions	Kajsa C. Garpe & Marcus C. Öhman Department of Zoology, Stockholm University, 10691 Stockholm, Sweden Tel: +46 8164002. Fax: +46 8167715. E-mail: kajsa.garpe@zoologi.su.se	2003
Mangroves Of East Africa	Michelle Taylor, Corinna Ravilious, Edmund P. Green	2003
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Local Governance in Zanzibar	(Edited Version of chapter by Per Tidemand in "Zanzibar Good Governance Strategy" A Report by the Consultants Prof. Othman, Prof Mukandala, Robert Makaramba and Per Tidemand, for Revolutionary Government of Zanzibar	2003
Managing Tanzania's Coast through Integrated Planning - Reflections upon the first five years of District ICM Action Planning	TCMP (Tanzania Coastal Management Partnership)	2002
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Coastal Tanzania ,A New Home To The Living Coelacanth An Oceanographic Analysis	N. Nyandwi Institute of Marine Sciences, University of Dar es Salaam P.O. Box 668 Zanzibar, Dar es Salaam, Tanzania	
Water Use Standard - Offshore Aqueous Discharges		
Sustaining the Marine Environment in Mainland Tanzania and Zanzibar	www.worldbank.org	
Survey of the extent of human-induced beach erosion problems in Tanzania	N. NyandwiInstitute of Marine Sciences, University of Dar es Salaam P.O. Box 668 Zanzibar, Dar es Salaam, Tanzania	
Draft National Land Surveying and Mapping Policy.		
Frequency and long-term distribution of coastal winds of Tanzania	A.M. Dubi	
A review of Climate Dynamics and Climate Variability in Eastern Africa.	S.E Nicholson,Department of Meteorology, Florida State University.	
Extending the Coastal Forest Protected Area Subsystem in Tanzania	United Nations Development Programme	
Botanical Assessment Of Ngezi Forest ,Pemba	H.J. Beentje	
Mangrove diversity Maps	NA	
Information Outline for Tanzania Coastal and Marine Atlas.		
Marine Science country profiles Tanzania	Julius Fransis/IOCINCWIO-IV/Inf. 8	

Title	Source	Year
Implications for sustainable coastal management	Huruma Sigalla,Richard Sambaiga, Godwin A. Lema, Emmanuel Shemaghembe, Vendelin Simon, Richard Abila, Jacob Ochiewo, Andrew Wamukota	
Mangrove diversity Maps		

Annex 2: Coastal Rapid Impact Assessment Matrix (CRIAM)

Introduction

Background

The coastal zone in Tanzania is under development pressure induced by population growth and economic activities and the area is experiencing a range of management problems giving rise to increased concern, including ecosystem encroachment, pollution, salinization of soils, estuaries and aquifers, degradation of resources, shoreline erosion and conflicts of interest among stakeholders depending on the coast for their livelihood. Climate change will further aggravate this situation due to sea level rise and more frequent extreme weather.

In order to address these management challenges the Government of Tanzania with World Bank assistance has through the project "Investment Prioritisation for Resilient Livelihoods and Ecosystems in Coastal Zones of Tanzania" embarked on identifying and prioritising threats with the view of developing fundable adaptation measures to address the most pertinent threats.

The complex situation in the coastal area requires a holistic approach to managing development addressing amongst others the problems linked to insufficient coordination between sectors and integration of knowledge, experience and resources in the management processes. For this purpose a rapid but comprehensive coastal profile has been produced based on as recent information as readily available. The profile has been organised to describe threats to coastal communities and ecosystems thematically (sector and other themes as presented in this Volume I of the coastal profile) and geographically by coastal district (as presented in Volume II of the coastal profile) and there is a need to analyse these threats in a coordinated manner to identify linkages and overlaps prior to embarking on developing recommendations for adaptation measures.

Given the extent of the area under concern and the multitude and complexity of activities therein the study as a first step adopts a bird's eye approach to identifying and ranking the most pertinent areas of concern and impacting issues and to relating these to the main development sectors. This approach does not initially produce detailed recommendations for specific locations of individual development projects and activities but rather offers directions to where efforts should be focused to alleviate the main pressures on the coast.

To accomplish the bird's eye overview we are suggesting a matrix approach allowing for a structured consideration of the main impact areas of concern along the coast of Tanzania, the impacting issues and the sectors involved (thematic origin).

The matrix approach apart from offering a tool for structured consideration of conditions in a complex management environment also provides means of transparently communicating the basis for the assessment. The Excel application described further in this appendix can therefore be used in validating the assessment at various levels of management.

This technical annex describes the methodology proposed.

Coastal Rapid Impact Assessment Matrix

The matrix presented in detail below is intended to systematically and in a structured way examine impact areas of concern in the coastal zone and the impacting issues. While the analysis also targets to establish an overview of which main economic and other sectors are concerned it is important to differentiate between the physical situation in the coastal areas and the management arrangements that are available to plan and control the development on

the ground. The matrix approach serves to establish an understanding and overview of the situation as it is on the ground. The result of the matrix analyses can identify deficiencies and shortcomings in the current management arrangements the most pertinent of which may be addressed in the subsequent phase of the study through identification of fundable actions. Management arrangements in this contexts cover policy, legal and institutional aspects, and management tools such as information and communication framework, institutional and human resources and financial aspects.

The Coastal Rapid Impact Assessment Matrix Method

The Coastal Rapid Impact Assessment Matrix method[52] is proposed to allow the attribution of reasonably qualified quantitative values to more or less subjective judgments[53], thus, offering at the same time an evaluation of a given impact and a recordable figure which can be used later, either for re-evaluation or for comparison with other impacts.

The method is based on a standard definition of the important assessment criteria as well as the means by which semi-quantitative values for each of these criteria can be assigned, with the aim to give a precise and independent score to each condition relevant to areas of concern in the coastal zone.

The impacts of issues considered are evaluated against the various components of the studied problem and, for each component, a score (using the defined criteria) is determined giving a measurement of the impact or importance for the component considered.

The assessment criteria fall into two groups:

A: Criteria that are of importance to the condition, and which can individually change the score obtained considerably;

B: Criteria that are of value to the given situation, but individually have a little effect on the score obtained.

For group A, the overall scoring system is based on multiplying the scores allocated each criterion. The principle of the multiplication is important since it assures that the weight of each criterion intervenes directly, whereas a sum of the scores could give identical results for groups of different scores.

For group B, the scoring system consists in summing up the scores allotted to each criterion. This ensures that an individual score cannot influence the overall result disproportionally. On the other hand, the sum assures that the combined importance of all values in group B is taken into account.

The scoring system is simple as there are only two criteria in group A (A_1 and A_2) and three criteria in group B (B_1, B_2 and B_3).

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[52] The method proposed for Tanzania has been adapted from the WRIAM method (Water Resources Impact Assessment Matrix) which again was derived from the RIAM (Rapid Impact Assessment Matrix) method used for complex project impact assessments.

[53] A comprehensive and detailed description of the situation in the coastal areas of Tanzania based on acquired information is difficult to make in a uniform manner as the level of documentation varies significantly in terms of resolution, accuracy, detail and updatedness. The matrix assessment method described in this technical note offers an opportunity to establish a rapid and uniform assessment of the situation at bird's eye level which again can guide in-depths efforts to address key problems at local and project level.

Calculation of the overall score for a given condition is also simple.

A_1 and A_2 represent individual criteria scores for group A;

B_1, B_2 and B_3 represent individual criteria scores for group B;

For each condition the following calculation is done:

$$A_T = A_1 \times A_2$$

$$B_T = B_1 + B_2 + B_3$$

$$ES = A_T \times B_T$$

where:

A_T is the result of multiplication of all A scores

B_T is the result of summation of all B scores

ES is the overall score of importance for the condition considered.

For a traditional environmental impact assessment, the criteria of group A can be determined by using scales that pass from negative to positive values through zero, thus reflecting both positive and negative impacts. However, in the present situation, the target is to quantify and compare negative impacts by only applying a one-way scale (from 0-4 and 0-3 for A_1 and A_2, respectively)[54]. In group B it has to be ensured that the sum of values cannot become zero as this in all cases would lead to an overall score of zero, which is against the required goal. For this reason the values of the criteria in group B is 1, 2 or 3, where 1 represents a neutral situation.

Compared to the RIAM method, the WRIAM method introduced a scoring system for the level of documentation as well as scores for the evolutionary character of each identified impact.

In the Coastal Rapid Impact Assessment Matrix (CRIAM) for Tanzania we have kept these scorings and in addition added three fields allowing for:

- Comments important for additional qualification related to the scoring which should be given only if required.
- Reference to the documentation database compiled by the project. This information may be useful for decision makers and managers in subsequent steps to address the areas of concern highlighted in the matrix.
- Reference to resources that are considered relevant for addressing the area of concern in more detail in later steps.

These three fields are not part of the structured impact assessment. The capture of documentation and competent resources at this point can however be useful for subsequent in-depth and localised analyses.

[54] This impact assessment for the coastal zone of Tanzania is a first step macro analysis of the threats identified to coastal communities and ecosystems. It is intended to assess the degree of impact from various issues in these areas of concern, while at the same time providing an indication of impacting sector or sectors if more are involved. Following such a "bird's eye" ranking decision makers and managers can prioritise efforts in addressing these areas of concern through individual and local interventions applying more detailed assessments that would allow a balanced capture of both positive and negative project impacts.

Assessment criteria for the coastal rapid impact assessment matrix method

The criteria should be defined for the two groups A and B, and should be based on fundamental conditions that may be affected by change introduced by the activities considered. It is theoretically possible to define a number of criteria, but those should always satisfy two principles:

- The universality and importance of the criterion;
- The nature of the criterion, which determines whether it should be treated as a group A or B condition.

For the purpose of ranking the coastal impacts of concern in Tanzania the method operates with 5 criteria in this first phase of the impact analysis (2 in group A and 3 in group B). These 5 criteria represent the most important fundamental assessment conditions and comply with the principles stated above.

These criteria, and their scales of scores, are defined in the following:

Group A criteria

Criterion A_1 - Importance of condition

A measure of the importance of the condition, which is assessed against the spatial boundaries or human interests it will affect:

A1 = 4: Important to national/international interests

A1 = 3: Important to regional/national interests

A1 = 2: Important to areas immediately outside local condition

A1 = 1: Important only to local condition

A1 = 0: No importance

Criterion A_2 - Magnitude of change / effect

Magnitude is defined as a measure of the scale of benefit / dis-benefit of an impact or a condition:

A2 = 0: No change / status quo

A2 = 1: Negative change to status quo

A2 = 2: Significant negative dis-benefit or change

A2 = 3: Major dis-benefit or change

Group B criteria

Criterion B_1 - Permanence

This criterion defines whether a condition is temporary or permanent:

B1 = 1: No change / not applicable

B1 = 2: Temporary

B1 = 3: Permanent

Criterion B_1 - Reversibility

This criterion defines whether the condition can be changed and is a measure of the control over the effect of the condition:

B2 = 1: No change / not applicable

B2 = 2: Reversible

B2 = 3: Irreversible

Criterion B_1 – Cumulative character

This criterion is a measure whether the effect will have a single direct impact or whether there will be a cumulative effect over time, or a synergistic effect with other conditions:

B3 = 1: No change / not applicable

B3 = 2: Non-cumulative / single

B3 = 3: Cumulative / synergistic

The overall evaluation score (ES) may reach values ranging from 0 to 108. The achieved score is translated into 5 levels describing the problem using range bands as shown in **Error! eference source not found. Error! Reference source not found.**.

Table 36: Translation of ES into Range Values and their significance.

Score (ES)	Range value (RV)	Description
0	0	No importance / Not applicable
1 to 9	1	Importance / slight negative impact
10 to 18	2	Importance / negative impact
19 to 35	3	Importance / moderate negative impact
36 to 71	4	Importance / significant negative impact
72 to 108	5	Importance / major negative impacts

To substantiate the assessment and support further analyses the matrix includes a field where the level of documentation relevant to the assessed condition can be indicated using a score between 0 and 3 as shown in Table 37 below.

Table 37: Scoring the level of documentation relevant to the assessed condition

Documentation Score (DS)	Description
0	No information / documentation
1	Slight actual information / documentation
2	Existing information / documentation, but insufficient
3	Good documentation / information

The speed with which the condition is developing is not captured in the EV and we have the matrix therefore also includes a field where the evolutionary character of the condition can be assessed using a score between 0 and 3 as shown in Table 38 below. The sensitivity to climate

change may have implications on the speed with which the condition is developing. Such a sensitivity assessment however will be pursued after the CRIAM has prioritised impacts.

Table 38: Scoring the speed of development of the condition

Evolutionary Score (ES)	Description
0	No evolutionary character
1	Light evolutionary character
2	Moderate evolutionary character
3	Strong evolutionary character

The scores for level of documentation and development speed of the condition at present do not enter into the calculation of the EV, but serves rather to assist at the subsequent decision making process.

Excel application to support the matrix analysis

To support the matrix analysis of impacts in the coastal zone of Tanzania we have developed an Excel application, which allows for structured input into the matrix, while providing the basis for semi-automatic queries.

The matrix itself is a database with the following fields (**Error! Reference source not found.**, REF _Ref306010001 \p \h **Error! Reference source not found.**):

Districts to specify which of the Tanzania's coastal districts are considered, thus determining the bird's eye scope of the analysis. Districts should not be keyed into the matrix itself but are selectable from drop down menus. When the impacts are derived from a thematic threat (Volume II of the Coastal Profile), and therefore lack in geographical reference the matrix provides under Districts for selecting MAINLAND for mainland Tanzania or ZANZIBAR for Zanzibar.

Impact area of concern to specify which physical area or physical resource of concern is considered for the conditional assessment. Examples could be a habitat, an ecosystem or another physical feature a water body or resource, a shoreline, an area vulnerable to flooding, etc. Impact areas of concern should not be keyed into the matrix itself but are selectable from drop down menus. This drop down list can be expanded should new impact areas emerge.

Nature of issue which serves to specify which impact issue is being considered. Examples could be pollution, encroachment, erosion, flooding, degradation, biodiversity degradation, etc. If there are several issues relevant to a problem area of concern these would emerge in separate records in the matrix. Nature of issues should not be keyed into the matrix itself but are selectable from drop down menus. This drop down list can be expanded should new natures of issue emerge.

Theme, which serves to specify which main development sector, can be identified as contributing to the impacting issue. Examples of main development sectors could be agriculture, fisheries, forestry, industry, infrastructure etc. If there are several sectors contributing these would emerge in separate records in the matrix. Theme should not be keyed into the matrix itself but are selectable from drop down menus, which initially contain the themes covered in Volume I of the Coastal Profile. Should new themes emerge from the drop down menu can be expanded.

Sub-sector, allowing for a finer level consideration of sector contribution to the impacting issue if this is required. Examples of sub-sectors could be transportation, water supply,

sanitation, etc. under infrastructure, and aquaculture, processing and coastal fisheries under fisheries. If there are several sub-sectors contributing these would emerge in separate records in the matrix. Sub-sector should not be keyed into the matrix itself but are selectable from drop down menus.

Criteria fields: These are fields for each of the five assessment criteria A_1, A_2, B_1, B_2 and B_3. The assessment consists of inputting values for these criteria for each of the conditions examined for a given area of concern. The values can be entered directly from the keyboard or using drop down menus. Values outside the respective ranges for these criteria are not allowed and will be rejected by the application.

EV field containing the evaluation score based on the values allocated to the criteria. The field will automatically calculate the EV based on the criteria input.

RV field which contains the range value corresponding to the EV. The field will automatically calculate and display the RV value based on the calculated EV.

Speed of evolution field, where the speed of the condition's development can be entered as a value between 0 and 3.

Documentation level, where the availability of documentation considered relevant for the condition can be entered as a value between 0 and 3.

Degree of problem field which provide a graphical display of the severity of the problem area of concern. These will appear as a bar display automatically generated based on the EV and RV.

Documentation (DOCBase) field, where references can be made to the database of documents compiled through the study.

Resources (Government, NGO, Academia, Individuals), allows references to be entered that may be useful in subsequent work, including the development of adaptation measures.

Comment field. Providing for any brief comment on the assessment made for the condition if relevant.

In the presentation above it was explained that selection of entries for a number of fields should be made using drop down menus. If a choice is not displayed in the dropdown menu a separate spread sheet in the Excel application provides for adding additional choices.

At the present state of development the application includes the following choices which serve as examples:

Districts

Only the 26 coastal districts are relevant for the present analysis. The application however could be used for assessments in other regions and districts, addressing concerns that go beyond the coastal zone.

Table 39: Table of administrative areas considered in the CRIAM, including Districts, Regions, Mainland Tanzania (MAINLAND) and Zanzibar (ZANZIBAR).

Districts	Super-Region	Region
Bagamoyo	Mainland	Pwani
Ilala	Mainland	Dar es Salaam
Kilwa	Mainland	Lindi
Kinondoni	Mainland	Dar es Salaam
Lindi Rural	Mainland	Lindi
Lindi Urban	Mainland	Lindi
Mafia	Mainland	Pwani
MAINLAND	**MAINLAND**	**MAINLAND**

Districts	Super-Region	Region
Mkinga	Mainland	Tanga
Mkuranga	Mainland	Pwani
Mtwara Rural	Mainland	Mtwara
Mtwara Urban	Mainland	Mtwara
Muheza	Mainland	Tanga
Pangani	Mainland	Tanga
Rujifi	Mainland	Pwani
Tanga	Mainland	Tanga
Temeke	Mainland	Dar es Salaam
Chakechake	Zanzibar	Kusini Pemba
Kaskazini A	Zanzibar	Kaskazini Unguja
Kaskazini B	Zanzibar	Kaskazini Unguja
Kati	Zanzibar	Kusini Unguja
Kusini	Zanzibar	Kusini Unguja
Magharibi	Zanzibar	Mjini Mhagaribi
Micheweni	Zanzibar	Kaskazini Pemba
Mjini	Zanzibar	Mjini Mhagaribi
Mkoani	Zanzibar	Kusini Pemba
Wete	Zanzibar	Kaskazini Pemba
ZANZIBAR	**ZANZIBAR**	**ZANZIBAR**

Impact area of concern

Table 40: Drop down list of Impact Areas of Concern emerging from the updated Coastal Profile

Impact Area of Concern
Bird Sanctuary
Coastal Vegetation
Coastal Villages
Coastal Zone
Coral Reefs
Estuaries/Backwater
Fishing Grounds
Islands
Lagoons
Mangroves
Mussel/Oyster Beds
Pearl Banks
Ponds and Lakes
Ramsar Sites
Rivers
Rocky Shores
Salt Marsh
Sand Bar/Dunes
Sandy Beach
Sea Grass Beds
Shoreline
Tidal Flats
Wetlands
Wildlife Sanctuary

The drop down list of impact areas of concern has been based on impact areas identified through the preparation of the updated Coastal Profile.

In discussions with stakeholders this list can be considered the point of departure based on the rapidly collected information contained in the coastal profiles, but should be expanded as and if these discussions identify additional areas of concern.

Nature of Issue

Nature of Issues
Accretion
Biodiversity Degradation
Conflict
Destructive Fisheries
Encroachment
Erosion
Flooding
Over Exploitation
Physical Degradation
Pollution
Sedimentation

Here again the discussions in the assessment group of experts will determine which main issues are relevant to take into account impacting on the problem area of concern. Any new main impacts should be added to this list.

Theme

Themes
Agriculture
Climate Change
Coastal Communities
Coastal Information Management
Fisheries
Forestry
Freshwater Resources
Hydrocarbons
Industry
Infrastructure
Management Framework for CZM
Natural Resources
Non-renewable Extractive Industry
Ports and Harbours
Salt Production
Shoreline Management
Tourism
Urbanisation

The main development sectors presently considered in the intersector impact assessment study are listed here.

It is not expected at present that additional sectors will be included but should it be required the list can be expanded.

Source of Concern

Source of Concern
Catchment Management
Fisheries Resources Management
Fishing Practices
Mangrove Management
Mining
Waste Management

A list of possible subsectors for consideration. The list is an example there are many more sub-sectors under the different sectors that may be included in the analysis. At this level of analysis however, care should be taken not to differentiate too much.

COASTAL THREATS IMPACT ASSESSMENT							Tanzania Coast																	
IMPACT RANKING							TABLE FOR CALCULATIONS																	
Super Region	Region	District	Themes	Source of Concern	Problem Area of Concern	Issue	A1 : Extent of issue	A2 : Seriousness of	B1 : Permanence	B2 : Irreversibility	B3 : Cumulative	ES	RY	Speed of evolution	Level of	Light problem	Problem	Important problem	Very important	Major problem	Documentation (DOCBase)	Resources (Government, NGO, Academia, Individuals)	Remarks
MAINLAND	MAINLAND	MAINLAND	Fisheries	Fishing Practices	Coastal Villages	Conflict	2	1	3	2	3	16	2										
MAINLAND	MAINLAND	MAINLAND	Fisheries	Fisheries Resources Management	Fishing Grounds	Conflict	4	3	3	3	3	108	5										
MAINLAND	MAINLAND	MAINLAND	Fisheries	Fishing Practices	Coral Reefs	Destructive Fisheries						0	0										
MAINLAND	MAINLAND	MAINLAND	Fisheries	Fishing Practices	Sea Grass Beds	Destructive Fisheries						0	0										
MAINLAND	MAINLAND	MAINLAND	Fisheries	Fishing Practices	Fishing Grounds	Destructive Fisheries						0	0										
MAINLAND	MAINLAND	MAINLAND	Fisheries	Fisheries Resources Management		Conflict						0	0										

Figure 43: Coastal Rapid Impact Assessment Matrix for Tanzania

Additional steps

Constraint analysis

In a later step, constraints analyses may be performed on the identified and ranked coastal zone issues in order to specify the types of constraints related to a specific coastal zone issue. The constraints used in the analysis could be divided into issues of technical, institutional, economic, sociological and legal character. The constraint analyses would involve an evaluation and identification of the existing technical level, responsible institutions, existing legal framework, sociological structure and the economic situation with respect to each coastal zone issue. Examples of different types of constraints are given below.

Constraints

Examples of technical constraints connected to a given coastal zone issue are lack of information/monitoring programs concerning pollution, encroachment, degradation and erosion, limited availability of water, technical difficulties in mobilising the water resources, constraints with rehabilitation of an ecosystem, a habitat, an aquifer or a reservoir, insufficient laboratory capacity/quality, few or no adequate sites for various desired development.

Institutional constraints can typically include subjects as lack of or dispersed co-operation and co-ordination between involved institutions, insufficient human resources, lack of capacity/expertise regarding a given issue, no clear operational framework between the involved parties, e.g. clear guidelines regarding responsibilities etc.

Types of economic constraints includes inadequate economic resources to; carry out monitoring of the quality and quantity of the resource, mobilise the resource, water purification treatment, establishment of reservoirs and hydropower installations, purchase of equipment etc.

Sociological constraints could be that the population ignores the risks connected to a given issue, lack of awareness and/or education concerning imposing issues.

Legal constraints could be that the existing legal framework is not fully covering a specific issue, that there are enforcement problems with respect to the existing legal framework, lacking or insufficient regulations and absence of required policies.

Management level

In a further step of the analysis each of the listed constraints can be evaluated with respect to the management level. In this context whether the management level can be characterised as international, national, regional, and local or a combination of these levels and both considering the government, non-government and civil society dimensions.

Identification of the responsible institutions

Furthermore an identification of the existing public and private institutions such as authorities, laboratories and industries involved with the types of constraints are conducted.

Policy option analysis

At this point relevant facts and the importance of a given coastal zone issue are established forming the first part of a Policy Option Analysis. The elements in a Policy Option Analysis can be summaries as:

- Observation and Description. Description of the key facts about the issue, process issues and policy context.
- Analysis. Identification of major issues, interests, costs and benefits.
- Option Identification. Identification of the most optimal solutions.
- Advice. Succinct and clear advice to the decision maker providing the basis for the policy choice.
- Action plans. Finally detailed action plans addressing high prioritised coastal zone issues can be prepared and implemented.

Annex 3: ERA Interim Re-analyses for Temperature, Wind Speed and Precipitation

Time series climate data for Pemba, Dar es Salaam, Zanzibar, and Mtwara, for the climatological period 1979 - 2010. As the software predominantly calculates area averages, the area average cover 6.5S-7.1S, 39E-39.6E. This area is broadly consistent with the grid length of ERA-Interim. Only land points are used. The anomalies are relative to the 1989-2001 climatology.

For temperature (2m) the linear trend is 0.24K/decade = 0.24°C/decade. Ascii and netCDF time series files are available if they are required. Annex 2 show monthly means of max and min temperatures registered once every day and measure the extremes of the diurnal cycle. The ERAInterim averages refer to monthly means of the full diurnal cycle, thus giving less weight to the extreme values. This is also clear from the variances of the time series, hence the R^2 in Annex 4 are about twice the value of the variance in the ERAInterim series.

The ERA-Interim data are computed using information about surface properties, upper air temperatures and surface observations in a full data assimilation system. The 2m temperature product is calculated through a vertical interpolation procedure. The interpolation as well as the coarse spatial resolution of reanalysis data decreases the variance compared to that of the localised observations.

Estimating a trend from highly variable data is sensitive to start/end points and temporal resolution. One should also calculate uncertainty estimates for the trend and compare two trends using the uncertainty bounds. The R^2 of around 0.5 K^2 (Annex 2) implies a standard deviation of around 0.7 K for the temperature series. This implies a fairly large uncertainty interval for the trend.

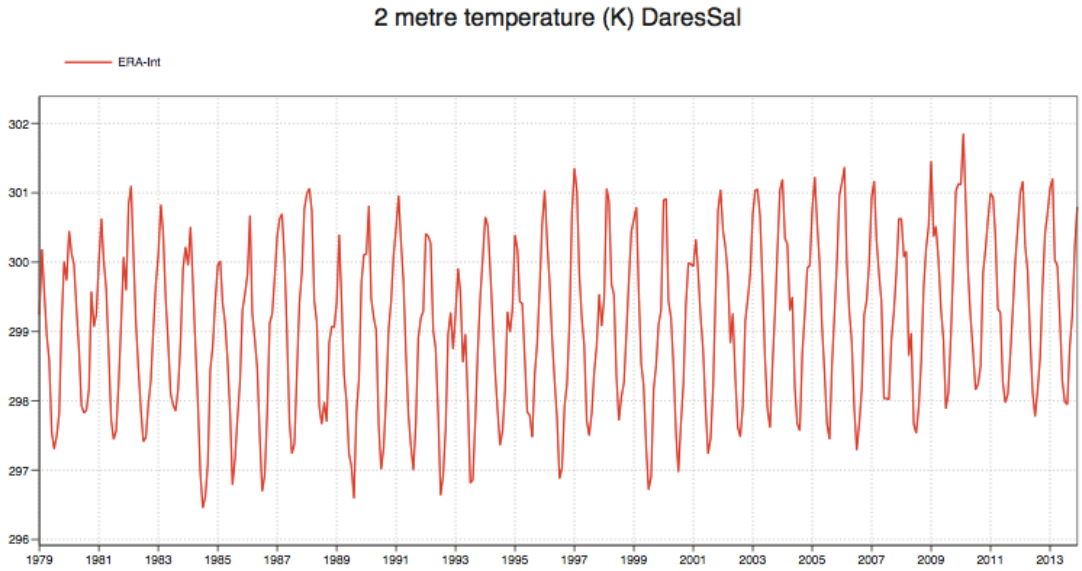

Figure 44: Dar es Salaam temperature variation in °K from 1979 to 2013 using ERA-Interim Software for reanalysis.

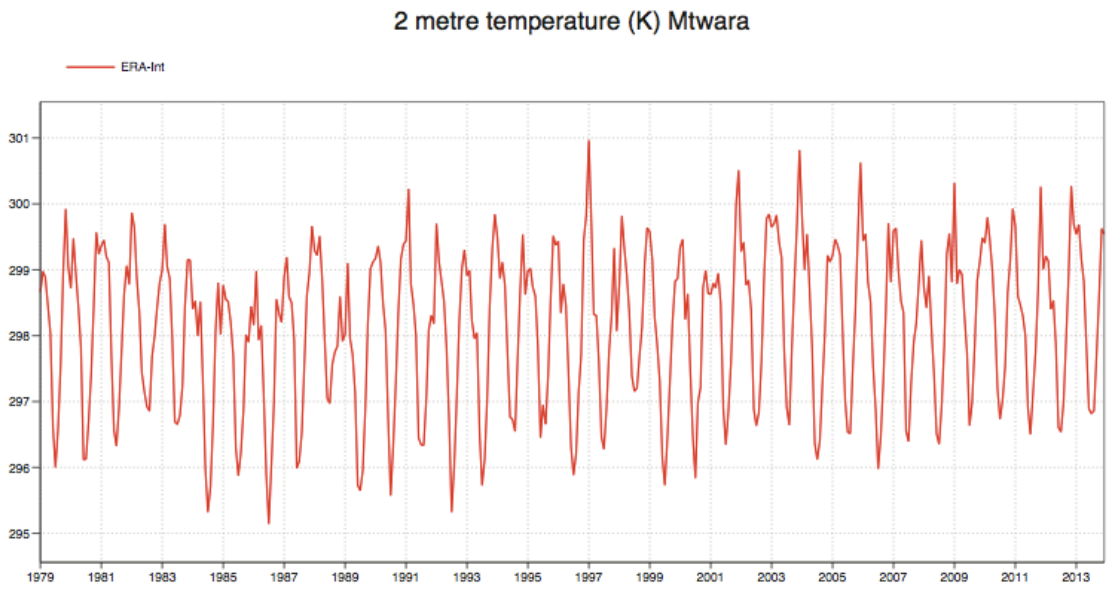

Figure 45: Mtwara temperature variation in °K from 1979 to 2013 using ERA-Interim Software for reanalysis.

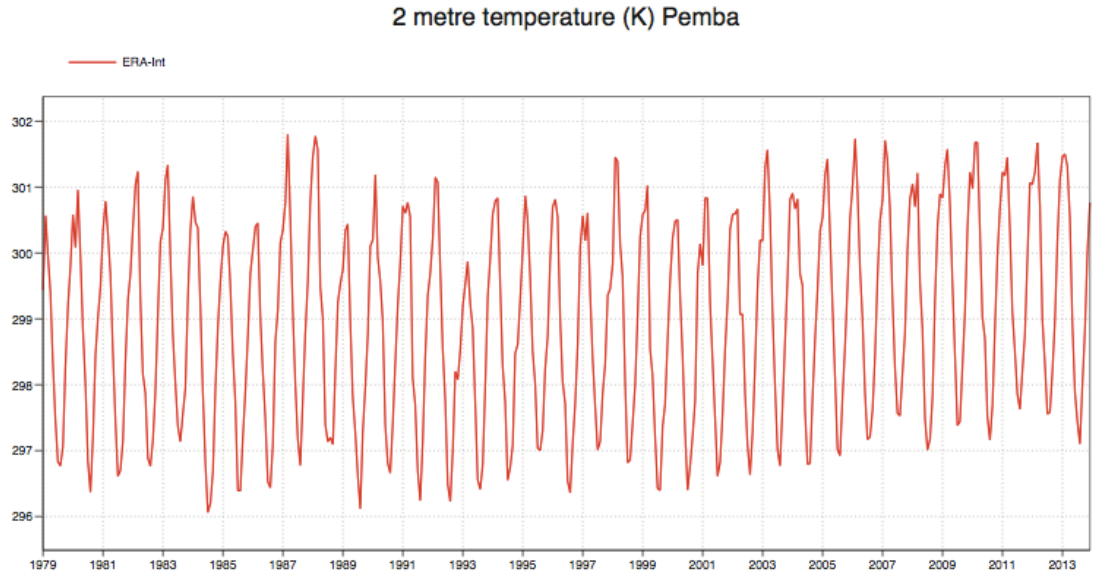

Figure 46: Pemba temperature variation in °K from 1979 to 2013 using ERA-Interim Software for reanalysis.

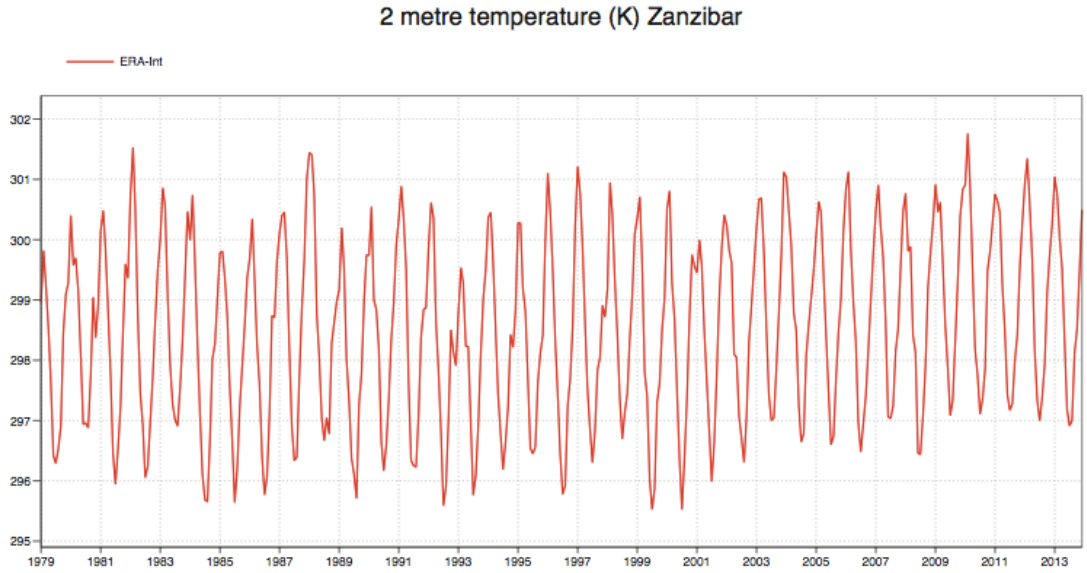

Figure 47: Zanzibar temperature variation in °K from 1979 to 2013 using ERA-Interim Software for reanalysis.

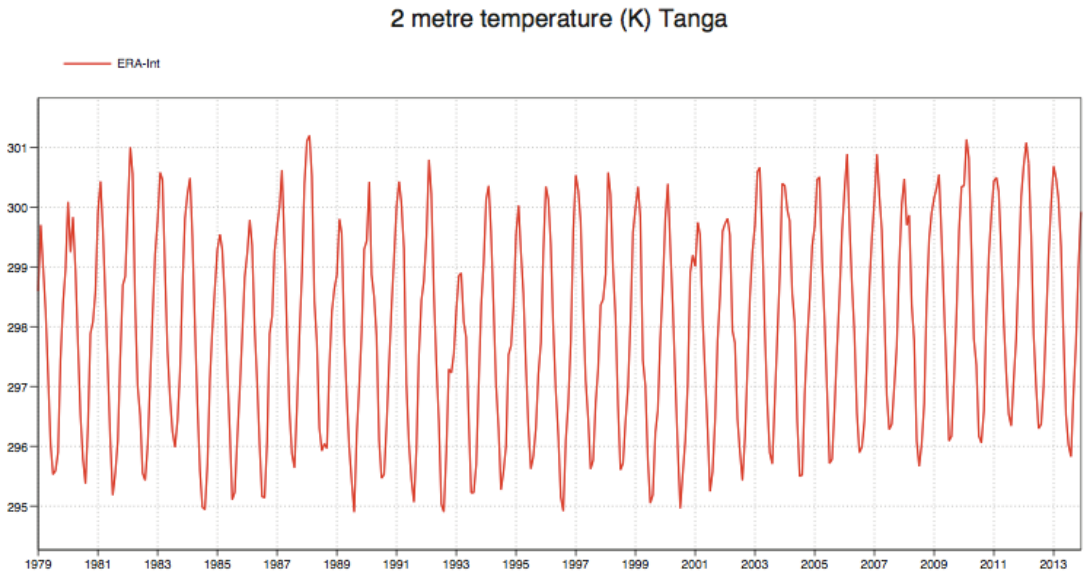

Figure 48: Tanga temperature variation in °K from 1979 to 2013 using ERA-Interim Software for reanalysis.

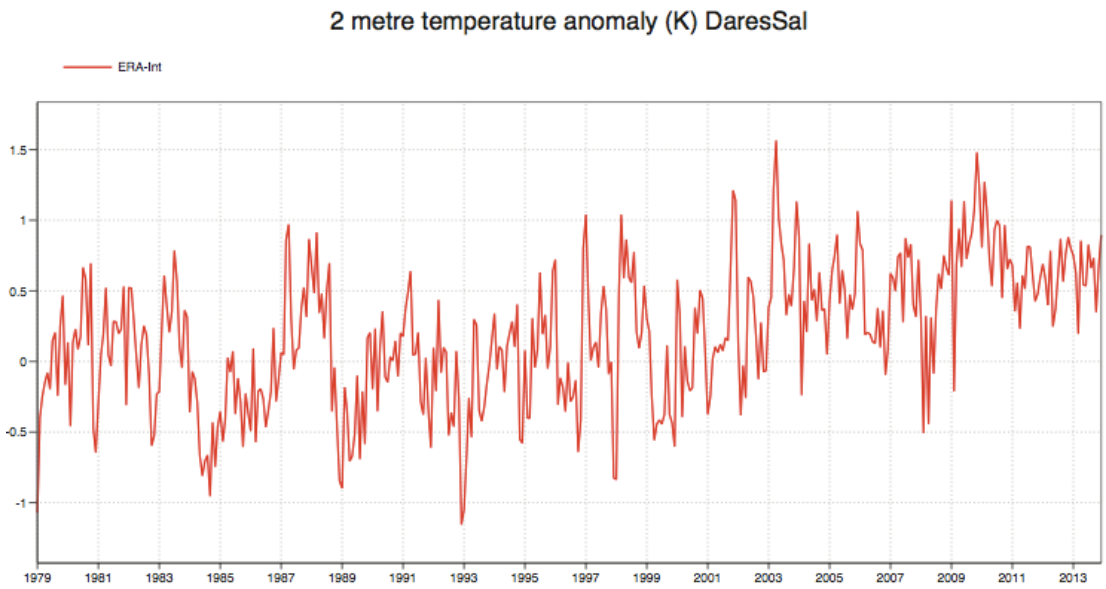

Figure 49: Dar es Salaam temperature anomaly assessment in °K from 1979 to 2013 using ERA-Interim Software for reanalysis.

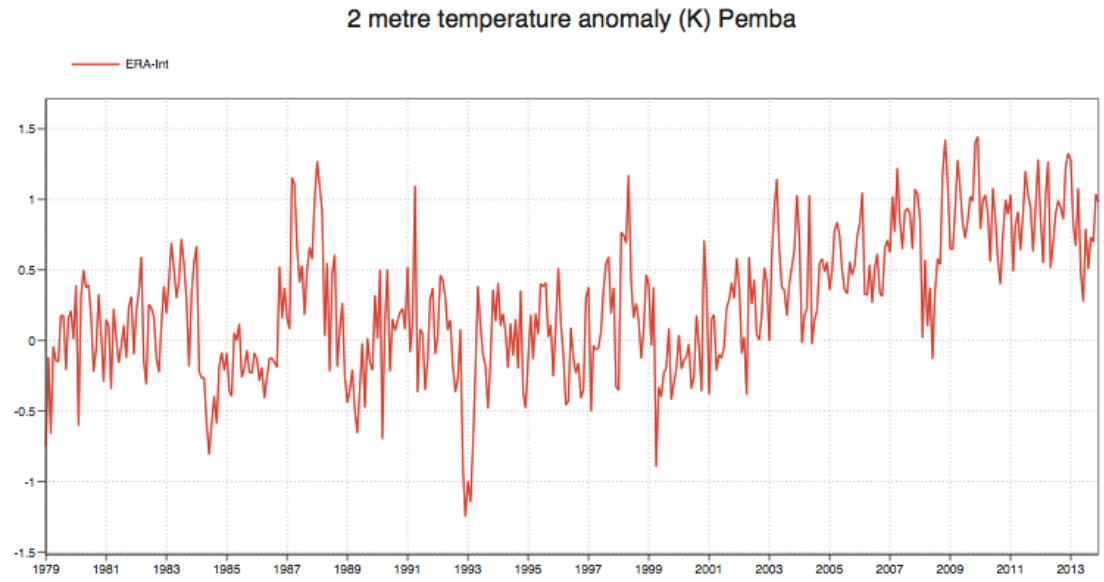

Figure 50: Pemba temperature anomaly assessment in °K from 1979 to 2013 using ERA-Interim Software for reanalysis.

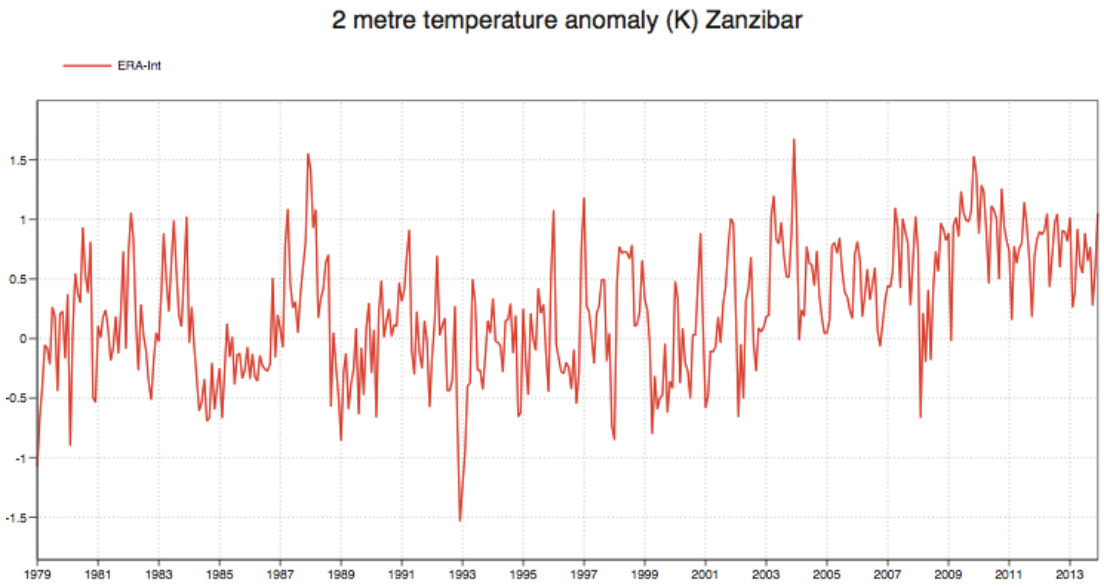

Figure 51: Zanzibar temperature anomaly assessment in °K from 1979 to 2013 using ERA-Interim Software for reanalysis.

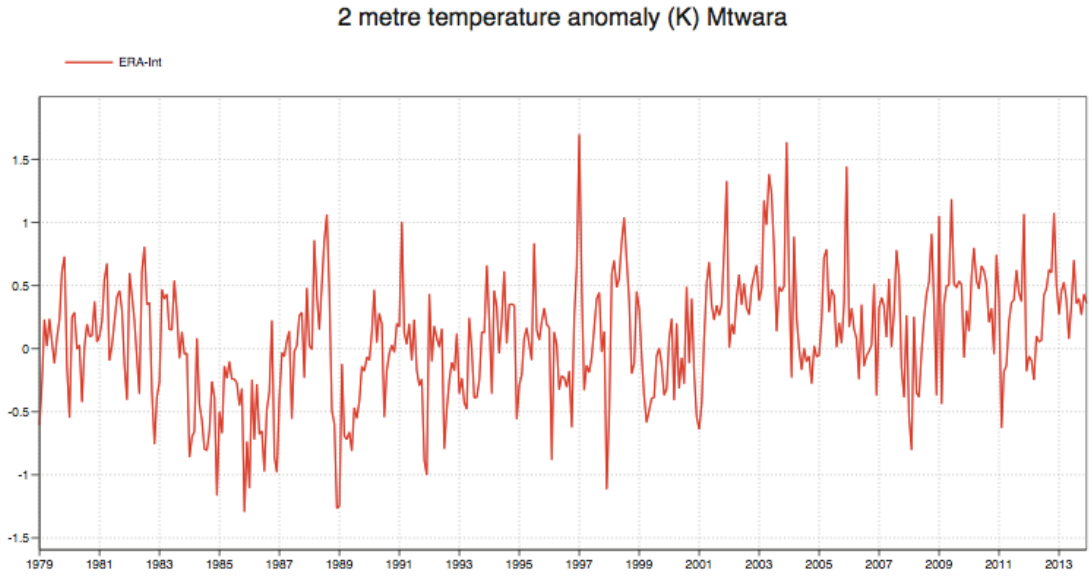

Figure 52: Mtwara temperature anomaly assessment in °K from 1979 to 2013 using ERA-Interim Software for reanalysis.

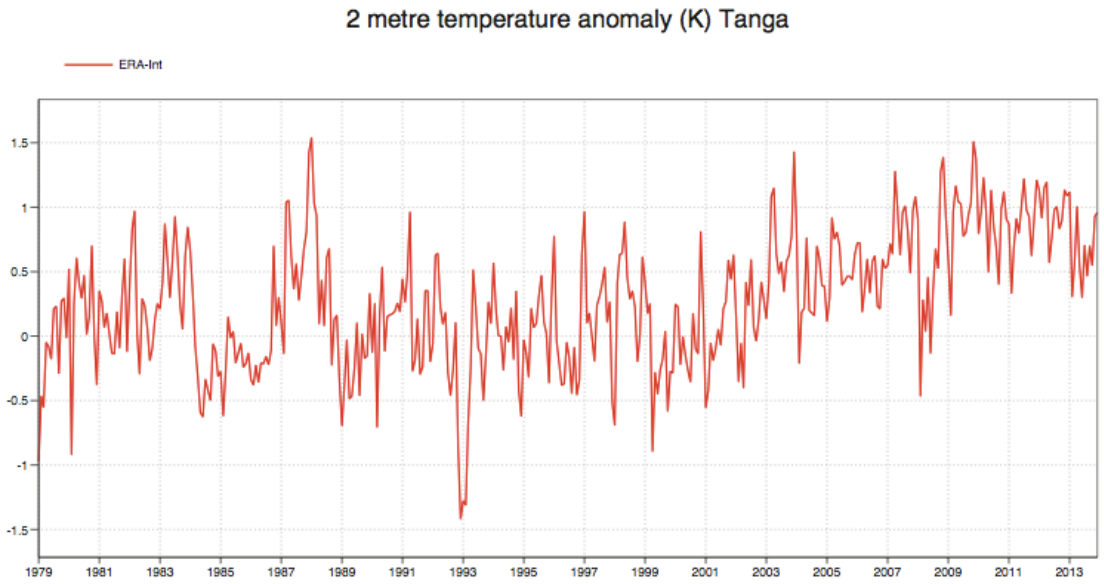

Figure 53: Tanga temperature anomaly assessment in °K from 1979 to 2013 using ERA-Interim Software for reanalysis.

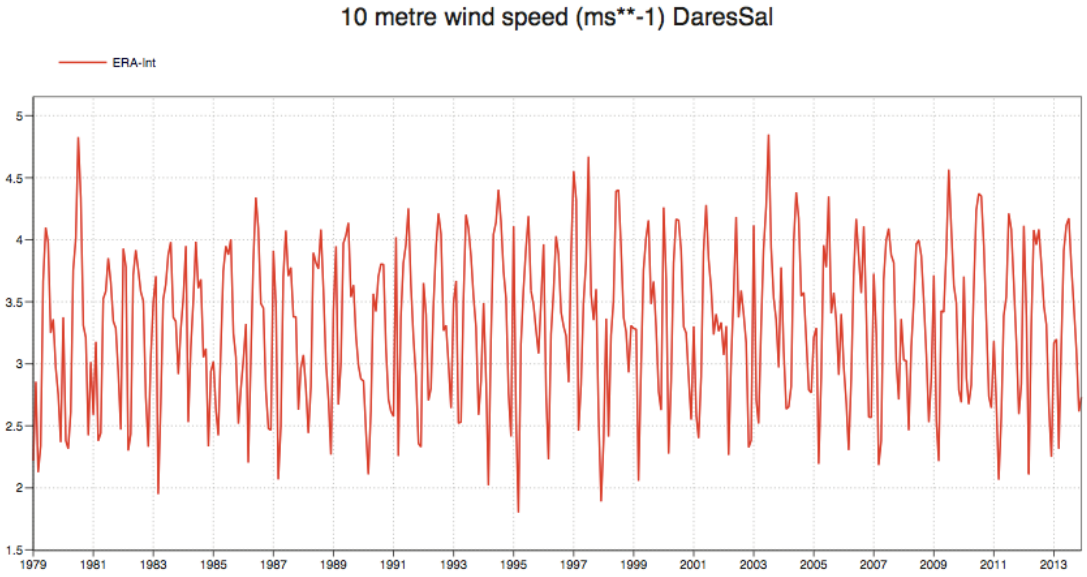

Figure 54: Dar es Salaam average wind speeds variation in m/s from 1979 to 2013 using ERA-Interim Software for reanalysis.

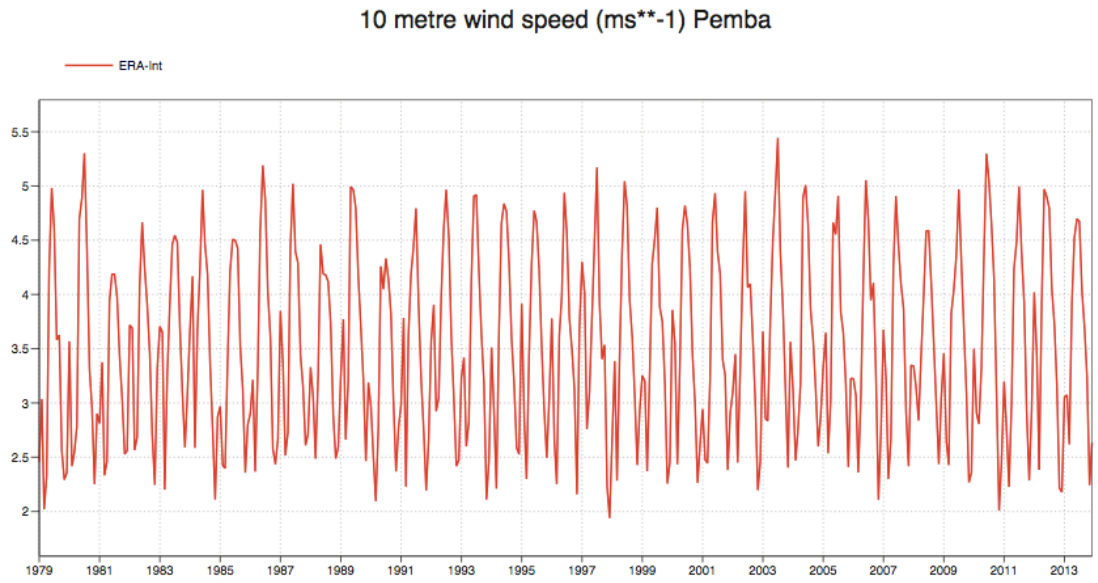

Figure 55: Pemba average wind speeds variation in m/s from 1979 to 2013 using ERA-Interim Software for reanalysis.

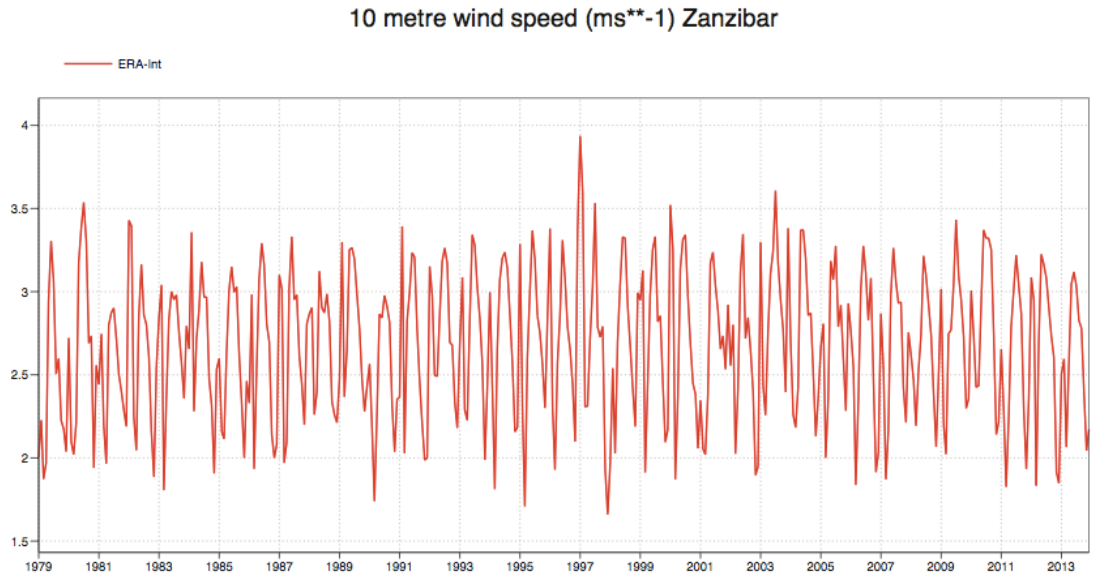

Figure 56: Zanzibar average wind speeds variation in m/s from 1979 to 2013 using ERA-Interim Software for reanalysis.

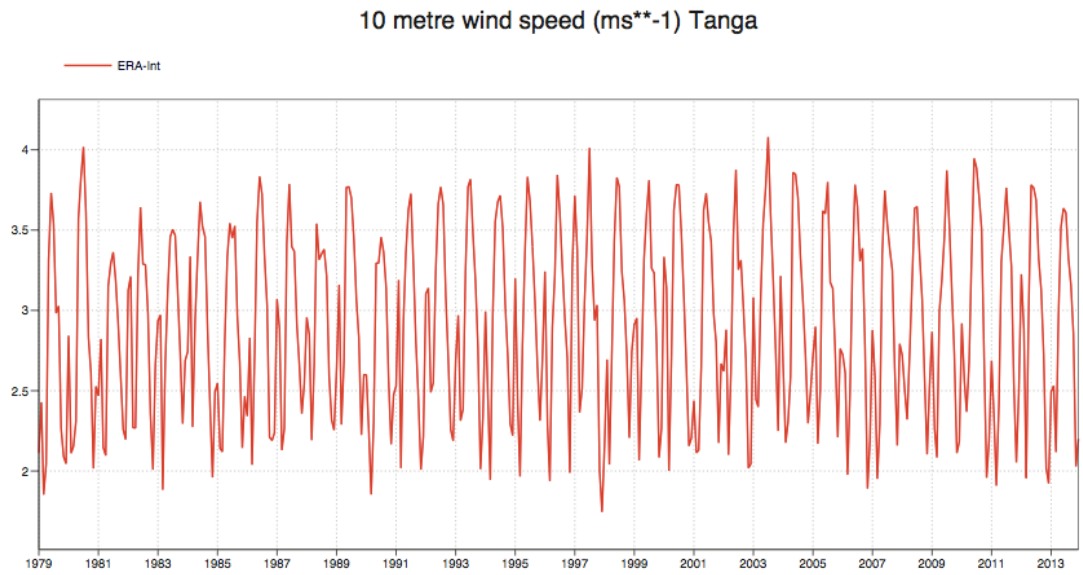

Figure 57: Tanga average wind speeds variation in m/s from 1979 to 2013 using ERA-Interim Software for reanalysis.

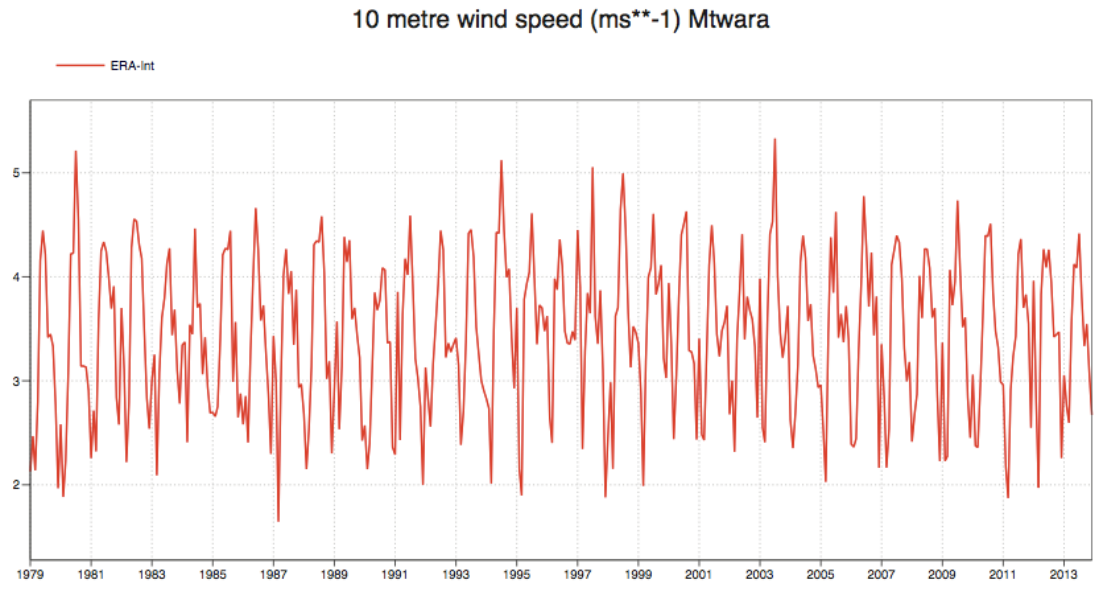

Figure 58: Mtwara average wind speeds variation in m/s from 1979 to 2013 using ERA-Interim Software for reanalysis.

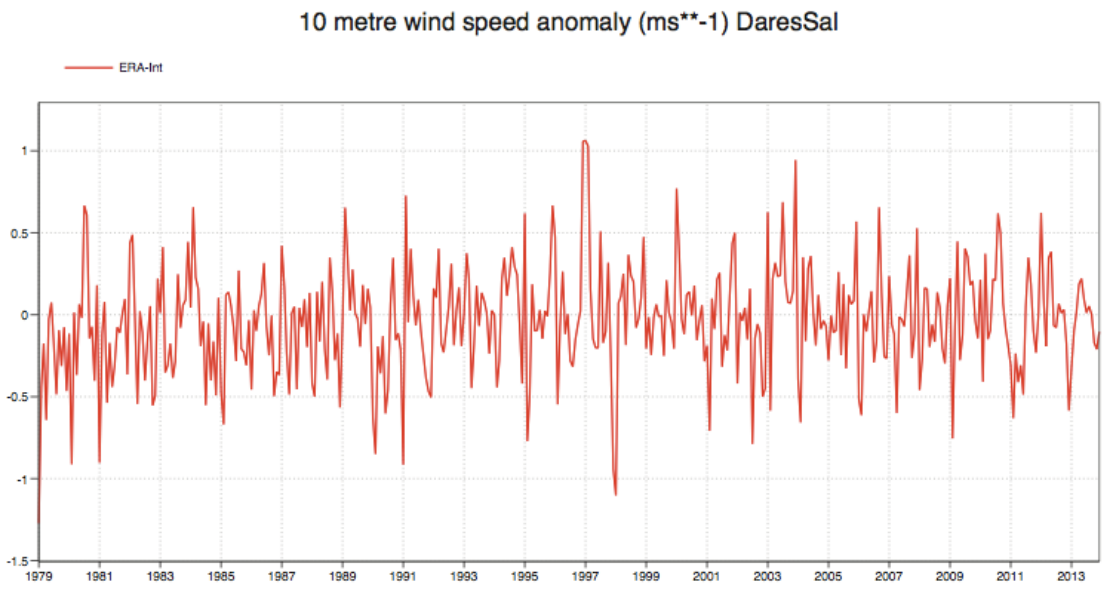

Figure 59: Dar es Salaam wind speed anomaly assessment in m/s (10 m above ground) from 1979 to 2013 using ERA-Interim Software for reanalysis.

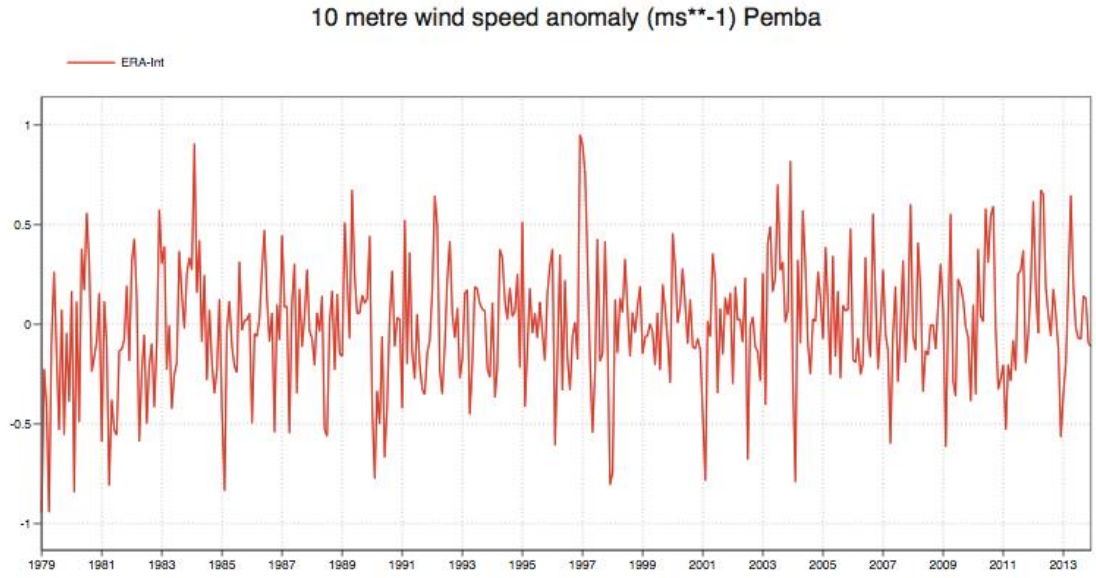

Figure 60: Pemba wind speed anomaly assessment in m/s (10 m above ground) from 1979 to 2013 using ERA-Interim Software for reanalysis.

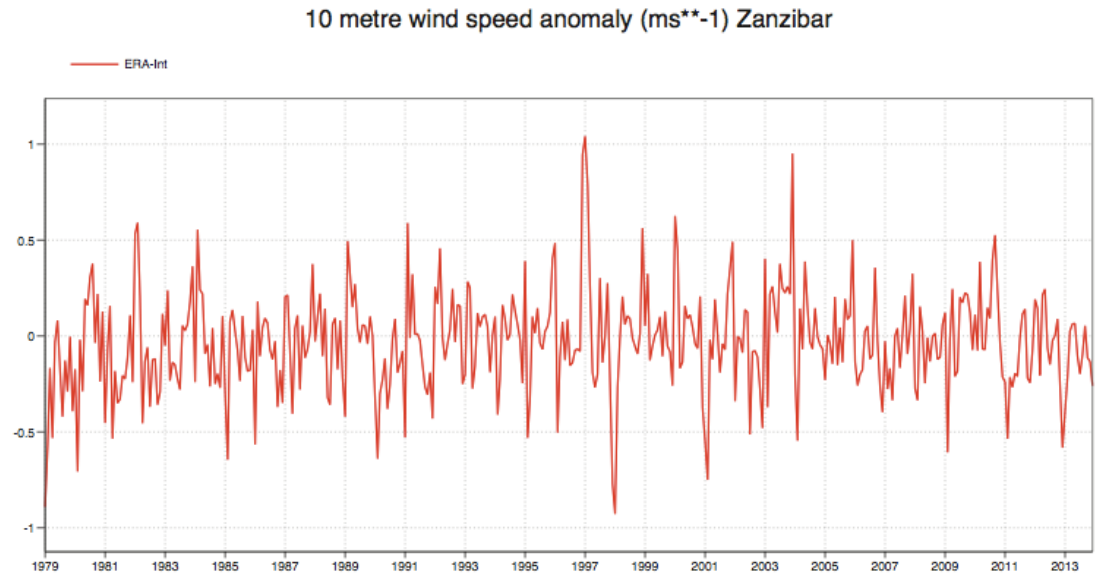

Figure 61: Zanzibar wind speed anomaly assessment in m/s (10 m above ground) from 1979 to 2013 using ERA-Interim Software for reanalysis.

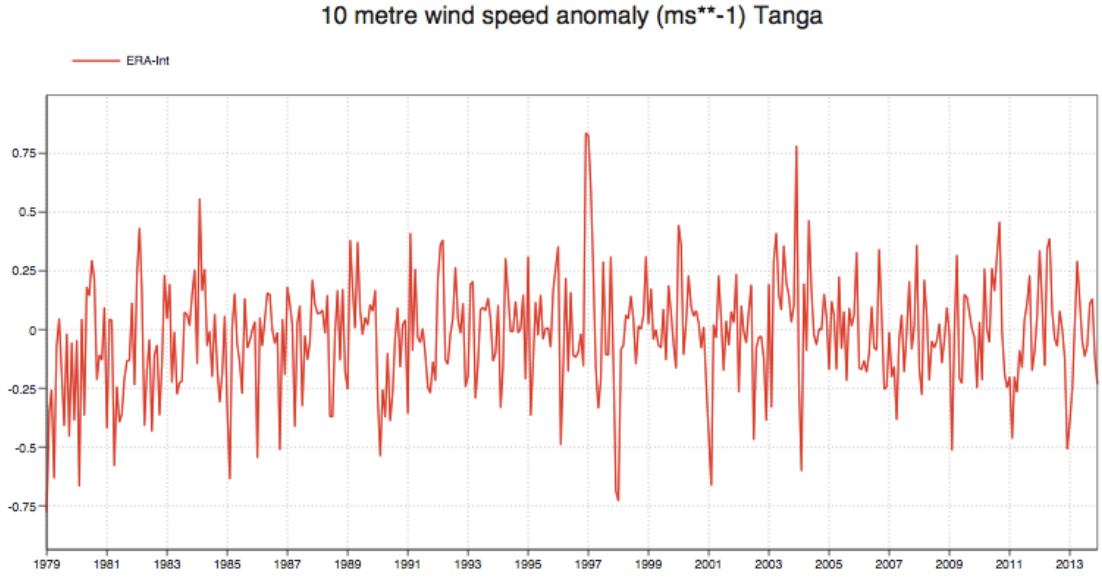

Figure 62: Tanga wind speed anomaly assessment in m/s (10 m above ground) from 1979 to 2013 using ERA-Interim Software for reanalysis.

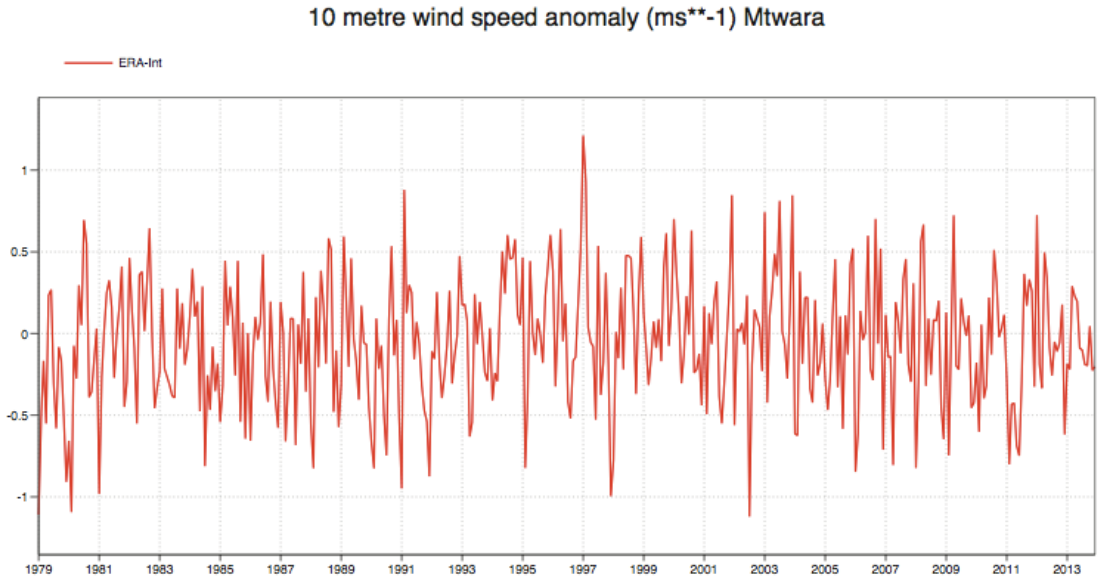

Figure 63: Mtwara wind speed anomaly assessment in m/s (10 m above ground) from 1979 to 2013 using ERA-Interim Software for reanalysis.

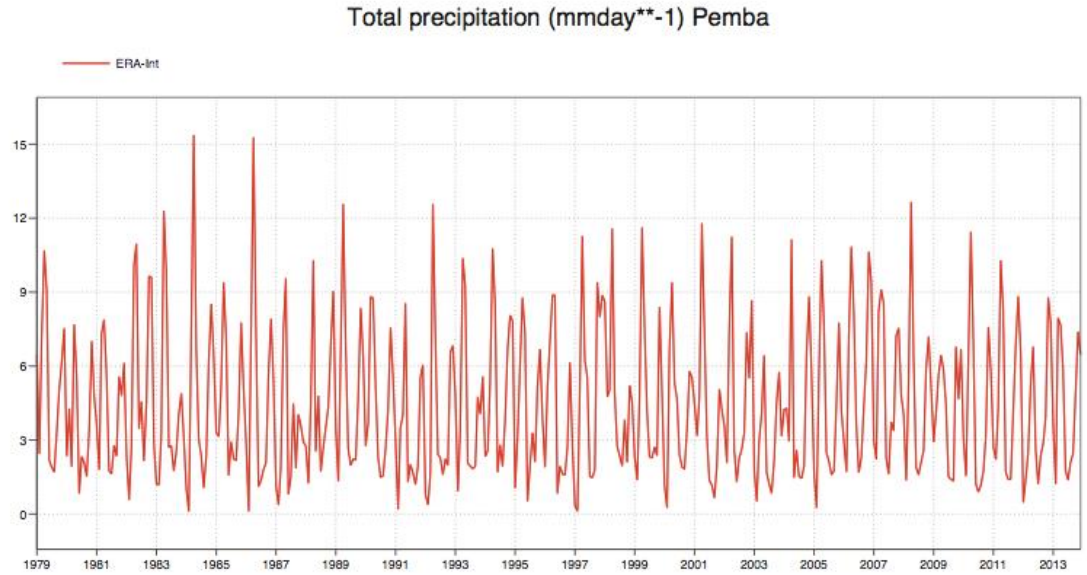

Figure 64: Dar es Salaam total precipitation variation in mm/day from 1979 to 2013 using ERA-Interim Software for reanalysis.

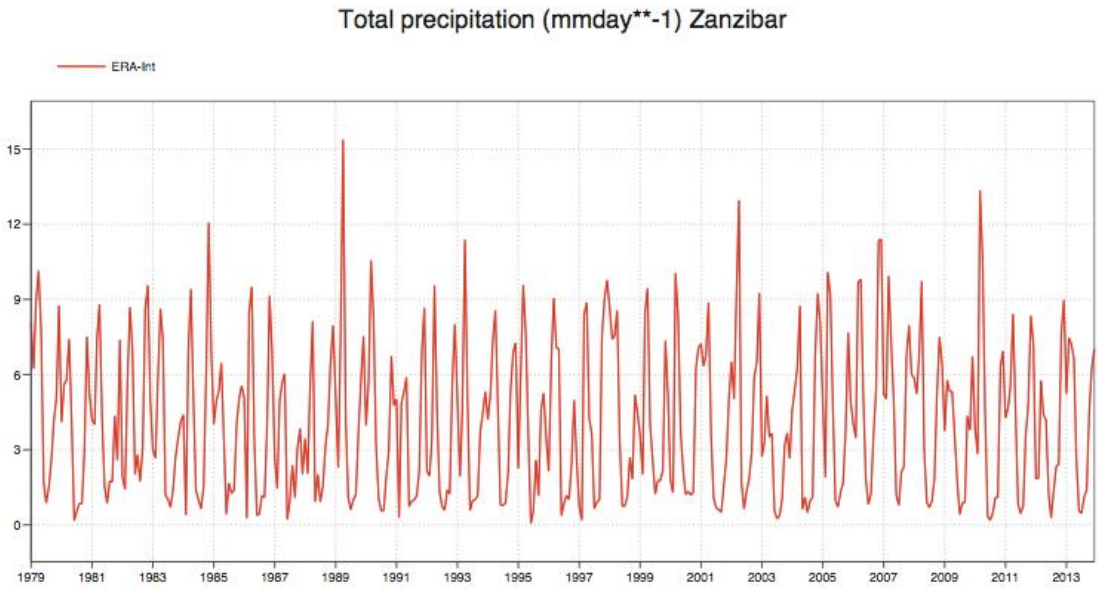

Figure 65: Zanzibar total precipitation variation in mm/day from 1979 to 2013 using ERA-Interim Software for reanalysis.

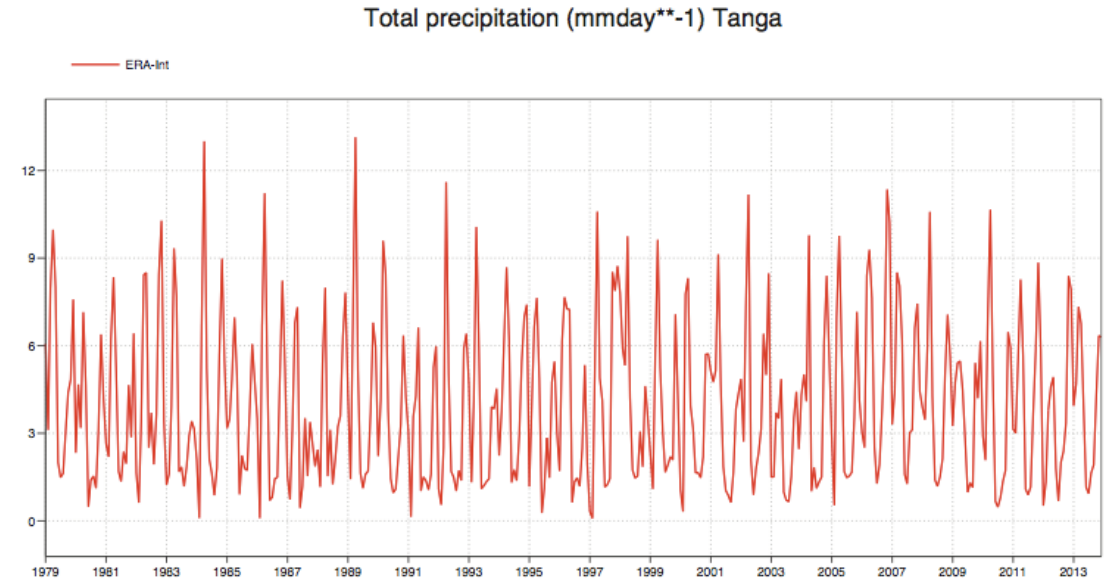

Figure 66: Tanga total precipitation variation in mm/day from 1979 to 2013 using ERA-Interim Software for reanalysis.

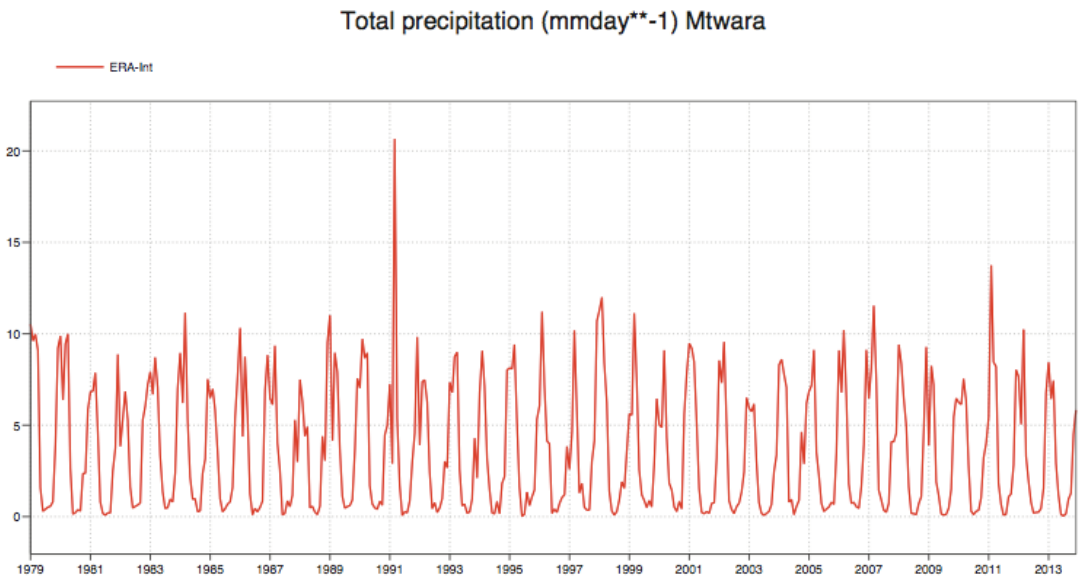

Figure 67: Mtwara total precipitation variation in mm/day from 1979 to 2013 using ERA-Interim Software for reanalysis.

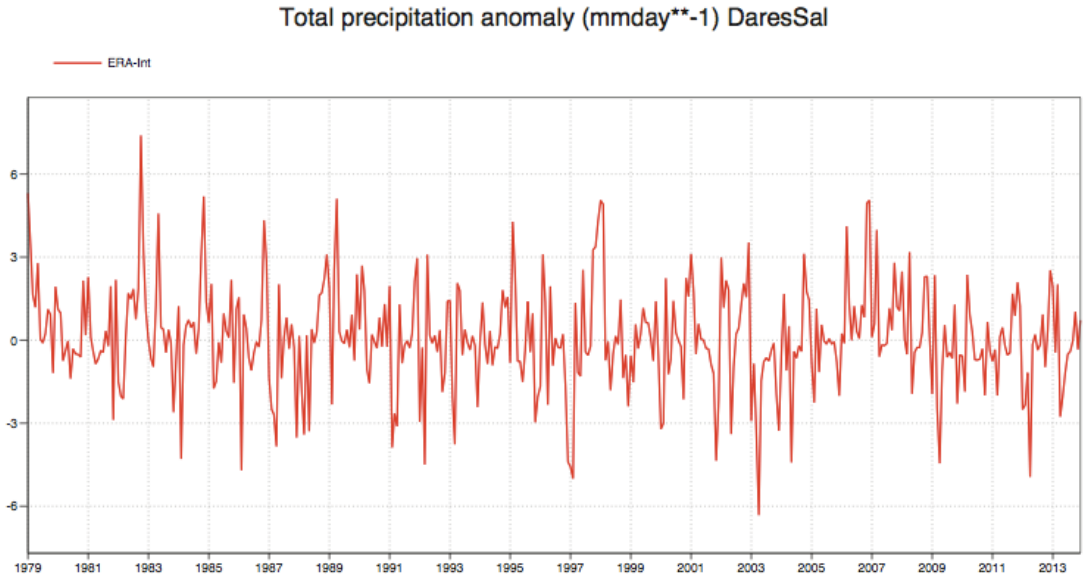

Figure 68: Dar es Salaam total precipitation anomaly assessment in mm/day from 1979 to 2013 using ERA-Interim Software for reanalysis.

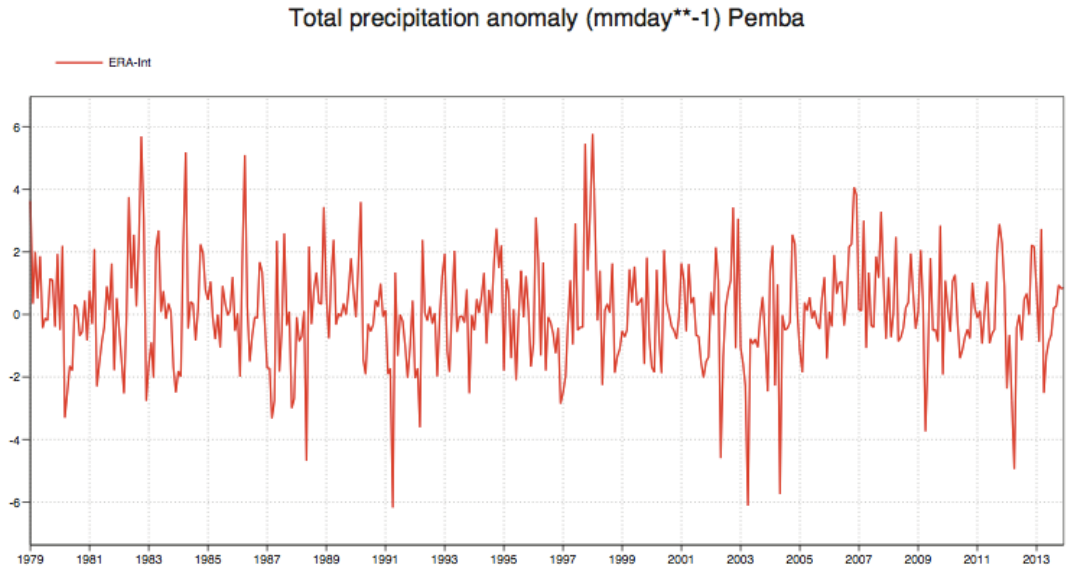

Figure 69: Pemba total precipitation anomaly assessment in mm/day from 1979 to 2013 using ERA-Interim Software for reanalysis.

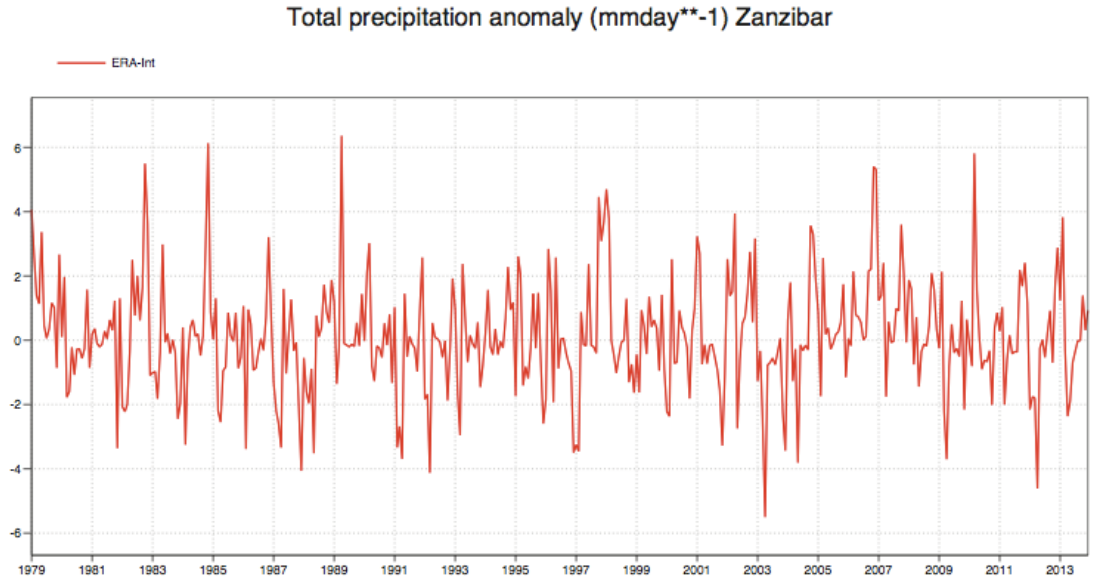

Figure 70: Zanzibar total precipitation anomaly assessment in mm/day from 1979 to 2013 using ERA-Interim Software for reanalysis.

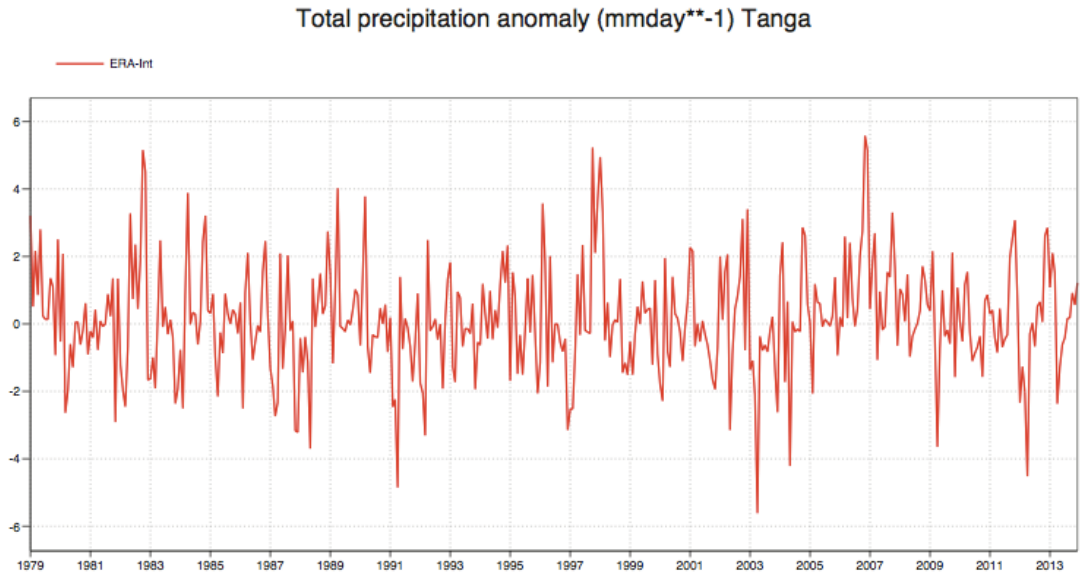

Figure 71: Tanga total precipitation anomaly assessment in mm/day from 1979 to 2013 using ERA-Interim Software for reanalysis.

Annex 4: Trend Assessment of Historical Temperature Data from National Bureau of Statistics

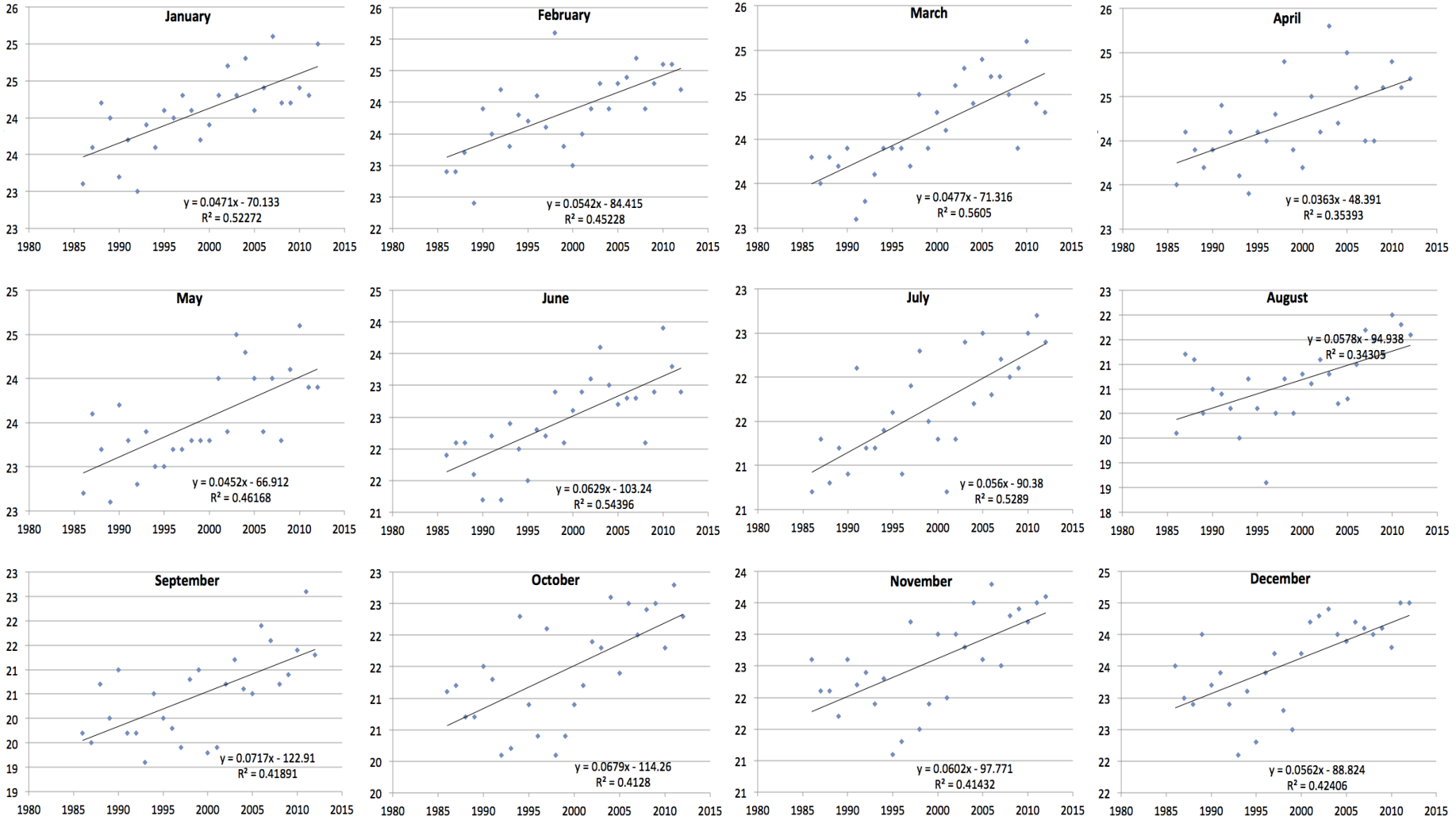

Figure 72: Zanzibar, monthly average minimum temperatures, 1985 – 2012 (National Bureau of Statistics).

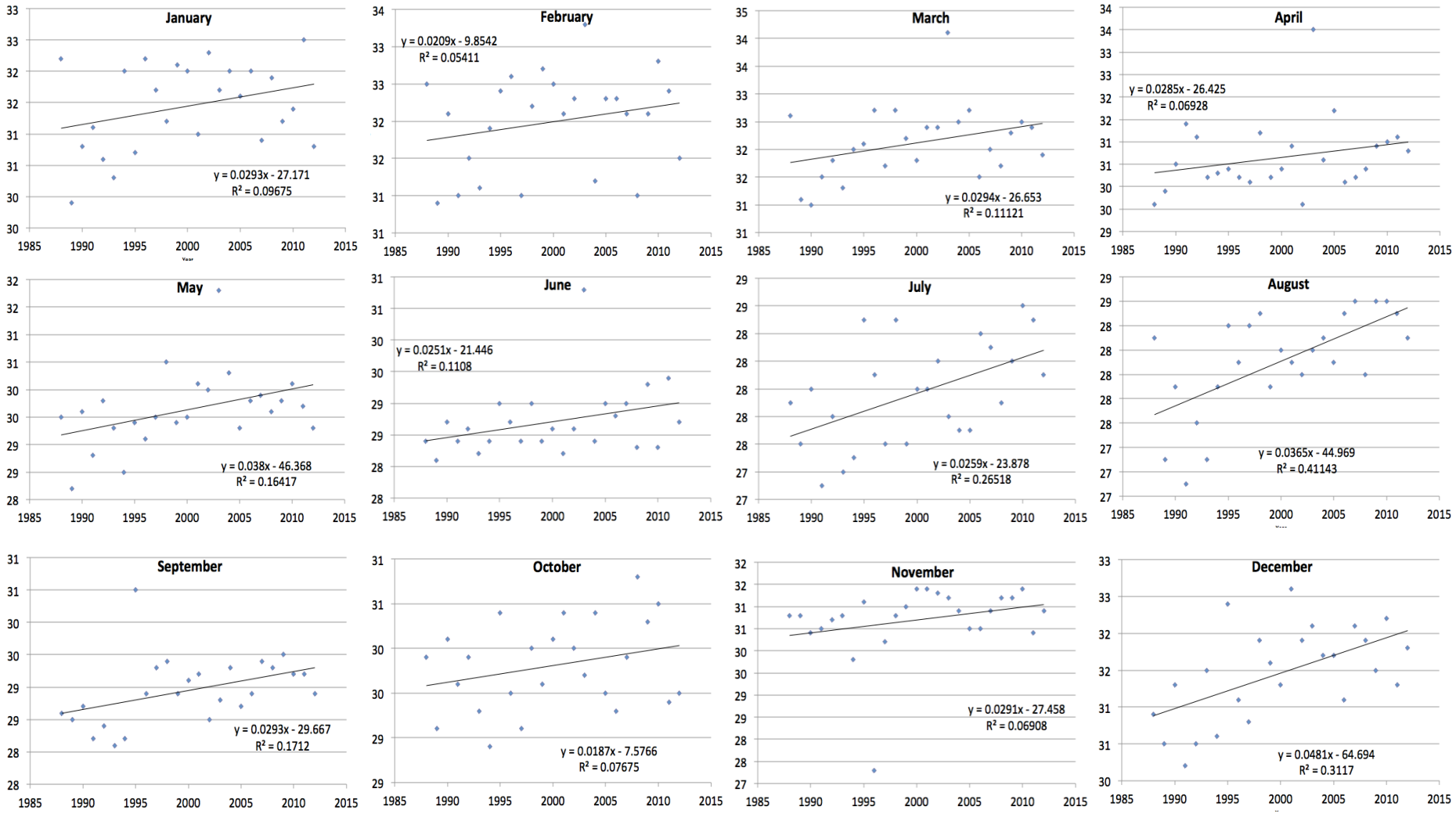

Figure 73: Pemba, monthly average maximum temperature, 1985-2012 (National Bureau of Statistics).

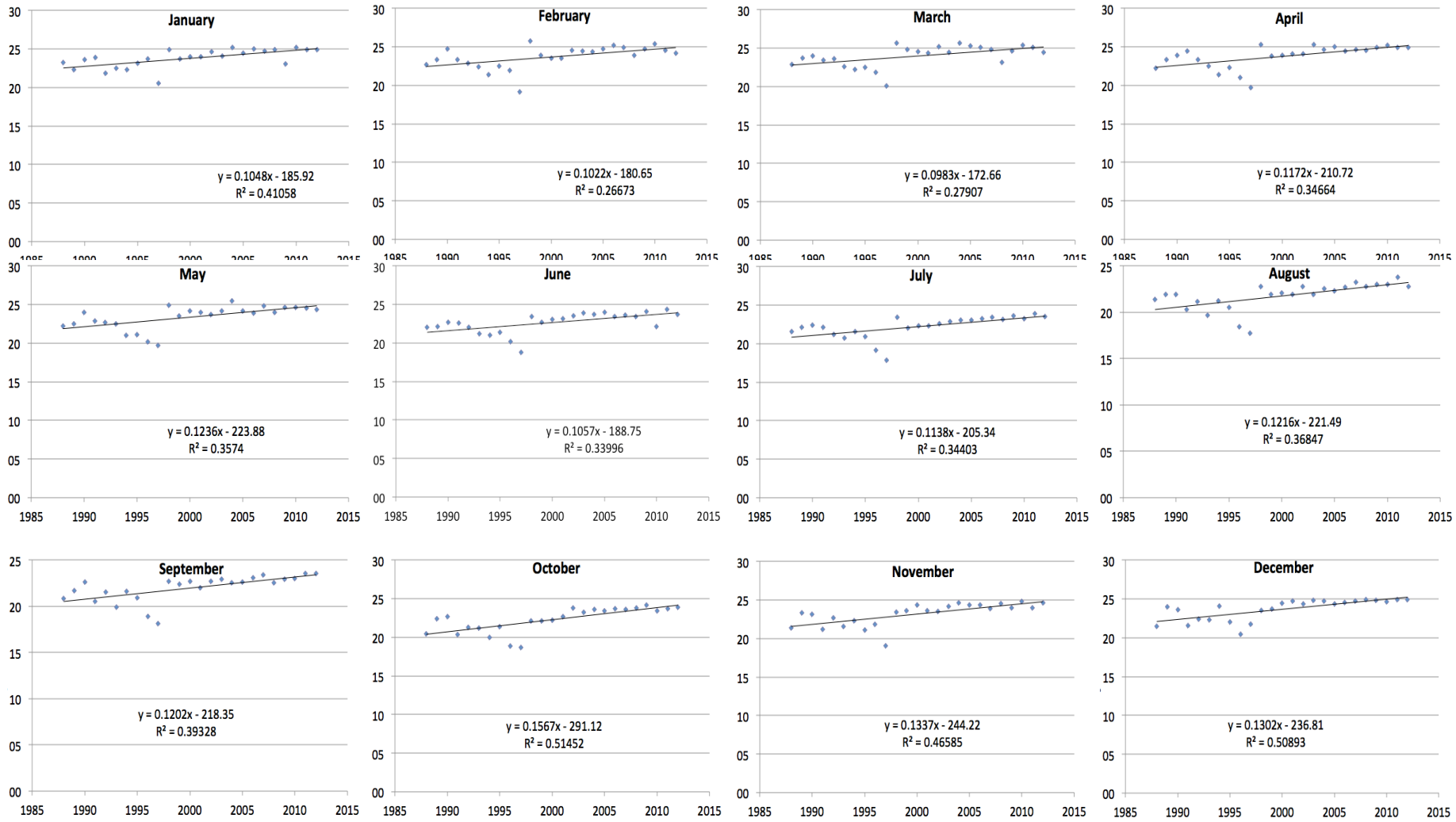

Figure 74: Pemba, monthly average minimum temperature, 1985-2012 (National Bureau of Statistics).

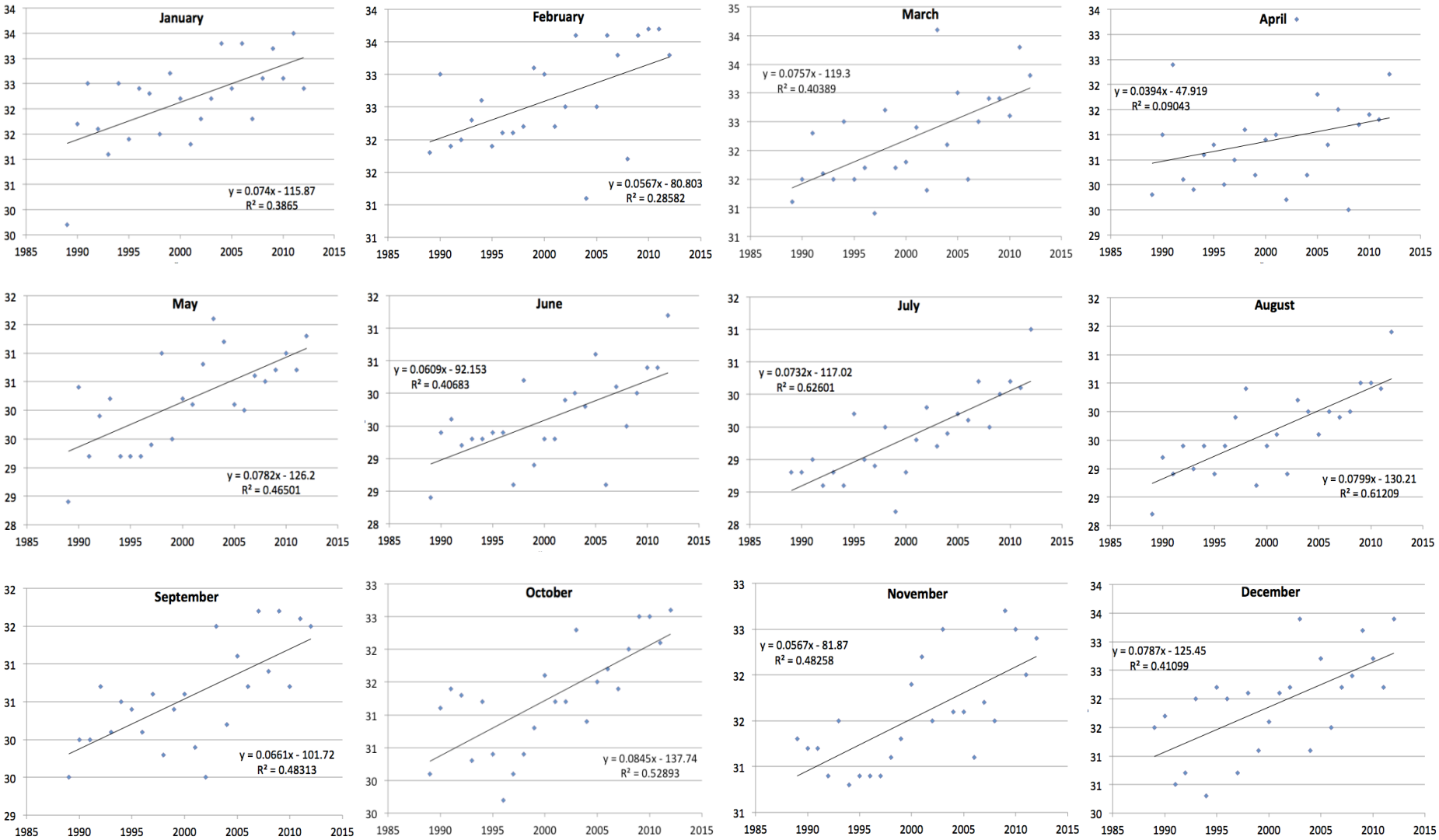

Figure 75: Dar es Salaam, monthly average maximum temperatures, 1985-2012 (National Bureau of Statistics).

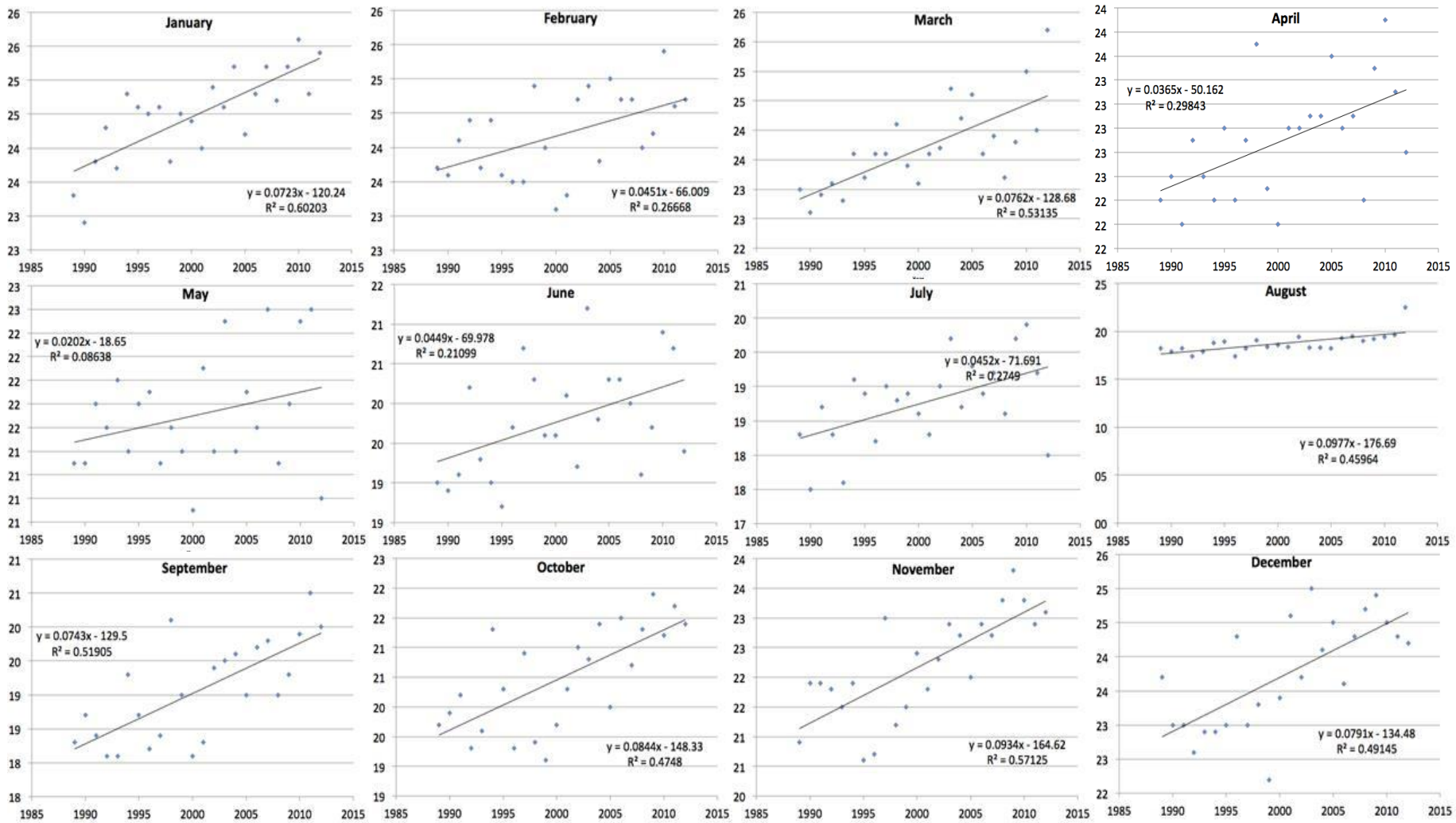

Figure 76: Dar es Salaam, average monthly minimum temperature, 1985-2012 (National Bureau of Statistics)..

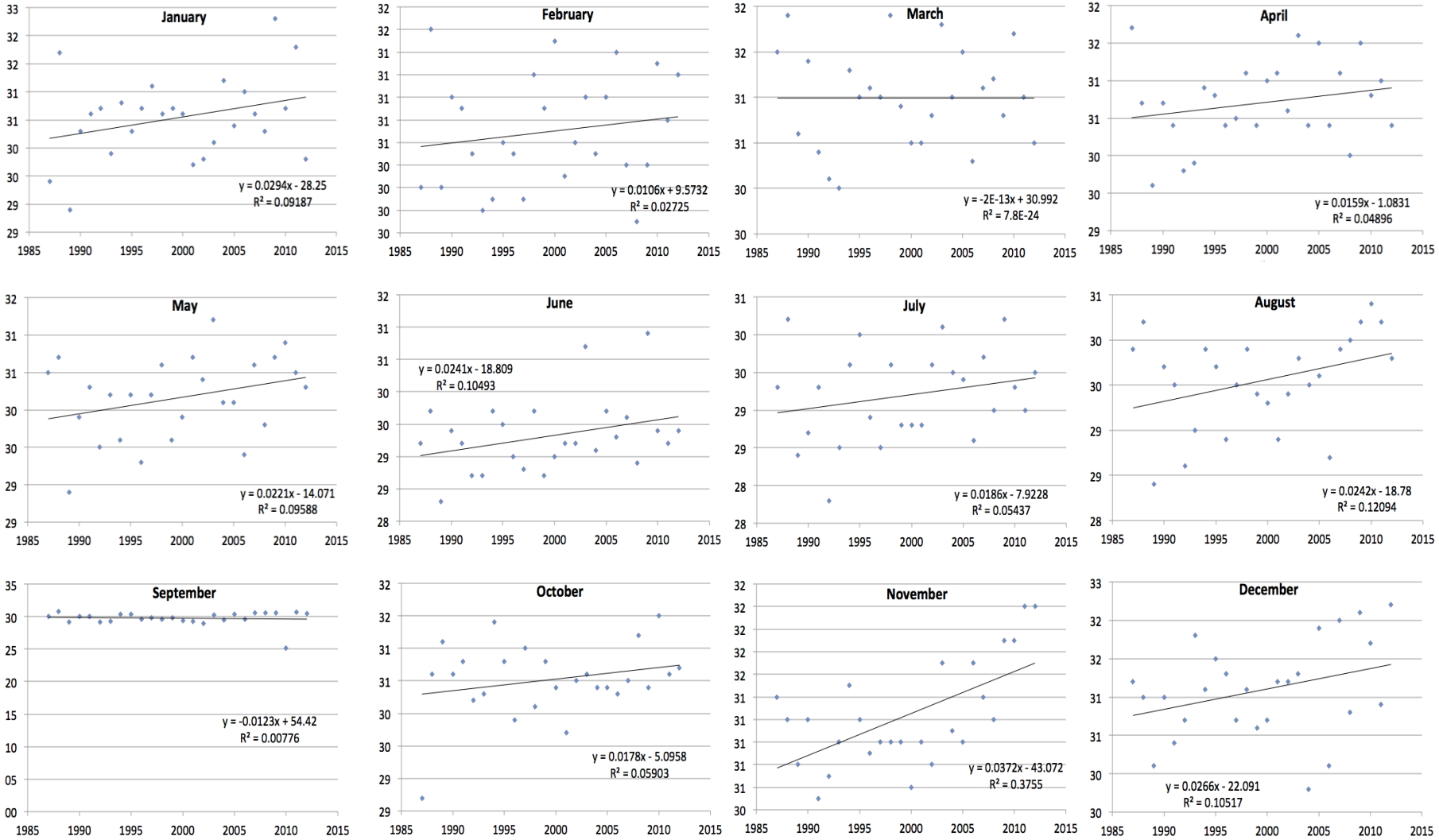

Figure 77: Mtwara, average monthly maximum temperatures, 1985-2012 (National Bureau of Statistics)..

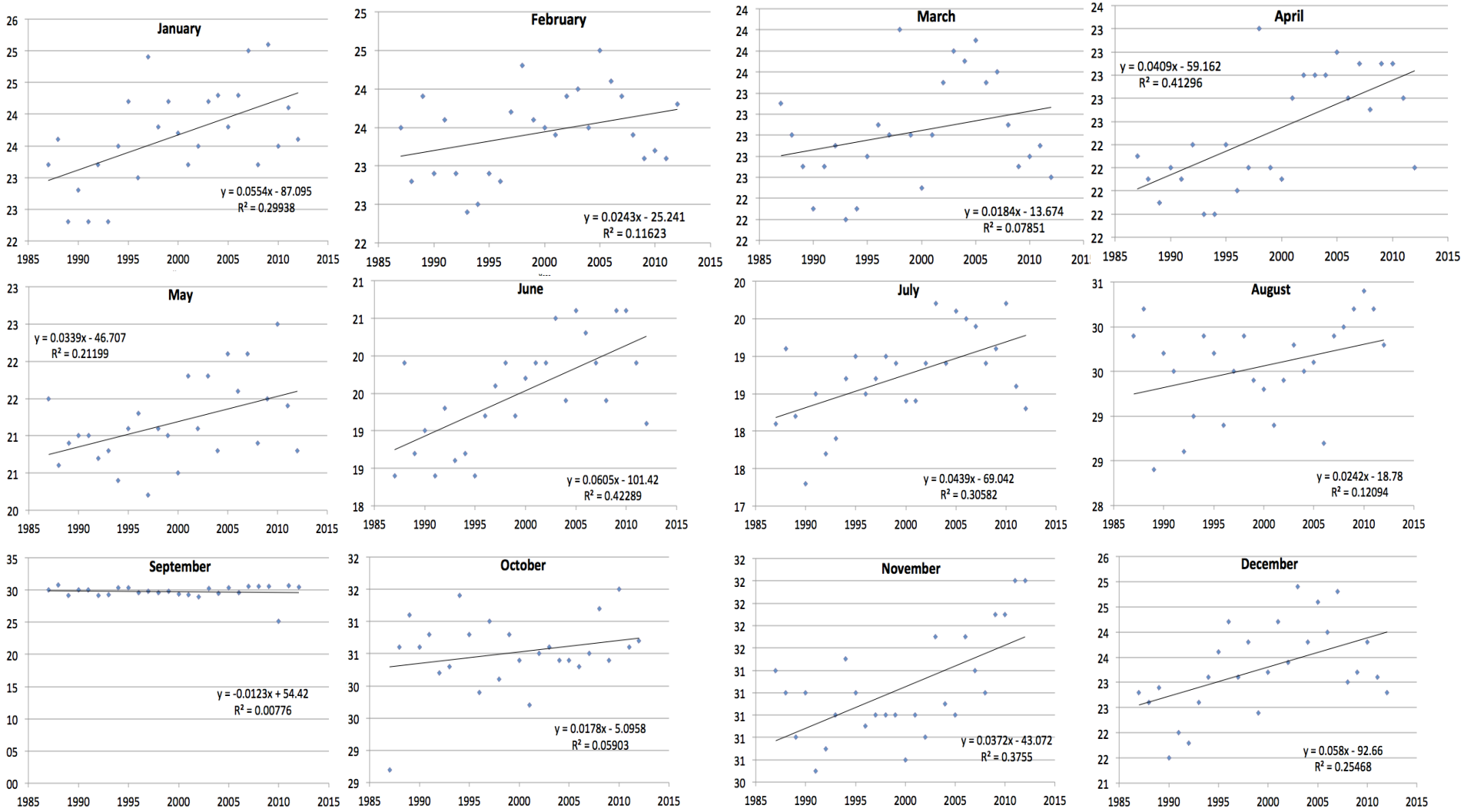

Figure 78: Mtwara, average monthly minimum temperatures, 1985-2012 (National Bureau of Statistics).

Annex 5: Inception Workshops – Participants

Dar es Salaam 8 April 2014

Table 41: List of Participants – Inception Workshop 8 April 2014, Dar es Salaam

Name	Organisation	Name	Organisation
Benaih Benno	UDSM-DASF	Shadrack Stephen	National Land Use Planning
Mathias Igulu	TAFIRI	Philbert Luhunga	TMA
Bupe. E. Mwansasu	Kinondoni	Magdalena Banasiall	DFID
Upendo Hamidu	MLFD (head quarter)	Jason Rubens	Sound Ocean Ltd
Mwanaidi R. Mlolwa	MLFD-FDD	J. M Daffa	WWF
Matthew Richmond	Samaki Consoltants Ltd	Doyi Mzenzele	IUCN TZ
Kimasa Bugomba	MLFD	Titus Mwisomba	NBS
Baraka S. M. Mngulwi	MLFD	Violaine Lepoosez	French Embassy
Magese . E. Bulayi	MLFD	Hannes Potgietel	SEE BREEZE MARINE
Dr. E. J. Mosha	MLFD	Alexander Riefer	SEA BREEZE MARINE
Jovice Mkuchu	MLFD	Ambakisye Simtoe	Fisheries Education Training
Ezra E. Mutagwaba	MLFD	Ramadhani H. Mwigah	UWAWADA-Katibu mkuu
Dr. Simon J. Kangwe	TAFIRI	Abdulkarim Salum	UWAWADA-Mwenyekiti
Flora Akwilapo	NEMC	Christopher Muhando	IMS
Theddy P. Chuwa	Temeke Municipal Council	Rosemarie N. Mwaipopo	UDSM
Juma Msangi	Ilala Municipal Council	Gorm Jeppesen	DHI
Rashidi Tamatamah	UDSM	B.E Mapunda	DAFIE
Rikard Liden	World Bank	Fadhila Ruzika	MLFD-AQUACULTURE DEPT
Jairos Mahenge	Marine Parks	Abdallah Mohamed	Samaki Consultants Ltd

Figure 79: Inception Workshop groups sessions examining threats from thematic sectors and considering prioritization and mitigation alternatives, Dar es Salaam, 8 April 2014

Figure 80: Dar es Salaam Inception Workshop participants, 8th April 2014

Zanzibar 10 April 2014

Table 42: List of Participants – Inception Workshop 10 April 2014, Zanzibar

Name	Organization	Name	Organization
Hamad S. Khatib	MLF-Department of Marine	Ali Kassim Mohamed	PECCA
Ali Ameir Ali	MLF-Fisheries Department	Saleh K. Kina	SMOLE
Othman Maulid	ZIPA	Miza S. Khamis	DFNR
Ali S. Mchenga	Mkoa Kusini (U)	Thani R. Said	SUZA
Dr. Mabau A. Usa	Mkoa Kaskazini (U)	Tammy Holter	SCUBA DO/ZATI/Ocean
Saleh Mohamed Juma	MANR	Rikard Liden	World Bank
Martin McDonald	Chumbe	Tamriri Ali Said	Forestry Zanzibar
Matthew Richmond	Samaki Consultants Ltd	Dr. N.S.Jiddawi	IMS
Gorm Jeppesen DHI	DHI	Amas M Othman	MBCA
Ramla Talik Omar	SWIOFish Coordinator	Omar Hakim Foum	MCU
Salum Rehan	Urban West Region	Ali S. Mkarafuu	DFD
Mohamed. M. Nur	Samaki Consultants	Makame Khamis Makame	Rc's Office Pemba North
Rosemarie Mwaipopo	Samaki Consultants	Sheha Mjaja Juma	DOE- FVPO
Rukia Kitula	Institute of Marine Science	Mwalim KH.Mwalim	DOE- FVPO Pemba
Omar Mohamed Ali	Kojani Fishermen Dev. Organization	Masoud S. Said	Zari-Kizimbani
Juvinaries M. Nyandoto	Deep Sea Fishing Authority	Othman Mohamed	Director KATI-Kizimbani
Asma Othman	Ministry of Livestock and Fisheries	Casper Loursen	Smole Project
Ummi Molid	SWIOFish	Makame Salum	C-Weed Corp Ltd
Amour Mlenge	Ministry of Livestock and Fisheries	Ramla Fadhil	Aquaculture
Abdulrahman Ali	ACRA-ZNZ	Batuli M. Yahaya	C-Weed section
Mohammed Chum	Department of Fisheries	Jadidi Abdulla	Zanea Seewed Co Ltd
Hussein M. Mohamed	ZFSE	Arif Mazrui	Zanqur Aqua Farms Ltd
Jaala Sumba	Department of Fisheries	Christian Mchloll	ZATI-Scuba Do Zanzibar
Mohamed Habib	Dept of Urban and Rural Planning	Issa Yussup	Daily News
Thani R. Said	SUZA	Hinja Haji	ZBC Radio
Hashim Runehielun	GIM SEA CO .Ltd	Salama Mohamed	Mwandishi Wizara
Amour Kassim	Dept of land and Registration	Madina Issa	Zanzibar Leo
Sihaba H. Vuai	Dept of Environment	Beatrice George	ZBZ Tv
Munira A. Arahman	Dept of Fisheries	Makame Ame Ussi	ZBZ Tv
Semeni Mohamed Salum	Dept of Fisheries	Chalid Abdallah	Ministry of Livestock and
Hamad Masoud	DPPR-MLF	Ngwali M. Haji	Forestry Department
Khatib Juma	ZARI	Dr. Ahmada H. Panda	ZCT
Lars Moller	SMOLE	Daud H. Pandu	DFA
Mwadidni Haji	DPF	Maryam Ali Mohamed	Fisheries
Radhiya R. Haroub	PORASD	Bahati Ameiri Khamis	Fisheries
Khamis Khalfan	CHICOP LTD		

Figure 81: Inception Workshop participants attending a presentation by Dr. Rosemarie Mwaipopo on the preliminary social and economic assessment of the coast as it relates to threats to livelihoods and the environment, prior to groups work considering prioritization and mitigation alternatives of thematic threats identified thus far, Zanzibar, 10 April 2014

Figure 82: Zanzibar Inception Workshop participants, 10 April 2014

Annex 6: Members of Working Groups

Tanzania Mainland Working Group

Table 43: Members of the Working Group for Mainland Tanzania

Name	Institution
Dr. Rashid Tamatamah	University of Dar es Salaam (USDM)
Jeremiah Daffa	Tanzania Coastal Zone Management Project (TCZMP) – National Environmental Management Council (NEMC)
Magese E. Bulayi	Ministry of Livestock and Fisheries Development MLFD
Shadrack Stephen	National Land Use Planning Commission
Deogratius Paul	Vice President's Office (VPO), Division of Environment
Abdallh Said Shah	International Union for Conservation of Nature (IUCN)
Lewis Nzali	National Environmental Management Council (NEMC)

Zanzibar Working Group

Table 44: Members of the Working Group for Zanzibar

Name	Institution
Sihaba Vuai	Department of Environment
Hamad Khatibu	Ministry of Livestock and Fisheries (MLF) -Department of Marine Resources
Rune Hashim	GIM SEA CO .Ltd
Daudi Pandu	DFA
Christian Zati	SCUBA DO/ZATI/Ocean watch
Bakari Asseid	Deputy PS, Ministry Natural Resources
Makame Kitwana	Institute of Marine Sciences, UDSM
Nariman Jiddawi	Institute of Marine Sciences, UDSM