Final Report

Urban Poverty & Climate Change in Dar es Salaam, Tanzania:

A Case Study

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Average exchange rate between July 15, 2010 and December 15, 2010:

United States Dollar (US$) 1 = Tanzanian Shilling (Tsh) 1418.90

Acronyms & Abbreviations

AIDS	Acquired Immune Deficiency Syndrome
AF	Adaptation Fund
CBO	Community-Based Organization
CCLM	Consortium for Small scale Modeling – ClimateLimited-areaModelling
CDM	Clean Development Mechanism
CDO	Community Development Organization
CIUP	City Infrastructural Upgrading Programme
CLACC	Capacity strengthening of Least developed countries for Adaptation to Climate Change
CTF	Clean Technology Fund
DAWASA	Dar es Salaam Water and Sewage Authority
DEM	Digital Elevation Model
DSM	Dar es Salaam
EIA	Environmental Impact Assessment
ENSO	El-Nino Southern Oscillation
FCPF	Forest Carbon Partnership Facility
FIP	Forest Investment Program
GCCA	Global Climate Change Alliance
GEEREF	Global Energy Efficiency and Renewable Energy Fund
GEF	Global Environment Fund
GHG	Greenhouse Gas
HIV	Human Immunodeficiency Virus
ICI	International Climate Initiative
IFPRI	International Food Policy Research Institute
IIED	International Institute for Environment and Development
ILO	International Labor Organization
IPCC	Intergovernmental Panel on Climate Change
IRA-UDSM	Institute of Resource Assessment – University of Dar es Salaam
ITCZ	Inter Tropical Convergence Zone
ITN	Insecticide Treated Net
IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
KICAMP	Kinondoni Integrated Coastal Area Management Project
LDCF	Least Developed Countries Fund
LGDG	Local Government Development Grant
LGSP	Local Government Support Project
LLITN	Long-Lasting Insecticide Treated Net
MEVT	Ministry of Education and Vocational Training
MUM	Mfuko wa Usafi wa Mazingira
NAPA	National Adaptation Programme of Action
NEMA	National Environmental Management Act
NEMC	National Management Council
NGO	Non-Governmental Organization
NHIF	National Health Insurance Fund

NLFEP	National Lymphatic Filariasis Elimination Programme
NSSCP	Schistosomiasis and Soil-transmitted Helminthes Control Programme
NTD	Neglected Tropical Disease
PMI	President Malaria Initiative
PMORALG	Prime Minister's Office, Regional Administration & Local Government (also abbreviated TAMISEMI)
PRB	Population Reference Bureau
PRECIS	Providing Regional Climates for Impact Studies
REDD	Reducing Emissions through Deforestation and forest Degradation
SACOS	Saving and Credit Societies
SCCF	Special Climate Change Fund
SCF	Strategic Climate Fund
SPA	Strategic Priority on Adaptation
SUDP	Strategic Urban Development Plan
TAMISEMI	See PMORALG, above
THIS	Tanzania HIV/AIDS Indicator Survey
TMA	Tanzania Meteorological Agency
UCLAS	University College of Lands and Architectural Studies
UNAIDS	United Nations Programme on HIV/AIDS
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNFCCC	United Nation Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
UNV	United Nations Volunteers
URASU	Uchoraji na Ramani na Sanaa Shirikishi Dhidi ya Ukimwi
URT	United Republic of Tanzania
WBG	World Bank Group
WBI	World Bank Institute
WHO	World Health Organization
WMO	World Meteorological Organization
WWF	World Wildlife Fund

List of Local Terms

Daladalas	Minibuses and minivans
Masika	Long rains
Mtaa	Sub-ward
Vuli	Short rains

EXECUTIVE SUMMARY

This study seeks to understand key aspects of vulnerability of the urban poor in Dar es Salaam, Tanzania, how climate impacts upon this vulnerability, and to determine how forward-looking policies and programs can be developed that reduce the vulnerability of the poor, taking both current and expected future climate into account. Over 70 percent of the city's four million residents live in informal, unplanned settlements that lack adequate infrastructure and services, and over half of them survive on roughly a dollar per day. With a population growth rate of about 8 percent per year, Dar es Salaam is one of the fastest-growing cities in sub-Saharan Africa. City and municipal authorities face significant challenges with respect to providing new or even maintaining existing infrastructure and services.

Vulnerability to current climate

Detailed information on existing vulnerability to climate variability among poor residents of informal settlements was obtained through (i) review of existing literature, (ii) surveys involving over 500 households, (iii) community focus group discussions, and (iv) in-person visits with Government, non-government and community development organization officials. The surveys were implemented in high flood-risk areas, with a few not-at-risk areas included for the sake of comparison.

Vulnerability to climate variability is high in the informal settlements. Flooding is frequent, and is a result of both heavy or prolonged rainfall and a range of non-climatic factors such as overcrowding, dumping of sewage and solid waste into rivers and channels, and blockage of storm drains with garbage or illegal construction. Apart from damage to property, factors such as inadequate or absent supply of clean water, poor sanitation provisions, widespread use of pit latrines that overflow easily, and unhygienic practices render many residents of these settlements vulnerable to disease, particularly following flooding. Residents of these settlements are prone to malaria, lymphatic filariasis, cholera, dengue fever and diarrhea, among other diseases. Dar es Salaam experiences drought, too, which also tends to increase disease incidence, as clean water becomes scarcer. Drought also has adverse implications for electric power generation in the city, as hydropower is an important energy source. Floods, drought, and other climatic factors (humidity, high temperatures) have an impact on the livelihoods of the poor, many of whom are employed by the informal sector and are street vendors.

Analysis of climatic trends over the past four decades indicates rising maximum and minimum temperature trends in Dar es Salaam. Precipitation trends are less clear, and appear to indicate a declining number of rain days per year along with high variability. Rainfall intensity is expected to increase. Sea level rise would result in increased coastal degradation and higher storm surges, which would exacerbate flooding. Several of Dar es Salaam's major floods over the past three decades appear to be linked to El Nino events.

Impacts of climate change on Dar es Salaam's urban poor

A flood modeling exercise was undertaken using a digital elevation model and a hydrodynamic model to estimate how climate change is likely to alter flood spatial extent

over coming decades in Dar es Salaam's unplanned settlements. The maps included in this report show inundation corresponding to floods of differing return periods.

Reductions in annual mean rainfall in coming years could also lead to more droughts in parts of Tanzania, which would adversely affect food and water security and have profound indirect impacts, e.g., reduction in electricity provision for the city's poor, and increased disease incidence. Specific projections on drought for Dar es Salaam are not available, however.

Policies and programs with potential to increase resilience to climate change

The city's poor are currently unable to cope adequately with existing climatic variability, and rapid urban growth compounds the current situation. Climate change, including the increased variability of climate that it will bring, is likely to greatly aggravate vulnerability.

Against this backdrop, this study has identified examples of current policies and programs for the city that serve to both address current vulnerability and promote adaptation to climate change. Two programs, the Community Infrastructural Upgrading Program (CIUP) and the Strategic Urban Development Plan (SUDP), have both been targeting infrastructure improvements in poor areas of the city and seek to nurture community-based initiatives. Such initiatives need to be supported and expanded and, importantly, their benefits sustained.

Tanzania has ratified the United Nations Framework Convention on Climate Change, and has prepared a National Adaptation Programme of Action in which urgent adaptation needs have been identified. Adaptation projects have been initiated in Dar es Salaam in response to needs identified in the NAPA. These primarily focus on coastal area protection and afforestation/reforestation.

Reducing urban greenhouse gas emissions while generating local benefits

The study produced household surveys that inquired into fuel use among urban poor households. Charcoal, a woodfuel and cheaper than alternative sources, was the predominant source; Dar es Salaam consumes about 50 percent of the charcoal consumed by the country, with an estimated 94 percent of its households using charcoal, either on its own or in combination with other fuels. Its widespread use in congested, overcrowded neighborhoods that often have poor ventilation has adverse implications for the respiratory health of residents of these neighborhoods in addition to contributing greenhouse gas emissions. Programs that lead to increased use of alternative fuels (and less charcoal) would not only serve a global cause but would improve resident health and lower deforestation rates in the country. Regarding the latter, Tanzania is exploring options for participation in REDD programs.

Tanzania has engaged in a CDM project that involved gas flaring reduction at a waste dumpsite. Follow-up has been proposed to this project that, in addition to reducing greenhouse gas emissions, will involve city departments in efforts to create programs in waste recycling, distribution of compost and fertilizer, city greening, construction of embankments, and provisions for waste collection, storage and treatment. If funded, this

program will also comprise enforcement measures such as a "polluter pays" policy on industry and control of illegal dumping and unsanitary practices among community residents.

Looking forward

The first step towards helping the urban poor adapt to climate change in Dar es Salaam is to address areas that contribute to current vulnerability. This requires improving the quality of life of poor residents by providing them with basic services such as clean water, improved stormwater drainage, sanitation facilities, and better healthcare. Efforts made in this direction will reduce both current and expected future vulnerability to climatic variability and change.

At the city level, adaptation to climate change requires planning at longer-term timescales, particularly where it comes to physical investments that have long lifespans (many infrastructure investments are of this nature). For example, given indications that rainfall variability is increasing and rainfall may become heavier during individual episodes, stormwater drainage systems currently being constructed or repaired should be designed with added flexibility built in. The Dar es Salaam City Council and Municipal Council departments should bear in mind, when laying out infrastructure provisions for the informal settlements, that climatic trends and variability are changing, and will affect investments in the long term, both directly and indirectly.

A series of in-depth case studies should be conducted by research and policy communities in Dar es Salaam, in partnership with relevant regional and international actors, to examine municipal program needs given expected changes in climate for the city. Capacity building is needed at several levels, including in the city's hydrometeorological departments, to improve forecasting and early warning abilities.

Education and training of poor communities on the links between inappropriate waste disposal practices and disease incidence, the benefits of switching to improved toilet facilities, and on hygiene and the need to boil drinking water, have immense potential in improving resident health in informal settlements in general, and particularly during times of flood and drought.

A relatively low-cost and yet potentially highly effective means of building resilience among the urban poor would be through enforcing oft-ignored laws and regulations that are already in place relating to waste disposal and illegal construction.

1 Introduction

1.1 Background to the Mayors Task Force case studies on climate change and urban poverty

This case study on climate change and urban poverty in Dar es Salaam is part of a multi-city effort that is rooted in the work program of the Mayors Task Force on Urban Poverty. The Task Force was established in January 2010 at the Global Dialogue for Mayors, at which mayors from Dar es Salaam, Jakarta, Mexico City and São Paolo, together with a global city network, decided upon the main elements of the Task Force's proposed work program. The World Bank Group is supporting the following elements of this work:

- Take stock of our understanding of the linkages between urban poverty and climate change;
- Identify good practice examples where shelter and services for the urban poor have been improved and have resulted in reducing the vulnerability to climate change and where carbon emissions have been reduced; and
- Propose policy and investment programs and municipal management improvements that benefit the urban poor and scale-up good practices.

In April 2010, the WBG and the Mayor's Task Force agreed to carry out four city case studies: Dar es Salaam, Jakarta, Mexico City and São Paulo. Given the close relationship between climate change adaptation and hazard management policies and programs, a strong focus of the case studies is examination of disaster risk management issues in the urban context.

The audience for this work includes mayors and city managers, national governments, donors, and practitioners in the fields of climate change, disaster risk management and urban development.

The case studies follow a common methodology drawing on the framework for Urban Risk Assessment (developed under a global study as part of the Task Force initiative), yet they will also have the flexibility to incorporate local contextual factors. Active participation of local experts and organizations is envisioned as an essential ingredient in the development of the case studies.

1.2 Climate change and cities: causes for concern

Cities are particularly vulnerable to the impacts of natural hazards due to their high concentration of people, infrastructure and economic assets. As many cities are located near the coast or along rivers and drainage lines, extreme climatic events such as windstorms and heavy rainfall can cause tidal surges and floods that have large impact on life and property. Climate change is likely to exacerbate risks. Sea level rise would result in larger storm surges (and flooding), coastal encroachment and salt-water intrusion. Increased climate variability would translate into possibly more frequent and/or severe storms, rain and drought.

Within cities, the impacts of climatic hazards are distributed unevenly among urban populations; generally speaking, lower-income communities tend to live in marginalized lands that face greater risk. Their capacity to respond is also lower; poorer residents tend to have less access to information, scant resources to withstand adverse impacts, and fewer safety nets. With little assurance that their homes and belongings will be safe in the case of evacuation, they can be reluctant leave them.

Apart from their vulnerability, the urban poor are important stakeholders for greenhouse gas (GHG) emission reduction strategies given that (i) they often suffer from the effects of poor air and water quality and will thus directly benefit from actions that improve local environmental quality; and (ii) as their living standards improve and as the city continues to grow, GHG emissions have the potential to rise markedly, even though they may be very low at present.

Many developing-country cities experience climatic hazards, yet most governments lack the financial and technical capacity to adequately address the risks. Understanding the factors that contribute to vulnerability to climatic and other risks, and the ways in which they can impede development at present and in the longrun, are essential in identifying lines of action for adaptation to climate change. This case study investigates how climatic factors feed into urban vulnerability in Dar es Salaam, Tanzania, and offers a preliminary identification of measures that can help reduce vulnerability to climate variability and change. Much follow on work will be needed, particularly involving a closer look at the water supply, sanitation and drainage, and health sectors.

1.3 Dar es Salaam: climatic hazards and urban poverty

Dar es Salaam is a city where urban poverty and climate variability – floods as well as drought - jointly create a situation of high vulnerability for the poor that affects crucial aspects of their lives, e.g., health, sanitation and access to clean water, and safety of housing and property.

Tanzania's largest city, with over 4 million inhabitants, Dar es Salaam is characterized by urban sprawl and expanding informal settlements, resulting from increasing population pressure, poor infrastructure and inadequate town planning. About 70 percent of the city's population lives in poor, unplanned settlements, of which 50 percent lives on an average income of about US$1 per day. Residents are usually too poor to pay for services or infrastructure, and health and environmental conditions are generally extremely poor.

Heavy rainfall frequently causes flooding in the city, particularly in unplanned settlements, which tend to be located in high-risk flood areas. Apart from the loss of property that floods often bring, and occasional loss of life, heavy rains pose widespread health risks for poor residents by causing pit latrines to overflow due to the high water table, and sewers and drains to overflow due to improper waste disposal practices. This creates breeding grounds for disease vectors and contaminates wells and springs so that

water is unsafe for household use. Malaria, lymphatic filariasis, and diarrhea are common in unplanned settlements, and other diseases are also found.

Tanzania – and Dar es Salaam – also experiences droughts; a particularly severe episode occurred in 2006. Drought affects the city's poor by reducing the availability of clean water, and causing food scarcity and higher food prices. This leads to disease and malnutrition. Also, the city's electricity generation is heavily dependent on hydropower, and electricity cuts during times of drought adversely affect the poor's wellbeing directly (domestic electricity use) and by affecting livelihood-generating activities.

An important projected aspect of climate change is an increase in climatic variability, which would result in more frequent and/or severe floods and droughts in the city. Given that the city's poor are unable to cope adequately with current variability, their situation is likely to worsen in the future, unless steps are taken to ensure that urban development and poverty reduction programs specifically take into account the prospect of changing climatic conditions. Infrastructure development programs and urban planning schemes, municipal services provision, and poverty reduction programs (including safety nets and health services) need to not only better integrate disaster risk management approaches, but also to consider that the trends are changing.

Average temperatures in Dar es Salaam have risen over the past few decades (mean maximum and mean minimum) and are projected to rise over coming years. Combined with heavier rainfall, this may raise humidity levels, with implications for health and environmental conditions in unplanned settlements.

Various initiatives have been taken over the past several decades to address the challenges posed to urban development in Dar es Salaam, but many of these have failed due to poor leadership, lack of a long-term approach, weak institutional capacity, absence of enforcement of laws and regulations, the very high rate of urban growth, and resource constraints.

This case study aims at providing an overview of the main issues, and is a first step towards identifying institutional constraints and good practice examples that can be built upon. It aims at providing policy recommendations and suggesting areas where detailed follow-up work is needed.

Seventy percent of Dar es Salaam's population lives in unplanned settlements, and over half of them live on an average income of $1 a day. These settlements lack adequate infrastructure and services, and are highly prone to adverse impacts of frequent flooding. Poor solid waste disposal and sanitation practices, combined with rainfall, result in contamination of water and spread of disease. Climate change will exacerbate these issues in the absence of sound, forward-looking planning measures.

1.4 Study methodology

Study Partners

This case study is a joint effort involving the following partners:

- *Institute of Resource Assessment, at University of Dar es Salaam*: background research and review of literature, interviews of households and institutional representatives, and on-site visits to flood-prone areas, report-writing
- *Ardhi University*: 2-dimensional flood modeling
- *Tanzania Meteorological Agency (TMA)*: provision of data on current climatic trends for Dar es Salaam, and projected future climate
- *International START Secretariat:* editing, coordination, report-writing
- *Support from Dar es Salaam City Council, consultation with NGOs and building on work from UNDP*
- *WBI:* guidance and feedback

Methodology

This case study was developed using the following 5 approaches:

Literature review

Preliminary research was done by examining available published information on Dar es Salaam's demographics, access to infrastructure and basic services, and climatic trends and projections. Gathering in-depth information on proposed policies and programs for the city, however, particularly those of relevance for the urban poor, proved very difficult. Obtaining meteorological data of high relevance to the study, e.g., in-depth analysis of rainfall intensity, was also difficult, suggesting capacity issues as well as resource and time constraints.

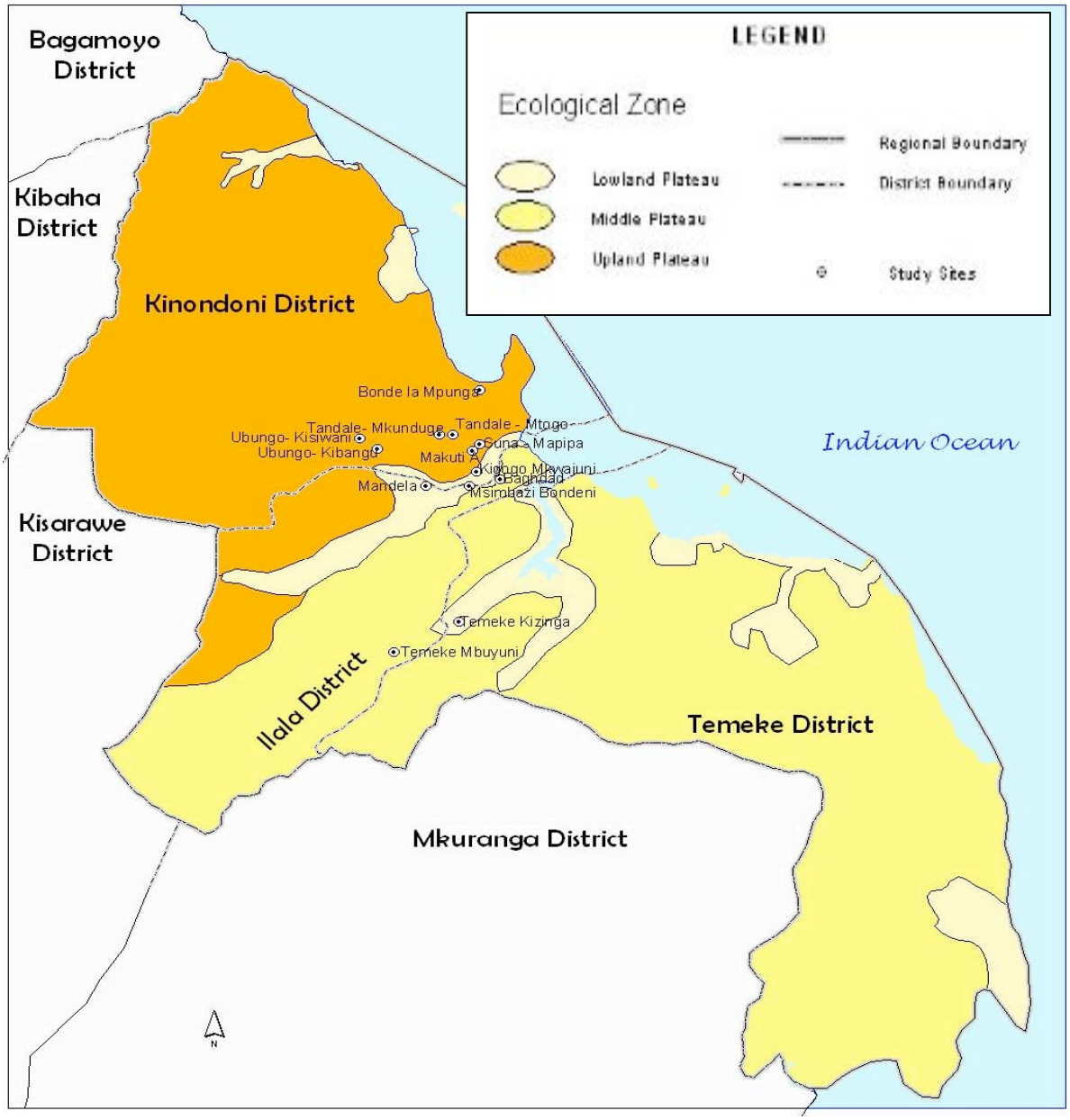
Household level socio-economic surveys

The surveys were designed to elicit information on populations living in flood-risk areas (see Annexes 1(a)-(e)) and contained questions on demographics; housing; household expenditure patterns; livelihoods; water sources, consumption and quality; disease prevalence; sanitation practices; energy use patterns; and knowledge and perceptions of climate risk and change. The study team supplemented the household interviews with on-site observations and inspection of surroundings, as well as focus group discussions with residents. Thirteen residential areas were studied, primarily in flood-prone areas (see Table 1). A total of 543 households were sampled.

For the sake of comparison, a few households from adjacent not-at-risk areas were also interviewed. These included (i) Kibangu area in the Makuburi Ward, which is a raised hilly area adjacent to Ubungo Kisiwani, a floodprone area along the Ubungo River system, and (ii) Makuti A (hilly and non-floodprone), for the Suna study area (Suna is in the lowland in Msimbazi Valley and receives wastewater from the Ubungo and Msimbazi Rivers).

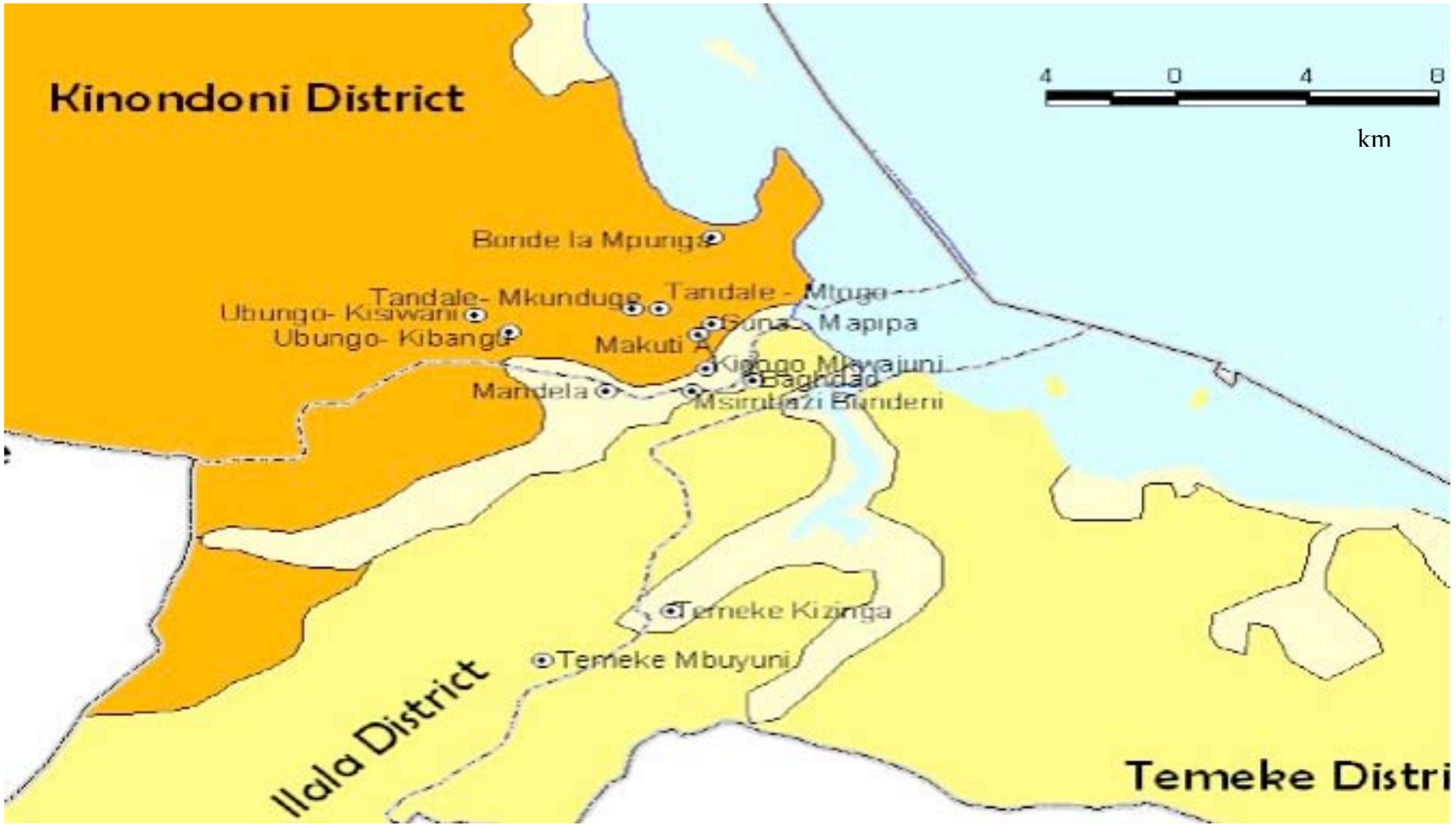
Figure 1(a) shows Dar es Salaam's districts and major topographical zones. Figure 1(b) is a closer look at this same map that shows the study areas.

Fig. 1(a): Map of Dar es Salaam municipal districts



Source: Institute of Resource Assessment Cartography Unit, Univ. of Dar es Salaam (2010)

Fig. 1(b): Map of Dar es Salaam case study areas



For each location, the area leader was asked to convene a meeting of individuals to share and discuss the information collected, analyze problems identified by households and other groups during the interviews, and jointly work out possible mitigation and adaptation measures.

All interviews and on-site visits were conducted by the study team based at the Institute of Resource Assessment at University of Dar es Salaam.

Table 1: Study areas covered by household surveys

No.	Study Area	District	River system	No. of households visited	Category: Flood risk /Control area
1	Suna (Magomeni Mapipa Jangwani Valley adjacent Muhimbili & Hannanasif)	Kinondoni	Ubungo-Ng'ombe	44	Flood risk
2	Msasani Bonde la Mpunga	Kinondoni	Sinza	41	Flood risk
3	Tandale Mtogole	Kinondoni	Ubungo-Ng'ombe	42	Flood risk
4	Tandale Mkunduge	Kinondoni	Ubungo-Ng'ombe	43	Flood risk
5	Ubungo Kisiwani	Kinondoni	Ubungo	41	Flood risk
6	Ubungo Kibangu	Kinondoni	Ubungo	42	Control area
7	Makuti A	Kinondoni	Ubungo	44	Control area
8	Mandela	Ilala	Msimbazi	43	Flood risk
9	Kigogo Mkwajuni	Ilala	Msimbazi and Ubungo-Kibangu	45	Flood risk
10	Ilala Quarters/Baghdad (near Yanga HQ)	Ilala	Msimbazi	34	Flood risk
11	Msimbazi Valley (Msimbazi Bondeni-down Msimbazi RC church mchicha valley)	Ilala	Msimbazi	35	Flood risk
12	Temeke Mbuyuni	Temeke	Kizinga	46	Flood risk
13	Temeke Kizinga	Temeke	Kizinga	43	Flood risk
Total				**543**	

Source: Survey Team, IRA, University of Dar es Salaam (2010)

Interviews with relevant institutional representatives

After gathering data and responses from residents living in floodprone areas, the study team conducted institutional visits to (i) learn about measures being taken by authorities to improve the situation for residents of floodprone areas, and (ii) compare their responses with views expressed by residents. The visits sought also to gather information on how authorities deal with other aspects of climatic variability, how they are planning to consider climate change impacts in the city, the barriers/obstacles they face, and any success stories and lessons learned in the process.

Municipal officials were interviewed from the Dar es Salaam City Council, including the City Drainage Engineer, the Waste Management Officer, and staff from the City Infrastructural Upgrading Programme (CIUP). Officials interviewed from the Municipal Councils included the CIUP coordinators, Community Development Officers, Environmental Management Officers, and Planning and Health Officers. Interviewees discussed ongoing and planned future CIUP efforts in solid waste management and carbon trade. Annex 2 provides information on the administrative structure of Dar es Salaam, i.e., how the City Council and Municipals relate to each other.

In addition to Government representatives, members of community-based organizations (CBOs) and non-government organizations (NGOs) were interviewed, as were members of the *Mtaa*[1] (sub-ward) administration, some of whom participated in the *Mtaa* level focus group discussions. Annex 3 provides a full list of people interviewed and their departmental/institutional affiliations.

Flood modeling exercise

A flood modeling exercise was undertaken by Ardhi University to map potential changes in rainfall regime and sea level rise on the flood extent and depth in the at-risk areas that were covered in the socio-economic surveys. A combined 1D-2D hydrodynamic model known as SOBEK was used (developed by Delft Hydraulics Software). The flood propagation model required spatial data (including a digital elevation model (DEM) and surface roughness estimates) and temporal data (such as initial water level, and downstream and upstream boundary conditions).

2 Geophysical and Climatic Background of Dar es Salaam

2.1 Geographical Location and Geophysical Characteristics

Dar es Salaam is located in the eastern part of the Tanzanian mainland at $6^{o}51'$S latitude and $39^{o}18'$E longitude. With an area of 1,350 km^2, it occupies 0.19 percent of the Tanzanian mainland, stretching about 100 km between the Mpiji River to the North and beyond the Mzinga River in the South. The Indian Ocean borders it to the East.

The beach and shoreline comprise sand dunes and tidal swamps. Coastal plains composed of limestone extend 10 km to the west of the city, 2-8 km to the north, and 5-8 km to the south. Inland, alluvial plains comprise a series of steep-sided U-shaped valleys. The upland plateau comprises the dissected Pugu Hills, 100-200 m in altitude. Dominated by limestones, sandy clays, coarse sands and mixed alluvial deposits, the soils of the Dar es Salaam region are not particularly fertile (Dongus, 2000).

The City is divided into three ecological zones, namely the upland zone comprising hilly areas to the west and north of the City, the middle plateau, and the lowlands, which include Msimbazi Valley, Jangwani, Mtoni, Africana and Ununio areas. Figure 1(a)

[1] *Mtaa* is the word for sub-ward; Dar es Salaam's administrative structure has four levels: city, municipality, ward and sub-ward.

displays the major zones. Natural vegetation mainly includes coastal palm groves, coastal shrubs, Miombo woodland, coastal swamps, and swampy mangrove trees and reeds. Prolonged human interference has reduced the diversity of woodland and scrub.

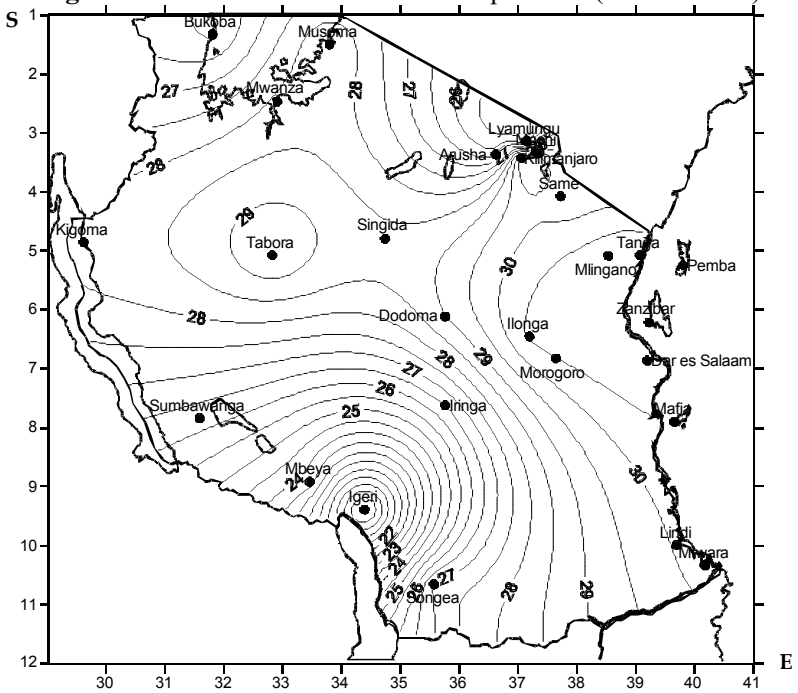
2.2 Climate

2.2.1 Climate overview

Dar es Salaam is a coastal city. It receives over 1,000 mm of rainfall per year and has a bimodal rainfall distribution, the two main rain seasons being the long rains and the short rains, associated with southward and northwards movements respectively of the Inter-Tropical Convergence Zone (ITCZ). The long rains season (*Masika*) occurs from mid March to end May, and the short rains (*Vuli*) from mid October to late December. Although June to September is typically a dry season for most parts of the country, coastal areas tend to receive a small amount of rainfall over this period. Rainfall in Tanzania is influenced by the southeast monsoon winds (May–September), the northeast monsoons (October–March), El-Nino Southern Oscillation (ENSO), tropical cyclones, easterly waves and the Congo air mass. Land and sea breezes along the Indian Ocean coast play a large role in modifying the spatial and temporal distribution of rainfall over coastal regions such as Dar es Salaam, Zanzibar, Pemba and Tanga.

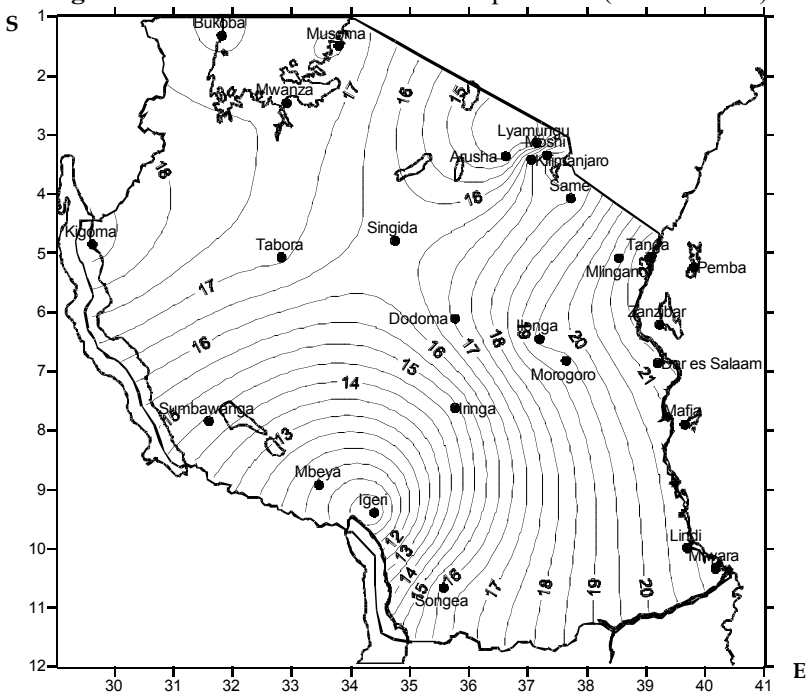
Dar es Salaam and Zanzibar have a mean annual maximum temperature of 30.8°C (Figure 2), and a mean annual minimum temperature of 21.3°C (Figure 3). The mean diurnal temperature range is 9.2°C, which is smaller than in inland areas.

Figure 2: Mean annual maximum temperature (1971 – 2000)



Source: Matari et al. (2008)

Figure 3: Mean annual minimum temperature (1971 – 2000)

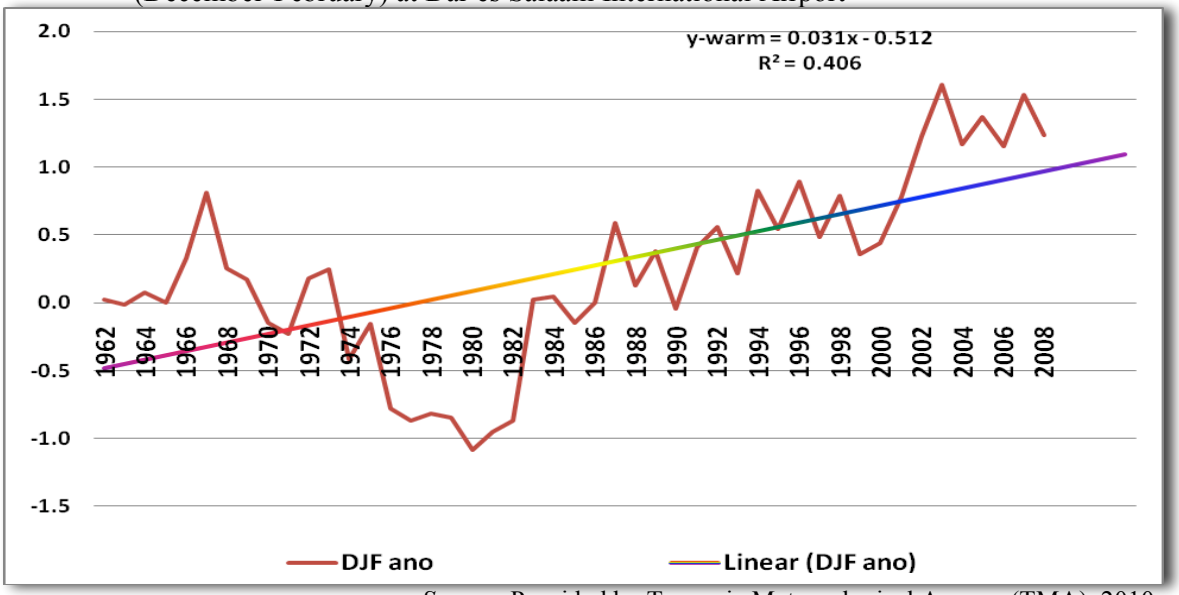


Source: Matari et al. (2008)

2.2.2 Temperature

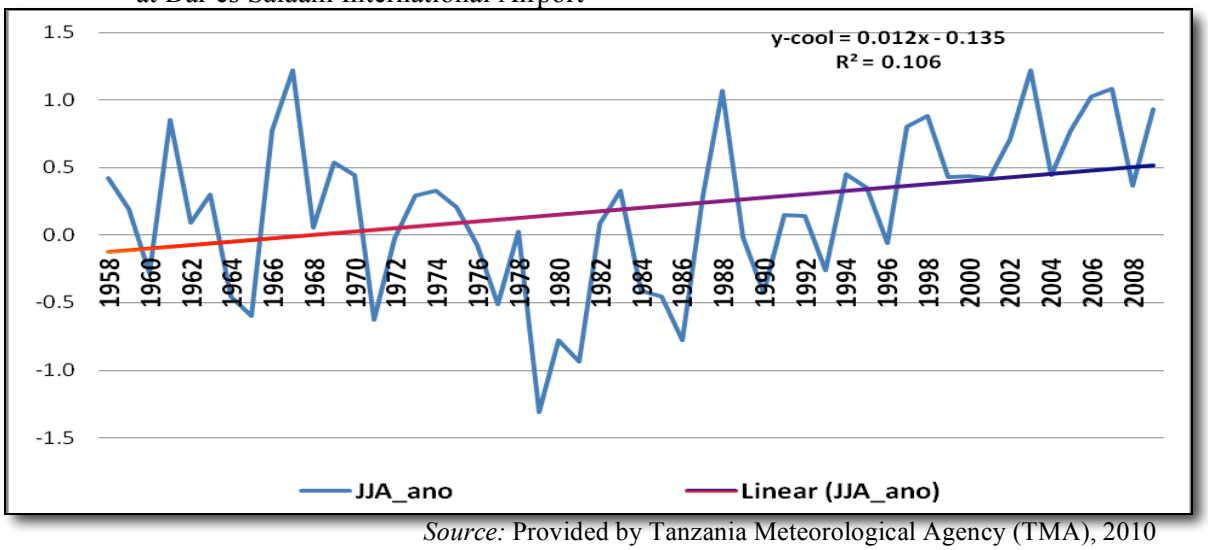
Analysis of both maximum (Figure 4) and minimum (Figure 5) temperatures at Dar es Salaam International Airport indicate significant positive trends over the past 4-5 decades.

Figure 4: Trend of mean maximum temperature anomalies during the warmest months (December-February) at Dar es Salaam International Airport



Source: Provided by Tanzania Meteorological Agency (TMA), 2010

Figure 5: Trend of mean minimum temperature anomalies during the cool months (June-August) at Dar es Salaam International Airport



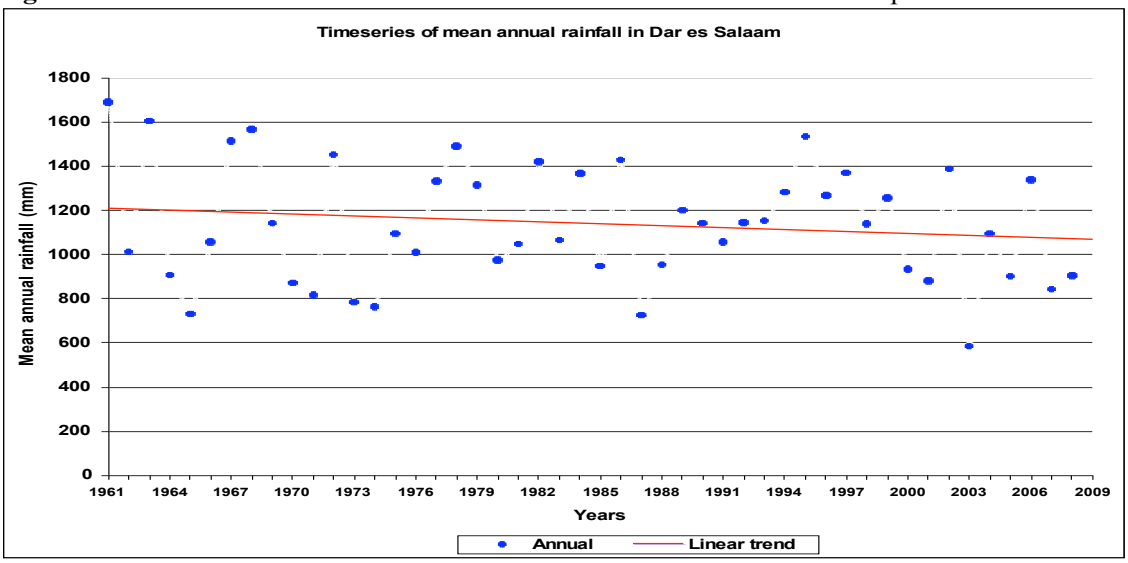
Source: Provided by Tanzania Meteorological Agency (TMA), 2010

2.2.3 Rainfall

Rainfall amount

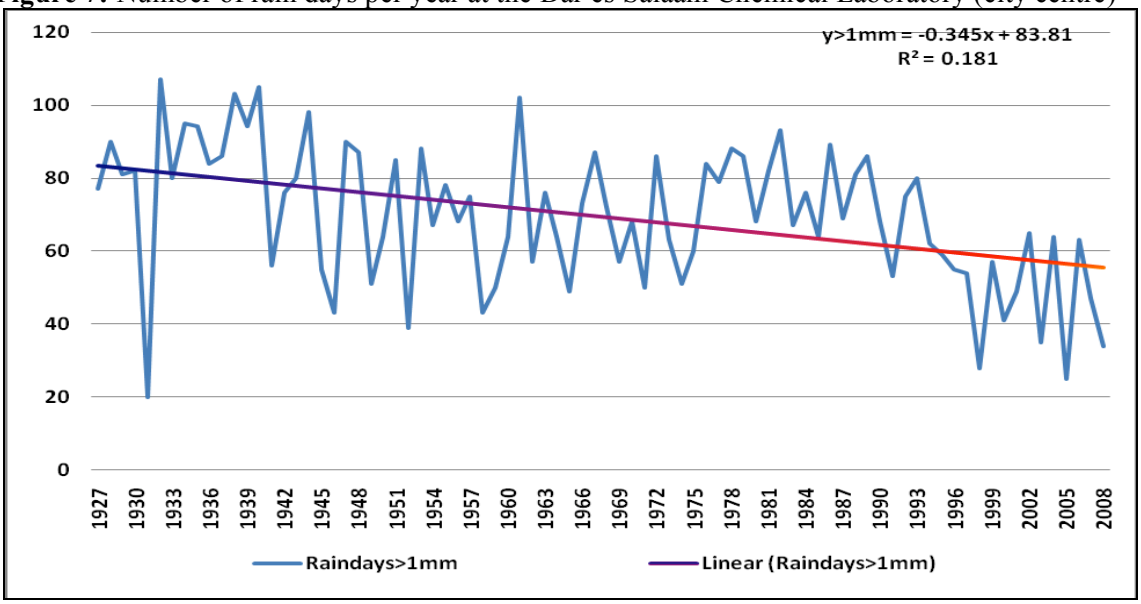
Figure 6 indicates that mean annual rainfall has declined in Dar es Salaam over the past five decades (as recorded at the Dar es Salaam Airport station). Figures 7 through 10 display the number of rain days for various locations in Dar es Salaam, and a declining trend may be seen at all four locations.

Figure 6: Trend of mean annual rainfall for Dar es Salaam International Airport station



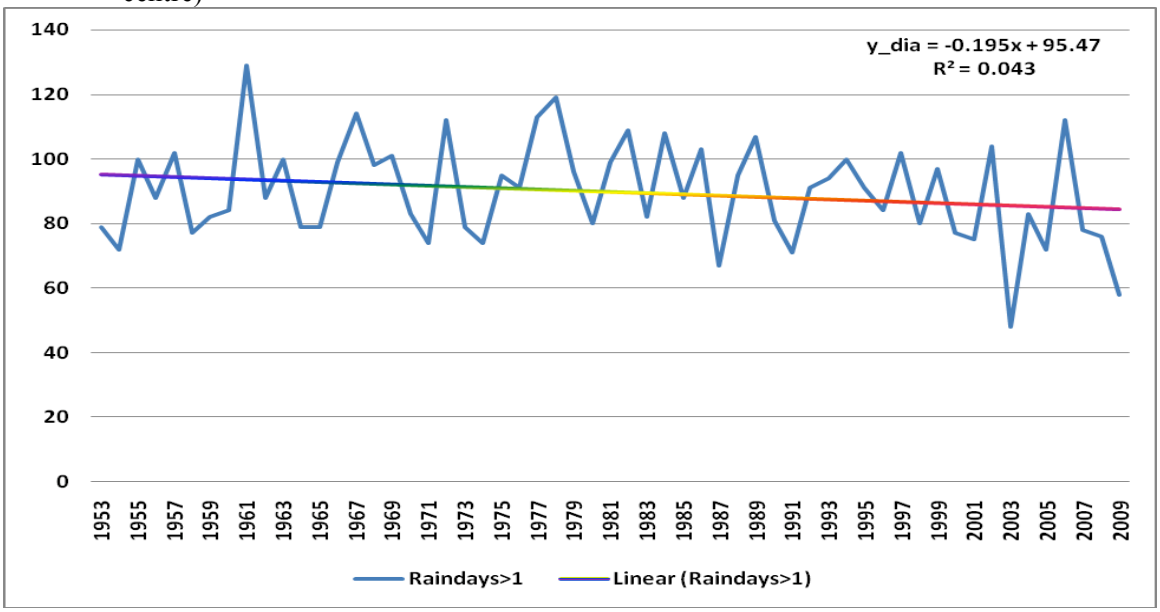
Source: Provided by Tanzania Meteorological Agency (TMA), 2010

Figure 7: Number of rain days per year at the Dar es Salaam Chemical Laboratory (city centre)



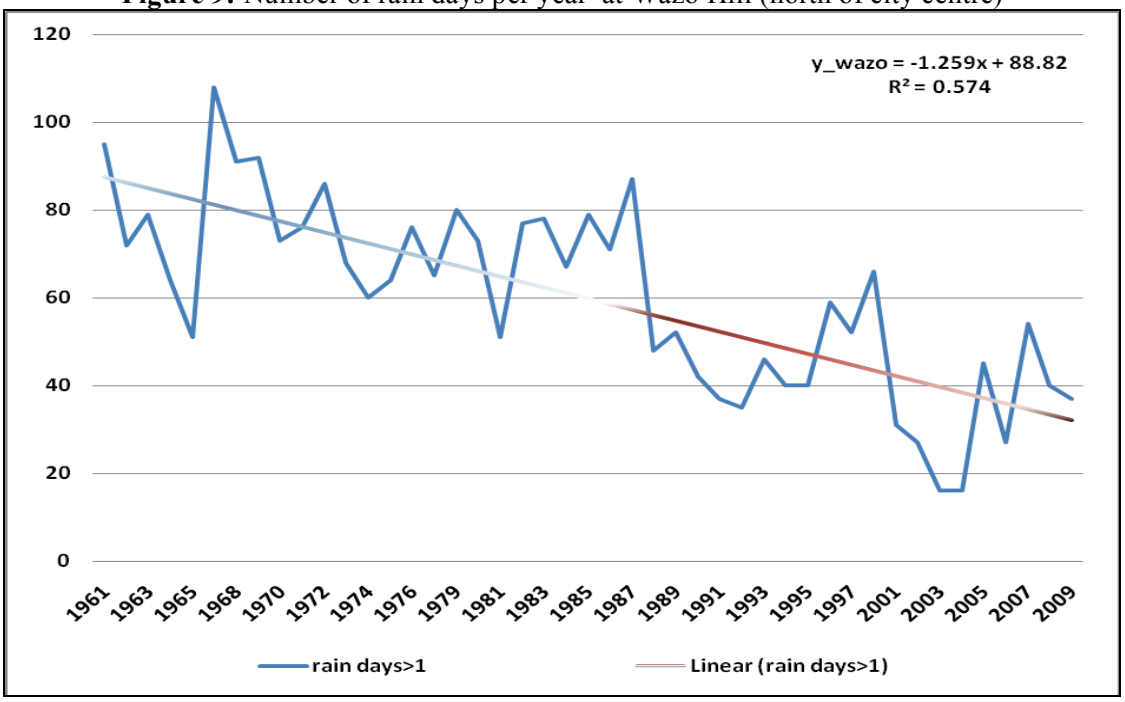
Source: Provided by Tanzania Meteorological Agency (TMA), 2010

Figure 8: Number of rain days per year at the Dar es Salaam International Airport (south of city centre)



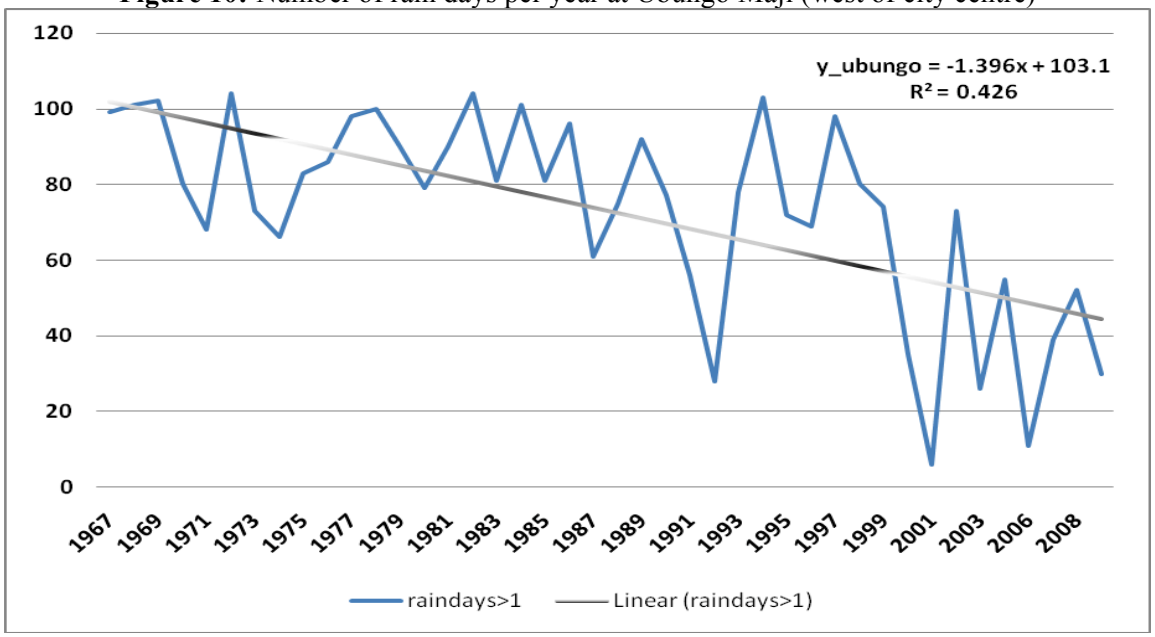
Source: Provided by Tanzania Meteorological Agency (TMA), 2010

Figure 9: Number of rain days per year at Wazo Hill (north of city centre)



Source: Provided by Tanzania Meteorological Agency (TMA), 2010

Figure 10: Number of rain days per year at Ubungo Maji (west of city centre)

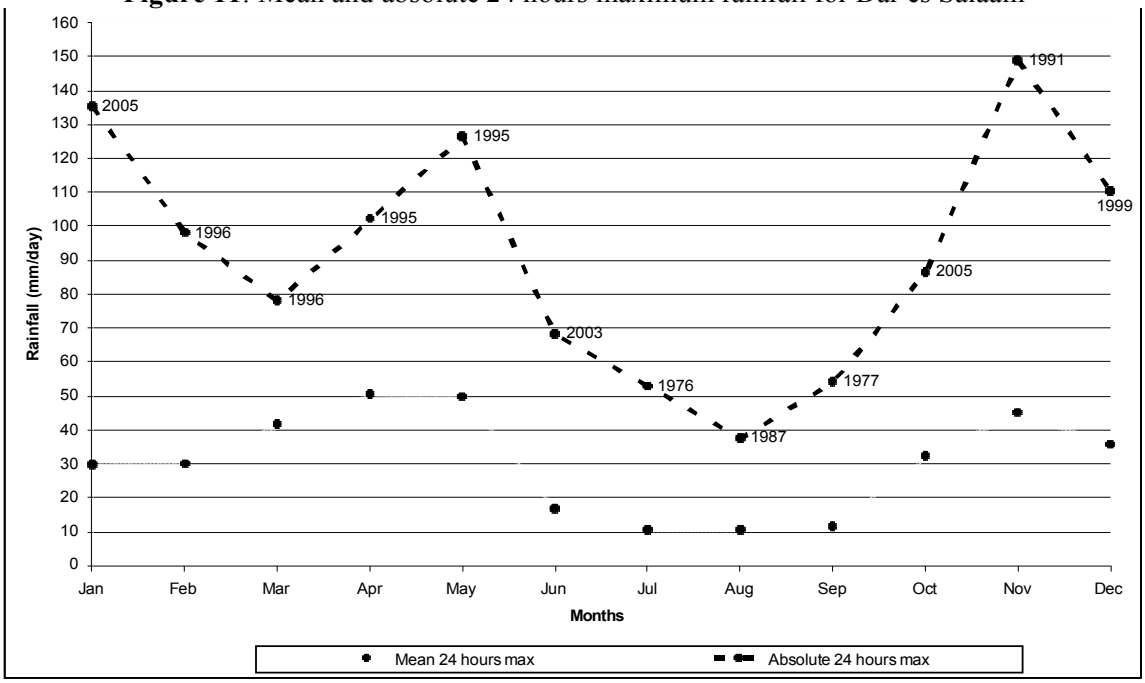


Source: Provided by Tanzania Meteorological Agency (TMA), 2010

Rainfall intensity

Figure 11 shows mean and absolute 24-hour maximum rainfall for the period 1971–2009. Mean 24-hour maximum rainfall ranges from over 50 mm in April-May to 10mm for July-August. The absolute 24-hour maximum rainfall for the time period studied was recorded within the past decade.

Figure 11: Mean and absolute 24 hours maximum rainfall for Dar es Salaam



Source: Provided by Tanzania Meteorological Agency (TMA), 2010

Both rainfall amount and intensity are variables of concern from the point of view of flooding in Dar es Salaam. Intensity is likely to increase as climatic variability rises in coming years with the progression of climate change.

2.2.4 Flooding

A brief analysis of rainfall corresponding to recent significant floods experienced in Dar es Salaam is provided in Table 2. Many of these were associated with strong El Niño episodes. Thus improved forecasting of El Niño and improved public warning systems could play a role in reducing damages in the future.

Table 2: Information on significant floods in Dar es Salaam, 1983-2006

No.	Year	Months	Monthly rainfall			Remarks
			Longterm mean (mm)	Actual (mm)	Percentage of longterm mean	
1	1983	May	197.8	405.6	**205**	The rain was enhanced by El Niño.
2	1989	December	117.8	175.6	**149**	Tropical cyclone Albera was largely responsible for the heavy rain.
3	1995	May	197.8	374.2	**189**	There was continuous rainfall for at least two days during the March–May rain season.
4	1997	October	69.3	250.8	**361**	The rain was associated with a strong El Niño episode.
		November	125.9	152	**121**	
		December	117.8	231	**196**	
5	1998	January	76.3	107.3	**141**	The rain was associated with strong El Niño episode.
		February	54.9	123.7	**225**	
		March	138.1	155.2	**112**	
		April	254.2	319.9	**126**	
6	2002	April	254.2	569.4	**224**	The rain was enhanced by El Niño.
7	2006	November	125.9	240.9	**191**	The rain was enhanced by El Niño.
		December	117.8	230.4	**196**	

Source: Provided by Tanzania Meteorological Agency (TMA), 2010

A recent study by Watkiss et al. (2011) shows that currently 140,000 people in Dar es Salaam are below the elevation map's 10 m contour line, and over 30,000 are considered at risk. Measures to gauge and convey risk to the public in advance of flood events are thus of critical importance in helping people to prepare for them. The Tanzania Meteorological Agency undertakes these tasks, providing both near term (24 hour) and seasonal forecasts and warnings (see Box 1).

Box 1: Flood Early Warning Systems in Dar es Salaam

The Tanzania Meteorological Agency (TMA) issues flood warnings for Dar es Salaam. It provides warnings and advisories on extreme rainfall and flooding based on daily weather monitoring. Cloud evolution is monitored through observations and by using satellite pictures. The evolution and pathway of tropical cyclones along the Western Indian Ocean are also monitored on a real time basis

Warnings and advisories are disseminated to the public as needed, through various stakeholders such as the mass media and the disaster management department at the Prime Minister's Office. Flood warnings and advisories are given up to a day in advance (24 hour forecast) or at seasonal timescales (up to two months in advance).

Source: Provided by Tanzania Meteorological Agency (TMA), 2010

It should be stressed, however, that flooding in Dar es Salaam's unplanned settlements is also largely a function of inadequately maintained storm drains and poor waste disposal practices, and not just extreme rainfall. In fact, in the study team observed that some settlements in Msimbazi Valley tended to flood even in the absence of rainfall in the city

or upstream zones, due to clogging and structural interferences along the course of the Msimbazi River.

2.2.4 Droughts

From time to time, Tanzania[2] experiences prolonged droughts with severe socio-economic implications. The drought of 2006 damaged agricultural production, necessitated electricity cuts (and thus industrial production) and cut GDP growth by 1 percent (ClimateWorks Foundation et al., 2009). A number of diseases are related to drought in the country: malnutrition, trachoma, dysentery, cholera, and diarrhea (*ibid.*).

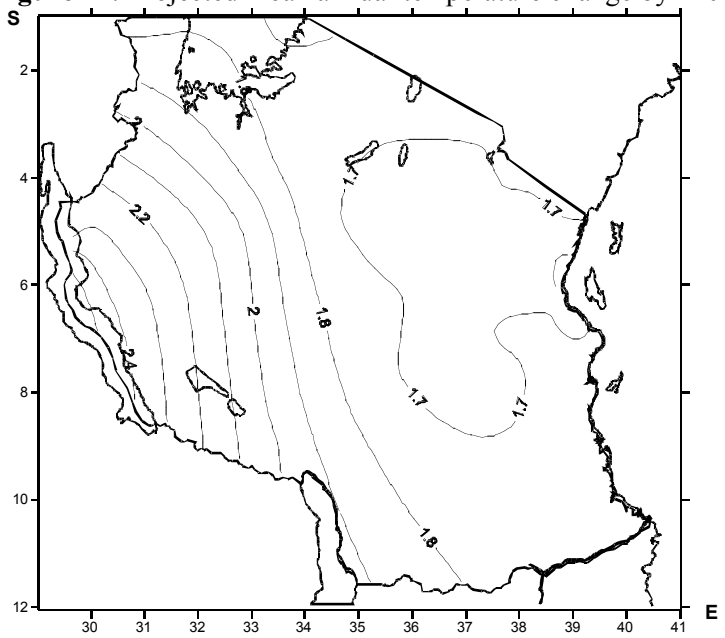
2.2.5 Climate change projections for Tanzania

Temperature

By 2100, mean annual temperature for Tanzania is expected to increase by 1.7°C over the northern coast, including areas around Dar es Salaam (Matari et al., 2008)[3], shown in Figure 12. Figure 13 shows CSAG's[4] analysis of projected change in monthly mean maximum temperature for Dar es Salaam by the 2050s. Depending on future rainfall regimes, these temperature increases could have wide-ranging effects, such as on urban agriculture (evapotranspiration, heat stress), disease incidence (direct effects of extreme heat on humans, as well as on disease vectors, e.g., by increasing humidity), hydropower generation (increased evaporation in reservoirs), household electricity requirements and a range of other factors of importance for the city's urban poor. Figure 13 indicates that temperature extremes will rise; Watkiss et al. (2011) looked at the projected increase in number of days exceeding 32°C in Dar es Salaam by 2050, and their results showed significantly increased exceedances, which would affect health as well as labor productivity in the city.

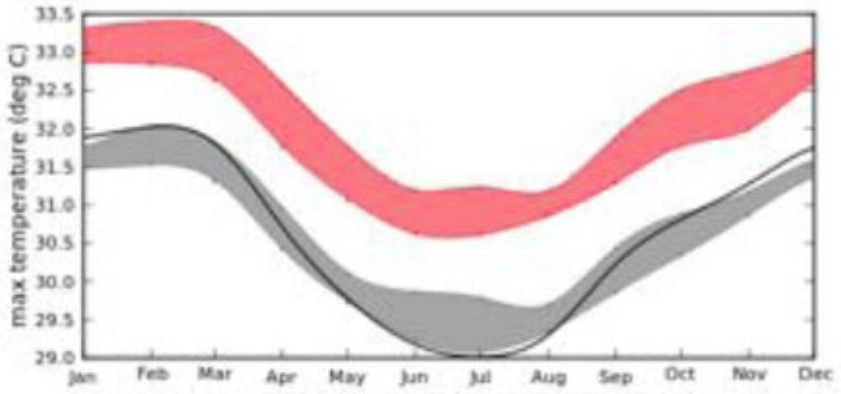
[2] It was not possible to obtain drought information for Dar es Salaam for this study.
[3] Matari et al. (2008) used the MAGICC/SCENGEN model to derive climate change projections for Tanzania for 2100, using five models and emissions scenario A1B.
[4] The analysis by CSAG (published in Watkiss et al., 2011) was conducted using CMIP3 Archive GCMs. Results are shown for the B1 emissions scenario.

Figure 12: Projected mean annual temperature change by 2100



Source: (Matari et al., 2008)

Figure 13: Projections of monthly mean maximum temperature for Dar es Salaam, 2046-2065 Scenario B1



(1961-2000) (2046-2065)

The black line represents the multi-model median. The grey envelope represents the envelope of climate model projections for 20th century period. The red envelope represents the future period (2046-2065).

Source: Watkiss et al. (2011)

Rainfall

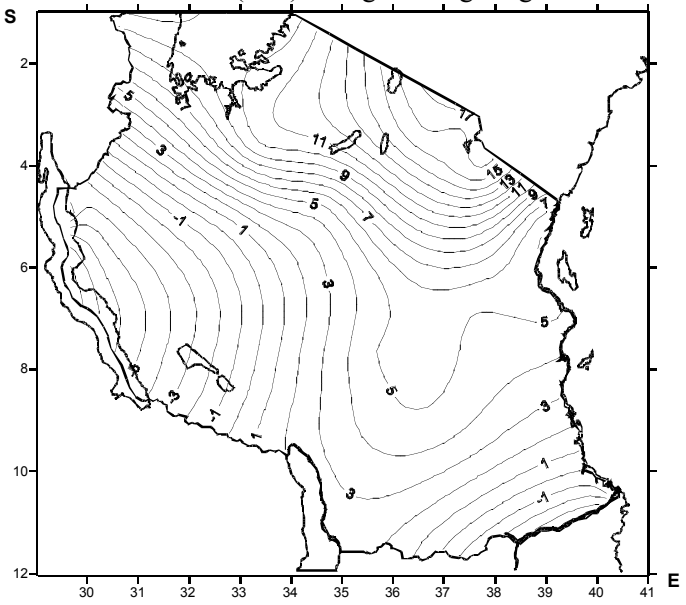
According to Matari et al. (2008), mean rainfall is projected to increase during the long-rain season over coastal areas, including Dar es Salaam, by up to 6 percent by 2100 (Figure 14). These results are also supported by two regional climate models[5], which

[5] The two regional climate models used include (i) PRECIS (Providing Regional Climates for Impact Studies), developed by UK Met Office, and (ii) CCLM (COSMO-CLM; COnsortium for Small scale MOdeling – ClimateLimited-areaModelling), maintained and developed by the COSMO Consortium.

indicate a slight increase in rainfall over the entire northern coast of Tanzania, including the Dar es Salaam region. According to Watkiss et al. (2011), however, it is unclear whether rainfall in Tanzania will increase or decrease with climate change, with some models projecting that precipitation may increase in the late summer, with some signs of drying in early summer. Figure 15 shows monthly precipitation projections to the 2050s for a B1 scenario.

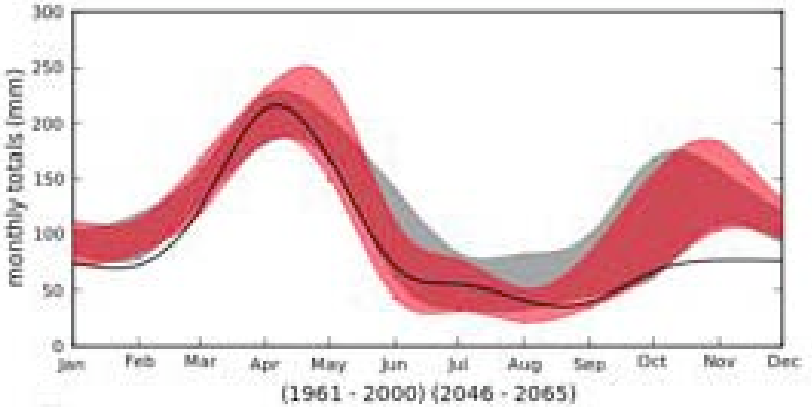
If annual rainfall does increase over coming years, the current observed declining trend in number of rainy days for Dar es Salaam over the past several decades (refer to Figures 7-10), should it continue into the future, indicates a potentially grim situation from the perspective of severe flooding in the city, as it suggests that rainfall intensity is rising. Increase in rainfall intensity is in agreement with general expectations that variability is increasing with climate change, and that both droughts and floods are likely to increase in magnitude and frequency.

Figure 14: Projected mean rainfall (mm) change during long rains season (March – May)



Source: (Matari et al., 2008)

Figure 15: Projections of monthly precipitation for Dar es Salaam, 2046-2065 Scenario B1



The black line represents the multi-model median. The grey envelope represents the envelope of climate model projections for 20th century period. The red envelope represents the future period (2046-2065).

Source: Watkiss et al. (2011)

Climate variability and extreme events

According to Watkiss et al. (2011), projections vary widely for Tanzania on extreme events; El Nino has been seen to have a large impact on inter-annual variability (with heavier rainfall associated with strong El Nino events), but it is not clear how climate change will affect the frequency and magnitude of El Niño events and thus their impact on Tanzania. However, Shongwe et al. (2009 in: Watkiss et al., 2011), upon examination of long-term trends, state that the intensity and frequency of extreme heavy rainfall may increase in the wet seasons, which would imply greater flood risk.

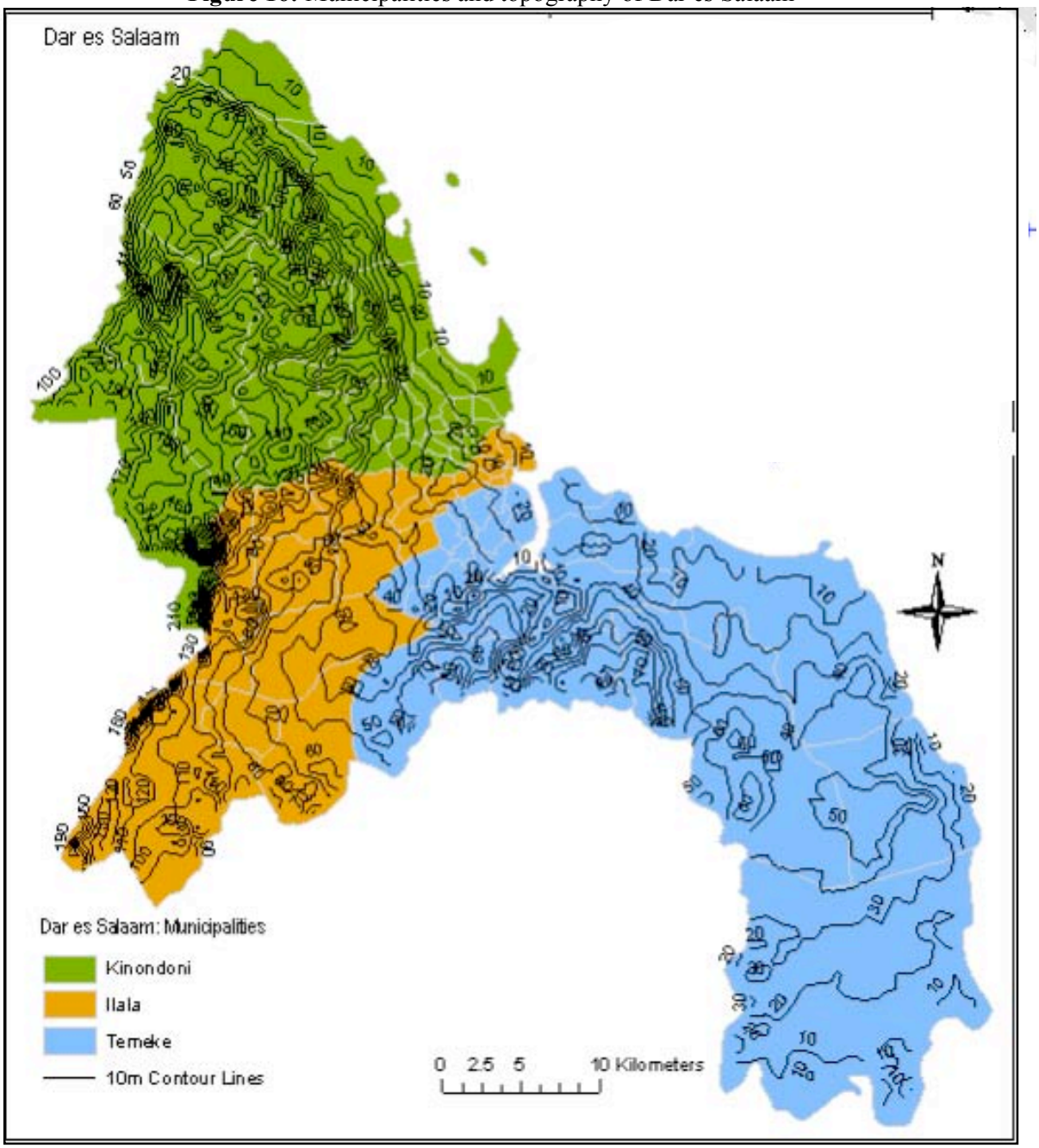
Impact on drought is uncertain (Watkiss et al., 2011) with some models predicting intensification with climate change and others a reduction in severity.

Sea level rise

Kebede and Nicholls (2010) have analyzed Dar es Salaam's vulnerability to sea level rise. They estimate that at present 8 percent of the city currently lies in a low elevation zone below the 10 m contour line (see Figure 16), inhabited by over 143,000 people, with associated economic assets estimated (in 2005) at US$168 million. Of these, over 30,000 people and US$35 million of assets are located in the 1 in 100 year floodplain. In the *absence* of climate change induced sea level rise, 60,000 people and US$219 million in assets are expected to be exposed to a 1 in 100 year flood by 2030. The results of their analysis, using various population growth rates and climate change scenarios, are summarized in Table 3, and reveal that the magnitude of socio-economic changes (rapid population growth, urbanization, spatial population distribution and associated economic growth) may be of greater import than sea-level rise in terms of overall increased exposure of population and assets to coastal flooding in Dar es Salaam (explanation of methodology for calculation of population and assets at risk is given in Annexes 4a and 4b). Figure 17 shows projected exposure of Dar es Salaam's population by municipality to a 1 in 100 year flood, in the absence of adaptation measures.

It is worth noting that mean sea level tide gauge measurements at Zanzibar (over 1984-2004) and Dar es Salaam (1986-1991) show a slight *declining* trend. Kebede and Nicholls (2010) caution, however, that records of short duration (<50 years), can be subject to bias due to interannual-to-decadal water level variability. However, if it is true that sea levels off the Tanzania coast are stable or falling, expected future rises will be slightly smaller than global mean changes (*ibid.*).

Figure 16: Municipalities and topography of Dar es Salaam



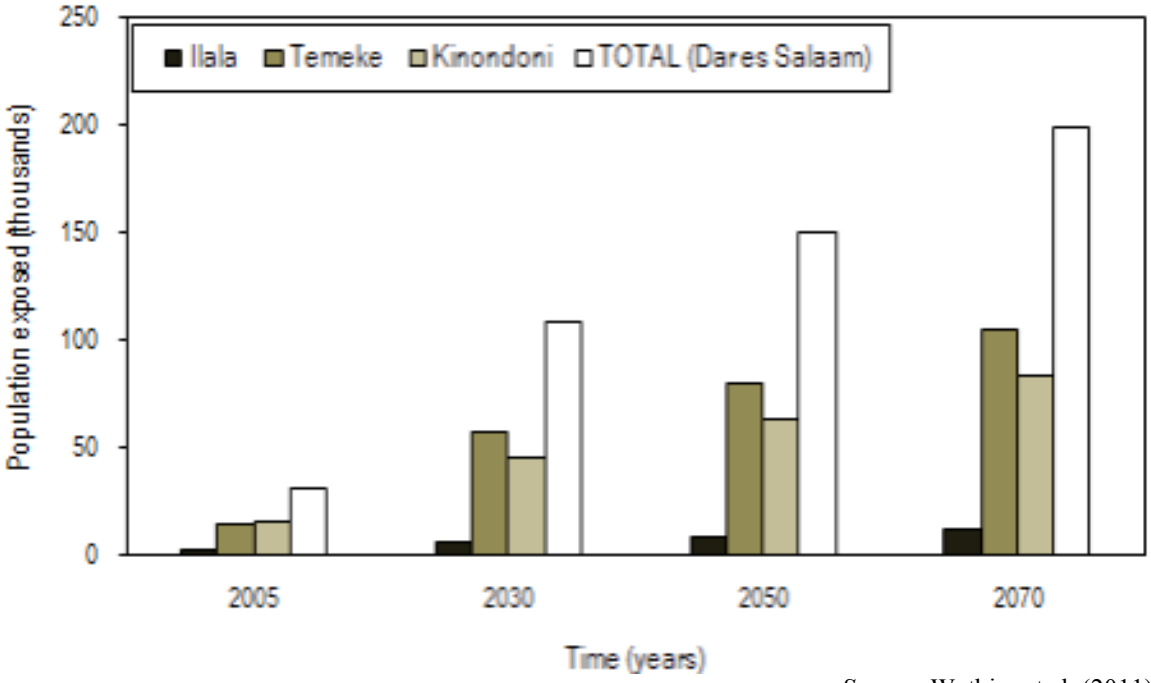
Source: Kebede and Nicholls (2010)

Table 3 Population and assets exposed to the 1 in 100 year return period extreme water levels in Dar es Salaam under the ranges of sea level rise scenarios

Year	Extreme Water Levels (m)	Population Exposed (thousands)			Assets Exposed (in US$ millions)		
		Population Growth Distribution Scenarios			Population Growth Distribution Scenarios		
		SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 1	SCENARIO 2	SCENARIO 3
No climate-induced SLR Scenario							
2005	3.06	30.1	30.1	30.1	35.4	35.4	35.4
2030	3.02	105.7	59.6	29.7	388.1	218.8	34.9
2050	2.99	140.6	79.1	28.7	1996.8	1123.3	33.7
2070	2.96	182.4	102.7	28.5	8434.4	4748.7	33.5
B1 low-range SLR Scenario							
2005	3.08	30.4	30.4	30.4	35.8	35.8	35.8
2030	3.07	106.8	60.8	30.3	392.4	223.1	35.6
2050	3.08	147.3	83.9	30.4	2092.4	1192.3	35.8
2070	3.09	193.1	110.5	30.7	8929.5	5112.0	36.1
A1B med-range SLR Scenario							
2005	3.09	30.7	30.7	30.7	36.1	36.1	36.1
2030	3.13	108.0	62.3	31.1	396.7	228.8	36.5
2050	3.19	150.2	87.7	31.8	2132.9	1245.7	37.4
2070	3.26	198.9	116.4	32.3	9197.7	5380.6	38.0
A1FI high-range SLR Scenario							
2005	3.12	31.1	31.1	31.1	36.5	36.5	36.5
2030	3.23	110.0	64.3	32.0	404.1	236.0	37.7
2050	3.38	155.7	91.5	33.2	2212.2	1299.9	39.0
2070	3.58	208.8	122.0	34.6	9658.0	5643.7	40.6
Rahmstorf SLR Scenario							
2005	3.11	31.0	31.0	31.0	36.5	36.5	36.5
2030	3.21	109.7	63.9	31.9	402.8	234.8	37.5
2050	3.37	155.5	91.3	33.1	2208.9	1297.1	39.0
2070	3.62	212.6	126.1	35.0	9831.1	5832.3	41.2

Note: The population growth scenarios used are: (i) Scenario 1: assuming uniform population growth per district weighted by 2005 population distribution (high scenario); (ii) Scenario 2: assuming uniform population growth per ward weighted by 2005 population distribution (medium scenario); and (iii) Scenario 3: a 'no population growth' scenario, assuming the population in all the city districts is kept to 2005 levels (low scenario).
Costs are provided in 2005 US$ and are not discounted.

Figure 17: Exposed population in Dar es Salaam in 2005, 2030, 2050 and 2070 to a 1 in 100 year flood event under the A1B mid-range SLR scenario, no adaptation



Source: Watkiss et al. (2011)

2.2.6 Implications of climate change for Dar es Salaam

As discussed in greater detail in Section 3, a large proportion of Dar es Salaam's population lives in informal, unplanned settlements and the majority of these residents are poor. Vulnerability to current climate conditions is high, and is a function of socio-economic factors (high population and overcrowding, poverty, malnutrition, exposure to disease), lack of adequate infrastructure and municipal services (e.g., waste removal, provision of clean water, access to working sanitation and drainage systems), poor hygienic practices, and climate variability (heavy rainfall, drought). Heavy rainfall frequently causes flooding in the settlements, and, among other problems, contributes to increased disease incidence. Drought, too, is associated with increased disease incidence in limiting the availability of clean water.

Given the city's current 'adaptation deficit'[6] and poor integration of disaster risk management approaches in urban planning, climate change is likely to exacerbate vulnerability over coming decades, particularly taken in conjunction with urban population growth and the increasing concentration of economic assets. Although future rainfall patterns are uncertain, variability is likely to increase and intensification of heavy rainfall is expected. Thus flooding may become an increasingly severe issue, particularly taken together with socio-economic projections, unless adaptation measures are implemented. Increases in mean temperature, combined with fewer rainy days per year, could also prolong the length of dry seasons or intensify droughts. Recent extreme

[6] I.e., its inability to cope adequately with existing conditions.

climatic events (e.g., the droughts of 2006 and 2008/2009, and the floods of 2009/2010) severely impacted sectors such as transport, energy and health, with adverse socio-economic implications.

Projected changes in climate will have significant impacts on Tanzania's rain-fed agriculture and food production (Matari et al., 2008; Mwandosya et al., 1999), and could thus impact on urban agriculture in Dar es Salaam, a means of livelihood and subsistence for the city's poor. Warming will shorten the growing season and, together with reduced rainfall, reduce water availability (Paavola, 2003).

Coastal degradation and salt-water intrusion are major problems for Dar es Salaam's coastal areas today, and under projected climate change and possible sea level rise, coastal ecosystems would be highly threatened (Watkiss et al., 2011), affecting the livelihoods and ecosystems services of coastal communities. Residents of coastal wetlands that have incurred saltwater intrusion (such as Suna, Mtoni Azimio, Msasani Bonde la Mpunga) informed the study team that they frequently need to repair their houses as salt-water intrusion is corroding the foundations and cement bricks are being eaten away.

In all, climate change will exacerbate problems experienced by Dar es Salaam's urban poor in areas such as health, living conditions, livelihoods and economic security. Urban development and poverty reduction policies and programs for the city need to be adjusted to not only better integrate disaster risk management approaches but to take a long-term perspective that takes climate change into account. At the same time, existing policies and regulations that can reduce the vulnerability of the poor need to be better enforced.

3 Dimensions of Urban Poverty in Dar es Salaam

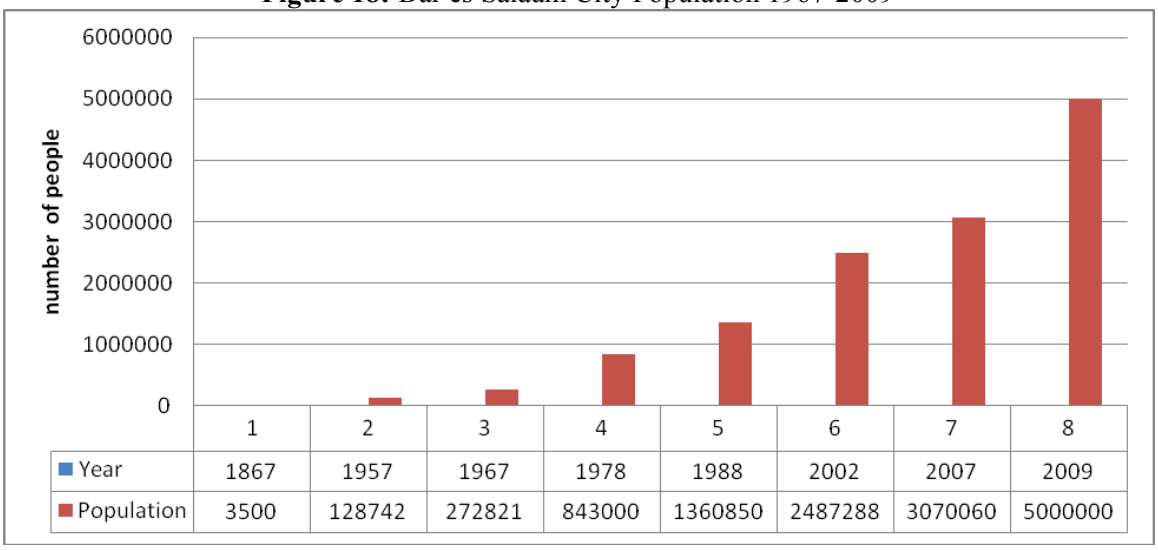
3.1 Overview: Population, poverty and settlement patterns

Size and growth

Dar es Salaam has a population of about 5 million (see Figure 18) that could reach up to 8 million by 2020 if present trends continue (Casmiri, 2009; DSM City Council, 2010). The city's population has been growing at the rapid rate of about 8 percent per annum (World Bank, 2002), a result of high in-migration from other areas and a birth rate of about 4.5 percent per annum. With population densities reaching 1,500 persons/hectare (on average, approximately 150 persons/hectare), it has a population about seven times the size of the next most populated city, Mwanza, and continues to attract the most migrants.

Incoming people move to Dar es Salaam in search of income-generating opportunities, education, and other subsidized or free public goods and services. Increasing levels of poverty, population growth and the lack of a sustainable housing policy, however, mean that much of this urban growth is often absorbed into informal settlements.

Figure 18: Dar es Salaam City Population 1967-2009



	1	2	3	4	5	6	7	8
Year	1867	1957	1967	1978	1988	2002	2007	2009
Population	3500	128742	272821	843000	1360850	2487288	3070060	5000000

Source: Casmiri (2009) and DSM City Council (2010)

The rise and expansion of informal settlements

An estimated 70 percent of Dar es Salaam's population lives in poor, unplanned settlements (World Bank, 2002). Residents are usually too poor to pay for services or infrastructure and authorities too resource-constrained to maintain these; thus, health and environmental conditions are generally extremely poor.

Tanzania's policy towards informal settlements in Dar es Salaam has varied over past decades (discussed in World Bank, 2002). In the 1960s, slum clearance was the main approach; slum sites were cleared and buildings with high construction standards were erected on cleared sites (implemented through the National Housing Corporation). This proved unsustainable, however, and was abandoned by the end of the 60s due to high economic and social costs, and having contributed little to the net housing stock.

In the 1970s and 1980s, the government's approach changed, and squatter area upgrading projects and service provision (supported by the World Bank) formed the national strategy for managing the growth of informal settlements. After World Bank funding for these projects ceased, however, the Government of Tanzania was unable to continue financing them, and subsequent years saw the growth and emergence of new unplanned settlements as well as deterioration of previously installed infrastructure, due to lack of maintenance (World Bank, 2002).

Poverty

About half the residents of Dar es Salaam's informal settlements live on an average income of US$1 per day (World Bank, 2002) and in constrained circumstances. Many are migrants from other parts of Tanzania in search of better opportunities; studies by Simler (2006) show that poverty rates for the country are lowest in Dar es Salaam, Arusha and Kilimanjaro. In a survey of three unplanned settlements, 79 percent of respondents were born outside the city, and 46 percent considered themselves poor or very poor (World

Bank, 2002). IFPRI (2006) also shows that child malnutrition tends to be lower in urban areas than rural ones (although absolute numbers of malnourished children is large in urban areas due to the higher population density). Life expectancy in Dar es Salaam's informal settlements is low, between 44-46 years, and infant mortality is high at about 97 deaths per 1000 live births (World Bank, 2002).

Access to clean water and sanitation are major problems for Dar es Salaam's poor, and, as discussed in more detail later in this Report, contribute to widespread illness, including cholera, malaria, lymphatic filariasis, and diarrhea, particularly during flood episodes, which could be more severe or frequent in future due to climate change.

Up to about 75 percent of the residents of Dar es Salaam's informal housing settlements are unemployed or under-employed (World Bank, 2002), with the main source of income for the latter group being through informal activities and micro-enterprise. Employment in Dar es Salaam as a whole declined from 64 percent to 42 percent between 1992 and 2000, and self-employment rose from 29 percent to 43 percent. Poverty for those in self-employment rose from 29 percent to 38 percent over the same period (*ibid.*).

The primary cooking fuel for the residents of informal communities is charcoal – the cheapest and most easily available option. Congested housing in these settlements, however, could mean that negative health effects of charcoal burning could be significant, particularly in poorly-ventilated areas, where respiratory illnesses are common. Alternative fuel and energy sources are available but currently too expensive for the poor to afford. Efforts to subsidize these for the poor would result in health benefits in urban settlements as well as global benefits in terms of greenhouse gas emissions reductions.

3.2 Urban infrastructure

The public and private sector have been unable to keep pace with population growth in the city. As a result, urban development is hindered by low management capacity and inadequate institutional arrangements, and demand for infrastructure and urban services is not being met (World Bank, 2002), least of all in informal settlements, with adverse implications for urban poverty.

3.2.1 Roads

The city's road network totals about 1,950 km in length, of which 1120 km (less than 60 percent) is paved, and is inadequate to satisfy its population density, spatial expansion and transportation needs. Dar es Salaam hosts about 52 percent of Tanzania's vehicles, and has a traffic density growth rate of over 6.3 percent per year (JICA, 1995; Kanyama et al., 2004). Roads generally do not have walkways or bicycle-ways, resulting in non-segregation of traffic.

Most people depend on public transportation, particularly *daladalas* – variously sized minibuses and minivans – though these are skewed in favor of the more affluent, as they

tend to focus on the most profitable lines (Olvera et al., 2002). The public transport system suffers from congestion and delays, poor vehicle condition and excessive gaseous emissions, an increasing number of road accidents, bus fares that are insufficient to cover operating costs, poor customer services, and uncomfortable traveling conditions.

Rapid urbanization is a leading cause for the poor state of the city's public transportation. As population continues to increase and urban sprawl expands, more people travel to and from urban centers, often over longer distances. The limited capacity of existing transport infrastructure is stretched to the limit, resulting in poor social, economic and environmental performance (Kanyama et al., 2004). The situation is particularly limiting for Dar es Salaam's poorest residents in unplanned wards; Howe and Bryceson (2000) found that almost 81 percent of unplanned residential areas in Dar es Salaam have poor access to public transportation, especially buses.

Climatic factors greatly exacerbate existing constraints to roads and transportation in Dar es Salaam. Although most roads are poorly maintained and have poor surface conditions, these "can even become impossible during the rainy season, when the increasing number and depth of holes can completely block vehicles" (Olvera et al., 2002: 88). Daily trips on foot can also become much more difficult during rains, when people are cut off from their neighborhoods if bridges or roads collapse (*ibid.*). Access problems are particularly serious in squatter settlements, where, most often, access roads were not planned from the start (*ibid.*) Increases in rainfall intensity, which are expected to occur with climate change, provide additional imperative for the need to address transportation issues.

3.2.2 Drainage

Poor drainage is a major contributor to flooding episodes in the city's unplanned settlements and to disease, environmental degradation, and degradation of roads and pavements. The city has a total of about 1100 km of open lined ditches and 600 km of piped stormwater drainage, but lack of regular maintenance, illegal construction of additional structures, and residents' practice of dumping refuse into the drains has led to deterioration of drain function. In informal settlements, alleyways are often too narrow to enable waste collection trucks to enter; thus, waste disposal is a major problem and it is often dumped into ditches and drains, or alongside drainage channels, obstructing flow.

The existing drainage system fails to serve the needs of the poor given current rainfall conditions; the prospect of an increase in rainfall intensity with climate change in coming decades makes a pressing case for the need to not only rehabilitate and maintain existing city drainage infrastructure and enforce laws that prohibit dumping solid waste into drains, but plan improvements and expansion with greater flexibility built into the design (i.e., ability to handle larger volumes of stormwater).

3.2.3 Physical access to services

Access to services such as schools and health facilities are also constrained in informal settlements, in large part due to physical issues associated with poor road access and

quality. Olvera et al. (2002) state that the "unequal access to transportation networks is all the more critical in that it is combined with a more or less pronounced lack of services" in various areas (p.89), with the poor road connections in unplanned settlements being the cause of greater distances to main schools and health services. They state:

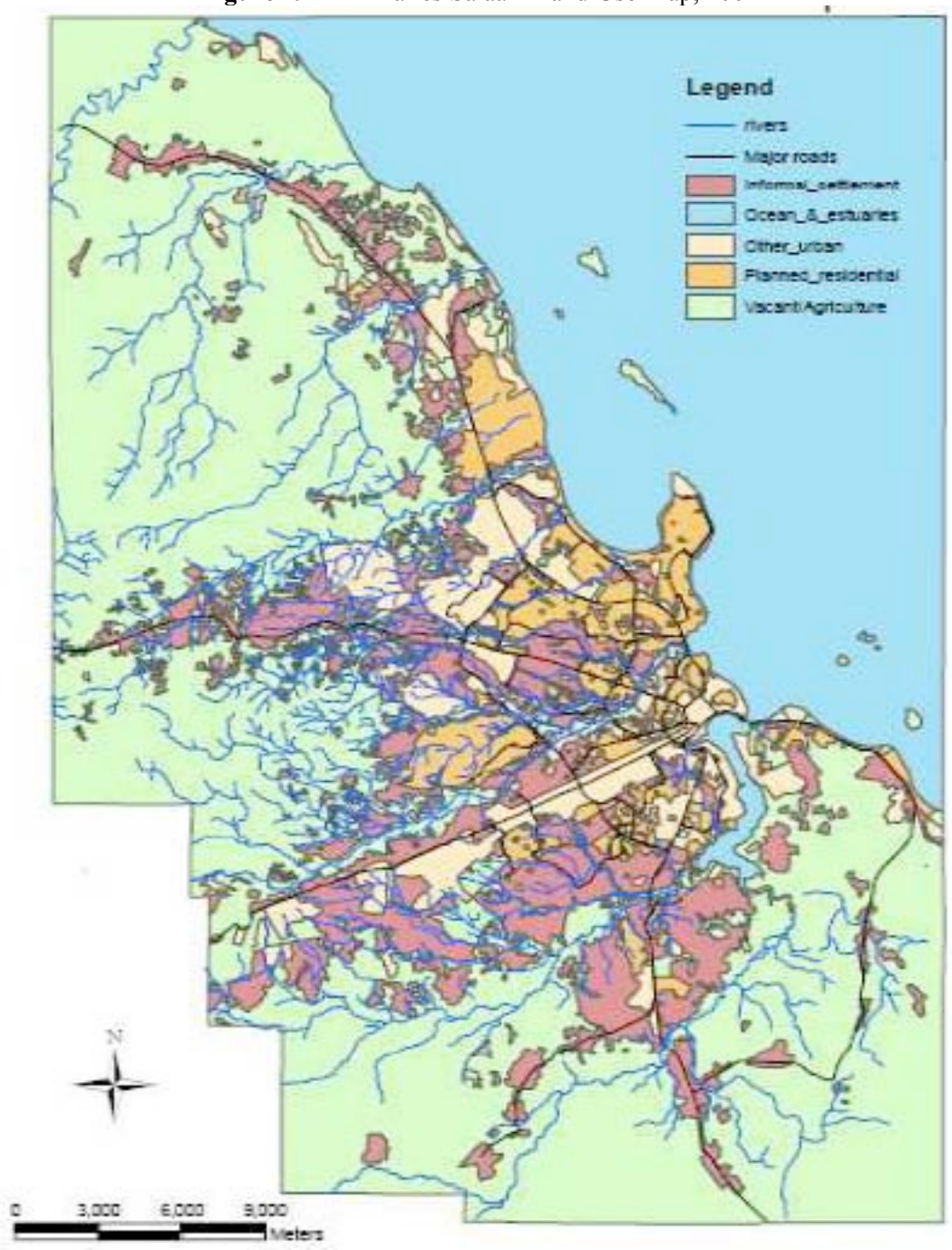
- The availability and cost of public transport weighs heavily on essential fields such as health and education in that they tend to reduce access to those services;
- Often, poor households (the vast majority) must limit their trips outside the neighborhood to the most indispensable activities;
- Both public and private primary and secondary schools are at a greater distance from unplanned settlements than from affluent neighborhoods;
- Above and beyond the difficulty of transportation, particularly for schoolchildren, the simple cost of trips increases the overall cost of schooling and may constitute one of the factors resulting in the premature exit from school for children in poor families.
- Transportation difficulties further reduce the possibilities of finding an accessible job;
- Health services such as public/private clinic/hospitals are closer in proximity to affluent neighborhoods than to squatter settlements. The cost and inconvenience of traveling to these areas, in compliance with the high cost of health care, greatly deters the poor population from using and benefiting from hospital services;

3.2.4 Housing

Dar es Salaam has three municipalities: Temeke, Ilala and Kinondoni (as shown in Fig. 1(a)). The largest concentration of poor unplanned settlements is in Kinondini; these are overcrowded and lack basic infrastructure services. Most of the city's unplanned settlements are located along the Kilwa, Morogoro, Nelson Mandela and Pugu roads (Howe and Bryceson, 2000). Briggs and Mwamfupe (2000) state that development of the city's informal settlements was driven by hydrological characteristics and the available public transportation system, and Sietchiping (2005) shows that informal growth patterns tend to emerge along riverbanks, steep slopes, dumping grounds, abandoned or unexploited plots, along transportation networks, near industrial and market areas, and in low-lying areas or wetlands. Figure 19 displays the location of Dar es Salaam's informal settlements (in year 2002).

Although formal procedures apply for plot acquisition in Dar es Salaam's planned urban areas, illegal housing is common in unplanned areas. This results in insecurity of land use, which can play a major role in the vulnerability of residents. Dar es Salaam's open spaces (public and private lands) are widely used for urban agriculture, for example, but agreements between owners and users are sometimes nonexistent or informal.

Figure 19 Dar es Salaam Land Use Map, 2002



Source: Vincent (2009)

Housing construction often occurs in areas that have been identified as hazardous lands, despite the fact that the Dar es Salaam City Master Plan of 1979 prohibits this. Some residents settle in former quarry areas, which are often also waterlogged areas, or build houses close to waste stabilization ponds that are not managed well. Such residents are highly exposed to illness associated with and standing wastewater and water that accumulates during rainfall-induced flooding.

Several agencies are engaged in housing issues in Dar es Salaam, The housing industry is, in fact, a major source of employment and catalyst for economic development in the city. The private sector is involved in housing construction, and the Government plays a role in housing and residential development directly as well as through its parastatal agencies (National Housing Corporation, involved in constructing shelter for rental) and Pension Funds (the Parastatal Pension Fund and National Social Security Fund have invested in major real estate developments in Dar es Salaam).

3.2.5 Water supply

The primary source of Dar es Salaam's water supply is the Ruvu River, from where about 262 million liters are extracted each day. An additional 6 million liters per day are extracted from the Kizinga River. After being treated at several water plants, the water is transmitted through pipes to various parts of the city. Unfortunately, a large volume of water is lost en route due to poor infrastructure (e.g., broken pipes) and unauthorized use. Broken pipes also serve as entry points for bacteria, which may result in disease.

Regular water supply is often not provided to unplanned settlements, and many farmers depend on water from wells or directly from rivers (however, rivers and streams are often contaminated with untreated waste that is dumped directly into them by households and industry). In the early 2000s, only 98,000 of the city's residents had access to piped water, and, with 60 percent lost through leakages, and another 13 percent through unauthorized use and illegal taps, only 26 percent of the water was billed (Greenhill and Wekiya, 2004) and only16 percent actually paid for (WaterAid, 2008). Water quality and reliability was poor, especially in low-income areas, and was frequently purchased at exorbitant prices from vendors, kiosks and neighbors.

In a study of 45 of Dar es Salaam's wards, containing 84 percent of the city's population, the percentage of informal residents without access to improved drinking water ranged from 37.8 percent to 90 percent, with a mean of 71.8 percent (Penrose et al., 2010). This also means that for residents engaged in urban agriculture, most are only able to cultivate during the rainy seasons.

Unpredictable water supply situations have led poorer residents to try to adapt to the situation by diversifying sources and reducing consumption. The considerable cost of a piped water connection continues to pose an obstacle for poorer households (see Box 2).

Box 2 Experiences of women of Dar es Salaam's unplanned settlements in obtaining water

> Mary, a social worker who came from Kilimanjaro region 10 years ago, has to get her water from a well 500 m from her home. Each bucket she carries back costs her 30 Tanzanian shillings (US 3 cents per bucket). "Getting water now is so much more difficult than before. Then we used to have piped water coming to the house. We used to pay 8,000 shillings a month for it. Then it stopped coming," she says. She thinks the pipe infrastructure broke down and was never repaired. Like many others, she buys her water from someone who has dug a well with no checks on the quality of the water she and others are using.
>
> Anna, who came to Dar es Salaam nearly two years ago with her husband and children after they could no longer scrape a living growing and selling vegetables in Tabora, western Tanzania, can at best only afford five buckets of water a day. With a husband unable to work and in poor health and the family of five living in one tiny room with no electricity, Anna struggles to keep the family afloat. Five buckets of water at a total cost of 15 US cents a day for drinking, washing and cooking in a country where millions of people are living on less than one dollar a day is a significant amount of money.

Source: Taken from Pandya (2009: 10)

Existing constraints to clean water supply for the residents of Dar es Salaam's unplanned settlements will become an increasingly severe issue given both increased climatic variability (with the possibility of more or longer drought periods) and the projected growth of the city's population over coming decades. At present the city's water demand is already far outstripping its water treatment capability. Existing treatment capacity is 282,000 m^3 per day; water demand in 2007 was 412,000 m^3 per day. Demand is projected to rise to 964,000 m^3 per day by 2032, and the planned future design capacity of the system is for 960,000 m^3 per day, using current sources as well as deep groundwater to be extracted from the Kimbii and Mpera wellfields (DAWASA, 2008b). Given immense resource constraints at present, substantial support is likely to be needed by city authorities to meet this design goal.

Pandya (2009) states that work is expected to commence shortly on the drilling of 20 deep wells that can produce 260,000 m^3 a day, and the lower Ruvu treatment plan will be expanded to increase output by nearly 90,000 m^3 a day. Additionally, the Norwegian Embassy is funding a US$6 million research project on the long-term sustainability of deep-water aquifer tapping, including the effects of climate change.

3.2.6 Sanitation systems

Sanitation and garbage disposal is an immense problem in informal settlements, in terms of sewage infrastructure, household provisions, and behavioral practices.

The sanitation system found most commonly in informal settlements is pit latrines. In Penrose et al's (2010) study of 45 of Dar es Salaam's wards, they found that the percentage of informal residents lacking improved sanitation ranged from 71.7 percent to 97.3 percent, with a mean of 92.4 percent. In heavy rains the pit latrines tend to fill up, and human excreta overflows into settlement areas. Some residents empty their pit latrines when it rains by discharging the waste into the rainwater, but due to the high

water table and poor drainage system, this polluted water can remain undrained in the settlement for a long period of time. As discussed in later sections, this is a major factor in disease prevalence in these settlements. Heavier rainfall, as might be experienced in Dar es Salaam with climate change, will exacerbate this situation.

To sum up, the city's planning agencies have been unable to keep apace with the rapid expansion of the city, largely fuelled by migrant growth. Most of the city's population lives in unplanned settlements – many in abject poverty – which are characterized by substandard infrastructure and lack of basic municipal and other services. These communities face transportation constraints, insecure housing, problems in accessing clean water, unhygienic sanitation provisions, and lack of awareness on hygienic sanitary practices. Climatic factors, e.g., heavy rainfall, work in conjunction with this situation to impose additional hardship and increase disease incidence.

3.3 Socio-economic issues

3.3.1 Health

Disease prevalence

According to WHO (2008), food and waterborne diseases such as diarrhea, cholera, hepatitis A, and typhoid fever, as well as vector-borne diseases – mainly malaria, dengue fever and schistosomiasis – are widespread in Dar es Salaam. Many of these diseases indicate poor environmental conditions, and it is important to note that climate change – in altering humidity and rainfall – could increase the spread of both vector- and water-borne disease.

Data from hospitals and health centers

The case study team determined disease prevalence for Dar es Salaam's three municipalities by reviewing the monthly health statistics of hospital and dispensary registers. Diseases were ranked according to number of cases, with the top 10 shown in Table 4.

Table 4. Diseases prevalent in Dar Es Salaam City, by municipality

Kinondoni 2006-Sept 2010		Ilala (2006-2009)		Temeke 2007 – Sept. 2010	
Above 5	*Under 5*	*Above 5*	*Under5*	*Above 5*	*Under 5*
Malaria	Malaria	Malaria	Malaria	Malaria	Malaria
Acute respiratory infection	Acute respiratory infection	Acute respiratory infection	Pneumonia	Urinary tract infection	Acute respiratory infection
Skin infections	Skin-Infection	Diarrhea	Gastroenteritis	Acute respiratory infection	Diarrhea
Anemia	Anemia	Nutritional Disorders	Acute respiratory infection	Pneumonia	Urinary tract infection

Diarrhea	Pneumonia	Pneumonia	Ski Infections	Diarrhea	Pneumonia
Urinary tract infection	Diarrhea	Urinary tract infection	Urinary tract infection	Skin infections	Skin Infection
Pneumonia	Protein energy malnutrition	Skin Infection	Anemia	Intestinal Worms	Ear Infection
Non-infectious gastro	Eye Infections	Skin infection, non-fungal	Worms	Anemia	Eye Infection
Skin infection, non fungal	Skin infection, non fungal	Tuberculosis	Minor Surgery	Ear Infection	Dysentery
Intestinal Worms	Nutritional deficiencies	Anemia	Diarrhea		

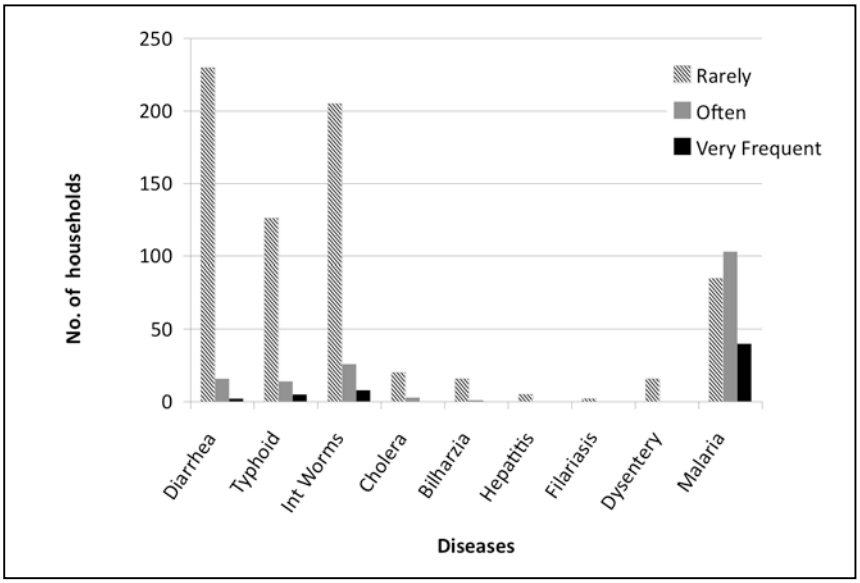
Source: Hospital and Health Centers, MTUHA Registers (researched in 2010 by IRA)

Table 4 shows that water borne disease, vector borne disease and parasites, infections, and malnutrition abound. Malaria is common – a vector-borne disease that is exacerbated by standing water conditions. Acute respiratory infection is also prevalent, reflecting poor housing conditions and improper ventilation. The high incidence of diarrhea, intestinal worms and gastroenteritis are indications of poor sanitation conditions and contamination of food and soil with human excrement. Poor personal hygiene is also evident from the fact that water-washed diseases (e.g., infectious skin and eye diseases) are rampant, as are fecal-oral diseases such as diarrhea and dysentery.

Data from household surveys

The University of Dar es Salaam study team included questions on health in the household questionnaires implemented in unplanned settlements. Residents were asked to rank diseases suffered in the household within the previous two weeks. As shown in Figure 20, more households suffered malaria "very frequently" than any other ailment, and diarrhea, typhoid and intestinal worms were also found to be common, indicating poor environmental conditions.

Figure 20: Illnesses and diseases suffered by residents in households within 2 two weeks prior to the survey implemented in October 2010 (n=543)



Source: University of Dar es Salaam, Case Study Team (2010)

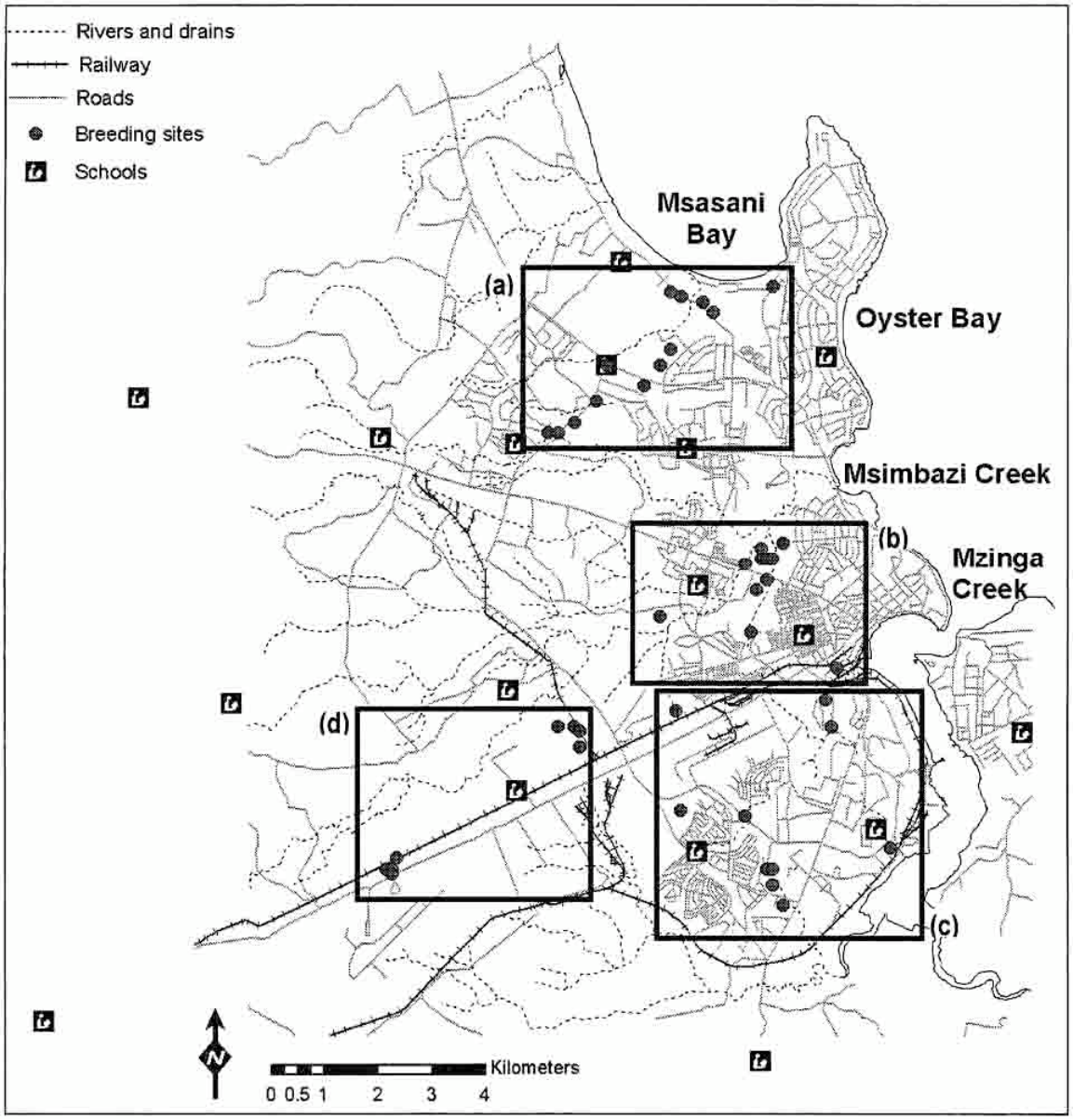
Malaria

Global malaria mapping ranks Tanzania a very high malaria endemicity area (as defined by WHO) with 10 percent of its urban and rural population at risk, the most vulnerable groups being pregnant women and children under 5 years of age (WMO, 2010). According to health services professionals, malaria is Dar es Salaam's foremost health problem for both adults and children (Tanner et al., 1991). Despite marked seasonality in mosquito densities, which usually peak with the rain season, malaria transmission is intense and recurrent, which could be explained by the fact that malaria-transmitting mosquitoes are reported to be rampant throughout the year in Dar es Salaam, due to frequent accumulation of water in residential environments. Figure 21 shows an urban malaria risk map for Dar es Salaam based on studies conducted by de Castro et al. (2004).

The mosquitoes *Anopheles gambiae* and *Anopheles funestus* are the main vectors, with an estimated 200–300 infective bites per person per year, mostly in waterlogged urban and rural areas of Tanzania (Smith et al., 1993). Life-threatening malaria is reported to occur largely in children, commonly those under a year old (Schellenberg et al., 1999). According to a study conducted by De Castro et al. (2004), 2-10 percent of school children living in urban Dar es Salaam are infected with malaria. Anemia, largely caused by malaria (Menendez et al., 2000), is also common in adults and children.

The Government's efforts to control malaria are discussed later in this Section.

Figure 21 Urban malaria risk map for Dar es Salaam, Tanzania



Source: De Castro *et al* (2004)

Cholera

Penrose et al. (2010) analyzed urban environmental data and the burden of cholera in Dar es Salaam and found that cholera incidence was most closely associated with informal housing, population density, and the income level of informal residents. Figure 22 shows cholera-prone areas in Dar es Salaam.

The household surveys documented only one case of cholera. The University of Dar es Salaam team had difficulty in obtaining data on trends in diseases epidemics such as cholera from the health facilities. They found, however, that Ilala Municipality reported

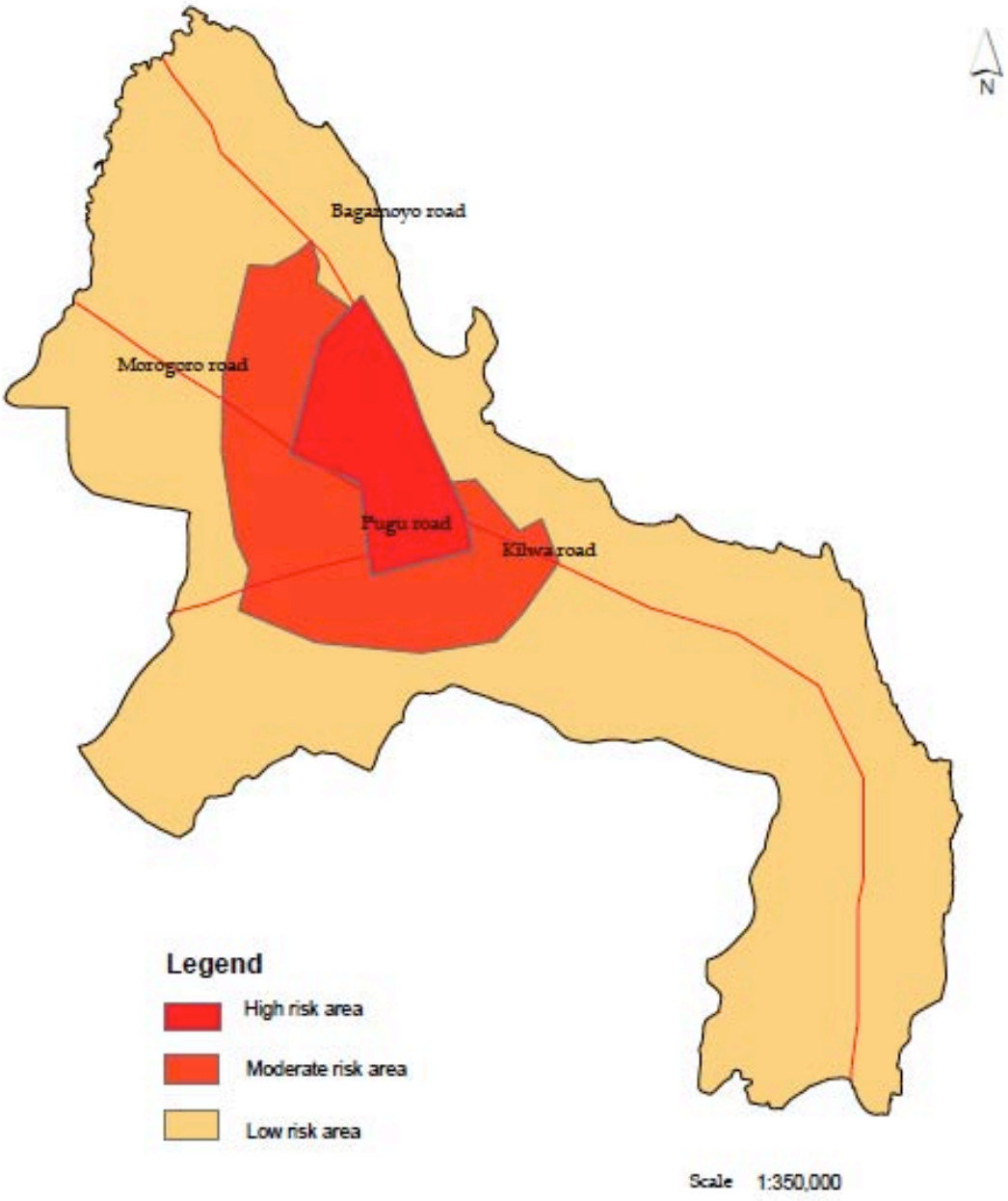
158 cases of cholera in 2009 (6 below and 152 above 5 years of age), all of which were fatal. Temeke Municipality was reported to be leading in cholera epidemics in Dar es Salaam. PRB (2007) report that since the first major cholera epidemic was reported in southern Tanzania in 1977, it has spread to most regions of the country and has remained endemic and a chronic problem in Dar es Salaam ever since. Between 1 January and 31 December 2006, a total of 14,297 cases, including 254 deaths (1.8 percent case fatality rate) were reported from 16 regions of Tanzania's 21 regions. Dar es Salaam represented 62.7 percent of the total cases and 101 deaths (39.8 percent of total deaths; WHO, 2008).

Dengue fever

Dengue fever is a tropical disease transmitted by four types of arthropod-borne viruses through a bite from an infected *Aedes aegypti* (rarely *Aedes albopictus*) mosquito species. The geographic spread of the infection is similar to that of malaria, although unlike malaria, which is also found in remote rural areas, dengue infections most often occur in the urban areas of tropical nations (Tomashek, 2009). Tourist facilities in Dar es Salaam (e.g., hotels, lodges) receive many visitors from tropical countries where the disease is prevalent. Tomashek reports of transmission of the dengue virus through exposure to dengue-infected blood, organs, or other tissues from blood transfusions; solid organ or bone marrow transplants; needle stick injuries; and mucous membrane contact with dengue-infected blood. Poor disposal of hospital waste, including syringes, could be a possible route of transmission of dengue; private health facilities have mushroomed over the city and hospital waste is mixed with other type of waste (industrial, domestic etc), with potentially serious consequences for waste scavengers, who usually work bare-footed and sort through waste with bare hands.

Climate change is likely to affect dengue fever outbreaks by creating increased breeding environments for mosquitoes, similar to the way it will affect malaria incidence. Dengue fever alerts have been generated from time to time in Dar es Salaam in recent years but the disease has generally been contained to a few cases.

Fig. 22 Areas in Dar es Salaam prone to cholera incidence



Source: Ardhi University (2010)

Other diseases

Lymphatic filariasis (elephantiasis) is another mosquito-related tropical disease found in Dar es Salaam (Castro et al., 2010); up to 30 percent of the city's population is estimated to host elephantiasis worms (Health Focus, 2006). Although a massive network of drains (~1130 km) was designed to prevent stagnant water from accumulating and consequently

providing a suitable breeding ground for mosquitoes, a study by Castro et al. (2010) found evidence that these drains are among the most common mosquito larvae habitats. Drains cannot serve their function due to blockage and degradation caused by illegal construction and improper solid waste disposal procedures by residents.

Dysentery and typhoid occur frequently in Dar es Salaam; in 2009, Ilele Municipality reported 58 cases of dysentery and 227 of typhoid. Diarrhea takes a large toll; WHO (2007) estimates that there are over 56,000 annual deaths in Tanzania due to diarrhea resulting from polluted water and poor hygiene. Rift Valley Fever outbreaks occur occasionally near borders with other countries, and Dar es Salaam's dwellers have been frequently warned about this illness.

Other notable health concerns in the city include the prevalence of HIV and drug abuse. According to the Tanzania HIV/AIDS Indicator Survey (THIS) conducted in 2003-2004, the prevalence of HIV in DSM was 10.9 percent – higher than the national percentage of 7 percent (Lorenz et al, 2005), with 12.2 percent of the women testing positive, and 9.4 percent of men. A widely neglected issue in this context adult mortality from AIDS is the increasing number of HIV/AIDS orphans, of whom there are nearly 2 million in the country (UNAIDS/WHO, 2004).

To sum up, residents of Dar es Salaam's informal settlements suffer frequently from a range of diseases and ailments that climatic factors have direct or indirect influence over, and include water-borne, vector-borne, and parasitic illnesses. These commonly include malaria, dengue fever, lymphatic filariasis, typhoid, diarrhea and various other bacterial infections. Humidity levels and ponding caused by rainfall can create breeding sites for vectors. Poor hygienic practices, cramped living conditions, and lack of clean water are also major factors.

Climate change, in increasing climate variability and thereby possibly giving rise to heavier rainfall as well as longer or more frequent drought, could further restrict the poor's access to clean water, and thus lends an added dimension of urgency to address these basic needs.

National efforts in disease prevention

Tanzania is involved in many programs for the elimination of communicable diseases such as malaria, schistosomiasis, filariasis, oncocerciasis and soil helminthes. Also, in recognition of the role of climate in the propagation of many local diseases, and of the fact that climate change may exacerbate this, Tanzania has established a multi-sectoral committee to work on issues of health and climate change. The committee is working on early warning mechanisms for diseases whose spread has climatic dimensions, such as malaria, cholera, Rift Valley fever and dengue fever. Rapid response teams are also being trained and equipped to handle cases of these diseases.

Schistosomiasis and soil-transmitted helminthes

The Schistosomiasis and Soil-transmitted Helminthes Control Programme (NSSCP) is a school health program that has been implemented in the country since 2004 and involves screening pupils for about 15 diseases annually. Depending on prevalence rates, they are treated on a mass or selective basis. Schistosomiasis, soil helminthes and river blindness are covered by the WHO Neglected Tropical Diseases (NTDs) Control Programme, which in Tanzania is implemented by the Ministry of Health and Social Welfare in collaboration with city and municipal authorities. In schools, it is implemented in collaboration with the Ministry of Education and Vocational Training (MEVT).

Medicine for combating filariasis is distributed free of charge to adults (Health Focus, 2006). With donor support, the Government of Tanzania started a National Lymphatic Filariasis Elimination Programme (NLFEP) in 2000, with massive campaigns in coastal areas. Dar es Salaam became involved in the programme at a later stage (in 2006). Donor funding for the programme ended in 2006 but was sustained through the government and respective districts and municipalities until July 2010, after which the agreement with districts/municipals and the National Institute of Medical Research to supply medicines ended.

Programs urgently need to focus on reducing unsanitary conditions in poor residential areas. Also, de-worming programs need to be implemented for both children as well as adults.

Malaria control

The tri-fold objectives of Tanzania's malaria control program are to reduce vector longevity, vector density and human-vector contact. The WHO-recommended strategy being employed is universal coverage with long-lasting insecticide treated nets (LLITNs), which are being distributed free of charge to all residents in rural and urban areas, targeting the poor in particular. The nets reduce the lifespan of female mosquitoes as well as their contact with humans. The LLITNs are designed to remain effective for at least three years, obviating the need for other insecticide treatments. In large households, two or more members are required to share a net.

Initially sold for a highly subsidized fee, the nets are now distributed free of charge. Groups at greatest risk – young children and pregnant women – are given priority, and are usually allocated nets when they attend antenatal, postnatal and immunization clinics. These malaria eradication efforts are largely funded by the USA President Malaria Initiative (PMI) and UNICEF.

Mass media campaigns – TV, newspapers and leaflets – are helping with mass distribution, in informing the public that the nets are free of charge, and in demonstrating how they should be used.

During the household surveys conducted for this study, residents that responded that they had a family member who suffered from malaria within the previous two weeks were

asked about strategies used to combat malaria. Only 10 percent reported using a mosquito net for prevention purposes. The responses mostly focused on recovery, i.e., seventy-two percent said they usually go to hospital after falling ill, and 8 percent said they buy medicine when they fall ill. Data from other studies in malaria eradication in high mosquito and malaria incidence areas (in Ifakara-Kilombero Wetlands and Ramsar Site area) show, for children aged under 5 years, that 13 percent of children sleep under a recently treated net, 54 four percent sleep use a net, and 37 percent use nets that were treated at some point in time (Ifakara Health Institute). Data on urban use of mosquito nets in Tanzania is shown in Table 5.

Table 5: Household Ownership of Mosquito Nets in Tanzania

Background characteristics	Any type of mosquito net			Ever-treated mosquito nets			Insecticide treated mosquito nets (ITNs)			Number of households investigated
	% with 1 net	% with > 1 net	Average nets per household	% with 1 net	% with > 1 net	Average nets per household	% with 1 net	% with > 1 net	Average nets per household	
Urban	76.6	47.2	1.6	72.3	42.1	1.5	59.2	41.6	1.1	2,106
Rural	48.9	26.5	0.9	44.8	23.3	0.8	32.6	14.6	0.6	6,391
Mainland general	55.6	30.7	1.1	50.8	27.0	0.9	38.3	17.9	0.7	8,269
Mainland urban	78.5	46.6	1.6	72.0	44.4	1.5	58.8	30.9	1.1	2,041
Mainland Rural	48.1	25.5	0.9	43.8	22.3	0.8	31.6	13.6	0.5	6,228
Dar es Salaam	**89.2**	**54.1**	**1.9**	**81.2**	**46.9**	**1.7**	**70.0**	**36.6**	**1.3**	**693**
Other Urban areas	74.1	43.5	1.5	68.2	39.1	1.4	54.2	28.6	1.0	1,448
Zanzibar	81.4	65.3	2.2	80.6	64.2	2.2	71.9	53.1	1.7	228

- An ever-treated net is a pretreated net or a non-pretreated that has subsequently been soaked with insecticide at any time.
- An insecticide-treated net (ITN) is 1) a factory-treated net that does not require any further treatment or 2) a pretreated net obtained within the past 12 months, or 3) a net that has been soaked with insecticide within the past 12 months.

Source: URT (2008:135) Tanzania HIV/AIDS Malaria Indicator Survey

From Table 5, it may be seen that although Dar es Salaam is ahead of other areas in the country, household usage of mosquito nets (treated or untreated) is low; while average household size is 4.2 people, the average number of nets per household is 1.3-2. These statistics reveal the limitations of relying on a single methodology, i.e., distribution of mosquito nets. An approach with multiple, integrated efforts is needed that includes improvements in environmental sanitation and eradication of vector borne diseases.

Factors contributing to spread of communicable disease

The following factors were observed by the study team during on-site visits and reported by residents during the survey to contribute to the spread of communicable diseases:

- *High groundwater table:* This causes many latrines and septic tanks to flood, allowing human excreta to enter streams, rivers and wells that are used for many domestic, food vending and other activities (gardening, washing utensils in restaurant/food vending sites, washing marketed fruits and vegetables, etc). This brings cholera bacteria (*Vibrio cholerae*) in contact with hands, or it may be ingested. The filling rate for disposal facilities of excreta and sullage is high. It is too costly for residents to have these emptied on a frequent basis using tankers. Also, tanker access to the facilities is problematic due to congestion of housing structures and narrow alleys.
- *Unsanitary practices/behavior* contribute to illness, e.g., poor hand washing before eating, after defecation or touching waste.
- *Poor latrine design:* Many of the latrines are not ventilated or covered, allowing fly breeding and the spread of disease pathogens. The majority of poorer urban dwellers have not adopted the ventilated, improved latrines that were promoted since the 1980-1990s under urban sewerage and sanitation programs that included demonstration of various low cost ventilated latrines as well as a loan scheme for their construction by trained masons. Other observations by the study team were (i) in cases where ventilated pipes for latrines and septic tanks were installed, the open tip usually had a wire mesh missing that is required for trapping flies, and (ii) covers for the latrine holes, that prevent flies from entering and breeding or escaping, were not always in place.
- *Crude disposal of solid and liquid waste*: Even where communities have participated in upgrading programs such as SUDP and CIUP, unsanitary practices continue. This is true even in cases where communities participated fully and contributed financially to the initiatives. This could indicate the need to empower local level structures, i.e., *Mtaa* environmental and other committees and their legal structures (e.g., Ward Tribunals) and grant such structures more authority in dealing with local level environmental matters.

3.3.2 Subsistence and livelihoods

Overview from literature

About 95 percent of the city's population depends on activities in the informal sector for its livelihood; involvement in the informal sector is, in fact, a survival strategy for the unemployed, low wage earners, and women without sufficient skills to secure well-paid jobs (Dongus, 2000). Residents' activities are diverse and include mining (sand, gravel stones,

limestone, salt extraction), urban agriculture (vegetables, cassava, legumes, sweet potatoes, cashewnuts, coconuts) and fishing. Recreation and tourism occur mostly along the Indian Ocean beach areas. Other informal activities include petty trade, vending of cooked and uncooked food items, vending of used clothes and other industrial produced goods; providing services in the transport sector and other activities that are characteristic of the informal economy in third world countries (Kinabo, 2003; Casmiri, 2009). Urban agriculture, also an informal sector activity, is chosen by a large number of residents, because it can offer employment, income and food security for the urban farmers and their families (Dongus, 2000). It can be seen that many of these activities – urban agriculture, food vending, tourism – are vulnerable to the impacts of adverse climate, and climate change may pose risks to the livelihoods of these groups (for example if droughts or storms intensify).

The Household Budget Survey of 2000/01 shows that wages and other income from employment provide 41 percent of total household income in Dar es Salaam, while income from self-employment represents almost 30 percent. Over one-third of households in Dar es Salaam depend on a single type of income source (URT 2002), indicting that a significant proportion of households experience constraints to household income. This situation is aggravated by a decline in government and parastatal employment and a rise in the self-employment. The survey indicated that income earnings from self-employment were usually less than those from employment in the public sector. It also revealed that the absolute number of people who are poor is increasing in Dar es Salaam, partly due to high population growth, and that income and expenditure gaps are increasing between low and high-income earning groups.

Unemployment was estimated at 46.5 percent in Dar es Salaam in 2002, while it was 25.5 percent in other urban and 18 percent in rural areas (URT, 2004).

Insights from household survey results

The surveys implemented by the Case Study Team of over 500 households in informal settlements showed that more than 57 percent of respondents were self-employed and were engaged in similar activities. Only 16 percent had regular employment (see Table 6).

Table 6: Occupational Status of Respondents

Occupation	Male	Female	**Total**	%
Employed	35	52	87	16
Self employed	89	219	308	57
Dependant	13	113	126	23
Retired officer	17	5	22	4
Total	154	389	543	100

Source: University of Dar es Salaam, Case Study Team (2010)

Of those who were self-employed, 67 percent were engaged in business (petty trade); 9 percent in activities requiring technical skills (car mechanics, carpentry, masonry, plumbing); 4 percent in agriculture; and 4 percent in professional jobs such as medical doctor, nurse, teacher, clerk, security guard and hairdresser. Fishing was also cited as an occupation.

The study team found that some of the respondents' income-earning activities are being undertaken in hazardous areas, such as contaminated environments. These include

contaminated rivers that not only contain sewage and items that may prick (nails, needles), but also chemical waste from industries and informal sector activities. Other residents had created bathing facilities that earn them a small income, but these swimming/bathing facilities are not disinfected, nor are they inspected by health officers (see Photo 4, pg. 63).

The activities of the 56 entrepreneurs that were interviewed are shown in Table 7.

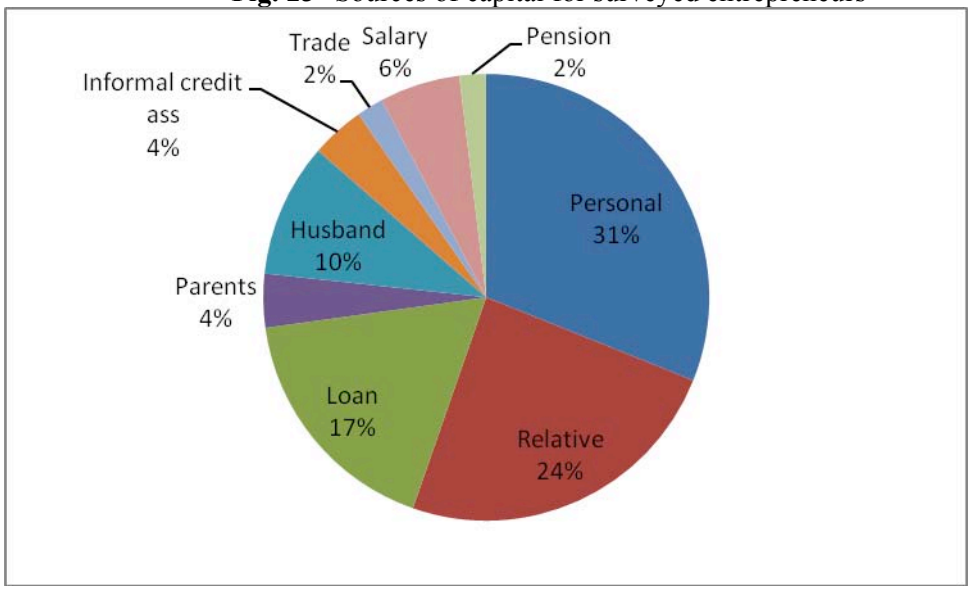
Table 7: Activities of the 56 Entrepreneurs

Income-generating activities	Frequency	%
Swift market (*genge* trade green, raw food, fruit, seed varieties)	15	26.8
Food vendor/tea room/soft drinks	14	25.3
Cleaner, house to house	3	5.4
Trade construction material	3	5.4
Tailoring activities	3	5.4
Shoe maker and sales of shoe items	3	5.4
Waste recycling	2	3.6
Meat Butcher	2	3.6
Charcoal vendor	2	3.6
Selling industrial *khanga* wear	2	3.6
Vending fodder to livestock keepers	2	3.6
Milling machine	1	1.8
Vending water	1	1.8
Hair salon	1	1.8
Mobile phone spare parts	1	1.8
Vending cigarettes, juices, groundnuts and candy	1	1.8
Total	56	100

Source: University of Dar es Salaam, Case Study Team (2010)

The main source of capital for these entrepreneurs was seen to vary, but, as can be seen in Figure 23, “personal source” of capital predominated, followed by “relative”, “loan facility” and “partner” (husband) as important sources. Other sources include savings from salary, informal credit associations, parents, pension and savings from petty trade undertaken in the past.

Fig. 23 Sources of capital for surveyed entrepreneurs



Source: University of Dar es Salaam, Case Study Team (2010)

Entrepreneurs were asked about problems they face in their business. The top ten are shown in Table 8, and some of these are climate related, such as disease, dust and environmental degradation. Shortages in water availability, which may be exacerbated with possible drought intensification in future, can result in low electricity generation and inability for vendors to use equipment such as fridges and electric stoves.

Table 8: Problems Commonly Faced by Entrepreneurs in Dar es Salaam's Informal Settlements

Problem	Rank
Low income of customers	1
Low capital	2
Few customers	3
Poor work equipment (fridges, stoves)	4
High prices of input items	5
Diseases	6
Customers do not make timely payment	7
Dust	8
Filthy environments, flies	9
Disruption by city authorities	10

Source: University of Dar es Salaam, Case Study Team (2010)

The low incomes of customers can result in delayed payment, which in turn affects the financial status of the vendors/traders and their ability to run a profitable business. Low capital inhibits the purchase of useful equipment such as refrigeration or deep freezers to store decomposable items. Other problems mentioned included rainfall, poor roads, high taxes charged by city authorities, and lack of proper venues for entrepreneurial activities. Lack of transport and disturbances caused by city authorities (who attempt to curtail activities that may contribute to filthy environments) are institutional problems that need to be addressed.

The link between climate and income for residents of informal settlements

The study team asked self-employed residents about how climate change might affect their business. The following ten effects were mentioned, in order of decreasing importance:

1. Dampness and spoilage of goods
2. Increased dust
3. Shortage of customers
4. Muddy, poor, or impassable roads
5. Increased flies
6. Smelly, decomposing garbage
7. Lack of goods as access becomes difficult
8. Increased prices of items
9. Poor health of traders
10. Spoiled furniture for those trading wood

Most if not all of these problems are already being faced to some degree by residents. Climate change was seen as having real potential to exacerbate challenges that are already being experienced. More of the problems identified appeared to be associated with rainfall than the dry season. The dry season can lead to increased income for vendors, as prices tend to rise due to drought-induced scarcity of items. However, street businesses are adversely affected by electricity cuts and rising costs of inputs.

3.3.3 Access to basic services

Education system

The city's main education system comprises pre-primary, primary, secondary and tertiary levels. Pre-primary services were provided by the government in the past but are now mostly privately owned. By 2004, Dar es Salaam had about 149 government schools and 74 private schools. The socio-economic profile for the city (2004) shows that school enrolment is much higher in primary schools than pre-primary, since primary education is mandatory. The pupil to classroom ratio in Dar es Salaam is very high, averaging about 124 pupils for each classroom, and the pupil to desk ratio is 6 (each desk serves six pupils). The high pupil to teacher ratio also means that many students do not have much access to the teacher.

The Government covers all tuition costs for government nursery schools and primary schools. In government secondary schools, the tuition costs are shared by the Government and parents. Many students receive government loans for college education, particularly university. Some pay tuition costs on their own.

Access to health services

Most Dar es Salaam dwellers with formal employment avail of medical services through insurance, mainly the National Health Insurance Fund (NHIF). By 2004, the NHIF medical care services covered over 1.2 million beneficiaries through a network of over 3,500 accredited public/private health facilities, with the majority of NHIF members living within an average of 10km from these facilities. Apart from the NIHF, there are private health insurance schemes operating in Dar es Salaam, notably MEDEX and AAR. The range of benefits offered is more or less similar to those of NHIF.

Most residents prefer government hospitals and health centers due to their lower fees. However, of Dar es Salaam's total of 22 hospitals (in 2004), only 4 were owned by the

government; similarly, and only 5 of its 25 health centers were owned by government. The number of hospitals is insufficient for the city's population. In 2004, Dar es Salaam's population to physician ratio was 18,637 (18,637 persons per physician). The poor quality of health services is also reflected in the long queues to see doctors, the congestion in hospital wards, and poor facilities in general (URT, 2004).

Social capital

Dar es Salaam's dwellers build their social network through their neighborhood as well as cooperative networks. The city's many cooperatives include: housing cooperatives, industrial cooperatives, saving and credit societies (SACOS), fisheries cooperative societies and service providers. These facilitate the provision of social and economic services that accomplish the city's efforts in improving living standards on the city dwellers. By 2001, the municipality of Kinondoni had about 134 cooperative societies. Other networks facilitating social capital are civil organizations within the city, which are mainly community-based organizations, non-government organizations, and economic development fund groups. These all seek to improve residents' living standards (URT, 2004).

3.3.4 Emerging issues

The city of Dar es Salaam has urbanized rapidly in recent decades, largely due to high in-migration from rural areas and nearby towns. However, the process has not brought about sustainable urbanization, as manifested in poor socio-economic and environmental conditions (URT, 2004). The city's growth has, to a large extent, favored the rich at the expense of the poor. Rent and land have become scarce resources, obtained at high prices, and sometimes involving payment of middlemen as chief bargainers. No effective measures are being taken to monitor and reduce these challenges.

The city has also experienced a sharp decline in employment provision by government and parastatal agencies, partly due to privatization. The city's ever-expanding urban sprawl is characterized by low-rise structures and a low-density built environment, and infrastructure provision to newly-built areas as well as maintenance of services in old, inner city areas is placing an increasing financial burden on the public sector (Kanyama et al., 2004).

Much of Dar es Salaam's poor are relegated to informal settlement areas. Areas such as these, with inadequate infrastructure, suffer from disease and livelihoods insecurity and are highly vulnerable to the impacts of adverse climatic conditions. Inadequate social services and lack of gainful opportunities also provide breeding grounds for violence, alcoholism, drug abuse, commercial sex, mugging and banditry in these settlements (URT, 2004). Urban ghettos and stigmatized neighborhoods can result. Urban violence borne of social inequality creates insecurity and erodes the social fabric, threatening the foundations of democratic institutions.

Against this backdrop of vulnerability for Dar es Salaam's poor, who lack basic infrastructure and services, climate change and variability lend an added dimension of adversity. Little effort has been made thus far to establish coping mechanisms that serve marginal communities living in flood-prone areas.

4 The Urban Poverty – Climate Change Nexus in Dar es Salaam

4.1 Vulnerability of the poor to climatic hazards

Dar es Salaam is already highly vulnerable to climatic variability, which is expected to increase as climate continues to change. The aspect of most frequent concern to Dar es Salaam currently is heavy rainfall. In combination with poor drainage, illegal construction and other infrastructure problems, heavy rainfall results in flooding that causes major losses and disruptions. For the multitudes of the city's population living in informal settlements, poor sanitation provisions and practices contribute to an additional threat: disease. Diseases commonly occurring in these congested, unsanitary settlements during flood periods include malaria, cholera, dysentery and diarrhea. Some other factors that contribute to flooding in these settlements include flat topography, lack of stormwater drainage systems, blockage of natural drainage systems, building in hazardous areas, and unregulated housing and infrastructure development. Livelihoods activities are also adversely affected by both heavy rainfall and by drought.

4.1.1 Flood risk

The following areas in Dar es Salaam are existing flood-prone sites where, in the absence of remedial measures, climate change is expected to exacerbate vulnerability:

(i) Msasani bonde la Mpunga

Covering an area of 60 ha (mixed residential, commercial & institutional), two main stormwater channels pass through the areas and plays an important role in the city's drainage system. The Master Plan of 1979 designated this area as hazard-prone land, yet development continues due to factors such as proximity to the new American Embassy, presence of a private hospital and large shopping malls, residences of former senior government officials, and the presence of hotels and private offices that provide employment.

Drainage channels are blocked by refuse throughout the year as well as by structures that hinder the flow of wastewater, causing houses to be flooded by unhygienic, sewage-based wastewater in houses (Kiwasila, 2010). Tandale Mtogole, Mkunduge, Ubungo Kisiwani and Msasani Valley – sites covered by this case study – all face these issues. In all flood-prone areas in slums, people have developed short and long-term solutions, which may not be viable in preventing diseases. Some of the temporary methods (cited by CLACC, 2009) include removing mattresses and other belongings and stowing them in the ceiling board area, and children being put to sleep on tabletops or roofs in the case of high floodwaters. Longer-term solutions included setting up barriers or constructing solid concrete walls around the house, with the entrance to the house being via a flight of steps or stones. This ad-hoc approach, however, often exacerbates flooding in surrounding areas.

This settlement has been the focus of a case study on integration of disaster risk management in urban planning, as part of the AURAN project (phases I and II), discussed further in Box 4.

(ii) Msimbazi Valley

The valley covers a wide area across both the Ilala and Kinondoni Municipalities. It is known to flood even during the absence of rainfall in Dar es Salaam, since the Msimbazi River, as it flows through Ilala and Kinondoni on its way to the sea, routinely encounters clogged drains

and structural interferences along its course. Msimbazi valley, in Kinondoni, and settlements in Kinondoni Municipality in general, are the fastest-growing settlements in the city despite their location in flood-prone areas. The influx of people in the Msimbazi valley has been accelerated by factors such as easy access to unregulated farming and building plots, proximity to the city centre, low levels of awareness, poor enforcement of regulations concerning land use, and availability of low-cost housing. These valley areas continue to be populated, exposing residents to life-threatening floods and flood-related health problems.

(iii) Jangwani

This is an informal settlement area in the vicinity of Morogoro Road, on the way to the city centre from Magomeni. It is a low-lying area that suffers flooding during the rainy season nearly every year. The Msimbazi River passes through this valley, and is joined by the Ubungo River which flows across Tandale Mkunduge and Mtogole. (While crossing Tandale, the Ubungo River is christened Ng'omber River, literary meaning 'Cow Dung Carrying River[7].) The two rivers turn the Jangwani Suna area (study site) into a peninsula, increasing the risk to dwellers that are at the mouth of the river. Due to its susceptibility to environmental threats, the area was declared 'not residential' by the former Minister for Lands and Human Settlement Development. However, it is at present highly inhabited, with a mixture of mud, wattle and modern housing constructed adjacent to the filthy sewage-based wetland area of Msimbazi River.

Disposing of sewage off-plot through a piping system connecting to open drains or the river valley is a common practice in Dar es Salaam city and in Jangwani-Suna area in particular. Solid waste is used in the area to reduce the impact of floods; it is collected by CBOs and the *Mtaa* pays lorry owners to haul it to the valley, where unemployed youths then pile it up. In this attempt to keep floodwaters at bay, however, they create muddy conditions and amass decomposing matter that provides breeding grounds for culex mosquitoes (vectors of filariasis).

(iv) City Centre

This is the most flooded area in the city. The problem is exacerbated by poor infiltration and outdated and mal-functioning sewerage and storm water drainage systems.

(v) Mikocheni B

Ponding water is common along the main road and in courtyards due to lack of space for construction of stormwater drainage systems. The natural stormwater drainage system has been blocked by haphazard construction, including of heavy cement block houses and multi-storied buildings. These have blocked underground channels that used to direct the water flow to Msasani and into the Indian Ocean. The water flow now tends to back up and flood houses and feeder roads for months.

[7] Low-income people in Tandale Mtogole and Mkunduge do keep livestock (cows, goats, sheep) under zero grazing and do sell milk for income. However, much of the dung is disposed of into Ubungo river and flows across Jangwani valley Suna residential area into the Indian Ocean, Filthy water containing animal dung, debris, human excrement from latrines, floating solid waste is a characteristic feature of the part of Ubungo River which is Ng'ombe. Dark chemical ridden waters is a characteristic of the Msimbazi River crossing Jangwani area as the river is illegally used by some industries in Ilala Municipality mostly in disposing off plot industrial liquid waste water.

(vi) Kunduchi and Bahari Beach

These areas are susceptible to the effects of sea level rise, storm surges and coastal erosion. Kunduchi beach and Bahari beach in Dar es Salaam have been eroded to the point that heavy investments had to be made to sustain them as beach areas. At Kunduchi, the headwater waves have advanced about 200 m in the past 50 years, as a result of which a mosque, five residential houses, and a historic fish market constructed in 1970s were washed away or destroyed (CLACC, 2009). Africana Hotel, constructed in 1967, is no longer operating due to damages. Sea walls have been constructed, stones placed and trees planted at several sites along the beach. These areas are particularly vulnerable to further coastal degradation, sea level rise and storm surge intensification as may occur with climate change.

(vii) Ocean Road Beach Area

Ocean Road has been eroded, threatening the sustainability of the road itself and of the State House. A sea wall has been constructed and barriers have been erected to deter cars from reaching the beach and loosening the sandy beach soils, which may accelerate beach erosion.

(viii) Vingunguti, Mtambani and Mnyamani

As Msimbazi River passes through these areas, it is prone to floods. These areas were formerly used largely for rice faming and now accommodate the city's Waste Stabilization Ponds, which receive wastewater from industries and residential areas. In order to reduce flood risk in the area, the World Bank funded the construction of a major storm and wastewater drainage channel that disposes of water into the Msimbazi River, and Plan International has provided boreholes to reduce the incidence of water-related disease. However, local practices of disposing of solid waste into drainage channels; constructing houses and industrial premises on the Msimbazi River valleys; and moving earth and constructing concrete walls without constructing underground passages to allow for seepage of water, have thwarted such remedial efforts. Flooding from river and rainwater into houses is a common problem, and tends to instigate conflict among residents (Kiwasila, 2010). Households living in valleys reported that they experience floods every year during the rainy season, with impacts including displacement and property damage. However, these residents return after the floods have receded – possibly due to lack of alternative options – and continue to dump solid waste and engage in activities that contribute towards exacerbation of flooding. Floods also influence the prevalence of cholera epidemics and typhoid.

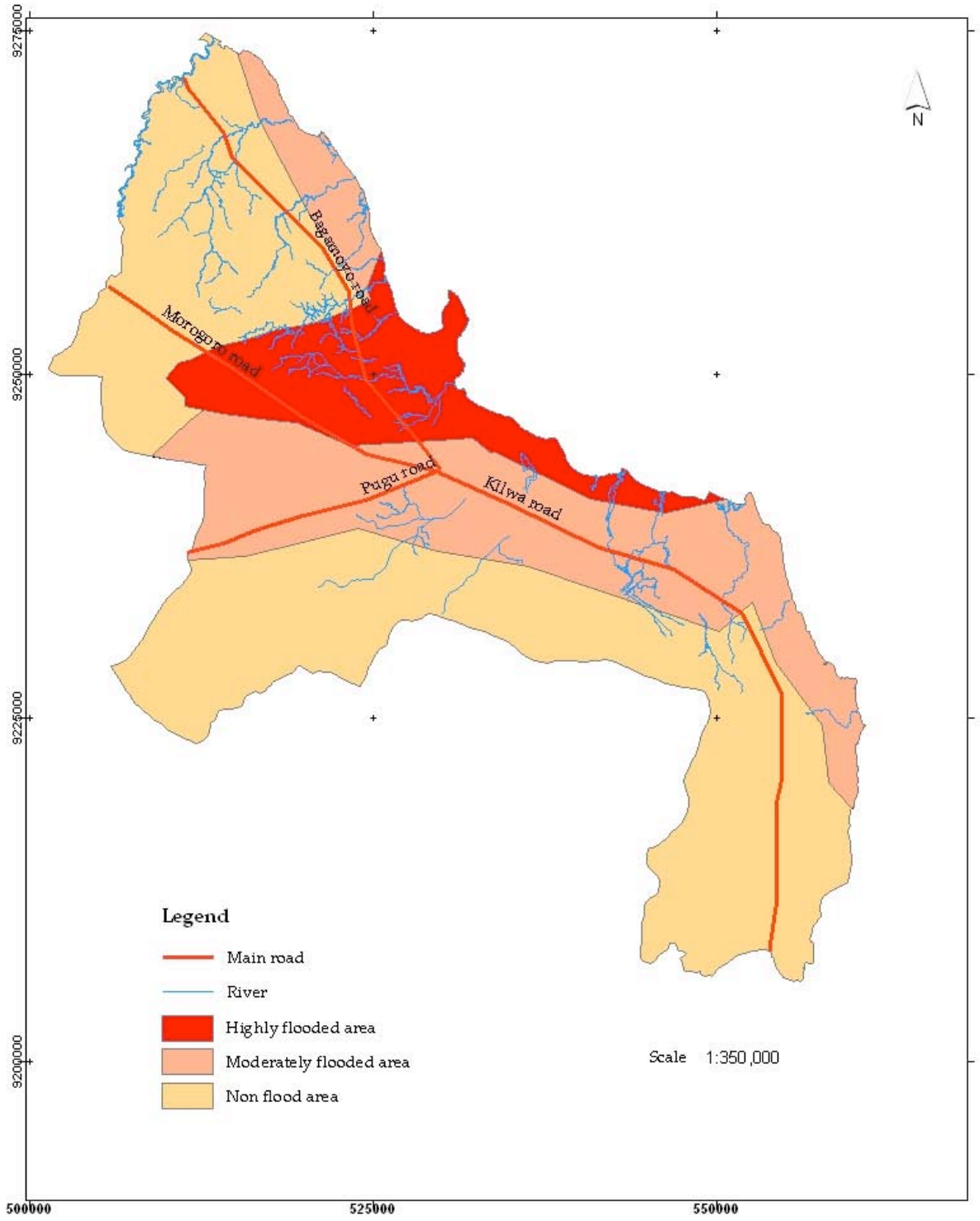
(ix) Temeke River Kizinga areas

The area along Kizinga River in Temeke Municipality is a largely unplanned settlement in a moderately floodprone area with a large population that is self-employed in the informal sector. Outdoor vending activities are common. Many residents use unclean water sources and do not boil their drinking water, and about 95 percent use pit latrines (which tend to overflow easily in floods) for disposal of excreta. The lowland area along Kizinga River floods during the rain season, and this fact combined with unhygienic practices has resulted in Mbagala Kizinga becoming a leader in cholera episodes in the city. Other diseases often found in this locality include malaria, bilharzia, typhoid and dysentery.

As the area is low-lying, residents frequently use solid waste during times of flooding to cover gullies and prevent water from ponding around their houses. It is common in the area to find a road full of piled-up solid waste, including plastics, coconut husks and wooden waste from carpentry shops, as a way of reducing the impact of floods and water-ponding along feeder roads and around houses. This practice, combined with inadequate stormwater drainage and clogging of existing drains, results in the creation of unsanitary areas that provide breeding sites for mosquitoes.

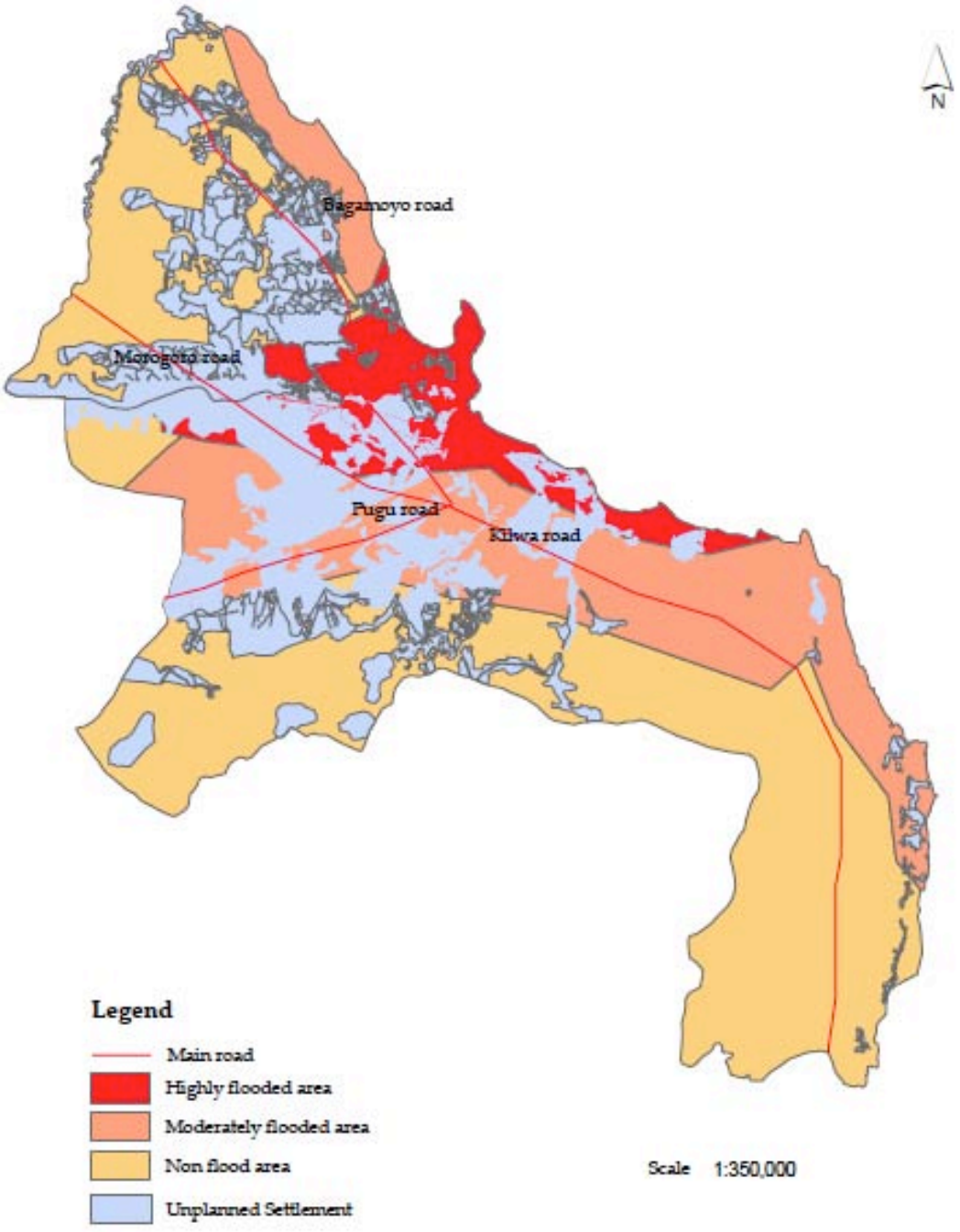
Figure 24 shows floodprone areas for Dar es Salaam. Figure 25 shows flood hazard zones overlain on urban poor (unplanned) settlements.

Figure 24: Flood hazard zone map for Dar es Salaam



Source: Ardhi University, 2010

Figure 25: Flood hazard zone map overlain on urban poor settlements



Source: Ardhi University, 2010

4.1.2 Drought risk

Tanzania[8] occasionally experiences prolonged droughts that can have severe socio-economic implications; the drought of 2006 damaged agricultural production, necessitated electricity cuts (and thus drops in industrial production) and cut GDP growth by 1 percent (ClimateWorks Foundation et al., 2009). A number of diseases are related to drought in the country: malnutrition, trachoma, dysentery, cholera, and diarrhea. Although increased drought has been projected for Tanzania's central regions (ClimateWorks Foundation, 2009), the impact of climate change on drought is uncertain for Tanzania in general (Watkiss et al., 2011), with some models predicting intensification and others reduction in severity. Prolonged droughts affect hydropower generation and result in electricity shortages and rationing in the city, as was the case in the drought of 2006.

Reduced water becomes a major issue for Dar es Salaam's poorer residents, causing disruption of social services and adversely affecting nutrition, subsistence, and livelihoods – particularly small-scale industries such as food vending, which require the use of freezers and refrigerators.

Drought was perceived as a risk posed by climate change to the community by 13 percent of the respondents interviewed by the study team (see Section 4.2, Figure 27).

4.1.3 Diseases

Sanitation provision in Dar es Salaam is grossly deficient; most people living in unplanned settlements do not have access to hygienic toilets and thus large amounts of fecal waste are discharged to the environment without adequate treatment. A high water table means that during heavy rainfall, flooding is quick to occur and waste-ridden muddy water remains undrained in settlements for a long period of time. Stormwater drains are frequently blocked by crude dumping of solid waste. Contaminated stagnant water is a common breeding site for mosquitoes, leading to high malaria incidence in settlements, and to other water borne diseases such as cholera, dysentery and diarrhea. Photos 1–6 below illustrate these conditions.

Photo 1 Stagnant water in an informal settlement

Photo 2 Crude dumping of solid waste

[8] It was not possible to obtain drought information for Dar es Salaam for this study.

Photo 3 Waste-dumping along storm-water drains

Photo 4 Contaminated swimming facility (paid)

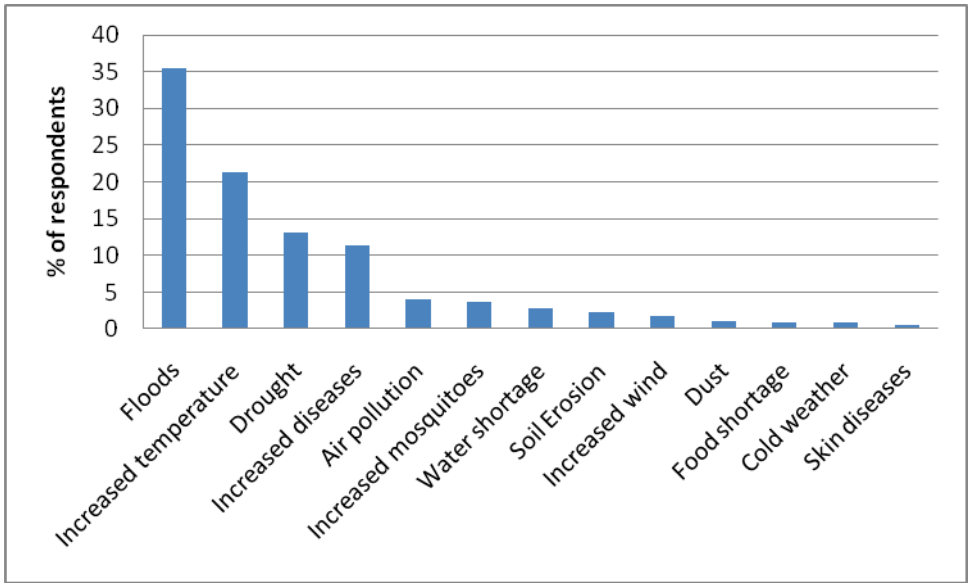
Source: Meshack et al. (2006)

4.2 Household identification of risk

Household identification of risks posed by climate change

When the study team inquired into household perception of risk associated with climate change, 35 percent identified floods as the topmost problem (see Figure 26). Increased temperatures, droughts and diseases also ranked high.

Figure 26: Community identification of risks associated with climate change



Source: University of Dar es Salaam, Case Study Team (2010)

Identification of risks generally faced by residents of unplanned settlements

When the study team asked residents of informal settlements about problems they face in general, many problems were found to be either directly or indirectly climate-related and have the potential to be largely ameliorated through appropriate policies and programs, thus reducing vulnerability to future climate threats. The results are shown in Table 9.

Table 9: Major problems faced by communities in the study area

Ranked Problems	Climate related?	No. of respondents who identified this threat	% of respondents
Floods	Yes	109	25.7
Diseases	Yes	97	22.9
Heat/Increased temperature	Yes	33	7.8
Mosquitoes	Yes	25	5.9
Theft		25	5.9
Shortage of water	Yes	19	4.5
Environmental pollution	Yes	17	4.0
Bad smell in the area	Yes	16	3.8
Crude garbage disposal		15	3.5
Drought	Yes	13	3.1
Dirty unsafe water	Yes	11	2.6
Off-plot sludge disposal	Yes	10	2.4
Noise		7	1.7
Poor infrastructure		7	1.7
Poor social services		5	1.2
Lack of roads		4	0.9
Mud	Yes	4	0.9
Hunger	Yes	3	0.7
Increased flies	Yes	2	0.5
Dust	Yes	1	0.2
Inflation		1	0.2
Total households		**424**	**100.0**

Source: University of Dar es Salaam, Case Study Team (2010)

Floods and diseases were identified as significant problems by over a fifth of the respondents interviewed. Other problems that rainfall and humidity can have significant impact on include mosquito presence, pollution and strong odors in the neighborhood, unsafe drinking water, mud, and flies. High temperatures, too, were identified as a problem and can increase decomposition rates and heat stress, while drought affects water quantity and quality, dust levels, and hunger.

As climate continues to change, increased rainfall variability, resulting in heavier and/or more frequent flooding, as well as the possibility of higher temperatures and more frequent drought, would greatly exacerbate the existing vulnerabilities identified. City and community measures to reduce existing vulnerability are crucial in building resilience towards future climatic changes.

4.3 Projected impacts of climate change in Dar es Salaam

A range of possible impacts of climate change could aggravate the vulnerability of Dar es Salaam's urban poor. Climate change is likely to increase rainfall intensity in Dar es Salaam and thus worsen flooding. A rise in sea level would exacerbate ongoing coastal erosion and degradation. Coastal storms could become more intense and be accompanied by greater storm surges than at present, placing coastal communities at greater risk. Increased temperature could raise humidity levels in rainy seasons, with adverse implications in terms of pest and

disease incidence. Prolonged drought would affect water and electricity, with adverse implications for health, agriculture, agribusiness, and small business enterprise in the city.

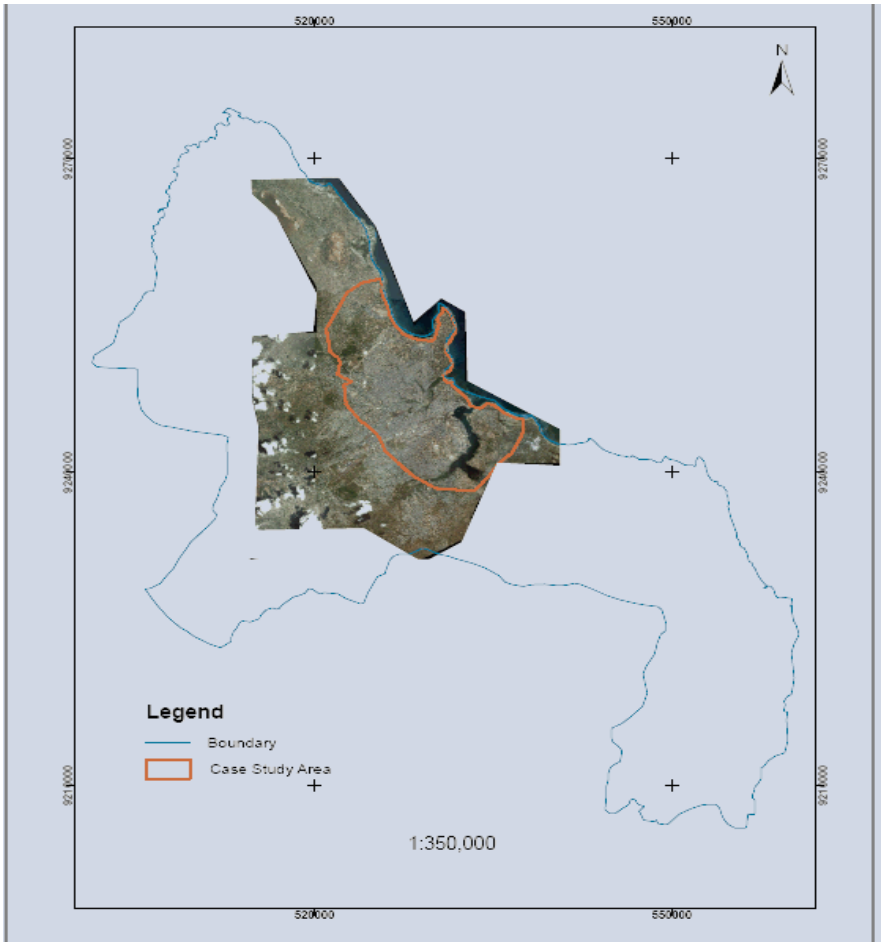
4.3.1 Flood modeling

Ardhi University undertook a flood modeling exercise that would provide an indication of the effects of climate change on flooding in Dar es Salaam by mapping potential changes in rainfall regime and sea level rise on the flood extent and depth in at-risk areas that were covered in the socio-economic surveys implemented by the University of Dar es Salaam. A combined 1D-2D hydrodynamic model known as SOBEK was used (developed by Delft Hydraulics Software). This flood propagation model required spatial data (including a digital elevation model and surface roughness estimates) and temporal data (such as initial water level, and downstream and upstream boundary conditions).

Figure 27 shows a map of Dar es Salaam with case study area outlined that was used for the modeling. Figures 28 (a), (b) and (c) show flood extents for floods with a 5, 10, and 50 year return period, using varying rainfall magnitudes taking sea level rise into account (kept constant across the maps).

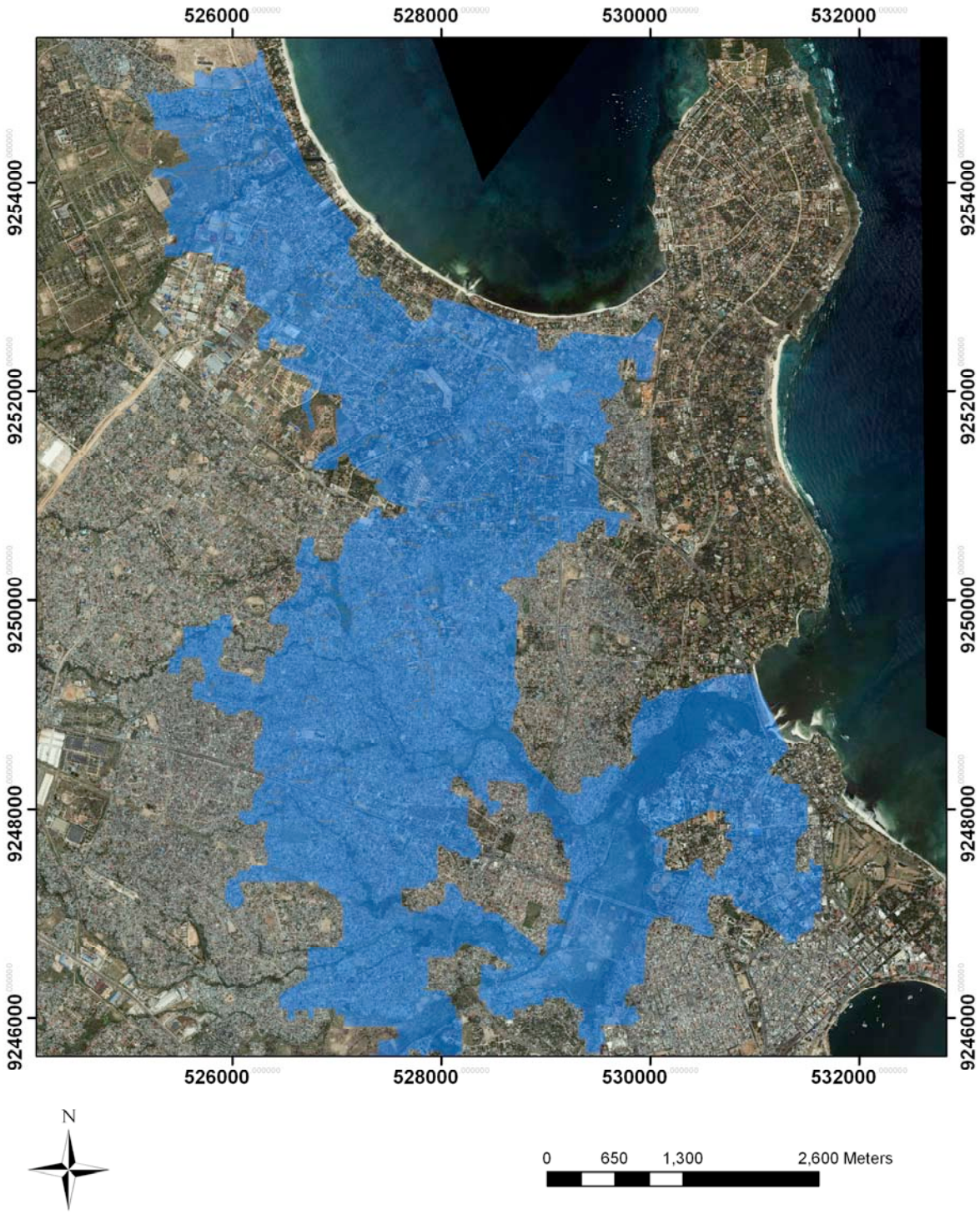
Detailed information on the digital elevation model used, and flood model parameters, schematization, calibration and scenarios, is available in Annex 5.

Figure 27 Dar es Salaam showing a case study involved in modelling



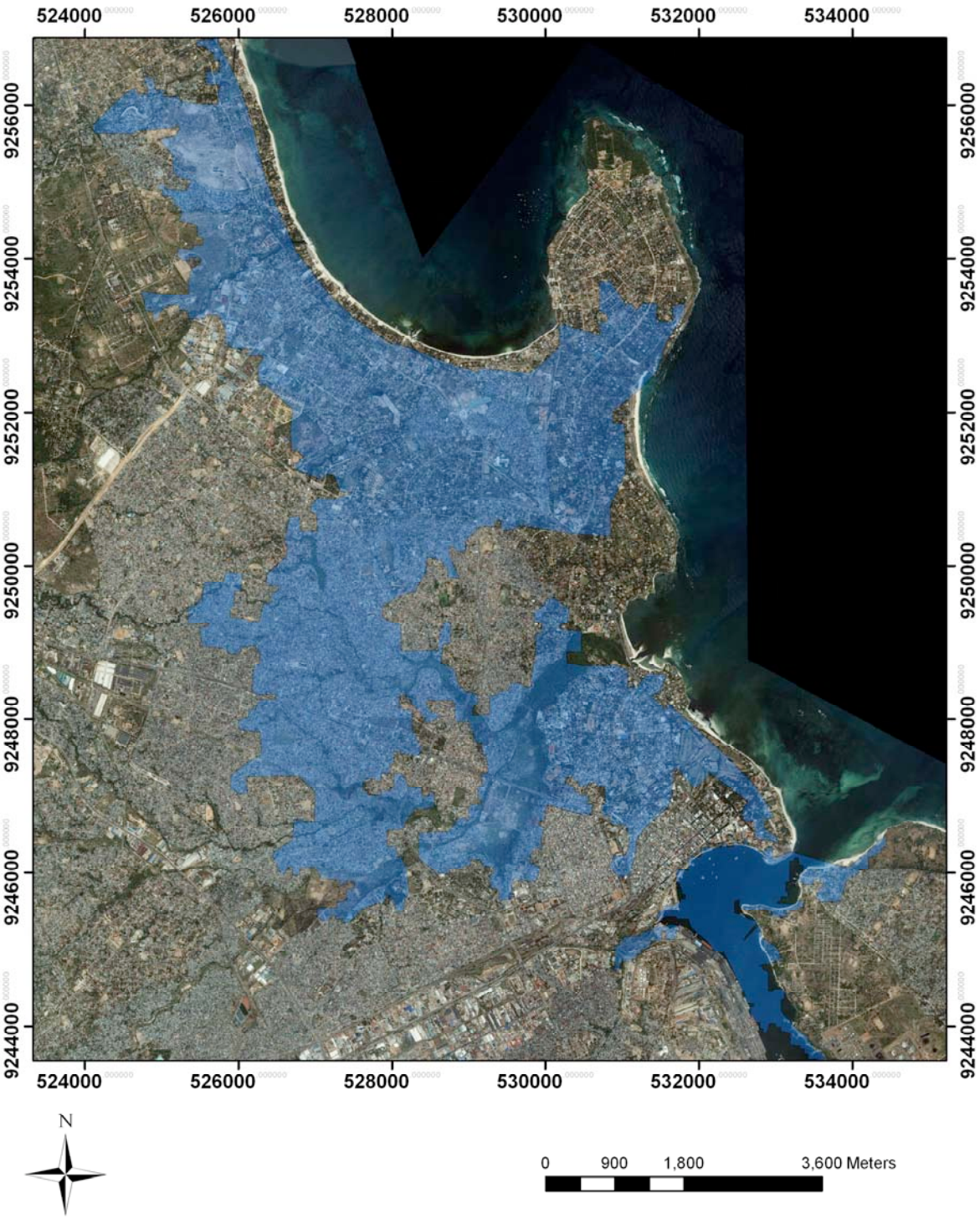
Source: Ardhi University (2011)

Figure 28 (a) Modeled flood extent for Dar es Salaam case study area showing a 5 year return period



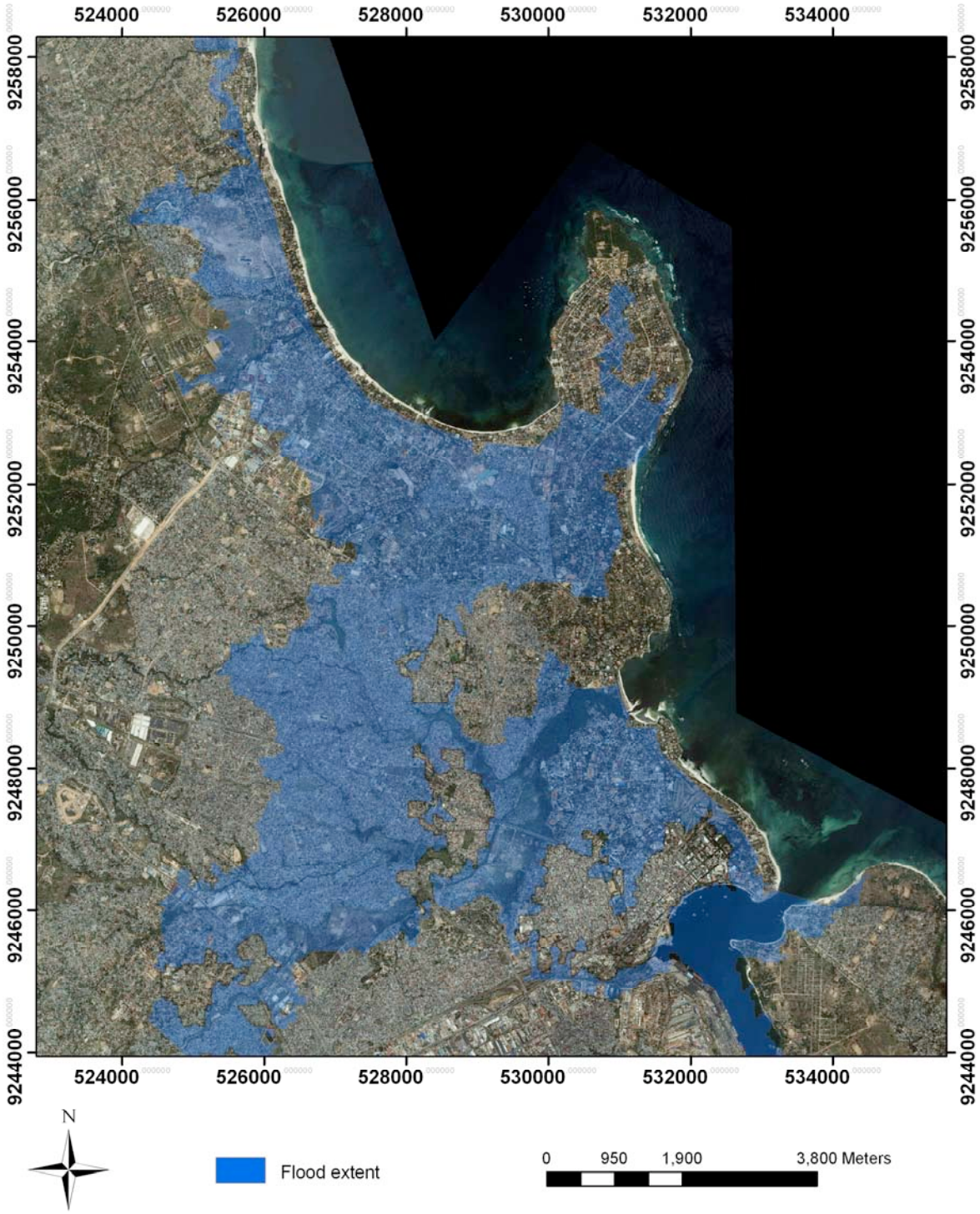
Source: Ardhi University (2011)

Figure 28 (b) Modeled flood extent for Dar es Salaam case study area showing a 10 year return period



Source: Ardhi University (2011)

Figure 28 (c) Modeled flood extent for Dar es Salaam case study area showing a 50-year return period



Source: Ardhi University (2011)

4.3 Poverty, pollution and GHG emitting activities

4.3.1 Overview

Climate change is of relevance for Dar es Salaam primarily in terms of its ability to exacerbate the current vulnerability of poor residents who historically have contributed little to the problem. Adaptation, and consideration of climate change in city development policies and programs, is therefore of utmost importance.

However, mitigation is also worth considering, from two perspectives. Firstly, although per capita emissions are currently low, the co-benefits aspects of mitigation may render such actions very worthwhile; conserving forests and reducing respiratory illness through improved air-quality are two examples of local benefits that could ensue from greenhouse gas emissions reduction efforts. Secondly, Dar es Salaam's emissions are expected to rise markedly over the coming years, due to factors such as heavy rural and urban dependence on biomass energy, unreliable electricity supply, and expansion of urbanization, industrialization and transportation activities. There is thus a need to think ahead and consider options for clean technology and improvements in energy efficiency.

Tanzania's Initial National Communication to the UNFCCC provides information on national sectoral greenhouse gas (GHG) emissions and removals. Tanzania's total GHG emissions in 2003 were 64,885 Gg (URT, 2003), with the Land Use and Forestry sector contributing 87 percent of all emissions, indicating a high dependence on natural resources by poor rural communities. Forests and woodlands cover about 34 million hectares in Tanzania, comprising about 40 percent of its land. Deforestation is estimated at between 130,000 to 500,000 hectares per annum (Malimbwi and Zahabu, 2008) with major reasons being harvesting for woodfuel (charcoal and firewood) and timber, and land clearing for the expansion of agriculture. According to URT (2003), removal of CO_2 is 6 percent of total CO_2 emitted by various sources.

Charcoal is produced in rural areas and consumed in cities and towns, where consumers prefer it to firewood due to: (i) its higher calorific value per unit weight than firewood, (ii) the fact that this makes it is more economic to transport charcoal over longer distances as compared to firewood, (iii) storage of charcoal takes less room compared to firewood, (iv) charcoal is not prone to deterioration by insects and fungi, which attack firewood, and (v) charcoal is almost smokeless and sulphur free, as such it is ideal fuel for towns and cities (Kaale, 2005 in: Malimbwi and Zahabu, 2008).

Even though waste management contributes a small percent to national emissions (less than 1 percent; URT, 2003), this sector offers significant opportunity for city-level qualitative improvements for residents as well as the potential to reduce GHG emissions. At present, Dar es Salaam generates 3,841 tons of solid waste per day, with a high proportion (33 percent) generated in unplanned settlements (Dar es Salaam City Council, 2010).

4.3.2 Residential energy sources in Dar es Salaam

Household surveys implemented by study team

The study team asked the sampled households about their sources of energy for cooking and lighting. Over eighty-eight percent of the respondents said they use charcoal cooking stoves, and 41.5 percent said they use kerosene stoves (indicating that some used both). Over 50 percent use electricity for lighting (see Table 10).

Table 10: Sources of energy used for cooking and lighting

Residential energy use	*Cooking*		*Lighting*	
	Number	*%*	*Number*	*%*
Fuelwood cooking stove	18	3.3	0	0
Charcoal stove	480	88.4	3	0.6
Batteries	1	0.2	10	1.8
Kerosene stove & lamp	225	41.4	248	45.7
Metered electricity Flat rate	1	0.2	29	5.3
LUKU-Payment by unit used	6	1.1	247	45.5
Electricity Shared with neighbor	0	0	2	0.4

Source: University of Dar es Salaam, Case Study Team (2010)

Households were paying between TSh 500 to 90,000 per month for kerosene (on average, TSh 13,556 per month), TSh 3,000-60,000 for fuelwood, TSh 1,000-300,000 for charcoal and TSh 1,000-210,000 for electricity. The present minimum monthly wage is TSh 135,270 ($90), while expenditure on charcoal ranges between $1 and $200 per month. Most households (78 percent) use traditional charcoal stoves. Improved charcoal stoves were reportedly used by 7 percent of the households, and improved firewood stoves by only 0.6 percent.

Published studies on Dar es Salaam household fuel consumption

Malimbwi and Zahabu (2008) estimate that 94 percent of Dar es Salaam's households use charcoal, either alone or mixed with other fuels, and about 78 percent use charcoal as their first choice energy source (see Table 11). Only 6 percent do not use charcoal. In addition to households, charcoal is also the major source of energy for hotels, bars and small-scale food vendors.

Table 11: Household fuel preferences

Type of fuel	*Percentage preference*		
	1991/92	2000/01	2007
Charcoal	51	69	78
Kerosene	28	25	13
Electricity	15	4	5
Firewood	1	2	4

Source: CHAPOSA (2002) in Malimbwi and Zahabu (2008)

According to Malimbwi and Zahabu (2008), total daily charcoal consumption in Dar es Salaam is 28,759 bags (each bag of 56 kg). Kerosene is Dar es Salaam's second major energy source for cooking (13 percent of households), followed by electricity (5 percent of

households) and gas (3 percent). Table 11 shows that the percentage of households using electricity has not increased since 2001. Reasons given by various households for not using electricity include: increased tariffs and the unreliability of electricity due to rationing of power during dry seasons. The low adoption of gas for cooking is attributed to low awareness (users still feel that gas can be risky, even though gas cookers have improved and explosions are infrequent), and the fact that the prices of appliances that use gas are high for low-income households. Most households (71 percent) combine more than one type of fuel such as charcoal, firewood, kerosene, electricity and gas.

Scope for mitigation actions

From the climate change policy perspective as well as local benefits, Malimbwi and Zahabu (2008) assess some measures that would reduce deforestation as well as exploit carbon-trading opportunities:

- Certain tree species yield more charcoal, focusing on these would reduce the amount of ongoing deforestation.
- Charcoal efficient stoves (thermal efficiency of up to 70 percent, as opposed to up to 15 percent for traditional stoves) are also becoming more widely available, with consequent increase in their uptake. However, these have lower durability.
- There is significant scope for improving the efficiency of kilns used in the charcoal production process (increasing wood-charcoal efficiency from 19 percent to 30 percent).

Tables 12 (a) and (b) below show the difference in CO_2 emissions that the above measures could yield.

Table 12 (a) Estimation of carbon trading potential of improved charcoal production efficiency for Dar es Salaam City

Bags per day	Kiln efficiency (%)	Equivalent green wood weight (tons/yr)	Equivalent green volume m^3	Biomass (0.5 green volume)	Carbon (tons/yr)	CO_2 emissions (tons/yr)
28759	19	3 051 481	3 589 978	1 794 989	897 494	3 293 805
28759	30	1 932 605	2 273 653	1 136 826	568 413	2 086 076

Table 12 (b) Estimation of carbon trading potential of improved charcoal consumption efficiency for Dar es Salaam City

Bags per day	Stove efficiency (%)	Equivalent green wood weight (tons/yr)	Equivalent green volume m^3	Biomass (0.5 green volume)	Carbon (tons/yr)	CO_2 emissions (tons/yr)
28759	15	3 865 210	4 547 305	2 273 653	1136 826	4 172 153
28759	40	1 449 454	1 705 240	852 620	426 310	1 564 557

Source: Malimbwi and Zahabu (2008)

Dar es Salaam consumes about 50 percent of the total charcoal consumed in the country and, according to Norconsult Tanzania Ltd. (2002), the resulting deforestation, woodland degradation, habitat destruction, loss of biodiversity, environmental pollution and loss of carbon sequestration potential taken together are equivalent to a loss equal to at least 2 percent of Tanzania's gross domestic product. Charcoal combustion emits carbon monoxide and nitrogen oxides. The smoke also includes particulates, formaldehyde and carcinogens, and exposure can cause acute lower respiratory infections in children, chronic bronchitis or chronic obstructive pulmonary disease in women, and other adverse health conditions (*ibid.*).

According to Norconsult Tanzania Ltd. (2002), it is important to remove misperceptions that household consumers in Dar es Salaam have about liquefied petroleum gas appliances being unsafe to use. The authors cite the example of Senegal, which actively promoted the use of liquefied petroleum gas and thus succeeded in checking the pace of deforestation.

Important measures to encourage Dar es Salaam residents to switch from charcoal to other fuels include subsidizing appliances that use gas or electricity and reducing tariffs, better awareness-raising on the benefits of alternative fuel use, and more reliable electricity supply during drought periods.

5 Policies, programs and institutions to address climate change in the context of the urban poor

Reducing vulnerability to climate change among Dar es Salaam's poorer residents will require first addressing pressing needs of the present. Many of these relate to improvements in urban planning and provision of basic infrastructure and services. In planning construction or upgradation of infrastructure, city authorities must consider engineering design that can handle changing climate regimes, as much of the water and sanitation infrastructure tends to be long-lifetime and will witness some extent of climate change. Climate change may also affect demand for services such as health and water. It is imperative that disaster risk management approaches are integrated into urban planning at present and that potential changes in climate be considered for long-term planning purposes.

The sub-sections below briefly cover major institutions, policies and projects that have shaped urban development in Dar es Salaam to date.

5.1 Identification of stakeholders and key institutions

Dar es Salaam City is managed by the Dar es Salaam City Council and the Municipal Councils of Temeke, Kinondoni and Ilala (see Box 3 for their respective roles). The three municipal authorities are under the Ministry of Regional Administration and Local Government. Each has individual sets of technical and administrative departments.

A key need for adaptation and reduction of vulnerability in Tanzania and Africa in general is integrated development planning, which will need to be implemented by various government sectors through partnership with non-government organizations, the private sector and stakeholder communities (IIED, 2006). A tripartite system has been established in Tanzania whereby NGOs and the private sector are sub-contracted for implementation of government projects that also require community engagement.

Box 3: Roles of the City Council and Municipal Councils

The Dar es Salaam City Council (DCC) has a coordinating role and attends to issues that cut across all the three municipalities. Its functions are:

- To coordinate the functions of the three Municipal authorities regarding infrastructure
- To prepare a coherent city-wide framework for the purpose of enhancing sustainable development
- To promote cooperation between the City Council and the three municipal or local authorities
- To deal with all matters where there is inter-dependency among the City's local authorities
- To support and facilitate the overall functioning and performance of the local authorities
- To maintain peace, provide security and emergency, fire and rescue services, ambulance and police
- To promote major functions relating to protocol and ceremonies

The Municipal Councils. The Municipal Councils are responsible for the provision of basic social services that includes primary education and partly secondary education especially where the community is involved, primary health care, waste management and cleanliness, district roads, water supply and monitor trade and development activities especially informal sector development and management, cooperatives, agriculture and livestock development, forestry, fisheries, recreational parks and urban planning.

Source: Dar es Salaam City Council (2010:) Dar es salaam Infrastructural Development Programme, Forum for Dar es Salaam Metropolitan Development.Focus on Action and Partnerships

5.2 Relevant policies

5.2.1 Urban planning

1979 Dar es Salaam Master Plan

According to Meshack et al. (2006), the 1979 Dar es Salaam Master Plan correctly recognized the importance of drainage in the city, designating areas such as Bonde la Mpunga as hazard land due to flood hazard. Hazard land status was accorded to areas susceptible to floods and erosion, with steep slopes associated with river valleys, and other physical limitations. The Plan permitted such areas to be used for only recreation, agricultural, or salt operations, and restricted residential construction. The period 1979-1990, however, saw residential development in areas zones as hazard lands by the Master Plan, for example in Bonde la Mpunga.

A local plan in violation of the Master Plan

Meshack et al. (2006) recount that in 1992, the Dar es Salaam City Council and the Ministry of Lands and Human Settlements development officially approved a local subdivision plan that accorded residential status to former 'hazard land' status along Old Bagomoyo road. New approved developments included the Tanzania Electric Company, a shopping center, and another private development. These decisions were not informed by environmental impact assessments or analysis of impact on drainage in the area. The commercial developments attracted new low-income residents to the area. The Bonde la Mpunga settlement is located in this area, and suffers frequent flooding.

National Land Policy, 1995

Driven by concern at the rate of encroachment on hazard lands (such as wetlands) for housing and other urban development in Dar es Salaam and other cities, the National Land Policy was formulated in 1995, which recommended effective management of these lands to reduce risks to life and property and to prevent land degradation. This has formed the basis for a number of supporting initiatives in integrated planning and resource management.

National Human Settlements Development Policy (2000)

This Policy emphasized the need to restrict construction in hazardous and undeveloped natural lands, called upon the Government to ensure that hazardous areas were protected from encroachment, and restricted the issuance of titles to developers invading open spaces and hazardous lands.

A year after this Policy was approved, however, the Kinondoni Municipal Council, in Dar es Salaam, prepared a subdivision plan that covered part of a wetland, and approved of the development of a large-scale shopping center and a high-rise hotel building. According to Meshack et al. (2006), these developments have increased the flood risk to the area, and both have been constructed *on the drainage channel that used to channel stormwater drainage to the Indian Ocean.* Consequently, when it rains, stormwater collects in the low-income residential area and stagnates in the settlement for more than three months (*ibid.*).

5.2.2 Environment and climate related policy

Environmental policies

The National Environmental Policy (1997) and the National Environmental Management Act (NEMA No. 20, of 2004) provide a framework for implementation of both adaptation responses and mitigation measures.

The NEMA (2004) provides a comprehensive environmental framework that is intended to streamline management of the environment in Tanzania and is used as a reference regulation for environmental protection in Tanzania. It makes an environmental impact assessment (EIA) mandatory prior to the development of specific types of projects, outlines steps to be followed during an EIA, and elaborates how authorization of a development project is to be given in accordance with the law. It gives powers to the National Management Council (NEMC) to ensure compliance of the NEMA in collaboration with other stakeholders.

Some measures have already been addressed and are carried forward. These include undertaking of EIAs for development projects and investments, and the promotion of energy saving cooking stoves and other energy efficient utilities (solar, biogas, biofuel). Efforts are being made to incorporate climate change concerns in development plans.

Climate change policy

Tanzania has ratified the UN Framework Convention on Climate Change (UNFCCC) and subsequently acceded to the Kyoto Protocol in April 1996. Since then it has been making efforts to contribute to the broad-level response to climate change, i.e., to reduce greenhouse gas (GHG) emissions as well as towards adapting to the impacts of climate change.

The country's Development Vision 2025 (URT, 2003) also provides an important basis for implementing climate change mitigation measures, although it does not mention climate change specifically.

5.3 Programs and projects

5.3.1 Reducing the vulnerability of Dar es Salaam's poor

The Sustainable Dar es Salaam Project, and the Strategic Urban Development Plan (SUDP)

The 1980s saw poor regulation of development in Dar es Salaam, which led to a leadership crisis and dismissal of the City Council in the early 1990s. With the goal of eventually revising the city's Master Plan to improve city management, the Ministry of Lands and Human Settlements Development requested technical assistance from UN-Habitat, which advised that a stakeholder-driven approach should be adopted, focusing on cross-sectoral and inter-agency coordination. Thus a new approach to development of the city began with the Sustainable Dar es Salaam Project, in 1992, and, following consultations, to the formulation of the Strategic Urban Development Plan (SUDP).

The SUDP, initiated in 1992, included management of hazardous lands and open spaces. The initiative was funded by ILO-Assist, UNDP-UNV, Ford Foundation, Cowi Consult (which designs stormwater drainage structures) and UNCH-Habitat, and involved the Kinondoni Municipal Council, the National Income Generating Programme and the University College of Lands and Architectural Studies (UCLAS). Residents were involved in land use planning and improvement of their areas.

The program covered floodprone areas such as Hanna Nassif, located along the Msimbazi Valley. Some 20,000 people (or 5,045 households) lived along the edge of Msimbazi Valley, an area highly prone to flooding due to its location.

The Project was implemented in three phases and involved (i) training residents (both men and women) in construction and repair of storm water drainage systems, (ii) provision of facilities for a credit association, dispensary, and water-vending kiosk, and (iii) creation of a community-based organization (CBO) for managing the credit facility and for improving livelihoods, as well as (iv) creation of a CBO for waste collection. Evaluation of the SUDP Hanna Nassif initiative in 2000, by the I.T. Transport of UK and IRA-UDSM, indicated great success in the control of floods, and in disposal of crude sewage and wastewater.

Reassessment of the area in 2010 (Kiwasila, 2010), however, showed resurgence of previous unsanitary practices, such as: direct disposal of sewage into open drains that were created under SUDP through participatory efforts of the community (see Photo 5); connecting septic tanks and pit latrines to the drains; constructing petty trade structures on top of drainage channels; and disposing of solid waste, sweepings and silt into the drains.

It also appears that improvements to the area led the land's value to increase and owners sold their land to investors (of bars, casinos and lodges) and themselves relocated to cheaper, more vulnerable valley areas. The fact that private owners of housing in improved unplanned settlements tend to sell their property upon its improvement poses an impediment to the goal of developing a well-planned city, as the sold houses are further constructed upon and unorganized multi-storey buildings are erected. Such community improvement programs should attempt to incorporate measures to induce the poor to retain their improved housing structures and improved plots of land.

Photo 5: Open drainage in Hanna Nassif, constructed during community-based settlement upgrading

Source: UN-HABITAT (2010)

Community Infrastructural Upgrading Programme (CIUP)

The Community Infrastructural Upgrading Programme (CIUP) is operating under the auspices of the Local Government Support Project (LGSP), financed by the World Bank and supported by the UNDP and ILO. Introduced in 2001 as a community driven infrastructure upgrading program targeting unplanned areas, it operates in 9 wards and 31 *Mtaas*.

The project aims at improving physical infrastructure such as stormwater drainage networks and strengthening the capacity of communities to better help themselves, especially those living in unplanned settlements. It also aims at eliminating poverty and disease, as well as child labor, through which family income is sometimes supplemented. Other factors considered for support under the CIUP include insecurity of land tenure, poor sanitation or environmental conditions, high unemployment rates, high population density, high crime rate, and social or environmental isolation.

The City Council has been engaged in a detailed baseline study for this project. Over 2005-2010, communities were classified for priority infrastructural development on the basis of cholera epidemics, congestion of houses, lack of services, flooding and poverty (poor housing, toilets, low income). This study covered 20 percent of the city's unplanned settlements – a population of 300,000 (13 percent of the city's population).

For areas chosen on the basis of the baseline study, technical project staff works with grassroots municipal extension staff in facilitating bottom-up planning with *Mtaa* residents and their leaders. Community awareness, capacity building and involvement are important elements of the program. Activities are jointly identified with communities and technocrats, and the level of community contribution in cash (financial contribution is usually 30 percent, with each household contributing), in-kind (in the form of labor power) and budget are decided and agreed upon. Experts determine infrastructure layout, and contractors are asked

to give employment priority to community residents. Community planning and facilitation tools are adapted for each municipality to facilitate democratic planning through an iterative process.

Only one *Mtaa* studied by the case study team for the household surveys and onsite observations was involved in CIUP, Kigogo Mkwajuni. The study team attended one of its CIUP facilitation meetings.

African Urban Risk Analysis Network (AURAN) Project Phases I and II

AURAN is an initiative of leading NGOs and universities in African urban areas, supported by UNDP and ProVention. In its first phase, which started in 2004, partners focused on seven cities in Africa, including Dar es Salaam, and worked on issues pertaining to vulnerable groups in informal settlements. As part of this work, the Ardhi University Disaster Management Training Centre in Dar es Salaam identified disaster risks and developed risk reduction training programs in three informal settlements in the city. Phase 2 (which started in 2008 and ended in 2009) focused on mainstreaming disaster risk reduction in urban planning practice, and conducted an in-depth study of the Monde la Mpunga settlement (Kinondoni Municipality) to arrive at several policy as well as technical recommendations (see Box 4 for a snapshot of this study).

Box 4: AURAN Project case study on integrating disaster risk management at Bonde la Mpunga

Objective: In Dar es Salaam, the AURAN Phase II project focused on flooding in the unplanned settlement Bonde la Mpunga, and in understanding how disaster risks reduction processes can be mainstreamed in urban planning practice.

Implemented by: A research team based at Ardhi University as well as a second team formed by the Prime Minister's Office to work on technical and financial proposals for solving flooding problems in the area.

Background: The larger part of Bonde la Mpunga lies between 0 and 3m above sea level, with the central part being the lowest, and waterlogged. Kijitonyama River bisects the area into two parts, and the western part of this stream floods heavily when it rains. Flooding is largely attributable to housing and commercial development in the area, which have led to:

- Re-routing of the storm water from its natural course to allow development of the area;
- Blocking of natural water courses, which causes water to pond;
- Land reclamation through backfilling of the wetland, which causes surrounding areas to flood;
- Construction of mounded pit latrines, which are emptied into flowing water during the rain season, placing residents at risk of contracting diseases;
- Ponding of water for a long time has destabilized foundations of many houses and consequently they have either collapsed or are at the verge of collapsing. Some houses are not fit for human habitation because they are about to collapse; and
- Inadequate waste management services and the high groundwater table are responsible for the outbreak of water related diseases, notably, cholera, dysentery and malaria.

Although various urban upgrading schemes and drainage channels were proposed and at times implemented in the area, analysis shows that in many cases disaster risk reduction issues were inadequately taken into account at both local and central government levels.

The study makes a number of technical and policy recommendations to better incorporate disaster risk reduction in urban planning processes in this area. The figure below is an example of one of the study outputs.

Existing and Proposed drainage channels at Msasani Bonde la Mpunga area

Source: Kiunsi et al. (2009)

Rehabilitation of storm water drainage and sewerage system

Improvements were undertaken by city authorities in the city centre. However, a new wave of investment has led to construction of new structures in former empty spaces, including the construction of multiple-use buildings that have increased demands for water supply and enlarged high capacity sewage pipes. The tonnage of solid and liquid waste generated has increased, demanding efficient solid and liquid waste management and monitoring services. On occasion, wide and deep stormwater drains are appropriated by private homeowners, fenced in as part of their property, and sealed up, which causes waste back-up problems among poorer neighbors.

Laws need to be better enforced and drainage line capacity needs re-assessed. It is important that when this occurs, planners consider the fact that capacity needs are likely to change over the drainage system lifetime; the system needs to plan for changing rainfall regimes over the planning horizon e.g., up to 2050.

Property formalization in Dar es Salaam

The government is implementing a project to identify all properties in informal settlements in Dar es Salaam and at the same time issuing land/property licenses or Right of Occupancy to curb further densification of those areas and to improve security of tenure, which could be used as collateral for economic empowerment (URT 2004 in: Kyessi and Kyessi, 2007). This formalization process will be a foundation for the regularization of the slums that will ultimately allow provision of infrastructure including drainage channels for stormwater, piped water supply, refuse collection services using municipal and private vehicles, sanitation (pit and septic tank emptying services), secure tenure (loans), improving housing conditions and reducing overcrowding in unplanned settlements.

5.3.2 Adaptation-friendly Policies and Activities

National Adaptation Programme of Action (NAPA)

Tanzania is party to the UNFCCC and the Kyoto Protocol and has prepared a National Adaptation Programme of Action (NAPA, 2007). The capacity for investing in adaptation activities (protecting vulnerable populations, infrastructure, and economies) is still low due to financial constraints (NAPA, 2007). However, the NAPA will help in the integration of adaptation issues in the development process, guiding development to address urgent and immediate needs for adapting to adverse impacts of climate change. Among other objectives, the NAPA aims at improving public awareness on the impacts of climate change and on potential adaptation measures that can be adopted. In Dar es Salaam, activities have included planting trees along the beach, roadsides, near houses and in open spaces.

Management of coastal areas

Dar es Salaam is a coastal city and climate change is expected to exacerbate vulnerability of poor coastal communities through sea level rise, possibly more intense coastal storms, and increased rainfall variability. Coastal management projects involve beach conservation, including conservation of mangroves and coral reefs, as well as Marine Park protection. Poverty alleviation components, such as facilitation of seaweed farming, are also often included. Some of the city's coastal management projects are noted below.

Kinondoni Integrated Coastal Area Management Project (KICAMP)

- A key aim of this project is to formulate a comprehensive plan focused on the use of land and water resources in coastal areas. The project has banned the excavation of sands in Kunduchi-Mtongani as a way to prevent further beach erosion from occurring along the coastal area.
- Households are being made aware of the value of mangroves and involved in their protection, and, combined with heavy protection from KICAMP, this has led to increase in mangroves. Other civil society organizations involved in conservation, awareness raising, and environmental management included Roots and Shoots, World Vision, URASU (Uchoraji na Ramani na Sanaa Shirikishi Dhidi ya Ukimwi), and the International Organization on Migration, which helped the formation of environmental management societies in schools, markets and dispensaries. Schools had already planted trees and botanical gardens in their compounds.

Sustainable Coastal Communities and Ecosystems

This USAID-funded project (implemented by Rhode Island &Hawaii-Hilo universities) builds adaptive capacity and resilience among vulnerable coastal communities. The program has introduced "raft culture" techniques where seaweed is grown in deeper water where it is less vulnerable to fluctuations in temperature and salinity, which will enable beneficiaries to earn a living throughout the year.

Construction of adaptive structures in Dar es Salaam

A comprehensive beach conservation program has been designed that includes the following components:

- Sea walls have been constructed along the front of the Aga Khan Hospital to prevent further erosion of Sea View Road.
- Sea walls and groins have been constructed along some beaches, which benefits hotels by reducing beach erosion and property damage from waves, and also helps fishing community settlements that live near the sea.
- Land reclamation activities are taking place along coastal areas, e.g., by covering quarry pits with soil and trees and building houses on these reclaimed areas. The Kunduchi-Salasala quarry area is an example.

Coastal conservation in Msasani Bonde la Mpunga

Msasani Bonde la Mpunga is involved in coastal conservation measures through a partnership with WWF, Wildlife Society for Nature Conservation, the private sector (running tourist hotels and sea boats), IUCN and Tanzania Marine Park authorities.

Other

The country has strengthened multi-lateral relations at the international level in order to enhance the ability to cope with climate change and variability for sustainable livelihoods. For example, Tanzania and the Kingdom of Norway have agreed to partner to combat adverse impacts of climate change. Under this program, Tanzanian scholars are trained on climate change issues (planning and forecasting), and, as short courses on climate change tend to be publicized through newspapers and on television, awareness is raised among the public on climate change impacts, adaptation measures and mitigation.

5.3.3 Mitigation-Friendly Policies and Activities

Party to the Kyoto Protocol

Tanzania has ratified the UN Framework Convention on Climate Change (UNFCCC) and subsequently acceded to the Kyoto Protocol in April 1996. Since then it has been making efforts to contribute to the broad-level response to climate change, i.e., to reduce greenhouse gas (GHG) emissions as well as towards adapting to the impacts of climate change.

Gas flaring at Mtoni dumpsite

Dar es Salaam has experience with emissions trade through this CDM project; the City Council closed the Mtoni solid waste dumpsite and, in collaboration with a private company, created mechanisms for tapping and flaring the gases produced at the dump. Together they invested over TSh 2 billion and in 2008 the partnership was able to sell the 13,895 tons of carbon that had been flared (the cost of carbon was reported as €10-15 per ton).

Follow-up to this CDM project has been proposed. An Environmental Officer will continue to work with health officers to control pollution, and communities will continue to be involved in waste collection. Industries and companies will be charged for generating solid and other types of waste, and plans are to deposit this revenue for investment in waste control and recycling and gas flaring programs. The city will also undertake the following activities, which will not only contribute to reduced GHG emissions but also help keep the city clean:

- *Create waste buy-back and drop-off collection centers* for people to sell recyclables (plastic, paper, cardboard, glass, metal) as well as package decomposable waste in special containers for disposal at the dumpsite in order to make and trade compost fertilizer. A number of activities involve working with the Municipal agencies, e.g., identifying contractors for collection and transportation of recyclables; educating city dwellers on how to separate waste; providing containers for waste separation; and constructing sub-station chambers or providing trailers for temporary storage of separated waste before it is transported to treatment sites.
- *Register industries by waste type*, to move towards implementation of a 'polluter pays' strategy;
- *Register all NGOs/CBOs and individuals that deal with recyclables,* to involve them in recyclables trading;
- *Look for interested donors and investors to support the initiative*, as the program requires substantial funding and City/municipal resources are limited. An initial capital of TSh 18,528,140,000 (US$12,352,093) is needed. Funds obtained will be put in a special environmental account (Mfuko wa Usafi wa Mazingira-MUM, a type of community fund), which will be monitored by a Board of Trustees and supervised by the Regional Administration and Municipalities. This fund will be used for purchase of transport and storage facilities, construction of waste recycling-incineration plants, research in waste management and emissions, greening the city (tree planting), construction of embankments where needed, and training of local CBOs in environmental management and helping them to acquire necessary work tools. Revenue from waste handling is expected to total over TSh 35 billion per year.
- *Place a health officer and a community development officer in charge of environmental sanitation and facilitation of environmental CBOs*. The officers will be supported with: radio communication facilities for in case they need to contact other officers for law enforcement purposes; *Mtaa* security guards for control of unsanitary waste handling; computers for data banking; cars (double cabin pick-ups) for street patrol on waste and hygiene issues; trailers (as waste sub-stations) and tractors for pulling trailers that contain waste; a van for community education, equipped with a public address system; and refuse collection trucks and compactors. *Mtaas* will be zoned for decentralized management.

- *Implement a Green Competition* for the cleanest area (by *Mtaa* and Municipality) based on several sectoral indicators.

5.4 Spending on pro-poor services and infrastructure

Dar es Salaam's municipal agencies provide infrastructure and socio-economic services such as health, water, education, solid waste management, cooperative and community development, roads, development of natural resources, trade and agriculture and livestock sectors, and information and communication technology development. Despite efforts to improve social services for city dwellers, increased migration and unemployment have made services poor and unaffordable. Rapid urbanization in Dar es Salaam is resulting in growing numbers of the population living in un-planned, densely settled squatter areas with little or no access to social services (URT, 2004).

Despite purported improvements in fiscal position and revenue collection systems, improved record-keeping and enhanced accountability, the Dar es Salaam City Council (including its Municipalities) still faces considerable challenges in spending on pro-poor services and on improving infrastructure in unplanned and underserved areas. Significant increase in revenue-generation is needed to ensure both increased service coverage and quality of services, particularly taking into account the additional resilience needed to reduce the risk posed by climate change for the city.

Priorities in meeting the challenges include improving information systems (databases) and updating valuation rolls; optimizing the potential of property tax and simplifying the development levy; and developing vigilant collection strategies and more enhanced law enforcement capacity (City Council, undated Brief DSM V2: 6)

5.5 Financial Mechanisms for climate change adaptation and mitigation

Many developing countries, including Tanzania, are adversely affected by current climatic variability as well as expected future impacts of climate change, and lack the financial resources to adapt. Poverty is also leading to the degradation of natural resources, such as forests, in many developing countries; this trend provides the basis for investment in projects to increase carbon sinks in these areas and thus contribute towards global efforts to mitigate climate change. Funding is increasingly being made available to developing countries for both adaptation and mitigation purposes (Table 13 lists funds that Tanzania is eligible to access).

Table 13: Climate Change finances in which Tanzania is eligible and status of the available fund (as of Dec 2010)

No.	*Fund*	*Pledged (US$ million)*	*Deposited (US$ million)*	*Disbursed: annual total (US$ million)*	*Funds available (including pledges) (US$ million)*
1	Adaptation Fund (AF)	162.57	162.56	5.98	156.59
2	Clean Technology Fund (CTF)	4,387.75	483.50	9.30	4372.45
3	GEF Trust Fund - Climate Change focal area (GEF 4)	1,032.92	1,032.92	1,017.88	15.04

4	GEF Trust Fund - Climate Change focal area (GEF 5)	1,359.38	0.00	N/A	1359.38
5	Least Developed Countries Fund (LDCF)	180.81	155.36	125.21	55.6
6	Special Climate Change Fund (SCCF)	123.09	104.12	97.15	25.94
7	Strategic Climate Fund (SCF)	2,529.00	635.07	N/A	N/A
8	Strategic Priority on Adaptation (SPA)	50.00	50.00	50.00	N/A
9	UN-REDD Programme	74.44	54.12	29.52	44.92
10	Forest Carbon Partnership Facility (FCPF)	220.64	166.44	4.42	216.22
11	Forest Investment Program (FIP)	562.10	33.90	2.00	560.1
12	Global Climate Change Alliance (GCCA)	204.15	205.15	8.10	196.05
13	Global Energy Efficiency and Renewable Energy Fund (GEEREF)	169.50	63.68	0.00	169.5
14	Hatoyama Initiative	15,000.00	5,320.00	5,320.00	9680
15	International Climate Initiative (ICI)	519.60	515.61	258.02	261.58

Source: Climate Change Updates (2010)

The governments of Norway and Denmark have both made commitments to support climate change initiatives in Tanzania. Norway has expressed interest in promoting economic growth and poverty reduction with a focus on energy, climate and environment, as well as improvements in maternal and child health. Tanzania and Norway are working together to combat climate change, including through efforts in reducing deforestation and forest degradation (REDD), for which Norway has allocated NOK 500 million (US$ 73 million) for the development of a 5-year national REDD program. Tanzania's REDD strategy is being developed in collaboration with the UN-REDD Programme.

Denmark has supported Tanzania on environmental issues for several years, on issues such as urban environmental management and natural resources management, including forestry and wetlands management. Denmark also supports environmental mainstreaming in policies, strategies and legislation, including in the Poverty Reduction Strategy.

Effectiveness and sustainability of existing mechanisms

Climate change mitigation and adaptation strategies have largely focused on the agriculture, forestry and land use sectors. Activities have centered on forestry and wildlife conservation, promotion of sustainable agriculture, and enhancing sustainable land use. A few REDD and CDM projects are in the pipeline for Tanzania.

Other measures are being undertaken through ministerial arrangements, e.g., the national forestry and beekeeping programme (Ministry of Natural Resources and Tourism), PADEP (Ministry of Agriculture and Food Security) and efforts in integrated water resources management (Ministry of Water and Irrigation). These programs receive local and international financial support to orient their focus on facilitating sustainable use of natural resources as a strategy for reducing GHG emissions, improving the livelihoods of poor

people, increasing resource productivity, and stabilizing the resilience capacity of natural resources. These components are essential ingredients to reduce vulnerability to adverse impacts of climate change in Tanzania, and to promote sustainable adaptation strategies.

There has not been much focus, however, on improving the livelihoods of rural people as an alternative strategy for reducing degradation of natural resources; apart from REDD activities, there is little support in place for activities in agricultural and other land-use sectors. Support for agricultural land management, grazing land management, soil conservation and agro-forestry is low. Projects in these sectors would have significant mitigation potential while offering attractive co-benefits by promoting sustainable development, poverty alleviation and adaptation to climate change. These activities also have direct relevance to the United Nations Convention to Combat Desertification (UNCCD), as they are often situated in arid to semi-arid regions and therefore the most prone to land degradation and ultimately desertification.

Most climate change programs and projects have been largely financed by external actors such as bilateral and multilateral donors and international NGOs, rather than by domestic sources of finance such as local civil society, citizens or the government. This renders the projects potentially unsustainable and vulnerable to changes in donor interests. Although this pattern of donor dependence constitutes a challenge for the development and climate change agendas in Tanzania, little has been done to mobilize local resources to complement or substitute the donor financial flow. There is a need for Tanzanian policies to encourage local funding as much as possible, e.g., through support from foreign direct investments and other business entities.

In order to effectively promote financial flows for climate change and synergize these with Tanzania's development processes, it is important that all relevant stakeholders be cognizant of issues and expected outcomes. Policymakers and planners should be aware of how climate change may impact on development. Linkages between sustainable land management and climate change need to be made clear, as do linkages between flooding, sanitation and health, and between air quality and health.

6 Looking forward

This report has captured some of the salient issues pertaining to urban poverty and climate variability and change in Dar es Salaam, and has highlighted some vulnerability reduction and climate change mitigation activities that are underway in the city. The best starting point for reducing vulnerability to climate change in the future is to take action to reduce *present* vulnerability, such as by reducing threats to health by improving city drainage and environmental sanitation. The sub-sections below suggest areas for continued support, preliminary lessons that have emerged from this study, capacity needs and recommendations for further study.

6.1 Proposed areas for support

Support for public agencies to improve waste collection, drainage, water and sanitation programs

All Municipal agencies are required to comply with and implement the National Environmental Policy and the National Environmental Act of 2004. Often, however, they lack the funding needed to meet the responsibilities entailed, or the supervision capabilities to counter actions that contravene city laws and bylaws. According to the CIUP Waste Management Officer and municipal environment officers, the Municipal agencies have requested allocation of sufficient funds to undertake activities such as:

- Create waste collection sub-stations. These will enable municipalities and Mtaa leadership to collect waste more frequently and thus reduce vector breeding;
- Plant trees along rivers and beaches (mangroves) with the support of NGOs and CBOs involved in environmental conservation;
- Contribute substantially to community-based programs that aim at environmental and infrastructural improvements, e.g., by providing feeder roads and small bridges that will enable waste collection, and covered drains and ditches for storm water drainage;
- Construct toilets, clean drinking water facilities and school fences where these are lacking;
- Support NGOs and CBOs that collect waste. CBOs in particular need support in the form of protective gear, tools for waste collection and transportation, and training on health issues and their responsibilities. These groups go from house to house collecting waste and transporting it to substation chambers for removal by Municipal or contractor vehicles;
- Finance and run awareness campaigns on health matters, roles and responsibilities, bylaws and penalties. If possible revitalize the Ministry of Health Education Unit to undertake (together with municipal health officers, CDOs, health and CIUP committees) health awareness-raising activities through grassroots level dialogue and mass media campaigns;
- Hire district experts or staff to facilitate bottom-up development in unplanned settlements that need to be involved in CIUP and SUDP activities;
- Change the perception among the public that attention to environmental issues is part of a 'political' agenda. Many people do not take the issues seriously, with the result that hazards (including climate-related ones) are increasing.
- Generate land suitability maps for Dar es Salaam for current and future climates. On their basis, cease allocation of land in wetlands for construction of hotels, industries and houses as this exposes people and property to floods and pest and disease vector breeding.
- Upgrade and clear drainage lines to reduce flood risk and flood duration
- Discontinue the services of those contractors (CBOs, NGOs and private companies) that are paid to remove waste, including from clogged stormwater drains, but tend to pile the waste alongside drains (see Plate 3 on pg. 63), or contribute to greenhouse gas emissions by burning them on site. Only efficient waste removal should be remunerated.

Integrate disaster risk management approaches in urban planning

The fact that heavy rainfall leads to prolonged and widespread flooding in Dar es Salaam's informal settlements is largely due to the fact that disaster risk management tends to be frequently overlooked in planning. Kiunsi et al. (2008) cite a range of interrelated problems that give rise to flooding in settlements such as Bonde la Mpunga, and emphasize the need for disaster risk reduction approaches need to be mainstreamed in urban planning.

> "… the mainstreaming of disaster risk reduction into physical planning is absent. Planning itself is problematic. While there are comprehensive plans and guidelines for implementation, implementation is constrained by poor project management,

> inadequate understanding of disaster risk accumulation processes and outright malpractice by both planners and developers. As revealed in Msasani Bonde la Mpunga, rezoning and allocation of commercial plots was not instigated by low-income inhabitants or small-scale developers, rather, by planners working at the behest of wealthy individuals with access to foreign capital. … In order to minimize hazards in urban areas, both in planned and unplanned settlements, disaster risk reduction measures should be part and parcel of the policies, laws and planning procedures. Once institutionalized, these measures must be consistently enforced." (p. 145).

Kiunsi et al. (2009) recommend that guidelines for disaster risk reduction be mainstreamed in the preparation of general planning schemes, detailed planning schemes, detailed urban renewal schemes, and schemes for regularization.

Support public health programs

Cost-effective mass treatment programs need to be implemented for a number of Neglected Tropical Diseases (NTDs), such as filariasis, soil helminthes, and schistosomiasis, which are all prevalent in Dar es Salaam. According to the WHO (2000:11), the cost is $1 per person for a combination drug to eliminate NTDs, taken once per year over a 4-5 year period. This drug combination also kills other intestinal and dermatological parasites. A mass drug administration program for elimination of NTDs should be implemented across national health facilities among people going for treatment for other diseases. The cost is likely to be affordable for community members. Their engagement depends on a well-mobilized program and whether they are fully aware of the benefits of the treatment.

More efforts also need to be put into integrated approaches to control malaria, rather than relying solely on the distribution of nets treated with insecticide. Improvements to drainage systems and their regular maintenance will go a long way towards reducing flooding and consequent ponding and stagnation of water, thereby reducing breeding sites.

Support CDM activities

Dar es Salaam should be supported through CDM funding in expanding and scaling up the City Council's existing plans to manage solid waste. Efforts to encourage fuel-switching at a household level from charcoal to LPG, for example, could also provide valuable health benefits to residents while reducing GHG emissions.

Support existing successful urban upgrading programs

Initiatives such as the Community Infrastructure Upgrading Programme (CIUP), through which informal settlements are being upgraded, have great potential in that they involve communities in identifying problems and solutions and cover a wide array of physical and institutional measures to improve urban areas. Projects such as AURAN have conducted detailed studies on flood risk to informal settlements in Dar es Salaam, and technical as well as community groups have already been established. They need to be supported and used as a resource for future such efforts.

Support for communities, based on survey results

In the surveys implemented by the study team from University of Dar es Salaam, residents and entrepreneurs were asked to identify priority actions needed in their areas. In order of decreasing importance, they identified the need for (i) education on the impacts of climate

change, so that they could formulate and implement adaptation measures; (ii) upgraded infrastructure such as roads, water supply, electricity and bridges; (iii) construction of drainage channels for storm and wastewater; and (iv) planting trees and punishment for those who cut them.

Residents were also in favor of stricter controls of polluting industries and of private entities engaged in haphazard construction in the settlements, and were unhappy about the construction of structures over stormwater drains by investors and other residents, which block drains and cause flooding. Lastly, they complained of some people illegally occupying public land and thus reducing public space for common activities (such as open marketplaces and playgrounds).

Encourage a long-term planning horizon

Climate change cuts across issues of poverty, health, environmental degradation, infrastructure design, land management and zoning, and flooding and disaster risk management. *The most effective form of adaptation for Dar es Salaam's poor residents will be to plan in a way that addresses their urgent needs for now and in times to come, given expected future impacts of climate change.* Addressing basic needs that are currently not being met adequately (e.g., clean water supply, secure housing, adequate drainage and sanitation infrastructure) will reduce the poor's vulnerability and reduce their 'adaptation deficit' (inability to cope with current conditions, including climate variability). The city's planners, engineers, and health officials, however, need to consider a long-term perspective in siting and designing new infrastructure, projecting demand and supply for services, projecting disease distribution, etc., given that climate change has the potential to impact profoundly on such factors. Thus projections for changes in rainfall intensity, for example, should be taken into account when planning stormwater drainage lines that are expected to last several decades. When constructing water reservoirs, decisions on surface area should consider possible increase in future evaporation rates.

6.2 Key lessons emerging from analysis conducted thus far

- Rapid unplanned urbanization in Dar es Salaam has led to flood risk in many informal settlements, with a wide range of associated health and other problems for residents;
- Disaster risk management has largely been ignored and needs to be integrated in all aspects of urban planning in Dar es Salaam;
- The ecological and hydrological role of wetlands needs to be understood and accounted for in urban development (despite being labeled 'hazard land', permits for commercial development on Hazard Lands were occasionally given in the past, fuelling development of informal settlements);
- The sustainability of infrastructure development initiatives and their maintenance is poor, suggesting that alternative approaches are needed. Suggestions include (i) empowering grassroots legal structures to effect the NEMA and the Land Law; (ii) requiring each resident of a community upgrading program to sign a contractual agreement not to expand his/her facility to encroach public land areas, (iii) prohibiting residents of settlement upgrading schemes from selling their property until about 10 years after development, with selling of the site to be approved by local authorities. This will reduce wastage of government and donor resources whereby immediately after an upgrading program (e.g., SUDP or CIUP) new investors move in, with original occupiers moving once again to wastelands or hazardous areas, exposing themselves to more risk than before.

- Coordination among local stakeholders is needed (according to Meshack et al. (2006), there is limited coordination among experts in the Municipalities: the office of the Town Planner, the Engineer, and the Health Officer tend to work independently of each other).
- Industries need to be relocated away from residential areas and each industry should construct or have access to its own waste stabilization pond. This will reduce disposal of chemical and other waste into rivers that households depend on for livelihood activities.
- Awareness-raising programs are needed at the community level educating people about the need for improved sanitation practices. Greater effort needs to go into provision of improved latrines for residents.

6.3 Capacity needs

- Communities in informal settlements need to be educated about the link between unsanitary waste disposal practices, stagnant water, unclean drinking water, and disease incidence.
- Environmental committees and community-based organizations need to be trained about the need for organized waste collection and its link to reduced vector/insect breeding and disease.
- The capacity of the Tanzania Meteorological Agency needs to be improved in weather and climate monitoring, including in more accurate prediction of severe weather and extreme climatic events, and in analysis and interpretation of data. Improvements are also needed in disseminating alerts and early warnings. As exceptionally heavy rainfall in Dar es Salaam appears to often be associated with strong El Niño episodes, efforts should be made to alert the public to increased flood risk at such times.
- Local research capacity needs to be built to better understand the likely impacts of climate change in the long term for the poor of Dar es Salaam.
- Capacity needs to be developed in city planning departments to understand the long-term sectoral impacts of climate change for Dar es Salaam.
- Links need to be forged and enhanced between climate experts and journalists to ensure effective dissemination of climate change information.
- It is important that the Health Education Unit of the Ministry of Health and Social Welfare be revived. This Unit was very active in the past, and undertook health education and awareness raising programs through radio programs and community out-reach.
- The capacity of Dar es Salaam's private sector entities needs to be better developed so they may engage actively in supporting adaptation and mitigation while profiting from such endeavors.

6.4 Recommendations for further study

- It is important to take stock of what has already been done in terms of comprehensive risk assessment of informal settlements in Dar es Salaam. Several disparate efforts have been made by various actors; what has and has not been done, and by whom? It is also very important to find out about technical teams and public officials that have been trained in risk management and sustainable urban planning under these efforts as they should continue to be engaged in similar future efforts, while new capacity is also built.
- Urban/Town Planning and Settlement related laws need to be reviewed to ensure they deal adequately with vulnerability and risk. It will also be important to determine how existing pro-anti-pollution and pro-poor policies and laws can be better enforced (for example, laws prohibiting illegal construction that blocks neighborhood drains).
- High-resolution digital maps are needed for city.

- In-depth analysis is needed of required and proposed long-life infrastructure investments that will be cost-effective and appropriate given changing socio-economic and climatic trends in the city.
- **A series of sectoral case studies should be undertaken** on various aspects of relevance to Dar es Salaam's urban poor, each of which seeks to examine future needs (for a 20-30 year timeframe, given socio-economic trends as well as projected climate change) for:
    - Drainage
    - Water supply
    - Waste management
    - Housing
    - Health planning, and
    - Other key sectors

  Such case studies should involve teams of local institutions as well relevant international institutions with advanced technical expertise.

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Annex 1 (a)

URBAN POVERTY AND CLIMATIC CHANGE IN DAR ES SALAAM CITY
HOUSEHOLD QUESTIONNAIRE
IRA-UDSM

A: LOCATION

Name of the Street: ..... Mtaa …….
Ward ..... District..... Name of River System:
…….. …….
Date/Month/Year of Interview..... Name of Ten Cell Leader
…….. Mtaa Door Number …….

B: INFORMATION ABOUT RESPONDENT

1. Name ..... 2. Sex: Male/Female [ ]

3. Age .....

4 Marital status of the respondent: [1] Single [2] Married [3] Divorced [4] Widow [5] Separated [6] Widower [ ]

5 Is the household Male or Female Headed 1. Male Headed ( ) 2. Female Headed ( )

6 Relation to the head of household 1. I am the head ( ) 2. Husband 3. Wife ( ) 4. Mother ( ) 5. Father ( ) 6. Other relations: Explain …….....

7 Employment status: 1. Employed [ ] 2. Self-employed [ ] 3. Dependant [ ] 4. Retired Officer [ ]

8 Occupation of Respondent. Type of Main and Minor occupation of the head of household

Major ..... earnings per month .....
Minor ..... earning per month .....

9 Total number of people in the households..... Give their details in Table 1. In Appendices 1.

C:RESIDENCE TYPE AND OCCUPANTS

8. Plot No. ……Has the plot been surveyed 1.Yes 2.No
9. Density: High ( ) Medium ( ) Low ( )
10. Geography of the area: 1. Dry hilly area [ ] 2. Low marshy wetland area [ ] 3. Low dry Sandy area [ ] 4. Low muddy clay soil area [ ] 5. Other, describe .....

11. Ownership: Are you the house owner or tenant 1. Owner ( ) 2. Tenant ( ) If owner of house, how did you acquire the land and how much did you pay to who? Give explanation below:

---

12. If tenant, does the owner live in? 1. Yes [ ] 2. No [ ]

13. Number of houses on plot ……

14. Total number of Rooms all buildings, Occupancy and use of building. Fill Table 1:

Table 1: Number of Families in a Residential Building

	No of families	Number of rooms	Type of House 1. story 2. Non story	Use of building 1.Residential only [R] 2.Commercial [c] explain 3. Mixed [M] explain	Is the house/building Rented 1.Yes 2. No	If Rented, how much per room/house per month
1. Main building 1						
Out Building 1						
2. Main Building 2						
Out building 2						
3. Main Building 3						
Out building 3						
Total						

15. If house owner, how much did construction of the house cost you? If more than one house take the cost of all houses.

House 1:..... House 2..... House 3 .....

House 4 ..... House 5. .....

D: HOUSING DETAILS:

16. If the house is a flat: What floor does the household live ( ) others: Specify ……

17. Material used in House Construction where respondent lives (Fill Table 2. If more than one house, fill additional Tables)

Table 2: Construction Materials

Walls:	**MB (main building)**	**OB (Outer building)**	**Roof Main House**	**MB**	**OB**	**Floor: Main House**	**MB**	**OB**
Cement blokes			CIS			Cement		
Burnt bricks			Coconut fronds (Makuti)			Mud		
Mud bricks			Grass			Gravel with cement (kokoto)		
Stones and cement			Grass ands plastics			Tiles with cement		
Canvas			Asbestos			Burnt bricks		
Mud and Poles			Concrete			Sand		
Timber			Use metal materials			Timber		
Mixed materials			Tiles			Mixed materials		
Poles only (miti/fito)			Mixed materials			Other		
Other			Other					

E: Household Demography

18. Household Density: What is the total number of people in all houses on Plot? Fill Table 3 below

Table 3: Total Population in a Building/House

	Number of adults all people in a family	Gender of Head of Household(Male/Female)	Main employment of head of household
Family 1			
Family 2			
Family 3			
Family 4			
Family 5			
Family 6			
Family 7			
Family 8			
Total			

F: Migration Information

19. Place of Birth of Respondent: where born

i. Within the District

ii. Outside the District but within Dar es Salaam region. Mention District: .....

iii. Outside Dare s Salaam Region. Name it .....

20. If not born in Dar es Salaam, when did you migrated to Dar es Salaam? Mention year ..... Give reasons for migration to Dare s salaam.

i) .....

ii) .....

iii) .....

21. Movements/relocation to different localities within Dar es Salaam. Please mention migration years and places settled before this locality

Table 4: Within city movement

No	Places settled within DSM	Year	Reason for moving/settling in this place	Reasons for moving out of the place (street/area)
1				
2				
3				
4				
5				
6				

G: Livelihood activities of the Household (all activities done by members)

22. Mention 5 Major and Minor income-earning activities of your family

Table 5: Livelihoods

	Major activities			Minor activities		
	Activity	Income per month	Use of this income	Activity	Income per month	Use of Income
1						
2						
3						
4						

H: HOUSEHOLD EXPENDITURE

23. How much do you spend in Tshs on the following items for your family

1. Food per day ..... x 30 days .....
2. Travel per day for adults/parents ..... x 30 days .....
3. Travel to school by children ..... x 30 days.....
4. Medicine/Treatment ..... x 30 days .....
5. Charcoal if used ..... x 30 days
6. Waste collection ..... x 30 days
7. Community contribution (night watchman etc) x 30 days name them and amounts

....
.....
.
.....
...

.....
.

24. Have you ever taken a loan/credit from any source? 1. Yes [ ] 2. No.

25. If Yes in Question 24, explain type and its use.

No	Amount of Loan	Objective/aim of taking the loan	Source	Year Taken	Status of loan repayment (R=repaid.NR=indebted NRP=indebted property confiscated
1					
2					
3					
4					

26. Mention problem faced in any of the above livelihood/income earning activities and how solved

Table 6: Livelihoods Problems

No	Livelihood activity	Type of problem faced	How solved at present	Proposal on how it should be solved
1				
2				
3				
4				
5				

I: INFRASTRURE AND SOCIAL SERVICES
WATER SOURCE

27. What is the main water source of the house of the respondent? (Check as many as they apply)

1. Municipal Piped water (a)-Indoor plumbing several outlets (b) Single Tap inside house plot (c) Single tap outside house ( ) Distance ……..
2. Municipal piped water (a) Free Public Stand pipe ( ) (d) Community Kiosk vending water ( ) Distance …….
3. Neighbour: (a) free ( ) (b) Paid ( ) Distance …….

4. Mobile Vehicles water tankers (a) regular [ ] (b) occasionally only when need arise

[ ] (c) Contractual

5. Mobile Vendor - individual water retailer: trolley/head service (a) regular (b) Only when need arise (c) Contractual [ ]

6. Institutional water facility ( ) Name it: (a) a school ( ) (b) a religious institution: name …… (c) GVT office ( ) (d) Private Office ( ) (e) NGO office

7. **Other Sources:** Check where appropriate

(a) Community Drilled well/Borehole ( ) **Type:** Shallow well with hand pump [ ] Deep Well electrified & piped [ ]. Medium deep well with pump ( ) Deep well piped diesel engine ( )

(b) Hand dug lined protected Public/private well ( )

(c) Unprotected well ( ) (d) Rainwater tank/s ( ) (e) ( ) (f) River/Stream ( )

(g) A pond ( ): Name the pond and its location ……..

J. WATER CONSUMPTION

28. How much water do you use per day for the following activities:

No	Type of Use	Amount per day (litres)	Cost per day per 20 litre container	Total Cost	Distance to source
1	Drinking				
2	Bathing				
3	Washing clothes				
4	Watering animals				
5	Gardening				

K. COST OF WATER COMPARED WITH SANITATION

29. How much do you pay for the following utilities

1. Water supply per month .....

2. Sewerage system services per month .....

3. Emptying septic tank ..... Give frequency .....

4. Emptying a latrine .....Give frequency .....

L. QUALITY OF WATER

30. How is your water: 1.Clear ( ) 2.turbid ( ) 3.With suspended Matter ( )

31. How does your water taste: 1.Good soft ( ) 2.Bad salty ( ) 3. Bad muddy taste ( )

32. Does your water smell: Yes 1. ( )2.No ( )

33. Do you boil your water 1.Yes ( ) 2.No ( ) 3. No drink bottled water ( )

34. Which diseases have members of your family suffered in the past two weeks? What are their possible causes and what steps did you take?

Table 7: Prevalence of Diseases

No	Disease	Main causes if known	Steps
1			
2			
3			
4			
5			

35. Has your family suffered from the following diseases?

1. Diarrhoea (a) rarely (b) Often (c) very frequently (d) Not at all

2. Typhoid (a) rarely (b) Often (c) very frequently (d) Not at all

3. Worms (a) rarely (b) Often (c) very frequently (d) Not at all

4. Cholera (a) rarely (b) Often (c) very frequently (d) Not at all

5. Bilharzias (a) rarely (b) Often (c) very frequently (d) Not at all

6.Hepatitis (a) rarely (b) Often (c) very frequently (d) Not at all

7. Filariasis (a) rarely (b) Often (c) very frequently (d) Not at all. Mention Type:

8. Amoebic Dysentery (a) rarely (b) Often (c) very frequently (d) Not at all

9. Other diseases: Name them.

M. SANITATION

36. Type of sanitation facility is on plot

i) WC connected to sewerage system ( ) Type sitting/squatting

2) WC connected to septic tanks ( ) Type: sitting/squatting

3) Traditional lined latrine unventilated ( )

4) Improved ventilated lined latrine (VIPL) ( ) Total Costs: ……..

5) Traditional unlined pit latrine unventilated ( )

6) Pour flush latrine connected to a soakage pit/septic tank

37. If the toilet facility shared 1. Yes ( ) 2. No ( ). If shared, with which category of people and why?

……

……

……..

38. If latrine is used. How much did it cost to construct it to its complete state? …….. (Tsh)

39. What is the depth of the latrine: …….. Feet or metres

40. What is the filling rate/time of the latrine/septic tank if used?

1. Monthly ( ) 2. Three to six months ( ) 3. A year ( ) 4. Three to five years ( )

41. What type materials were used for latrine construction (Fill Table 8)

Table 8: Building Material Used in Latrine construction

Shelter Walls:	Check where appropriate	Roof	Check where appropriate	Floor	Check where appropriate
Cement blocks		No roof		Cement	
Burnt bricks		Coconut fronds (Makuti)		Mud	
Mud/mud bricks		Corrugated roofing sheets		Gravel with cement (kokoto)	
Stones and cement		Grass		Tiles with cement	
Canvas		Asbestos		Burnt bricks	
Mud and Poles		Concrete		Sand	
Timber		Used metal materials		Timber	
Mixed materials		Tiles		Mixed materials	
Poles only (miti/fito)		Mixed materials (name them)		Log	
Grass		Other type of materials		Wooden plate	
Coconut mats/fronds				Metal plate	
Other: Name them				Other: Name them	

Interviewer to observe status and assess my eyes value of building: High [ ] Medium [ ] Low cost [ ] Shanty mixed materials very poor [ ]

42. If the facility is a septic tank or Latrine. How often do you empty it?

1. Monthly ( ) 2. Three to six months ( ) 3. Annually ( ) 4. Three to five years ( ) Other ( ) Explain

……

……

…

43. Which services do you use for empting your septic tank/latrine ( )

1. Municipal vacuum truck services ( ) I pay Tshs……. Per one emptying services

2. Private vacuum truck services ( ) I pay Tshs…….. for one emptying service

3. I have connected my septic tank and latrine to a sewer line ( ) Monthly charges Tshs …….

4. I have formally connected my septic tank and latrine to a drainage facility ( ) (specify if open or closed drain) ……I pay Tshs ……per month

5. I use manual pit emptiers (Frog men) I pay Tshs…….. for emptying one toilet/septic tanks

6. Secretly connected my latrine into open/close drain ( )

7. I empty liquid contents (effluent) off-plot ( )

8. I never empty my toilet facility as the area has sandy soil that takes care of water ( )

44. Where do you dispose of grey water from the kitchen, washing clothes and cleaning household utensils etc?

1. Disposed off-plot ( ) 2. Into open drain ( ) 3. Into Dawasa sewer formal connection through indoor plumbing ( ) 4. Into Dawasa sewer informal illegal connection secretly done by Dawasa staff/myself ( ) 5. Into Septic tanks (6) into pit latrine ( ) 7. Other: Explain

……

…..

45. Condition of the Toilet facility (Check the condition if allowed to inspect the facility and jot down discreetly. Check what is appropriate).

1. Clean toilet room, slab and seat/latrine drop hole ( )
2. Dirty toilet room, slab and seat/latrine drop hole: faeces, papers, liquid and other matter observed ( )
3. Clean but smelly as not ventilated ( )
4. Substandard facility broken down, unsafe and unrepaired ( )
5. No privacy ( )

6. Flooded with ponding water ( )

7. Other: Explain ……..

46. What do you do when your sewer connection/septic tank/latrine clogs or overflows? (Check where appropriate)

1. Call DAWASA office ( ) 2. Call private services and pay directly ( ) 3. Engage a manual pit emptier ( ) 4. Do nothing ( ) 5. Channel effluent and other matter off-plot ( ) 6. Other actions: explain .....

N: ENERGY USED

47. What type of energy is used for lighting and cooking?

Table 9: Energy used

NO	Type of Use	Lighting	Cooking	Cost per month
1	Electricity connected to LUKU			
2	Metered electricity flat rate charges			
3	Metered electricity charges (payment by unit used)			
4	Electricity from neighbour shared bill			
5	Electricity from a generator			
6	Kerosene lamps			
7	Batteries			
8	Solar power			
9	Fuelwood cooking stove			
10	Charcoal cooking stove			

48. Does the family have and use any of the following type of cooking stove?

1. Improved efficient household fuelwood cooking stove [ ]
2. Traditional fuelwood cooking stove [ ]
3. Traditional charcoal stove [ ]
4. Improved firewood stove with water heater [ ]
5. Improved charcoal stove (check below) [ ][9]

O. KNOWLEDGE AND PERCEPTION ON CLIMATIC CHANGE

[9] Bellbottom, Sazawa, straight wall, triple, double plate Box, Double plate stand, improved charcoal oven (TaTEDO designs, use pictures to make respondent identify what you are inquiring about).

49. Rank five (5) major problems faced by your household in this locality. Mention also their major causes and measures taken to the problems. Rank the problems by severity level.
Table 10: Ranked Problem

No	Problem	Rank order	Major cause	Measures taken to solve the problem	Suggestions on how to solve the problem
1					
2					
3					
4					
5					

50. Do you know what climate change is (1) Yes [ ] 2. No [ ]. If Yes, please explain what it is and its potential impacts.
Response of what climate change is:
……
……
……
……
……
51. If the respondent knows what climate change is (quest 50), what climate-related disasters can he/she remember that have occurred in his/her residential area and action taken:
Table 11: Occurrence of Climate-related Disasters

No	Disaster event	Year occurred	Duration	Effects	Action taken

52. In general, what impacts of climate change do you face in your area and which actions do you usually take to reduce negative impacts? Fill Table 11.

53. Effects of Climate Change. List them by causes

Table 13: Climatic Change Events and Effects

No	Climate change Events	Possible causes	Effects to your street/community	Strategy/measures taken	Effects to your household/family	Strategy/measures taken	Present adaptation measures taken to dealing/living with the recurring problem
1							
2							
3							
4							
5							

54. What activities/behaviour practices done in your neighbourhood exacerbate the effects of climate change, shown in Table 14?

Table: 14: Behavioral Practices and Effects of Climatic Change

No	Effects of climate change	Behaviour or practices contributing or exacerbating effects	What is done in containing them	What should be done to contain them
	Flooding			
	Increased heat			
	Sea rise			
	Land Erosion/land slides			
	Poor health in humans			
	Water tress & Low pressure in pipes			
	Other:			

55. What do you think are major sources of pollution in your area and what should be done?

Table 15:Major Sources of Pollution

No	Sector	Sources/causes of pollution	What is done at present to contain causes	What should be done to contain causes/source of pollution
1	Piped Drinking water supply			
2	Drinking water supply from open wells if used			
3	Environment around your house			
4	Environment in your street			
5	A river in your area			
6	Open drainage system in your area (open channel)			
7	Sea water/the Sea if adjacent your area			
8	Mangroves near you area			

56: Are you aware of any programs in your area implemented to reduce environmental hazards so as to promote human health and better livelihoods?

1. Yes [ ] 2. No [ ]

57. If Yes in question 56, put their information in Table 16

Table 16: Projects for mitigation of the impacts of climate change:

No	Name of the program/project	Institutions involved in facilitating the program	Donor/funder	Comments from respondent about the outcome and effectiveness of the program/project with evidence

58. What changes have you noted in your settlement/house that you think may be contributed by climatic changes (Fill Table 17).

Table 17: Climate-related factors noted in the area by the residents.

No	Risk and Vulnerability	Level of seriousness					Comments on possible causes of the situation
		Extreme increase intensity and more common	Ordinary increase or average	Decrease or Low amount	Not at all (NIL)	D'know	
1	Rainfall						
2	Indoor heat (intensity)						
3	Outdoor heat						
4	Wind						
5	Floods						
6	Moisture/wetness in the air						
7	Cold weather						
8	Dry weather						
9	Mosquitoes						
10	Malaria disease						
11	Crop//vegetable pests & diseases						
12	Food insecurity						
13	Loss of customers as have no income						
14	Eating less meals due to poverty & low household income						
15	Falling sources of underground/river/piped water for gardening/livelihood activity						

59: What is your assessment of the existing environmental situation for averting the impact of floods in your area. Use Table 18.

Table 18: Existing Environmental Situation

		Status				
No	Issue	Present Y/N	Wide enough Y/N	Clean Y/N	Dirty clogged with solid & liquid waste Y/N	Flood at times & water enters houses Y/N
1	Presence of open drain for storm water drainage					
2	Quality of available storm	Well paved no cracks	Not well paved,	Well paved	Full of solid waste,	No storm water drainage channel

	water drainage channel		cracks	but clogged with waste	overgrown with weeds; has sewage, sullage dirty water not easy to assess status	
2.1	Assessment Column for no.2 check one (put a√)					
3	Quality Arrangement of the street		Well arranged Y/N			
4	Presence of waste collection and disposal services known by respondent		Y/N			
5	Help received from LGT on adaptation to climate change effects		Y/N			

60. Have you attended any type of education for awareness-raising on climate change issues?
    1. Yes [ ] 2 No [ ]

61. If Yes in Question 60, list type of educational input and who provided it.

Table 19: Climatic Change Educational input

No	Topic of educational input	Who provided it	Where provided W=within street Out-Outside Mtaa -Outside DSM	Was the educational input helpful Y/N

62. Any other comments regarding the impacts of climate change:

THANK YOU FOR YOUR PARTICIPATION

TABLE 1: HOUSEHOLD DEMOGRAPHY, OCCUPATIONAL ACTIVITIES OF HOUSEHOLD MEMBERS AND THEIR EARNINGS

No	Name of Household Member (if accepted)	Sex	Age	Relation to the head of Household	Education Exact class attained	Main occupational activity	Income earned per month	Farm/garden land owned if any F=farm G=Garden N=Nil	Size of land owned (acre/hectare	Location of farm/garden 1.Valley bottom nearby 2.Within house compound 3.Within district 4.Outside district 5. Outside Region	Distance in km	Crops Grown and use
1												
2												
3												
4												
5												
6												
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16												
17												
18												
19												
20												

Annex 1(b)

URBAN POVERTY AND CLIMATIC CHANGE IN DSM CITY
TOOL NO 2: Checklist for Institutional Interview
IRA-UDSM

A: LOCATION

1. Name of Institution.....

2. Ward.....
3. Division ..... 4. District .....
   .....
4. Category of the Institution: (a) Local GVT [ ] (b) Local NGO/CBO [ ] (c) International NGO [ ] (d) Central Government [ ] (e) Embassy [ ] (f) Local Company [ ] (g) International Company [ ]
5. Type of key Services rendered as per Organization Objectives/Mission

   1.....
   2.....
   3.....
   4. .....

6. Climate Change, Disaster, Risk and Urban Poverty Alleviation related Area of Operation and Population Served

No	Project name	Area of operation	Population served	Comments on status
1				
2				
3				
4				
5				
6				
7				

7. How are target groups and areas of support/operation identified?
   .....
   .....

.....
.....

8. Methods used in identifying problems and what to support.

.....
.....
.....
.....
.....

9. Main Sources of Funds by Project

No	Name/categoryof Project	Source of funds	Comments

10. Mention five effects of climate change or weather variability and how they impact on the wealthy and the poor in DSM City. Rank them by order of priority.

No	Climate change factor identified	How affects the wealthy	How affects the poor	Measures taken
1				
2				
3				
4				
5				

11. Based on Question number 10, are there any types of programmes responsive to climate change known to the respondent, implemented in the City of Dar Es Salaam?

No	Name of City Program	Institutions involved	Where implemented	Comments about status & outcome
1				
2				
3				
4				
5				

12. What do you think are human induced activities that generate C02 that alter the atmosphere in addition to natural climate variability?

No	Human Induced Activity	Place or sector occurring in the city	Measures taken	Recommendation for further measures
1				
2				
3				
4				

13. What are key lessons learned from climate related problems and interventions known or implemented by you or others in DSM?

No	Climate related intervention	Barriers noted	Lessons learned	Recommendations
1				
2				
3				
4				
5				
6				

Annex 1 (c)

URBAN POVERTY AND CLIMATIC CHANGE IN DSM CITY
TOOL NO 3: Checklist for Interview of Municipal Councils
IRA-UDSM

A: LOCATION

1. Name of Municipality .....

2. Name of Officer interviewed .....Position in the Municipal

.....

B: ASSESSMENT OF CLIMATE CHANGE ISSUES

3: Climate change indicators noted by the office, where occurring and their impact

No	Climate change indicator (weather elements)	Policy/legal measures instituted to deal with this problem	Social protection measures instituted and where	Barriers faced	Status of measures taken and comments on achievement
1					
2					
3					
4					
5					
6					
7					
8					
9					

4.Capacity of local authorities to deal with the indicators and effects of climatic change noted in Question 3:

No	Climate change indicator	Capacity of Municipality	Limitations	Proposals for capacity building to reduce limitations (including appropriate systems)
1				
2				
3				
4				
5				
6				
7				
8				
9				

5. Sectoral Plans and policies incorporated in city land use and industrial planning to achieve reduction in GHG emissions:

No	Sector	Policy	Legal Framework	Comments
1	Land use planning			
2	Waste collection and disposal			

3	Environmental Monitoring			
4	Beach Erosion			
5	Disposal of Industrial chemical waste and effluent			
6	Disposal of Hospital and dispensary waste			
7	Fumes/smoke from industries for reduction of carbon emission			
8	Protection of city water from Pollution			
9	Lime extraction, salt pans and quarrying for sand and stone mining			
10	Tree cutting			
11	Alternative energy Sources			
12	Protection of Rivers			
13	Drilling of boreholes and over extraction of ground water			

6. Document measures undertaken at present in waste collection in planned and unplanned settlements. Who does what and at with what cost, supervision and monitoring system?

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8. Measures undertaken at present. What support is there in the Municipality for reducing/combating poverty and effects of climatic change on poverty?

No	Type of poverty alleviation support	Funding source	Where implemented	Category of group of community supported	Achievements/outcome	Lessons leant
1						
2						
3						
4						
5						
6						

8. Any other comments on climatic change and urban poverty and adaptation and how local perceptions influence adaptation to climatic change impacts

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Annex 1(d)

KEY INFORMANT INTERVIEW CHECKLIST

Name of the Area/Mtaa ----------
Name of the River System
……
Sex of Respondent …….
Total years lived in the area …….. since year ……
What are the Major Socio-economic activities of people in the area
……
……..
How is land acquired in the area and what is its cost?

How do you characterize the residents in the area in terms of: Ethnicity, religion, employment, wealth status and education.

What have you observed over the years as major occurrences and what are their causes?

How have the events impacted on people including your family?

How have people mitigated and adapted to the occurrences?

What has been the progress in dealing with the occurrences?

How would you describe the climate in the area and what events can you associate with climatic change?

What recommendations can you give to the government and the people in dealing with events that impact negatively on people and their environment?

Annex 1 (e)

FOCUS GROUP DISCUSSION

Name of the Area/Mtaa ----------
Name of the River System……
Sex of Respondent ……
Total years lived in the area…….. since year ……

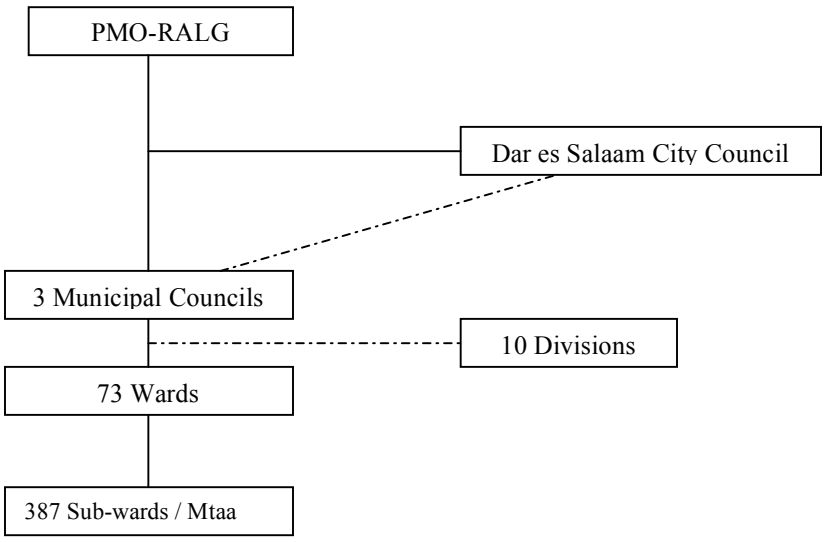
1. To discuss the history of the settlement/locality
2. People's major livelihood activities, how they are organized
3. Socio-economic facilities that exist in the area (health facilities, markets, banks, waste tipping sites, drinking water supply, cooperative unions, schools etc) and distances/locations; costs (if any) for payment for services facilities.
4. Problems are associated with the facilities.
5. Waste collection: how is it organized and forms of contribution if any?
6. Land tenure and land acquisition. How is land acquired, cost of land, problems related to land ownership and management.
7. Main ranked problems faced in the area, main causes and effects, how these are solved, who assists and how. What is the GVT and people's contribution?
8. Progress in solving the ranked problems. What else could be done if the problems mentioned continue?
9. Depth of poverty in the area, its categorization (wealth classes indicators) and its facilitating/inhibiting factors.
10. Common diseases that are prevalent in the area
11. People's perception of their environment. What perceptions do they hold regarding the environmental and social conditions they live in? What solutions are available (policy, strategy, structural organization, legal issues for law enforcement)?

Annex 2

Dar Es Salaam Administrative Structure[10]

Dar es Salaam's administrative structure comprises three Municipalities and a City Council. The City Council co-ordinates the activities of the three Municipalities and handles cross-cutting issues. The figure below shows the relationship between the Dar es Salaam Local Government Authorities and the Prime Minister's Office, Regional Administration and Local Government (PMO-RALG). The Municipalities report directly to the Minister of State responsible for local government within PMO-RALG.

Structure of local government authorities in Dar es Salaam



The table below shows the administrative structure within the City of Dar es Salaam.

Administrative structure and representation in Dar es Salaam

Municipality	Divisions	Wards	Mitaa	Councilors	MPs
Ilala	3	22	102	33	2
Kinondoni	4	27	127	41	3
Temeke	3	24	158	34	2
Total	10	73	387	108	7

[10] **Brief on Dar es Salaam V2** ***(material for discussion) Undated Obtained from Mr K.Mvano-City waste Management Officer***

Each Council has a number of Departments, as shown in the table below:

Functional Departments of the Councils

Dar es Salaam City Council	Ilala Council	Kinondoni Council	Temeke Council
Administration and Finance	Administration and Personnel	Administration and Personnel	Administration and Personnel
	Finance	Finance	Finance
Planning and Coordination	Planning and Co-ordination	Urban Development, Natural Resources and Environment	Urban Planning
	Health	Health and Waste Management	Health and Waste Management
Urban Planning, Environment & Utility	Waste Management	Community Development, Social Welfare and Cooperatives	Industries and Trade
	Rural Management		
	Trade and Infrastructure	Trade and Industry	Works and Fire Rescue
	Works	Works and Fire Brigade	Education and Culture
	Education	Education and Culture	

Each municipal authority is required to establish three to six standing committees. Ilala, Kinondoni, and Temeke each have standing committees for: Finance and Administration; Economic Affairs, Health and Education; and Urban Planning and Environment. All have recently also been required to establish a separate standing committee on HIV/AIDS. The standing committees of the Dar es Salaam City Council are: Finance, Transport, Works and Fire Rescue, and Health and Solid Waste.

Annex 3

Officials Interviewed and People Met

CITY COUNCIL

Kasulwa Mvano	City waste Management Officer
Magreath Mazwile	CIUP Coordinator
Geogre Makanyadigo	City Drainage Engineer

Temeke Municipality

P.A. Kagimbo-	Planning Officer
N.M Mwakalinga	Community Development Officer
Rehema Sadiki	Acting Health Officer
Mr Sued	Planning Officer Environment
Mr Ally Khatibu	Waste Management Officer
Robert John Chenge	Water Engineer

Ilala Municipality

Mr A.D. Mapunda	Municipal Environmental Officer

Kinondoni

Mary Komba	Environmental Management Officer

OTHER PEOPLE MET WITH

Kigogo Mkwajuni

Nyange Bakari Kimangare	Mtaa Kigogo Mkwajuni Chairperson Since 2010
Leon Karumba	Mtaa Executive Officer Kigogo Mkwajuni
Mr Oswald Wakati	Chairperson Infrastructure Committee (CUIP)
Ramadhani Liganduka	Member, Mtaa GVT
Valeria S. Mosha	Ward Community Development Officer
Emmanuel Riwa	Kigogo Ward Executive Officer
Rehema Ally Seseme	Secretary CIUP Kigogo Ward
Clara Mweyo	Mtaa Executive Officer Kigogo Mbuyuni
Mwajuma Mchuma	Mtaa Executive Secretary Kigogo Centre
Mohamed Mnukoa	Kigogo Centre Mtaa Chair Person

Bonde la Mpunga

Filbert Mbepela	Mtaa Chairperson
Raymond Chimbuya	Mtaa Executive Secretary
Bertha E. Kazoza	Member Mtaa Adm Leadership
Ahmed S. Pongolani	"

Salum Shariff	“
Hatibu Mohamed	“
Maua W. Makwinya	“
Abdallah I Ng’utto	“
Tandale Mtogole	
Ramadhani Kabanga	“
Jerome Mwambe	“

Suna Magomeni-Jangwani area

Alex A. Tulu	Member Mtaa Administrative Government
Awetu Alfat	Mtaa Executive Secretary
Halfan hald	Petty Trader
Biasha Bakari	“
Mama Shirima	“
Juma Abdul	“
Banzi Said	“
Evarist Koba	“
Elizabeth Doriat	“
Bahati Daniel	“
Edita Alex	“

Mbagala Kizinga
Shaaban Pawa
Shaaban Mgomi

Tandale Mtogole

Mariam Mpina
Hamisa Mpapay

Tandale Mkunduge
Jumanne Je Kinukile
Abdul S. Kehekuje

Ubungo Kisiwani
Tatu Mketo
Asnath Mambo

Ubungo Makuburi
Richard Mwalukosya
Godlove Mushi

Temeke Mbuyuni
Salum Mchumo
Asha Kassim

Ubungo Kibangu
Paul Thomas

Tabata-Mandela Site area Ilala
Zulfa Kassim
Amina Salum
Ilala Mchikichini/Msimbazi Valley

Ilala Msimbazi Valley/Mchikichini Ilala
Doroth Sophera- Ward Community Development Officer Mchikichini Ward
Said Walala
Antoni Sangaweo
Digina Donati
Fadhili Kalugira

Makuti A
Amina Matimbwa
Mr Emmanuel

NGOs

- Yemen Group-Mkorofi si Mwenzetu-Refuse Collectors Tandale Mkunduge
- KIWAWAM-Kikundi cha Wavuvi wadogo wadodo (Small fishermen's registered CBO) Msasani Rice Valley
- Bongoyo Conservation Society-Msasani valley. Msasani Valley Mtaa CBO.
- YOPAC-Youth Parents Crisis Counseling-Ilala Mchikichini/Msimbazi Valley or Bondeni Mtaa
- Women of Wisdom Trust-
- Kibangu Juhudi Group-waste collectors

Annex 4a

Estimates of Population and Asset Exposure

The sea-level rise scenarios considered are coupled with the A1 socio-economic (with rapid urbanisation) scenarios for estimating the future projected population and asset exposure. This follows the methodology used by Hanson *et al*. (2009). The simulations to estimate exposed number of people and associated economic assets that are located below the 1 in 100 year return period extreme water levels for each scenarios are performed based on a population distribution data available from the International Livestock Research Institute (ILRI) GIS-compatible online spatial data layers [*http://www.ilri.org/GIS*] (see *Table 1 and Figure 5*) and a Shuttle Radar Topography Mission (SRTM) elevation data of approximately 90m resolution obtained from the U.S. Geological Survey (USGS) server *http://www.usgs.gov*]. The population by elevation on a horizontal map of geographical cells is then estimated by mapping the population distribution over the wards of each district onto the SRTM, which allows the total population distribution against elevation to be estimated. In quantifying the infrastructure assets exposed to the 1 in 100 year extreme water levels, a method commonly used in the insurance industry and applied by Nicholls *et al*. (2008) is adopted which estimates the value of assets using the population exposed (*Equation 2*).

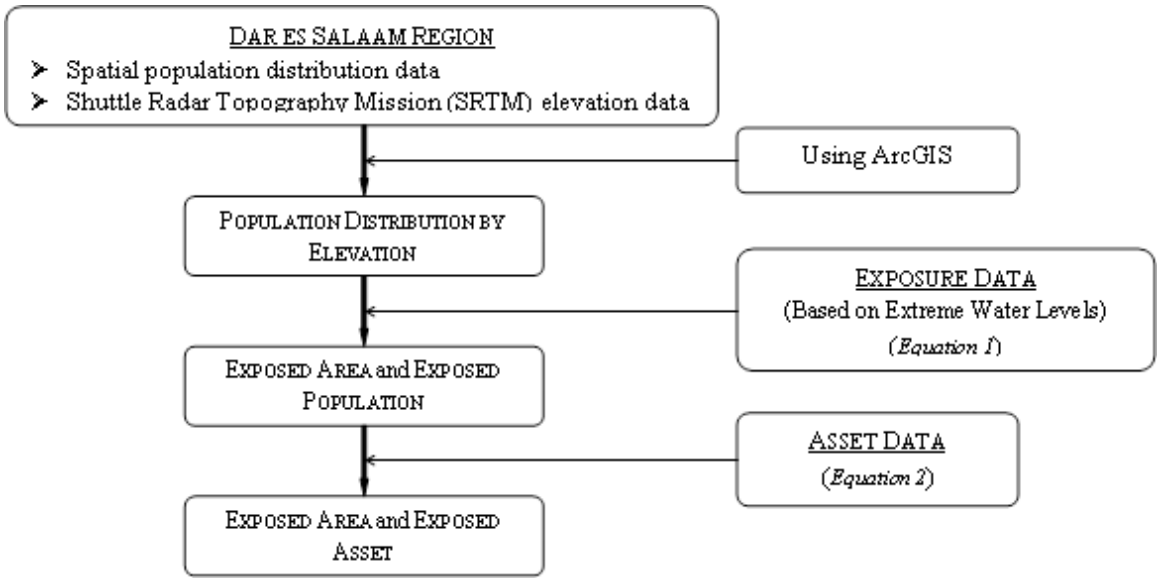
$$E_a = E_p \, x \, GDP_{\text{percapita (PPP)}} \, x \, 5 \quad \ldots\ldots (2)$$

Where, E_a is exposed asset (monetary value), E_p is exposed population, and $GDP_{\text{percapita (PPP)}}$ is the national per capita Gross Domestic Product (GDP) Purchasing Power Parity (PPP).

Source: Excerpted from Kebede and Nicholls (2010)

Annex 4b

A simplified flowchart of the methodology



Source: Kebede and Nicholls (2010)

Annex 5

Flood Modeling

A flood modeling exercise was undertaken by Ardhi University to map potential changes in rainfall regime and sea level rise on the flood extent and depth in the at-risk areas that were covered in the socio-economic surveys. A combined 1D-2D hydrodynamic model known as SOBEK was used (developed by Delft Hydraulics Software). The flood propagation model required spatial data (including a digital elevation model (DEM) and surface roughness estimates) and temporal data (such as initial water level, and downstream and upstream boundary conditions).

Digital Elevation Model (DEM)

Aster Digital Elevation model (DEM) with 30m resolution was used in this study and the 30m grid size was resampled to 15m. The DEM was then converted to standard Arc Info ASCII (.asc) format, required by SOBEK.

Surface Roughness

Surface roughness is another important spatial data parameter, indicating resistance to the flow of water on a floodplain. The surface roughness map was derived from a land-use map and was generated at the same resolution as the DEM to ensure that for each cell, both elevation information and roughness values were available (Alkema et al., 2007).

Initial and boundary conditions

The initial condition describes the initial state of the system, in this case water levels and fluxes at the start of the computation. In this study the restart file was used to define initial condition of the model. The restart file was created by running the model starting with dry conditions until the hydraulically stable starting point of simulation was reached (Alkema et al., 2007).

Boundary conditions for flood model were applied to define the inflow and outflow elements of the model domain. In this study, there were a number of upper boundary conditions in which discharge data was used and one downstream boundary where a constant water level was used.

Model schematization

Schematization involved adding the flood model components using a network editor known as NETTER available in SOBEK. The model components added include: river cross-section, flow calculation points, 1D boundary nodes (upstream and downstream), 1D-2D-internal boundary node, connection nodes, measurement stations, and hydraulic structures (bridges). NETTER offers a way to assign attribute values for various added nodes. The schematization starts by importing the 2D network, which represents the terrain elevation in ASCII data format. For quick assessment of the model performance, history boundaries (where water depth, and water velocity are recorded for a specific pixel) were placed for selected areas. A 1D flow was represented by a series of cross-sections perpendicular to the direction of the river flow. The river is defined by reaches

connected together by connection nodes. In the 1D model the flow of water is characterized by the channel characteristics defined by the cross section, bed and surface level as well as the roughness coefficient

Model calibration and scenario simulations

The model was calibrated in order to find the optimal set of roughness values that would result in acceptable differences between the model outputs and observed field data. After calibration of the1D-2D flood model, the effects of changes in rainfall and sea level on flood characteristics in Dar es Salaam city were analyzed, with various sets of values used. In the Report, Figure 28 shows a map of Dar es Salaam with the case study area that was modeled, while Figures 29 (a), (b) and (c) shows flood extents for a 5, 10, and 50 year flood return period with varying rainfall magnitudes and sea level rise set at 2m.