

DAR ES SALAAM CASE STUDY OVERVIEW

CLIMATE CHANGE, DISASTER RISK AND THE URBAN POOR: CITIES BUILDING RESILIENCE FOR A CHANGING WORLD



INTRODUCTION AND APPROACH

Over 70 percent of Dar es Salaam five 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.

This case study presents the first comprehensive overview of the intersection between climate change, disaster risk and the urban poor in Dar es Salaam. It seeks to understand (i) what are the key aspects of the vulnerability of the urban poor in the city, (ii) how climate change increases this vulnerability, and (iii) which policies and programs can be developed that reduce the vulnerability of the poor, taking both current and expected future climate change into account.

The case study is a joint work between the World Bank, the Institute of Resource Assessment, at University of Dar es Salaam, Ardhi University, the Tanzania Meteorological Agency (TMA), International START Secretariat, and the Dar es Salaam City Council.

The approach used in this case study is based on the Urban Risk Assessment (URA) framework.

Accordingly, it includes an assessment of the hazards, socioeconomic vulnerabilities and institutional aspects related to climate change and disasters in Dar es Salaam.

Firstly, the case study reviews available published information on Dar es Salaam's demographics, access to infrastructure and basic services, and climatic trends and projections. Secondly, it conducts a household level socio-economic survey on populations living in flood-risk areas. The survey is complemented by on-site observations and inspection of surroundings, as well as focus group discussions with residents. Thirdly, the study completes a series of interviews with relevant institutional representatives. Finally, a flood modeling exercise is conducted, which maps the potential changes in rainfall regime and sea level rise and models flooding impacts in those highly vulnerable areas that were covered in the socio-economic surveys.

KEY FINDINGS OF THE STUDY

- 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 not been addressed and needs to be integrated in all aspects of urban planning in Dar es Salaam
- The ecological and hydrological role of wetlands is not well understood or incorporated in urban development planning
- The sustainability of infrastructure development initiatives and their maintenance is poor
- Coordination among local stakeholders is needed
- Industries need to be relocated away from residential areas and will require access to a waste stabilization pond.
- Awareness-raising programs are needed at the community level for improved sanitation practices.

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THE GOVERNMENT OF DAR ES SALAAM AT WORK

Despite the number of challenges that Dar es Salaam is facing, the government has been supporting various key initiatives in areas such as coastal management, slum upgrading, and greenhouse gases mitigation. For instance, the Kinondoni Integrated Coastal Area Management Project (KICAMP) formulated a comprehensive plan on land and water resources management in coastal areas. This project resulted in banning excavation of sands in critical areas 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. The government has also invested recently in a number of sea walls on highly susceptible areas to sea level rise, storm surges and coastal erosion such as Kunduchi beach and Bahari beach.

Another example of the government at work, is the Community Infrastructural Upgrading Program (CIUP) which improves physical infrastructure such as storm water drainage networks and strengthens the capacity of communities to better help themselves, especially those living in unplanned settlements.

On the mitigation side, Dar es Salaam City Council has shown great leadership by closing the Mtoni solid

waste dumpsite and, in collaboration with a private company, created mechanisms for tapping and flaring the gases produced at the dump and recovering costs through the clean development mechanism.

KEY CONSTRAINTS

Key constraints in dealing effectively with climate change, disaster risk, and the urban poor include:

DATA – lack of high-resolution digital maps is a limitation for comprehensive risk assessment.

INFORMATION SYSTEMS – 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

LIMITED CAPACITY – Limited capacity hinders progress in dealing with climate change, natural disasters and urban poverty reduction. For instance, at the community level is important to build capacity on the link between unsanitary waste disposal practices, stagnant water, unclean drinking water, and disease incidence. At the same time, 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.

At the local level 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. In the city planning departments is important to build a common understanding of the long-term sectoral impacts of climate change for Dar es Salaam.

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At the national level, 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.

Finally, Links need to be forged and enhanced between climate experts and journalists to ensure effective dissemination of climate change information.

MAIN INFORMATION GAPS IDENTIFIED

This case study has been a first step in taking stock of what has already been done in terms of comprehensive risk assessment of informal settlements in Dar es Salaam. An important finding is that Urban/Town Planning and Settlement related laws need to be reviewed to ensure they deal adequately with vulnerability and risk. It is also important to determine how existing environmental and pro-poor policies and laws can be better enforced.

The case study recommends conducting an in-depth analysis of cost-effective adaptation actions in light of changing socio-economic and climatic trends in the city. Furthermore, a series of sectoral case studies with an emphasis on the urban poor should be conducted in order to examine future needs -for a 20-30 year timeframe - on: Drainage, Water supply, Waste management, Housing, and Health planning among others. Such case studies should involve teams of local institutions as well relevant international institutions with advanced technical expertise.

LOOKING FORWARD

The case study suggests that 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

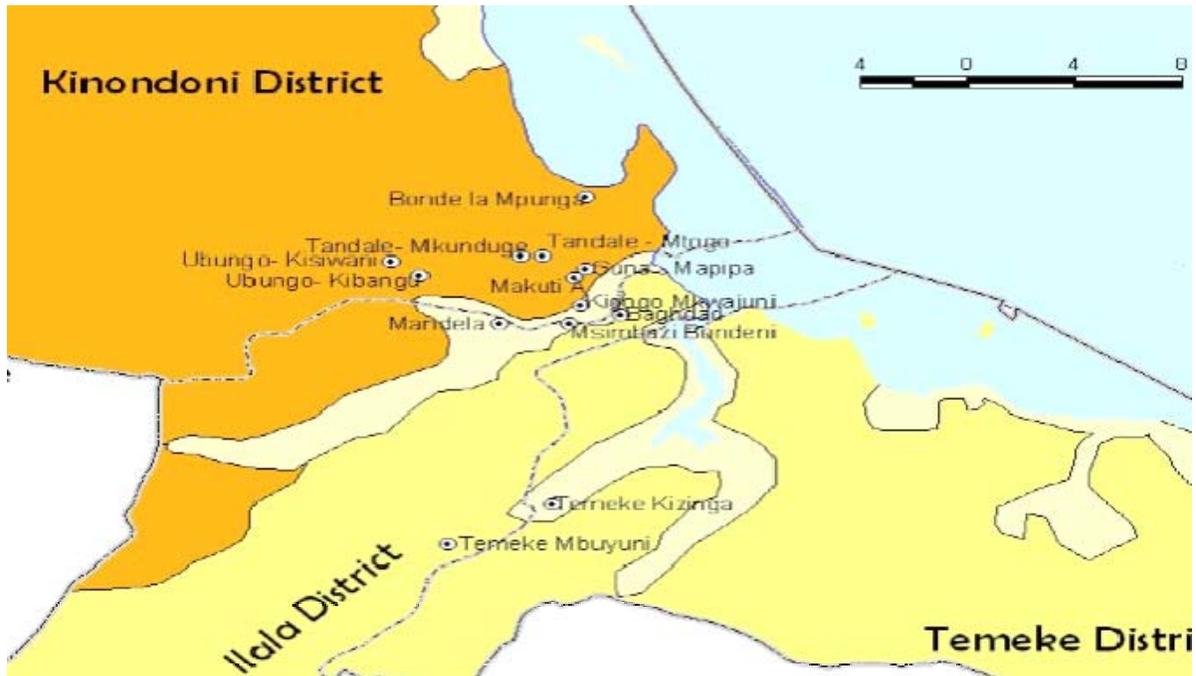
sanitation. The case study also captures key areas for further collaborative work moving forward:

- Support for public agencies to improve waste collection, drainage, water and sanitation programs. Although all Municipal agencies are required to comply with and implement the National Environmental Policy and the National Environmental Act, often they lack the funding needed to meet the responsibilities entailed, or the supervision capabilities to counter actions that contravene city laws and bylaws.
- Integrate disaster risk management approaches in urban planning. 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) and 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 seek further CDM support in expanding and scaling up the City Council's existing plans to manage solid waste.
- Support existing successful urban upgrading programs. These 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.
- Encourage a long-term planning horizon. Adaptation planning for Dar es Salaam's poor residents should address their present urgent needs and those to come, given expected future impacts of climate change.

CASE STUDY SUMMARY

CITY PROFILE

Figure 1: Administrative Map of Dar es Salaam



Dar es Salaam is located in the eastern part of the Tanzanian mainland at 6°51'S latitude and 39°18'E longitude. With an area of 1,350 square kilometers (km²), 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.

CITY SNAPSHOT

Total City Population in 2002	2.5 million
	Estimated 5 million in 2020
Population Growth (% annual)	4.39% (City Mayor's Statistics 2006)
	8% (World Bank, 2002)
Land Area (Km ²)	1590
Population density (per hectare):	1,500
Country's per capita GDP (US\$)	1300 (2007)
Date of last Urban Master Plan	2010

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BUILT ENVIRONMENT AND BASIC SERVICE PROVISION

An estimated 70% 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. About half the residents of Dar es Salaam's informal settlements live on an average income of US\$1 per day and in constrained circumstances. Many are migrants from other parts of Tanzania in search of better opportunities.

Access to clean water and sanitation are major problems for Dar es Salaam's poor, and 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% 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% to 42% between 1992-2000, and self-employment rose from 29% to 43%. Poverty for those in self-employment rose from 29% to 38% over the same period (ibid.).

The city's road network totals about 1,950 kilometers (km) in length, of which 1120 km (less than 60%) is paved, and is inadequate to satisfy its population density, spatial expansion and transportation needs. Dar es Salaam hosts about 52% of Tanzania's vehicles, and has a traffic density growth rate of over 6.3% per year (JICA, 1995; Kanyama et al., 2004).

The city's planning agencies have been unable to keep pace 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.

PILLAR 1 - INSTITUTIONAL ASSESSMENT

AGENCIES IN DISASTER RISK MANAGEMENT AND CLIMATE CHANGE ADAPTATION

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

The Dar es Salaam City Council (DCC) has a coordinating role and attends to issues that cut across all 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 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 monitoring trade and development activities especially informal sector development and management, cooperatives, agriculture and livestock development, forestry, fisheries, recreational parks and urban planning.

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).

RELEVANT POLICIES AND LEGISLATION

- At National level: National Human Settlements Development policy (2000): National Environmental Policy (1997), Ratification of the UN Framework Convention on Climate Change (UNFCCC) (1996).
- At local level: The Sustainable Dar es Salaam Project, and the Strategic Urban Development Plan (SUDP) started in 1992, Community Infrastructural Upgrading Programme (CIUP) started in 2001, African Urban Risk Analysis Network (AURAN) Project Phases I and II started in 2004.

ONGOING PROGRAMS IN DISASTER RISK MANAGEMENT AND CLIMATE CHANGE

- *Rehabilitation of storm water drainage and sewerage system:* Improvements were undertaken by city authorities in the city center. 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 storm water 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 storm water, 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.

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- *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. In particular, the Kinondoni Integrated Coastal Area Management Project (KICAMP) aims 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 an 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. Msasani Bonde la Mpunga is also 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.
- *Sustainable Coastal Communities and Ecosystems:* This USAID-funded project (implemented by Rhode Island and 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: i) Sea walls have been constructed along the front of the Aga Khan Hospital to prevent further erosion of Sea View Road; ii) 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; iii) 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.
- *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.

LEADING AGENCIES

Currently, there isn't a leading agency coordinating the disaster risk management activities at the local level. There is a lack of coordination horizontally among departments and vertically with National policies.

PRO-POOR SERVICES AND INFRASTRUCTURE LOCAL EXPENDITURE

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).

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PILLAR 2 - HAZARDS ASSESSMENT

PAST NATURAL DISASTERS

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 storm-water drainage systems, blockage of natural drainage systems, building in hazardous areas, and unregulated housing and infrastructure development. Livelihood activities are also adversely affected by both heavy rainfall and by drought.

NATURAL HAZARDS SNAPSHOT

	Y/N	Date of last major event
Earthquake	N	
Wind Storm	N	
River Flow	N	2010
Floods, Inundations and waterlogs	Y	
Tsunami	N	
Drought	Y	2006
Volcano	N	
Landslide	Y	
Storm Surge	N	
Extreme Temperature	Y	

Table 1: Effects and Losses

Hazard	Effects	Losses
Floods	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. Major effects are water-borne diseases.	Not available
Drought	Diseases: malnutrition, trachoma, dysentery, cholera, and diarrhea	The drought of 2006 damaged agricultural production, necessitated electricity cuts (and thus drops in industrial production) and cut GDP growth by 1% (ClimateWorks Foundation et al., 2009)

Table 2: Significant Floods in Dar es Salaam (1983-2006)

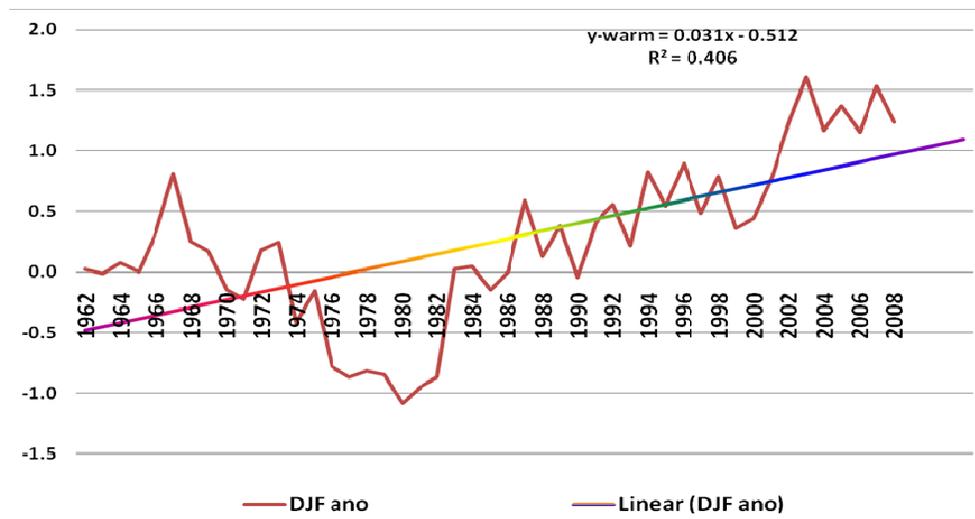
Year	Months	Monthly rainfall		
		Long term mean (mm)	Actual (mm)	% of Long term mean
1983	May	197.8	405.6	205
1989	Dec.	117.8	175.6	149
1995	May	197.8	374.2	189
1997	Oct.	69.3	250.8	361
	Nov.	125.9	152	121
	Dec.	117.8	231	196
1998	Jan.	76.3	107.3	141
	Feb.	54.9	123.7	225
	Mar.	138.1	155.2	112
	April	254.2	319.9	126
2002	April	254.2	569.4	224
2006	Nov.	125.9	240.9	191
	Dec.	117.8	230.4	196

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

MAIN CLIMATE HAZARDS

Temperature trends over the past 4-5 decades show significant increase. Temperature is projected to increase.

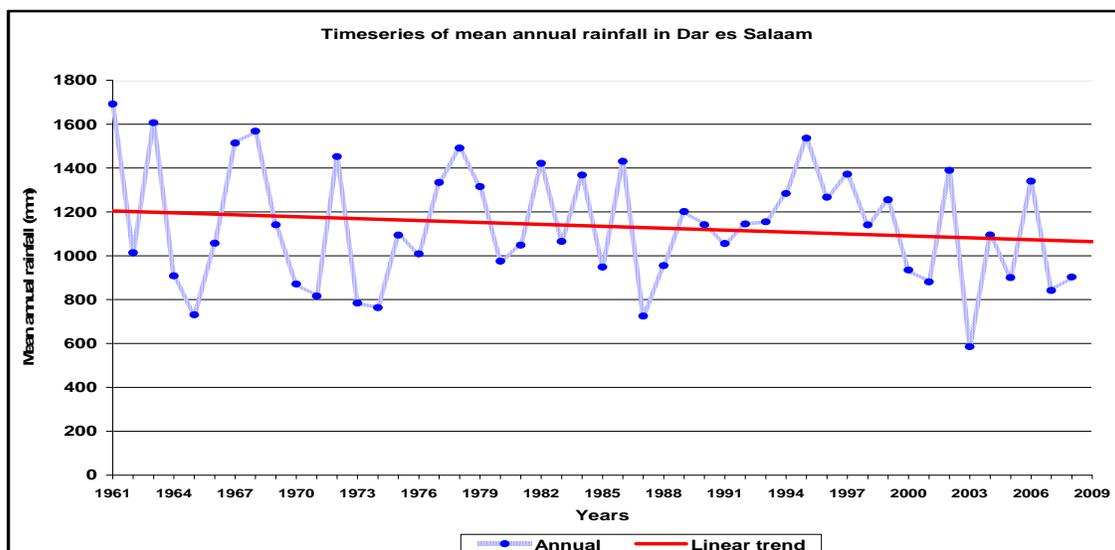
Figure 2: Trend of mean maximum temperature anomalies during the warmest months (December-February) at Dar es Salaam International Airport.



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

Mean annual rainfall has declined in Dar es Salaam over the past five decades (as recorded at the Dar es Salaam Airport station).

Figure 3: Timeseries of Mean Annual Rainfall in Dar es Salaam



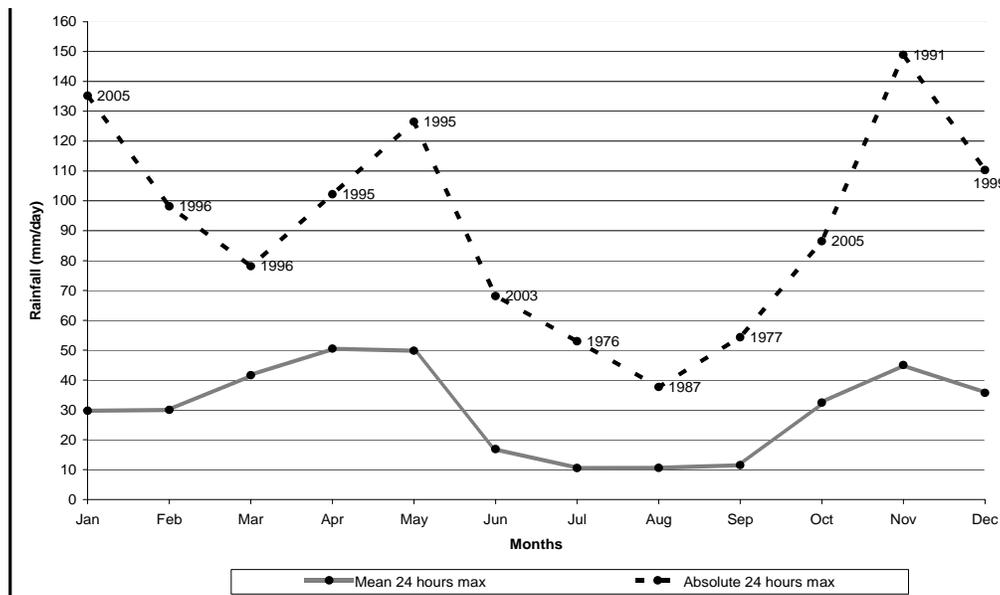
Source: Provided by Tanzania Meteorological Agency (TMA), 2010

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Figure 4 below shows mean and absolute 24-hour maximum rainfall for the period 1971–2009. Mean 24-hour maximum rainfall ranges from over 50 millimeters (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 4: Mean and Absolute 24-hour Maximum Rainfall for the Period 1971–2009



Both rainfall amount and intensity are variables of concern from the point of view of flooding in Dar es Salaam. Intensity has been increasing in last 15 years, where rainfall intensity has been well above the 38 years recorded history. This trend is expected to continue with climate change.

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.

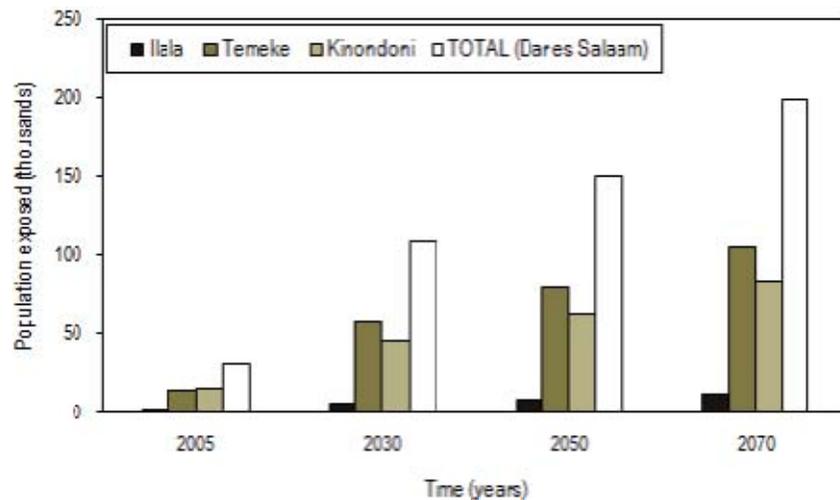
PROJECTIONS OF FUTURE CLIMATE

A summary of climate baseline data and severity of dry periods for March-May (MAM) and October-December (OND) are presented in the case study. Under the SRES A2 emissions scenarios, and data representing 14 of the Global Circulation Models used to simulate the 20th Century and future global climate, by mid-century, the coarser-resolution global climate models project that this site will become warmer, with more frequent heat waves. They disagree on whether this site will become wetter or drier. 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). Rainfall intensity is expected to increase. Runoff (precipitation minus evapo-transpiration), a measure of water availability, is projected to increase. The maximum amount of rain that falls in any five day period (a surrogate for

an extreme storm event) is expected to increase. The maximum period between rainy days is expected to increase (McSweeney et al. 2008).

Kebede and Nicholls (2010) have analyzed Dar es Salaam's vulnerability to sea level rise. They estimate that at present 8% of the city currently lies in a low elevation zone below the 10 meter contour line, inhabited by over 143,000 people, with associated economic assets estimated (in 2005) at US\$168 million.

Figure 5: 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: Kebele and Nicholls (2010).

MAGNITUDE, DISTRIBUTION, AND PROBABILITY OF POTENTIAL LOSSES

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 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.

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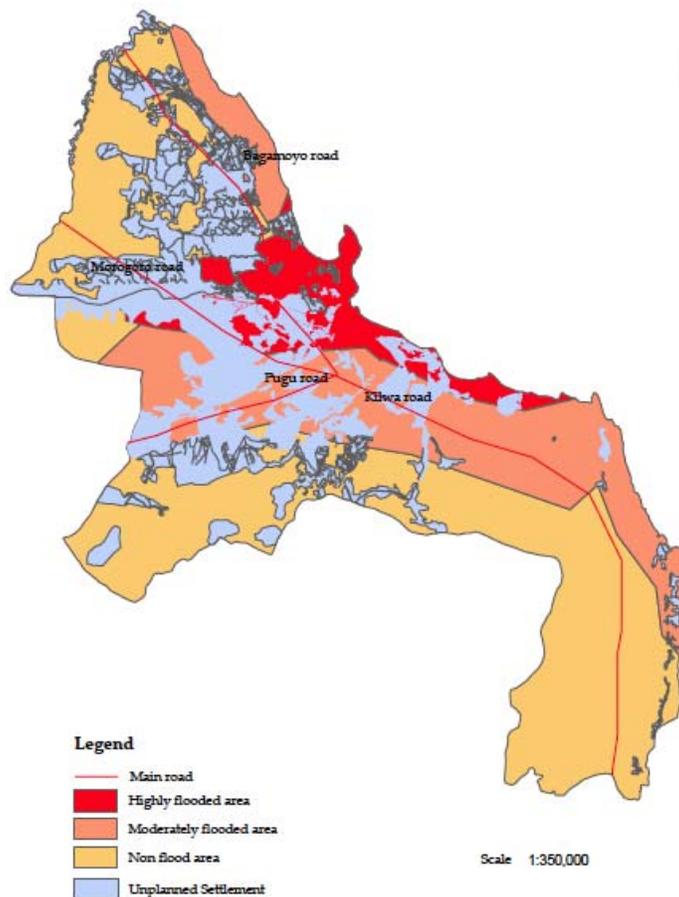
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PILLAR #3 -SOCIECONOMIC ASSESSMENT

LOCATION AND EXPOSURE OF THE URBAN POOR

An estimated 70% of Dar es Salaam's population lives in poor, unplanned settlements (World Bank, 2002). 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.

Figure 6: Flood hazard zone map overlain on urban poor settlements



Source: Ardhi University, 2010.

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 1960s 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).