URBAN CLIMATE RISK PROFILE FOR THE MUNICIPALITY OF LAMU

2025

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Municipality of Lamu
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Foreword

The Municipality of Lamu stands at a critical moment in its development journey, one that demands informed, proactive, and climate-resilient decision-making. As climate change continues to shape our urban environment, coastal systems, cultural heritage, and livelihoods, it is essential that our planning, investments, and governance structures are guided by accurate and context-specific climate information. This *Urban Climate Risk Profile* provides that foundation.

Lamu is a unique urban landscape: a UNESCO World Heritage Site, a centre of Swahili culture, and one of Kenya's most ecologically and historically significant municipalities. Yet, our geographic location and rapid socio-economic changes also make us highly vulnerable to climate-related risks such as sea-level rise, coastal erosion, flooding, saltwater intrusion, extreme heat, and pressures on water and waste management systems. These risks threaten not only our physical environment, but also our cultural assets, tourism economy, fisheries, and the well-being of our communities.

This Urban Climate Risk Profile is therefore both timely and strategic. It synthesizes scientific data, local knowledge, and sectoral assessments to highlight current and future climate vulnerabilities, identify priority hotspots, and propose practical adaptation pathways. The profile will inform municipal planning, guide public investments, support evidence-based decision-making, and strengthen institutional coordination across sectors such as housing, infrastructure, natural resource management, waste management, and early warning systems.

As the Municipal Manager, I reaffirm our commitment to mainstreaming climate resilience across all our urban development processes. This profile will be integrated into ongoing initiatives such as the Lamu Municipal Integrated Development Plan, urban infrastructure upgrades, cultural heritage protection programs, and community-based resilience projects. Our aim is to ensure that Lamu remains a safe, sustainable, and thriving municipality for generations to come.

I extend my sincere appreciation to all partners who contributed to the development of this profile, including national and county government agencies, local stakeholders, technical experts, and community representatives. Your insights and collaboration have been invaluable in shaping a tool that will guide our collective efforts toward a resilient and climate-adapted Lamu.

Together, we can safeguard our heritage, strengthen our urban systems, and build a future where the Municipality of Lamu continues to flourish despite the challenges of a changing climate.

Abduswamadu Ali
Municipal Manager
Municipality of Lamu

Executive Summary

The Urban climate risk profile for the municipality of Lamu has adopted for major hazards as summarized in the tables below.

Table 1: Summary of Heat Stress risks for Municipality of Lamu

	Time Horizon & Climate Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level					
Categories	**Impact**	**Risk Levels**				
		Current	**2050 SSP2-4.5**	**2050 SSP5-8.5**	**2100 SSP2-4.5**	**2100 SSP5-8.5**
Infrastructure & Services						
Stormwater Drainage	Moderate	Medium	Medium	High	Medium	High
Water & Wastewater Management	Moderate	Medium	High	High	High	High
Solid Waste Management	Moderate	Medium	High	High	High	High
Transport and Mobility	Moderate	Medium	High	High	High	High
Energy	Minor	Medium	Medium	High	Medium	High
Economic Infrastructure	Major	High	High	High	High	High
Social Infrastructure	Major	High	High	High	High	High
Emergency Services	Moderate	Medium	High	High	High	High
Populations						
Urban Residents	Major	High	High	High	High	High
Informal Settlement Residents	Major	High	High	High	High	High
Vulnerable and Marginalized Groups	Major	High	High	High	High	High
Natural Assets						
Urban Green Infrastructure	Major	High	High	High	High	High

Urban Blue Infrastructure	Moderate	Medium	Medium	High	Medium	High
Peri-urban and Agricultural Systems	Major	High	High	High	High	High

Table 2: Summary of Flooding risks for Municipality of Lamu

	Time Horizon & Climate Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level					
Categories	**Impact**	**Risk Levels**				
		Current	**2050 SSP2-4.5**	**2050 SSP5-8.5**	**2100 SSP2-4.5**	**2100 SSP5-8.5**
Infrastructure & Services						
Stormwater Drainage	Major	Medium	Medium	High	Medium	High
Water & Wastewater Management	Major	Medium	High	High	High	High
Solid Waste Management	High	Medium	Medium	High	Medium	High
Transport and Mobility	Major	High	High	High	High	High
Energy	Moderate	Medium	Medium	High	Medium	High
Economic Infrastructure	Major	High	High	High	High	High
Social Infrastructure	Major	High	High	High	High	High
Emergency Services	Moderate	Medium	High	High	High	High
Populations						
Urban Residents	Major	Medium	High	High	High	High
Informal Settlement Residents	Catastrophic	High	High	High	High	High

Vulnerable and Marginalized Groups	Major	Medium	High	High	High	High
Natural Assets						
Urban Green Infrastructure	Major	Medium	High	High	High	High
Urban Blue Infrastructure	Major	High	High	High	High	High
Peri-urban and Agricultural Systems	Major	High	High	High	High	High

Table 3: Summary of Water Stress risks for Municipality of Lamu

	Time Horizon & Climate Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level					
Categories	**Impact**	**Risk Levels**				
		Current	**2050 SSP2-4.5**	**2050 SSP5-8.5**	**2100 SSP2-4.5**	**2100 SSP5-8.5**
Infrastructure & Services						
Stormwater Drainage	Minor	Low	Medium	Medium	Medium	Medium
Water & Wastewater Management	Major	High	High	High	High	High
Solid Waste Management	Minor	Medium	Medium	High	Medium	High
Transport and Mobility	Moderate	Medium	High	High	High	High
Energy	Moderate	Medium	High	High	High	High
Economic Infrastructure	Major	High	High	High	High	High
Social Infrastructure	Major	High	High	High	High	High
Emergency Services	Moderate	Medium	High	High	High	High

Populations						
Urban Residents	Major	High	High	High	High	High
Informal Settlement Residents	Major	High	High	High	High	High
Vulnerable and Marginalized Groups	Major	High	High	High	High	High
Natural Assets						
Urban Green Infrastructure	Major	High	High	High	High	High
Urban Blue Infrastructure	Major	High	High	High	High	High
Peri-urban and Agricultural Systems	Major	High	High	High	High	High

Table 4: Summary of Storms risks for Municipality of Lamu

	Time Horizon & Climate Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level					
Categories	**Impact**	**Risk Levels**				
		Current	**2050 SSP2-4.5**	**2050 SSP5-8.5**	**2100 SSP2-4.5**	**2100 SSP5-8.5**
Infrastructure & Services						
Stormwater Drainage	Major	Medium	Medium	High	Medium	High
Water & Wastewater Management	Major	Medium	Medium	High	Medium	High
Solid Waste Management	Major	Medium	Medium	High	Medium	High
Transport and Mobility	Major	Medium	Medium	High	Medium	High
Energy	Moderate	Medium	Medium	High	Medium	High
Economic Infrastructure	Major	High	High	High	High	High

Social Infrastructure	Moderate	Medium	Medium	High	Medium	High
Emergency Services	Major	High	High	High	High	High
Populations						
Urban Residents	Moderate	Medium	Medium	High	Medium	High
Informal Settlement Residents	Major	High	High	High	High	High
Vulnerable and Marginalized Groups	Major	High	High	High	High	High
Natural Assets						
Urban Green Infrastructure	Moderate	Medium	Medium	High	Medium	High
Urban Blue Infrastructure	Major	High	High	High	High	High
Peri-urban and Agricultural Systems	Moderate	Medium	Medium	High	Medium	High

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List of Acronyms

RCRA	Rapid climate risk assessment
CCKP	Climate Change Knowledge Portal
CRA	Climate risk assessment
GCA	Global Center on Adaptation
GIS	Geographic Information System
IDeP	Integrated Development Plan
KUSP -II	Second Kenya Urban Support Program
NbS Nature	Nature-based solutions
NDMA	National Disaster Management Authority
NGO	Non-governmental organization
RCP	Representative concentration pathways
RCRA	Rapid climate risk assessment
SDHUD	State Department of Housing and Urban Development

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1. Chapter 1: Context

1.1. Objective

This Urban Climate Risk Profile aims to establish a clear and evidence-based understanding of climate-related risks facing the Municipality of Lamu in order to inform resilient urban planning, investment, and service delivery. The Profile provides a baseline assessment of how current and future climate hazards interact with local development patterns, socio-economic conditions, infrastructure systems, and natural ecosystems within the municipality.

Specific objectives of this Climate Risk Profile are to:

- Identify and characterize key climate hazards affecting the Municipality of Lamu, including their likelihood, intensity, and projected future trends.
- Assess the exposure and vulnerability of populations, critical infrastructure, urban services, and natural assets to these hazards, with particular attention to vulnerable and marginalized groups.
- Analyse how climate risks evolve over time, from historical conditions to current and future climate scenarios, and how these risks may compound existing development challenges.
- Provide an evidence base to support climate risk–informed decision-making in spatial planning, infrastructure investment, and municipal service delivery.
- Guide the prioritization of adaptation and resilience-building actions that reduce climate-related losses, protect livelihoods, and strengthen long-term urban resilience.
- Support the Municipality of Lamu in integrating climate adaptation into policies, plans, and projects, and in mobilizing resources and accessing climate finance.

By grounding urban development decisions in a robust understanding of climate risk, this Urban Climate Risk Profile seeks to enable the Municipality of Lamu to safeguard lives, protect infrastructure and ecosystems, enhance socio-economic well-being, and build a resilient, inclusive, and sustainable urban future.

1.2. Urban Context

1.2.1. Geographic area

The Municipality of Lamu is the administrative urban unit responsible for planning and managing all areas within the municipality jurisdiction. As host to the UNESCO World Heritage Site of Lamu Old Town (one of the oldest and best-preserved Swahili settlements in East Africa), the municipality carries a unique mandate that blends heritage conservation with modern urban service delivery. It oversees key functions such as solid waste management, environmental safeguards, spatial planning, urban infrastructure, and community engagement across Mkomani, Shella, Hindi, and Basuba wards. With its rapidly growing population, fragile coastal ecosystem, and exposure to climate risks such as flooding, shoreline erosion, and pluvial flooding, the Municipality of Lamu plays a critical role in shaping a resilient, clean, and culturally vibrant urban environment while safeguarding the island's centuries-old architectural and cultural identity. Municipality of Lamu measures approximately 2,660 square kilometers (Land-1,860, Sea-800). It covers the entire extent of Hindi, Mkomani and Shella Wards and a part of Basuba Ward (Kiangwe and Milimani) as shown in the map below.

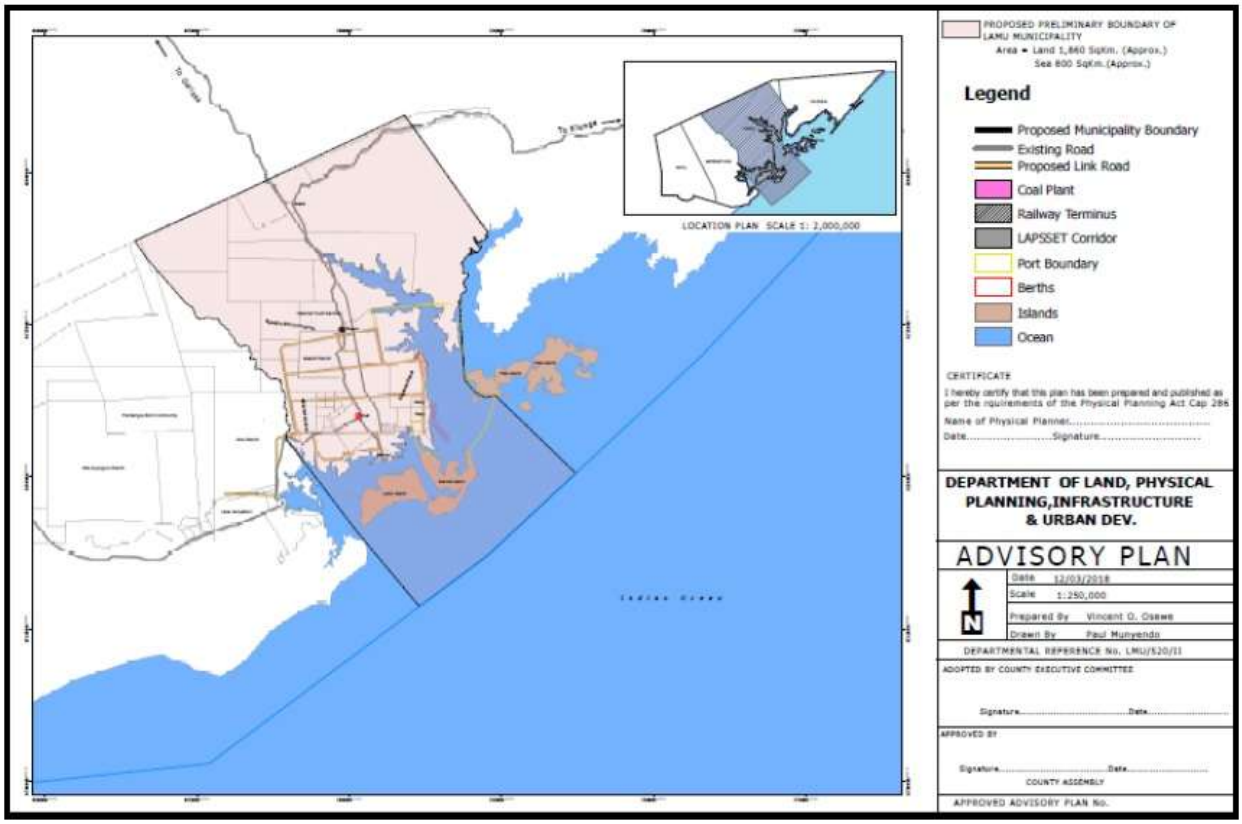

Figure 1: A map Showing the boundaries of the Urban Area

1.2.2. Governance Structure

The Municipality of Lamu operates within the institutional and governance framework of the County Government of Lamu and is currently established as a department under the County Executive. The governance structure provides strategic oversight, policy direction, and implementation authority for urban planning instruments, including the Urban Climate Risk Profile and the Integrated Development Plan (IDeP).

At the county level, the Municipality of Lamu falls under the Ministry of Lands and Urban Planning. The Ministry is led by the County Executive Committee Member (CECM) for Lands, who sits in the County Executive Committee chaired by the Governor of Lamu County government. The CECM for Lands provides overall policy leadership, ensures alignment of municipal plans with county development priorities, and facilitates approval and resourcing of key urban initiatives, including climate resilience and adaptation actions.

Within the Ministry, the Directorate of Lands and Urban Planning is headed by a Director, supported by a Chief Officer who provides administrative and technical oversight of the directorate. This structure ensures that municipal planning processes, including climate risk assessment and integration into spatial and development plans, are consistent with county policies, legal frameworks, and technical standards.

The Municipality of Lamu is governed by a Municipal Board comprising ten (10) members, with the Municipal Manager serving as the Secretary to the Board. The Municipal Board is the highest administrative decision-making organ at the municipal level and is responsible for setting annual development priorities, approving expenditure plans, overseeing revenue collection, and providing strategic direction for urban development within the municipal

jurisdiction. The Board plays a central role in endorsing the Urban Climate Risk Profile and ensuring its findings are mainstreamed into municipal planning and investment decisions.

The Municipal Manager heads the municipal administration and is responsible for the day-to-day management of municipal functions. The Manager coordinates technical departments and units involved in the preparation of the Urban Climate Risk Profile and leads the integration of climate risk considerations into the Integrated Development Plan. Working closely with the Municipal Board and the CECM for Lands, the Municipal Manager ensures effective implementation, monitoring, and reporting of agreed climate resilience actions.

Reporting to the Municipal Manager are Heads of Departments (HoDs) who lead the various administrative and technical units of the municipality. These departments form the operational backbone of the municipality and are directly responsible for implementing climate risk–informed actions within their respective mandates. The key municipal departments include:

- Administration
- Human Resources
- Finance (Accounting, Revenue, Procurement)
- Environment and Sanitation
- Enforcement
- Engineering and Development Control

These departments contribute sector-specific data, technical expertise, and implementation capacity during the preparation of the Urban Climate Risk Profile and are responsible for mainstreaming identified climate risks and adaptation measures into day-to-day service delivery, infrastructure development, regulatory enforcement, and financial planning.

As the Municipality of Lamu advances towards autonomy, the CECM for Lands, the Municipal Board, and the Municipal Manager as supported by the Heads of Departments constitute the core institutional actors responsible for the development, approval, and implementation of the Urban Climate Risk Profile and the Integrated Development Plan. This governance and administrative structure provides a clear organogram, strengthens accountability, and enables coordinated, climate risk-informed urban planning and resilient service delivery across the municipality.

1.2.3. Socio-economic Context

The socio-economic context of Municipality of Lamu is shaped by its unique island–mainland geography, rich cultural heritage, coastal and marine resources, and the transformative influence of major infrastructure investments, particularly the Lamu Port and the LAPSSET Corridor. Understanding the current and projected demographic trends, as well as ward-level socio-economic characteristics, is critical for identifying climate risks, vulnerabilities, and resilience priorities.

Demographic Overview

Municipality of Lamu is located within Lamu County and covers an area of approximately 2,660 km², comprising 1,860 km² of land and 800 km² of marine area. The municipality spans the entire extent of Mkomani, Shela, and Hindi Wards, and parts of Basuba Ward (specifically Kiangwe and Milimani areas).

According to the 2019 Kenya Population and Housing Census, the municipality had a population of 56,191 persons. Due to ongoing urbanization, migration, and economic opportunities particularly associated with the LAPSSET Corridor this population is projected

to grow to approximately 75,850 persons by 2031 and 97,393 persons by 2041**.** This growth will place increasing pressure on housing, infrastructure, natural resources, and urban services, while also amplifying exposure to climate-related hazards such as flooding, heat stress, and water scarcity.

Table 5: POPULATION DEMOGRAPHICS OF MUNICIPALITY OF LAMU

POPULATION DEMOGRAPHICS OF MUNICIPALITY OF LAMU						
Sub-Location	**Total**	**Male**	**Female**	**House Holds**	**Land Area (Sq Km)**	**Density Persons Per Sq Km**
AMU	28,032	14,432	13,599	7,079	99.5	282
Langoni	13,386	6,617	6,769	3,343	11.5	1,167
Kipungani	540	330	210	111	11.9	45
Matondoni	2,001	996	1,005	465	19.7	102
Mkomani	8,401	4,406	3,994	2,065	3.5	2388
SHELLA/MANDA	3,704	2,083	1,621	1,095	52.9	70
Shella	2,485	1,321	1,164	647	14.9	166
Manda	1,219	762	457	448	38	32
HINDI	19,193	11,348	7,845	6,895	1149.2	17
Hindi/Magogoni	11,336	6,750	4,586	4,036	1073.7	11
Bargoni	1,963	1,238	725	742	584.6	3
Bodhei Junction	422	323	99	248	79.9	5
Hindi	8,951	5,189	3,762	3,046	409.1	22
MOKOWE	7,857	4,598	3,259	2,859	75.6	104

Kilimani	2,076	1,128	948	560	32.2	64
Mokowe	5,781	3,470	2,311	2,299	43.3	133
BASUBA	857	497	360	267	884	1
Kiangwe	494	292	202	135	270.4	2
Milimani	363	205	158	132	613.6	1

Ward Level Socio-Economic and Demographic Context

Mkomani Ward

Mkomani Ward is the most densely populated and socio-economically significant ward within Municipality of Lamu. Covering approximately 172.5 km², it is located on Lamu (Amu) Island and forms the heart of Amu Town. The ward hosts Lamu Old Town, a UNESCO World Heritage Site and one of the oldest and best-preserved Swahili settlements in East Africa. With an estimated population of 52,360 persons, Mkomani is the most populated ward in Lamu County and has historically served as the administrative and coordination center for government services since independence.

The local economy is driven by fishing and maritime activities, tourism and heritage-based services, commerce and trade, and traditional handicrafts such as woodcarving and kofia making. Limited urban and peri-urban agriculture, mainly vegetable and fruit farming, supplements household livelihoods. However, rapid population growth—partly fueled by migration linked to LAPSSET-related expectations—has led to pressure on land, infrastructure, water supply, sanitation, and housing, as well as the expansion of unplanned settlements. Youth unemployment, environmental degradation, and vulnerability of heritage assets to climate hazards remain key challenges.

Hindi Ward

Hindi Ward is located on the mainland and covers approximately 1,150.8 km². It is the site of the Lamu Port, the flagship project of the LAPSSET Corridor, and currently serves as the County Government headquarters following devolution. Hindi Ward is experiencing rapid socio-economic transformation driven by large-scale infrastructure development.

Key economic activities include crop production, fishing, livestock keeping, and business and trade, all of which have expanded with improved connectivity and market access. Agriculture involves fruits, vegetables, grains, and cash crops such as coconut and cashew, while fisheries and pastoralism remain important traditional livelihoods. The port development has created employment opportunities and stimulated local businesses but has also contributed to population influx, land-use pressure, land disputes, and concerns over access to traditional fishing grounds.

Social challenges in Hindi Ward include inadequate water supply, limited healthcare and education services, cultural tensions due to in-migration, and weak land management systems. These dynamics increase vulnerability to climate risks, particularly drought, heat stress, and flooding, especially for low-income and migrant populations.

Basuba Ward (Kiangwe and Milimani Areas)

Basuba Ward, located in Lamu East Constituency on the mainland, measures approximately 1,708.7 km², though only Kiangwe and Milimani fall within the Municipality of Lamu. The socio-economic context of this area is largely rural and resource-dependent, with livelihoods centered on the Blue Economy, including fishing, mangrove-related activities, and small-scale tourism, alongside traditional crafts, subsistence agriculture, and livestock keeping.

Communities in Kiangwe and Milimani face persistent development challenges, including severe water scarcity, recurrent droughts, food insecurity, and poor access to health, education, and transport infrastructure. Competition over land, water, and pasture between farmers, pastoralists, and wildlife is common, contributing to social tension and displacement. Indigenous and marginalized communities often experience exclusion from decision-making processes, increasing their vulnerability to climate shocks and stresses.

Shela–Manda Ward

Shela–Manda Ward covers approximately 54.7 km² and has a population of about 3,704 persons. The ward spans parts of Lamu Island and the full extent of Manda Island. Its economy is predominantly driven by tourism, supported by pristine beaches, cultural heritage, and marine ecosystems, alongside fishing, small-scale trade, and traditional handicrafts.

Tourism-related employment includes hospitality services, recreational activities such as dhow sailing and snorkeling, and retail trade catering to both residents and visitors. While agriculture is limited, small-scale farming on Manda Island contributes modestly to local food security. Socially, the ward is characterized by strong Swahili cultural traditions and community cohesion, but it also faces challenges related to water supply, waste management, sanitation, and increasing population pressure from in-migration linked to economic opportunities.

Implications for Climate Risk

The diverse socio-economic and demographic profiles across the wards of Municipality of Lamu highlight varying levels of exposure and vulnerability to climate hazards. Rapid population growth, urban expansion, reliance on climate-sensitive livelihoods, and unequal access to basic services collectively heighten climate risk. These dynamics underscore the need for ward-specific, climate risk–informed planning approaches that protect vulnerable populations, sustain economic livelihoods, conserve natural and cultural assets, and support inclusive, resilient urban development across the municipality.

1.2.4. Economic Context

Municipality of Lamu economy is driven by a combination of traditional livelihood sectors, service-based activities, and infrastructure-led growth, which together contribute to household incomes, local employment, and municipal revenue generation.

1. Fishing and Maritime Activities

Fishing remains a foundational economic activity, particularly within coastal and island wards such as Mkomani and Shela–Manda. The marine and coastal ecosystems support artisanal fishing, dhow-based maritime transport, and seaweed harvesting—activities that underpin food security and incomes for local households.

2. Tourism and Heritage Economy
Tourism is one of the most prominent drivers of economic activity.

- Lamu Old Town**,** a UNESCO World Heritage Site, attracts domestic and international visitors, adding value to cultural tourism, historical preservation, and hospitality services.
- Shela Ward's beaches, islands, and marine environments draw niche tourism markets interested in cultural heritage, relaxation, and coastal experiences. Tourism supports a range of job opportunities in hotels, restaurants, tour operations, crafts, transport services, and retail, contributing significantly to local incomes and municipal revenue through fees, licensing, and trade.

3. Commerce, Trade, and Services

Urban markets in Amu Town (Mkomani) and Hindi facilitate commerce and small-scale trade with an array of goods and services. Retail businesses, wholesale traders, transport services, and informal sector activities provide livelihoods for numerous residents. These markets serve as focal points for economic exchange across wards and with external trading partners along the Kenyan coast.

4. Traditional Crafts and Small Industries

Traditional skills remain a vibrant part of the economy, particularly woodcarving, the production of kofias (embroidered caps), carpentry, and other artisanal trades. These activities generate income for households and contribute to the municipality's cultural identity.

5. Agriculture and Livestock

Although urban in character, Municipality of Lamu retains strong socio-economic linkages with agricultural activities such as vegetable farming, fruit production, and livestock keeping, particularly on the mainland wards of Hindi and Basuba. These sectors support food availability and provide supplementary income for households.

6. Emerging Infrastructure-Led Growth – Lamu Port (LAPSSET Corridor)

The Lamu Port South Sudan–Ethiopia Transport (LAPSSET) Corridor Project, with its multi-billion-shilling port complex located in Hindi Ward, represents the most significant economic transformation in recent decades. The Lamu Port has bolstered employment opportunities, stimulated construction and logistics sectors, expanded market linkages, and increased demand for services including accommodation, transport, and goods supply.

However, port-led growth brings challenges related to land disputes, population influx, competition for resources, and environmental pressure on coastal and marine ecosystems.

Projected Economic Context

Looking ahead, Municipality of Lamu is poised for sustained and potentially rapid economic transformation. Several key trends are expected to shape future economic growth:

1. Expansion of Trade and Logistics

With full operationalization of the Lamu Port and associated logistics linkages under LAPSSET, the municipality is projected to become a major regional hub for maritime trade. This will enhance cargo throughput, storage facilities, and transport services, attracting investment in related sectors such as freight forwarding, warehousing, and supply chains.

2. Growth in Tourism and Cultural Economy

Tourism is expected to expand as infrastructure investments improve connectivity, hospitality services diversify, and global interest in heritage and coastal tourism increases. Strategic promotion of eco-tourism, cultural heritage tours, and niche marine tourism will broaden economic opportunities for local businesses.

3. Increased Urban Economic Opportunities

Urbanization and population growth will stimulate demand for housing, utilities, markets, and formal services, encouraging entrepreneurship, retail expansion, and real estate investment. Higher population densities will support diversified economic activities, including information and communication services, education, health care, and professional services.

4. Diversification of Livelihoods

Emerging economic sectors, including renewable energy, marine-based industries, artisanal processing, and digital services, present new pathways for employment and enterprise development, particularly among youth and women.

5. Integration of Climate-Smart Economic Planning

Economic planning is increasingly expected to factor in climate resilience, ensuring that future investments in infrastructure, trade facilities, and urban services are protected from risks such as sea level rise, flooding, drought, and extreme heat. This will shape public-private investments and municipal revenue allocations.

1.2.5. Land-use Context

The land use context of Municipality of Lamu reflects a dynamic interplay between historical settlement patterns, cultural heritage preservation, natural ecosystems, urban expansion, and emerging infrastructure-led development. Understanding how land is presently utilized and how it may change in the future—is critical for assessing exposure and vulnerability to climate risks, guiding spatial planning, and ensuring sustainable, resilient urban growth.

Current Land Use Patterns

Municipality of Lamu spans approximately 2,660 km², encompassing both land (1,860 km²) and marine areas (800 km²). The land use context of Municipality of Lamu is foundational to understanding climate risk exposure and informing spatial planning decisions. As the municipality grows, integrated land use strategies that align cultural heritage conservation, ecological protection, urban development, and climate adaptation will be essential to achieving sustainable and resilient urban futures.

The predominant land use types within Municipality of Lamu can be broadly categorized as:

1. Urban and Built-Up Areas

Mkomani Ward (Amu Town and Lamu Old Town): This area represents the primary urban core, with dense residential settlements, commercial corridors, public facilities, cultural sites, and mixed-use developments.

Hindi Town: Emerging as a secondary urban node, Hindi serves as the administrative and commercial center, particularly with the relocation of the county headquarters and the ongoing expansion of the Lamu Port.

Urban land use is characterized by residential, institutional, commercial, and service-oriented functions. However, rapid population growth and migration have placed pressure on existing urban land, contributing to informal settlements and unplanned expansion in peri-urban fringes.

2. Heritage and Conservation Zones

Lamu Old Town in Mkomani Ward is a UNESCO World Heritage Site with strict land use regulations aimed at preserving Swahili architectural integrity, cultural identity, and historical continuity.

Adjacent heritage precincts and protected areas are managed to balance conservation with tourism-driven economic activity.

Conservation zones also include sensitive natural habitats including mangroves, coral reefs, seagrass beds, and coastal ecosystems that provide vital ecological services and support local livelihoods.

3. Agricultural and Rural Land

On the mainland in Hindi and Basuba (Kiangwe and Milimani), land use is largely dedicated to crop cultivation, livestock grazing, and pastoral activities. Large tracts of arable land support food production and cash crops such as coconut and cashew.

Although agriculture is less intensive within the island wards, small-scale urban and peri-urban farming exists to support household food needs.

These rural land uses are intertwined with socio-cultural land rights, communal grazing areas, and evolving land tenure systems, which sometimes generate conflicts between farming, pastoralism, and conservation priorities.

4. Marine and Coastal Land Use

Lamu's coastal and marine spaces are essential components of its land use context. These areas support fisheries, navigation channels, tourism beaches, marine transport routes**,** and ecosystem services. Zones of seascape management are increasingly critical due to their exposure to climate-related hazards such as sea-level rise, coastal erosion, and storm surges.

5. Infrastructure and Special Economic Zones

Lamu Port and LAPSSET Corridor Infrastructure**:** A major transformational land use driver, the port and associated logistics infrastructure have reshaped land allocation in Hindi Ward and surrounding areas.

Road networks, public service facilities, industrial and storage areas are evolving to support economic linkages with national and regional markets.

Projected and Emerging Land Use Trends

As Municipality of Lamu continues to urbanize and develop, its land use context is expected to undergo significant change:

1. Urban Expansion and Densification

Population growth and economic opportunities are projected to intensify demand for urban land. Residential, commercial, institutional, and mixed-use developments will increase in both existing urban centers (Amu Town and Hindi) and emerging urban fringes.

Unplanned and informal land settlements may expand without effective spatial planning and land management systems, increasing risks to public health, safety, and environmental sustainability.

2. Heritage Protection and Regeneration

Land use planning will need to strengthen mechanisms to protect Lamu Old Town's heritage assets while enabling sustainable tourism development. Sensitive heritage zones will require tailored zoning regulations, design guidelines, and investment controls.

3. Integration of Climate Resilience in Land Use Planning
Climate-sensitive land use planning will become increasingly important. This includes:

- Coastal setback regulations
- Floodplain and mangrove buffer zoning
- Green infrastructure corridors
- Heat-responsive urban design
- Protected ecological areas

4. Expansion of Economic Infrastructure

The operational maturation of the Lamu Port and LAPSSET Corridor will continue to influence land demand for logistics, industrial facilities, housing, and urban services. Special economic zones and related support facilities will reshape peri-urban landscapes, requiring strategic land allocation and environmental safeguards.

5. Multi-Use and Integrated Land Strategies

Land use planning approaches are expected to evolve from sectoral to multi-functional and integrated systems—balancing conservation, heritage management, infrastructure development, agriculture, pastoralism, and livelihood needs. This requires stronger spatial planning frameworks, participatory land allocation processes, and clear land tenure arrangements.

Land Use Challenges and Planning Implications

The evolving land use context presents several planning and climate resilience challenges:

- Informal settlement growth in ecologically sensitive and hazard-prone zones.
- Pressure on coastal and marine ecosystems due to urban expansion, port operations, and tourism.
- Conflicts over land rights and tenure security between pastoralists, farmers, investors, and traditional landholders.
- Inequitable access to urban land for vulnerable populations, increasing socio-economic disparities.
- Inadequate enforcement of zoning regulations**,** leading to unplanned developments.

1.3. Key Stakeholders & Inclusiveness

The preparation of the Urban Climate Risk Profile (UCRP) for the Municipality of Lamu adopts an inclusive, participatory, and multi-stakeholder approach. This approach recognizes that climate risks cut across sectors, livelihoods, ecosystems, and social groups, and therefore require the involvement of actors with diverse knowledge, mandates, and interests. Stakeholder engagement is essential to ensure the credibility, relevance, and local ownership of the Climate Risk Profile, as well as its effective integration into municipal planning and implementation processes.

Stakeholder Engagement Approach

Stakeholders are engaged throughout the preparation of the Urban Climate Risk Profile through a combination of consultative meetings, technical discussions, validation forums, and information-sharing platforms. Engagement focuses on:

Co-producing knowledge by combining scientific climate data with local and indigenous knowledge of climate hazards, impacts, and coping mechanisms.

Identifying vulnerabilities and priorities from the perspectives of different social groups, including women, youth, and informal sector actors.

Validating risk findings and proposed adaptation options to ensure they are context-specific, feasible, and socially acceptable.

Strengthening partnerships and coordination for future implementation of resilience-building actions.

Stakeholders are mapped and categorized based on their level of influence (ability to shape decisions, policies, or resource allocation) and level of interest (degree to which they are affected by or actively engaged in climate resilience and urban development issues).

Stakeholder Mapping: Influence–Interest Matrix

The stakeholder engagement process intentionally promotes inclusiveness by ensuring representation of community-based organizations, environmental groups, women- and youth-focused organizations, and actors from both island and mainland wards. Special attention is given to voices that are often underrepresented in formal planning processes but are disproportionately affected by climate hazards, such as informal workers, coastal resource users, and marginalized communities.

Engagement strategies

Active and continuous engagement through technical working groups, joint assessments, data sharing, co-design of adaptation measures, and participation in validation and decision-making forums.
Targeted sensitization and advocacy to demonstrate the relevance of climate risks to social justice, livelihoods, gender equity, and youth empowerment, while involving them in consultative forums and community outreach activities.

By structuring engagement according to levels of influence and interest, the Municipality of Lamu ensures that the Urban Climate Risk Profile is not only technically robust but also socially grounded, equitable, and aligned with local priorities. This inclusive approach strengthens legitimacy, fosters shared responsibility, and lays a strong foundation for collaborative implementation of climate resilience actions.

Table 6: Stakeholder mapping for Municipality of Lamu

High	**High Influence – Low Interest** ● Lamu Women Alliance ● MUHURI ● Lamu Youth Alliance ● Lamu Environment Foundation ● Kibokoni Cooperative Hindi ● MOHIBA Sacco Hindi	**High Influence – High Interest** ● Municipal Board ● Municipal Manager ● Municipal environment & Development Control Departments ● County Climate Change Unit ● SDHUD ● Local Media, Radio Lamu ● County Medical Services ● BMU ● RED CROSS, Lamu ● National Government (CC, Ward admns) ● NDMA ● MOHIBA Sacco Hindi ● County Disaster Coordination Unit ● The FlipFlopi Project ● Lamu Tourism Association ● Save Lamu ● Media ● National Environment Management Authority (NEMA)
	Low Influence – Low Interest ● MWARP ● MUG ● SERG ● Mama Safi ● LATTA ● INTERFAITH ● Kenya Power ● Lawasco/Himwa	**Low Influence – High Interest** ● LOYD ● Takataka Heroes ● WELASA ● Awer & Boni Communities
Low		High

2.0 Chapter 2: HAZARD ASSESSMENT

This section presents the hazard assessment component of the Urban Climate Risk Profile for the Municipality of Lamu. It identifies and analyses the key climate-related hazards affecting the municipality, considering their probability, intensity, geographic extent, and timescales under current and future climate conditions. The assessment draws on available climate data, historical trends, and local knowledge to understand how hazards such as flooding, drought, extreme heat, sea level rise, and coastal erosion are evolving and how they may intensify over time. By establishing a clear picture of present and projected climate hazards, this section provides the foundation for assessing impacts, vulnerabilities, and risks in subsequent sections, and supports climate risk–informed urban planning, investment, and service delivery.

1.4. Key Climate Hazards

Table 7: Hazard screening for Municipality of Lamu

Hazard	Hazard Likely (Y/N)	Significant Impact (Y/N)	High Priority (Y/N)	Key Hazard (Y/N)
Heat Stress				
Average surface temperature increase	**Y**	**Y**	**Y**	**Y**
Average ocean temperature increase	**Y**	**Y**	**Y**	**Y**
Extreme heat	**Y**	**Y**	**Y**	**Y**
Marine heatwaves	**Y**	**Y**	**Y**	**Y**
Flooding				
Changes in precipitation patterns	**Y**	**Y**	**Y**	**Y**
Pluvial (surface level) flooding, including flash flooding and urban flooding	**Y**	**Y**	**Y**	**Y**
Fluvial (river) flooding	**Y**	**Y**	**N**	**N**
Sea level rise	**Y**	**Y**	**Y**	**Y**
Coastal flooding, including storm surges	**Y**	**Y**	**Y**	**Y**
Waterlogging	**Y**	**Y**	**Y**	**Y**
Water Stress				
Drought (meteorological, hydrological)	**Y**	**Y**	**Y**	**Y**
Groundwater salinization	**Y**	**Y**	**Y**	**Y**
Saline intrusion	**Y**	**Y**	**Y**	**Y**
Storms				
Extreme wind	**Y**	**Y**	**Y**	**Y**
Tropical cyclones	**Y**	**N**	**N**	**N**
Sand and dust storms	**Y**	**Y**	**N**	**N**
Hailstorms	**N**	**N**	**N**	**N**

** These hazards can be highly impactful and are therefore included in the screening step, as they may significantly influence the urban planning informed by this urban climate risk profile.*

1.5. Climate Indicators and Hazard Thresholds

Table 8: Climate indicators and hazard thresholds selected for the assessment

Key Hazard	Climate indicator	Data source	Threshold		
			Low	Medium	High
Heat Stress	Average Daily Maximum Temperature (°C)	Kenya Meteorological Department (KMD)	< 30°C	30°C – 34°C	> 34°C
Flooding	Maximum 24-hour Rainfall Intensity (mm/day)	World Bank Climate Change Knowledge Portal	<50 mm/day	50 – 100 mm/day	100 mm/day
Water Stress	Standardized Precipitation Index (SPI – 12 month)	Kenya Meteorological Department (KMD)	≥ -0.5	-0.5 to -1.5	≤ -1.5
Storms	Maximum Wind Speed (km/h)	Kenya Meteorological Department (KMD)	< 40 km/h	40 – 70 km/h	> 70 km/h

1.6. Current Hazard Levels and Climate Projections

Climate risks in Municipality of Lamu are shaped by chronic (slow-onset) hazards such as rising temperatures, sea level rise, and increasing water stress which progressively worsen baseline conditions, and in turn amplify acute (shock) hazards such as floods, extreme heat events, and storm impacts. Historical climate observations along Kenya's coast indicate a steady increase in average air and ocean temperatures, greater rainfall variability, and more frequent drought conditions, all of which heighten the severity and frequency of extreme events.

Rising baseline temperatures increase the likelihood and duration of extreme heat events and marine heatwaves, stressing human health, marine ecosystems, and tourism assets. Changes in precipitation patterns characterized by fewer rainy days but more intense rainfall events raise the risk of flash flooding, urban flooding, and waterlogging, especially in low-lying island settlements and poorly drained urban areas. At the same time, prolonged dry spells contribute to water stress, groundwater over-abstraction, and saline intrusion, particularly on Lamu Island and coastal aquifers. Sea level rise and ocean warming further compound flood and storm risks by increasing the reach and impact of storm surges and coastal erosion.

Future climate projections indicate that these trends will intensify under all emissions scenarios, with significantly higher risks under high-emissions pathways. The interaction between chronic and acute hazards will therefore pose growing challenges to infrastructure, livelihoods, ecosystems, and service delivery across the municipality.

Table 9: Current and future hazards levels for Municipality of Lamu

	Hazard Level				
Hazard	**Current (Baseline)**	**2050 SSP2-4.5**	**2050 SSP5-8.5**	**2100 SSP2-4.5**	**2100 SSP5-8.5**
Heat Stress	Medium	Medium	Very High	High	Very High
Flooding	Medium	Medium	High	High	Very High
Water Stress	High	High	Very High	Very High	Very High
Storms	Low–Medium	Medium	Medium-High	Medium-High	High

For this Urban Climate Risk Profile, hazard levels should be interpreted in accordance with the table below.

Table 10: Interpretation of hazard levels

Level	Interpretation
High	Hazard events that are likely to occur with high frequency and/or intensity
Medium	Hazard events that are likely to occur with moderate frequency and/or intensity
Low	Hazard events that are likely to occur with low frequency and/or intensity

1.7. Current and Future Hazard Impact Areas

The spatial distribution of climate hazards within the Municipality of Lamu is shaped by its unique geography, comprising low-lying coastal islands (Lamu Island and Manda Island) and mainland areas (Hindi and parts of Basuba). The interaction between oceanic processes, rainfall variability, and land-use patterns results in distinct hazard impact zones across the municipality.

Current Hazard Impact Areas

At present, the most significant hazard impacts are concentrated in the following areas:

- **Coastal and Island Zones (Mkomani and Shela–Manda Wards)**

  These areas are highly exposed to coastal flooding, sea level rise, storm surges, and high tides due to their low elevation and direct proximity to the Indian Ocean. Sections of Lamu Old Town are particularly vulnerable, with recurrent tidal inundation affecting buildings, access routes, and tourism-related infrastructure.

- **Urban Core and Densely Settled Areas (Mkomani Ward)**

  Experiences **pluvial flooding and waterlogging**, driven by intense rainfall events and inadequate drainage systems. Informal settlements and poorly drained neighborhoods are especially affected.

- **Mainland Areas (Hindi Ward and parts of Basuba)**

These zones are more exposed to drought and water stress, including declining

groundwater levels and seasonal water shortages. At the same time, localized flooding occurs along poorly drained transport corridors and low-lying inland areas during heavy rains.

- **Peri-urban and Agricultural Zones**

These areas face compound risks of drought, erratic rainfall, and occasional flooding, affecting crop production, livestock systems, and food security.

Future Hazard Impact Areas (2050–2100 Projections)

Climate projections indicate a significant expansion and intensification of hazard impact areas across the municipality under both moderate (SSP2-4.5) and high-emission (SSP5-8.5) scenarios.

- **Expansion of Coastal Flooding Zones**

Rising sea levels and increased storm intensity are expected to extend coastal inundation further inland, particularly in Mkomani and Shela–Manda. Critical infrastructure, cultural heritage sites, and tourism facilities will face increasing exposure, with more frequent and prolonged flooding events.

- **Increased Urban Flooding in Built-Up Areas**

Intensification of extreme rainfall events will lead to more frequent and severe pluvial flooding in urban centers. Existing drainage systems may become increasingly inadequate, expanding flood-prone zones into previously unaffected neighborhoods.

- **Intensification of Water Stress in Mainland Areas**

Hindi and Basuba wards are projected to experience longer and more frequent drought periods, coupled with groundwater salinization and saline intrusion. Water scarcity is expected to become more acute, affecting both domestic supply and livelihoods.

- **Heat Stress Across All Wards**

Rising temperatures will increase heat exposure across the entire municipality, with the greatest impacts in dense urban areas lacking green cover. This will exacerbate water demand, energy consumption, and public health risks.

- **Degradation of Coastal and Marine Ecosystems**

Key ecosystems such as mangroves, coral reefs, and seagrass beds will face increasing stress from warming waters, sea level rise, and storm impacts, reducing their role as natural protective buffers.

- **Emergence of Compound Risk Zones**

Certain areas, particularly the urban core of Mkomani and low-lying coastal settlements, will face multiple overlapping hazards (e.g., flooding + heat stress + infrastructure pressure), increasing overall vulnerability and risk.

Implications for Spatial Planning

The evolving spatial distribution of hazards underscores the need for:

- Risk-sensitive land use planning and zoning,
- Protection and restoration of natural buffers such as mangroves,
- Upgrading of urban drainage and water systems,
- Targeted interventions in high-risk wards and vulnerable communities.

Understanding current and future hazard impact areas is essential for prioritizing investments, guiding development, and ensuring that Lamu Municipality builds long-term climate resilience.

3.0 Chapter 3: EXPOSURE & VULNERABILITY ASSESSMENT

This section examines how climate hazards interact with people, assets, systems, and ecosystems within the Municipality of Lamu to create risk. It assesses who and what is exposed to the identified key climate hazards and why certain groups, locations, and systems are more vulnerable than others. The analysis considers demographic characteristics, socio-economic conditions, land use patterns, infrastructure distribution, and environmental sensitivity, with particular attention to vulnerable and marginalized populations, critical urban services, heritage assets, and key livelihood systems. By understanding exposure and vulnerability alongside hazard intensity, this section provides a comprehensive basis for identifying priority risk hotspots and informing targeted, equitable, and climate-resilient urban planning and investment decisions.

3.1 Urban Elements

Table 11: Urban elements inventory

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
Infrastructure & Services				
Stormwater Drainage	Stormwater drainage conveyance network	**Y**	**N**	● Amu Town Open Stormwater Drainage draining to the Ocean ● Shela Storm water vertical earth drainage ● Matondoni Open Drainage Draining to the Ocean. ● Mokowe Open Drains Draining to the ocean. ● Hindi open drains Draining into the Hindi Prison Natural Water Reseiovor
	Stormwater storage	**N**	**N**	N/A
Water & Wastewater Management	Pumping stations	**Y**	**N**	N/A
	Groundwater abstraction	**Y**	**N**	
	Water treatment facilities	**N**	**N**	N/A
	Water supply networks	**Y**	**N**	LAWASCO and HIMWA Companies Supply Networks in Lamu Island and Hindi Wards.
	Sewer networks	**N**	**N**	

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Wastewater treatment facilities	**N**	**N**	
Solid Waste Management	Transfer facilities	**Y**	**N**	13 Waste Transfer/Holding facilities available across most the municipal urban nodes.
	Landfills and dump sites	**Y**	**N**	One dumpsite approximately 5acres available in Lamu Island and a 40acre landfill undeveloped is available at Kibokoni in Hindi.
	Recycling centers	**Y**	**N**	Jua-Kali metal recycling handles metal waste while the Flipflopi project at Mnazi Mmoja handles plastic waste recycling.
	Collection fleet	**Y**	**N**	Four functional bargabe collection truck available within the municipality area.
Transport and Mobility	Road networks	**Y**	**Y**	Good road network but most remains earthen and unpaved.
	Bridges	**N**	**N**	No bridges but two main jetties connecting Lamu Island from other islands and the mainland i.e Mokowe and Amu jetties.
	Public transport networks (rail, bus, mini-bus, etc.)	**Y**	**Y**	Bus, Matatus and Boda Boda are the main public transport means and air transport facilitated by Manda Airport located in Manda island.
	Transportation terminals	**Y**	**Y**	Main Bus park is located at Mokowe Jetty and remains unpaved.
	Vehicle depots	**N**	**N**	
	Non-motorized transport networks	**Y**	**Y**	Limited non-motorized transport network is available.
	Freight and logistics hubs	**Y**	**N**	Garsen-Lamu Tarmac road network to Lamu Sea Port facilitates freight carried by road.
Energy	Energy power plants	**N**	**N**	

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Poles and power lines	**Y**	**Y**	Kenya Power lines cover main centers; some exposed to pluvial flooding & fall risk.
	Transformers and substations	**Y**	**Y**	Several small substations in Lamu Island & Mokowe; stable supply.
	Street lighting	**Y**	**Y**	Installed along major streets and public facilities; limited coverage in peri-urban zones.
Economic Infrastructure	Markets	**Y**	**Y**	Amu Market is the biggest market critical for livelihoods, while Mokowe Open air market remains underutilized and prone to pluvial flooding.
	Businesses and commercial hubs	**Y**	**Y**	High concentration in both Amu and Hindi towns; exposed to heat stress and poor drainage.
	Industrial zones/parks and logistics parks	**N**	**N**	Emerging industrial facilities in Hindi for cashew-nut processing with zoned industrial park areas underdeveloped.
Social Infrastructure	Government buildings and service centers	**Y**	**Y**	County and municipal offices in Mokowe and Amu respectively.
	Education facilities	**Y**	**Y**	Over 40 schools and 2 vocational centers; some in pluvial flooding risk areas i.e Mokowe & Amu VTCs.
	Healthcare facilities	**Y**	**Y**	King Fahad Level 5 Hospital serves the region; accessible but only by sea from the mainland and through road networks in Lamu Island.
	Public spaces	**Y**	**Y**	Mkunguni Town Square in Amu town; Emerging recreational park along the King Fahad Hospital road.
	Faith-based buildings	**Y**	**Y**	Numerous across wards; act as emergency shelters during floods.

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Cultural and heritage assets	**Y**	**Y**	The Mkomani Old Stone Town a UNESCO site, Takwa Ruins in Manda Island, and other sites including sacred graves in Matondoni.
Emergency Services	Fire stations	**N**	**N**	County Emergency Respond Center at Hindi coordinates all emergencies including fire.
	Police stations	**Y**	**Y**	Main stations in Amu Town, Manda, Hindi and Mokowe; accessible but limited emergency response capacity.
	Telecommunications networks	**Y**	**Y**	Mobile coverage is good in most areas but limited in Basuba Ward.
	Early warning systems	**N**	**N**	None established by the local government, residents rely on Red Cross and National Government warning systems.
	Disaster management centers and shelters	**Y**	**Y**	One County Emergency response center at Hindi with unlimited capacity for shelter; Public schools and churches serve as temporary shelters.
	Evacuation routes	**N**	**N**	Not formally designated or mapped.
Populations				
Urban Residents	Population	**Y**	**Y**	Estimated population 56,191 (2019 census); projected 97,393 by 2041.
	Households	**Y**	**Y**	A total of 18,195 households available.
Informal Settlement Residents	Population living in informal settlements	**Y**	**Y**	Residents in low-lying i.e Kashmir, Wiyoni etc lack land tenure and basic services. Although KISIP II is remedying that issue.
	Households lacking land tenure	**Y**	**Y**	Not documented
	Households / residents lacking access to basic services	**Y**	**Y**	Not documented

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
Vulnerable and Marginalized Groups	Low-income households	**Y**	**Y**	Women-headed households, PWDs, elderly, and unemployed youth concentrated in peri-urban zones.
	Women-headed households	**Y**	**N**	Not Documented
	Children and youth	**Y**	**N**	Not Documented
	Elderly persons	**Y**	**N**	Not Documented
	People with disabilities (PWD)	**Y**	**N**	Not Documented
	Homeless populations	**N**	**N**	Not Documented
	Unemployed or precariously employed workers	**Y**	**N**	Not Documented
	Seasonal workers / migrant laborers	**Y**	**N**	Not Documented
	Nomadic groups in peri-urban areas	**Y**	**N**	Not Documented
	Urban refugees and migrants	**N**	**N**	Not Documented
	Minority ethnic groups in urban areas	**Y**	**N**	Not Documented
Natural Assets				
Urban Green Infrastructure	Urban parks and gardens	**N**	**N**	Not Available
	Green corridors	**N**	**N**	Not Available
	Street landscaping	**N**	**N**	Not Available
	Urban forests and forest reserves	**N**	**N**	Not Available
Urban Blue Infrastructure	Natural wetlands	**Y**	**N**	Hindi Prison Land privately owned by the KPS and sporadic small ponds.
	Rivers	**N**	**N**	Not Available
	Riparian zones	**N**	**N**	A large extent of Indian ocean riparian buffer in all municipal wards.
	Lakes, ponds and reservoirs	**Y**	**Y**	No available lake; Hindi Prison Land privately owned by the KPS and sporadic small ponds.

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Coastal ecosystems	**Y**	**Y**	A large extent of Indian ocean riparian buffer in all municipal wards; Mangroves Forest; Sea Grass & Corals
	Urban agriculture	**Y**	**N**	Subsistence Farming is practiced within urban nodes
Peri-urban and Agricultural Systems	Peri-urban agriculture	**Y**	**Y**	Subsistence Farming is practiced within peri-urban nodes
	Agroforestry systems	**Y**	**Y**	Agroforestry is practiced mainly at the mainland in Hindi ward.
	Forests and forest reserves	**Y**	**Y**	Boni Forest is the main forest in the area coupled with mangroves forests.
	Protected areas and national parks	**Y**	**Y**	Not Available
	Savannahs and rangelands	**Y**	**N**	Not Available

1.8. Exposure, Vulnerability, and Impacts of Climate Hazards on Urban Elements

For this Urban Climate Risk Profile, exposure and vulnerability levels should be interpreted in accordance with the table below.

Table 12: Interpretation of exposure and vulnerability levels

Level	Exposure Level Interpretation	Vulnerability Level Interpretation
High	A large number and high-value urban elements (e.g., critical infrastructure, dense neighborhoods, major economic assets) are located within the hazard footprint.	The urban element is vulnerable to the climate hazard due to high natural sensitivity – considering physical and non-physical characteristics – and limited adaptive capacity.
Medium	A moderate number or a mix of low- and medium-value urban elements are located within the hazard footprint.	The urban element is somewhat vulnerable to the climate hazard due to moderate sensitivity and adaptive capacity.
Low	Few or no critical urban elements lie within the hazard footprint or area of impact.	The urban element is minimally vulnerable to the climate hazard due to limited sensitivity and/or a high degree of adaptive capacity.

For this Urban Climate Risk Profile, the following matrix summarizes likely impacts on each urban element by combining the assigned exposure and vulnerability levels.

Table 13: Impact Matrix

		Vulnerability Level		
		Low	**Medium**	**High**
Exposure Level	**High**	Moderate	Major	Catastrophic
	Medium	Minor	Moderate	Major
	Low	Insignificant	Minor	Moderate

Table 14: Exposure, Vulnerability, and Impacts of Heat Stress on Urban Elements

Hazard: Heat Stress

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Infrastructure & Services					
Stormwater Drainage	□ Heat stress accelerates evaporation, drying drains and sediment traps, increasing accumulation of debris. □ Concrete surfaces expand and crack under prolonged high temperatures mostly in Mkomani, Mokowe old town & Hindi Township areas.	**Medium**	**Sensitivity:** • Limited drainage capacity, shallow gradients, and sediment accumulation increase system sensitivity to heat-related degradation. • Stormwater drainage systems in Lamu are moderately to highly sensitive to heat stress due to the widespread use of concrete-lined open drains, plastic piping, and aging infrastructure that were not originally designed for prolonged extreme temperature exposure. **Adaptive Capacity:** • Regular maintenance of drainage systems.	**Medium**	**Moderate**
Water & Wastewater Management	□ Higher temperatures increase evaporation in water pans and reduce surface and ground water reliability. □ Increased water demand (cooling, sanitation) stresses municipal supply systems.	□ **High (Lamu & Manda Islands)** □ **Moderate–High (Mainland Wards – Hindi & Basuba)**	**Sensitivity:** • Lamu's water supply systems are highly sensitive to heat stress due to their dependence on shallow groundwater lenses, boreholes, and limited surface water sources. **Adaptive Capacity:** • LAWASCO/HIMWA can ration and optimize supply, but limited storage capacity remains a constraint.	**High**	**High**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Solid Waste Management	□ Increased risk of spontaneous fires at informal dumpsites. □ High temperatures accelerate decomposition and odor emissions from dumpsites.	**Medium**	**Sensitivity:** • **Medium** — waste handling becomes more hazardous; public health risks rise. **Adaptive Capacity:** • Low — informal dumpsites lack fire-control and monitoring systems.	**Medium**	**Moderate**
Transport and Mobility	□ Extreme heat softens asphalt surfaces, causing rutting; dust increases on unpaved roads. □ Pedestrian mobility reduces, especially for elderly and vulnerable groups.	**Medium**	**Sensitivity:** • **Medium** — roads degrade faster; heat affects public transport reliability. **Adaptive Capacity:** • **Medium** — routine maintenance possible but costly.	**Medium**	**Moderate**
Energy	□ Increased cooling demand (fan use, refrigeration, cold storage) drives up electricity consumption. □ Heat affects transformer efficiency and increases chances of power outages.	**High**	**Sensitivity:** • **High** — increased demand stresses the grid, especially in urban centres. **Adaptive Capacity:** • **Medium** — KPLC system adjustments possible but limited redundancy.	**High**	**High**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Economic Infrastructure	□ Heat affects productivity of markets, shops, agro-processors, and informal businesses. □ Post-harvest losses increase due to faster spoilage.	**High**	**Sensitivity:** □ Heat affects productivity of markets, shops, agro-processors, and informal businesses. □ Post-harvest losses increase due to faster spoilage. **Adaptive Capacity:** • **Medium** — some businesses adopt refrigeration, but high energy costs limit access.	**High**	**High**
Social Infrastructure	□ High indoor temperatures reduce learning capacity and increase heat-related illnesses. □ Hospitals face increased caseloads for dehydration, heat exhaustion.	**High**	**Sensitivity:** • **High** — buildings poorly ventilated; few have cooling systems. **Adaptive Capacity:** • **Medium** — can adopt shading, ventilation strategies but limited funding.	**High**	**High**
Emergency Services	• Fire risk and heat-related medical emergencies increase; staff performance may drop in extreme heat.	**Medium**	**Sensitivity:** • Medium— emergency operations directly affected by high temperatures. **Adaptive Capacity:** • **Medium** — response capacity exists but is strained during heatwaves.	**High**	**Major**
Populations					
Urban Residents		**High**	**Sensitivity:** • **High** — many homes lack ventilation, insulation, or shading.	**High**	**High**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	□ High temperatures increase discomfort, indoor overheating, and energy bills for cooling. □ Heat stress worsens in dense settlements with limited tree cover.		**Adaptive Capacity:** • **Medium** — some can afford fans or cooling, but energy prices limit uptake.		
Informal Settlement Residents	□ Corrugated iron-sheet houses trap heat, making indoor conditions extremely high. □ Little vegetation or shaded areas; limited access to cooling.	**High**	**Sensitivity:** • **Very High** — poor housing materials, overcrowding, and lack of water worsen heat stress. **Adaptive Capacity:** • **Low** — low incomes and lack of cooling infrastructure.	**High**	**High**
Vulnerable and Marginalized Groups	□ Infants and elderly at greatest risk; heat stress worsens chronic illness. □ Limited mobility increases difficulty accessing cool areas.	**High**	**Sensitivity:** • **Very High** — physiological susceptibility to overheating. **Adaptive Capacity:** • **Low** — depend on caretakers and access to cooling or water. …	**High**	**High**
Natural Assets					
Urban Green Infrastructure	□ Parks, trees, and green belts dry quickly; canopy cover reduces. □ Increased risk of vegetation die-off.	**High**	**Sensitivity:** • **High** — species sensitive to moisture loss. **Adaptive Capacity:** • **Medium** — county watering programs exist but limited in scale.	**High**	**High**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Urban Blue Infrastructure	Higher temperatures accelerate water loss and reduce oxygen levels, affecting ecosystems. Reduced flow worsens pollution concentration.	**High**	**Sensitivity:** • **High** — aquatic ecosystems fragile under heat. **Adaptive Capacity:** • **Medium** — poor protection of riparian areas; limited restoration programmes.	**High**	**High**
Peri-urban and Agricultural Systems	Heat reduces crop yields (vegetables, bananas, coffee seedlings). Livestock experience heat stress reducing productivity.	**High**	**Sensitivity:** • **Very High** — many crops are temperature sensitive; heat increases irrigation demand. **Adaptive Capacity:** • **Low** — limited irrigation access; smallholder farmers lack cooling sheds.	**High**	**High**

Table 15: Exposure, Vulnerability, and Impacts of Flooding on Urban Elements

Hazard: Flooding

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Infrastructure & Services					
Stormwater Drainage	• Urban drainage channels (in Mkomani Town) are undersized & overwhelmed by grown population. • Frequent blockage by solid waste reduces conveyance capacity.	**High**	**Sensitivity:** Major — drains are shallow/undersized and many roads drain into low points. **Adaptive Capacity:** • Need to increase municipal maintenance budget, retention ponds, and stormwater storage.	**High**	**High**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Water & Wastewater Management	• No Piped sewer networks in the municipality; all peri-urban areas depend on boreholes. shallow wells and septic systems. Flooding overwhelms soak-away pits.	**High**	• **Sensitivity:** • The whole population relies on soak/septic system with frequent overflows during floods risking of public health. • informal (septic/pits) are vulnerable to inundation. **Adaptive Capacity:** • Transition to sewer system at the mainlands areas of Hindi and Basuba and adoption of bio-digesters in the islands where sewer system is not feasible. • Development of flood-resilient infrastructure.	**High**	**High**
Solid Waste Management	• Main dumpsite (Kandahar) located in low area; open dumping and poor collection lead to blocked drains and increased surface water contamination during floods.	**High**	• **Sensitivity:** • Unlined dumps and informal burning increase contamination risk when inundated. **Adaptive Capacity:** • Low — irregular collection fleet, informal recycling; limited engineered transfer stations.	**Medium**	**Moderate**
Transport and Mobility	• Urban roads and some rural access roads become impassable during pluvial events; • Key pedestrian routes in Mokowe and Hindi flood.	**Medium**	• **Sensitivity:** • Key arterial and feeder roads cross low points. • Maintenance is reactive; limited alternative routes and weak design standards for drainage capacity.	**Medium**	**Moderate**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			Adaptive Capacity: • Develop alternative routes and adopt climate adaptive road designs.		
Energy	• Overhead power lines & utility poles are anchored on dense peri-urban buildings of Mkomani old town; substations located in accessible urban nodes that can be surrounded by flood water in Mokowe.	**Medium**	• **Sensitivity:** • Anchoring power lines on buildings increases the risk for fire emergencies and electrocution. • substations tolerate some water but prolonged inundation risks service outages. **Adaptive Capacity:** • Kenya Power maintains networks and find alternative methods of connecting power lines in closed up communities like Mkomani area and localized resilience measures are limited.	**Medium**	**Moderate**
Economic Infrastructure	• Mokowe market, shops and commercial premises concentrated in the mainland flood, disrupting trade and loss of perishable goods.	**High**	• **Sensitivity:** • Most businesses suffer stock losses, supply chain interruption. **Adaptive Capacity:** • Drainage works around market areas and urban nodes should be designed and developed to be climate adaptive.	**High**	**High**
Social Infrastructure	• Some of the social infrastructure like Schools, health centers and government offices sit in moderate-low ground and floods. i.e. Mokowe arid zone primary school.	**Medium**	• **Sensitivity:** • Critical services affected by access loss rather than total asset loss. **Adaptive Capacity:** • Institutions should have contingency budgets but also require climate adaptive drainage systems.	**Medium**	**Moderate**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Emergency Services	• The county emergency response unit exists in Hindi ward coordinating all types of emergencies in the county but with weak capacity to responds to emergencies in most islands and far areas like Kiunga. • No dedicated local early-warning for pluvial events. Shelters are informal (churches, schools).	**Medium**	• **Sensitivity:** • Response time hindered by flooded roads and areas. • Limited resources, no mapped evacuation routes or dedicated shelters. **Adaptive Capacity:** • Have adequate contingency budgets and develop satellite emergencies respond centers in the islands and remote areas of Kiunga and Basuba wards. • Need to map evacuation routes and develop dedicated shelters.	**High**	**High**
Populations					
Urban Residents	• Majority live in formal and peri-urban neighborhoods; many households in low points face periodic inundation; population density rising (urbanization).	**Medium**	• **Sensitivity:** • Property damage and health risk when flooded. **Adaptive Capacity:** • Develop early warning system and have an adequate disaster response contingency fund.	**Medium**	**Moderate**
Informal Settlement Residents	• Informal housing in low-lying Kashmir,Kandahar, Mokowe and wiyoni areas with poor drainage and insecure land tenure; limited access to services.	**High**	• **Sensitivity:** • Poor Sanitation, with high exposure to water contamination and displacement. **Adaptive Capacity:** • Land Tenure support and regularization of settlements. • Adopt climate resilience drainage systems.	**Medium**	**Moderate**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Vulnerable and Marginalized Groups	• The Awer and Boni communities among other VMGs live in lower quality housing and have weaker mobility/resources to evacuate or protect assets.	**High**	• **Sensitivity:** • Health & livelihood impacts disproportionate; evacuation access limited, low livelihood opportunities, high dependence on natural ecosystem for livelihood, i.e Hunting & Gathering. **Adaptive Capacity:** • Very Low — limited savings, social protection coverage.	**High**	**High**
Natural Assets					
Urban Green Infrastructure	• Street trees and riparian vegetation are sparse/fragmented; green cover provides limited attenuation of runoff.	**Medium**	• **Sensitivity:** • Low and degraded green cover reduces infiltration and aesthetics. • Potential to expand green infrastructure but constrained by land pressure **Adaptive Capacity:** • Adopt urban ecosystem regeneration with reintroduction of green life in open public spaces and streets.	**Medium**	**Moderate**
Urban Blue Infrastructure	• Floating and beach facilities like hotels and bars faces risk of destruction during intense storms.	**Low**	• **Sensitivity:** • Facilities in the Indian ocean and along the beach faces destruction risks during storms. **Adaptive Capacity:** • Adopt climate resilience building design and technology; Develop risk analysis for the infrastructure with clear funded evacuation plans.	**Low**	**Low**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Peri-urban and Agricultural Systems	• Low-lying farm plots and roadside plots receive runoff; soils already eroding on slopes and terraces; agricultural drains often fail under heavy surface flows.	**Medium**	• **Sensitivity:** • Most of the lands gradient is low draining to the ocean with high rates of crop damage, soil loss and siltation. **Adaptive Capacity:** • Develop modern terraces with adequate investment in retention structures.	**Medium**	**Moderate**

Table 16: Exposure, Vulnerability, and Impacts of Water Stress on Urban Elements

Hazard: Water Stress

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Infrastructure & Services					
Stormwater Drainage	• Reduced rainfall and prolonged dry periods lead to sediment hardening and debris accumulation in drains, reducing functionality during sudden rainfall events in Mokowe and Hindi townships.	**Medium**	**Sensitivity:** • Open drains with limited maintenance are prone to blockages after dry spells, increasing flash flood risk when rain occurs. **Adaptive Capacity:** • Scheduled pre-rainy season clearing; redesign of drains for dual drought–flood functionality; integration of vegetated swales.	**Medium**	**Moderate**
Water & Wastewater Management	• Declining groundwater recharge, saline intrusion, and higher water demand during drought periods strain supply systems.	**High**	**Sensitivity:** • Heavy reliance on shallow aquifers (especially in island wards) and limited wastewater treatment infrastructure increases vulnerability.	**High**	**High**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			Adaptive Capacity: ● Diversify water sources (desalination, rainwater harvesting); aquifer protection; leakage reduction programs; water reuse initiatives.		
Solid Waste Management	● Water scarcity reduces cleaning and washing activities, increasing solid waste accumulation and illegal dumping.	**Medium**	**Sensitivity:** ● Informal waste systems and limited collection frequency heighten sanitation risks during drought. **Adaptive Capacity:** ● Improve collection coverage; promote waste segregation and composting; enforce anti-dumping regulations.	**Medium**	**Moderate**
Transport and Mobility	● Dust generation increases during prolonged dry periods, affecting road visibility and degrading unpaved roads.	**Medium**	**Sensitivity:** ● Many access roads (especially in mainland wards) are unpaved and highly sensitive to drought-related surface deterioration. **Adaptive Capacity:** ● Upgrade key roads; implement dust suppression measures; climate-resilient road surfacing.	**Medium**	**Moderate**
Energy	● Increased energy demand for water pumping and cooling during drought and heat periods.	**Low**	**Sensitivity:** ● Dependence on centralized grid and diesel-powered pumping systems increases operational vulnerability. **Adaptive Capacity:** ● Promote solar-powered boreholes; energy-efficient pumping systems; decentralized renewable energy systems.	**Low**	**Low**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Economic Infrastructure	● Water shortages affect sanitation services, hygiene, and facility operations.	**Medium**	**Sensitivity:** ● Facilities often rely on limited storage and shallow wells. **Adaptive Capacity:** ● Install rainwater harvesting tanks; increase storage capacity; prioritize water allocation to critical facilities.	**Medium**	**Medium**
Social Infrastructure	● Water shortages affect sanitation services, hygiene, and facility operations.	**Medium**	**Sensitivity:** ● Facilities often rely on limited storage and shallow wells. **Adaptive Capacity:** ● Install rainwater harvesting tanks; increase storage capacity; prioritize water allocation to critical facilities.	**Medium**	**Medium**
Emergency Services	● Limited water availability for firefighting and emergency response during drought periods for areas not close to the Ocean.	**High**	**Sensitivity:** ● No designated municipal water hydrants/systems for fire services from competing domestic uses. **Adaptive Capacity:** ● Develop emergency water reserves; install dedicated firefighting storage tanks.	**High**	**High**
Populations					
Urban Residents	● Increased water rationing and higher household expenditure on water purchases.	**High**	**Sensitivity:** ● Low-income households have limited storage and coping capacity. **Adaptive Capacity:** ● Community water kiosks; subsidized water programs; public awareness on conservation.	**High**	**High**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Informal Settlement Residents	● Acute exposure to water scarcity and poor sanitation during prolonged dry periods.	**High**	**Sensitivity:** ● Limited piped connections; dependence on vendors and shallow wells; overcrowding increases health risks. **Adaptive Capacity:** ● Expand pro-poor water connections; communal boreholes; mobile water supply during drought.	**High**	**High**
Vulnerable and Marginalized Groups	● Women, elderly, children, and persons with disabilities disproportionately affected by water collection burdens.	**High**	**Sensitivity:** ● Limited mobility and financial capacity increase vulnerability. **Adaptive Capacity:** ● Targeted support programs; improved local access points; inclusive water governance.	**High**	**High**
Natural Assets					
Urban Green Infrastructure	● Vegetation stress and tree loss during drought reduce urban cooling capacity.	**Medium**	**Sensitivity:** ● No irrigation and maintenance capacity for public green spaces. **Adaptive Capacity:** ● Drought-resistant native species; greywater irrigation; community tree stewardship programs.	**Medium**	**Moderate**
Urban Blue Infrastructure	● Reduced freshwater inflow and saline intrusion degrade aquatic ecosystems.	**Low**	**Sensitivity:** ● Coastal and island ecosystems are sensitive to hydrological changes.	**Low**	**Low**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			Adaptive Capacity: ● Mangrove restoration; watershed protection; groundwater monitoring and recharge schemes.		
Peri-urban and Agricultural Systems	● Crop failure and livestock stress due to recurrent drought.	**High**	**Sensitivity:** ● Rain-fed agriculture highly climate-sensitive; limited irrigation infrastructure. **Adaptive Capacity:** ● Promote drought-resistant crops; small-scale irrigation schemes; water-efficient farming practices.	**High**	**High**

Table 17: Exposure, Vulnerability, and Impacts of Storms on Urban Elements

Hazard: Storms

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Infrastructure & Services					
Stormwater Drainage	● Intense storms increase debris, sediment wash-off, and structural damage to open drains.	**High**	**Sensitivity:** ● Open, shallow, and aging drainage systems prone to blockage and overtopping during high-intensity storms. **Adaptive Capacity:** ● Upgrade drainage capacity; regular desilting; reinforced drain linings.	**High**	**High**
Water & Wastewater Management	● Storm surges and heavy rainfall may contaminate water sources and damage pumping infrastructure.	**High**	**Sensitivity:** ● Shallow wells and septic systems vulnerable to inundation and saline intrusion.	**High**	**High**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			Adaptive Capacity: ● Elevate boreholes; seal wellheads; improve wastewater containment; emergency chlorination protocols.		
Solid Waste Management	● Strong winds disperse waste bringing solid wastes through the ocean to the local shorelines; storms disrupt collection services.	**High**	**Sensitivity:** ● Informal dumping and uncovered waste sites easily scattered by wind. **Adaptive Capacity:** ● Secure waste storage; improve collection frequency; enforce waste regulations.	**High**	**High**
Transport and Mobility	● Extreme winds and flooding damage roads, jetties corrosion, and coastal transport infrastructure.	**High**	**Sensitivity:** ● Many roads are unpaved (mainland); coastal transport exposed to wave action and storm surge. **Adaptive Capacity:** ● Climate-resilient road design; shoreline protection; jetty reinforcement.	**High**	**High**
Energy	● Storm winds damage power lines, transformers, and solar installations.	**Medium**	**Sensitivity:** ● Overhead power distribution systems highly wind-sensitive. **Adaptive Capacity:** ● Underground cabling (priority areas); storm-resistant mounting; decentralized solar backup systems.	**Medium**	**Moderate**
Economic Infrastructure	● Roof damage and structural impacts to schools and health centers.	**Medium**	**Sensitivity:** ● Most public buildings not designed for extreme wind loads.	**Medium**	**Moderate**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			Adaptive Capacity: ● Roof reinforcement; disaster-resilient building standards; routine inspection.		
Social Infrastructure	● Roof damage and structural impacts to schools and health centers.	**Medium**	**Sensitivity:** ● Older public buildings not designed for extreme wind loads. **Adaptive Capacity:** ● Roof reinforcement; disaster-resilient building standards; routine inspection.	**Medium**	**Moderate**
Emergency Services	● Disruption of communication and access routes during severe storms.	**Low**	**Sensitivity:** ● Limited emergency equipment and alternative access routes. **Adaptive Capacity:** ● Develop Early warning systems; emergency response drills; backup communication systems.	**Medium**	**Moderate**
Populations					
Urban Residents	● Direct exposure to wind damage, flying debris, and flooding.	**Medium**	**Sensitivity:** ● High population density in island wards increases exposure. **Adaptive Capacity:** ● Public awareness campaigns; resilient housing upgrades; evacuation planning.	**Medium**	**Medium**
Informal Settlement Residents	● Light structures highly vulnerable to wind uplift and collapse.	**High**	**Sensitivity:** ● Use of temporary materials; limited structural reinforcement.	**High**	**High**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			Adaptive Capacity: ● Housing improvement programs; enforce safer construction practices; relocation from high-risk zones.		
Vulnerable and Marginalized Groups	● Limited mobility during evacuations; higher disaster recovery burden.	**High**	**Sensitivity:** ● Reduced financial capacity and support networks. **Adaptive Capacity:** ● Inclusive disaster planning; targeted social protection programs.	**High**	**High**
Natural Assets					
Urban Green Infrastructure	● Tree fall and vegetation damage during extreme wind events.	**Low**	**Sensitivity:** ● Limited maintenance of urban trees increases fall risk. **Adaptive Capacity:** ● Tree risk assessments; wind-resistant species selection.	**Low**	**Low**
Urban Blue Infrastructure	● Coastal ecosystems exposed to storm surge and wave erosion.	**Low**	**Sensitivity:** ● Mangroves sensitive but also protective buffers if intact. **Adaptive Capacity:** ● Mangrove restoration; coastal buffer zoning.	**Low**	**Low**
Peri-urban and Agricultural Systems	● Crop damage and livestock exposure during storms.	**High**	**Sensitivity:** ● Rain-fed and open-field systems highly exposed.	**High**	**High**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			Adaptive Capacity: ● Windbreak planting; crop insurance; diversified farming systems.		

2. Climate Risk Assessment

This section integrates the findings from the hazard assessment and the exposure and vulnerability analysis to determine the overall climate risks facing the Municipality of Lamu. It evaluates the likelihood and potential consequences of climate-related hazards by examining how hazard intensity and frequency intersect with exposed populations, assets, services, and ecosystems, as well as their capacity to cope and adapt. The assessment highlights priority climate risks across sectors and locations, including impacts on livelihoods, public health, infrastructure, natural systems, and cultural heritage. By identifying high-risk areas and systems, this section provides a clear evidence base to guide risk prioritization, resilience-building actions, and the mainstreaming of climate considerations into the Integrated Development Plan and other municipal planning instruments.

For this Urban Climate Risk Profile, the following matrix summarizes overall risk for each urban element by combining the assessed hazard level and the estimated impact level.

Table 18: Risk matrix

		Hazard Level		
		Low	**Medium**	**High**
Impact Level	**Catastrophic**	High	Very High	Very High
	Major	Medium	High	Very High
	Moderate	Low	Medium	High
	Minow	Low	Low	Medium
	Insignificant	Very Low	Low	Low

For this Urban Climate Risk Profile, risk levels should be interpreted based on the table below.

Table 19: Interpretation of risk levels

Level	**Interpretation**
Very High	Very high risks are unacceptable. Risk should be avoided, reduced or transferred. Immediate planning and implementation of risk reduction measures is required. Allocate resources and coordinate interventions to prevent or minimize impact.
High	High risks should be actively addressed. Develop and implement mitigation actions promptly. Monitor environmental indicators and ensure readiness of emergency or adaptation measures.
Medium	Medium risks should be managed. Plan and implement mitigation activities to reduce them to acceptable levels. Regularly review climate data and risk levels.
Low	Low risks are acceptable under current conditions. Minimal control or monitoring is needed, provided they remain stable and do not escalate.
Very Low	Very low risks are negligible in terms of likelihood and consequences. No immediate action is required beyond routine monitoring and periodic review.

2.1. Current and Future Climate Risks on Urban Elements

Table 20: Summary of Heat Stress risks for Municipality of Lamu

	Time Horizon & Climate Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level					
Categories	**Impact**	**Risk Levels**				
		Current	**2050 SSP2-4.5**	**2050 SSP5-8.5**	**2100 SSP2-4.5**	**2100 SSP5-8.5**
Infrastructure & Services						
Stormwater Drainage	Moderate	Medium	Medium	High	Medium	High
Water & Wastewater Management	Moderate	Medium	High	High	High	High
Solid Waste Management	Moderate	Medium	High	High	High	High
Transport and Mobility	Moderate	Medium	High	High	High	High
Energy	Minor	Medium	Medium	High	Medium	High
Economic Infrastructure	Major	High	High	High	High	High
Social Infrastructure	Major	High	High	High	High	High
Emergency Services	Moderate	Medium	High	High	High	High
Populations						
Urban Residents	Major	High	High	High	High	High
Informal Settlement Residents	Major	High	High	High	High	High
Vulnerable and Marginalized Groups	Major	High	High	High	High	High
Natural Assets						
Urban Green Infrastructure	Major	High	High	High	High	High
Urban Blue Infrastructure	Moderate	Medium	Medium	High	Medium	High
Peri-urban and Agricultural Systems	Major	High	High	High	High	High

Table 21: Summary of Flooding risks for Municipality of Lamu

	Time Horizon & Climate Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level					
Categories	**Impact**	**Risk Levels**				
		Current	**2050 SSP2-4.5**	**2050 SSP5-8.5**	**2100 SSP2-4.5**	**2100 SSP5-8.5**
Infrastructure & Services						
Stormwater Drainage	Major	Medium	Medium	High	Medium	High
Water & Wastewater Management	Major	Medium	High	High	High	High
Solid Waste Management	High	Medium	Medium	High	Medium	High
Transport and Mobility	Major	High	High	High	High	High
Energy	Moderate	Medium	Medium	High	Medium	High
Economic Infrastructure	Major	High	High	High	High	High
Social Infrastructure	Major	High	High	High	High	High
Emergency Services	Moderate	Medium	High	High	High	High
Populations						
Urban Residents	Major	Medium	High	High	High	High
Informal Settlement Residents	Catastrophic	High	High	High	High	High
Vulnerable and Marginalized Groups	Major	Medium	High	High	High	High
Natural Assets						
Urban Green Infrastructure	Major	Medium	High	High	High	High
Urban Blue Infrastructure	Major	High	High	High	High	High
Peri-urban and Agricultural Systems	Major	High	High	High	High	High

Table 22: Summary of Water Stress risks for Municipality of Lamu

	Time Horizon & Climate Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level					
Categories	**Impact**	**Risk Levels**				
		Current	**2050 SSP2-4.5**	**2050 SSP5-8.5**	**2100 SSP2-4.5**	**2100 SSP5-8.5**
Infrastructure & Services						
Stormwater Drainage	Minor	Low	Medium	Medium	Medium	Medium
Water & Wastewater Management	Major	High	High	High	High	High
Solid Waste Management	Minor	Medium	Medium	High	Medium	High
Transport and Mobility	Moderate	Medium	High	High	High	High
Energy	Moderate	Medium	High	High	High	High
Economic Infrastructure	Major	High	High	High	High	High
Social Infrastructure	Major	High	High	High	High	High
Emergency Services	Moderate	Medium	High	High	High	High
Populations						
Urban Residents	Major	High	High	High	High	High
Informal Settlement Residents	Major	High	High	High	High	High
Vulnerable and Marginalized Groups	Major	High	High	High	High	High
Natural Assets						
Urban Green Infrastructure	Major	High	High	High	High	High
Urban Blue Infrastructure	Major	High	High	High	High	High
Peri-urban and Agricultural Systems	Major	High	High	High	High	High

Table 23: Summary of Storms risks for Municipality of Lamu

	Time Horizon & Climate Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level					
Categories	**Impact**	**Risk Levels**				
		Current	**2050 SSP2-4.5**	**2050 SSP5-8.5**	**2100 SSP2-4.5**	**2100 SSP5-8.5**
Infrastructure & Services						
Stormwater Drainage	Major	Medium	Medium	High	Medium	High
Water & Wastewater Management	Major	Medium	Medium	High	Medium	High
Solid Waste Management	Major	Medium	Medium	High	Medium	High
Transport and Mobility	Major	Medium	Medium	High	Medium	High
Energy	Moderate	Medium	Medium	High	Medium	High
Economic Infrastructure	Major	High	High	High	High	High
Social Infrastructure	Moderate	Medium	Medium	High	Medium	High
Emergency Services	Major	High	High	High	High	High
Populations						
Urban Residents	Moderate	Medium	Medium	High	Medium	High
Informal Settlement Residents	Major	High	High	High	High	High
Vulnerable and Marginalized Groups	Major	High	High	High	High	High
Natural Assets						
Urban Green Infrastructure	Moderate	Medium	Medium	High	Medium	High
Urban Blue Infrastructure	Major	High	High	High	High	High
Peri-urban and Agricultural Systems	Moderate	Medium	Medium	High	Medium	High

2.2. Climate Risk Hotspots

Climate risks within the Municipality of Lamu are not evenly distributed but are shaped by the municipality's unique island–mainland geography, land use patterns, population density, ecosystem sensitivity, and infrastructure development. Distinct climate risk hotspots emerge

across wards where high hazard exposure intersects with high vulnerability and limited adaptive capacity.

Mkomani Ward (Amu Island)

Mkomani Ward constitutes one of the highest climate risk hotspots in the municipality. As the most densely populated municipal ward and the location of Lamu Old Town (a UNESCO World Heritage Site), it faces compounded risks from extreme heat, pluvial flooding, sea level rise, and coastal flooding**.** Narrow streets, limited drainage infrastructure, and high building density exacerbate surface runoff and flash flooding during intense rainfall events. Rising temperatures and marine heatwaves threaten public health, fisheries, and tourism livelihoods, while sea level rise and coastal erosion pose long-term risks to heritage buildings, waterfront infrastructure, and informal settlements along the shoreline. The concentration of population, cultural assets, and economic activity significantly amplifies potential impacts.

Shela/Manda Ward

Shela–Manda Ward is a coastal and marine climate risk hotspot**,** particularly exposed to sea level rise, coastal flooding, marine heatwaves, and saline intrusion**.** Tourism infrastructure located close to the shoreline is highly sensitive to coastal erosion and storm surges, while coral reefs, seagrass beds, and fisheries are vulnerable to rising ocean temperatures. Limited freshwater availability on Manda Island increases sensitivity to water stress and salinization**,** especially under prolonged dry periods. Although population density is lower than Mkomani, the ward's strong dependence on climate-sensitive tourism and marine ecosystems heightens economic vulnerability.

Hindi Ward (Mainland)

Hindi Ward represents a dynamic and emerging climate risk hotspot**,** driven by rapid urbanization and large-scale infrastructure development associated with the Lamu Port and LAPSSET Corridor. The ward is particularly exposed to flooding (pluvial), water stress, and extreme heat**.** Expansion of impervious surfaces, settlement growth in low-lying areas, and pressure on drainage systems increase flood risks. At the same time, rising temperatures and recurrent drought conditions strain water supply, agriculture, and livestock-based livelihoods. The influx of migrant populations and land-use changes elevate vulnerability, especially in informal or poorly serviced settlements.

Basuba Ward (Kiangwe and Milimani – Municipal Areas)

The municipal portions of Basuba Ward constitute a chronic climate vulnerability hotspot**,** mainly linked to water stress, drought, groundwater salinization, and livelihood insecurity**.** Communities in Kiangwe and Milimani experience severe freshwater scarcity, which is projected to worsen under climate change due to reduced recharge and saline intrusion. Dependence on natural resources such as mangroves, fisheries, and small-scale agriculture increases sensitivity to climate variability. While exposure to coastal flooding is lower than island wards, limited infrastructure, poverty, and marginalization significantly heighten vulnerability and reduce adaptive capacity.

Overall Spatial Risk Pattern

In summary, island wards (Mkomani and Shela–Manda) are predominantly exposed to coastal and marine-related climate risks, while mainland wards (Hindi and Basuba) face more pronounced risks related to flooding, drought, water stress, and heat**.** Areas with high population density, cultural heritage assets, critical infrastructure, and climate-sensitive livelihoods consistently emerge as priority risk hotspots. These spatial risk patterns underscore the need for ward-specific, context-sensitive climate resilience strategies within the Municipality of Lamu, aligned with both urban development and ecosystem conservation objectives.

3. What's Next?

This subsection contains the way forward regarding the highlighted key climate hazards.

3.1. Key Findings

Table 24: Summary of climate risks affecting urban elements for Municipality of Lamu

Category	**Key Hazards**	**List of Key Hazards**		
		Current	**Mid-term (2050)**	**Long-term (2100)**
Infrastructure & Services				
Stormwater Drainage	Flooding, Storms	High	High	Very High
Water & Wastewater Management	Water Stress, Flooding	High	High	Very High
Solid Waste Management	Flooding, Storms	Moderate	High	High
Transport and Mobility	Flooding, Storms	High	High	Very High
Energy	Heat Stress, Storms	Moderate	High	High
Economic Infrastructure	Flooding, Storms	Moderate	High	High
Social Infrastructure	Flooding, Storms	Moderate	High	High
Emergency Services	Flooding, Storms	Moderate	High	High
Populations				
Urban Residents	Flooding, Heat Stress	High	High	Very High
Informal Settlement Residents	Flooding, Storms, Water Stress	High	Very High	Very High
Vulnerable and Marginalized Groups	Flooding, Water Stress, Heat Stress	High	Very High	Very High
Natural Assets				
Urban Green Infrastructure	Heat Stress, Water Stress			
Urban Blue Infrastructure	Heat stress Storms	High	Very High	Very High
Peri-urban and Agricultural Systems	Water Stress, Heat Stress , Storms, Flooding	High	High	Very High

3.2. Climate Adaptation and Resilience Solutions

Table 25: Climate adaptation and resilience solutions recommended for Municipality of Lamu

Category	Recommended Solutions		
	Immediate	**Mid-term**	**Long-term**
Infrastructure & Services			
Stormwater Drainage	● Routine desilting before rainy seasons; identify flood hotspots; enforce anti-dumping bylaws.	● Upgrade undersized drains; introduce covered drains in dense areas; construct retention ponds.	● Integrated urban drainage masterplan; climate-resilient drainage redesign accounting for sea level rise.
Water & Wastewater Management	● Repair leaks; emergency water rationing plans; promote rainwater harvesting.	● Develop additional boreholes with salinity monitoring; small-scale desalination pilots; wastewater reuse systems.	● Diversified water supply systems; aquifer recharge schemes; centralized wastewater treatment expansion.
Solid Waste Management	● Increase collection frequency; community clean-up campaigns; secure waste storage.	● Establish controlled transfer stations; improve waste segregation; composting programs.	● Integrated waste management facility; waste-to-energy or circular economy initiatives.
Transport and Mobility	● Routine road maintenance; repair critical culverts; map vulnerable road segments.	● Upgrade priority roads to climate-resilient standards; reinforce jetties.	● Elevate or redesign critical transport corridors in flood-prone areas; climate-proof port access infrastructure.
Energy	● Install surge protectors; maintain distribution lines; promote household solar kits.	● Solar-powered boreholes; decentralized renewable microgrids; reinforce substations.	● Underground cabling in priority zones; transition to resilient renewable energy systems.
Economic Infrastructure	● Install rainwater harvesting tanks; roof inspections; emergency preparedness plans.	● Retrofit buildings to wind-resistant standards; expand water storage capacity.	● Relocate or elevate critical facilities in high-risk zones; climate-resilient public facility standards.
Social Infrastructure	● Install rainwater harvesting tanks; roof inspections; emergency preparedness plans.	● Retrofit buildings to wind-resistant standards; expand water storage capacity.	● Relocate or elevate critical facilities in high-risk zones; climate-resilient public facility standards.

Category	Recommended Solutions		
	Immediate	**Mid-term**	**Long-term**
Emergency Services	• Update disaster response plans; early warning dissemination; conduct drills.	• Procure emergency equipment; establish backup communication systems.	• Develop multi-hazard emergency operations center; dedicated emergency water/fire reserves.
Populations			
Urban Residents	• Public awareness campaigns (heat, floods, water conservation); early warning alerts.	• Incentivize climate-resilient housing upgrades; promote rooftop water harvesting.	• Risk-sensitive land use planning; planned settlement upgrading in high-risk zones.
Informal Settlement Residents	• Map high-risk informal areas; improve drainage access; temporary flood barriers.	• Incremental housing improvement programs; expand pro-poor water and sanitation access.	• Relocation or in-situ upgrading with climate-resilient infrastructure; tenure security integration.
Vulnerable and Marginalized Groups	• Targeted social protection during drought/flood events; accessible early warnings.	• Livelihood diversification programs; microfinance for resilience upgrades.	• Institutionalized inclusive climate governance frameworks; permanent safety-net systems.
Natural Assets			
Urban Green Infrastructure	• Tree planting campaigns; protect existing green spaces.	• Establish shaded corridors; drought-resistant native species programs.	• Integrated urban greening strategy for heat island reduction.
Urban Blue Infrastructure	• Protect existing mangroves; enforce coastal setback regulations.	• Mangrove restoration programs; shoreline stabilization projects.	• Nature-based coastal defense systems integrated into spatial planning.
Peri-urban and Agricultural Systems	• Promote drought-resistant crops; farmer awareness programs.	• Small-scale irrigation schemes; water-efficient farming technologies.	• Climate-smart agriculture transition; watershed-level water resource management.

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Annex 1. Historical Hazard Events

1. 2023 El Niño–Related Flooding

Category	Description
Hazard Event/Type	Riverine and pluvial flooding associated with enhanced short rains (El Niño event).
Date or Period	October – December 2023.
Location	Lamu Island (Shela, Mkomani, Hindi, Mokowe) and low-lying mainland settlements within Lamu Municipality.
Intensity	Prolonged heavy rainfall over several weeks led to surface runoff accumulation; drainage systems were overwhelmed; flooding persisted for several days in poorly drained areas.
Social Impacts	Thousands displaced; increased cases of cholera, diarrhea, and malaria; vulnerable groups (elderly, children, persons with disabilities, low-income households) most affected.
Physical Impacts	Damage to roads and culverts; inundation of homes and schools; contamination of wells; localized electricity disruptions.
Economic Impacts	Loss of household assets; disruption to tourism and trade; infrastructure repair costs.
Ecological Impacts	Soil erosion; marine pollution from runoff; localized mangrove stress due to sedimentation.

2. December 2025 High Tides and Coastal Flooding

Category	Description
Hazard Event/Type	Coastal flooding due to extreme high tides and sea level variability.
Date or Period	December 2025.
Location	Lamu Island waterfront including Lamu Old Town seafront and Shela village.
Intensity	Abnormally high tides inundated sections of the seafront and adjacent streets; shallow saltwater intrusion into shoreline buildings; temporary but recurrent over several days.
Social Impacts	Temporary displacement; disruption of daily movement; health risks from stagnant saltwater; exposure risk to heritage structures.
Physical Impacts	Flooding of waterfront roads; minor structural damage; saltwater corrosion; jetty disruptions.

Economic Impacts	Temporary closure of tourism businesses; fishing activity disruptions; cleanup and minor repair costs.
Ecological Impacts	Coastal erosion; saltwater intrusion affecting vegetation; stress on fragile coastal ecosystems.

3. 2017 Severe Drought

Category	Description
Hazard Event/Type	Meteorological and hydrological drought.
Date or Period	2016 – 2017 dry seasons (peak impacts in 2017).
Location	Municipality of Lamu and mainland settlements (Hindi, Mokowe, Witu).
Intensity	Prolonged rainfall deficit; declining borehole and shallow well levels; emergency water trucking required.
Social Impacts	Acute water shortages; increased human–wildlife conflict; food insecurity; disproportionate burden on women and children.
Physical Impacts	Drying of wells; reduced urban water supply; sanitation stress due to limited water availability.
Economic Impacts	Livestock losses; reduced agricultural productivity; increased household water costs; slowed local businesses.
Ecological Impacts	Vegetation loss; rangeland degradation; wildlife encroachment; ecosystem stress.

4. 2019 Flooding Event

Category	Description
Hazard Event/Type	Extreme rainfall leading to widespread flooding.
Date or Period	April – May 2019 (Long Rains season).
Location	Municipality of Lamu including Mokowe, Hindi, and other low-lying settlements.
Intensity	Intense rainfall caused flash floods; homes inundated; roads cut off; floodwaters remained for several days.
Social Impacts	Over 5,000 households affected countywide; displacement; disease outbreaks; temporary school closures.
Physical Impacts	Destruction of semi-permanent houses; road washouts; drainage damage; water contamination.
Economic Impacts	Livestock and crop losses; disruption of trade and tourism; emergency response and rehabilitation costs.

Ecological Impacts	Soil erosion; sediment deposition; contamination of coastal waters.

Annex 2. Data Sources

Page	Data	Data Source
p. 8–12	Historical temperature and rainfall trends	IPCC, Climate Change 2021: The Physical Science Basis
p. 13–16	Climate projections (RCP/SSP scenarios)	IPCC, Climate Change 2021: The Physical Science Basis
p. 17–21	Climate impact risks for Africa (heat, drought, coastal flooding)	IPCC, Climate Change 2022: Impacts, Adaptation and Vulnerability
p. 22–25	National climate policy framework	Government of Kenya, Climate Change Act
p. 26–30	Adaptation priorities and sectoral actions	Government of Kenya, Kenya National Adaptation Plan (NAP) 2015–2030
p. 31–35	National mitigation and adaptation interventions	Government of Kenya, Kenya Climate Change Action Plan (KCCAP) 2018–2022
p. 36–40	County development priorities and infrastructure gaps	Government of Kenya, Lamu County Integrated Development Plan (CIDP)
p. 41–45	Land use patterns and zoning information	Government of Kenya, Lamu County Spatial Plan
p. 46–49	Observed local climate variability	Kenya Meteorological Department (KMD), State of the Climate in Kenya Reports
p. 50–54	Environmental degradation trends and coastal pressures	National Environment Management Authority (NEMA), State of the Environment Report
p. 55–58	Urban resilience frameworks	UN-Habitat, Enhancing Urban Climate Resilience: A Guide for Local Governments
p. 59–62	Climate integration in urban planning	UN-Habitat, Integrating Climate Change into Urban Planning
p. 63–66	National-level climate risk overview	World Bank, Climate Risk Country Profile: Kenya
p. 67–70	Flood risk management approaches	World Bank, Urban Flood Risk Management: A Tool for Integrated Planning
p. 71–74	Global climate trends and extremes	World Meteorological Organization (WMO), State of the Global Climate Reports
p. 75–78	Global adaptation finance and gap analysis	UNEP, Adaptation Gap Report
p. 5–7	Urban Climate Risk Profile methodology	Global Center on Adaptation (GCA), Urban

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