



URBAN CLIMATE RISK PROFILE

FOR

MARSABIT MUNICIPALITY

2025

APPROVAL

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FOREWORD

The Municipality of Marsabit is extremely susceptible to impacts of changing climate. Most livelihoods and economic activities in the municipality are reliant on climate sensitive sectors namely agriculture, livestock, water, trade, tourism, forestry and wildlife conservation. Dependence on these natural resources means that recurring droughts, erratic rainfall patterns and floods as a result of climate change will continue to negatively impact livelihoods and community asset in the municipality.

In order to cushion key sectors against the impact of climate change, the Municipality of Marsabit undertook a Rapid Climate Risk Assessment (RCRA). The assessment was done as part of the municipality policy framework. As per the Marsabit County Climate Change Policy (2019) and Marsabit County Climate Change Fund Act (2020), climate risk assessment is essential to enable to identify climate risks, impacts and priority resilience options to build local capacities through locally led action.

The RCRA process culminated into the development of a Municipality climate risk profile report, which identifies the key climate risks for the municipality as well as possible solutions that would lead to urban climate resilience. This climate risk profile will inform future decision-making with regard to the development of policies & strategies, embedment into the urban planning framework as well as future investment in infrastructure. The profile is expected to inform the review of the Marsabit Municipality Integrated Development Plans (IDeP), as well as provide valuable input when developing the Local Physical and Land Use Development Plan (LPLUDP).

Indeed, the Municipality of Marsabit is committed to implementing the proposed solutions in this climate risk profile together with the programs proposed in the Marsabit County Climate Change Action Plan (2023-2027). The climate risk profile adds to the policy, legal and institutional strengthening efforts aimed at enhancing urban climate governance in the municipality. Already, the municipality has adopted Marsabit County Climate Change Policy (2019) and Marsabit County Climate Change Fund Act (2020) and Marsabit County Climate Finance Framework (2023-2025). It is my hope that this profile will help all partners in Marsabit to mainstream climate change in their interventions for the benefit of the people of Marsabit.

ADAN WARIO BORU

CHAIRMAN, BOARD OF MANAGEMENT,
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EXECUTIVE SUMMARY

Objectives of the rapid climate risk assessment

The overarching objective of this Urban Climate Risk Profile is to inform urban policies, planning, and development, enabling integration of climate adaptation and resilience including informing the Integrated Development Plan (IDeP) and the Local Physical and Land Use Development Plan (LPLUDP). The profile will inform prioritization of actions and resources to protect the most vulnerable populations, infrastructures and services, and natural assets. This profile will also guide investment decisions and support access to climate finance.

This Profile was produced through a rapid climate risk assessment (RCRA), whose objectives were to establish the evidence base that underpins an Marsabit's climate risk management; to identify the relevant climate hazards, the urban elements exposed, and the drivers of risk; to analyse how hazards interact with underlying vulnerabilities, including inequality and exclusion, in Marsabit; and to assess how risks change over time.

It is expected that this profile will provide the foundation for developing policies and strategies at the urban level that outline how to address current and future climate risks. This will ensure that resilience is integrated into long-term urban plans such as urban master plans, capital expenditure plans and disaster risk reduction plans. Such plans will further guide the planning and delivering of climate resilient infrastructure so that it can withstand current and future climate impacts and minimizes climate risks for citizens.

List of key hazards identified

For Marsabit Municipality, the key climate hazards were identified based on its geography, climate patterns, and urban infrastructure. Based on available data and common climate risks in Marsabit, the main hazards are:

- a) **Drought** characterized by deficient rainfall that leads to water shortages, reduced agricultural productivity, and stress on ecosystems and human systems.
- b) **Extreme Heat** characterized by extended periods of high temperatures that increase risks to human health, agriculture, and infrastructure.
- c) **Pluvial Flooding** that is caused by intense rainfall overwhelming local drainage systems, leading to surface water accumulation in urban or rural areas.
- d) **Changes in precipitation patterns** including gradual changes in the amount, timing, intensity, or distribution of rainfall over time, which can produce extended dry spells, more intense storms, or altered seasonality, disrupting water supply, agriculture, flood drainage and ecosystems.

Risk results summary for each key hazard

Summary of Drought risks for Marsabit Municipality

Categories	Risk Levels				
	Current	2050 SSP2- 4.5	2050 SSP5- 8.5	2100 SSP2- 4.5	2100 SSP5- 8.5
Infrastructure & Services					
Stormwater Drainage	High	High	High	High	High
Water & wastewater Management	Low	Low	Low	Low	Low
Solid Waste Management	Low	Low	Low	Low	Low
Transport and Mobility	Low	Low	Low	Low	Low
Populations					
Urban Residents	Very high	Very high	Very high	Very high	Very high
Informal Settlement Residents	Very high	Very high	Very high	Very high	Very high
Vulnerable and Marginalized Groups	Very high	Very high	Very high	Very high	Very high
Natural Assets					
Urban Green Infrastructure	Very high	Very high	Very high	Very high	Very high
Urban Blue Infrastructure	High	High	High	High	High
Peri-urban and Agricultural Systems	Very high	Very high	Very high	Very high	Very high

Table 1: Summary of Flooding risks for Marsabit Municipality

Categories	Risk Levels				
	Current	2050 SSP2- 4.5	2050 SSP5-8.5	2100 SSP2- 4.5	2100 SSP5- 8.5
Infrastructure & Services					
Stormwater Drainage	Very high	Very high	Very high	Very high	Very high
Water & Wastewater Management	Very high	Very high	Very high	Very high	Very high
Solid Waste Management	Very high	Very high	Very high	Very high	Very high
Transport and Mobility	Medium	Medium	High	High	High
Energy	Low	Low	Low	Low	Low
Economic Infrastructure	Low	Low	Medium	Medium	Medium
Social Infrastructure	Very high	Very high	Very high	Very high	Very high
Emergency Services	Low	Low	Medium	Medium	Medium
Populations					
Urban Residents	Very high	Very high	Very high	Very high	Very high
Informal Settlement Residents	Very high	Very high	Very high	Very high	Very high
Vulnerable and Marginalized Groups	Very high	Very high	Very high	Very high	Very high
Natural Assets					
Urban Green Infrastructure	Very high	Very high	Very high	Very high	Very high
Urban Blue Infrastructure	Very high	Very high	Very high	Very high	Very high
Peri-urban and Agricultural Systems	Medium	Medium	High	High	High

Table 2: Summary of Extreme Precipitation risks for Marsabit Municipality

Categories	Risk Levels				
	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
Infrastructure & Services					
Stormwater Drainage	Very high	Very high	Very high	Very high	Very high
Water & Wastewater Management	Very high	Very high	Very high	Very high	Very high
Solid Waste Management	Very high	Very high	Very high	Very high	Very high
Transport and Mobility	High	High	High	High	High
Energy	Low	Low	Low	Low	Low
Economic Infrastructure	High	High	High	High	High
Social Infrastructure	Very high	Very high	Very high	Very high	Very high
Emergency Services	Medium	Medium	Medium	Medium	Medium
Populations					
Urban Residents	Very high	Very high	Very high	Very high	Very high
Informal Settlement Residents	Very high	Very high	Very high	Very high	Very high
Vulnerable and Marginalized Groups	Very high	Very high	Very high	Very high	Very high
Natural Assets					
Urban Green Infrastructure	Very high	Very high	Very high	Very high	Very high
Urban Blue Infrastructure	Very high	Very high	Very high	Very high	Very high
Peri-urban and Agricultural Systems	High	High	High	High	High

Table 3: Summary of Extreme Heat risks for Marsabit Municipality

Categories	Risk Levels				
	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
Infrastructure & Services					
Stormwater Drainage	Very low	Low	Low	Low	Low
Water & Wastewater Management	Medium	High	High	High	High
Solid Waste Management	Very low	Low	Low	Low	Low
Transport and Mobility	Very low	Low	Low	Low	Low
Energy	Very low	Low	Low	Low	Low
Economic Infrastructure	Low	Medium	Medium	Medium	High
Social Infrastructure	Medium	High	High	High	High
Emergency Services	Very low	Low	Low	Low	Medium
Populations					
Urban Residents	High	Very high	Very high	Very high	Very high
Informal Settlement Residents	High	Very high	Very high	Very high	Very high
Vulnerable and Marginalized Groups	High	Very high	Very high	Very high	Very high
Natural Assets					
Urban Green Infrastructure	High	Very high	Very high	Very high	Very high
Urban Blue Infrastructure	High	Very high	Very high	Very high	Very high
Peri-urban and Agricultural Systems	High	Very high	Very high	Very high	Very high

Key takeaways on what can be done to mitigate the higher risks

Climate adaptation and resilience solutions proposed for Marsabit Municipality can be categorized into three groups, that can also be designed and implemented in various combinations:

Structural Solutions which are physical constructions and assets that are built to reduce or avoid the impacts of climate hazards.

Non-Structural Solutions which focus institutional, on improving organizational and human capacity to reduce climate risks, including policies, plans, capacity building, investment in data collection and technology, awareness raising, monitoring and evaluation.

Nature-based Solutions refers to actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits.

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1. CONTEXT

1.1. OBJECTIVES

The overarching objectives of this Urban Climate Risk Profile are:

- To inform urban policies, planning, and development, enabling integration of climate adaptation and resilience including informing the Integrated Development Plan (IDeP) and the Local Physical and Land Use Development Plan (LPLUDP).
- To prioritize actions and resources to protect the most vulnerable populations, infrastructures and services ,and natural assets.
- To guide investment decisions and support access to climate finance

This Profile was produced through a rapid climate risk assessment (RCRA), whose objectives were to:

- Establish the evidence base that underpins an Marsabit's climate risk management
- Identify the relevant climate hazards, the urban elements exposed, and the drivers of risk.
- Analyse how hazards interact with underlying vulnerabilities, including inequality and exclusion, in Marsabit.
- Assesse how risks change over time

It is expected that this profile will provide the foundation for developing policies and strategies at the urban level that outline how to address current and future climate risks. This will ensure that resilience is integrated into long-term urban plans such as urban master plans, capital expenditure plans and disaster risk reduction plans. Such plans will further guide the planning and delivering of climate resilient infrastructure so that it can withstand current and future climate impacts and minimizes climate risks for citizens.

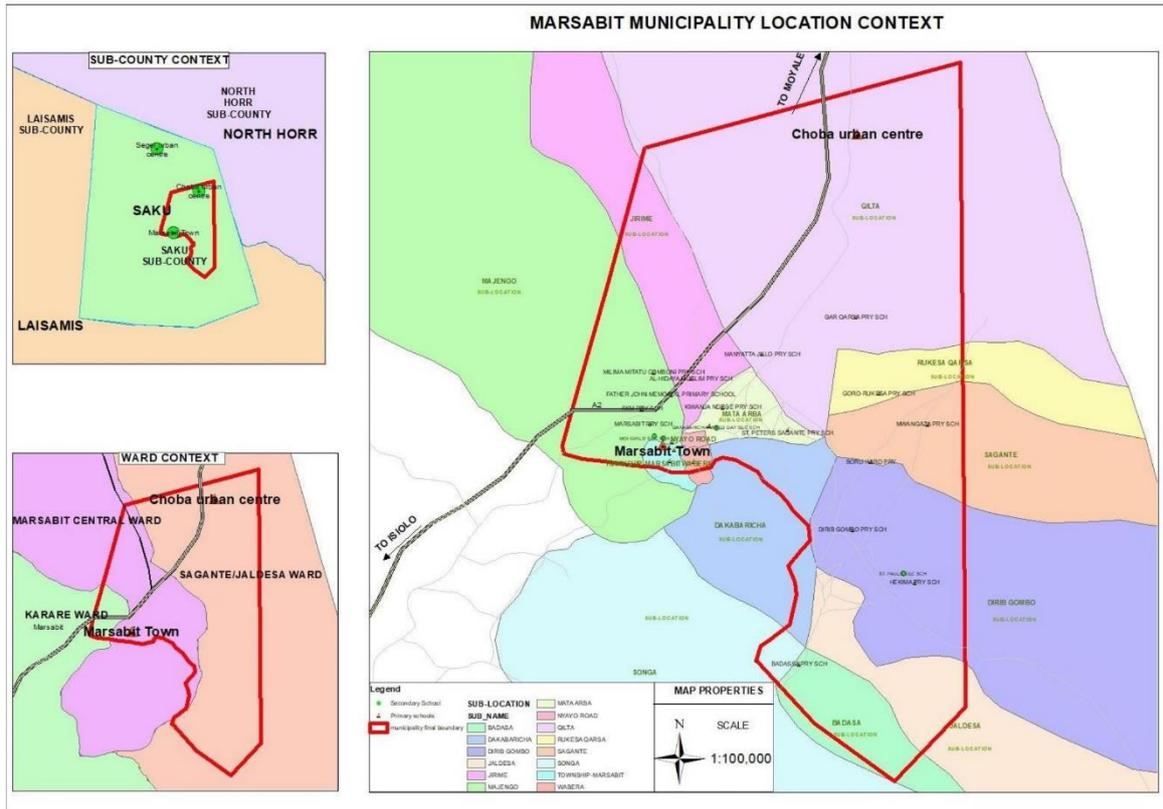
1.2. URBAN CONTEXT

1.2.1. Geographic area

The Municipality of Marsabit is located in the County of Marsabit. It covers an approximate area of 224 km². The Municipality lies to the South-East of the Chalbi Desert, at the slopes of Mt. Marsabit. It is located along latitude 2° 20' 0" North and longitude 35° 59' 15" East . The Municipality is 550 kilometres North East of Kenya's capital city –Nairobi, 250 kilometres North of Isiolo town; a Vision 2030 resort city flagship project town and 250 kilometres south west of Moyale town (at the border of Kenya and Ethiopia). It lies at an altitude of 1500m above sea level and has an urban built-up area of less than 10 square kilometres.

The municipality is covered by the Choba and Marsabit Town central areas. Marsabit Town is the major urban centre within the municipality and also serves as headquarter for Marsabit County. The municipality is located in Saku Constituency within Marsabit Central Sub-County.

Map 1: Geographical Location of Marsabit Municipality



Wards in Marsabit Municipality

The municipality is covered by sections of 3 Wards namely; Karare, Marsabit Central and Sagante/Jaldesa. Sagante/Jaldesa Ward contributes the largest portion accounting for 70.0% followed by Marsabit Central at 26.00% as shown in the table below.

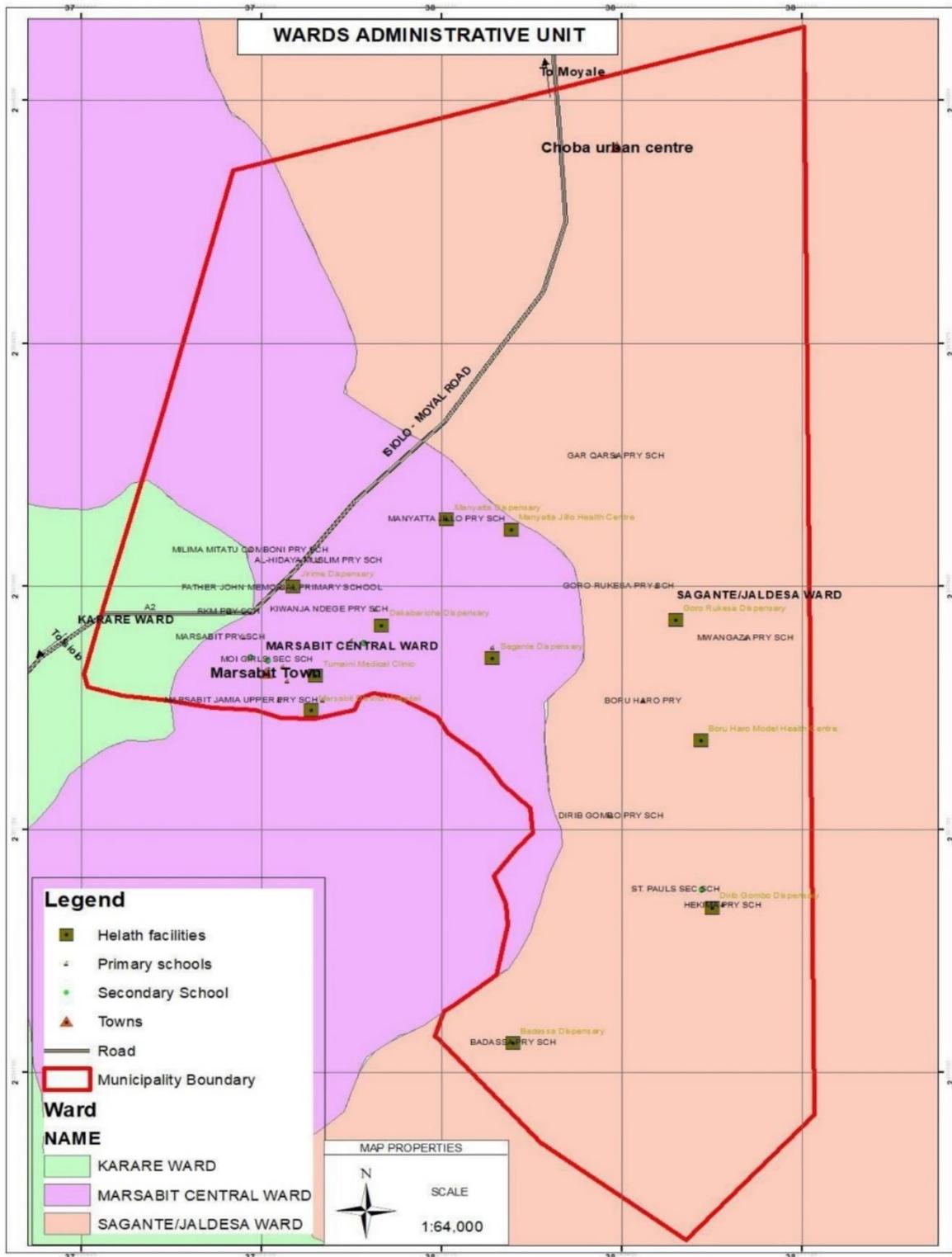
Table 4: Wards in Marsabit Municipality

Ward	Area (km ²) within County	Area within Municipality (km ²)	% of Municipality within Ward
Karare	704.67	9.08	4.00
Marsabit Central	645.19	58.28	26.00
Sagante/Jaldesa	708.56	156.85	70.00
		224.21	100.00

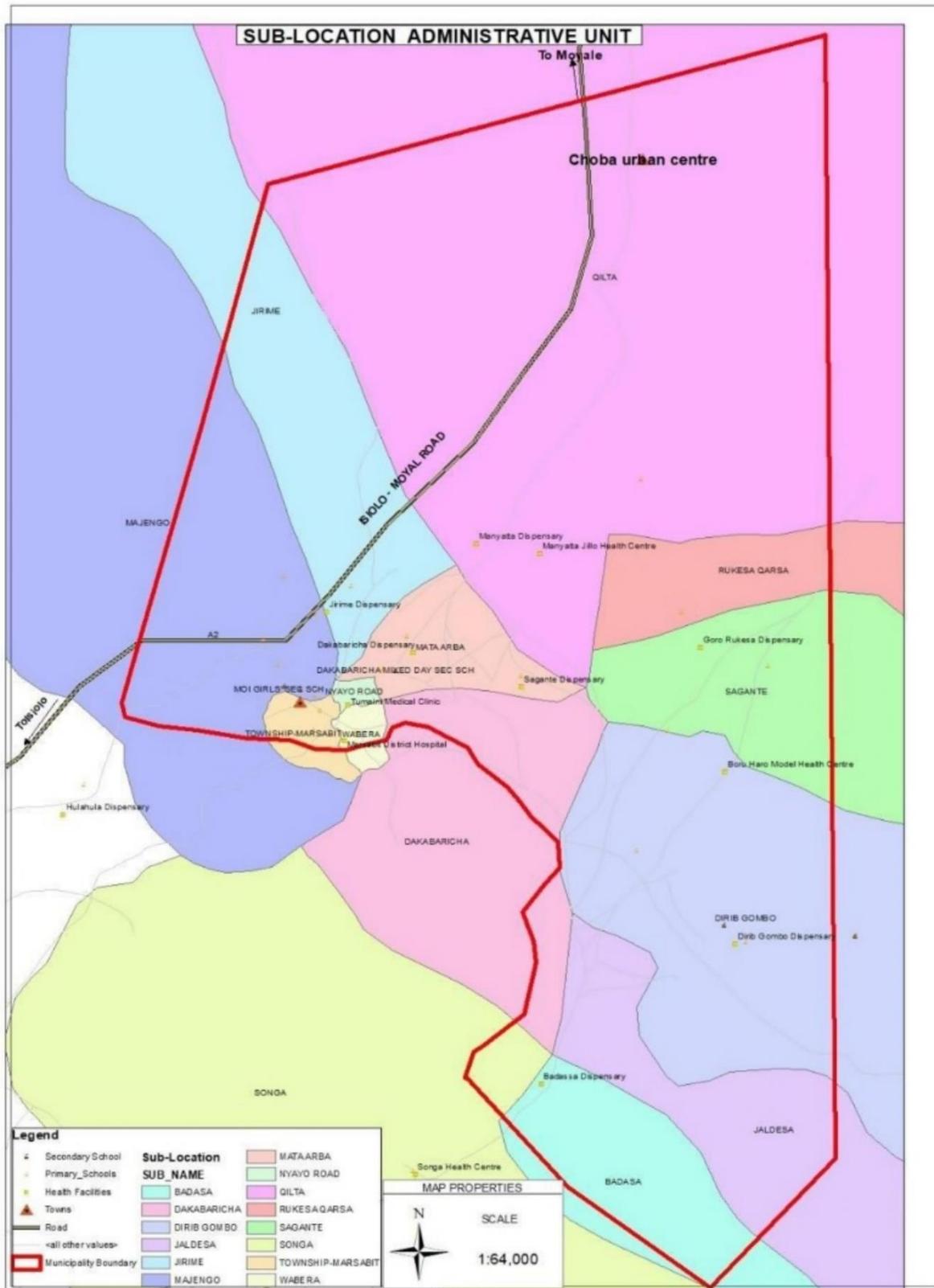
Sub-locations in Marsabit Municipality

The municipality boundary fully covers the following sub-locations; Mata Arba, Township, Wabera and Badasa. It also covers sections of the Majengo, Qilta, Jirime, Rukesa Qarsa, Sagante, Dakabaricha, Dirib Gombo, Songa and Jaldesa sub-locations. The table below demonstrates the population of the sub locations covered by the Municipality of Marsabit.

Map 2: Wards in Marsabit Municipality



Map 3: Sub-locations in Marsabit Municipality



1.2.2. Governance Structure

The Municipality of Marsabit was established through the Marsabit Municipal Charter as approved by the County Assembly in 2019 and assented to by H.E the Governor in line with the Urban Areas and Cities Act (UACA) of 2011, amended 2019.

The Municipality is managed through a Board whose members are competitively recruited by the Executive and approved by the County Assembly. The members comprise of a Chairman and Nine (8) Members, four of whom are nominated by Umbrella bodies. The Board is a body corporate and responsible to the County Executive through the Executive Member for Lands, Urban Planning, Environment and Climate Change.

However, most of the functions of the municipality are being carried out by the various County Government Departments because the municipality lacks capacity as it is only the Municipal Board and Municipal Manager's office which are currently operational. The Municipality therefore lacks operational governance and management structure to perform its mandate effectively.

Developing the climate risk profile was an integrated approach that included several units in the Municipality. The Public Health and Environment Unit took the lead in identifying the climate hazards and how they intersect with social exposure and vulnerability. On the other hand, the Urban Development Unit was involved in providing data on critical infrastructure (roads, drainage, housing) that could be damaged by climate events and conducted spatial analysis to determine the levels of impact. The Social Safeguards Unit was responsible in evaluating how climate hazards specifically disrupt livelihoods. It is expected that the three units will still work together to embed the findings and proposed solutions into urban plans such as the IDEP, LPLUDP and disaster management plans.

1.2.3. Socio-economic Context

Population and Demographic Characteristics

The Municipality of Marsabit population was 36,289 in 2019 according to the national census conducted by the Kenya National Bureau of Statistics. The municipality is covered by sections of three wards namely; Karare, Marsabit Central and Sagante/Jaldesa.

s.no	Ward	2019, Base population			2021 Projected Population			2025 projected population		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
1	Karare	6,150	6,273	12,423	6906	7045	13951	8710	7045	13951
2	Marsabit Central	20,251	18,750	39,001	22742	21056	43798	28680	26554	55234
3	Sagante/Jaldesa	14,555	13,191	27,746	16345	14813	31159	20613	18682	39295

Source, KNBS data, 2019

Population Size and Growth

The population of Marsabit Municipality has seen steady growth, driven by its role as an "oasis" in the northern arid zone and the recent completion of the Isiolo-Marsabit-Moyale highway, which has spurred economic activity.

Population Density - Settlement patterns in the municipality are influenced by soil fertility, topography, road networks, urbanization and rainfall. The population density is concentrated within the Marsabit Central Areas due to the availability of social amenities.

Age and Gender Distribution - Median Age: Approximately 16.5 years, indicating a very young population with high dependency ratios.

Household Characteristics

Average Household Size: 5.8 persons, significantly higher than the Kenyan national average of 3.9.

Education: Literacy rates in the municipality are higher than the county average (which is roughly 20-30%) but still face challenges due to historical marginalization and high school-dropout rates among girls.

Poverty: The municipality faces "urban poverty" issues, with limited access to piped water (only about 7% of households) and reliance on seasonal springs and boreholes.

Socio-Cultural Profile

Marsabit is one of the most ethnically diverse towns in Kenya, serving as a melting pot for various Cushitic and Nilotic groups. The Borana are the most populous, followed closely by the Gabbra, Rendille, and Burji. Other groups include the Samburu, Turkana, and Sakuye.

Religion: about 48% of the residents are Muslim, predominant in the town center and among Borana/Gabra/Burji communities. About 35% of the residents are Christians of various denominations including Catholic, Anglican, and Evangelical. Around 15% of the residents are Traditionalists, strongest among rural-urban migrants.

Languages: Afaan Oromo (Borana), Gabbra, and Rendille are the primary local languages, with Swahili and English used for trade and official business.

1.2.4. Economic Context

Municipality of Marsabit main economic activities include; agriculture, tourism and commerce.

Agriculture is one of the main economic activities due to large rural hinterland in Municipality of Marsabit. The most dominant agricultural sector in Marsabit is livestock rearing specifically, nomadic- pastoralism version. However, nowadays Marsabit people are shifting to sedentary lifestyle thus indulging in farming activities on the much-limited space they have. This include growing of Khat as a cash crop. The area is a significant producer of meat animals in Kenya.

Crop Farming - The rising temperatures and reducing rainfall and its poor distribution have affected the optimal temperatures for crop production and reproduction. The increased temperatures have especially affected crops that used to thrive in low temperatures. As a result, farmers have experienced reduced crop yields leading to food insecurity, reduced nutrition and livelihoods. The common type of crops grown are the cereals and legumes followed by horticultural crops and lastly by fruits.

Livestock keeping is one of the major agricultural activities carried widely in the county with farmers keeping large herds of cattle, sheep and goats as well as camels. The livestock species kept in the area are herds of cattle, sheep, goats, camels, donkeys and indigenous chicken. Livestock farmers normally practice nomadic livestock keeping method i.e. they keep moving from one area to another in search of pastures and water for their livestock and for other domestic purposes.

Tourism - Marsabit Municipality is a key tourist stopping center and has rich and diverse tourist attraction sites in the country with immense potential of developing as a tourist resort with ecotourism activities. It is located in the proximity of significant tourist attractions such as the Marsabit National Park and Reserve where all the big five animals can be found; the magical Lake Paradise, at Mount Marsabit peak, scenic view of hills and calderas that form a belt around the Municipality, as well as "singing" wells just outside the town.

Commercial activities - Most of the commercial activities are mainly concentrated in Marsabit Town and other central areas within the municipality. Marsabit Urban Area being the core business and administrative centre has bulk of the commercial activities within Municipality of Marsabit. The commercial activities are grouped into two broad categories;

a. Formal commercial activities

The formal commercial activities include; banking services, transport business, SACCOs, wholesale businesses, general shops, hotels and restaurants among others.

b. Informal business activities (*Jua kali*) - There are several informal activities within the municipality. These include artisans (small scale artisanal miners, welding, motor garages, furniture making, car wash activities, branding and wall painting, household items and tools, tailoring etc.) Informal trading such as hawking, fruit and vegetable, vending second hand clothes (mitumba) selling, watch repairs, charcoal and miraa vending among others. Hawking activities are concentrated at the reserves of busy internal roads, fronting the formal businesses housed on permanent structures. The boda boda and taxi businesses also form part of the informal trading. This service is in high demand due to the need for quick mobility within the municipality urban centres.

1.2.5. Land-use and Urbanization Context

While Marsabit County is 76% rural, the Municipality itself is a dense urban pocket where land use is shifting from pastoralist "manyattas" to permanent stone and cement structures. The Central Areas within the municipality are experiencing high rate of urbanization especially Central Business District.



Section of Marsabit CBD, 2000 Image



Section of Marsabit CBD, 2010 Image



Section of Marsabit CBD, 2021 Image

1.3. KEY STAKEHOLDERS & INCLUSIVENESS

1.3.1. Mapping of Stakeholders

The preparation of the Marsabit Climate Risk Profile was an inclusive process that began with mapping out all the relevant stakeholders who influence or are affected by the climate risk assessment. For ease of knowing who they are, where they work, programs and projects they are implementing stakeholders mapping is important for effective coordination, good synergy, avoid overlapping and for equal distribution of resources. The relevant stakeholders include:

- a) Municipality departments including urban development, public health and environmental, and social safeguards unit.
- b) County departments such as the county climate change units, disaster risk management offices, and line departments such as water, health, and roads;
- c) Urban communities, especially vulnerable and marginalized groups, with representation at ward level.
- d) National public sector stakeholders such as the State Department for Housing and Urban Development (SDHUD), Kenya Meteorological Department (KMD), National Disaster Management Authority (NDMA), Kenya Forest Services (KFS), National Environmental Management Authority (NEMA)
- e) Civil society organizations such as NGOs, community-based organizations (CBOs) and faith-based organizations (FBOs) such as PACIDA (Pastoralist Community Initiative Development and Assistant), Caritas Marsabit, CRS-Nawiri; Marsabit, FHI-Kenya, Wealth Hunger Hilfe (WHH), IREMO-Indigenous Resource Management Organization, Mercy Corps-LMS, and Kenya Red Cross.
- f) Private sector actors, including utilities and service providers
- g) Academic and research institutions
- h) Technical experts and professional associations
- i) Development partners and financiers such as the World Bank, World Food Programme, Global Centre on Adaptation, and USAID Kuza

Figure 1: Stakeholder mapping for Marsabit Municipality

	High Influence - Low Interest	High Influence - High Interest
	<ul style="list-style-type: none"> • Private utility service providers such as Marsabit Water and Sewerage Company • Private developers and real estate investors • Local media stations 	<ul style="list-style-type: none"> • Officials of the Municipality of Marsabit e.g., manager, staff, board members • County officials such as the CECM for urban and CECM for Environment • National Public Sector actors like SDHUD, KMD, NEMA, NDMA, KFS
	Low Influence - Low Interest	Low Influence - High Interest
	<ul style="list-style-type: none"> • Urban residents outside the high-risk hotspots • Members of the Marsabit business community 	<ul style="list-style-type: none"> • Marginalized and vulnerable communities e.g., residents of informal settlements and flood-prone areas, Women, youth, elderly, and PWDS • CBOs, FBOs and local NGOs • Development partners • Research institutions

1.3.2. Public Stakeholder Engagement Sessions

Stakeholder engagement methods included consultation meetings, participatory workshops, focus group discussions, and targeted meetings depending on availability of time and resources. Engagement of communities was done at ward level. The Municipality engaged wards members drawn from Ward Climate Change planning committee, Chairs of water, grazing, peace, environment committees, beach management units, community forest association, gum and resins cooperative, CSO, FBO among others. Other participants included ward administrators, sub county livestock, agriculture, environment officers, foresters and other technical officers with ward level mandate. More time was taken to introduce the RCRA process and its importance in addressing climate risk/hazards. Step by step engagement was done, that is community mapped resources they have, identification of hazards/risk and prioritize them in terms of those it affects, consolidated historical timeline and trend of different prioritized risk/hazards, vulnerability analysis and level of vulnerability, identify existing adaptation strategies and identify future adaptation strategies based on exiting one and see if there is scale up. With this guidance, the communities were able to identified key climate change risks and hazards and, priority response measures.

Figure 2: Community engagements in Central, Sagante and Karare Wards



Figure 3: Marsabit Central Ward Resource Map



1.3.3. Stakeholder Validation Workshop

A validation workshop was held for the RCRA for two days. The meeting was attended by members from various categories of stakeholders. They were taken through the introduction of PCRA process, prioritized hazards/risk, existing adaptation strategies in the Municipality and future adaptation strategies. More time and discussion was given to prioritized hazards and their impact on different livelihoods. This was linked to the prioritized future adaptation strategies. Also, discussions were done to establish how RCRA will feed into the IDEP and LPLUDP.

Raising awareness among these stakeholders, building their support, and enabling their participation is critical for an effective climate risk assessment and for ensuring that recommendations feed into subsequent planning and investment processes. Their insights provide essential local context and ensure that the assessment reflects the unique realities of the municipality.

2. HAZARD ASSESSMENT

The Hazard Assessment section identifies and characterizes the most significant climate-related hazards that influence Marsabit municipality, both historically and under future projections. It examines historical and projected trends in rainfall, temperature, drought, and water availability to determine the frequency, intensity, and potential impact of each hazard. By analyzing these indicators using local meteorological, hydrological, and environmental data, the assessment categorizes hazards into low, medium, and high levels. This provides a foundation for understanding the city’s exposure to climate risks and informs the development of targeted adaptation and resilience strategies.

The hazards evaluated are linked to climate change, and manifest in two ways:

- a) Rapid-onset (acute) climate hazards that are sudden and intense environmental events, such as floods, which unfold rapidly, often with little warning, and result in immediate and severe impacts on communities and ecosystems.
- b) Slow-onset (chronic) climate hazards, such as droughts and changes in rainfall patterns, that develop gradually over time, progressively worsening environmental conditions and posing long-term challenges to adaptation and resilience efforts

2.1. KEY CLIMATE HAZARDS

For Marsabit Municipality, the key climate hazards were identified based on its geography, climate patterns, and urban infrastructure. Based on available data and common climate risks in Marsabit, the main hazards are:

- a) **Drought** characterized by deficient rainfall that leads to water shortages, reduced agricultural productivity, and stress on ecosystems and human systems.
- b) **Extreme Heat** characterized by extended periods of high temperatures that increase risks to human health, agriculture, and infrastructure.
- c) **Pluvial Flooding** that is caused by intense rainfall overwhelming local drainage systems, leading to surface water accumulation in urban or rural areas.
- d) **Changes in precipitation patterns** including gradual changes in the amount, timing, intensity, or distribution of rainfall over time, which can produce extended dry spells, more intense storms, or altered seasonality, disrupting water supply, agriculture, flood drainage and ecosystems.

Table 5: Hazard screening for Marsabit Municipality

Hazard	Hazard Likely (Y/N)	Significant Impact (Y/N)	High Priority (Y/N)	Key Hazard (Y/N)
Drought	Y	Y	Y	Y
Extreme Heat	Y	Y	Y	Y
Pluvial flooding	Y	Y	Y	Y
Extreme precipitation	N	Y	Y	N

2.2. CLIMATE INDICATORS AND HAZARD THRESHOLDS

Table 6: Climate indicators and hazard thresholds selected for the assessment

Key Hazard	Climate indicator	Data source	Threshold		
			Low	Medium	High
Drought	Standardized Precipitation Evapotranspiration Index (SPEI) Drought Index	SPEI database, NDMA, KMD, Kenya Red Cross	> -1.0	-1.0 to -1.5	<-1.5
Extreme Heat	# days with heat index > 35°C (Mean)	World Bank Climate Change Knowledge Portal, KMD	<5 days per season	5 -15 days per season	>15 days per season
Pluvial flooding	#of days with precipitation >50mm	World Bank Climate Change Knowledge Portal, KMD, NDMA	<3 days/year	3 -6 days/year	>6 days/year
Extreme Precipitation	Number of days per year with daily precipitation > 100 mm	World Bank Climate Change Knowledge Portal, KMD, NDMA	<10 days per year	10 - 20 days per year	>20 days per year

2.3. CURRENT HAZARD LEVELS AND CLIMATE PROJECTIONS

2.3.1. Historical and Current Hazard Levels

Drought, flooding and extreme heat are the most pressing hazards in Marsabit Municipality. In recent times, frequency, severity and magnitude of these hazards have increased. Drought ranks as the most important hazard and it has happened for a period of four years within the last ten years, particularly in Sagate/Jaldesa ward. Drought has led to scarcity of water, food insecurity/shortage of food, animal theft, human wildlife conflict, and scarcity of pasture. Flooding on the other hand is prevalent in all the three wards in the municipality namely Marsabit Central, Sagante/Jaldesa and Karare. Flooding has happened throughout the last ten years. Urban flooding has led to destruction of property, human and livestock deaths, and increase in water borne diseases. When roads are flooded, or power infrastructure is destroyed, the ability to both access and prepare foods is impacted and the government must distribute safe water and food (or nutritional supplements) to its population.

Disasters are increasingly becoming a common phenomenon in Marsabit Municipality. This may be attributed to changes in the ecosystem driven by many factors such as increased population growth that puts pressure on many resources and climate change among others. The historical timeline below illustrates the major hazards and their changing trends dating thirty years back.

Table 7: Major historical hazards in Marsabit Municipality

YEAR	EVENT/HAZARD	NEGATIVE EFFECTS/IMPACTS
1990-1992	Drought	Livestock deaths, human starvation, conflicts and migrations
1997-1998	El -Nino (Extreme Precipitation)	Outbreak of livestock diseases, destruction of infrastructure, shortage of food supplies, interrupted communication channels, loss of livestock, human diseases

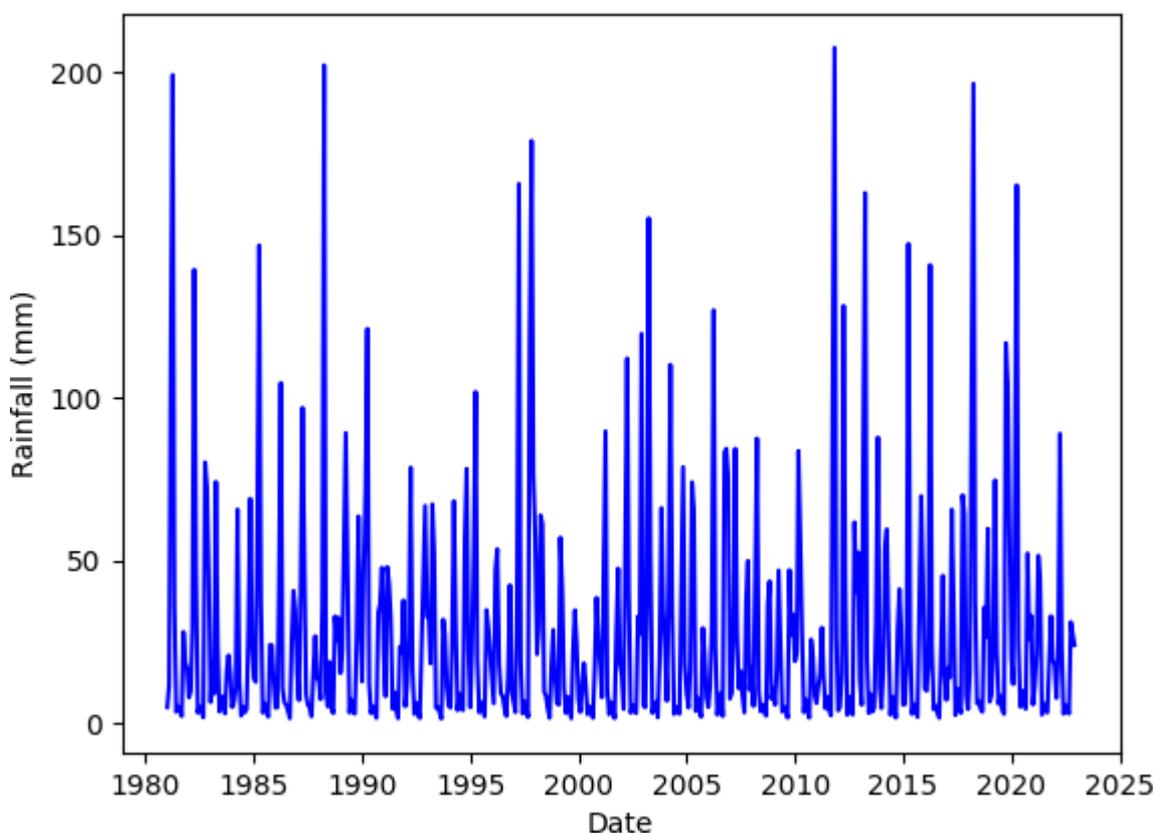
YEAR	EVENT/HAZARD	NEGATIVE EFFECTS/IMPACTS
2001-2004/5	Drought	Conflicts, migrations, outbreak of diseases, livestock diseases, shortage of food due to loss of livelihoods (Livestock)
2008-2011	Drought	Conflicts, migrations, outbreak of diseases, livestock diseases, shortage of food due to loss of livelihoods (Livestock), massive school drop-outs to join bird shooting as a livelihood
2014-2015	Drought	Conflicts, migrations, outbreak of diseases, livestock diseases, shortage of food due to loss of livelihoods (Livestock), massive school drop-outs to join bird shooting as a livelihood
2019-2022	Drought	Massive livestock deaths, estimated at over 50% of the total herd
2023	Flooding	Destruction of farm land/crops/rangeland human and livestock deaths

2.3.2. Future Climate Scenarios and Hazard Levels

Climate Trends and projections

Rainfall is erratic and highly variable with high evaporation rates that exceed rainfall more than 10 times. The municipality experiences tropical climatic conditions with extreme temperatures ranging from a minimum of 15° C to a maximum of 26° C, with an annual average of 20.5° C. Rainfall ranges between 200 mm and 1,000 mm per annum and its duration, amount and reliability increases as altitude rises. The area around Mt. Marsabit receive a mean annual rainfall of 800 mm and 700 mm.

Figure 4: Rainfall Pattern from 1981 to 2022



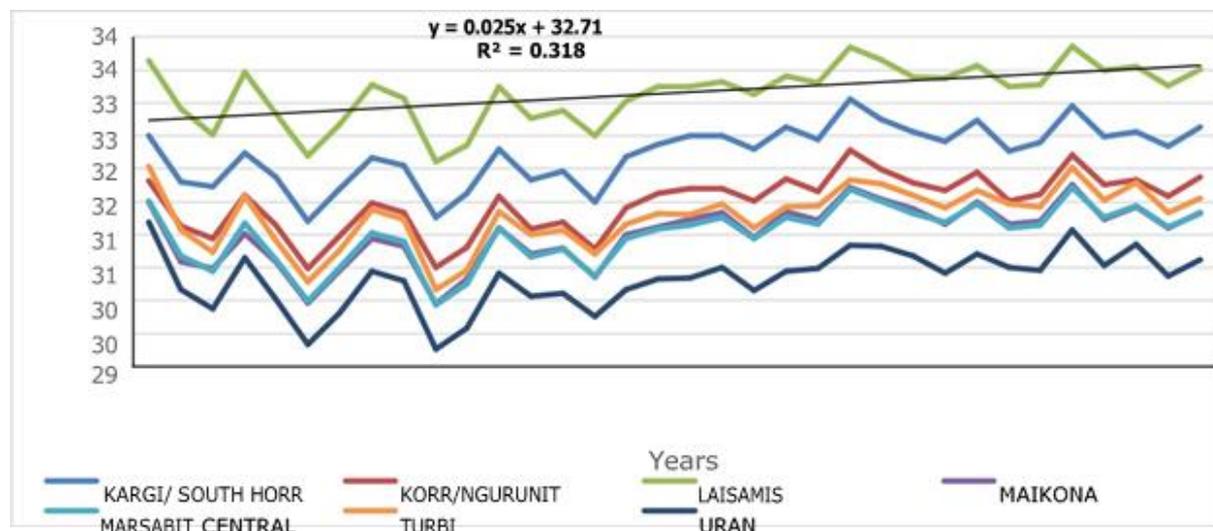
The Intergovernmental Panel on Climate Change (IPCC) 2007, recommended indicators that can be used to detect climate change. Some of these indicators include the “number of nights with temperature below/above certain threshold values”, cold and warm spells indicators, the daily temperature range, extremely wet days, and the number of heavy precipitation days; among others. Several approaches can be used for the analysis of climate change, including statistical and graphical techniques. Modelling is one technique used to simulate climatic variables to generate projections of climatic conditions in the future. However, these projections are based on assumptions and have high uncertainties, to inform responses and address current and future climate- related impacts.

Temperature Change Trends and projections

Climate change is expected to cause global average surface temperature to increase some 1 to 2.5 °C by 2030 and it is predicted that during this period, billions of people, particularly those in developing countries will face changes in rainfall patterns and extreme events, such as severe water short-ages, droughts or flooding. These events will increase the risk of land degradation and biodiversity loss. Climate change will also affect the length of growing seasons, and crop and livestock yields, and bring about increased risk of food shortages, insecurity, and pest and disease incidence, putting populations at greater health and livelihood risks.

The mean annual temperature in Kenya has increased by 1.0°C since 1960 and daily temperature observations show a significant upward trend in the frequency of hot days, and an even larger upward trend in the frequency of hot nights. The frequency of cold days has decreased significantly, and the frequency of cold nights has decreased even more rapidly and significantly, in all seasons. It is largely assumed that temperatures will continue to increase. Long term temperature change trends for Marsabit (1980-2014) revealed an increase in average temperatures of about 1.5°C. The trend demonstrates that while temperature is increasing with time, the rainfall does not follow the same trend.

Figure 5: Marsabit Municipality temperature trends maps (1980 - 2014)

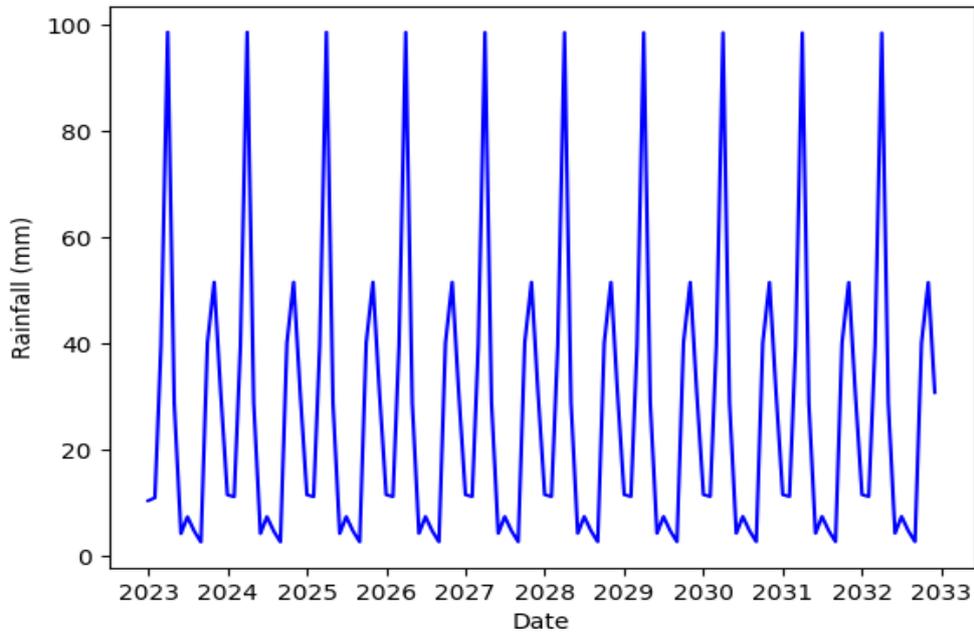


Source: REGAL IR 2016

Rainfall trends and projections

Rainfall projections for the future in Kenya are inconsistent. A range of models and scenarios suggest both increases and decreases in total precipitation (www.cimatewizard). The large influence of El Niño Southern Oscillation (ENSO), as well as uncertainties, and inaccuracies for county levels in climate models make it very hard to find scientific evidence that the climate is going to change in Marsabit County. It is however, largely taken that temperatures continue to increase, and rainfall will even be more erratic than it already is today.

Figure 6: Forecasted rainfall pattern from Jan 2023 to Dec 2032 in Marsabit Municipality

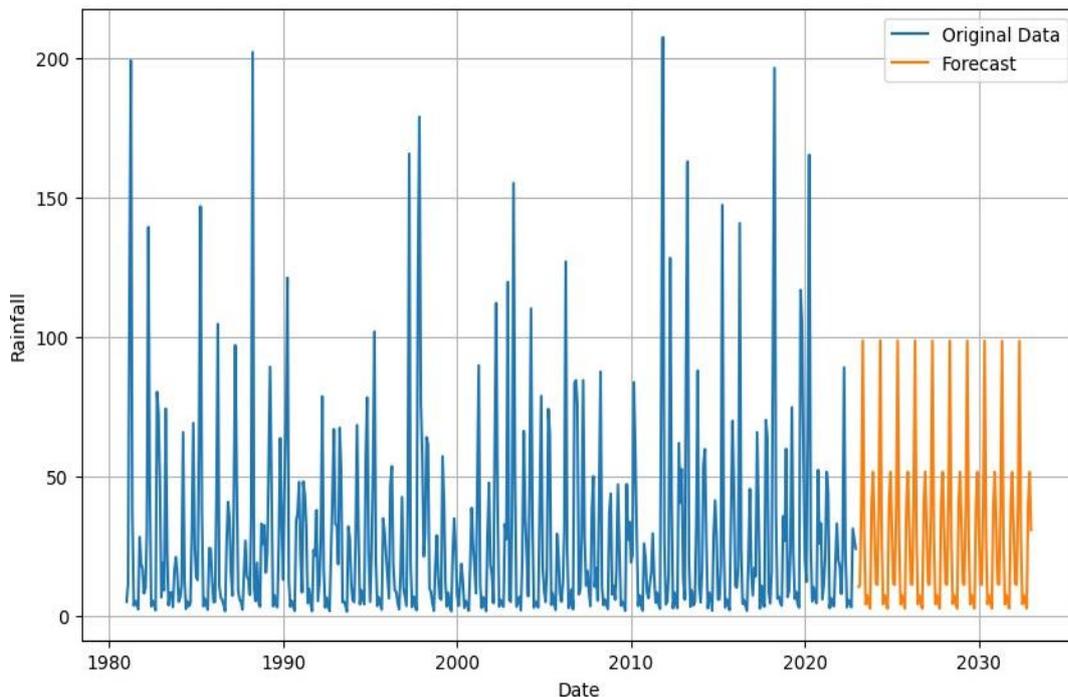


Source: NDMA

The forecasted rainfall for Marsabit Municipality shows a trend with the highest peak experienced in April followed by November, then October, March, December and finally May. These are the 6 months with notable high rainfall ranging from 30.75mm in Dec to 98.62mm in April. This can be translated to long rains from March, peaking in April with an average of 98.56mm across the decade and ending in May and short rains starting in October, peaking in November at an average of 51.50mm across the years and ending in December.

Subsequently, April and November are the months with the highest rainfall all through the years, whereas September is the month with the least rainfall at an average of 2.58mm over the decade followed by June at 4.16mm.

Figure 7: Marsabit Municipality Rainfall data from 1980 to 2021 and forecast from 2023 to 2032



Comparably, the months with the highest rainfall in the previous decade were April, November, October, March, December and May each averaging at 115.28mm, 52.56mm, 44.05mm, 43.74mm, 30.41mm and 28.72mm respectively and across the decade. On the other hand, September and June were also the driest months with 3.11mm and 3.88mm monthly average across the last 10 years. The forecast data gives a similar trend as the most dry and wet months of both decades, mirror.

Figure 8: Next Decade and Last Decade Comparison

Next Decade and Last Decade Comparison												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Last Decade	11.34	11.08	39.49	98.56	28.78	4.16	7.65	4.65	2.58	40.09	51.50	30.74
Next Decade	9.68	11.18	43.74	115.28	28.72	3.88	7.68	4.54	3.11	44.05	52.56	30.41

Source: KMD and NDMA

In the coming decade, Marsabit Municipality will experience a monthly average rainfall of 27.55mm and a decade sum of 3306.14mm compared to the previous decade that had a decade sum of 3548.23mm and 29.57mm monthly mean rainfall. Taken together, this represents a 6.82% reduction in the amount of rainfall in Marsabit Municipality for the coming decade.

Table 8: Current and future hazards levels for Marsabit Municipality

Hazard	Hazard Level				
	Current (Baseline)	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
Drought	High	High	High	High	High
Extreme Heat	Medium	Medium	High	High	High
Pluvial flooding	High	High	High	High	High
Extreme precipitation	Low	Medium	Medium	Medium	High

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

Table 9: Interpretation of hazard levels

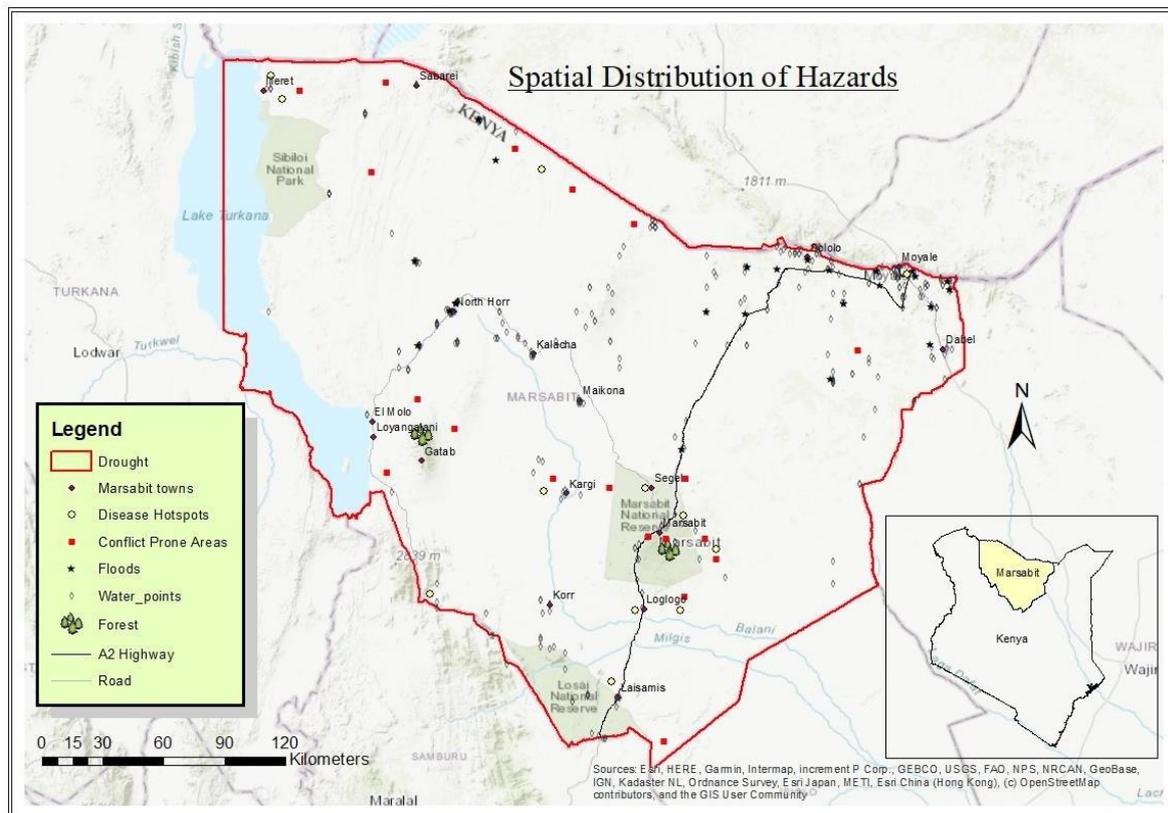
Level	Interpretation
High	Hazard events that are likely to occur with high frequency and/or intensity
Medium	Hazard events that are likely to occur with moderate frequency and/or intensity
Low	Hazard events that are likely to occur with low frequency and/or intensity

2.4. CURRENT AND FUTURE HAZARD IMPACT AREAS

Drought: Drought is experienced in the entire Marsabit county with its intensity of effect varying according to sub county vulnerability exposure. Laisamis and North Horr Sub Counties are mostly affected due to their aridity and over-dependence on pastoralism.

Floods: After a prolonged drought, the County is always visited by flash floods following heavy down pour. The ongoing short rains of 2023 has led to widespread flooding in areas like Moyale Sub County (Dabel, Kinisa, Godoma, Watiti) Sololo (Anona, Watiti, Bori, Antut, Qate, Madowadi, Uran and elebor, Bathanareno, Ambalo), Saku town, Balesa, Milgis and Kargi. This has led to destruction of property, social infrastructure, loss of livelihoods and disease outbreaks.

Map 4: Spatial Distribution of Climate Hazards



3. EXPOSURE & VULNERABILITY ASSESSMENT

This section presents the Exposure and Vulnerability Assessment for Marsabit Municipality. First, there is an inventory of urban elements that are present in hazard-prone areas. These elements include infrastructures and services, populations, and natural assets. The section further gives an assessment of the sensitivity and adaptive capacity of urban elements to key climate hazards, to understand vulnerability. Lastly, the section evaluates how exposure interacts with vulnerability, resulting in impacts.

3.1. URBAN ELEMENTS

Urban elements in Marsabit Municipality include all the components that make up the urban system, including communities, the built environment and nature. These elements can be described based on their spatial location (e.g., wards, neighborhoods, informal settlements), asset type (e.g., house, hospital, powerplant) or function in association with a sector (e.g., transportation, waste water management). The urban elements assessed in this RCRA are categorized in three:

- a) **Infrastructures and Services** - storm water drainage, water & wastewater management, solid waste management, transport and mobility, energy, economic infrastructure, social infrastructure, emergency services
- b) **Populations** - urban residents, informal settlement residents, vulnerable and marginalized groups
- c) **Natural Assets** - urban green infrastructure, urban blue infrastructure, peri-urban and agricultural systems

Table 10: 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	Y	Storm drains, sewers, culverts and open channels, ditches
	Stormwater storage	Y	N	Community tanks, household tanks
Water & Wastewater Management	Pumping stations	N	N	N/A
	Groundwater abstraction	N	N	N/A
	Water treatment facilities	Y	Y	Water treatment facilities owned by Marsabit Water and Sewerage Company
	Water supply networks	Y	Y	Water supply networks owned by Marsabit Water and Sewerage Company
	Sewer networks	Y	Y	Sewer networks owned by Marsabit Water and Sewerage Company
	Wastewater treatment facilities	Y	Y	Sewer networks owned by Marsabit Water and Sewerage Company
Solid Waste Management	Transfer facilities	Y	N	Skip bins in the municipality
	Landfills and dump sites	N	Y	N/A
	Recycling centers	N	N	N/A

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Collection fleet	N	N	N/A
Transport and Mobility	Road networks	Y	Y	Isiolo-Moyale Highway, urban roads, access streets
	Bridges	N	N	N/A
	Public transport networks (rail, bus, mini-bus, etc.)	Y	Y	Matatus, buses, bodaboda
	Transportation terminals	Y	Y	Marsabit bus park, Marsabit Airport
	Vehicle depots	N	N	N/A
	Non-motorized transport networks	Y	Y	Pedestrian walkways
	Freight and logistics hubs	N	N	N/A
Energy	Energy power plants	N	N	N/A
	Poles and power lines	N	N	N/A
	Transformers and substations	N	N	N/A
	Streetlighting	Y	Y	Street lighting along the highway and local streets, floodlights
Economic Infrastructure	Markets	Y	Y	Marsabit Modern Market, Saku Modern Market
	Businesses and commercial hubs	Y	Y	Marsabit CBD, Saku commercial areas
	Industrial zones/parks and logistics parks	N	N	N/A
Social Infrastructure	Government buildings and service centers	Y	Y	County Government buildings, National Government buildings, Huduma Centre
	Education facilities	Y	Y	Major Primary and High Schools, Tertiary education centres
	Healthcare facilities	Y	Y	Marsabit County Referral Hospital, health centres and dispensaries
	Public spaces	Y	Y	Green open spaces, social halls, playgrounds, Marsabit Stadium
	Faith-based buildings	Y	Y	Mosques and Churches
	Cultural and heritage assets	N	N	N/A
Emergency Services	Fire stations	N	N	N/A
	Police stations	Y	Y	Marsabit Police Station, Saku Police Station
	Telecommunications networks	Y	N	Telecommunication Masts
	Early warning systems	N	N	N/A
	Disaster management centers and shelters	N	N	N/A
	Evacuation routes	N	N	N/A
Populations				
Urban Residents	Population	Y	Y	Population in Marsabit Municipality
	Households	Y	Y	All households in Marsabit Municipality
Informal Settlement Residents	Population living in informal settlements	Y	Y	Population living in the informal settlements in Marsabit such as Manyatta Otte

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Households lacking land tenure	Y	N	Households lacking land tenure
	Households / residents lacking access to basic services	Y	N	Households / residents lacking access to basic services
Vulnerable and Marginalized Groups	Low-income households	Y	N	Low-income households in Marsabit Municipality
	Women-headed households	Y	N	Women-headed households in Marsabit Municipality
	Children and youth	Y	N	Children and youth in Marsabit Municipality
	Elderly persons	Y	N	Elderly persons in Marsabit Municipality
	People with disabilities (PWD)	Y	N	People with disabilities (PWD) in Marsabit Municipality
	Homeless populations	Y	N	Homeless populations in Marsabit Municipality
	Unemployed or precariously employed workers	Y	N	Unemployed or precariously employed workers in Marsabit Municipality
	Seasonal workers / migrant laborers	N	N	N/A
	Nomadic groups in peri-urban areas	Y	N	Nomadic groups in peri-urban areas in Marsabit Municipality
	Urban refugees and migrants	N	N	N/A
	Minority ethnic groups in urban areas	N	N	N/A
Natural Assets				
Urban Green Infrastructure	Urban parks and gardens	Y	Y	Green open spaces
	Green corridors	Y	Y	Isiolo - Moyale highway
	Street landscaping	Y	Y	Major Streets in Marsabit CBD
	Urban forests and forest reserves	Y	Y	Mt. Marsabit Forest Reserve
Urban Blue Infrastructure	Natural wetlands	Y	Y	Natural wetlands in Marsabit Municipality
	Rivers	Y	Y	Rivers in Marsabit Municipality
	Riparian zones	Y	Y	Riparian zones in Marsabit Municipality
	Lakes, ponds and reservoirs	N	N	N/A
	Coastal ecosystems	N	N	N/A
	Urban agriculture	Y	N	Urban agricultural areas in Marsabit Municipality
Peri-urban and Agricultural Systems	Peri-urban agriculture	Y	Y	Agricultural areas in the periphery areas of Marsabit Municipality
	Agroforestry systems	N	N	N/A
	Forests and forest reserves	Y	Y	Mt. Marsabit Forest Reserve
	Protected areas and national parks	Y	Y	Mt. Marsabit National Park
	Savannahs and rangelands	N	N	N/A

3.2. 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 11: 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 12: Impact Matrix

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

Table 13: Exposure, Vulnerability, and Impacts of Drought on Urban Elements

Hazard: Drought

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Infrastructure & Services					
Stormwater Drainage	Reduced efficiency of stormwater drainage due to heat damage and evaporation	High	Sensitivity: Poorly maintained drainage, materials vulnerable to heat stress.	Low	Moderate
			Adaptive Capacity: Expansion of heat-resilient drainage networks, use of durable materials, routine maintenance		
Water & Wastewater Management	Rising demand for water, treatment challenges, contamination risks under high temperatures	Low	Sensitivity: Aging sewer lines, limited treatment capacity, increased evaporation.	Low	Insignificant
			Adaptive Capacity: Upgrading treatment facilities, emergency water trucking, resilient cooling and treatment designs		
Solid Waste Management	Accelerated decomposition of waste, odor problems, blocked drains	Low	Sensitivity: Inadequate collection systems, heat-induced faster decomposition.	Low	Insignificant
			Adaptive Capacity: Improved waste collection, awareness campaigns, enforcement of bylaws, heat-resistant storage		
Populations					
Urban Residents	Urban residents exposed to malnutrition, dehydration, health risks	High	Sensitivity: High population density, poor housing without cooling.	High	Catastrophic
			Adaptive Capacity: Insurance, awareness campaigns, community preparedness, cooling centers		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Informal Settlement Residents	Informal settlement residents highly exposed due to lack of access to economic opportunities	High	Sensitivity: Poor housing, lack of basic services, limited ventilation	High	Catastrophic
			Adaptive Capacity: Community-based adaptation, relocation programs, upgrading informal settlements		
Vulnerable and Marginalized Groups	Vulnerable groups face higher risk of injury, disease, exclusion	High	Sensitivity: Poverty, limited mobility, lack of social safety nets.	High	Catastrophic
			Adaptive Capacity: Targeted support, social protection programs, inclusive disaster planning		
Natural Assets					
Urban Green Infrastructure	Urban parks and vegetation stressed, soil degradation	High	Sensitivity: Poor maintenance, encroachment on green spaces, heat stress on vegetation.	High	Catastrophic
			Adaptive Capacity: Reforestation, green design, conservation initiatives		
Urban Blue Infrastructure	Urban water bodies reduced due to evaporation, aquatic stress	Medium	Sensitivity: Encroachment on riparian land, pollution, declining water levels.	Medium	Moderate
			Adaptive Capacity: River restoration, enforcement of buffer zones, sustainable water management		
Peri-urban and Agricultural Systems	Crop loss, soil degradation, reduced yields in peri-urban farms	High	Sensitivity: Poor drainage, monoculture practices, heat-sensitive crops.	High	Catastrophic
			Adaptive Capacity: Diversified farming, improved irrigation, soil conservation measures		

Table 14: 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	Frequent clogging of drains Shallow drains	High	Sensitivity: Poorly maintained drainage, rapid urbanization without adequate planning	High	Catastrophic
			Adaptive Capacity: Expansion of drainage networks, routine desilting, community clean-up programs		
Water & Wastewater Management	Flooding of waste water treatment plants	High	Sensitivity: Aging sewer lines, limited treatment capacity.	High	Catastrophic
			Adaptive Capacity: Upgrading treatment facilities, emergency water trucking, resilient designs		
Solid Waste Management	Solid waste blocking drains, spread of debris during flood	High	Sensitivity: Inadequate collection systems, illegal dumping in river valleys.	High	Catastrophic
			Adaptive Capacity: Improved waste collection, awareness campaigns, enforcement of bylaws		
Transport and Mobility	Flooded roads, disruption of matatu and boda boda transport	Medium	Sensitivity: Poor road drainage, unpaved roads in informal settlements.	Medium	Moderate
			Adaptive Capacity: Elevated roads, improved drainage, flood-resilient transport planning		
Energy	Damage to power lines, substations near flood-prone areas	Low	Sensitivity: Above-ground distribution lines, limited redundancy	Low	Insignificant
			Adaptive Capacity: Underground cabling, backup generators, diversification of energy source		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Economic Infrastructure	Flooding of markets and commercial areas in low lying areas	Medium	Sensitivity: Poor location planning, lack of insurance coverage.	Low	Minor
			Adaptive Capacity: Relocation of businesses, insurance uptake, resilient construction		
Social Infrastructure	Flooding of schools and health facilities in low lying areas	High	Sensitivity: Limited emergency preparedness, poor building design.	High	Catastrophic
			Adaptive Capacity: Flood-proofing, emergency response plans, disaster drills		
Emergency Services	Disruption of police, fire, and ambulance services during floods	Low	Sensitivity: Limited resources, poor coordination.	Medium	Minor
			Adaptive Capacity: Training, equipment upgrades, contingency planning		
Populations					
Urban Residents	Severe flooding, displacement in low lying informal settlements like Manyatta Otto	High	Sensitivity: Poor housing, lack of basic services.	High	Catastrophic
			Adaptive Capacity: Community-based adaptation, relocation programs, upgrading informal settlements		
Informal Settlement Residents	<ul style="list-style-type: none"> Severe flooding, displacement in low lying informal settlements like Manyatta Otto 	High	Sensitivity: Poor housing, lack of basic services.	High	Catastrophic
			Adaptive Capacity: Community-based adaptation, relocation programs, upgrading informal settlements		
Vulnerable and Marginalized Groups	<ul style="list-style-type: none"> Severe flooding, displacement in low lying informal settlements like Manyatta Otto 	High	Sensitivity: Poverty, limited mobility, lack of social safety nets.	High	Catastrophic
			Adaptive Capacity: Targeted support, social protection programs, inclusive disaster planning		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Natural Assets					
Urban Green Infrastructure	Damage to parks, vegetation, soil erosion	High	Sensitivity: Poor maintenance, encroachment on green spaces.	High	Catastrophic
			Adaptive Capacity: Reforestation, green design, conservation initiatives		
Urban Blue Infrastructure	River s tributaries overflowing from flash floods	High	Sensitivity: Encroachment on riparian land, pollution.	High	Catastrophic
			Adaptive Capacity: River restoration, enforcement of buffer zones, floodplain management		
Peri-urban and Agricultural Systems	Crop loss, soil erosion in surrounding farmlands	Medium	Sensitivity: Poor maintenance, encroachment on green spaces.	Medium	Moderate
			Adaptive Capacity: Reforestation, green design, conservation initiatives		

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

Hazard: Extreme precipitation

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Infrastructure & Services					
Stormwater Drainage	Frequent clogging of drains Shallow drains	High	Sensitivity: Poorly maintained drainage, rapid urbanization without adequate planning	High	Catastrophic
			Adaptive Capacity: Expansion of drainage networks, routine desilting, community clean-up programs		
Water & Wastewater Management	Flooding of waste water treatment plants	High	Sensitivity: Aging sewer lines, limited treatment capacity.	High	Catastrophic
			Adaptive Capacity: Upgrading treatment facilities, emergency water trucking, resilient designs		
Solid Waste Management	Solid waste blocking drains, spread of debris during flood	High	Sensitivity: Inadequate collection systems, illegal dumping in river valleys.	High	Catastrophic
			Adaptive Capacity: Improved waste collection, awareness campaigns, enforcement of bylaws		
Transport and Mobility	Flooded roads, disruption of matatu and boda boda transport	Medium	Sensitivity: Poor road drainage, unpaved roads in informal settlements.	Medium	Moderate
			Adaptive Capacity: Elevated roads, improved drainage, flood-resilient transport planning		
Energy	Damage to power lines, substations near flood-prone areas	Low	Sensitivity: Above-ground distribution lines, limited redundancy	Low	Insignificant
			Adaptive Capacity: Underground cabling, backup generators, diversification of energy source		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Economic Infrastructure	Flooding of markets and commercial areas in low lying areas	Medium	Sensitivity: Poor location planning, lack of insurance coverage.	Medium	Moderate
			Adaptive Capacity: Relocation of businesses, insurance uptake, resilient construction		
Social Infrastructure	Flooding of schools and health facilities in low lying areas	High	Sensitivity: Limited emergency preparedness, poor building design.	High	Catastrophic
			Adaptive Capacity: Flood-proofing, emergency response plans, disaster drills		
Emergency Services	Disruption of police, fire, and ambulance services during floods	Low	Sensitivity: Limited resources, poor coordination.	Medium	Minor
			Adaptive Capacity: Training, equipment upgrades, contingency planning		
Populations					
Urban Residents	Severe flooding, displacement in low lying informal settlements like Manyatta Otto	High	Sensitivity: Poor housing, lack of basic services.	High	Catastrophic
			Adaptive Capacity: Community-based adaptation, relocation programs, upgrading informal settlements		
Informal Settlement Residents	Severe flooding, displacement in low lying informal settlements like Manyatta Otto	High	Sensitivity: Poor housing, lack of basic services.	High	Catastrophic
			Adaptive Capacity: Community-based adaptation, relocation programs, upgrading informal settlements		
Vulnerable and Marginalized Groups	Severe flooding, displacement in low lying informal settlements like Manyatta Otto	High	Sensitivity: Poverty, limited mobility, lack of social safety nets.	High	Catastrophic
			Adaptive Capacity: Targeted support, social protection programs, inclusive disaster planning		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Natural Assets					
Urban Green Infrastructure	Damage to parks, vegetation, soil erosion	High	Sensitivity: Poor maintenance, encroachment on green spaces.	High	Catastrophic
			Adaptive Capacity: Reforestation, green design, conservation initiatives		
Urban Blue Infrastructure	River s tributaries overflowing from flash floods	High	Sensitivity: Encroachment on riparian land, pollution.	High	Catastrophic
			Adaptive Capacity: River restoration, enforcement of buffer zones, floodplain management		
Peri-urban and Agricultural Systems	Crop loss, soil erosion in surrounding farmlands	Medium	Sensitivity: Poor maintenance, encroachment on green spaces.	Medium	Moderate
			Adaptive Capacity: Reforestation, green design, conservation initiatives		

Table 16: Exposure, Vulnerability, and Impacts of Extreme Heat on Urban Elements

Hazard: Extreme Heat

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Infrastructure & Services					
Stormwater Drainage	Reduced efficiency of stormwater drainage due to heat damage and evaporation	Low	Sensitivity: Poorly maintained drainage, materials vulnerable to heat stress	Low	Insignificant
			Adaptive Capacity: Expansion of heat-resilient drainage networks, use of durable materials, routine maintenance		
Water & Wastewater Management	Rising demand for water, treatment challenges, contamination risks under high temperatures	Medium	Sensitivity: Aging sewer lines, limited treatment capacity, increased evaporation.	High	Major
			Adaptive Capacity: Upgrading treatment facilities, emergency water trucking, resilient cooling and treatment designs		
Solid Waste Management	Accelerated decomposition of waste, odor problems, blocked drains	Low	Sensitivity: Inadequate collection systems, heat-induced faster decomposition.	Low	Insignificant
			Adaptive Capacity: Improved waste collection, awareness campaigns, enforcement of bylaws, heat-resistant storage		
Transport and Mobility	Road surface damage, asphalt softening, transport disruption	Low	Sensitivity: Poor road materials, unpaved roads in informal settlements.	Low	Insignificant
			Adaptive Capacity: Elevated roads, heat-resilient surfacing, improved maintenance planning		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Energy	Damage to power lines, substations stressed by cooling demand	Low	Sensitivity: Above-ground distribution lines, limited redundancy.	Low	Insignificant
			Adaptive Capacity: Underground cabling, backup generators, diversification of energy sources		
Economic Infrastructure	Economic hubs (markets, CBD areas) disrupted by heat stress and productivity loss	Medium	Sensitivity: Poor location planning, lack of insurance coverage, heat-sensitive industries.	Medium	Moderate
			Adaptive Capacity: Relocation of businesses, insurance uptake, resilient construction		
Social Infrastructure	Schools, hospitals affected by rising admissions and cooling demand Hospitals strained by rising heat-related emergencies	Medium	Sensitivity: Limited emergency preparedness, poor building design.	High	Major
			Adaptive Capacity: Heat-proofing, emergency response plans, disaster drills, cooling infrastructure		
Emergency Services	Emergency services strained by rising heat-related emergencies	Low	Sensitivity: Limited resources, poor coordination.	Medium	Minor
			Adaptive Capacity: Training, equipment upgrades, contingency planning		
Populations					
Urban Residents	Urban residents exposed to heat waves, dehydration, health risks	High	Sensitivity: High population density, poor housing without cooling.	High	Catastrophic
			Adaptive Capacity: Insurance, awareness campaigns, community preparedness, cooling centers		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Informal Settlement Residents	Informal settlement residents highly exposed due to poor housing	High	Sensitivity: Poor housing, lack of basic services, limited ventilation.	High	Catastrophic
			Adaptive Capacity: Community-based adaptation, relocation programs, upgrading informal settlements		
Vulnerable and Marginalized Groups	Vulnerable groups face higher risk of injury, disease, exclusion	High	Sensitivity: Poverty, limited mobility, lack of social safety nets. Adaptive Capacity:	High	Catastrophic
			Adaptive Capacity: Targeted support, social protection programs, inclusive disaster planning		
Natural Assets					
Urban Green Infrastructure	Urban parks and vegetation stressed, soil degradation	High	Sensitivity: Poor maintenance, encroachment on green spaces, heat stress on vegetation.	High	Catastrophic
			Adaptive Capacity: Reforestation, green design, conservation initiatives		
Urban Blue Infrastructure	Urban water bodies reduced due to evaporation, aquatic stress	Medium	Sensitivity: Encroachment on riparian land, pollution, declining water levels.	High	Catastrophic
			Adaptive Capacity: River restoration, enforcement of buffer zones, sustainable water management		
Peri-urban and Agricultural Systems	Urban water bodies reduced due to evaporation, aquatic stress	High	Sensitivity: Poor drainage, monoculture practices, heat-sensitive crops.	High	Catastrophic
			Adaptive Capacity: Diversified farming, improved irrigation, soil conservation measure		

4. CLIMATE RISK ASSESSMENT

[Write a short paragraph to introduce the section.]

Climate Risk Assessment for Marsabit Municipality integrates hazards, exposure, and vulnerability to express the present and future climate risks across the municipality. Climate risk assessment combines the results of hazard and impact assessments to determine overall climate risk in a qualitative way. It evaluates how current and future climate hazards interact with the municipality’s people, infrastructure, services, and ecosystems. Building on the hazard analysis, the assessment examines exposure, vulnerability, and adaptive capacity to identify areas, sectors, and populations most at risk from climate-related impacts such as flooding, heat stress, and extreme rainfall. The findings provide an evidence base to inform climate-resilient urban planning, infrastructure investment, and disaster risk reduction measures in Marsabit Municipality.

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 17: 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 18: 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.

4.1. CURRENT AND FUTURE CLIMATE RISKS ON URBAN ELEMENTS

Table 19: Summary of Drought risks for Marsabit Municipality

	Time Horizon & Climate Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level	High	High	High	High	High
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	High	High	High	High	High
Water & Wastewater Management	Insignificant	Low	Low	Low	Low	Low
Solid Waste Management	Insignificant	Low	Low	Low	Low	Low
Transport and Mobility	Insignificant	Low	Low	Low	Low	Low
Populations						
Urban Residents	Catastrophic	Very high	Very high	Very high	Very high	Very high
Informal Settlement Residents	Catastrophic	Very high	Very high	Very high	Very high	Very high
Vulnerable and Marginalized Groups	Catastrophic	Very high	Very high	Very high	Very high	Very high
Natural Assets						
Urban Green Infrastructure	Catastrophic	Very high	Very high	Very high	Very high	Very high
Urban Blue Infrastructure	Moderate	High	High	High	High	High
Peri-urban and Agricultural Systems	Catastrophic	Very high	Very high	Very high	Very high	Very high

Table 20: Summary of Flooding risks for Marsabit Municipality

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

Table 21: Summary of Extreme Precipitation risks for Marsabit Municipality

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

Table 22: Summary of Extreme Heat risks for Marsabit Municipality

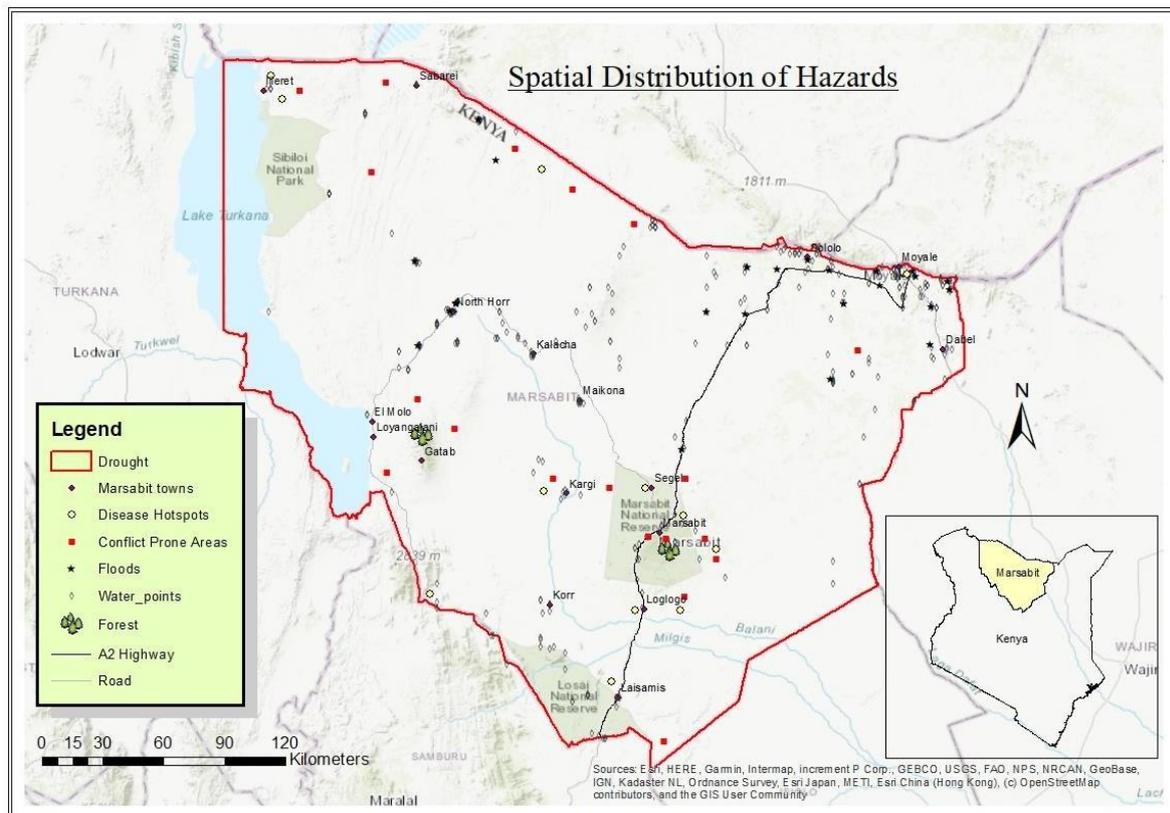
	Time Horizon & Climate Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level	Low	Medium	Medium	Medium	High
Categories	Impact	Risk Levels				
		Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
Infrastructure & Services						
Stormwater Drainage	Insignificant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

4.2. CLIMATE RISK HOTSPOTS

Drought: Drought is experienced in the entire Marsabit county with its intensity of effect varying according to sub county vulnerability exposure. Laisamis and North Horr Sub Counties are mostly affected due to their aridity and over-dependence on pastoralism.

Floods: After a prolonged drought, the County is always visited by flash floods following heavy down pour. The ongoing short rains of 2023 has led to widespread flooding in areas like Moyale Sub County (Dabel, Kinisa, Godoma, Watiti) Sololo (Anona, Watiti, Bori, Antut, Qate, Madowadi, Uran and elebor, Bathanareno, Ambalo), Saku town, Balesa, Milgis and Kargi. This has led to destruction of property, social infrastructure, loss of livelihoods and disease outbreaks.

Map 5: Spatial Distribution of Climate Hazards



5. WHAT'S NEXT?

This section translates the findings of the rapid climate risk assessment into preliminary climate adaptation and resilience options that inform urban planning processes and future investments.

5.1. KEY FINDINGS

This is a summary of observed patterns of risk and highlighting the most significant climate threats to the city. This includes the hazards that pose the greatest risk, the urban elements at greatest risk, and how risk levels are expected to change over time.

Key Hazards

The hazards associated with the most widespread risks in Marsabit Municipality include:

- a) Extreme Precipitation: Cited as a current and future risk for nearly every category, including transport, waste management, and social infrastructure.
- b) Flooding: A primary hazard for infrastructure (stormwater, wastewater, and solid waste) and all population groups.
- c) Drought: Specifically impacts water services, urban residents, informal settlements, and agricultural systems.
- d) Extreme Heat: Identified as an emerging or constant threat for energy-related economic infrastructure, social services, and natural assets.

Populations and Assets Most at Risk

Certain groups and systems are exposed to a higher variety of hazards simultaneously:

- a) Urban Residents: Subject to drought, flooding, extreme precipitation, and extreme heat.
- b) Vulnerable and Marginalized Groups: Face the full spectrum of hazards, including drought, flooding, extreme precipitation, and heat.
- c) Informal Settlement Residents: Primarily threatened by drought, flooding, and extreme precipitation.
- d) Natural Assets (Green & Blue Infrastructure): These are vulnerable to all four major hazards (drought, flooding, heat, and extreme precipitation) across all timeframes.
- e) Peri-urban and Agricultural Systems: Highly susceptible to drought and heat, which directly impact food security and land health.
- f) Water & Wastewater Management: Critical infrastructure that must contend with flooding, precipitation, and increasingly, extreme heat.

Trends Likely to Intensify

The analysis indicates a clear progression of risk intensification from the present day toward 2100. While extreme heat is not a risk for some current infrastructure categories (like water/wastewater and economic infrastructure), it appears as a new risk in the mid-term and long-term projections. Transport and mobility systems are projected to face flooding in the mid and long-term, a hazard that is not currently common. For populations and natural assets, there is no projected relief; the analysis shows that every current hazard persists through 2100, often with additional hazards, like extreme heat, being added to the mix.

Table 23: Summary of climate risks affecting urban elements for Marsabit Municipality

Category	List of Key Hazards		
	Current	Mid-term (2050)	Long-term (2100)
Infrastructure & Services			
Stormwater Drainage	<ul style="list-style-type: none"> • Drought • Flooding • Extreme precipitation 	<ul style="list-style-type: none"> • Drought • Flooding • Extreme precipitation 	<ul style="list-style-type: none"> • Drought • Flooding • Extreme precipitation
Water & Wastewater Management	<ul style="list-style-type: none"> • Flooding • Extreme precipitation 	<ul style="list-style-type: none"> • Flooding • Extreme precipitation • Extreme heat 	<ul style="list-style-type: none"> • Flooding • Extreme precipitation • Extreme heat
Solid Waste Management	<ul style="list-style-type: none"> • Flooding • Extreme precipitation 	<ul style="list-style-type: none"> • Flooding • Extreme precipitation 	<ul style="list-style-type: none"> • Flooding • Extreme precipitation
Transport and Mobility	<ul style="list-style-type: none"> • Extreme precipitation 	<ul style="list-style-type: none"> • Flooding • Extreme precipitation 	<ul style="list-style-type: none"> • Flooding • Extreme precipitation
Energy	N/A	N/A	N/A
Economic Infrastructure	<ul style="list-style-type: none"> • Extreme precipitation 	<ul style="list-style-type: none"> • Extreme precipitation 	<ul style="list-style-type: none"> • Extreme precipitation • Extreme heat
Social Infrastructure	<ul style="list-style-type: none"> • Flooding • Extreme precipitation 	<ul style="list-style-type: none"> • Flooding • Extreme precipitation • Extreme heat 	<ul style="list-style-type: none"> • Flooding • Extreme precipitation • Extreme heat
Emergency Services	N/A	N/A	N/A
Populations			
Urban Residents	<ul style="list-style-type: none"> • Drought • Flooding • Extreme precipitation • Extreme heat 	<ul style="list-style-type: none"> • Drought • Flooding • Extreme precipitation • Extreme heat 	<ul style="list-style-type: none"> • Drought • Flooding • Extreme precipitation • Extreme heat
Informal Settlement Residents	<ul style="list-style-type: none"> • Drought • Flooding • Extreme precipitation 	<ul style="list-style-type: none"> • Drought • Flooding • Extreme precipitation 	<ul style="list-style-type: none"> • Drought • Flooding • Extreme precipitation
Vulnerable and Marginalized Groups	<ul style="list-style-type: none"> • Drought • Flooding • Extreme precipitation • Extreme heat 	<ul style="list-style-type: none"> • Drought • Flooding • Extreme precipitation • Extreme heat 	<ul style="list-style-type: none"> • Drought • Flooding • Extreme precipitation • Extreme heat
Natural Assets			
Urban Green Infrastructure	<ul style="list-style-type: none"> • Drought • Flooding • Extreme precipitation • Extreme heat 	<ul style="list-style-type: none"> • Drought • Flooding • Extreme precipitation • Extreme heat 	<ul style="list-style-type: none"> • Drought • Flooding • Extreme precipitation • Extreme heat
Urban Blue Infrastructure	<ul style="list-style-type: none"> • Drought • Flooding • Extreme precipitation • Extreme heat 	<ul style="list-style-type: none"> • Drought • Flooding • Extreme precipitation • Extreme heat 	<ul style="list-style-type: none"> • Drought • Flooding • Extreme precipitation • Extreme heat

Category	List of Key Hazards		
	Current	Mid-term (2050)	Long-term (2100)
Peri-urban and Agricultural Systems	<ul style="list-style-type: none"> • Drought • Extreme precipitation • Extreme heat 	<ul style="list-style-type: none"> • Drought • Flooding • Extreme precipitation • Extreme heat 	<ul style="list-style-type: none"> • Drought • Flooding • Extreme precipitation • Extreme heat

5.2. CLIMATE ADAPTATION AND RESILIENCE SOLUTIONS

Climate adaptation and resilience solutions proposed for Marsabit Municipality can be categorized into three groups, that can also be designed and implemented in various combinations:

Structural Solutions which are physical constructions and assets that are built to reduce or avoid the impacts of climate hazards.

Non-Structural Solutions which focus institutional, on improving organizational and human capacity to reduce climate risks, including policies, plans, capacity building, investment in data collection and technology, awareness raising, monitoring and evaluation.

Nature-based Solutions refers to actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits.

Table 24: Climate adaptation and resilience solutions recommended for Marsabit Municipality

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
Infrastructure & Services			
Stormwater Drainage	Clear blocked drains; install temporary culverts; community awareness on waste disposal	Construct lined drainage channels; introduce permeable pavements; integrate rainwater harvesting	Develop smart stormwater systems; large-scale floodplain restoration; climate-resilient drainage masterplans
Water & Wastewater Management	Emergency water trucking; repair leaks; chlorination of supplies	Expand piped networks; build decentralized wastewater treatment plants; promote greywater reuse	Integrated water resource management; advanced treatment plants; circular water economy
Solid Waste Management	Increase collection frequency; deploy skips; community clean-up drives	Establish transfer stations; introduce segregation at source; composting facilities	Waste-to-energy plants; circular economy hubs; zero-waste city strategies
Transport and Mobility	Repair potholes; improve traffic control; prioritize pedestrian safety	Expand public transport routes; introduce cycling lanes; regulate informal transport	Smart mobility systems; mass rapid transit (light rail/BRT); electric vehicle infrastructure
Energy	Provide backup generators; promote solar lanterns; repair faulty grid lines	Expand mini-grids; incentivize solar rooftops; improve transmission efficiency	Transition to renewable-dominated grid; smart grids; regional energy interconnections

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
Economic Infrastructure	Support local markets; microfinance for small businesses	Develop industrial parks; logistics hubs; ICT infrastructure	Regional trade corridors; innovation ecosystems; global investment hubs
Social Infrastructure	Temporary shelters; mobile clinics; emergency schooling	Expand health centers; build affordable housing; strengthen education facilities	Smart hospitals; resilient housing programs; world-class universities
Emergency Services	Stockpile relief supplies; train volunteers; improve communication systems	Build fire stations; expand ambulance services; integrate disaster response centers	Advanced disaster management systems; predictive analytics for emergencies; resilient city networks
Populations			
Urban Residents	Improve water access; enhance waste collection; ensure reliable electricity	Affordable housing schemes; expanded public transport; community health programs	Smart city services; resilient housing; inclusive urban planning
Informal Settlement Residents	Provide clean water points; mobile toilets; emergency health outreach	Upgrade settlements; introduce tenure security; community-led infrastructure	Full integration into formal city fabric; equitable service delivery; inclusive governance
Vulnerable and Marginalized Groups	Emergency food aid; targeted health services; social protection	Skills training; inclusive education; accessible infrastructure	Long-term equity policies; universal healthcare; inclusive economic participation
Natural Assets			
Urban Green Infrastructure	Protect existing trees; initiate community greening	Develop urban parks; green corridors; rooftop gardens	Large-scale reforestation; biodiversity networks; climate-adaptive green belts
Urban Blue Infrastructure	Clean rivers/lakes; prevent dumping	Restore wetlands; build retention ponds; improve waterfront access	Integrated blue-green networks; ecological restoration; sustainable aquaculture
Peri-urban and Agricultural Systems	Support farmers with inputs; protect farmland from encroachment	Promote agroforestry; improve irrigation; strengthen cooperatives	Climate-smart agriculture; regional food hubs; sustainable land-use planning

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ANNEX 1. HISTORICAL HAZARD EVENTS

YEAR	EVENT/HAZARD	NEGATIVE EFFECTS/IMPACTS
1990-1992	Drought	Livestock deaths, human starvation, conflicts and migrations
1997-1998	El -Nino (Extreme Precipitation)	Outbreak of livestock diseases, destruction of infrastructure, shortage of food supplies, interrupted communication channels, loss of livestock, human diseases
2001-2004/5	Drought	Conflicts, migrations, outbreak of diseases, livestock diseases, shortage of food due to loss of livelihoods (Livestock)
2008-2011	Drought	Conflicts, migrations, outbreak of diseases, livestock diseases, shortage of food due to loss of livelihoods (Livestock), massive school drop-outs to join bird shooting as a livelihood
2014-2015	Drought	Conflicts, migrations, outbreak of diseases, livestock diseases, shortage of food due to loss of livelihoods (Livestock), massive school drop-outs to join bird shooting as a livelihood
2019-2022	Drought	Massive livestock deaths, estimated at over 50% of the total herd
2023	Flooding	Destruction of farm land/crops/rangeland human and livestock deaths

ANNEX 2. DATA SOURCES

Page	Data	Data Source
20	Drought	SPEI database, National Drought Management Authority, Kenya Metrological Department, Kenya Red Cross Society
20	Extreme Heat	World Bank Climate Change Knowledge Portal, Kenya Metrological Departmen
20	Pluvial flooding	World Bank Climate Change Knowledge Portal, National Drought Management Authority, Kenya Metrological Department
20	Extreme precipitation	World Bank Climate Change Knowledge Portal, National Drought Management Authority, Kenya Metrological Department