THE COUNTY GOVERNMENT
Of Samburu

URBAN CLIMATE RISK PROFILE FOR MARALAL MUNICIPALITY

2026

Foreword

This Participatory Climate Risk Assessment (PCRA) is the first comprehensive, consultative climate assessment undertaken in Maralal Municipality. It responds to the growing threat that climate change poses to the Municipality's development aspirations and to the achievement of the Sustainable Development Goals (SDGs), Kenya Vision 2030, the Big Four Agenda, and the County Integrated Development Plans (CIDPs), particularly in relation to poverty reduction and food security.

Maralal Municipality has experienced increasing climate variability, including prolonged droughts, erratic rainfall, and occasional floods. These events have heightened food insecurity, strained water resources, accelerated land degradation, and reduced biodiversity. Given the Municipality's reliance on pastoralism, small-scale agriculture, and natural resource-based livelihoods, climate shocks continue to undermine household incomes and local economic stability.

In alignment with Kenya's commitments under the UNFCCC and the Paris Agreement, Maralal Municipality draws guidance from the Climate Change Act (2016), the National Climate Change Action Plan, the National Adaptation Plan (2021–2026), the Samburu County Climate Change Policy (2021), and the Samburu County Climate Fund Act (2021). Through the County Government of Samburu, 2% of the development budget has been allocated to climate change interventions, providing a critical foundation for resilience-building and low-carbon development within the Municipality.

The Municipality is committed to mainstreaming climate change into its planning and investment decisions. Priority will be given to climate-smart and bankable projects such as renewable energy development, water harvesting and storage, sustainable rangeland management, ecosystem restoration, and climate-resilient infrastructure. Enhancing carbon sinks, promoting sustainable land use, and adopting clean production technologies remain central to ensuring long-term environmental sustainability.

The actions outlined in this Plan aim to strengthen preparedness, reduce vulnerability to droughts and floods, and safeguard livelihoods against future climate risks. These efforts will also contribute to Kenya's Nationally Determined Contribution (NDC) under the Paris Agreement.

The participatory approach adopted in this assessment empowers communities to identify climate hazards, analyze their impacts, and propose locally driven solutions. By engaging municipal leadership, county government departments, civil society, academia, the private sector, and community members, the process ensures inclusivity, ownership, and accountability.

Guided by the findings of this PCRA, Maralal Municipality will develop a Climate Change Action Plan that provides clear, community-led direction for climate adaptation and mitigation. This Action Plan will serve as a practical roadmap to build resilience, enhance adaptive capacity, and promote sustainable development for present and future generations in Maralal Municipality.

Steve Lemeteki - Municipality Manager

MARALAL MUNICIPALITY * MANAGER * P.O. Box 3-20300, MARALAL

Risk Results Summary

1. Prolonged Drought – Likelihood: Very High | Impact: Very High | Risk Level: Extreme
Effects: Livestock losses, crop failure, food insecurity, declining incomes, and increased resource conflicts.

2. Water Scarcity – Likelihood: Very High | Impact: Very High | Risk Level: Extreme
Effects: Limited access to safe water, reduced productivity, increased burden on women and children, and strained livelihoods.

3. Rising Temperatures and Heat Stress – Likelihood: Very High | Impact: High | Risk Level: High
Effects: Reduced livestock productivity, higher evaporation rates, heat-related health risks, and ecosystem stress.

4. Erratic and Intense Rainfall – Likelihood: High | Impact: High | Risk Level: High
Effects: Soil erosion, crop damage, infrastructure stress, and unpredictable farming seasons.

5. Flash Floods – Likelihood: Moderate to High | Impact: High | Risk Level: High
Effects: Damage to roads, drainage systems, homes, and businesses; water contamination; and service disruption.

6. Land Degradation and Vegetation Loss – Likelihood: High | Impact: High | Risk Level: High
Effects: Declining pasture productivity, biodiversity loss, reduced carbon sequestration, and increased vulnerability to droughts and floods.

Table 2:Risk Results

Risk Results Summary

Hazard	Likelihood	Impact	Risk Level	Effects
Prolonged Drought	Very High	Very High	Extreme	Livestock losses, crop failure, food insecurity, declining incomes, and increased resource conflicts.
Water Scarcity	Very High	Very High	Extreme	Limited access to safe water, reduced productivity, increased burden on women and children, and strained livelihoods.
Rising Temperatures and Heat Stress	Very High	High	High	Reduced livestock productivity, higher evaporation rates, heat-related health risks, and ecosystem stress.
Erratic and Intense Rainfall	High	High	High	Soil erosion, crop damage, infrastructure stress, and unpredictable farming seasons.
Flash Floods	Moderate to High	High	High	Damage to roads, drainage systems, homes, and businesses; water contamination; and service disruption.
Land Degradation and Vegetation Loss	High	High	High	Declining pasture productivity, biodiversity loss, reduced carbon sequestration, and increased vulnerability to droughts and floods

Category	Risk Level				
	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
Transport and Mobility	Existing transport infrastructure (roads, bridges, public transit) designed for historical climate conditions; occasional disruptions during heavy rainfall or storms	Moderate increase in extreme weather causing periodic road flooding, traffic disruption, and higher maintenance needs	More frequent intense rainfall and heat leading to road damage, transport delays, and reduced reliability of public transport	Significant stress on transport networks; increased flooding of roads and damage to infrastructure requiring upgrades and climate-resilient designs	Severe disruptions from extreme rainfall, flooding, and heatwaves; major infrastructure redesign and resilient transport systems required
Populations					
Urban Residents	Urban populations live with existing infrastructure and services; some exposure to flooding, heat stress, and pollution in densely populated areas	Moderate increase in heatwaves and heavy rainfall affecting urban living conditions; increased risk of urban flooding and heat stress	Higher exposure to extreme heat, intense rainfall, and flooding; increased health risks and pressure on urban services	Greater vulnerability of urban populations due to climate stress; need for improved urban planning and resilient infrastructure	Severe impacts from extreme heat, flooding and climate hazards; major adaptation needed to protect urban populations and maintain livability
Informal Settlement Residents	Many residents live in high-risk areas (floodplains, unstable slopes) with limited access to basic services such as drainage, sanitation, and waste management	Moderate increase in flooding, heat stress, and service disruptions affecting already vulnerable communities	More frequent extreme rainfall and heatwaves leading to increased flooding, housing damage, and health risks	Growing vulnerability due to stronger climate impacts; higher need for improved housing, drainage, and social protection	Severe impacts from floods, heatwaves, and infrastructure failure; significant displacement risk and urgent need for resilient housing and infrastructure

Category	Risk Level				
	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
Peri-urban and Agricultural Systems	Peri-urban agricultural lands provide food supply, livelihoods, and ecosystem services but may face pressures from urban expansion, land degradation, and water scarcity	Moderate climate changes affect crop productivity through changes in rainfall patterns and temperature, requiring adaptation in farming practices	Increased heat, droughts, and extreme rainfall events reduce crop yields and increase soil erosion and water stress	Greater climate variability puts pressure on agricultural systems, requiring climate-resilient crops, improved irrigation, and sustainable land management	Severe climate impacts significantly reduce productivity, increase land degradation and water shortages, and threaten food security and livelihoods

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

1. Chapter 1: Context

The **Urban Climate Risk Profile** aims to support Maralal municipal in understanding and addressing clima related risks in urban areas. It seeks to guide the development of policies and strategies that address both curre and future climate risks at the municipal level. The profile also informs the formulation of development cont standards that promote sustainable and climate-resilient urban growth. In addition, it supports urb development planning by encouraging the adoption of programs and projects that integrate resilience measur Furthermore, it facilitates the planning and implementation of climate-resilient infrastructure capable withstanding present and future climate impacts, thereby minimizing climate-related risks and enhancing t safety and well-being of citizens.

1.1. Objective

This Urban Climate Risk Profile aims to;

a) To guide development of policies and strategies that address current and future climate risks at t municipal level
b) To inform development controls standards for sustainable development
c) To guide the development plans by adopting of programs and projects that intergrate resilier measures.
d) To facilitate planning and implementation of climate resilient infrastructure that withstand current a future climate impacts and minimizes climate risks for citizens.

1.2. Urban Context

1.2.1. Geographic area

Maralal Municipality is one of the Municipalities in Kenya and is located within Samburu County. Maralal Municipality is located within Maralal ward and Samburu Central sub-county in Samburu County and is approximately 338km from Nairobi City. The Municipality has area coverage of 176 km2. Geographically it lies between 1° 05'36. 1" North and 36° 41' 42.1" East.
Maralal Municipality was under the local authority found within the former Samburu District. Urban Areas and Cities Act, 2012 recommends that a township with a population of more than 50,000 and less than 250,000 people qualify to be classified as a municipality.

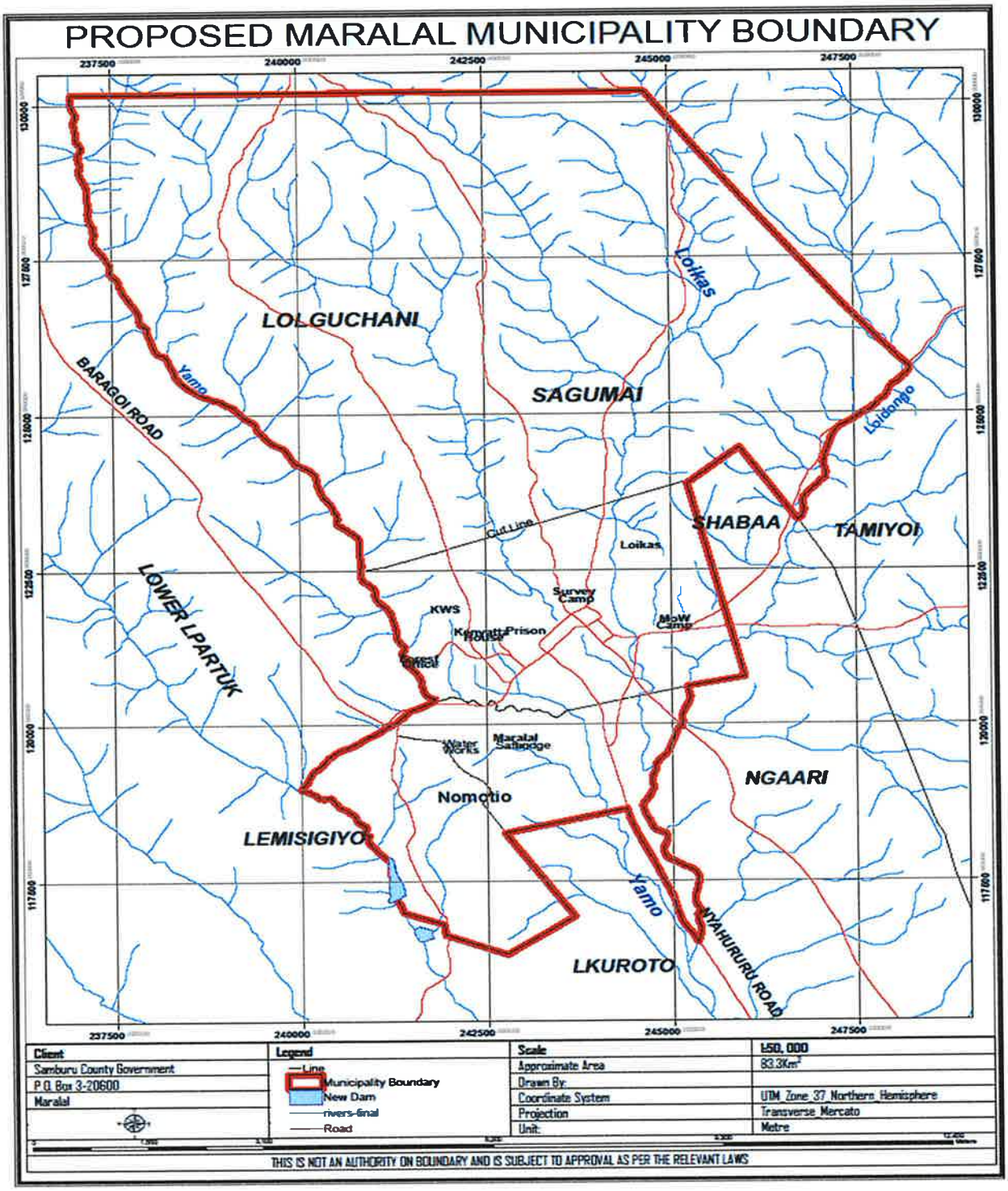


Figure 2: A map showing Municipality Boundaries.

1.2.2. Physical and Topographic Features

The Municipality has a hilly landscape sloping gently from west to east, with undulating hills and valleys. The streams generally flow from northwest to southeast, draining into the Ewaso Nyiro River Basin. The

Soils

Soils in the municipality are mainly dystric acrisols and humic nitisols. The soils are deep and well drained with a pH of 5.7, soil fertility is low due to continuous cultivation, low organic matter, and soil erosion and leaching.

1.2.4 Administrative Units

The Municipality lies within Kirisia Division of Samburu West Sub-County and covers an area of approximately 176.km2.

The municipality is further subdivided into 4 sub locations:

1. Maralal
2. Milimani
3. Shabaa
4. Lkurroto

1.2.5. Demographic Features

The main urban center is Maralal whose estimated population in 2009 was 53,555 and is projected to be 67,221 by 2022. The population projections of these centers is as shown in Table below.

The growth in the urban centers is mainly attributed to rural-urban migration. The urban centers attract population in search of employment and access to better social amenities. The growing population in these towns will require proper integrated planning for improved social amenities such as housing, sewerage systems, solid waste disposal facilities and increased capacity in schools and hospitals.

Table 1: Population Projection for Maralal

Urban center	Census			Projections											
	2019			2022			2025			2030			2029		
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
Maralal	15831	15519	31350	17299	16958	34257	18903	18530	37434	20655	20248	40903	22570	22125	44695

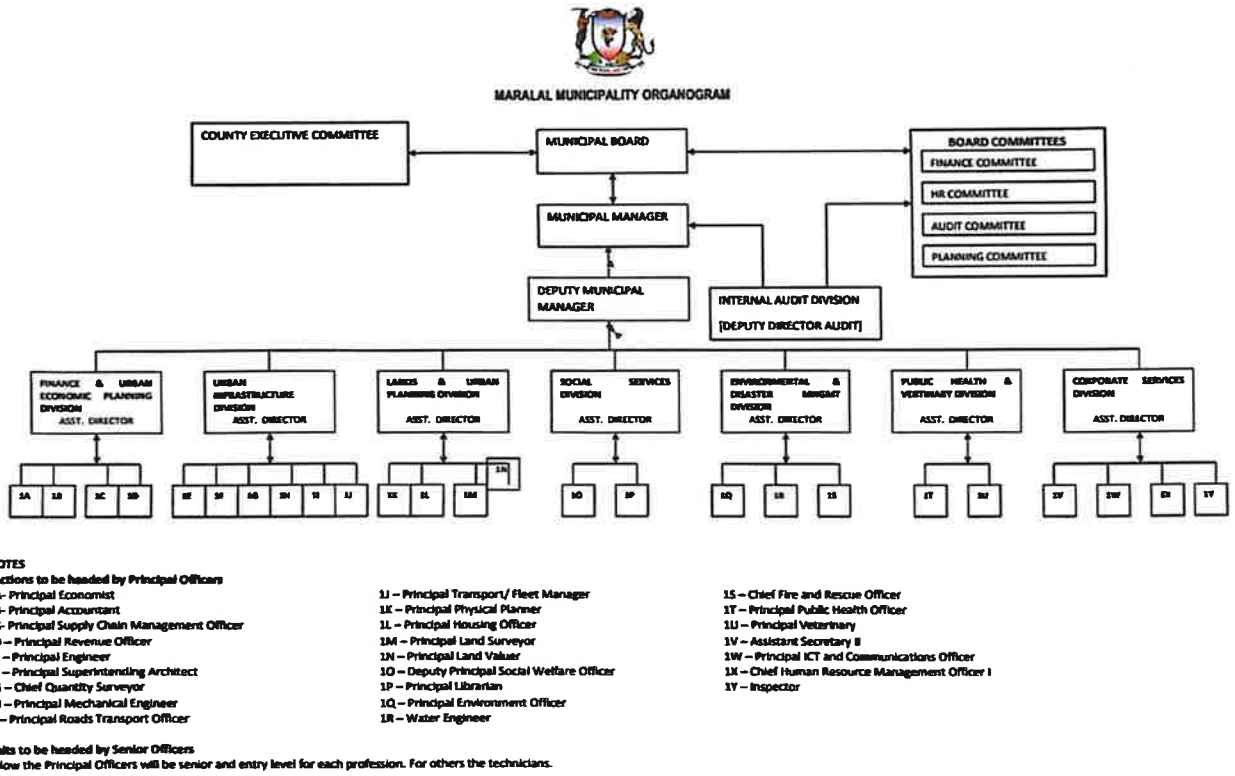
Map:

A map illustrating Maralal Municipality's administrative boundaries, wards, and key physical features (e.g.,

- **Planning and Development Department** – leads integration of climate risks into the Integrated Development Plan (IDP)./

The governance structure for climate risk assessment and municipal development planning is illustrated in th organogram below, showing the flow of coordination and decision-making from the Municipal Manager to sectoral departments, technical committees, and community stakeholders.

Organogram:
(Insert a visual organogram showing the Municipal Manager at the top, linked to the Municipal Council, Planning & Development, Environment Unit, Infrastructure, Water & Sanitation, Disaster Management, and Community/CSO representatives.)



NOTES
Sections to be headed by Principal Officers
1A- Principal Economist
1B- Principal Accountant
1C- Principal Supply Chain Management Officer
1D – Principal Revenue Officer
1E – Principal Engineer
1F – Principal Superintending Architect
1G – Chief Quantity Surveyor
1H – Principal Mechanical Engineer
1I – Principal Roads Transport Officer
1J – Principal Transport/ Fleet Manager
1K – Principal Physical Planner
1L – Principal Housing Officer
1M – Principal Land Surveyor
1N – Principal Land Valuer
1O – Deputy Principal Social Welfare Officer
1P – Principal Librarian
1Q – Principal Environment Officer
1R – Water Engineer
1S – Chief Fire and Rescue Officer
1T – Principal Public Health Officer
1U – Principal Veterinary
1V – Assistant Secretary II
1W – Principal ICT and Communications Officer
1X – Chief Human Resource Management Officer I
1Y – Inspector

Units to be headed by Senior Officers
Below the Principal Officers will be senior and entry level for each profession. For others the technicians.

Fig 1: Maralal Municipal Organogram

1.2.3. Population Distribution: Rural -Urban Population

Kenya"s population is mainly rural at an average of 78.1% while the rest is urban. According to the National Population and Housing Census, 2009, Maralal township population is majorly urban with a small percentage constituting peri-urban and rural population.

1.2.3.1. Population Distribution

According to the 2009 Population and Housing Census, the population of Samburu County was 223,947. Given a population growth rate of 4.45 percent per annum, as opposed to the national growth rate of 3 percent, the county population is expected to have risen to 255,931 persons in 2012 comprising of 128,004 females and 127, 927 males. The population is projected to increase to 292,484 in 2015 and 319,708 in 2017. These changes represent a 24.9 percent population rise between 2012 and 2017.This increase is significant and calls for commensurate expansion of basic amenities in the county. Kenya has a Population density of 68.1 persons per Km^2 whilst that of Maralal planning area is 76 persons per km^2. CBD leads with a population density 710 followed by Ng"aari with 197 and followed by Milimani with the density of 156 and Elkuroto respectively.

1.2.3.2. Population Composition and Structure

In the planning area, population of men is almost equal to that of women according to Kenya Population Census, 2009. This is substantiated with various demographic characteristics including increased life expectancy which has females outliving males. Maralal Population Profile/Interest Groups

Table 2: Population Distribution by Cohorts Source: National Population Census, 2009

Age Group	Male	Female	Total
1-4	1409	1430	2839
5-9	1255	1316	2571
10-14	1172	1195	2367
15-19	1041	1099	2140
20-24	904	1099	2003
25-29	852	915	1767
30-34	712	605	1317
35-39	513	456	969
40-44	311	260	571
45-49	277	208	485
50-54	182	150	332
55-59	106	77	183
60-64	96	110	206
65-69	48	58	106
70-74	53	67	120
75-79	21	34	55
80+	47	70	117

Socio-Economic Characteristics

- **Livelihoods:** The majority of residents depend on livestock rearing, small-scale crop farming, trading, and casual employment.
- **Education:** Access to primary and secondary education is improving, but literacy and enrollment rates vary by ward.
- **Health:** Health facilities are limited, with the Municipality relying on a few dispensaries and a sub-county hospital. Access to clean water and sanitation remains a challenge in peri-urban settlements.
- **Economic Activities:** Key sectors include livestock markets, small retail businesses, government services, and informal trade.

Projected Demographic Trends

Population projections indicate continued growth, particularly in peri-urban areas, driven by natural increase and rural-to-urban migration. This urban expansion increases demand for housing, water, sanitation, and infrastructure, heightening vulnerability to climate hazards such as drought, water scarcity, and flooding.

Graph 2: Projected Population Growth (2025–2040)
(Insert line graph showing projected total population for the Municipality over the next 15 years.)

Urban center	Census			Projections											
	2019			2022			2025			2030			2029		
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
Maralal	15831	15519	31350	17299	16958	34257	18903	18530	37434	20655	20248	40903	22570	22125	44695

Table 2: Population Projection for Maralal
Source: KNBS 2019, County Government of Samburu 2022

This socio-economic overview highlights the **population pressures, livelihood dependence, and infrastructure gaps** that make Maralal Municipality particularly vulnerable to climate risks. These insights guide planning for climate-resilient infrastructure, water security, and adaptive livelihood interventions.

1.4 Economic Context

Economic Context

Maralal Municipality serves as the commercial and administrative center of Samburu North Sub-County and plays a critical role in supporting the county's predominantly pastoral economy. The local economy is largely driven by **livestock production and trade**, small-scale agriculture, retail businesses, transport services, informal trade, and public sector employment. Climate variability significantly influences economic performance, as key sectors depend heavily on natural resources and rainfall patterns.

Trend	Implication
Population growth and urban expansion	Increased demand for housing, water, energy, and services
Expansion of livestock markets	Greater revenue potential but higher vulnerability to drought
Infrastructure development	Opportunity for climate-resilient investments
Diversification into renewable energy & SMEs	Potential for reduced climate risk and sustainable growth

Table 1

Climate–Economy Linkages

The Municipality's heavy reliance on climate-sensitive sectors increases economic vulnerability. Droughts reduce livestock productivity and purchasing power, while floods and erratic rainfall damage roads, markets, and infrastructure. Rising temperatures increase water demand and operational costs for households and businesses.

To strengthen economic resilience, Maralal Municipality must:

- Promote diversification of livelihoods beyond climate-sensitive sectors.
- Invest in climate-resilient infrastructure and water systems.
- Support climate-smart agriculture and sustainable livestock management.
- Encourage renewable energy investments and green enterprise development.
- Strengthen value chains in livestock and agricultural products to reduce vulnerability to climate shocks.

This economic context highlights the need to integrate climate risk considerations into economic planning to ensure stable, inclusive, and sustainable growth for Maralal Municipality

1.4.3. Land-use Context

The land-use context of Maralal Municipality reflects its dual function as an administrative urban center and a service hub within a predominantly pastoral and semi-arid landscape. Land use patterns influence settlement distribution, economic activities, infrastructure development, and exposure to climate risks such as drought, flash floods, and land degradation. Understanding current and projected land-use trends is essential for integrating climate resilience into spatial planning and development control.

map 8: Maralal Town Existing Land Use

Land-Use Challenges

- Expansion of settlements into flood-prone and riparian areas.
- Overgrazing leading to vegetation loss and soil erosion.
- Inadequate enforcement of zoning and development controls.
- Limited integration of climate risk information in land allocation and infrastructure siting.

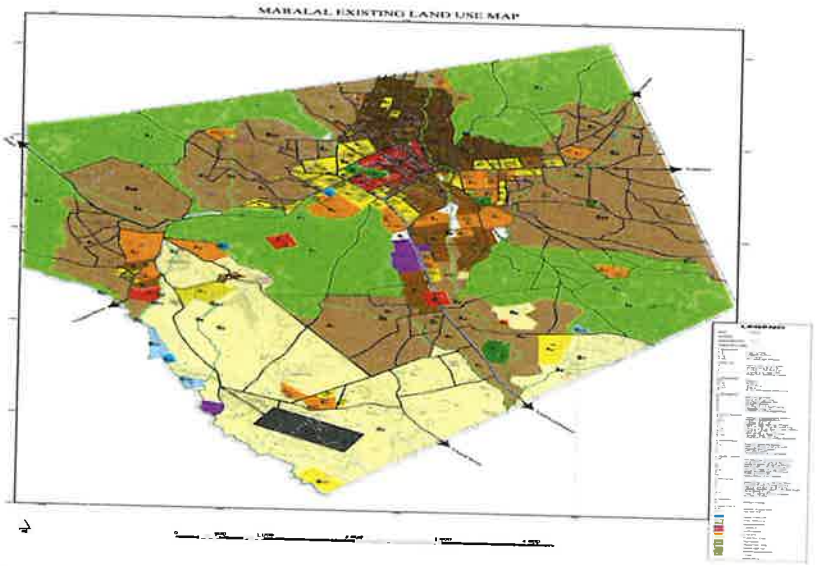
These issues increase vulnerability to extreme weather events and undermine long-term sustainability.

Projected Land-Use Trends (2025–2040)

Population growth and urban expansion are expected to drive changes in land use, particularly increased residential and commercial development. Without proper planning, this expansion may reduce open and grazing land and increase pressure on water and infrastructure systems.

Table 2: Projected Land-Use Trends and Implications

Projected Trend	Expected Impact	Climate Implication
Expansion of residential areas	Increased housing demand	Greater exposure to floods and water scarcity
Growth of commercial zones	Economic development	Need for climate-resilient infrastructure
Reduction in open/rangeland areas	Pressure on pastoral livelihoods	Increased land degradation risk
Infrastructure development	Improved connectivity	Opportunity to integrate resilience measures



Map 4: showing residential and commercial land use

High

High Influence – Low Interest • KERRA • Ministry of Interior and National Administration – County Commissioner • WRA • SAWASCO • KPLC • KMD • Serian FM • Radio Ashe • Radio Mchungaji	**High Influence – High Interest** • County Governor • County Executive • Members of county Assemble • County Government department of Environment, Energy and Natura resources. • Municipal Manager • State department for Urban Development. • Council of Governors • NEMA • NCA • NDMA • KURA • KENHA
Low Influence – Low Interest • Faith Based Organizations • ...	**Low Influence – High Interest** • Development partners • Institutions of higher learning • Community based Organizations • Samburu Chambers of Commerce

Low

High

Figure n. Stakeholder mapping for Maralal Municipality

2.2. Climate Indicators and Hazard Thresholds

Table n. Climate indicators and hazard thresholds selected for the assessment

Key Hazard	Climate indicator	Data source	Threshold		
			Low	Medium	High
Pluvial (surface level) flooding, including flash flooding and urban flooding	Number of days with precipitation >50 mm	World Bank Climate Change Portal	<3 days/year	3 – 6 days/year	>6 days/year
Fluvial (river) flooding	100 year return period flood depth	Aqueduct Flood	No Flooding	NA	Flooding
Drought (meteorological, hydrological)	SPEI Drought index	SPEI database	>-1.0	-1.0 to -1.5	<-1.5

2.3. Current Hazard Levels and Climate Projections

Maralal Municipality has experienced increasing climate variability over recent decades, marked by more frequent and prolonged droughts alongside episodes of intense rainfall. Drought remains the most persistent chronic hazard, with recurring meteorological droughts (below-average rainfall) often leading to hydrological droughts characterized by declining river flows, drying water sources, and reduced groundwater recharge. These drought cycles have intensified water scarcity, livestock losses, crop failure, and land degradation. At the same time, rainfall patterns have become more erratic, with short, heavy downpours contributing to pluvial (surface-level) flooding, including flash and urban flooding, particularly in poorly drained and low-lying areas. Seasonal rivers and streams have also increasingly overflowed during intense rainfall events, leading to localized fluvial (river) flooding, worsened by encroachment into riparian zones and reduced vegetation cover.

The interaction of these chronic hazards has heightened the severity of acute climate events. Prolonged drought degrades soils and reduces vegetation, increasing surface runoff when heavy rains occur, which in turn intensifies flash floods and river flooding. Similarly, intense rainfall following extended dry periods often results in more destructive flooding due to hardened soils and inadequate drainage infrastructure. Overall, historical trends indicate growing frequency and intensity of both drought and flooding hazards in Maralal Municipality, underscoring the need for improved water management, sustainable land use practices, resilient infrastructure, and strengthened early warning system

Figure 6: Elevation (left), historical (1985-2015) annual mean precipitation in mm (center), and historical (1985-2015) annual mean temperature in °C (right) for Samburu County for the long rainy seas

'Long rainy season'

'Short rainy season'

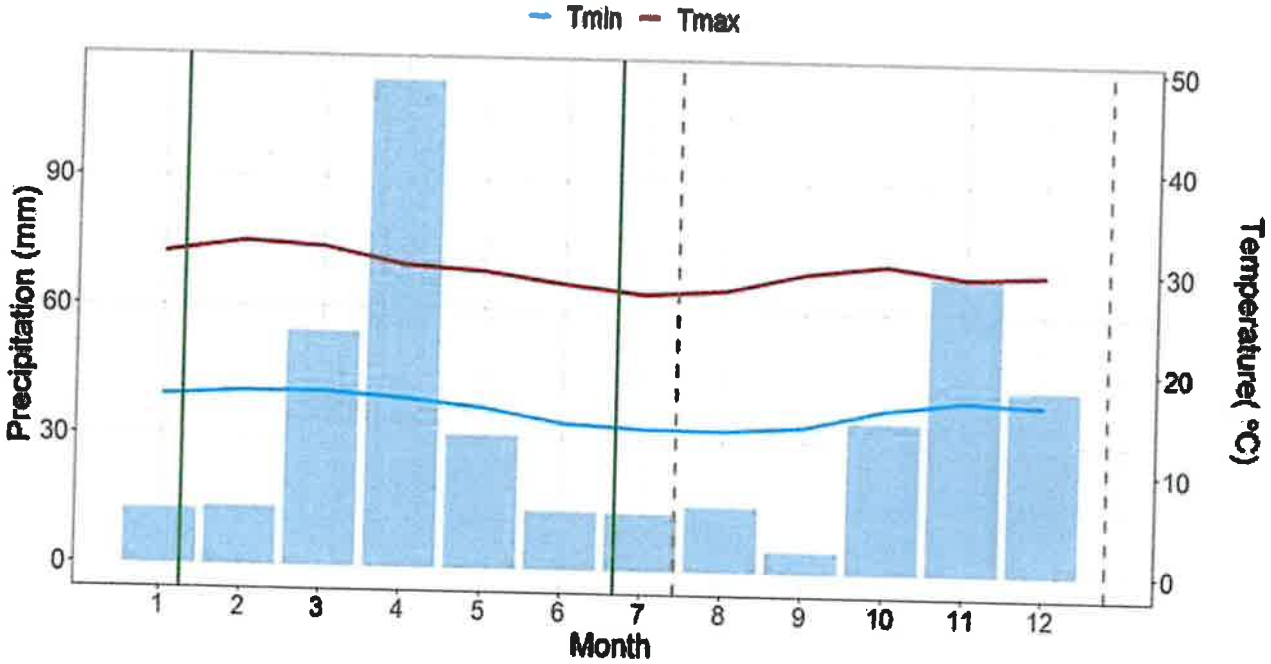


Figure 7: Historical monthly mean temperature and precipitation for Samburu County. The long rainy season is the 100-day wettest period from January to June, while the second, short rainy season is the 100-day wettest period from July to December. Bars represent total monthly precipitation and lines represent maximum (red) and minimum (blue) monthly mean temperatures (average 1985-2015)

This section presents the spatial distribution, frequency, severity, and overlap of key climate hazards affecting Maralal Municipality under both current and projected future climate conditions. Mapping hazard impact areas supports identification of hotspots, prioritization of interventions, and integration of climate risk considerations into spatial planning and infrastructure development.

Current Hazard Impact Areas

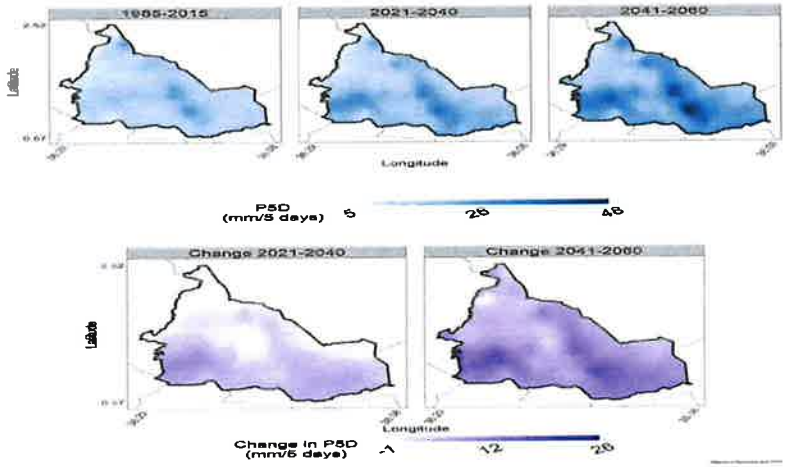
Current hazard mapping indicates that:

- **Drought and Water Scarcity** affect the entire Municipality, with more severe impacts in peri-urban and rangeland areas where livelihoods depend on livestock and rain-fed activities. Water stress is particularly pronounced in wards with limited water infrastructure and seasonal water sources.
- **Pluvial (Surface-Level) and Flash Flooding** are concentrated in low-lying urban zones, informal settlements, and areas with inadequate drainage systems. These areas experience localized flooding during intense rainfall events.
- **Fluvial (River) Flooding** occurs along seasonal rivers and drainage channels, especially in riparian zones and areas where settlement encroachment has reduced natural flood absorption capacity.
- **Land Degradation and Heat Stress** are widespread, particularly in open grazing lands and sparsely vegetated peri-urban zones.

Future Hazard Projections

Climate projections indicate an increase in temperature, more variable rainfall patterns, and a higher likelihood of extreme weather events. Future hazard mapping suggests:

- **Expansion of drought severity zones**, with longer dry spells and increased pressure on water resources.
- **Increased frequency and intensity of flash floods**, particularly in rapidly urbanizing areas without upgraded drainage infrastructure.
- **Greater flood risk along river channels**, especially where development continues within riparian reserves.
- **Intensified land degradation and heat exposure**, particularly in areas experiencing urban apsexpansion and vegetation loss.



3. Exposure & Vulnerability Assessment

This section assesses the exposure and vulnerability of communities, infrastructure, livelihoods, and ecosystems in Maralal Municipality to key climate hazards, including pluvial (surface-level) flooding, flash and urban flooding, fluvial (river) flooding, and meteorological and hydrological drought. While these hazards vary in frequency and intensity, their impacts are shaped by where people live, how land is used, the condition of infrastructure, and the adaptive capacity of households and institutions. Understanding who and what is most exposed and the factors that increase vulnerability provides a foundation for prioritizing targeted, risk-informed adaptation and resilience measures across the Municipality.

3.1. Urban Elements

Table n. Urban elements inventory

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
Infrastructure & Services				
Storm water Drainage	Storm water drainage conveyance network	Y	Y	Storm Water drainage network – Urban area
	Storm water storage	N	N	N/A
Water & Wastewater Management	Pumping stations	N	N	N/A
	Groundwater abstraction	Y	Y	Public and Private boreholes
	Water treatment facilities	Y	Y	SAWASCO storage tanks and treatment facility
	Water supply networks	Y	Y	SAWASCO water supply networks
	Sewer networks	Y	Y	SAWASCO serving Maralal Town
	Waste water treatment facilities	Y	Y	SAWASCO
Solid Waste Management	Transfer facilities	N	N	N/A
	Landfills and dump sites	Y	Y	Maralal dumpsite
	Recycling centers	N	N	N/A

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Cultural and heritage assets	Y	N	Kenyatta House
Emergency Services	Fire stations	Y	Y	Maralal Fire engine serving the entire county.
	Police stations	Y	N	NPS
	Telecommunications networks	Y	N	ICT Authority
	Early warning systems	Y	N	KMD and NDMA
	Disaster management centers and shelters	Y	N	County Disaster Management Unit
	Evacuation routes	N	N	N/A
Populations				
Urban Residents	Population	Y	N	KNBS
	Households	Y	N	KNBS
Informal Settlement Residents	Population living in informal settlements	Y	N	Loikas,Rangau and Mtaro
	Households lacking land tenure	Y	Y	Lare Oibor
	Households / residents lacking access to basic services	Y	N	No data available
Vulnerable and Marginalized Groups	Low-income households	Y	N	Lokuto,Loikas and Mtaro
	Women-headed households	Y	N	No data available
	Children and youth	Y	N	No data available
	Elderly persons	Y	N	No data available
	People with disabilities (PWD)	Y	N	No data available
	Homeless populations	Y	N	No available data

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Protected areas and national parks	Y	Y	Kirisia Forest
	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 n. 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 n. Impact Matrix

	Vulnerability Level		
	Low	Medium	High

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	• Waste facilities often lack adequate drainage or containment.		**Adaptive Capacity:** • Limited emergency response capacity, poor redundancy in collection systems.		and damage to waste management infrastructure
Transport and Mobility	• Roads, bridges, railways, and public transport networks are located in flood-prone areas, landslide zones, or areas prone to storm damage. • Key transport corridors may be disrupted during extreme weather events.	High	**Sensitivity:** • Pavements, bridges, and rail tracks are susceptible to erosion, collapse, and structural damage **Adaptive Capacity:** • Some maintenance and emergency detour plans exist, but limited resilience to frequent or severe events	High	Road closures, bridge damage, traffic disruptions, delays in public transport, increased accident risk, and economic losses due to impaired mobility
Economic Infrastructure	• Commercial buildings, markets, industrial zones, and financial centers are located in areas exposed to flooding, storms, or other hazards. • Critical economic facilities may lack hazard-resilient design.	High	**Sensitivity:** • Physical damage to buildings, machinery, and equipment. • Disruption of business operations and supply chains. **Adaptive Capacity:** • Limited insurance coverage, partial contingency planning, and some structural reinforcements	High	Severe economic losses due to business interruption, property damage, and reduced productivity; potential long-term impact on employment and local economy
Social Infrastructure	• Schools, hospitals, community centers, and emergency facilities are located in areas exposed to flooding, storms, or other hazards.	High	**Sensitivity:** • Damage to buildings and critical equipment • Disruption of essential services such as healthcare and education	High	Severe disruption of essential services, risks to health and safety, delayed emergency response, and potential long-term social impacts

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			Adaptive Capacity: • Very limited financial, technical, and institutional support; weak community preparedness		
Vulnerable and Marginalized Groups	• Includes elderly, children, people with disabilities, low-income households, and socially marginalized communities. • Often live in hazard-prone areas or have limited access to essential services.	High	**Sensitivity:** • Higher susceptibility to injury, illness, displacement, and loss of livelihood • Limited access to shelters, healthcare, and social safety nets **Adaptive Capacity:** • Weak financial, technical, and social support; limited emergency preparedness	Very High	Severe impacts on health, safety, and livelihoods; increased risk of social inequities; longer recovery times after Hazard-1 events
Natural Assets					
Urban Green Infrastructure	• Parks, street trees, urban forests, and green spaces exposed to flooding, storms, or heatwaves. • Limited coverage or maintenance can reduce resilience.	Moderate	**Sensitivity:** • Vegetation may be damaged or destroyed by extreme weather • Soil erosion and reduced storm water absorption capacity **Adaptive Capacity:** • Some maintenance programs, but limited resources for large-scale restoration	Moderate	Loss of cooling, storm water management, and air quality benefits; Increased urban heat stress and flood risk; reduced ecosystem services
Urban Blue Infrastructure	• Rivers, lakes, canals, ponds, and wetlands in urban areas exposed to flooding, storms, and pollution risks. • Some water bodies are encroached upon or poorly managed	High	**Sensitivity:** • Susceptible to overflow, erosion, water contamination, and ecosystem degradation **Adaptive Capacity:** • Limited management, flood control measures, and restoration programs	High	Reduced storm water management and flood mitigation capacity, water quality deterioration, loss of biodiversity, and increased urban flood risk

Solid Waste Management	• Wind scatters waste from open collection points • Increased litter accumulation along Maralal town market	High	**Sensitivity:** • Open waste storage points • Limited waste containment facilities **Adaptive Capacity:** • Increased waste collection fleet and equipment.	Medium	Major

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Urban Residents	• Increased respiratory illnesses (e.g., asthma, allergies) • Reduced outdoor economic activities	High	**Sensitivity:** • High exposure due to outdoor informal sector activities **Adaptive Capacity:** • Use of masks and indoor sheltering	Medium	Major
Informal Settlement Residents	• Severe dust exposure in urban and peri urban areas due to unpaved surfaces • Dust intrusion into temporary housing structures	High	**Sensitivity:** • Houses constructed with temporary materials • Congested settlements **Adaptive Capacity:** • Limited mitigation measures		
Vulnerable and Marginalized Groups	• Children and elderly highly affected by respiratory infections • Persons with disabilities face mobility challenges during low visibility	High	**Sensitivity:** • Pre-existing health conditions • Limited access to protective gear **Adaptive Capacity:** • Limited targeted support programs	High	Catastrophic
Natural Assets					
Urban Green Infrastructure	• Drying of vegetation in the municipal park and public open spaces • Soil erosion in open grounds near the CBD	High	**Sensitivity:** • Sparse vegetation cover **Adaptive Capacity:** • Tree planting and greening initiatives	Medium	Major
Urban Blue Infrastructure	• Increased sediment load along stadia stream • Reduced water quality due to dust runoff	Medium	**Sensitivity:** • Limited riparian buffer protection **Adaptive Capacity:** • Annual clean-up exercises	Medium	Moderate
Peri-urban and Agricultural Systems	• Topsoil erosion in peri-urban farms • Reduced crop productivity due to moisture loss	High	**Sensitivity:** • Reliance on rain-fed agriculture • Limited windbreak structures **Adaptive Capacity:** • Adoption of agroforestry and windbreak trees	High	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	• Culverts blocked by debris during heavy rainfall		**Adaptive Capacity:** • Ongoing culvert upgrades • Road rehabilitation efforts		
Energy	• Flooding in low-lying areas threatens ground-mounted transformers • Temporary power outages during heavy rainfall events	Medium	**Sensitivity:** • Overhead power infrastructure **Adaptive Capacity:** • Elevated transformer installations in select areas	Medium	Moderate
Economic Infrastructure	• Businesses in low-lying areas experience temporary closures • Reduced access during flood events	Medium	**Sensitivity:** • Informal business structures **Adaptive Capacity:** • Temporary relocation during heavy rains		
Social Infrastructure	• Schools and public offices in low-elevation areas experience temporary access disruption	Medium	**Sensitivity:** • Buildings located below road level • Limited flood barriers **Adaptive Capacity:** • Localized embankments and drainage diversion	Medium	Moderate
Emergency Services	• Flooded access roads delay emergency response • Increase in waterborne diseases post-flooding	High	**Sensitivity:** • Limited specialized flood response equipment **Adaptive Capacity:** • Availability of Fire engine and personnel.	Medium	Major
Populations					
Urban Residents	• Surface water accumulation in residential compounds • Temporary displacement in extreme rainfall seasons	High	**Sensitivity:** • Settlement expansion in low-lying areas within catchment **Adaptive Capacity:** • Informal sandbagging and temporary channels	Medium	Major

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	• Prolonged dry periods cause cracking of unlined drainage channels • Increased sediment and debris accumulation due to dry winds	Medium	**Sensitivity:** • Mostly unlined and exposed drainage channels **Adaptive Capacity:** • Periodic maintenance and desilting	Medium	Moderate
Water & Wastewater Management	• Increased water demand during hot periods • Reduced groundwater recharge levels	High	**Sensitivity:** • Heavy reliance on boreholes and samburu Water and Sanitation Company • Limited water storage infrastructure **Adaptive Capacity:** • Borehole drilling and water rationing measures	High	Catastrophic
Solid Waste Management	• Accelerated decomposition of waste in open collection points • Increased odor and vector attraction • Dumpsite fires due to Methane and excessive heat	Medium	**Sensitivity:** • Open waste dumpsites • Limited waste containment facilities **Adaptive Capacity:** • Private garbage collectors operating in CBD • Construction of a Modern landfill	Medium	moderate
Transport and Mobility	• Heat stress affects pedestrians and boda boda operators • Surface degradation of unpaved roads	High	**Sensitivity:** • Limited shaded walkways • High pedestrian dependency **Adaptive Capacity:** • Limited tree cover initiatives	Medium	Major

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Informal Settlement Residents	• Extreme indoor heat in iron-sheet structures in low income residential areas • Limited access to clean water during peak heat	High	**Sensitivity:** • Housing made of heat-absorbing materials • High density settlements **Adaptive Capacity:** • Minimal mitigation options	High	Catastrophic
Vulnerable and Marginalized Groups	• Children, elderly, and persons with disabilities at high risk of heat stress • Increased health complications	High	**Sensitivity:** • Pre-existing medical conditions • Limited mobility **Adaptive Capacity:** • Limited targeted cooling or relief programs	High	Catastrophic
Natural Assets					
Urban Green Infrastructure	• Drying of vegetation in Municipal park and public open spaces • Increased tree mortality during prolonged heat periods.	High	**Sensitivity:** • Limited irrigation systems **Adaptive Capacity:** • Tree planting initiatives (rain-dependent)	Medium	Major
Urban Blue Infrastructure	• Reduced river flow levels • Increased evaporation rates	High	**Sensitivity:** • Limited protection of riparian zones • Reduced recharge during dry periods **Adaptive Capacity:** • Community lake conservation initiatives	High	Catastrophic
Peri-urban and Agricultural Systems	• Crop wilting and reduced yields • Livestock heat stress • Soil moisture loss	High	**Sensitivity:** • Heavy reliance on rain-fed agriculture • Limited irrigation coverage **Adaptive Capacity:** • Adoption of drought-resistant crops and agroforestry	High	Catastrophic

4. 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 Maralal Municipality. 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 n. 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 n. 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.

Category	Risk Level				
	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
Populations					
Urban Residents	Urban populations live with existing infrastructure and services; some exposure to flooding, heat stress, and pollution in densely populated areas	Moderate increase in heatwaves and heavy rainfall affecting urban living conditions; increased risk of urban flooding and heat stress	Higher exposure to extreme heat, intense rainfall, and flooding; increased health risks and pressure on urban services	Greater vulnerability of urban populations due to climate stress; need for improved urban planning and resilient infrastructure	Severe impacts from extreme heat, flooding and climate hazards; major adaptation needed to protect urban populations and maintain livability
Informal Settlement Residents	Many residents live in high-risk areas (floodplains, unstable slopes) with limited access to basic services such as drainage, sanitation, and waste management	Moderate increase in flooding, heat stress, and service disruptions affecting already vulnerable communities	More frequent extreme rainfall and heatwaves leading to increased flooding, housing damage, and health risks	Growing vulnerability due to stronger climate impacts; higher need for improved housing, drainage, and social protection	Severe impacts from floods, heatwaves, and infrastructure failure; significant displacement risk and urgent need for resilient housing and infrastructure
Vulnerable and Marginalized Groups	Groups such as low-income households, elderly people, children, people with disabilities, and socially marginalized communities often have limited access to resources, services, and climate protection measures	Moderate climate changes increase exposure to heatwaves, flooding, and health risks; limited adaptive capacity makes these groups more vulnerable	More frequent extreme events intensify health, livelihood, and housing risks; inequalities in access to services and support become more pronounced	Increasing climate stress worsens social and economic vulnerabilities; greater need for inclusive policies and social protection	Severe climate impacts disproportionately affect marginalized groups, with higher risks of displacement poverty, and health crises without strong adaptation measures
Natural Assets					

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	medium	medium	medium	medium	medium
Water & Wastewater Management	major	Very high	Very high	Very high	Very high	Very high
Solid Waste Management	minor	medium	medium	medium	medium	Medium
Transport and Mobility	moderate	high	high	high	high	high
Energy	moderate	high	high	high	high	high
Economic Infrastructure	major	Very high	Very high	Very high	Very high	Very high
Social Infrastructure	Moderate	high	high	high	high	High
Emergency Services	major	Very high	Very high	Very high	Very high	Very high
Populations						
Urban Residents	Moderate	high	High	high	high	High
Informal Settlement Residents	Major	Very high	Very high	Very high	Very high	Very high
Vulnerable and Marginalized Groups	Major	Very high	Very high	Very high	Very high	Very high
Natural Assets						
Urban Green Infrastructure	Minor	medium	medium	medium	medium	medium
Urban Blue Infrastructure	moderate	high	high	high	high	High
Peri-urban and Agricultural Systems	Major	Very high	Very high	Very high	Very high	Very high

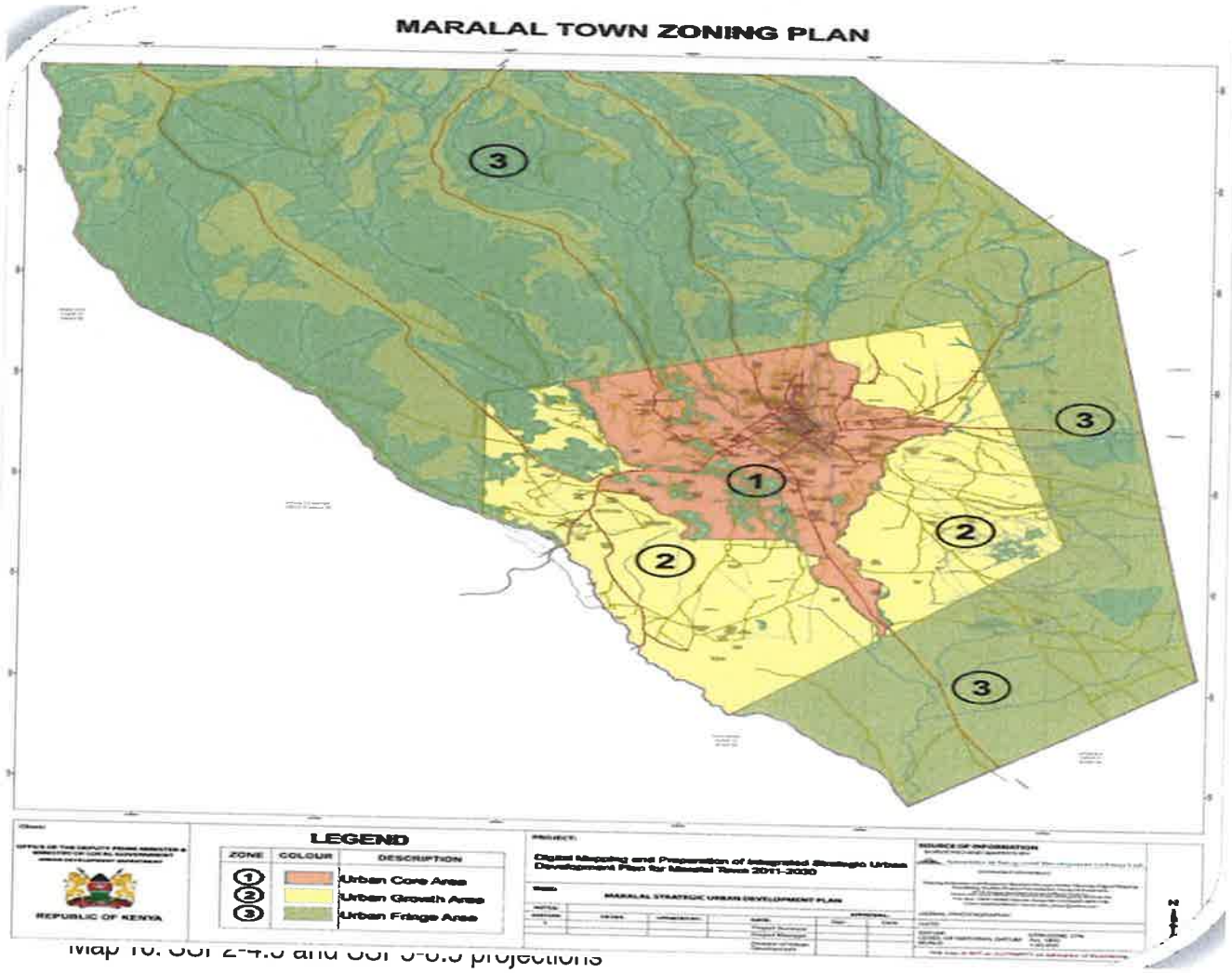
Table 21. Summary of Sand and Dust Storms risks for Maralal Municipality

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						

Water & Wastewater Management	moderate	medium	medium	high	high	high
Solid Waste Management	minor	medium	medium	high	high	high
Transport and Mobility	moderate	medium	medium	high	high	high
Energy	major	high	high	Very high	Very high	Very high
Economic Infrastructure	major	high	high	Very high	Very high	Very high
Social Infrastructure	moderate	medium	medium	high	high	high
Emergency Services	major	high	high	Very high	Very high	Very high
Populations						
Urban Residents	Moderate	medium	medium	high	high	high

4.2.4 Mapping Climate Risk Hotspots



Map 16: SSP 2-4.5 and SSP 5-8.5 projections

5. What's Next?

5.1. Key Findings

- **Highest Priority Hazards: Flooding** and **Drought** present the most severe and interconnected challenges, creating a cycle of disaster and scarcity.
- **Most At-Risk Groups: Residents of informal settlements** (Loikas, DEB, Loresho & Kenyatta stadium) face catastrophic risks from flooding and major risks from water stress and heat.
- **Most Critical Systems:** The **municipal water supply system** is highly vulnerable to drought and lacks the capacity to cope with demand spikes or supply shocks..
- **Economic Vulnerability:** The business community, while a major water user, is itself highly vulnerable to water stress, posing a significant risk to the local economy and employment.

5.1.1 Key Hazards

Hazard	High-Risk Populations	Vulnerable Infrastructure / Assets	Future Trend (2050–2100)
Flooding (pluvial, fluvial, coastal)	Informal settlement residents, low-income households, urban residents in low-lying areas	Stormwater drainage, water & wastewater systems, transport networks, economic & social infrastructure, urban blue infrastructure	Increased frequency and intensity of extreme rainfall; higher flood-prone areas; urban expansion increases exposure
Heatwaves / Urban Heat Stress	Elderly, children, people with disabilities, urban residents in dense areas	Urban green infrastructure, roads, energy networks, social infrastructure	Rising urban temperatures; urban heat island effect intensifies; green infrastructure may degrade without intervention
Storms & Strong Winds	Residents in coastal or exposed wards, informal settlements	Transport networks, energy infrastructure, economic infrastructure, emergency services	More frequent intense storms; structural damage to buildings and critical infrastructure
Drought / Water Scarcity	Low-income households, peri-urban farmers	Water supply systems, irrigation networks, peri-urban agricultural systems, urban blue infrastructure	Increased water stress; reduced water availability; agricultural productivity decline
Secondary Hazards (Landslides, Water	Vulnerable & marginalized groups, residents in hazard-prone areas	Peri-urban agricultural lands, urban blue & green infrastructure, water systems	Higher risk of landslides, contamination, and disease outbreaks following extreme event

5.2. Climate Adaptation and Resilience Solutions

Table n. Climate adaptation and resilience solutions recommended for Maralal Municipality

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
Infrastructure & Services			
Stormwater Drainage	• … • …	• … • …	• … • …
Water & Wastewater Management	• Aggressive campaign to repair water pipe leaks and reduce non-revenue water. • Promote rainwater harvesting in public buildings.	• Invest in wastewater treatment and reuse for non-potable uses (e.g., flower farms). • Construct managed aquifer recharge schemes.	• Diversify water sources (e.g., advanced treatment, new sustainable boreholes). • Implement a smart water grid.
Solid Waste Management	• Reliable campaign of door to door collections system for households • Organizing clean up activities. • Eliminate illegal dumping • Implement community scale composing plants for organic waste	• Establish material recovery facility (MRF) • Promote reduce and reuse culture • Increase waste collection infrastructure through purchase of skip bins, skip loaders and litterbins • Establish a modern landfill	• Zone to develop a circular economy park to host recycling, composting and up cycling industries to reduce land fill pressure. • Waste to energy interventions
Populations			

Annex N1. Historical Hazard Events – Maralal Municipality

Annex N2. Data Sources

Field	Description
Hazard Event/Type	Urban Flooding caused by heavy rainfall and drainage overflow
Date or Period	July 2022
Location	Low-lying residential neighborhoods near the main river and drainage canals within the urban area, particularly informal settlements along riverbanks and poorly drained roads. (A city flood hazard map can be attached to show affected wards/blocks.)
Intensity	Continuous heavy rainfall for about **36 hours** caused the river to overflow and drainage systems to fail. Floodwater depth reached **0.8–1.5 meters** in the most affected neighborhoods and remained stagnant for **2–3 days**. Major roads experienced waterlogging and transport disruptions.
Social Impacts	Around **4,500 people affected**, with approximately **800 households temporarily displaced. 3 fatalities and 12 injuries** were reported. Vulnerable groups such as **low-income households, informal settlers near riverbanks, elderly residents, women, and children** were the most affected. Temporary shelters were established in schools and community centers.
Physical Impacts	Approximately **120 houses severely damaged** and **350 houses partially damaged**. Flooding damaged roads, blocked drainage channels, and disrupted **electricity and water supply for 24–48 hours**. Some schools and health facilities experienced temporary service disruption.
Economic Impacts	Estimated **economic loss of about USD 1–1.5 million**. Small businesses lost goods due to water damage, daily wage workers lost income during the flooding period, and repair costs for homes and infrastructure were significant. Transportation and market activities were interrupted.
Ecological Impacts	Floodwaters carried solid waste and pollutants into nearby wetlands and streams. **Riverbank erosion**, sediment deposition, and damage to urban vegetation occurred. Some natural drainage channels became clogged with debris.

Resource Type	Name / Title of Resource	Source / Organization	Year	Purpose in Analysis (Sections 2–5)
Hazard Data	Historical Flood Records	National Disaster Management Authority / Local Government	2015–2024	Used to identify past flood events and analyze hazard frequency and intensity (Section 2: Hazard Assessment).
Climate Data	Historical Rainfall and Temperature Data	National Meteorological Department	2014–2024	Used to analyze climate trends and extreme weather patterns affecting urban hazards.

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