



# KIMILILI MUNICIPALITY URBAN CLIMATE RISK PROFILE 2025



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## Foreword

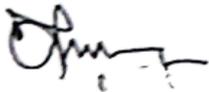
Climate change continues to shape the social, economic, and environmental realities of urban areas across Kenya. As cities and municipalities grow, so does the urgency to understand the risks posed by shifting weather patterns, rising temperatures, and increasingly unpredictable rainfall. In this context, the preparation of the Urban Climate Risk Profile for Kimilili Municipality marks an important milestone in strengthening our ability to anticipate, prepare for, and respond to climate-related challenges.

This profile provides a rapid yet comprehensive assessment of the key climate hazards affecting Kimilili both now and in the future. By examining evidence from historical data, scientific projections, and local observations, the report identifies the major hazards with the highest impact on our community—namely rising temperatures, pluvial flooding, meteorological drought, and thunderstorms. These hazards increasingly threaten critical infrastructure, natural ecosystems, economic activities, and, most importantly, the wellbeing of our residents.

The insights and findings in this profile will support more informed decision-making, guide investments in climate-resilient infrastructure, and ensure that vulnerable populations are not left behind. It also provides a foundation for integrating climate risk considerations into municipal planning instruments such as the Integrated Development Plan (IDP), spatial planning processes, and sectoral strategies.

I commend the efforts of the technical team, development partners, and stakeholders who contributed to this assessment. Their commitment to evidence-based planning strengthens our resolve to build a safer, healthier, and more resilient Kimilili. As leadership, we reaffirm our dedication to supporting climate adaptation actions that protect our people, enhance economic stability, and safeguard the natural assets that define our municipality.

Let this Urban Climate Risk Profile be a guiding step toward a climate-resilient future—one where every resident, institution, and system is better prepared to withstand the impacts of a changing climate.



**WANYONYI BUTEYO**  
**Board chair Kimilili municipality**  
**2025**

## **Executive Summary**

### **Objective(s) of the Rapid Climate Risk Assessment**

The objective of this Urban Climate Risk Profile is to provide a rapid and evidence-based assessment of Kimilili Municipality's current and future climate risks. The assessment identifies the key climate hazards affecting the municipality, evaluates their severity under present and projected climate conditions, and examines how they interact with local exposure and vulnerability factors. The findings serve to guide municipal planning, support risk-informed decision-making, and prioritize investments that strengthen resilience across infrastructure systems, natural assets, and vulnerable populations.

### **List of Key Hazards Identified**

The assessment identifies four priority climate hazards that currently affect Kimilili Municipality and are projected to intensify under future climate scenarios:

1. Average surface temperature increase (dry spell)
2. Pluvial (surface) flooding
3. Meteorological drought
4. Thunderstorms

These hazards were selected based on historical climate trends, observed impacts within the municipality, and future projections under both SSP2-4.5 and SSP5-8.5 emission pathways.

### **Key Takeaways on What Can Be Done to Mitigate the Higher Risks**

The assessment highlights several strategic actions that can help reduce climate risks in Kimilili Municipality:

- Strengthen stormwater drainage systems through improved channel capacity, routine maintenance, and expanded coverage in flood-prone zones.
- Invest in nature-based solutions such as urban greening, riverbank restoration, and increased permeable surfaces to reduce runoff, mitigate heat, and improve microclimates.
- Enhance water resource management to address drought risks through rainwater harvesting, groundwater recharge, and diversified water supply options.
- Increase heat resilience by expanding shading, improving building designs, introducing reflective roofing, and promoting green public spaces.
- Improve early-warning systems for thunderstorms, heavy rainfall, and heatwaves to ensure timely alerts for communities.
- Integrate climate risk considerations into land-use planning, especially in informal settlements, riparian zones, and high-exposure areas.
- Strengthen social protection and community preparedness to support vulnerable and marginalized groups who face the highest climate risks.
- Plan for long-term climate-resilient infrastructure by incorporating mid-century (2050) and late-century (2100) climate projections into design standards.

**Summary of Average surface temperature increase (dry spell) risks for Kimilili municipality**

		<b>Time Horizon &amp; Climate Scenario</b>	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
		<b>Hazard Level</b>	Medium	High	High	High	High
<b>Categories</b>	<b>Impact</b>	<b>Risk Levels</b>					
		<b>Current</b>	<b>2050 SSP2-4.5</b>	<b>2050 SSP5-8.5</b>	<b>2100 SSP2-4.5</b>	<b>2100 SSP5-8.5</b>	
<b>Infrastructure &amp; Services</b>							
Stormwater Drainage	Major	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	Moderate	Medium	High	High	High	High	
Transport and Mobility	Catastrophic	Very high	Very high	Very high	Very high	Very high	
Energy	Moderate	Medium	High	High	High	High	
Economic Infrastructure	Moderate	Medium	High	High	High	High	
Social Infrastructure	Major	High	Very high	Very high	Very high	Very high	
Emergency Services	Moderate	Medium	High	High	High	High	
<b>Populations</b>							
Urban Residents	Major	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	
<b>Natural Assets</b>							
Urban Green Infrastructure	Major	High	Very high	Very high	Very high	Very high	
Urban Blue Infrastructure	Moderate	Medium	High	High	High	High	
Peri-urban and Agricultural Systems	Catastrophic	Very high	Very high	Very high	Very high	Very high	

**Summary of pluvial flooding risks for kimilili 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
<b>Infrastructure &amp; Services</b>						
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	Major	High	High	Very high	Very high	Very high
Transport and Mobility	Major	High	High	Very high	Very high	Very high
Energy	Moderate	Medium	Medium	High	High	High
Economic Infrastructure	Catastrophic	Very high	Very high	Very high	Very high	Very high
Social Infrastructure	Major	High	High	Very high	Very high	Very high
Emergency Services	Major	High	High	Very high	Very high	Very high
<b>Populations</b>						
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
<b>Natural Assets</b>						
Urban Green Infrastructure	Moderate	Medium	Medium	High	High	High
Urban Blue Infrastructure	Moderate	Medium	Medium	High	High	High
Peri-urban and Agricultural Systems	Minor	Low	Low	Medium	Medium	Medium

**Summary of metrological drought (dry spell) risks for kimilili 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	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
<b>Infrastructure &amp; Services</b>						
Stormwater Drainage	Insignificant	Low	Low	Low	Low	Low
Water & Wastewater Management	Catastrophic	Very high	Very high	Very high	Very high	Very high
Solid Waste Management	Moderate	Medium	High	High	High	High
Transport and Mobility	Moderate	Medium	High	High	High	High
Energy	Insignificant	Low	Low	Low	Low	Low
Economic Infrastructure	Moderate	Medium	High	High	High	High
Social Infrastructure	Major	High	Very high	Very high	Very high	Very high
Urban Residents	Major	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
<b>Natural Assets</b>						
Urban Green Infrastructure	Major	High	Very high	Very high	Very high	Very high
Urban Blue Infrastructure	Moderate	Medium	High	High	High	High
Peri-urban and Agricultural Systems	Major	High	Very high	Very high	Very high	Very high

**Summary of thunderstorms risks for kimilili municipality**

	<b>Time Horizon &amp; Climate Scenario</b>	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	<b>Hazard Level</b>	Medium	Medium	High	High	High
<b>Categories</b>	<b>Impact</b>	<b>Risk Levels</b>				
		<b>Current</b>	<b>2050 SSP2-4.5</b>	<b>2050 SSP5-8.5</b>	<b>2100 SSP2-4.5</b>	<b>2100 SSP5-8.5</b>
<b>Infrastructure &amp; Services</b>						
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	Major	High	High	Very high	Very high	Very high
Transport and Mobility	Major	High	High	Very high	Very high	Very high
Energy	Major	High	High	Very high	Very high	Very high
Economic Infrastructure	Catastrophic	Very high	Very high	Very high	Very high	Very high
Social Infrastructure	Major	High	High	Very high	Very high	Very high
Emergency Services	Major	High	High	Very high	Very high	Very high
<b>Populations</b>						
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
<b>Natural Assets</b>						
Urban Green Infrastructure	Moderate	Medium	Medium	High	High	High
Urban Blue Infrastructure	Moderate	Medium	Medium	High	High	High
Peri-urban and Agricultural Systems	Moderate	Medium	Medium	High	High	High

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## List of Acronyms

<b>RCRA</b>	Rapid climate risk assessment
<b>AC</b>	Adaptive Capacity
<b>CCA</b>	Climate Change Adaptation
<b>CCKP</b>	Climate Change Knowledge Portal (World Bank)
<b>CHIRPS</b>	Climate Hazards Group InfraRed Precipitation with Stations
<b>CIDP</b>	County Integrated Development Plan
<b>CIESIN</b>	Center for International Earth Science Information Network
<b>CMIP5</b>	Coupled Model Intercomparison Project Phase 5
<b>CMIP6</b>	Coupled Model Intercomparison Project Phase 6
<b>CO<sub>2</sub></b>	Carbon Dioxide
<b>COP</b>	Conference of the Parties (UNFCCC)
<b>CSO</b>	Civil Society Organization
<b>DRM</b>	Disaster Risk Management
<b>DRR</b>	Disaster Risk Reduction
<b>EWS</b>	Early Warning System
<b>EMA</b>	Environmental Management Authority
<b>ENSO</b>	El Niño–Southern Oscillation
<b>GIS</b>	Geographic Information System
<b>GPC</b>	Global Protocol for Community-Scale Greenhouse Gas Inventories
<b>GHG</b>	Greenhouse Gas
<b>GLOF</b>	Glacial Lake Outburst Flood
<b>GoK</b>	Government of Kenya
<b>IDP</b>	Integrated Development Plan
<b>ILRI</b>	International Livestock Research Institute
<b>IPCC</b>	Intergovernmental Panel on Climate Change
<b>KMD</b>	Kenya Meteorological Department
<b>KUSP</b>	Kenya Urban Support Programme
<b>LCDA</b>	Local Climate Data Assessment
<b>LULC</b>	Land Use and Land Cover
<b>MAM</b>	March–April–May (long rains season)
<b>MoE</b>	Ministry of Environment
<b>NASA</b>	National Aeronautics and Space Administration
<b>NDMA</b>	National Drought Management Authority
<b>NGO</b>	Non-Governmental Organization
<b>NOAA</b>	National Oceanic and Atmospheric Administration
<b>NRM</b>	Natural Resource Management
<b>O&amp;M</b>	Operation and Maintenance
<b>PPE</b>	Probabilistic Projection Ensemble
<b>RAI</b>	Rainfall Anomaly Index
<b>RCRA</b>	Rapid Climate Risk Assessment
<b>RCMRD</b>	Regional Centre for Mapping of Resources for Development
<b>SDG</b>	Sustainable Development Goals
<b>SEA</b>	Strategic Environmental Assessment
<b>SOP</b>	Standard Operating Procedure
<b>SPI</b>	Standardized Precipitation Index
<b>SSP</b>	Shared Socioeconomic Pathway

<b>TAM</b>	Transport Asset Management
<b>UCRP</b>	Urban Climate Risk Profile
<b>UNDP</b>	United Nations Development Programme
<b>UNFCCC</b>	United Nations Framework Convention on Climate Change
<b>UN-Habitat</b>	United Nations Human Settlements Programme
<b>WASH</b>	Water, Sanitation and Hygiene
<b>WMO</b>	World Meteorological Organization
<b>WRMA</b>	Water Resources Management Authority

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## 1. Context

### 1.1. Objective

This **Urban Climate Risk Profile (UCRP)** for Kimilili Municipality aim to identify, analyze, and document climate-related risks and vulnerabilities affecting Kimilili Municipality, and to guide the integration of risk-informed and climate-resilient strategies into municipal planning and investment frameworks.

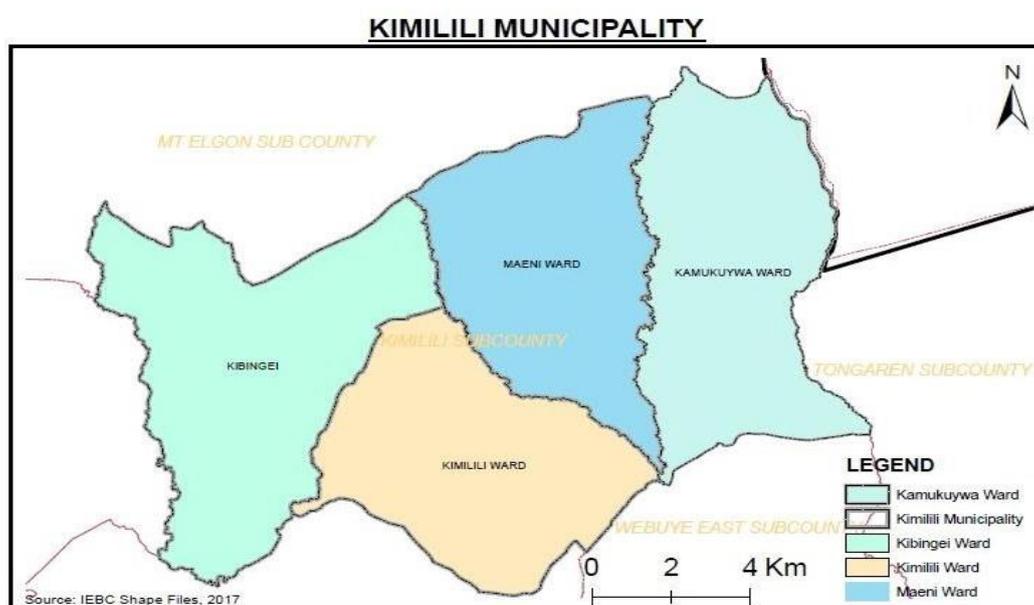
#### 1.1.1 Specific Objectives

The specific objectives of the Urban Climate Risk Profile are to:

1. Assess and characterize key climate-related hazards (such as flooding, drought, and heat extremes) and evaluate their spatial and temporal patterns within Kimilili Municipality.
2. Determine the level of exposure and vulnerability of critical urban assets, infrastructure, and populations to these hazards.
3. Generate and present spatial data, maps, and indicators that illustrate areas of high risk and potential impact under current and projected climate scenarios.
4. Support integration of climate and disaster risk information into municipal development plans, urban investment programs, and land-use policies.
5. Inform prioritized resilience interventions that strengthen the municipality's adaptive capacity and safeguard livelihoods, services, and ecosystems.

### 1.2. Urban Context

#### 1.2.1. Geographic area



**Figure 1 map of Kimilili Municipality**

Kimilili Municipality is situated in the northern region of Bungoma County, Western Kenya. It spans approximately **181.2 square kilometres** and comprises **four administrative wards**—Kimilili, Kibingei, Maeni, and Kamukuywa. The municipality lies between latitudes **0.7130°N and 0.8520°N**, and longitudes **34.7740°E**, with an average elevation of **1,570 metres above sea level**.

The municipality borders Mt. Elgon Sub-County to the northwest, Tongaren to the east, Kabuchai and Webuye to the south, and Sirisia to the west. Its proximity to the fertile slopes of Mt. Elgon provides it with a favorable agro-ecological environment and a reliable water network sustained by rivers such as **Kuywa, Sosio, Kamusinga, Kibingei, and Kibisi**. These rivers support domestic use, irrigation, and small-scale agro-industrial activities but are increasingly affected by siltation, encroachment, and pollution caused by human settlement and farming expansion.

The municipality's topography is predominantly **undulating to hilly**, with pockets of steep slopes prone to soil erosion and localized landslides, especially in the upper zones towards Mt. Elgon. The area experiences a **bimodal rainfall pattern**, with long rains between March and June and short rains from August to November, averaging **1,400–1,700 mm annually**. Mean temperatures range between **15°C and 27°C**, making the area suitable for mixed farming and settlement. However, rainfall variability and land degradation have begun altering hydrological patterns, affecting both agricultural productivity and urban drainage efficiency.

### **1.2.2. Governance Structure**

Kimilili Municipality operates under the **County Government of Bungoma** in accordance with the **Urban Areas and Cities Act (2011)** and the **County Governments Act (2012)**. The municipality is administered by a **Municipal Board**, which oversees policy implementation, planning, and service delivery. The **Municipal Manager** serves as the chief executive officer responsible for day-to-day operations, supported by technical officers across key sectors such as environment, infrastructure, planning, and public health.

The municipality collaborates closely with county departments—particularly the **Department of Lands, Urban Development, Environment, Water, and Natural Resources**—as well as national agencies such as **NEMA, NDMA**, and the **Kenya Meteorological Department**. These institutions provide technical guidance on climate resilience, environmental management, and disaster risk reduction.

Decision-making processes within the municipality are guided by the **Integrated Development Plan (CIDP/IDeP)** and other statutory frameworks, ensuring that climate and risk information are mainstreamed into planning, infrastructure development, and budgeting. Stakeholder participation is a legal requirement under Article 10 of the Constitution of Kenya (2010), promoting inclusivity, transparency, and accountability in urban governance.

### **1.2.3. Socio-economic Context**

Kimilili Municipality comprises four wards—Kimilili, Kibingei, Maeni, and Kamkuywa covering a total area of 181.2 km<sup>2</sup>. According to the 2019 Kenya Population and Housing Census, the municipality had a total population of **162,038 persons**, of whom **78,560 (48.5 %) were male** and **83,475 (51.5 %) females**, distributed across 35,158 households. The overall population density was about **460 persons per km<sup>2</sup>**, although density varies widely per ward within kimilili municipality. Here is the summarized ward statistics.

**Table 1 summarizes the ward-level statistics.**

Ward	Population (2019)	Male	Female	Households	Area (km <sup>2</sup> )	Density (p/km <sup>2</sup> )
Kimilili	44,246	21,343	22,902	10,417	42.2	1,051
Kibingei	41,858	20,401	21,456	8,904	51.9	810
Maeni	29,477	14,257	15,219	6,012	41.0	744
Kamkuywa	46,457	22,559	23,898	9,825	46.2	1,999
<b>Total Average</b>	<b>162,038</b>	<b>78,560</b>	<b>83,475</b>	<b>35,158</b>	<b>181.2</b>	<b>≈ 460 overall</b>

*Table 1: Ward-level population and household data (KNBS 2019 Census).*

### Population Projections (2027 – 2050)

Population projections were computed from the 2019 baseline using compound annual growth under two scenarios:

- **Scenario A – 2.2 % p.a.** (national average);
- **Scenario B – 3.1 % p.a.** (estimated Bungoma County trend, including Kimilili).

#### Scenario A – 2.2 % Growth (National Reference)

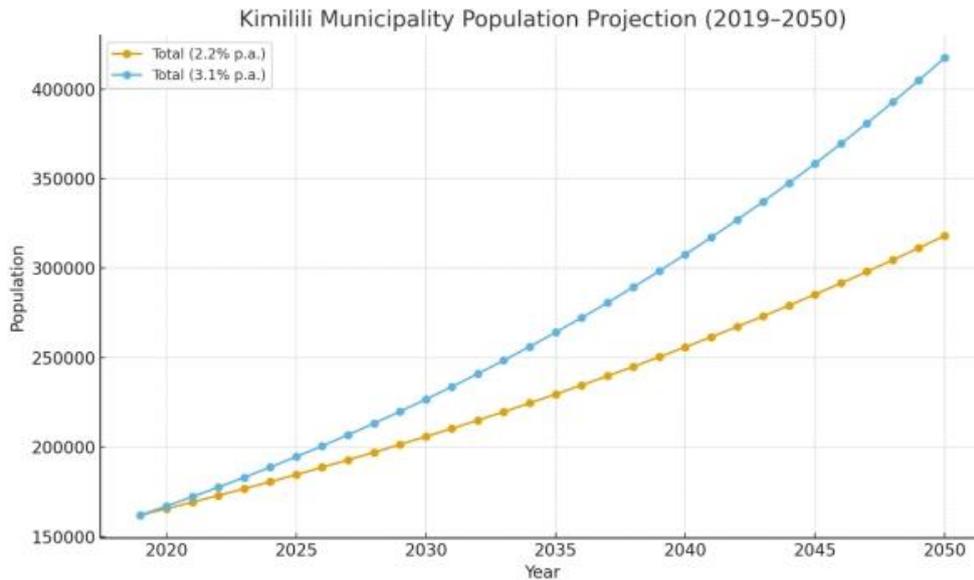
**Table 2 Scenario A – 2.2 % Growth (National Reference)**

Ward	2019	2027	2035	2050
Kimilili	44,246	52,660	62,674	86,866
Kibingei	41,858	49,818	59,292	82,178
Maeni	29,477	35,082	41,754	57,871
Kamkuywa	46,457	55,291	65,806	91,207
<b>Total</b>	<b>162,038</b>	<b>192,852</b>	<b>229,526</b>	<b>318,123</b>

#### Scenario B – 3.1 % Growth (County Higher Rate)

Ward	2019	2027	2035	2050
Kimilili	44,246	56,486	72,113	113,997
Kibingei	41,858	53,438	68,221	107,844
Maeni	29,477	37,632	48,042	75,945
Kamkuywa	46,457	59,309	75,716	119,693
<b>Total</b>	<b>162,038</b>	<b>206,865</b>	<b>264,092</b>	<b>417,480</b>

**Table 3 Projected population by ward (2019 – 2050) under two growth scenarios.**



**Figure 2 Kimilili Municipality Population Projections (2019 – 2050) under 2.2 % and 3.1 % Growth Scenarios**

### Analysis and Implications

- Even under the conservative 2.2 % scenario, Kimilili’s population is projected to expand from 162 thousand (2019) to ≈ 193 thousand by 2027, 230 thousand by 2035, and over 318 thousand by 2050.
- Under the local 3.1 % scenario, the population could reach ≈ 207 thousand (2027), 264 thousand (2035) and exceed 417 thousand by 2050.
- The youth (under 35 years) constitute more than 70 % of residents, forming a dynamic labour base yet exerting pressure on job creation and skills development.
- Rising density—especially in Kimilili and Kamukuywa wards—will heighten demand for housing, water supply, sanitation, health care, and waste management.
- Without proactive land-use control, expansion into wetlands and riparian corridors could amplify flood risk and environmental degradation.

About 72 % of households have access to protected or piped water sources managed by **Bungoma Water and Sanitation Company (BUWASCO)**, though service gaps persist in peri-urban areas.

Electricity connectivity is improving through the Rural Electrification Programme, yet firewood and charcoal remain dominant cooking fuels.

The informal sector—including trade, transport (boda boda), and small-scale processing—remains the largest employer.

Persistent unemployment and under-employment, particularly among youth and women, highlight the need for diversified green-enterprise opportunities.

#### 1.2.4. Economic Context

Kimilili Municipality’s economy is dominated by **agriculture, trade, education, and transport services**, reflecting its role as a regional market hub within Bungoma County. The fertile soils and reliable rainfall along the Mt. Elgon slopes make agriculture the backbone of local livelihoods. Smallholder farmers cultivate **maize, beans, bananas, coffee, sugarcane, and**

**vegetables**, while dairy and poultry farming supplement incomes. Agricultural produce from surrounding rural areas is channeled through Kimilili Town to markets in **Bungoma, Webuye, Eldoret, and Busia**, supporting an active trading economy.

The **informal sector** remains the primary employer, engaging more than **60 percent** of the working population in small retail, boda-boda transport, food vending, and artisanal construction. Formal employment is concentrated in **education, health, financial services, and public administration**, supported by institutions such as **Friends School Kamusinga, Kimilili Hospital**, and various government offices. Average household income is estimated at **KES 15,000 – 25,000 per month**, though this varies widely by occupation and location.

#### Indicative Employment Structure (2024 baseline)

Economic Sector	Share of Employment (%)	Key Activities
Agriculture & agro-processing	45	Crop and livestock production, milling, aggregation
Trade & informal services	25	Retail, open-air markets, boda-boda transport, repair services
Education & health	10	Schools, training institutions, hospitals, clinics
Construction & manufacturing	8	Building works, block-making, light industries
Public administration & finance	7	County offices, financial institutions
Tourism & hospitality	5	Lodging, eateries, cultural tourism
<b>Total</b>	<b>100</b>	

**Table 4 Indicative sectoral employment structure, Kimilili Municipality (2024 estimate).**

Agriculture’s dominance exposes household incomes to **climate variability**—particularly rainfall fluctuation, flooding, and prolonged dry spells. Erratic seasons often reduce yields of maize and beans, leading to income instability and food-price volatility. Meanwhile, expanding urbanization is shifting portions of the labour force toward trade, construction, and transport.

#### 1.2.4.1 Projected Economic Trends (2027 – 2050)

The local economy is expected to expand proportionally at **3–4 % annually** in real terms, provided enabling infrastructure and credit access improve. Key projections and transitions include:

Indicator	2024 Baseline	2027 Projection	2035 Projection	2050 Projection	Trend / Remarks
Agricultural share of employment	45 %	42 %	38 %	30 %	Gradual decline as urban services grow
Informal services & trade	25 %	28 %	32 %	38 %	Increasing with urban expansion
Manufacturing & construction	8 %	9 %	12 %	15 %	Growth driven by infrastructure investments
Poverty incidence (%)	46 %	42 %	35 %	25 %	Decline expected with diversification

**Table 5 Indicative economic projections for Kimilili Municipality (2024–2050).**

#### **1.2.4.2 Key Drivers and Constraints**

##### **Drivers:**

- Proximity to Mt. Elgon’s fertile catchments and cross-border trade corridors.
- Expanding education sector generating skilled youth workforce.
- County investments in roads, markets, and electrification.
- Adoption of digital and mobile-money services facilitating commerce.

##### **Constraints:**

- Low value-addition in agriculture; reliance on raw produce.
- Inadequate infrastructure, especially drainage, waste management, and industrial land.
- Limited access to finance for SMEs.
- Climate-related crop losses, flooding, and soil erosion.

#### **1.2.4.3 Resilience and Future Opportunities**

1. **Agro-industrial clustering:** Establish small agro-processing parks for coffee, maize, and dairy to stabilize farm incomes.
2. **Green enterprise development:** Promote waste-recycling, renewable-energy, and eco-tourism ventures for youth employment.
3. **Urban infrastructure investment:** Upgrade markets, roads, and drainage to support commerce and reduce losses from flooding.
4. **Financial inclusion:** Expand micro-credit and cooperative funding for women and youth groups.
5. **Skills transition:** Align vocational training with construction, ICT, and climate-smart agriculture needs.

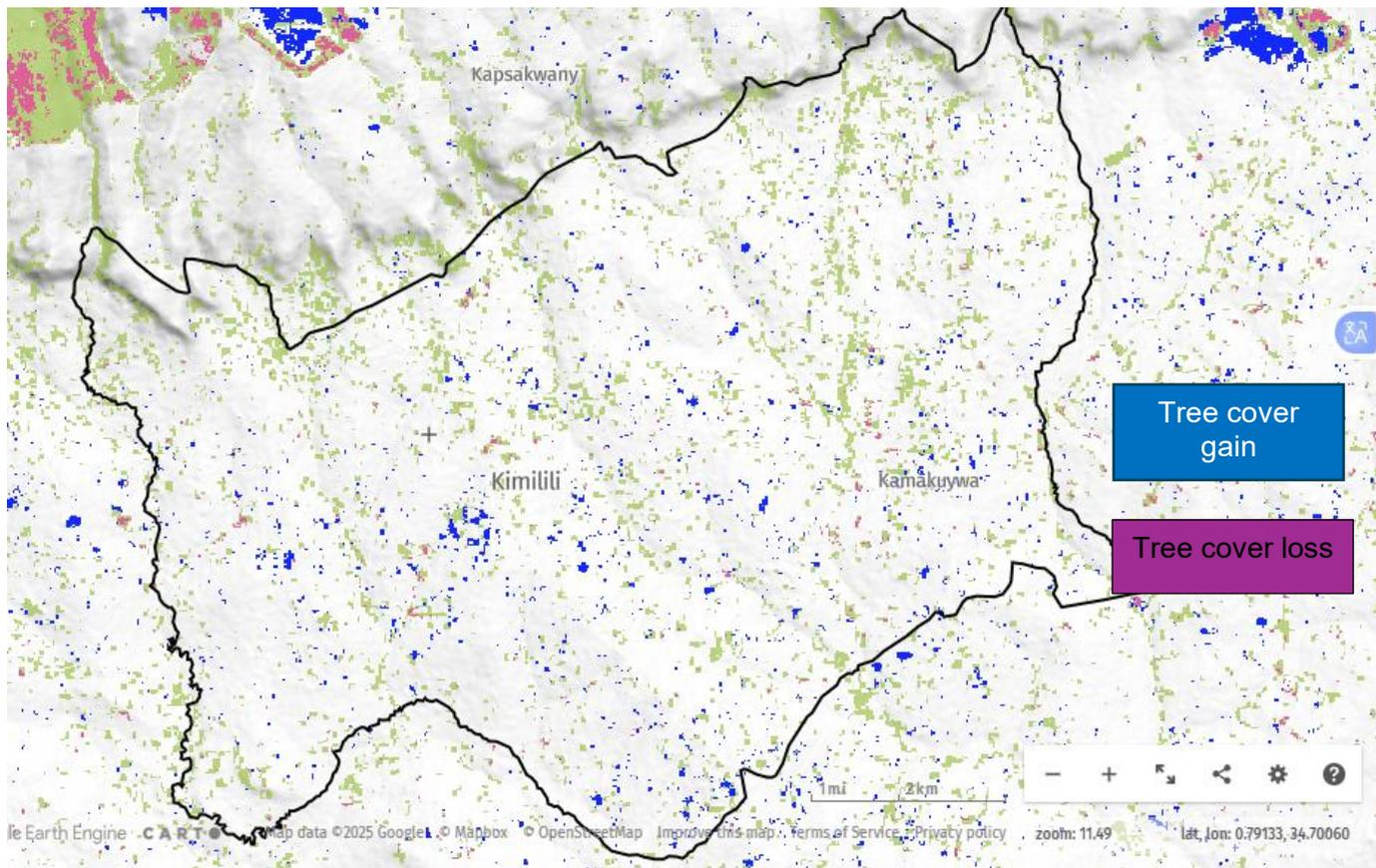
#### **1.2.5. Land-use Context**

Kimilili Municipality exhibits a mixed land-use structure dominated by **agricultural, residential, and commercial activities**, with smaller proportions of institutional and natural vegetation areas. Over the past three decades, land use in the municipality has undergone rapid transformation driven by population growth, urban expansion, and infrastructure development.

A study on peri-urban land-use changes in Kimilili (1990–2020) established that built-up area increased by approximately 16.6 %, while agricultural land declined by 16.7 % within the same period, reflecting the rapid conversion of farmland into residential and commercial. The study further noted that the municipality’s land-use categories include built-up, agricultural, dense vegetation, and bare terrain, with built-up areas concentrated around the main trading centres and along major transport corridors.

Satellite data from **Global Forest Watch (2020)** indicate that the Kimilili area had approximately **12.7 thousand hectares of land with over 10 % tree cover**, representing about **71 % of the municipality’s total area** (Global Forest Watch, 2020). However, much of

this vegetation is fragmented and under pressure from encroachment, settlement, and small-scale cultivation.



**Figure 3 map of Kimilili municipality showing land cover**

Source: global forest watch

Despite the strong agricultural base, Kimilili Municipality lacks a comprehensive local physical and land-use development plan, resulting in uncoordinated land conversion, weak zoning control, and increasing land-use conflicts (Municipality of Kimilili Development Approval Standards and Guidelines, 2022). The **Bungoma County Integrated Development Plan (CIDP 2023–2027)** also recognizes growing land-use pressure within Kimilili and highlights the need to strengthen spatial planning to manage competing demands between agriculture, housing, and commercial development.

### Estimated Land-Use Composition

Land-Use Category	Estimated Share (%)	Description / Notes
Agricultural land / cropland	45	Dominant land use historically, though declining due to urban expansion
Built-up (residential & commercial)	25	Expanding rapidly along the Kimilili–Kamakuywa corridor
Vegetation / forest / tree cover	20	Remnant green patches, riparian vegetation, and scattered forests
Institutional / public land	5	Schools, hospitals, and government installations

Bare / degraded land & open spaces	5	Quarries, undeveloped plots, and exposed soils
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**Table 6 Indicative land-use composition of Kimilili Municipality (2025, assumption-based estimate).**

These proportions are derived from literature and spatial-change trends, and should be updated through a detailed GIS analysis or the forthcoming Local Physical and Land-Use Development Plan (LPLUDP) once finalized.

### Spatial Dynamics and Drivers of Change

- **Urban sprawl:** Unplanned expansion is occurring along transport corridors and trading centres such as Kamukuywa, Kibingei, and Maeni, leading to loss of prime agricultural land.
- **Proximity influence:** A recent analysis showed that land-use type correlates strongly with distance from the central business district (CBD)—built-up uses dominate near the core, while agriculture and vegetation prevail in outer zones (AJERNet, 2022).
- **Encroachment and fragmentation:** Expansion into riparian zones and forested slopes around Mt. Elgon has intensified erosion, flooding, and biodiversity loss.
- **Weak enforcement:** Absence of local zoning maps and limited enforcement capacity have encouraged informal subdivisions and development on unsuitable terrain.
- **Land-use conflicts:** The Bungoma CIDP (2023–2027) identifies disputes arising from overlapping land rights and competition between agricultural and settlement uses as key governance challenges.

### Planning Instruments and Policy Alignment

Kimilili’s spatial development is guided by the **Bungoma County Spatial Plan**, which establishes the overarching county land-use framework (KIP, 2015–2025). At municipal level, the **Municipality of Kimilili Development Approval Standards and Guidelines (2022)** set interim planning principles for building control and environmental compliance until the Local Physical and Land-Use Development Plan (LPLUDP) is approved. The CIDP 2023–2027 commits to developing this plan to integrate land inventory, zoning, and hazard mapping for climate-resilient growth.

#### 1.3. Key Stakeholders & Inclusiveness

The preparation of this Urban Climate Risk Profile (UCRP) for Kimilili Municipality was guided by a participatory process that engaged a wide range of stakeholders from county, ward, and community levels. This inclusive approach ensured that the risk assessment was grounded in local knowledge and experience, capturing the specific realities of climate impacts observed across the four wards.

Effective participation at the lowest level—through ward committees, community-based groups, and residents’ associations—ensures that locally observed risks, such as flooding, erosion, waste mismanagement, and drought, inform municipal and county planning decisions. This multi-level governance framework aligns with Article 10 of the Constitution of Kenya (2010), the Urban Areas and Cities Act (2011), and the Climate Change Act (2016), which collectively require inclusive, participatory, and devolved decision-making in environmental and climate governance.

High	<p><b>High Influence – Low Interest</b></p> <ul style="list-style-type: none"> <li>• National Treasury and Ministry of Finance (budget allocation)</li> <li>• National Environment Management Authority (NEMA)</li> <li>• National Drought Management Authority (NDMA)</li> <li>• Kenya Meteorological Department</li> <li>• Ministry of Water, Sanitation and Irrigation</li> <li>• Kenya National Highways Authority (KeNHA)</li> <li>• World Bank, IMF and other international financiers</li> <li>• United Nations Development Programme (UNDP)</li> <li>• Other bilateral development partners</li> </ul>	<p><b>High Influence – High Interest</b></p> <ul style="list-style-type: none"> <li>• County Governor of Bungoma and County Executive Committee</li> <li>• Bungoma County Department of Environment &amp; Natural Resources</li> <li>• Bungoma County Department of Water &amp; Energy</li> <li>• Bungoma County Department of Roads &amp; Public Works</li> <li>• Bungoma County Department of Health Services</li> <li>• Kimilili Municipal Board and Municipal Manager</li> <li>• Kimilili Municipal Physical Planning Office</li> <li>• All Ward Administrators (Kimilili, Kibingei, Maeni, Kamukuywa)</li> <li>• Kimilili Sub-County Police Commander</li> <li>• Kimilili Sub-County Health Management Team</li> </ul>
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Low Influence – Low Interest	Low Influence – High Interest
<ul style="list-style-type: none"> <li>• Small and Medium Enterprise Owners</li> <li>• Private Landlords and Property Developers</li> <li>• Local Print Media and Bloggers</li> <li>• Private Insurance Companies</li> <li>• Tourism and Hospitality Service Providers</li> </ul>	<ul style="list-style-type: none"> <li>• Kimilili Central Market Traders Association</li> <li>• Boda Boda Operators Association</li> <li>• Kimilili Farmers' Cooperative Union</li> <li>• Water User Associations (River Kibisi, Kamusinga, sosio)</li> <li>• Community-Based Health Workers</li> <li>• Youth Groups and Youth Enterprise Associations</li> <li>• Women's Mercy Groups and Chamas</li> <li>• Persons with Disabilities (PWD) Representative Groups</li> <li>• Religious Leaders and Inter-Faith Council</li> <li>• School Management Committees (Primary &amp; Secondary)</li> <li>• Village Elders and Community Peace Committees</li> <li>• Residents of flood-prone areas (e.g., near River Kimilili)</li> <li>• Residents of informal settlements in all four wards</li> <li>• All household heads and tenants in Kimilili Municipality</li> </ul>
Low	High

**Figure 4 stakeholder mapping for kimilili municipality**

## 2. Hazard Assessment

The hazard assessment provides an overview of the main natural and human-induced hazards affecting Kimilili Municipality and their spatial distribution across the four wards—Kimilili, Kibingei, Kamukuywa, and Maeni. It seeks to identify and describe the key hazards that threaten lives, livelihoods, and infrastructure, forming the basis for risk profiling and resilience planning. The assessment considers both current and emerging hazards influenced by urbanization, land-use changes, and climate variability. Information was derived from existing county reports, community consultations, and municipal observations to capture the specific realities at the ward level.

### 2.1. Key Climate Hazards

**Table 7 . Hazard screening for kimilili municipality**

Hazard	Hazard Likely (Y/N)	Significant Impact (Y/N)	High Priority (Y/N)	Key Hazard (Y/N)
<b>Heat Stress</b>				
Average surface temperature increase	YES	YES	YES	YES
Average ocean temperature increase	NO	NO	NO	NO
Extreme heat	NO	NO	NO	NO
Marine heatwaves	NO	NO	NO	NO
<b>Cold Stress</b>				
Average surface temperature during winter	NO	NO	NO	NO
Extreme cold (e.g., cold spells, frost)	NO	NO	NO	NO
Snowfall and ice storms	NO	NO	NO	NO
<b>Flooding</b>				
Changes in precipitation patterns	YES	YES	NO	NO
Pluvial (surface level) flooding, including flash flooding and urban flooding	YES	YES	YES	YES
Fluvial (river) flooding	YES	YES	NO	NO
Sea level rise	NO	NO	NO	NO
Coastal flooding, including storm surges	NO	NO	NO	NO
Waterlogging	NO	NO	NO	NO
<b>Water Stress</b>				
Drought (meteorological, hydrological)	YES	YES	YES	YES
Groundwater salinization	YES	NO	NO	NO
Saline intrusion	NO	NO	NO	NO
<b>Wildfire</b>				
Wildfires & bushfires	NO	NO	NO	NO
<b>Storms</b>				
Extreme wind	NO	NO	NO	NO
Tropical cyclones	NO	NO	NO	NO
Sand and dust storms	NO	NO	NO	NO
Thunderstorms	YES	YES	YES	YES
<b>Mass Movement</b>				
Landslides	YES	NO	NO	NO
Coastal erosion	NO	NO	NO	NO
Gully erosion	NO	NO	NO	NO
<b>Marine Conditions</b>				

Hazard	Hazard Likely (Y/N)	Significant Impact (Y/N)	High Priority (Y/N)	Key Hazard (Y/N)
Ocean acidification	NO	NO	NO	NO
<b>Geophysical*</b>				
Subsidence	NO	NO	NO	NO
Earthquakes	NO	NO	NO	NO
Volcanos	NO	NO	NO	NO

## 2.2. Climate Indicators and Hazard Thresholds

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

Key Hazard	Climate indicator	Data source	Threshold		
			Low	Medium	High
Average surface temperature increase	Mean annual temperature anomaly (°C above 1991–2020 baseline)	World Bank Climate Change Knowledge Portal/KMD station data (Bungoma); /CMIP6 ensemble	< +1 °C increase	+1–2 °C	> +2 °C
Pluvial flooding	No. of rain days > 50 mm per year	World Bank Climate Change Knowledge Portal/CHIRPS gridded rainfall; RCMRD/ KMD extreme precipitation indices	<3 days/year	3 - 6 days/year	>6 days/year
Drought-meteorological	Standardized Precipitation Index (SPI-12); Rainfall deficit (%) vs means	SPEI databased bulletins; CHIRPS rainfall time series; KMD rainfall records	> -1.0	-1.0 to -1.5	<-1.5
Thunderstorms	No. of days with rain > 25 mm and/or max wind speed > 25 m/s per year	KMD convective storm reports; World Bank CCKP wind and storm indices	< 10 events per year	10–20 events	> 20 events per year

## 2.3. Current Hazard Levels and Climate Projections

### 2.3.1 Average surface temperature increase (heat)

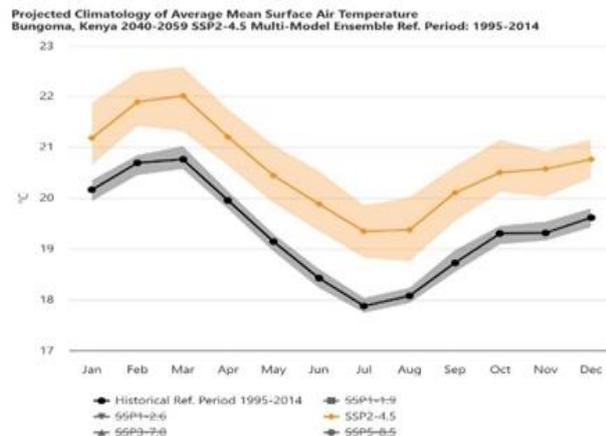
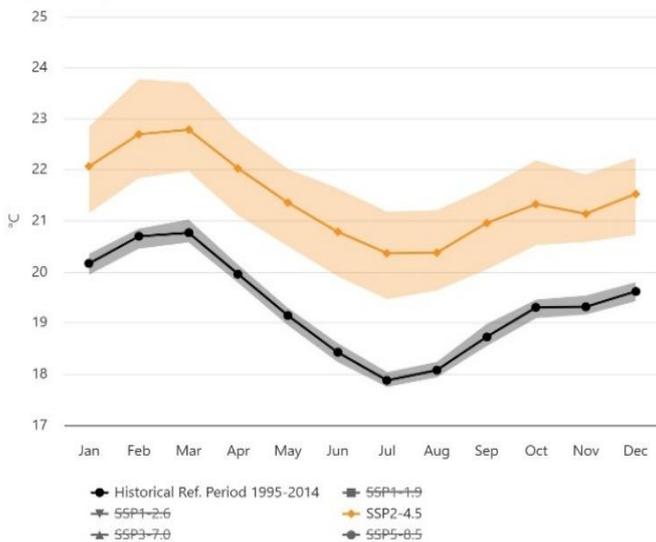
Projections from the World Bank Climate Change Knowledge Portal and CMIP6 ensemble datasets indicate continued warming under both emission pathways. Under SSP2-4.5, mean annual temperature in Kimilili Municipality is projected to increase by approximately +1.8 °C to +2.3 °C by 2050, and by about +2.5 °C to +3.0 °C by 2100 relative to the 1991–2020 baseline.

Under SSP5-8.5, projected warming is higher, reaching approximately +2.2 °C to +2.8 °C by 2050 and potentially +3.5 °C to +4.0 °C by 2100. This indicates a clear divergence between moderate and high-emission futures toward the end of the century.

Accordingly, the hazard level for average surface temperature increase is assessed as Medium under current conditions and High under future scenarios, with late-century escalation under SSP5-8.5 representing the most severe warming trajectory.

These projections show a substantial rise well above the historical average, pointing to a persistent warming trend regardless of the emission scenario. Such temperature increases are expected to intensify heat stress in urban environments, accelerate evapotranspiration, and heighten risks of drought, crop failure, and heat-related health challenges. Overall, the trend signifies a **high hazard level** for temperature increase in both the mid- and late-century horizons, underscoring the need for adaptive planning measures that promote heat-resilient infrastructure, improved urban shading, and community awareness on thermal health risks.

Projected Climatology of Average Mean Surface Air Temperature  
Bungoma, Kenya 2080-2099 SSP2-4.5 Multi-Model Ensemble Ref. Period: 1995-2014



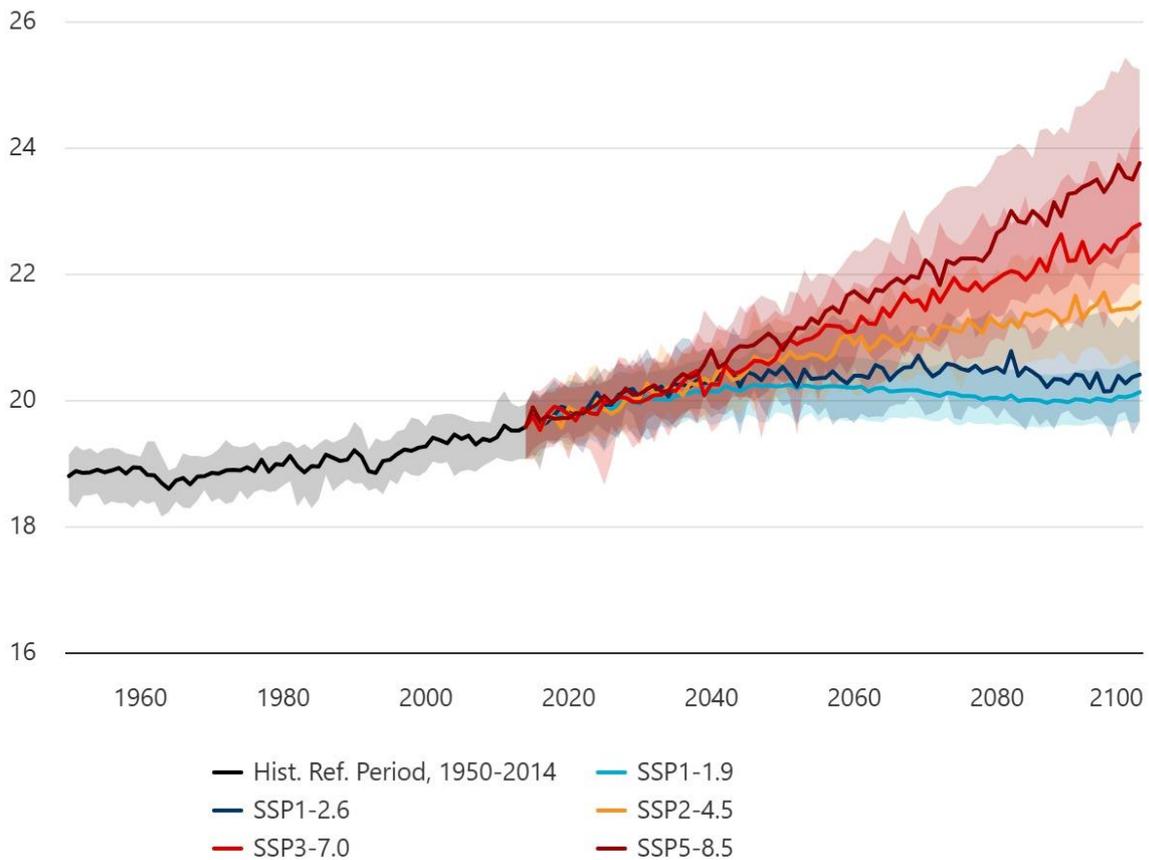
**Projected Anomaly of Average Mean Surface Air Temperature  
Bungoma, Kenya 2080-2099 SSP2-4.5 Multi-Model Ensemble Ref. Period: 1995-2014**



**Projected Anomaly of Average Mean Surface Air Temperature  
Bungoma, Kenya 2080-2099 SSP5-8.5 Multi-Model Ensemble Ref. Period: 1995-2014**



**Projected Timeseries of Average Mean Surface Air Temperature  
Bungoma, Kenya 1950-2100 Multi-Model Ensemble Ref. Period: 1995-2014**

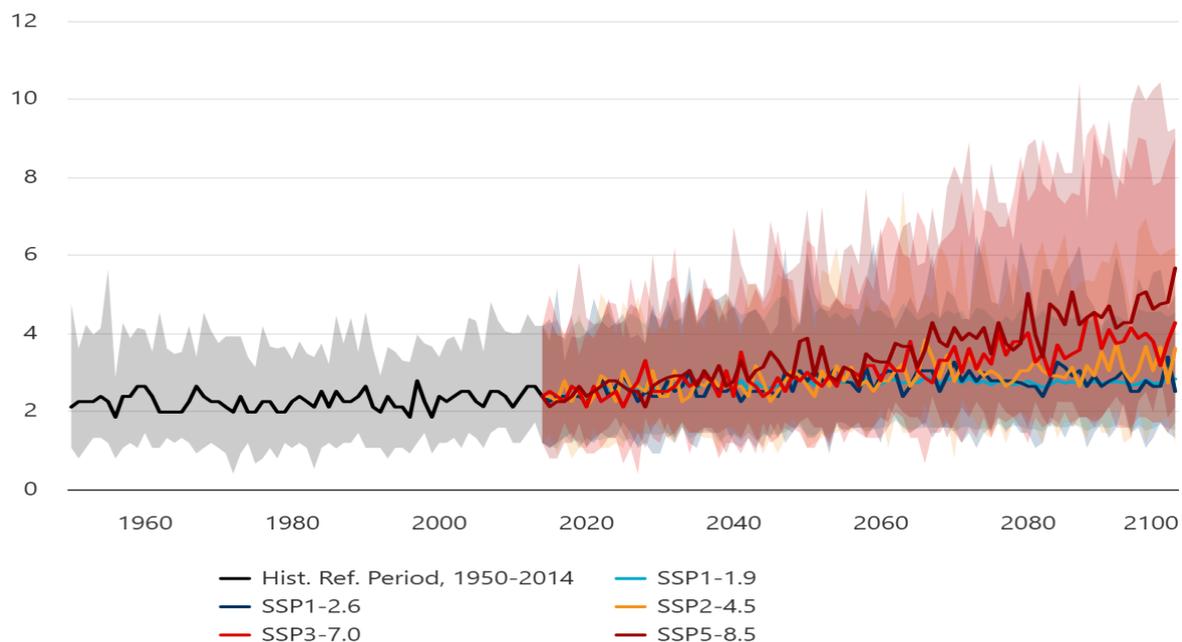


Source: World Bank Climate Change Knowledge Portal

### 2.3.2 Pluvial Flooding

Kimilili Municipality experiences occasional surface and street flooding during intense rainfall episodes, particularly in the March–May and October–December seasons. Observations from the Climate Hazards Group InfraRed Precipitation with Stations (CHIRPS, 1981–2023) and Kenya Meteorological Department records for the Bungoma region show that days exceeding **50 mm of rainfall** occur roughly **once per year** on average, though clustered storms can cause significant local runoff. Limited drainage capacity within the urban core amplifies the impacts of such short-duration downpours. Projections from the World Bank Climate Change Knowledge Portal (CMIP6 ensemble) indicate that under the **SSP2-4.5** scenario, the frequency of very heavy rainfall days in Kimilili is expected to rise to about **one day per year by 2050**, increasing to **two to three days by 2100**. Under the **SSP5-8.5** high-emission pathway, the frequency is projected at **one to two days by 2050** and **two to four days by 2100**. Although these absolute values appear small, they represent a **two- to four-fold increase** in the occurrence of extreme rainfall relative to the historical baseline. Such a relative increase corresponds to a **medium-to-high hazard level**, given the steep rise in short-duration rainfall intensity. These changes imply higher probabilities of flash floods and surface runoff, especially in low-lying and densely built-up zones of Kimilili where drainage infrastructure is limited. The combination of more intense storms, expanding impervious surfaces, and inadequate storm-water channels is likely to heighten local flood exposure. Therefore, pluvial flooding for Kimilili Municipality is assessed as **medium hazard under current conditions, rising toward high hazard** by mid- to late-century under both emission scenarios.

**Projected Timeseries of Number of Days with Precipitation >50mm  
Bungoma, Kenya 1950-2100 Multi-Model Ensemble Ref. Period: 1995-2014**



Sources: World Bank Climate Change Knowledge Portal

### 2.3.3 Meteorological Drought

Kimilili Municipality occasionally experiences prolonged dry spells that affect crop yields and water supply. Records from the National Drought Management Authority (NDMA) and the Kenya Meteorological Department show that the Bungoma region undergoes rainfall deficits

of varying intensity during some March–May and October–December seasons. Analysis of CHIRPS rainfall data (1981–2023) indicates an overall slight decline in total seasonal rainfall during several years of the past two decades, with more frequent episodes when the twelve-month Standardized Precipitation Index (SPI-12) drops below  $-1$ , signifying moderate drought conditions.

Projections from the World Bank Climate Change Knowledge Portal (CMIP6 ensemble) suggest that, under the **SSP2-4.5** pathway, rainfall variability is expected to increase modestly by 2050, producing more frequent moderate droughts (SPI  $\approx -1$  to  $-1.5$ ). Under the **SSP5-8.5** pathway, higher temperatures and evapotranspiration are projected to intensify drying conditions, increasing the likelihood of severe droughts (SPI  $< -1.5$ ) by both 2050 and 2100. While total annual rainfall may remain within historical ranges, the combination of warmer temperatures and irregular seasonal distribution implies reduced soil-moisture availability and shorter recovery periods between dry spells.

Overall, Kimilili is assessed to experience a **medium level of drought hazard under current conditions**, reflecting periodic but manageable rainfall deficits. By mid-century, hazard levels are projected to rise toward **high** under both emission scenarios, as enhanced warming accelerates water loss and extends the duration of dry periods. Strengthening local water-storage capacity, watershed protection, and climate-smart agriculture will be vital for managing future drought risk.

*Sources: National Drought Management Authority (NDMA) bulletins; CHIRPS Rainfall Dataset (1981–2023); Kenya Meteorological Department (KMD) climatological data; World Bank Climate Change Knowledge Portal (CCKP, 2025).*

### **2.3.4 Thunderstorms (convective storms; strong wind / hail)**

Thunderstorms are a recurring weather feature in Kimilili Municipality, particularly during the March–May and October–December rainfall seasons. Records from the Kenya Meteorological Department indicate that the western highlands, including Bungoma and its surrounding areas, experience between **10 and 20 thunderstorm days per year**, often accompanied by intense rainfall, lightning, and short-lived gusty winds. Although most storms are localized, some have caused damage to property, power interruptions, and soil erosion on steep slopes.

Analysis of CHIRPS rainfall data shows that episodes of very intense short-duration rainfall ( $>25$  mm per day) have slightly increased in frequency over the past two decades. This observation is supported by the Regional Centre for Mapping of Resources for Development (RCMRD) storm-risk layers, which identify Kimilili as an area of moderate to high susceptibility to convective activity due to orographic lifting along the foothills of Mount Elgon.

Future projections from the World Bank Climate Change Knowledge Portal (CMIP6 ensemble) suggest that as average surface temperatures continue to rise, atmospheric instability and moisture availability will increase, enhancing the potential for stronger convective storms. Under both the **SSP2-4.5** and **SSP5-8.5** scenarios, the frequency and intensity of heavy convective rainfall events are expected to rise gradually through mid-century and more markedly toward 2100. Although precise local wind projections remain uncertain, most models indicate an upward trend in the magnitude of extreme gusts associated with thunderstorms.

Taken together, these findings indicate that Kimilili currently faces a **medium hazard level** from thunderstorms, primarily from rainfall-induced flash flooding, lightning, and occasional structural wind damage. By mid-century, this hazard is projected to shift toward the **high category**, particularly under the higher-emission pathway, as convective energy and moisture

fluxes intensify. Continuous monitoring of severe weather events, improved early-warning systems, and storm-resilient urban infrastructure will be essential to mitigate future impacts.

Sources: Kenya Meteorological Department (KMD) severe-weather reports; CHIRPS Rainfall Dataset (1981–2023); Regional Centre for Mapping of Resources for Development (RCMRD) SERVIR storm-risk layers; World Bank Climate Change Knowledge Portal (CCKP, 2025)

**Table 9 Current and future hazards levels for kimilili municipality**

Hazard	Hazard Level				
	Current (Baseline)	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
Average surface temperature increase	Medium	High	High	High	High
Pluvial flooding	Medium	Medium	High	High	High
Meteorological drought	Medium	High	High	High	High
Thunderstorms	Medium	Medium	High	High	High

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

**Table 10 Interpretation of hazard levels**

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

## 2.4. Current and Future Hazard Impact Areas

The spatial distribution of climate hazards across Kimilili Municipality varies depending on land use patterns, topography, settlement density, and proximity to natural drainage systems. Based on the hazard screening and climate projections presented in the previous sections, four key climate hazards were identified as the most significant for the municipality: average surface temperature increase, pluvial flooding, meteorological drought (dry spells), and thunderstorms. These hazards affect different parts of the municipality with varying intensity and are expected to intensify under future climate scenarios.

Currently, pluvial flooding impacts are most pronounced within the built-up areas of Kimilili town, particularly in low-lying sections of the central business district and around major transport corridors where stormwater drainage systems are limited or frequently blocked. During periods of intense rainfall, runoff accumulates on roads, around market areas, and within residential compounds, disrupting mobility and damaging infrastructure. Peri-urban settlements experiencing rapid urban expansion are also increasingly exposed to surface flooding as natural drainage channels are modified by construction activities and increased impervious surfaces.

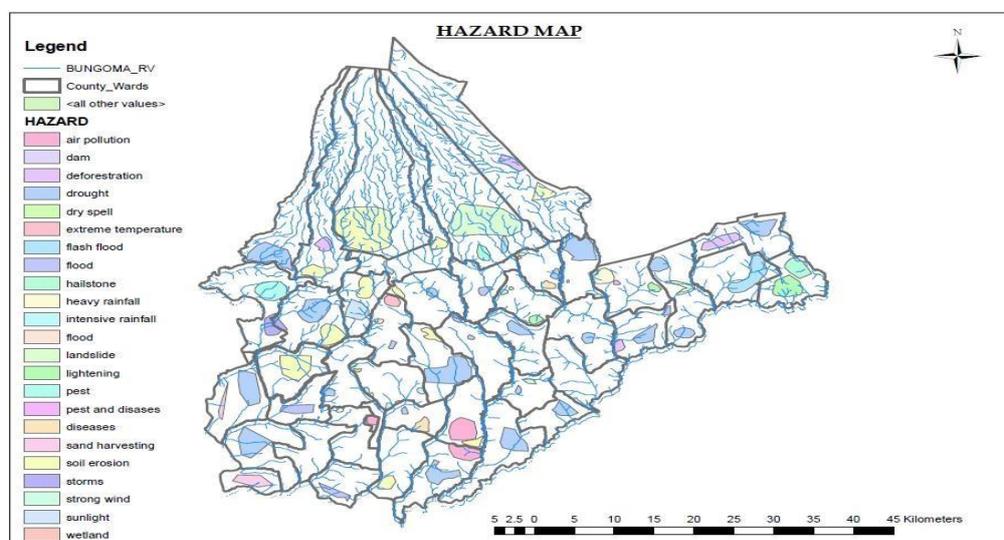
Meteorological drought and prolonged dry spells primarily affect peri-urban and agricultural areas surrounding the municipality, especially in wards where livelihoods depend heavily on rain-fed agriculture. Reduced rainfall and delayed onset of rainy seasons affect crop yields, pasture availability, and the recharge of surface and groundwater sources. As a result, agricultural productivity and water availability become increasingly vulnerable during extended dry periods.

Rising temperatures and heat stress are most evident in densely built-up urban areas, particularly within the Kimilili town centre where limited tree cover, extensive paved surfaces, and increasing building density contribute to localized warming conditions. These areas experience higher daytime temperatures compared to surrounding rural zones, affecting human comfort, increasing water demand, and placing pressure on energy and health systems.

Thunderstorms associated with intense rainfall, lightning, and strong winds affect both urban and peri-urban areas across the municipality. However, their impacts are particularly severe in locations with lightweight roofing structures, exposed electricity infrastructure, and open market areas. Strong winds may damage roofs, trees, and power lines, while lightning strikes pose risks to public safety and electrical infrastructure.

Looking into the future, climate projections indicate that the spatial extent and intensity of these hazards are likely to increase. Higher rainfall intensity may expand flooding hotspots within urbanized areas, while continued urban expansion may increase runoff and drainage pressure. Rising temperatures are expected to intensify urban heat stress, particularly in areas with limited green infrastructure. At the same time, prolonged dry spells may place additional pressure on water resources and agricultural systems surrounding the municipality.

Figure 5 illustrates the spatial distribution of key climate hazards affecting Kimilili Municipality and surrounding areas, highlighting locations that are currently exposed to drought conditions, intense rainfall events, flooding, and temperature extremes. The map provides an overview of hazard patterns that inform subsequent analysis of exposure, vulnerability, and climate risk within the municipality.



**Figure 5 hazard within Kimilili Municipality**

### 3. Exposure & Vulnerability Assessment

Kimilili Municipality hosts a rapidly growing urban population and a mix of residential, commercial, and agricultural land uses that are increasingly exposed to climate-related hazards. The municipality's compact settlement pattern, limited storm-water drainage, and expanding built-up areas heighten exposure to surface flooding and heat accumulation, while dependence on rain-fed agriculture makes surrounding communities sensitive to temperature rise and rainfall variability. Critical infrastructure such as roads, markets, health facilities, and water supply systems is also at risk from recurrent heavy rainfall, drought, and storm events. Vulnerability is further influenced by socio-economic factors including informal housing, limited adaptive capacity among low-income residents, and inadequate maintenance of urban infrastructure. Together, these elements underscore the need for integrated urban planning and climate adaptation strategies that enhance resilience of both people and assets to evolving climate risks.

#### 3.1. Urban Elements

**Table 11 Urban elements inventory**

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
<b>Infrastructure &amp; Services</b>				
Stormwater Drainage	Stormwater drainage conveyance network	yes	No	Open roadside drains and culverts concentrated in Kimilili CBD and along Bungoma–Kitale road corridor; limited coverage in residential areas. System prone to blockages, siltation, and overflow during heavy rainfall events. No comprehensive GIS mapping available.
	Stormwater storage	No	No	n/a
Water & Wastewater Management	Pumping stations	No	No	n/a
	Groundwater abstraction	Yes	No	Numerous boreholes and shallow wells exist in peri-urban areas (e.g., Maeni, Kibingei and Kamukuywa wards), used for domestic and institutional supply. Mostly privately operated; data on yield limited.

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Water treatment facilities	Yes	Yes	Kimilili Water Treatment Plant, located ~3 km from town along River Kibisi, operated by BWASCO; supplies treated water to Kimilili and neighboring areas. Plant expanded to 5,000 m <sup>3</sup> /day under LVNWWDA project (2023).
	Water supply networks	Yes	Yes	Piped system serves CBD, Maeni, and Kibingei; gaps in peri-urban wards. Breakages and pipe bursts occur during floods; reduced pressure during dry spells
	Sewer networks	NO	NO	N/A
	Wastewater treatment facilities	NO	NO	N/A
Solid Waste Management	Transfer facilities	NO	NO	N/A
	Landfills and dump sites	NO	NO	N/A
	Recycling centers	NO	NO	N/A
	Collection fleet	Yes	NO	Municipal trucks and several handcarts handle solid waste collection; irregular service frequency due to limited capacity and funding. flooded roads and storms disrupt collection schedules.
Transport and Mobility	Road networks	YES	YES	Paved and unpaved roads in OSM / county datasets; mapped under local GIS initiatives. feeder roads often impassable in heavy rainfall and eroded by runoff. Heat stress accelerates asphalt wear.
	Bridges	YES	YES	Bridges over seasonal streams; structural locations available in regional hydro/topographic GIS layers. often overtopped or scoured by floods and thunderstorm runoff.
	Public transport networks (rail, bus, mini-bus, etc.)	YES	NO	Matatu and boda boda routes across the municipality; not formally mapped

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Transportation terminals	YES	NO	main matatu terminus in CBD; small informal staging areas in wards.
	Vehicle depots	NO	NO	N/A
	Non-motorized transport networks	NO	NO	N/A
	Freight and logistics hubs	NO	NO	N/A
Energy	Energy power plants	NO	NO	
	Poles and power lines	YES	YES	Overhead lines mapped in utility GIS layers; service network present across town.
	Transformers and substations	YES	YES	Local substations (small) serve core sectors; location known in utility records
	Streetlighting	YES	NO	Streetlights installed along main roads and town centre; intermittent outages and coverage gaps in residential zones
Economic Infrastructure	Markets	YES	YES	Central Market and satellite markets; commonly flooded in heavy rainfall events.
	Businesses and commercial hubs	YES	NO	Retail and service hubs in town centre; limited GIS data publicly available.
	Industrial zones/parks and logistics parks	NO	NO	n/a
Social Infrastructure	Government buildings and service centers	YES	YES	Municipal offices and wards, likely present in public facilities GIS data.
	Education facilities	YES	YES	Locations of primary, secondary schools known in county educational GIS record.
	Healthcare facilities	YES	YES	Hospital and clinics mapped in health sector GIS datasets
	Public spaces	YES	NO	Markets, sports fields, open gathering areas.
	Faith-based buildings	YES	NO	Mosques, churches widely present across town.
	Cultural and heritage assets	YES	NO	Community grounds and cultural venues.
Emergency Services	Fire stations	NO	NO	N/A
	Police stations	YES	YES	Main police station and posts; GIS points likely in law enforcement datasets.

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Telecommunications networks	YES	YES	Mobile towers and network nodes mapped in telecom GIS coverage datasets
	Early warning systems	NO	NO	N/A
	Disaster management centers and shelters	NO	NO	N/A
	Evacuation routes	NO	NO	N/A
<b>Populations</b>				
Urban Residents	Population	YES	YES	~96,000 residents (KNBS 2019); spatial distribution in WorldPop / census GIS.
	Households	YES	YES	Household counts per ward available in census GIS layers
Informal Settlement Residents	Population living in informal settlements	YES	NO	Clusters of unplanned housing lacking drainage and tenure, especially in peri-urban wards.
	Households lacking land tenure	YES	NO	Many informal settlement residences without formal title deeds.
	Households / residents lacking access to basic services	YES	YES	Peri-urban clusters experience deficits in water, sanitation, waste services
Vulnerable and Marginalized Groups	Low-income households	YES	YES	Large share of informal sector workers and low-income families
	Women-headed households	YES	NO	Present, underserved in infrastructure and services
	Children and youth	YES	NO	Significant share of population; sensitive to climate disruption
	Elderly persons	YES	NO	Present, with mobility and heat sensitivity
	People with disabilities (PWD)	YES	NO	Present; access constraints in infrastructure and services
	Homeless populations	YES	NO	Small but visible; exposed to weather extremes.
	Unemployed or precariously employed workers	YES	NO	Many depend on informal economy; sensitive to shocks.
	Seasonal workers / migrant laborers	YES	NO	Present in farming and trade cycles.
	Nomadic groups in peri-urban areas	NO	NO	N/A
Urban refugees and migrants	NO	NO	N/A	

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Minority ethnic groups in urban areas	YES	NO	Small minority populations present; sometimes marginalized in service access
<b>Natural Assets</b>				
Urban Green Infrastructure	Urban parks and gardens	NO	NO	Small city parks and garden patches within town; limited spatial layers.
	Green corridors	YES	YES	Some tree-lined road verges and riparian strips; partial mapping in land-cover GIS
	Street landscaping	YES	YES	Scattered roadside trees and landscaping in major roads. occasionally uprooted by <b>thunderstorms</b>
	Urban forests and forest reserves	YES	YES	Small forest patches near Mt Elgon foothills; mapped in RCMRD / land cover GIS. buffer <b>flooding</b> and <b>heat</b> , risk of degradation from <b>drought</b> .
Urban Blue Infrastructure	Natural wetlands	YES	YES	Seasonal wetlands mapped in regional water-land cover datasets.
	Rivers	YES	YES	All rivers within the municipality and tributaries mapped in hydrographic datasets. overflow during <b>floods</b> , water scarcity in <b>dry seasons</b> .
	Riparian zones	YES	YES	Buffer strips along rivers; partially mapped in landcover GIS. Provide buffer against <b>flooding</b> but face encroachment and erosion after <b>storms</b> .
	Lakes, ponds and reservoirs	NO	NO	N/A
	Coastal ecosystems	NO	NO	N/A
	Urban agriculture	YES	YES	Smallholder farms, informal gardens in peri-urban zones; visible in high-resolution imagery / land-use GIS. crops affected by <b>heat</b> , <b>drought</b> , and <b>flash floods</b> .

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
Peri-urban and Agricultural Systems	Peri-urban agriculture	YES	YES	Farms surrounding town boundary; important livelihood zone; mapped in regional agricultural GIS; yield loss from <b>drought</b> and <b>flooding</b> .
	Agroforestry systems	YES	NO	Some local tree-farming integrations; not yet mapped. trees suffer from <b>heat stress</b> and <b>wind damage</b> .
	Forests and forest reserves	NO	NO	N/A
	Protected areas and national parks	NO	NO	N/A
	Savannahs and rangelands	NO	NO	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 12 Interpretation of exposure and vulnerability levels**

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

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

**Table 13 Impact Matrix**

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

**Table 14 Exposure, Vulnerability, and Impacts of Average surface temperature increase on Urban Elements**

**Hazard:** Average surface temperature increase

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
<b>Infrastructure &amp; Services</b>					
Stormwater Drainage	<ul style="list-style-type: none"> <li>Stormwater drainage infrastructure is distributed across built-up urban areas where impervious surfaces intensify heat retention.</li> <li>Drainage corridors located within densely developed zones experience elevated surface temperatures due to limited tree cover.</li> <li>Open channels and roadside drains are directly exposed to ambient air temperature fluctuations and prolonged dry conditions.</li> <li>Urban expansion into low-vegetation zones increases the proportion of drainage infrastructure exposed to elevated thermal stress.</li> </ul>	Medium	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>Shallow, unlined drains lose functionality quickly under desiccation and sediment build-up.</li> <li>Poor shading and absence of vegetation increase local surface heating.</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>Maintenance possible but unscheduled; no heat-resilient materials in use.</li> <li>Limited greening along drainage rights-of-way to moderate surface temperature.</li> </ul>	High	Major

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Water & Wastewater Management	<ul style="list-style-type: none"> <li>Water supply infrastructure, including reservoirs, treatment plants, and distribution networks, is located within areas subject to rising ambient temperatures.</li> <li>Surface water sources and shallow groundwater systems are directly exposed to prolonged heat conditions.</li> <li>Open storage facilities and above-ground infrastructure are exposed to direct solar radiation.</li> <li>Water abstraction systems dependent on river flow are exposed to temperature-driven hydrological changes.</li> </ul>	High	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>Strong dependence on surface water; system vulnerable to decline in base flow.</li> <li>Increased evaporation from open reservoirs reduces supply.</li> <li>Distribution networks lose efficiency as PVC pipes deform under sustained heat.</li> <li>Reduced river flow lowers intake volumes for treatment operations.</li> <li>Concentrated pollutants increase treatment costs and health risks.</li> <li>Shallow wells and boreholes show declining recharge during extended dry seasons.</li> <li>Plastic components soften and leak under prolonged high temperature exposure.</li> <li>Groundwater abstraction becomes unsustainable without recharge.</li> </ul>	High	Catastrophic
			<p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>Limited storage and no advanced demand management systems.</li> <li>Utility lacks real-time monitoring; no formal water conservation strategy.</li> <li>Rainwater harvesting adoption remains informal and small-scale.</li> </ul>		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Solid Waste Management	<ul style="list-style-type: none"> <li>• Solid waste facilities, collection points, and disposal sites are located within built-up areas subject to rising ambient temperatures.</li> <li>• Open dumping areas and transfer stations are directly exposed to prolonged heat and solar radiation.</li> <li>• Informal waste handling areas within densely populated neighborhoods experience elevated surface temperatures.</li> </ul>	Medium	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>• Waste decomposition accelerates under high temperatures, increasing odor and vector breeding.</li> <li>• Heat increases the risk of spontaneous fires at dumpsites and accelerates leachate generation.</li> <li>• Plastic waste softens and adheres to drainage channels, compounding blockage issues.</li> <li>• Open dumping and lack of shading make waste infrastructure thermally exposed.</li> <li>• Waste burning practices worsen air-quality and health burdens.</li> </ul>	Medium	Moderate
			<p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>• No heat-tolerant containment systems or protective equipment for workers.</li> <li>• Weak regulation of open burning and emissions control.</li> <li>• Community clean-up drives provide modest but irregular mitigation support.</li> </ul>		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Transport and Mobility	<ul style="list-style-type: none"> <li>The road network and transport corridors are distributed across built-up urban areas experiencing rising surface temperatures.</li> <li>High-traffic zones in Kimilili Town and surrounding trading centres are located in areas with limited tree cover and significant heat retention.</li> <li>Pedestrian pathways and public transport nodes are situated within densely developed zones exposed to elevated ambient temperatures.</li> </ul>	High	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>Asphalt surfaces soften and rut during prolonged high-temperature periods.</li> <li>Dust generation from dry unpaved roads increases respiratory issues and traffic risk.</li> <li>Pedestrian comfort drops sharply in unshaded sections.</li> <li>Tyre and engine failures rise under heat, affecting mobility and delivery reliability.</li> <li>Public transport waiting areas lack shelter, reducing usability.</li> <li>High proportion of murrum and bituminous roads without heat-resistant materials.</li> <li>Pedestrian zones poorly shaded, increasing heat stress exposure.</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>Limited road design adaptation; maintenance reactive.</li> <li>County pilot tree-planting provides partial shading but not scaled.</li> <li>No urban design guidelines addressing thermal comfort</li> </ul>	High	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Energy	<ul style="list-style-type: none"> <li>Electricity distribution infrastructure, including overhead lines, substations, and transformers, is distributed across built-up urban areas experiencing rising ambient temperatures.</li> <li>Above-ground grid components are directly exposed to prolonged solar radiation and heat stress.</li> <li>Energy infrastructure located within dense commercial and residential zones is subject to elevated surface temperature conditions.</li> </ul>	Medium	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>Power demand for cooling increases substantially, straining supply capacity.</li> <li>Overhead lines sag and transformers overheat under sustained high temperatures.</li> <li>Street-lighting poles and cables experience thermal expansion and material fatigue.</li> <li>Substations without adequate ventilation overheat, reducing equipment lifespan.</li> <li>Ageing grid infrastructure and limited redundancy exacerbate thermal stress.</li> <li>Few heat-resistant materials are currently installed.</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>Maintenance limited to reactive repairs; minimal preventive thermal monitoring.</li> <li>Renewable mini-grid options under exploration but not yet implemented.</li> </ul>	Medium	Moderate

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Economic Infrastructure	<ul style="list-style-type: none"> <li>Markets, retail centres, workshops, and informal trading areas are located within densely built-up urban zones exposed to rising ambient temperatures.</li> <li>Open-air markets and roadside stalls operate in areas with limited tree cover and high surface heat accumulation.</li> <li>Commercial structures constructed with lightweight materials are situated in heat-retentive environments.</li> </ul>	Medium	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>Open-air markets and informal stalls experience increased produce spoilage under high temperatures.</li> <li>Productivity declines in workshops and retail spaces lacking cooling.</li> <li>Structural materials deform or fade under prolonged heat exposure.</li> <li>Revenue losses rise due to reduced trading hours during extreme heat.</li> <li>Temporary structures with metallic roofing intensify internal heat load.</li> <li>Food spoilage increases operational costs.</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>Traders have low capital to retrofit shading or cooling.</li> <li>County market-upgrade projects include some roofing but lack passive-cooling design.</li> </ul>	Medium	Moderate

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Social Infrastructure	<ul style="list-style-type: none"> <li>Schools, health facilities, and public buildings are located within densely developed urban areas experiencing elevated temperatures.</li> <li>Many public facilities are situated in zones with limited green cover and high surface heat retention.</li> <li>Social infrastructure buildings are directly exposed to prolonged high ambient temperatures.</li> </ul>	High	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>Classrooms and clinics overheat during prolonged high-temperature periods.</li> <li>Medicine storage and laboratory operations are affected by fluctuating indoor temperatures.</li> <li>Public buildings without insulation or ventilation trap heat.</li> <li>Health facility staff and patients experience dehydration and fatigue.</li> <li>Buildings constructed with iron sheets and poor ventilation amplify internal temperatures.</li> <li>Thermal stress disproportionately affects vulnerable users such as patients and children.</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>Minimal investment in cooling systems; reliance on natural ventilation.</li> <li>Ongoing facility improvement programmes not yet climate-proofed.</li> <li>Limited awareness on passive-cooling design among local contractors.</li> </ul>	Medium	Major

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Emergency Services	<ul style="list-style-type: none"> <li>Emergency service buildings such as police stations, and health centers lack adequate insulation and natural ventilation, exposing staff and equipment to high indoor temperatures.</li> <li>Vehicles and machinery parked in open areas absorb excessive heat, reducing efficiency and increasing fuel consumption.</li> <li>Unshaded outdoor work areas and long exposure during rescue operations put staff at risk of heat exhaustion.</li> <li>Sensitive electronics like communication devices, radios, and control panels are prone to overheating, causing operational delays.</li> <li>Power outages caused by high energy demand during heatwaves further affect coordination and data systems.</li> </ul>	Medium	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>Health facilities experience higher patient loads due to heat-related illnesses, stretching emergency capacity.</li> <li>High indoor temperatures in emergency command rooms affect concentration, decision-making, and response efficiency.</li> <li>Increased use of cooling equipment raises operational costs and energy dependency, straining limited budgets.</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>Emergency services can adapt through installation of passive cooling systems (vents, reflective roofs, and shaded windows).</li> <li>Use of solar panels with battery backup reduces power disruptions during heat-related blackouts.</li> <li>Provision of heat-protective uniforms, hydration stations, and scheduled rest breaks improves staff resilience.</li> <li>Tree planting and creation of shaded parking areas can reduce ambient heat around facilities.</li> <li>Long-term capacity could be strengthened by constructing climate-smart emergency centers with natural ventilation and green roofing.</li> <li>However, current budget limitations and lack of climate design standards constrain adaptation efforts</li> </ul>	Medium	Moderate
<b>Populations</b>					

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Urban Residents	<ul style="list-style-type: none"> <li>Urban households are located within densely built-up zones experiencing elevated surface temperatures and reduced nighttime cooling.</li> <li>Residential areas with limited tree cover and high impervious surface concentration are directly exposed to rising ambient temperatures.</li> <li>High-density neighborhoods are situated within urban heat accumulation zones.</li> </ul>	High	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>Poor housing design and materials (corrugated metal, uninsulated walls) trap heat.</li> <li>Overcrowding intensifies indoor exposure.</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>Few affordable cooling options; intermittent electricity supply.</li> <li>Community shade trees and ventilation improvements modest but growing.</li> </ul>	Medium	Major
Informal Settlement Residents	<ul style="list-style-type: none"> <li>Informal settlements are located in densely built areas with limited vegetation and high surface heat retention.</li> <li>Informal housing clusters are directly exposed to prolonged high ambient temperatures and limited airflow conditions.</li> <li>Many informal dwellings are situated in compact layouts that intensify heat accumulation.</li> </ul>	High	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>Informal structures built from highly conductive materials; minimal insulation.</li> <li>Scarce green or open spaces limit cooling.</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>Very limited resources for retrofitting or cooling.</li> <li>Community coping strategies include night-time work and shared shade spaces, insufficient for prolonged heat events.</li> </ul>	High	Catastrophic
Vulnerable and Marginalized Groups	<ul style="list-style-type: none"> <li>Vulnerable groups reside and work within urban areas exposed to rising temperatures and prolonged heat periods.</li> </ul>	High	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>Health conditions amplify heat vulnerability; limited mobility hinders avoidance.</li> <li>Economic constraints reduce capacity to modify dwellings</li> </ul>	High	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	<ul style="list-style-type: none"> <li>Many elderly persons, persons with disabilities, and low-income households live in high-density zones with limited cooling infrastructure.</li> <li>Outdoor workers and informal vendors operate in open environments directly exposed to solar radiation.</li> </ul>		<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Weak social protection for heat-wave periods.</li> <li>Limited community health outreach on heat-risk awareness.</li> <li>No dedicated cooling shelters or emergency alerts.</li> </ul>		
<b>Natural Assets</b>					
Urban Green Infrastructure	<ul style="list-style-type: none"> <li>Urban green spaces, parks, roadside trees, and landscaped areas are distributed within zones experiencing elevated surface temperatures.</li> <li>Public green infrastructure is located in built-up areas with increasing heat stress and limited irrigation support.</li> </ul>	medium	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Limited irrigation or maintenance for public green areas.</li> <li>Heat-tolerant species not yet mainstreamed.</li> </ul> <b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Community greening projects offer localized mitigation.</li> <li>County greening programme planned but funding constrained.</li> </ul>	High	Major
Urban Blue Infrastructure	<ul style="list-style-type: none"> <li>Rivers, wetlands, and riparian corridors within the municipality are located in areas subject to rising temperatures and prolonged dry periods.</li> <li>Shallow water bodies and wetlands are directly exposed to increased evaporation under elevated heat conditions.</li> </ul>	Medium	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Shallow wetlands highly susceptible to desiccation.</li> <li>Pollutant concentrations rise as dilution capacity falls.</li> </ul> <b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>No active restoration programme; natural regeneration slow.</li> <li>Some community water-source protection initiatives under implementation.</li> </ul>	Medium	Moderate

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Peri-urban and Agricultural Systems	<ul style="list-style-type: none"> <li>• Peri-urban agricultural lands and livestock systems are located in open environments directly exposed to elevated temperatures and prolonged dry conditions.</li> <li>• Rain-fed farming areas lack shading and are spatially exposed to heat accumulation across cultivated fields.</li> </ul>	High	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>• Predominantly rain-fed systems with low shading and poor moisture retention.</li> <li>• Limited diversification into heat-resilient crops.</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>• Farmer training and extension limited; irrigation coverage minimal.</li> <li>• Some pilot conservation-agriculture projects underway but not scaled.</li> </ul>	High	Catastrophic

**Table 15 Exposure, Vulnerability, and Impacts of pluvial flooding on Urban Elements**

**Hazard:** pluvial flooding

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
<b>Infrastructure &amp; Services</b>					
Stormwater Drainage	<ul style="list-style-type: none"> <li>Stormwater drainage infrastructure is located within low-lying residential and commercial areas prone to intense surface runoff during heavy rainfall.</li> <li>Primary and secondary drainage channels pass through densely built urban zones with high impervious surface coverage.</li> <li>Flat topography in sections of the town center slows runoff, increasing exposure to surface ponding and localized flooding.</li> <li>Drainage corridors intersect major roads and trading areas, placing critical infrastructure within flood pathways.</li> <li>Rapid urban expansion has increased runoff volumes without proportional drainage capacity upgrades.</li> </ul>	High	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Many drainage channels are unlined or partially lined, making them vulnerable to erosion and structural failure during peak flows.</li> <li>Several culverts and roadside drains are undersized relative to current runoff volumes.</li> <li>Absence of engineered retention structures such as detention ponds increases overflow risk.</li> <li>Encroachment and solid waste blockage reduce hydraulic efficiency.</li> <li>Low channel gradients in some areas increase backflow and prolonged water stagnation.</li> </ul>	High	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Preventive maintenance is irregular and largely reactive.</li> <li>Limited funding and technical equipment for drainage rehabilitation and expansion.</li> <li>No formal stormwater management master plan guiding systematic upgrades.</li> <li>Absence of localized flood early-warning systems.</li> <li>Community drain-clearing efforts occur but lack coordination and technical support.</li> </ul>		
Water & Wastewater Management	<ul style="list-style-type: none"> <li>Water treatment facilities, pumping stations, and storage tanks are located in low-lying areas exposed to surface flooding during intense rainfall events.</li> <li>Shallow wells and boreholes are situated within residential zones prone to stormwater accumulation.</li> <li>Sewer networks traverse densely populated areas where heavy runoff increases inflow and infiltration.</li> <li>Some wastewater infrastructure lies near natural drainage channels and flood-prone corridors.</li> <li>Critical water infrastructure is distributed across urban areas without full flood zoning controls.</li> </ul>	High	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Shallow wells and open water storage systems are highly susceptible to contamination during flood events.</li> <li>Mixed or aging stormwater and wastewater networks increase risk of cross-contamination during peak flows.</li> <li>Sewer systems experience overloading due to inflow and infiltration during heavy rainfall.</li> <li>Pumping stations and treatment units positioned at low elevation are vulnerable to inundation.</li> <li>Manholes and inspection chambers lack adequate sealing against floodwater intrusion.</li> </ul>	High	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			<p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>• Limited flood-proofing measures such as raised platforms, bund walls, or protective barriers around facilities.</li> <li>• Emergency pumping capacity and backup power systems are insufficient during severe storm events.</li> <li>• Maintenance and inspection are largely reactive rather than preventive.</li> <li>• No integrated flood risk mapping guiding placement or upgrading of water infrastructure.</li> <li>• Emergency response coordination exists but lacks equipment and rapid deployment systems.</li> </ul>		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Solid Waste Management	<ul style="list-style-type: none"> <li>• Solid waste collection points and temporary storage areas are located within low-lying urban zones exposed to surface flooding during heavy rainfall.</li> <li>• Open dumping sites are situated near drainage channels and natural runoff pathways.</li> <li>• Waste transfer areas and informal disposal points are distributed across densely populated neighborhoods prone to stormwater accumulation.</li> <li>• Waste collection routes pass through flood-prone roads that become waterlogged during intense rainfall events.</li> <li>• Absence of engineered landfill facilities increases exposure of waste materials to direct floodwater contact.</li> </ul>	High	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>• Waste disposal is predominantly open-air, making it highly susceptible to wash-off and leachate spread during floods.</li> <li>• Solid waste frequently blocks culverts and drainage channels, intensifying localized flooding.</li> <li>• Temporary storage yards lack containment systems to prevent waste dispersal.</li> <li>• Collection vehicles are unable to access flooded areas, delaying removal and increasing accumulation.</li> <li>• Organic waste decomposition accelerates under waterlogged conditions, increasing health and environmental risks</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>• Limited heavy machinery and personnel for emergency waste clearance after flood events.</li> <li>• Weak coordination between drainage and waste management departments.</li> <li>• Absence of engineered landfill or flood-proof containment infrastructure.</li> <li>• Emergency response is largely reactive, with no structured pre-rainfall waste clearance program.</li> <li>• Community clean-up initiatives occur but lack sustained technical and financial support.</li> </ul>	Medium	Major

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Transport and Mobility	<ul style="list-style-type: none"> <li>Major town roads and access routes are located in low-lying built-up areas prone to surface runoff accumulation during heavy rainfall.</li> <li>Sections of the road network intersect natural drainage paths and seasonal water channels.</li> <li>High-traffic corridors within Kimilili Town and Kamukuywa Market are directly exposed to intense rainfall events.</li> <li>Several feeder roads serving residential and peri-urban areas traverse poorly drained zones.</li> <li>Pedestrian walkways and informal access paths are situated in areas without formal stormwater control systems.</li> </ul>	High	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>Road surfaces are susceptible to erosion and pothole formation during heavy rainfall.</li> <li>Some culverts and drainage crossings have limited hydraulic capacity.</li> <li>Informal roadside developments obstruct natural drainage pathways.</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>Road maintenance is mostly reactive rather than preventive.</li> <li>Limited incorporation of climate-resilient road design standards.</li> <li>Budget constraints delay timely rehabilitation of damaged road sections.</li> </ul>	Medium	Major
Energy	<ul style="list-style-type: none"> <li>Electricity substations, transformers, and distribution lines are located within urban zones exposed to surface flooding during heavy rainfall events.</li> <li>Some power infrastructure is situated in low-lying or poorly drained areas susceptible to stormwater accumulation.</li> <li>Overhead transmission lines cross flood-prone corridors and drainage pathways.</li> <li>Electrical distribution equipment is installed at ground level in certain commercial and residential zones.</li> </ul>	Medium	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>Floodwater ingress into substations and transformers can cause short-circuiting and equipment damage.</li> <li>Pole foundations may weaken due to soil erosion and prolonged waterlogging.</li> <li>Electrical components in older systems lack adequate waterproofing.</li> <li>Power outages during storms disrupt pumping, lighting, and communication services.</li> <li>Repair works are delayed when access roads become flooded.</li> </ul>	Medium	Moderate

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	<ul style="list-style-type: none"> <li>Energy supply systems are spatially interconnected with other infrastructure exposed to flooding, such as roads and water facilities.</li> </ul>		<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Kenya Power conducts periodic inspections, but localized flood-risk mapping is limited.</li> <li>Some redundancy exists within the grid, reducing prolonged outage risk.</li> <li>Emergency response protocols are moderately effective but constrained by access limitations.</li> <li>Limited investment in elevating or flood-proofing vulnerable substations.</li> <li>Backup systems are not uniformly available across all facilities</li> </ul>		
Economic Infrastructure	<ul style="list-style-type: none"> <li>Markets, trading centers, and informal stalls are located in low-lying commercial zones exposed to surface runoff during heavy rainfall.</li> <li>Many informal trading areas are situated along streets lacking adequate stormwater drainage.</li> <li>Commercial buildings are concentrated in the central business district where impervious surfaces increase runoff accumulation.</li> <li>Small-scale workshops and storage facilities are positioned near drainage lines and flood-prone corridors.</li> </ul>	High	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Many market structures are temporary or semi-permanent with low floor elevation.</li> <li>Informal stalls lack flood barriers or raised platforms to protect goods.</li> <li>Perishable goods are highly susceptible to water damage and spoilage.</li> <li>Drainage around commercial premises is often inadequate or blocked by solid waste.</li> <li>Business operations depend on uninterrupted access and electricity, which are disrupted during flooding.</li> </ul>	High	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	<ul style="list-style-type: none"> <li>Economic activity hubs are interconnected by roads that frequently experience waterlogging during intense storms.</li> </ul>		<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Small-scale traders have limited financial reserves to recover from flood losses.</li> <li>Insurance coverage among informal traders is minimal or absent.</li> <li>Community-level clean-up initiatives provide temporary recovery but lack structured support.</li> <li>Drainage improvement projects are ongoing in some market precincts but remain incomplete.</li> <li>No formal flood risk reduction strategy specifically targeting commercial zones.</li> </ul>		
Social Infrastructure	<ul style="list-style-type: none"> <li>Schools, health facilities, and public buildings are located within urban zones exposed to surface flooding during intense rainfall events.</li> <li>Several social facilities are situated in low-elevation or poorly drained neighborhoods.</li> <li>Access roads serving schools and clinics pass through flood-prone corridors.</li> <li>Sanitation facilities within public institutions are connected to drainage systems vulnerable to overflow.</li> <li>Some community centers and public offices are positioned near natural runoff pathways.</li> </ul>	Medium	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Many buildings lack elevated entryways or flood-resistant structural design.</li> <li>Internal drainage systems are inadequate to prevent water ingress during heavy rainfall.</li> <li>Sanitation systems are vulnerable to backflow and overflow during flood events.</li> <li>Educational and health equipment stored at ground level is susceptible to water damage.</li> <li>Service delivery depends on road access, which is frequently disrupted by flooding.</li> </ul>	High	Major

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			<p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>• Institutional budgets for flood-proofing and structural retrofitting are limited.</li> <li>• Emergency preparedness plans exist but are not fully integrated with municipal flood management systems.</li> <li>• Some facilities were upgraded under earlier urban programs, improving partial resilience.</li> <li>• Temporary relocation or use of alternative spaces is possible but disrupts service continuity.</li> <li>• Coordination between facility management and drainage authorities remains informal.</li> </ul>		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Emergency Services	<ul style="list-style-type: none"> <li>• Emergency service facilities such as health centers, police posts, and fire response units are located in urban zones exposed to surface flooding during heavy rainfall.</li> <li>• Several emergency facilities are positioned near major roads that frequently experience waterlogging.</li> <li>• Access routes connecting emergency stations to markets, hospitals, and residential zones pass through flood-prone corridors.</li> <li>• Some emergency compounds are situated in low-lying areas with inadequate stormwater drainage.</li> <li>• Critical support systems (fuel storage, generators, communication equipment) are installed at ground level in certain facilities.</li> </ul>	Medium	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>• Emergency services in Kimilili are <b>highly sensitive</b> to flooding because they depend on functional roads, power, and communication networks that are easily disrupted.</li> <li>• Most facilities lack elevated flooring, sealed doors, or raised equipment platforms — meaning even moderate flooding can disable operations.</li> <li>• Vehicles are easily damaged by waterlogged roads, leading to delayed or failed response.</li> <li>• Sensitive paper records and medical supplies stored at ground level are frequently at risk of water damage.</li> <li>• Limited drainage maintenance and blocked culverts near emergency facilities increase their exposure and downtime.</li> <li>• Because emergency units already have limited manpower and equipment, any flood event quickly overwhelms their capacity to respond effectively.</li> </ul>	High	Major

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			<p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>• The existing emergency services have <b>low adaptive capacity</b> to manage flood impacts due to poor infrastructure resilience and weak backup systems.</li> <li>• There are no permanent flood barriers, raised access routes, or flood storage ponds around most facilities.</li> <li>• Emergency staff lack specialized training and equipment for flood rescues such as boats, life jackets, or pumps.</li> <li>• Backup power and water systems are limited — during floods, power cuts often paralyze communication and lighting.</li> <li>• Coordination with the municipal drainage department remains informal, leading to slow preventive action before heavy rains.</li> <li>• Resource constraints mean facility upgrades and preventive maintenance are irregular or reactive rather than planned.</li> <li>• Although volunteer networks exist, they are not fully equipped or structured to provide rapid flood response support</li> </ul>		
<b>Populations</b>					

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Urban Residents	<ul style="list-style-type: none"> <li>Residential neighborhoods are located in low-lying areas exposed to surface flooding during heavy rainfall events.</li> <li>High-density housing zones are situated near drainage channels prone to overflow.</li> <li>Many residential access roads pass through flood-prone corridors.</li> <li>Informal extensions and unplanned housing developments are located in areas without adequate stormwater infrastructure.</li> <li>Household sanitation facilities are connected to drainage systems vulnerable to backflow during storms.</li> </ul>	High	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>High population density increases the number of households affected during flood events.</li> <li>Many homes have low floor elevation and limited flood-proof construction.</li> <li>Household drainage systems are often poorly maintained or undersized.</li> <li>Floodwater intrusion damages property, household goods, and sanitation systems.</li> <li>Post-flood water stagnation increases exposure to waterborne diseases.</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>Household preparedness for flooding is generally low.</li> <li>Informal neighborhood groups clear drains but lack adequate tools and equipment.</li> <li>Enforcement of development control in flood-prone zones remains weak.</li> <li>Limited access to insurance or formal recovery financing.</li> <li>Municipal emergency response provides support but is often delayed during widespread flooding.</li> </ul>	High	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Informal Settlement Residents	<ul style="list-style-type: none"> <li>• Informal settlements are located in low-lying and riparian zones highly exposed to surface flooding during heavy rainfall.</li> <li>• Many informal housing clusters are situated along drainage corridors and seasonal water channels.</li> <li>• Settlement layouts are dense and unplanned, limiting natural runoff pathways.</li> <li>• Access routes serving informal areas pass through flood-prone zones that become impassable during storms.</li> <li>• Sanitation facilities within informal settlements are directly exposed to stormwater overflow.</li> </ul>	High	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>• Dwellings are constructed from non-durable materials such as timber, iron sheets, and mud, which are easily damaged by floodwater.</li> <li>• Floor levels are often at or below surrounding ground level, increasing flood intrusion risk.</li> <li>• Inadequate sanitation and drainage infrastructure intensifies contamination during flooding.</li> <li>• High population density increases exposure to waterborne diseases.</li> <li>• Household assets are rarely elevated or protected against floodwater.</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>• Residents have limited financial resources for structural improvements or relocation.</li> <li>• No permanent upgrading or flood-resilient housing program is currently operational.</li> <li>• Access to insurance and formal recovery financing is minimal.</li> <li>• Emergency response and relief distribution are often delayed due to access challenges.</li> <li>• Strong community solidarity exists but lacks technical and financial support for large-scale mitigation.</li> </ul>	High	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Vulnerable and Marginalized Groups	<ul style="list-style-type: none"> <li>Elderly persons, persons with disabilities (PWDs), children, and low-income households reside within residential areas exposed to surface flooding during heavy rainfall.</li> <li>Many vulnerable individuals depend on infrastructure and services located in flood-prone zones.</li> <li>Outdoor workers and informal vendors operate in areas frequently affected by stormwater accumulation.</li> <li>Social support services accessed by vulnerable groups are located along roads prone to flooding.</li> <li>Some vulnerable households occupy low-cost housing in poorly drained neighborhoods.</li> </ul>	High	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>Limited physical mobility makes evacuation during flooding difficult for elderly persons and PWDs.</li> <li>Pre-existing health conditions increase susceptibility to flood-related illness.</li> <li>Children are more exposed to contaminated water and sanitation failures.</li> <li>Low-income households have limited ability to elevate assets or reinforce dwellings.</li> <li>Dependence on public services increases sensitivity to service disruption.</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>Social protection mechanisms during flood events are limited and often delayed.</li> <li>County disaster funds are insufficient to provide sustained recovery support.</li> <li>Access to formal insurance or savings mechanisms is minimal.</li> <li>Community and civil society assistance is largely short-term and relief-focused.</li> <li>No dedicated municipal cooling or shelter centers designed for vulnerable populations during emergencies.</li> </ul>	High	Catastrophic
Natural Assets					

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Urban Green Infrastructure	<ul style="list-style-type: none"> <li>Urban parks, roadside medians, public gardens, and landscaped areas are located within zones exposed to surface runoff during intense rainfall events.</li> <li>Green spaces situated in low-lying sections of the municipality are directly exposed to stormwater accumulation.</li> <li>Vegetated corridors along drainage channels are subject to overflow during peak rainfall.</li> <li>Recreational fields and open spaces receive concentrated runoff from surrounding impervious surfaces.</li> <li>Tree-lined streets intersect flood-prone road corridors</li> </ul>	Medium	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>Inadequate surface drainage within parks increases waterlogging during storms.</li> <li>Soil compaction reduces infiltration capacity, intensifying erosion.</li> <li>Sparse vegetation cover in some areas limits natural stormwater absorption.</li> <li>Newly planted trees are susceptible to uprooting under saturated soil conditions.</li> <li>Green spaces located near drainage channels are vulnerable to sediment deposition and damage.</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>Routine Park maintenance exists but does not include structured flood management measures.</li> <li>Limited investment in permeable landscaping or bio-retention systems.</li> <li>Community clean-up activities provide short-term recovery but limited long-term resilience.</li> <li>Few engineered green infrastructure solutions such as rain gardens or swales have been implemented.</li> <li>Budget allocation for green infrastructure upgrades is constrained.</li> </ul>	Medium	Moderate

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Urban Blue Infrastructure	<ul style="list-style-type: none"> <li>Rivers, streams, wetlands, and riparian corridors within the municipality are directly exposed to increased runoff during intense rainfall events.</li> <li>Urban watercourses receive stormwater discharge from surrounding built-up areas with high impervious surface coverage.</li> <li>Sections of riverbanks and wetlands are located adjacent to residential and commercial zones exposed to overflow.</li> <li>Natural drainage pathways intersect road networks and settlement areas prone to pluvial flooding.</li> <li>Modified or channelized stream sections are exposed to sudden increases in flow velocity during heavy storms.</li> </ul>	Medium	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>Riparian encroachment reduces natural flood storage capacity.</li> <li>Vegetation loss along riverbanks increases erosion during peak flows.</li> <li>Channel modification and narrowing increase downstream flow velocity and overflow risk.</li> <li>Solid waste accumulation obstructs natural water flow.</li> <li>Sediment deposition reduces channel depth and conveyance efficiency.</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>Limited riverbank protection works or engineered flood-control structures.</li> <li>Minimal routine desilting or channel rehabilitation programs.</li> <li>Few community-led restoration or riparian protection initiatives.</li> <li>Weak enforcement of setback regulations along riparian zones.</li> <li>No comprehensive blue infrastructure restoration strategy currently implemented.</li> </ul>	Medium	Moderate

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Peri-urban and Agricultural Systems	<ul style="list-style-type: none"> <li>• Peri-urban agricultural lands are located along streams, wetlands, and seasonal drainage channels exposed to overflow during intense rainfall.</li> <li>• Farm plots in low-lying zones receive concentrated runoff from adjacent built-up areas.</li> <li>• Livestock enclosures and grazing areas are situated in open landscapes directly exposed to stormwater accumulation.</li> <li>• Access roads connecting farms to markets pass through flood-prone corridors.</li> <li>• Irrigation furrows and small water diversion channels intersect natural runoff pathways.</li> </ul>	Medium	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>• Predominantly rain-fed farming systems lack engineered flood protection measures.</li> <li>• Poor soil conservation practices increase erosion during heavy rainfall.</li> <li>• Crop varieties grown are sensitive to waterlogging and root rot.</li> <li>• Livestock shelters are not elevated above surrounding ground level.</li> <li>• Topsoil loss reduces fertility and long-term productivity.</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>• Limited extension services focused on flood-resilient farming practices.</li> <li>• Low mechanization and limited drainage improvement within farm plots.</li> <li>• Farmers have constrained financial buffers to absorb crop loss.</li> <li>• Minimal crop insurance uptake.</li> <li>• Some conservation agriculture pilots exist but remain small-scale.</li> </ul>	Low	Minor

**Hazard:** of metrological drought (dry spells)

**Table 16 Exposure, Vulnerability, and Impacts of metrological drought (dry spells) on Urban Elements**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
<b>Infrastructure &amp; Services</b>					
Stormwater Drainage	<ul style="list-style-type: none"> <li>Stormwater drainage infrastructure is indirectly exposed to prolonged dry periods through reduced runoff and extended absence of flushing flows.</li> <li>Drainage channels located in built-up areas experience sediment accumulation during extended dry conditions.</li> <li>Concrete-lined and masonry channels are exposed to thermal stress and desiccation during prolonged heat and dry weather.</li> <li>Surrounding soils supporting culverts and drainage structures are exposed to shrinkage and cracking under moisture deficit conditions.</li> </ul>	Low	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Reduced flow during dry periods allows silt, debris, and solid waste to accumulate within drainage channels.</li> <li>Unlined or masonry drains are susceptible to cracking due to thermal expansion and soil desiccation.</li> <li>Vegetation growth within dry channels obstructs hydraulic capacity.</li> <li>Shrinking soils around culvert foundations may create minor structural instability.</li> <li>Lack of moisture reduces soil cohesion, increasing erosion risk during the first heavy rainfall after drought.</li> </ul>	Low	Insignificant

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	<ul style="list-style-type: none"> <li>Drainage corridors in peri-urban zones experience vegetation overgrowth during dry months, reducing conveyance capacity.</li> </ul>		<p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>Drainage maintenance programs are largely rainfall-triggered rather than preventive during dry months.</li> <li>There is limited integration of structured desilting schedules prior to onset of rainy seasons.</li> <li>Technical inspection of cracks and structural wear during dry periods is not systematic.</li> <li>Funding prioritizes emergency flood response rather than pre-season preparedness.</li> <li>Community awareness of the importance of dry-season maintenance remains limited.</li> </ul>		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Water & Wastewater Management	<ul style="list-style-type: none"> <li>• Surface water sources supplying the municipality, including rivers and seasonal streams, are directly exposed to reduced flow during prolonged dry periods.</li> <li>• Shallow wells and groundwater recharge zones are located in areas dependent on seasonal rainfall patterns, making them exposed to declining water tables during drought.</li> <li>• Water treatment and distribution systems rely heavily on rainfall-fed sources with limited alternative supply redundancy.</li> <li>• Wastewater systems are exposed to reduced inflow volumes during drought, altering hydraulic balance and increasing sedimentation.</li> <li>• Boreholes and abstraction points are spatially distributed across zones with variable aquifer recharge capacity, increasing exposure to groundwater stress.</li> </ul>	High	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>• The municipality demonstrates high dependence on surface water and shallow groundwater sources, with limited diversification into climate-resilient supply systems.</li> <li>• Reduced river flow directly lowers intake volumes at treatment facilities, forcing rationing and reducing service coverage.</li> <li>• Infrastructure is not designed for prolonged low-flow scenarios, increasing operational stress during drought conditions.</li> <li>• Groundwater abstraction increases during dry periods, accelerating aquifer depletion and reducing long-term sustainability.</li> <li>• Reduced sewer flow volume increases sediment deposition, odor formation, and system blockages.</li> <li>• Water quality deteriorates as reduced dilution capacity concentrates pollutants in remaining water bodies.</li> </ul>	High	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			<p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>• There is no formal drought-contingency water supply plan outlining phased response mechanisms.</li> <li>• Rainwater harvesting infrastructure remains limited at both household and institutional levels.</li> <li>• Borehole rehabilitation, monitoring, and aquifer management systems are underfunded.</li> <li>• Real-time water demand management systems are absent.</li> <li>• Emergency water trucking may occur but lacks structured municipal coordination.</li> <li>• Public awareness campaigns on water conservation are inconsistent and not institutionalized.</li> </ul>		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Solid Waste Management	<ul style="list-style-type: none"> <li>• Solid waste collection points and open dumping areas are directly exposed to prolonged dry and windy conditions during extended dry spells.</li> <li>• Waste storage areas located in unpaved and open environments are exposed to increased dust and wind dispersion.</li> <li>• Informal disposal sites situated near residential zones are exposed to elevated temperatures and reduced moisture conditions.</li> <li>• Temporary waste transfer points lack cover and are exposed to ignition risks during hot, dry weather.</li> <li>• Collection routes pass through dry, dusty roads that increase airborne particulate dispersion during waste handling.</li> </ul>	Medium	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>• Open dumping practices make waste highly susceptible to wind dispersal and spontaneous combustion.</li> <li>• Organic waste decomposes under dry heat, increasing odor concentration and vector attraction.</li> <li>• Dry conditions increase the risk of landfill or dumpsite fires, especially where methane accumulation is unmanaged.</li> <li>• Reduced water availability limits cleaning of collection vehicles and sanitation of storage containers.</li> <li>• Accumulated dry waste becomes more combustible, increasing fire hazards.</li> <li>• Dust generation during collection and transportation increases occupational and public health risks.</li> </ul>	Medium	Moderate

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			<p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>• Fire prevention and suppression systems at dumpsites are limited or absent.</li> <li>• No structured drought-specific waste management operational protocol exists.</li> <li>• Water storage for sanitation and dust suppression is minimal.</li> <li>• Coordination between environmental health and fire response services is limited.</li> <li>• Community clean-up initiatives occur intermittently but are not systematically integrated into drought preparedness.</li> <li>• Engineered landfill containment infrastructure is lacking, limiting environmental control during dry conditions.</li> </ul>		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Transport and Mobility	<ul style="list-style-type: none"> <li>• A significant proportion of the municipal road network consists of unpaved (murrum and gravel) roads exposed to prolonged dry and dusty conditions.</li> <li>• Road corridors located in open peri-urban areas are directly exposed to moisture deficit and soil desiccation.</li> <li>• Bridge and culvert foundations are exposed to soil shrinkage during extended dry periods.</li> <li>• Roadside vegetation along transport corridors is exposed to drought stress, reducing windbreak effects.</li> <li>• Pedestrian pathways and informal access roads lack dust control measures and are exposed to surface degradation during dry months.</li> </ul>	Medium	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>• High proportion of murrum and gravel roads are prone to dust formation and surface cracking under prolonged dryness.</li> <li>• Absence of routine dust suppression measures increases airborne particulate concentration.</li> <li>• Soil shrinkage around culvert and bridge foundations may weaken structural stability.</li> <li>• Reduced vegetation cover increases wind speed across open road sections, intensifying dust storms and reducing visibility.</li> <li>• Surface hardening during drought increases erosion risk during the first rainfall after dry periods.</li> <li>• Lack of climate-resilient road surfacing materials increases susceptibility to dry-wet transition damage.</li> </ul>	Medium	Moderate

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			<p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>• Routine road maintenance exists but is largely reactive to visible deterioration.</li> <li>• Limited availability of soil stabilization treatments or dust suppression technologies.</li> <li>• No specific drought-adapted road material standards incorporated into municipal planning.</li> <li>• Budget allocations prioritize pothole repair over preventive soil stabilization.</li> <li>• Emergency response capacity for dust-related visibility hazards is minimal.</li> </ul>		
Energy	<ul style="list-style-type: none"> <li>• Electricity distribution infrastructure, including transformers and overhead lines, operates in open environments exposed to prolonged dry and high-temperature conditions.</li> <li>• Energy supply systems depend partly on water-dependent infrastructure (e.g., pumping stations) affected during drought.</li> <li>• Solar installations within the municipality are exposed to increased dust accumulation during extended dry periods.</li> <li>• Power lines traverse vegetated and peri-urban zones exposed to heightened fire risk during dry spells.</li> </ul>	Low	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>• Transformers and electrical components experience thermal stress during prolonged dry and hot conditions.</li> <li>• Dust accumulation reduces efficiency of solar panels and increases maintenance requirements.</li> <li>• Dry vegetation near transmission corridors increases fire risk and potential line damage.</li> <li>• Increased energy demand for water pumping and cooling can strain distribution capacity.</li> <li>• Ageing grid components may degrade faster under combined heat and dust exposure.</li> </ul>	Low	Insignificant

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	<ul style="list-style-type: none"> <li>Energy demand for water pumping and cooling systems increases during drought periods.</li> </ul>		<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Kenya Power conducts routine inspection and vegetation clearing along transmission corridors.</li> <li>Grid redundancy reduces risk of prolonged outage.</li> <li>Maintenance capacity exists for transformer replacement and line repair.</li> <li>However, there is no dedicated drought-contingency energy management plan.</li> <li>Off-grid renewable storage and backup systems remain limited in scale.</li> </ul>		
Economic Infrastructure	<ul style="list-style-type: none"> <li>Markets, small enterprises, and informal businesses operate within urban zones dependent on reliable municipal and groundwater supply.</li> <li>Water-dependent businesses such as food vendors, car wash operators, restaurants, and agro-based traders are exposed to reduced water availability during dry periods.</li> <li>Commercial activities linked to agricultural supply chains are exposed to reduced rural production during drought.</li> <li>Informal trading areas operate in open environments exposed to prolonged heat and dust conditions.</li> <li>Economic hubs are spatially concentrated in areas lacking independent water storage or backup supply systems.</li> </ul>	Medium	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Many small and medium enterprises rely on continuous water supply for sanitation, processing, and cleaning.</li> <li>Reduced agricultural output during drought lowers supply to markets, affecting trade volumes and prices.</li> <li>Informal traders have limited capital reserves to absorb prolonged revenue decline.</li> <li>Increased cooling and sanitation costs reduce profit margins.</li> <li>Consumer purchasing power declines during drought periods due to food price inflation.</li> <li>Businesses lack infrastructure such as water storage tanks to buffer supply interruptions.</li> </ul>	Medium	Moderate

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			<p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>• Some businesses source water from private boreholes or vendors during rationing periods.</li> <li>• Informal coping mechanisms such as reduced operating hours are common.</li> <li>• Access to formal credit for drought recovery remains limited.</li> <li>• No municipal drought contingency fund specifically targets small enterprises.</li> <li>• Economic diversification is limited, particularly among informal traders.</li> <li>• Business continuity planning for drought conditions is largely absent.</li> </ul>		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Social Infrastructure	<ul style="list-style-type: none"> <li>• Schools, health facilities, and public institutions depend on municipal and groundwater supply exposed to prolonged dry periods.</li> <li>• Many social facilities are located in areas without independent water storage systems.</li> <li>• Institutional sanitation systems rely on consistent water availability for hygiene and waste management.</li> <li>• Public buildings operate in environments exposed to elevated indoor temperatures during extended dry conditions.</li> <li>• Community service centers serve populations whose demand for water-related services increases during drought</li> </ul>	Medium	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>• Reliance on municipal or borehole water without adequate storage redundancy increases service disruption risk.</li> <li>• Sanitation systems within schools and clinics are compromised when water rationing occurs.</li> <li>• Elevated indoor temperatures during drought reduce comfort, productivity, and service efficiency.</li> <li>• Medical facilities require reliable water for infection prevention and control.</li> <li>• Increased patient load during drought-related health issues (dehydration, hygiene-related diseases) strains facilities.</li> <li>• Many public buildings lack passive cooling design or climate-resilient construction materials.</li> </ul>	High	Major

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			<p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>• Alternative water sources such as water tanks exist in some facilities but coverage is limited.</li> <li>• Support from NGOs for water storage infrastructure is sporadic and not universal.</li> <li>• Budget constraints limit expansion of storage and backup systems.</li> <li>• Institutional awareness of water-use efficiency is increasing but not formalized into operational policy.</li> <li>• No structured municipal drought-response framework specifically supporting schools and health facilities.</li> <li>• Facility upgrades under past urban programs improved infrastructure but did not fully integrate drought resilience.</li> </ul>		
<b>Populations</b>					

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Urban Residents	<ul style="list-style-type: none"> <li>Urban households rely primarily on municipal and groundwater sources exposed to seasonal rainfall variability.</li> <li>Residential areas are supplied by water systems vulnerable to declining river flow and falling groundwater levels during prolonged dry periods.</li> <li>High-density neighborhoods without private storage are directly exposed to water rationing.</li> <li>Urban food supply chains serving households depend on rain-fed peri-urban agriculture exposed to drought.</li> <li>Informal settlements and low-income neighborhoods are spatially located in areas with limited independent water infrastructure.</li> </ul>	High	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Many households have limited water storage capacity to buffer supply interruptions.</li> <li>Low-income households are highly sensitive to rising water prices during rationing.</li> <li>Poor sanitation infrastructure increases health risks when water availability declines.</li> <li>Reduced food production during drought increases household food expenditure.</li> <li>Children and elderly individuals are more susceptible to dehydration and hygiene-related illnesses.</li> <li>Informal settlements rely on seasonal water vendors, increasing exposure to unsafe or overpriced supply.</li> </ul>	Medium	Major

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			<p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>• Some households access private boreholes, but coverage is limited and often shared among many users.</li> <li>• Informal coping mechanisms such as rationing and shared water purchasing exist.</li> <li>• No formal municipal drought-relief or household water subsidy program is operational.</li> <li>• Household-level rainwater harvesting adoption remains limited.</li> <li>• Social support networks provide informal assistance but lack institutional backing.</li> <li>• Water conservation awareness is growing but not universally practiced.</li> </ul>		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Informal Settlement Residents	<ul style="list-style-type: none"> <li>• Informal settlements rely heavily on communal taps, shallow wells, and seasonal water vendors exposed to declining supply during prolonged dry periods.</li> <li>• Many informal housing clusters lack piped water connections and depend on rainfall-sensitive groundwater sources.</li> <li>• Informal neighborhoods are located in densely populated areas with limited independent water storage capacity.</li> <li>• Livelihoods within informal settlements depend on casual labor and informal trade linked to climate-sensitive economic activities.</li> <li>• Food access in informal areas depends on market supply chains affected by peri-urban agricultural drought.</li> </ul>	High	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>• Absence of formal water connections increases dependence on expensive or unsafe alternative sources.</li> <li>• High household density amplifies sanitation challenges during water shortages.</li> <li>• Minimal household storage infrastructure limits buffering capacity during rationing.</li> <li>• Low and unstable incomes reduce ability to purchase water at elevated prices.</li> <li>• Hygiene conditions deteriorate rapidly during prolonged dry spells, increasing disease transmission.</li> <li>• Informal dwellings lack cooling systems, compounding heat stress during drought.</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>• Informal water vending systems provide alternative supply but are unreliable and poorly regulated.</li> <li>• Limited municipal oversight of water pricing during drought periods.</li> <li>• Health outreach and sanitation monitoring are insufficient during extended dry spells.</li> <li>• No permanent upgrading or drought-resilience housing program in place.</li> <li>• Social safety nets for drought-related income loss are weak or absent.</li> <li>• Community solidarity provides informal support but lacks financial scale.</li> </ul>	High	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Vulnerable and Marginalized Groups	<ul style="list-style-type: none"> <li>Elderly persons, persons with disabilities (PWDs), children, and low-income women-headed households reside in neighborhoods dependent on climate-sensitive water systems.</li> <li>Many vulnerable individuals depend on public health facilities and community services exposed to drought-related water shortages.</li> <li>Households caring for chronically ill members are exposed to increased water and sanitation demands during dry periods.</li> <li>Vulnerable populations often rely on informal water vendors operating in drought-affected areas.</li> <li>Food access for vulnerable groups depends on local markets supplied by</li> </ul>	High	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Limited physical mobility makes water collection during shortages more difficult for elderly persons and PWDs.</li> <li>Pre-existing health conditions increase susceptibility to dehydration and heat-related illness.</li> <li>Children are highly sensitive to poor hygiene and waterborne disease outbreaks.</li> <li>Women-headed households often carry increased care and water-collection burdens during drought.</li> <li>Low-income households have limited savings to purchase alternative water sources.</li> <li>Nutritional deficits increase when food prices rise during prolonged dry periods</li> </ul>	High	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	rain-fed agricultural systems exposed to prolonged dry spells.		<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>• Formal drought relief assistance targeting vulnerable groups is limited or delayed.</li> <li>• No structured municipal social safety net specifically designed for dry spell response.</li> <li>• Access to insurance, savings, or credit is minimal among marginalized groups.</li> <li>• Civil society organizations provide short-term support but lack sustained funding.</li> <li>• Community solidarity networks exist but cannot offset prolonged systemic shortages.</li> <li>• Limited dissemination of drought preparedness information targeted to vulnerable populations.</li> </ul>		
<b>Natural Assets</b>					

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Urban Green Infrastructure	<ul style="list-style-type: none"> <li>Urban parks, roadside trees, public gardens, and landscaped spaces are directly exposed to prolonged moisture deficit during extended dry periods.</li> <li>Green infrastructure located within highly built-up zones is exposed to elevated surface temperatures and reduced soil moisture retention.</li> <li>Street trees planted in compacted soils are exposed to limited groundwater recharge during drought.</li> <li>Recreational fields and open spaces without irrigation systems are exposed to prolonged vegetation stress.</li> <li>Peri-urban green corridors dependent on seasonal rainfall are exposed to declining canopy health during drought.</li> </ul>	High	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>Many public green spaces lack irrigation systems to sustain vegetation during extended dry periods.</li> <li>Landscaping often relies on non-drought-tolerant species vulnerable to moisture stress.</li> <li>Soil compaction in urban areas reduces water infiltration and root depth resilience.</li> <li>Tree mortality risk increases under prolonged drought stress.</li> <li>Loss of vegetation cover reduces shade provision and increases urban heat intensity.</li> <li>Dry vegetation increases susceptibility to fire outbreaks in parks and open spaces.</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>County greening programs exist but funding for maintenance is inconsistent.</li> <li>Community-led watering initiatives occur sporadically but are not systematic.</li> <li>Limited integration of drought-resilient landscaping designs such as xeriscaping.</li> <li>Few monitoring systems track vegetation health during dry spells.</li> <li>Urban forestry planning has not fully incorporated climate resilience standards.</li> </ul>	Medium	Major

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Urban Blue Infrastructure	<ul style="list-style-type: none"> <li>Rivers, streams, wetlands, and riparian corridors within the municipality are directly exposed to declining flow during prolonged dry periods.</li> <li>Shallow wetlands and seasonal streams are exposed to partial or complete drying under extended rainfall deficits.</li> <li>Urban water bodies receiving reduced inflow are exposed to elevated evaporation rates.</li> <li>Downstream aquatic ecosystems are exposed to reduced baseflow conditions during drought.</li> <li>Blue infrastructure located within degraded catchments is exposed to intensified hydrological stress during prolonged dry spells.</li> </ul>	Medium	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>Reduced river flow decreases dilution capacity, increasing pollutant concentration.</li> <li>Wetlands with shallow water tables are highly susceptible to desiccation.</li> <li>Loss of riparian vegetation reduces bank stability and ecological buffering capacity.</li> <li>Aquatic biodiversity declines under prolonged low-flow conditions.</li> <li>Sediment accumulation increases during low-flow periods, reducing channel capacity upon return of rainfall.</li> <li>Encroachment along riparian corridors limits ecological resilience.</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>Limited catchment restoration or riverbank stabilization programs are currently implemented.</li> <li>Environmental monitoring of streamflow and water quality is minimal.</li> <li>Weak enforcement of riparian setback regulations reduces long-term resilience.</li> <li>Few community-led watershed protection initiatives exist, and scale remains limited.</li> <li>No structured drought response plan for maintaining ecological baseflows.</li> </ul>	Medium	Moderate

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Peri-urban and Agricultural Systems	<ul style="list-style-type: none"> <li>• Peri-urban agricultural lands are directly exposed to prolonged rainfall deficits during extended dry periods.</li> <li>• Crop fields dependent on seasonal precipitation are exposed to soil moisture depletion.</li> <li>• Livestock grazing areas are exposed to reduced pasture regeneration under sustained drought conditions.</li> <li>• Irrigation water sources, including shallow wells and streams, are exposed to declining recharge rates.</li> <li>• Smallholder farming systems located on marginal soils are exposed to accelerated moisture loss during dry spells.</li> </ul>	High	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>• Farming systems are predominantly rain-fed with limited irrigation coverage.</li> <li>• Soil moisture retention capacity is low due to limited conservation practices.</li> <li>• Crop varieties grown are often sensitive to prolonged moisture stress.</li> <li>• Livestock productivity declines due to reduced forage availability and water scarcity.</li> <li>• Limited diversification of crops increases risk of total yield failure.</li> <li>• Pasture degradation increases susceptibility to erosion upon return of rainfall.</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>• Some farmers have adopted drought-tolerant crop varieties through county extension programs.</li> <li>• Community-level savings groups provide limited financial buffering.</li> <li>• Irrigation infrastructure exists but covers only a small proportion of cultivated land.</li> <li>• Agricultural extension services are present but under-resourced.</li> <li>• Access to crop insurance remains minimal.</li> <li>• No comprehensive municipal drought mitigation strategy specifically targeting peri-urban agriculture.</li> </ul>	Medium	Major

**Hazard: Thunderstorms**

**Table 17 Exposure, Vulnerability, and Impacts of Thunderstorms on Urban Elements**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
<b>Infrastructure &amp; Services</b>					
Stormwater Drainage	<ul style="list-style-type: none"> <li>Intense short-duration convective storms generate rapid surface runoff that overwhelms roadside drains and culverts within Kimilili CBD and along the Bungoma–Kitale corridor.</li> <li>Drainage pinch points near Kimilili Central Market experience repeated surge loading during heavy downpours.</li> <li>Lightning-related tree falls and wind-blown debris frequently block open channels and inlet grates in Maeni and Kibingei wards.</li> </ul>	High	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Open and shallow drains are easily overwhelmed by high-velocity surge flows.</li> <li>Undersized culverts lack hydraulic capacity for peak thunderstorm intensity.</li> <li>Inlet grates clog quickly due to vegetative debris and market waste.</li> <li>Limited stormwater retention or buffer storage increases overflow risk.</li> <li>Flat gradients in sections of town prolong ponding after sudden downpours.</li> </ul>	High	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	<ul style="list-style-type: none"> <li>High-intensity rainfall events deposit large sediment and organic debris loads into drainage corridors.</li> <li>Open drainage systems in densely built areas are directly exposed to sudden hydraulic shock during storm bursts.</li> </ul>		<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Drainage clearing is largely reactive rather than pre-storm scheduled.</li> <li>No rapid-deployment teams for immediate debris removal after storm bursts.</li> <li>Absence of storm-event forecasting integration into municipal maintenance.</li> <li>Limited stockpiling of emergency drainage repair materials.</li> <li>Community desilting occurs but lacks coordination with official storm response units.</li> </ul>		
Water & Wastewater Management	<ul style="list-style-type: none"> <li>Water intake points along River Kibisi and other surface sources are exposed to sudden turbidity spikes during intense downpours.</li> <li>Pump houses and borehole installations in peri-urban Kamukuywa and Kibingei are exposed to lightning strikes and wind-related damage.</li> <li>Treatment facilities located in low-lying areas are exposed to flash runoff and temporary access blockage.</li> <li>Shallow wells and communal taps are exposed to rapid surface inflow during high-intensity rainfall events.</li> <li>Sewer and on-site sanitation systems are exposed to stormwater intrusion during short-duration extreme rainfall.</li> </ul>	High	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Borehole casings and pump electrical components lack surge protection against lightning.</li> <li>Exposed pipelines and treatment units are vulnerable to soil erosion and debris impact.</li> <li>Shallow wells are poorly sealed against rapid surface contamination.</li> <li>On-site sanitation systems (latrines, septic pits) overflow during sudden rainfall bursts.</li> <li>Power interruptions during lightning events halt pumping operations.</li> <li>Inter-agency coordination (WWDA, Kimilili Water Supply, County) is slow during rapid-onset events.</li> </ul>	High	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			<p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>• No lightning arresters or surge protection systems installed at most pump houses.</li> <li>• Limited redundancy in water storage buffers for short-term supply interruptions.</li> <li>• Emergency water trucking occasionally deployed but not sustainable for repeated storm events.</li> <li>• Repair capacity depends on county public works with limited spare parts stock.</li> <li>• No dedicated localized rapid-response technical unit within the municipality.</li> <li>• Technical support from WWDA exists but response time is not immediate.</li> </ul>		
Solid Waste Management	<ul style="list-style-type: none"> <li>• Open dumping sites and market waste bins are directly exposed to strong winds and intense rainfall during thunderstorms.</li> <li>• Waste collection points near Kimilili Central Market and residential zones are exposed to storm-driven runoff.</li> <li>• Uncovered waste piles are exposed to wind dispersal and flash wash-off into drainage channels.</li> <li>• Informal disposal areas located near River Kimilili are exposed to rapid debris transport during heavy rainfall.</li> <li>• Waste transfer routes pass through streets prone to temporary storm flooding.</li> </ul>	High	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>• Open-air waste piles lack containment structures to prevent wind or runoff dispersal.</li> <li>• Absence of engineered landfill or transfer station increases exposure to leachate spread.</li> <li>• Limited fencing allows wind-blown waste dispersion into surrounding neighborhoods.</li> <li>• Manual collection methods reduce speed of post-storm clearance.</li> <li>• Electrical faults during storms increase fire risk at informal dumpsites.</li> </ul>	High	Major

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>County waste fleet is insufficient for rapid large-scale post-storm clearing.</li> <li>No formal emergency waste-clearing protocol exists.</li> <li>Enforcement of waste disposal regulations around markets is weak.</li> <li>Voluntary cleanup groups operate but lack tools and coordination.</li> <li>Lack of engineered containment infrastructure increases recovery time</li> </ul>		
Transport and Mobility	<ul style="list-style-type: none"> <li>Major trunk roads including the Bungoma–Kitale corridor are directly exposed to intense short-duration rainfall during thunderstorms.</li> <li>Urban access streets within Kimilili CBD experience rapid surface runoff accumulation during heavy downpours.</li> <li>Feeder roads in Maeni, Kamukuywa, and Kibingei wards are exposed to flash flooding and localized washouts.</li> <li>Road corridors lined with mature trees are exposed to wind-driven branch falls and obstruction.</li> <li>Bridges and culvert crossings are exposed to sudden high-velocity flow surges during storm bursts.</li> </ul>	Medium	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>High proportion of internal roads are gravel or murrum with limited compaction and drainage reinforcement.</li> <li>Cross-drainage structures are undersized for high-intensity convective rainfall.</li> <li>Road shoulders lack erosion protection, increasing scouring risk.</li> <li>Limited stormwater conveyance at key intersections causes rapid surface pooling.</li> <li>Absence of traffic diversion planning increases congestion during storm events.</li> <li>Tree roots undermine pavement structure, increasing collapse risk during soil saturation.</li> </ul>	High	Major

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			<p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>• Road maintenance is largely reactive and budget constrained.</li> <li>• Deployment of graders and excavators depends on county workshops located outside the municipality, delaying response.</li> <li>• No municipal-level early-warning communication for motorists.</li> <li>• Community groups remove debris informally but without coordination.</li> <li>• Ongoing KUSP II upgrades may reduce future exposure but are not yet fully implemented.</li> </ul>		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Energy	<ul style="list-style-type: none"> <li>Electricity distribution infrastructure in Kimilili is predominantly overhead and directly exposed to lightning and strong winds during thunderstorms.</li> <li>Power lines traverse tree-lined streets and peri-urban zones vulnerable to falling branches.</li> <li>Wooden and aging poles are exposed to soil saturation and wind-induced instability.</li> <li>Local substations are exposed to temporary surface flooding during prolonged rainfall bursts.</li> <li>Street-lighting circuits are exposed to lightning-related surges and short-circuiting.</li> </ul>	Medium	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>Entire distribution network is overhead, increasing susceptibility to wind and lightning damage.</li> <li>Wooden poles are prone to rot and wind-induced failure under saturated soil conditions.</li> <li>Transformers lack surge arresters and elevated plinth protection.</li> <li>Vegetation clearance programs focus on main lines, leaving secondary lines vulnerable.</li> <li>Limited separation between tree canopy and power lines increases fault frequency.</li> <li>Storm-induced voltage surges damage sensitive equipment in commercial and health facilities.</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>KPLC crews stationed in Kapsokwony respond to faults but face access delays during heavy rainfall.</li> <li>Routine vegetation trimming exists but is not comprehensive.</li> <li>Underground cabling is minimal.</li> <li>Only major facilities (e.g., hospital) have partial generator backup.</li> <li>Residents use solar lanterns or small backup systems for short outages.</li> <li>No municipal-level coordinated storm energy resilience strategy.</li> </ul>	High	Major

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Economic Infrastructure	<ul style="list-style-type: none"> <li>• Open-air markets such as Kimilili Central Market and Milo Centre are directly exposed to intense rainfall, strong winds, and lightning during thunderstorms.</li> <li>• Informal stalls constructed along streets and drainage corridors are exposed to flash runoff and wind uplift.</li> <li>• Commercial buildings in the CBD are exposed to power interruptions and debris impact during severe storms.</li> <li>• Market zones located in low-lying areas experience temporary waterlogging during high-intensity rainfall.</li> <li>• Economic hubs depend on storm-sensitive infrastructure such as electricity, transport, and drainage systems.</li> </ul>	High	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>• Many market stalls are constructed from lightweight timber and iron sheets with minimal anchorage.</li> <li>• Roofing systems are vulnerable to wind uplift and structural displacement.</li> <li>• Drainage around market plots is insufficient to prevent water intrusion.</li> <li>• Traders store goods at ground level, increasing flood damage risk.</li> <li>• Businesses depend on continuous electricity for refrigeration and transactions.</li> <li>• Informal enterprises lack structural reinforcement against storm damage.</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>• Traders conduct minor self-repairs but lack capital for structural upgrading.</li> <li>• Business-interruption insurance coverage is minimal.</li> <li>• County upgrades under KUSP II are ongoing but not yet comprehensive.</li> <li>• Cooperative groups provide limited mutual aid after storm events.</li> <li>• No municipal early-warning communication system for traders.</li> <li>• Recovery depends heavily on individual resilience rather than institutional support.</li> </ul>	High	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Social Infrastructure	<ul style="list-style-type: none"> <li>Schools such as Kimilili RC and Maeni Primary are directly exposed to strong winds, heavy rainfall, and lightning during thunderstorms.</li> <li>Health facilities including Kimilili Sub-County Hospital are exposed to storm-related power outages and wind-driven debris impact.</li> <li>Public buildings with metallic roofing and elevated structures are exposed to lightning strikes.</li> <li>School and hospital compounds experience temporary waterlogging during intense downpours.</li> <li>Community halls and churches used as emergency shelters are exposed to structural stress during severe storms.</li> </ul>	High	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>Many classrooms and wards use lightweight roofing sheets with limited anchorage against wind uplift.</li> <li>Drainage around compounds is insufficient to prevent water accumulation.</li> <li>Electrical systems lack surge protection for sensitive equipment.</li> <li>School buildings are not uniformly equipped with lightning arresters.</li> <li>Public buildings are rarely insured against storm damage.</li> <li>Windows and doors are not reinforced to withstand strong wind pressure.</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>Kimilili Sub-County Hospital has partial generator backup but lacks full surge and lightning protection.</li> <li>School management committees organize minor repairs after damage.</li> <li>County government provides intermittent repair funding.</li> <li>Faith-based organizations provide temporary shelter and relief.</li> <li>No standardized severe weather safety protocol across schools.</li> <li>Limited public awareness campaigns on lightning safety.</li> </ul>	Medium	Major

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Emergency Services	<ul style="list-style-type: none"> <li>• Emergency facilities including police posts, health centres, and fire response units are exposed to lightning, strong winds, and intense rainfall during thunderstorms.</li> <li>• Communication masts and metallic roofing increase exposure to lightning strikes.</li> <li>• Access roads to emergency facilities are exposed to temporary flooding and wind-blown debris.</li> <li>• Power supply system's supporting emergency operations are exposed to lightning-induced outages.</li> <li>• Outdoor emergency operations (rescue, traffic control, evacuation) are directly exposed to storm hazards.</li> </ul>	Medium	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>• Most emergency facilities in Kimilili lack lightning arresters, surge protectors, or reinforced structures to withstand high winds.</li> <li>• Communication systems (radio base sets, mobile networks) are easily damaged by surges and lack redundancy.</li> <li>• Power dependency is high — few stations have solar or generator backups, so power loss instantly disrupts coordination.</li> <li>• Vehicles and metal equipment are often stored in open compounds without protective sheds, increasing risk during lightning events.</li> <li>• Personnel safety protocols for thunderstorms are minimal — limited training, no emergency shelters, and no weather alert system for staff deployment.</li> <li>• Repairs after thunderstorm damage are slow due to limited budget and spare parts, leading to prolonged downtime.</li> </ul>	High	Major

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Emergency response teams are experienced but not equipped with storm-specific protective infrastructure.</li> <li>Generator backup exists at the hospital but not uniformly across all emergency units.</li> <li>No integrated early-warning system tailored to emergency services deployment.</li> <li>Inter-agency coordination exists but is reactive rather than forecast-based.</li> <li>Resource limitations constrain proactive resilience upgrades.</li> </ul>		
<b>Populations</b>					
Urban Residents	<ul style="list-style-type: none"> <li>Residential estates in Kimillili CBD, Milo, Maeni, and surrounding wards are directly exposed to intense rainfall, strong winds, and lightning during thunderstorms.</li> <li>Unpaved residential streets are exposed to flash runoff and localized flooding.</li> <li>Overhead electricity connections in residential plots are exposed to lightning surges and wind damage.</li> <li>Homes located near drainage corridors are exposed to temporary surface flooding.</li> <li>Tree-lined neighborhoods are exposed to falling branches and debris impact.</li> </ul>	High	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Many houses use lightweight corrugated iron sheets loosely fixed to timber frames, increasing wind uplift risk.</li> <li>Plot-level drainage is inadequate, leading to compound flooding.</li> <li>Electrical wiring and earthing systems are often substandard.</li> <li>Encroachment into drainage lines increases structural exposure.</li> <li>Limited routine tree maintenance increases risk of branch fall.</li> <li>Household goods are stored at ground level, increasing flood damage risk</li> </ul>	High	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Residents perform minor repairs but lack capital for structural retrofitting.</li> <li>No municipal early-warning SMS or alert system in operation.</li> <li>Insurance penetration remains extremely low.</li> <li>Community groups respond after events but lack tools and coordination.</li> <li>County support is limited to post-event damage assessment.</li> <li>Some households have informal coping strategies (temporary relocation to relatives).</li> </ul>		
Informal Settlement Residents	<ul style="list-style-type: none"> <li>Informal settlements in Kibingei, Kamukuywa outskirts, and riparian zones are directly exposed to intense rainfall, strong winds, and lightning during thunderstorms.</li> <li>Dwellings located along drainage paths are exposed to flash runoff and surface flooding.</li> <li>High-density informal housing clusters are exposed to rapid water accumulation due to absence of engineered drainage.</li> <li>Informal electricity connections are exposed to lightning and surge events.</li> <li>Narrow access paths are exposed to obstruction by debris and fallen structures.</li> </ul>	High	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Houses constructed from iron sheets, mud walls, and timber frames are highly vulnerable to wind uplift and collapse.</li> <li>Structures lack secure foundations and anchorage systems.</li> <li>Drainage infrastructure is absent, causing prolonged stagnation after storms.</li> <li>Informal wiring increases electrocution risk during lightning events.</li> <li>Overcrowding amplifies health and safety risks during roof collapse or flooding.</li> <li>Household assets are easily destroyed due to ground-level storage and lack of waterproofing.</li> </ul>	High	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			<p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>• Very limited financial capacity for structural reinforcement.</li> <li>• Absence of secure land tenure discourages permanent housing upgrades.</li> <li>• No formal relocation or upgrading program operational.</li> <li>• Emergency shelter options are temporary (churches, schools) and not storm-rated.</li> <li>• County disaster response is reactive and resource-constrained.</li> <li>• No structured early-warning dissemination tailored to informal settlements.</li> </ul>		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Vulnerable and Marginalized Groups	<ul style="list-style-type: none"> <li>Elderly persons, persons with disabilities (PWDs), children, and women-headed households reside in areas directly exposed to heavy rainfall, strong winds, and lightning.</li> <li>Many vulnerable individuals depend on structurally weak housing located in storm-prone zones.</li> <li>Outdoor workers, street vendors, and casual laborers are exposed to lightning and wind hazards during active storms.</li> <li>Children attending schools without lightning protection are exposed during daytime storm events.</li> <li>Marginalized households rely on electricity and water systems vulnerable to storm disruption.</li> </ul>	High	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Limited mobility makes evacuation during sudden storms difficult for elderly and PWDs.</li> <li>Pre-existing medical conditions increase susceptibility to injury and stress during severe weather.</li> <li>Children are highly vulnerable to structural collapse and electrocution risk.</li> <li>Women-headed households often lack financial resources for immediate repairs.</li> <li>Low-income households lack protective infrastructure such as reinforced roofing or safe wiring.</li> <li>Homeless and street families are fully exposed to wind and lightning hazards</li> </ul>	High	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>• Social protection systems are not structured specifically for storm events.</li> <li>• No formal municipal relocation centers designed for severe weather emergencies.</li> <li>• Early-warning information does not consistently reach marginalized groups.</li> <li>• Civil society and churches provide temporary relief but lack sustained recovery funding.</li> <li>• Insurance and financial buffers are minimal or nonexistent.</li> <li>• Recovery depends heavily on informal aid networks.</li> </ul>		
<b>Natural Assets</b>					
Urban Green Infrastructure	<ul style="list-style-type: none"> <li>• Urban trees along major roads, CBD streets, and public compounds are exposed to strong winds and lightning during thunderstorms.</li> <li>• Landscaped strips and public gardens are exposed to intense rainfall and short-duration soil saturation.</li> <li>• Trees in Kimilili CBD, Kamukuywa, and Maeni are exposed to uprooting where soils become waterlogged.</li> <li>• Vegetation near power lines and drainage corridors is exposed to wind-driven breakage.</li> </ul>	Medium	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>• Common street tree species such as Grevillea and Jacaranda are tall and shallow-rooted, increasing windthrow risk.</li> <li>• Compacted urban soils reduce root anchorage strength.</li> <li>• Limited routine pruning increases branch breakage during gusts.</li> <li>• Absence of structured tree health assessments increases hazard risk.</li> <li>• Lack of proper spacing between trees and infrastructure increases damage potential.</li> </ul>	Medium	Moderate

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	<ul style="list-style-type: none"> <li>Green spaces located on compacted soils are exposed to rapid runoff during heavy rainfall bursts.</li> </ul>		<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>No formal urban forestry unit or arboricultural expertise within the municipality.</li> <li>Emergency tree removal is reactive and budget-constrained.</li> <li>Collaboration with Kenya Forest Service occurs mainly during planting drives, not storm management.</li> <li>Community greening initiatives do not systematically incorporate storm-resilient species selection.</li> <li>Public awareness on safe tree planting near buildings is inconsistent.</li> </ul>		
Urban Blue Infrastructure	<ul style="list-style-type: none"> <li>Rivers in Kimilili and its tributaries are exposed to sudden flash rises during high-intensity convective storms.</li> <li>Urban stormwater drains discharge directly into rivers without sediment traps, increasing debris inflow during thunderstorms.</li> <li>Low-lying riverbank sections near Kimilili Market and residential fringes are exposed to temporary overtopping.</li> <li>Bridges and culvert crossings are exposed to debris accumulation during storm surges.</li> </ul>	Medium	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>River corridors are narrowed by encroachment, reducing conveyance capacity.</li> <li>Riparian vegetation is insufficient to stabilize banks against scouring.</li> <li>Absence of upstream retention basins increases rapid runoff discharge into channels.</li> <li>Sediment and solid waste accumulation reduces effective channel depth.</li> <li>Lack of hydrometric monitoring prevents early warning of rapid water level rise.</li> </ul>	High	Major

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	<ul style="list-style-type: none"> <li>Encroached riparian corridors are exposed to rapid flow velocity increases during peak rainfall bursts.</li> </ul>		<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Desilting activities by county and community groups are irregular.</li> <li>No engineered riverbank stabilization works (e.g., gabions, revetments) in urban reach.</li> <li>Weak enforcement of riparian setback regulations.</li> <li>Residents rely on experiential knowledge rather than formal warning systems.</li> <li>Post-event cleanup is ad hoc and not systematically planned.</li> </ul>		
Peri-urban and Agricultural Systems	<ul style="list-style-type: none"> <li>Peri-urban farms in Maeni, Kamukuywa, and Kibingei wards are exposed to high-intensity rainfall, strong winds, and occasional hail during convective storm events.</li> <li>Crop fields located on sloping terrain are exposed to rapid surface runoff and soil erosion during short-duration downpours.</li> <li>Greenhouses and temporary crop shelters are exposed to wind uplift and structural tearing.</li> <li>Livestock enclosures constructed from light materials are exposed to storm damage.</li> <li>Farm access roads are exposed to washouts and temporary impassability following intense rainfall bursts.</li> </ul>	Medium	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Smallholder farms rely on lightweight crop shelters and temporary fencing vulnerable to wind damage.</li> <li>Limited contouring and soil conservation increase erosion during intense rainfall.</li> <li>Windbreaks and agroforestry buffers are insufficient in many farms.</li> <li>Drainage within farm plots is minimal, increasing waterlogging risk for sensitive crops.</li> <li>Livestock housing often lacks anchorage and storm-resistant design.</li> </ul>	Medium	moderate

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			<p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>• Farmers employ traditional coping strategies such as early harvesting and replanting.</li> <li>• Extension services exist but provide limited storm-specific advisory support.</li> <li>• Access to agricultural insurance remains low.</li> <li>• Credit access for post-storm recovery is limited.</li> <li>• Few organized farmer cooperatives coordinate preventive soil conservation or storm-resilient infrastructure.</li> <li>• County agricultural assessments are mostly post-event rather than preventive.</li> </ul>		

#### 4. Climate Risk Assessment

The climate risk assessment for Kimilili Municipality integrates findings from the previous sections on hazard, exposure, and vulnerability to determine the overall level of climate risk. Each hazard's risk level was derived by combining its estimated **impact** with its **likelihood of occurrence**, based on observed historical trends and projected future climate scenarios. The analysis considers both the **current climate conditions** and **future projections for 2050 and 2100** under two scenarios (SSP2-4.5 and SSP5-8.5). The results provide an indication of how climate hazards are likely to evolve and which urban systems are most exposed to potential losses. The following tables summarize the overall risk levels for the identified hazards and highlight the sectors and areas most affected within the 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 18 Risk matrix**

		Hazard Level		
		Low	Medium	High
Impact Level	Catastrophic	High	Very High	Very High
	Major	Medium	High	Very High
	Moderate	Low	Medium	High
	Minor	Low	Low	Medium
	Insignificant	Very Low	Low	Low

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

**Table 19 Interpretation of risk levels**

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

#### 4.1. Current and Future Climate Risks on Urban Elements

**Table 20 Summary of average surface temperature increase risks for kimilili municipality**

	<b>Time Horizon &amp; Climate Scenario</b>	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	<b>Hazard Level</b>	Medium	High	High	High	High
<b>Categories</b>	<b>Impact</b>	<b>Risk Levels</b>				
		<b>Current</b>	<b>2050 SSP2-4.5</b>	<b>2050 SSP5-8.5</b>	<b>2100 SSP2-4.5</b>	<b>2100 SSP5-8.5</b>
<b>Infrastructure &amp; Services</b>						
Stormwater Drainage	Major	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	Moderate	Medium	High	High	High	High
Transport and Mobility	Catastrophic	Very high	Very high	Very high	Very high	Very high
Energy	Moderate	Medium	High	High	High	High
Economic Infrastructure	Moderate	Medium	High	High	High	High
Social Infrastructure	Major	High	Very high	Very high	Very high	Very high
Emergency Services	Moderate	Medium	High	High	High	High
<b>Populations</b>						
Urban Residents	Major	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
<b>Natural Assets</b>						
Urban Green Infrastructure	Major	High	Very high	Very high	Very high	Very high
Urban Blue Infrastructure	Moderate	Medium	High	High	High	High
Peri-urban and Agricultural Systems	Catastrophic	Very high	Very high	Very high	Very high	Very high

**Table 21 Summary of pluvial flooding risks for kimilili municipality**

	<b>Time Horizon &amp; Climate Scenario</b>	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	<b>Hazard Level</b>	Medium	Medium	High	High	High
<b>Categories</b>	<b>Impact</b>	<b>Risk Levels</b>				
		<b>Current</b>	<b>2050 SSP2-4.5</b>	<b>2050 SSP5-8.5</b>	<b>2100 SSP2-4.5</b>	<b>2100 SSP5-8.5</b>
<b>Infrastructure &amp; Services</b>						
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	Major	High	High	Very high	Very high	Very high
Transport and Mobility	Major	High	High	Very high	Very high	Very high
Energy	Moderate	Medium	Medium	High	High	High
Economic Infrastructure	Catastrophic	Very high	Very high	Very high	Very high	Very high
Social Infrastructure	Major	High	High	Very high	Very high	Very high
Emergency Services	Major	High	High	Very high	Very high	Very high
<b>Populations</b>						
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
<b>Natural Assets</b>						
Urban Green Infrastructure	Moderate	Medium	Medium	High	High	High
Urban Blue Infrastructure	Moderate	Medium	Medium	High	High	High
Peri-urban and Agricultural Systems	Minor	Low	Low	Medium	Medium	Medium

**Table 22 Summary of metrological drought (dry spell) risks for kimilili municipality**

<b>Time Horizon &amp; Climate Scenario</b>	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
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	<b>Hazard Level</b>	Medium	High	High	High	High
<b>Categories</b>	<b>Impact</b>	<b>Risk Levels</b>				
		<b>Current</b>	<b>2050 SSP2-4.5</b>	<b>2050 SSP5-8.5</b>	<b>2100 SSP2-4.5</b>	<b>2100 SSP5-8.5</b>
<b>Infrastructure &amp; Services</b>						
Stormwater Drainage	Insignificant	Low	Low	Low	Low	Low
Water & Wastewater Management	Catastrophic	Very high	Very high	Very high	Very high	Very high
Solid Waste Management	Moderate	Medium	High	High	High	High
Transport and Mobility	Moderate	Medium	High	High	High	High
Energy	Insignificant	Low	Low	Low	Low	Low
Economic Infrastructure	Moderate	Medium	High	High	High	High
Social Infrastructure	Major	High	Very high	Very high	Very high	Very high
Urban Residents	Major	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
<b>Natural Assets</b>						
Urban Green Infrastructure	Major	High	Very high	Very high	Very high	Very high
Urban Blue Infrastructure	Moderate	Medium	High	High	High	High
Peri-urban and Agricultural Systems	Major	High	Very high	Very high	Very high	Very high

**Table 23 Summary of thunderstorms risks for kimilili municipality**

	<b>Time Horizon &amp; Climate Scenario</b>	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	<b>Hazard Level</b>	Medium	Medium	High	High	High
<b>Categories</b>	<b>Impact</b>	<b>Risk Levels</b>				
		<b>Current</b>	<b>2050 SSP2-4.5</b>	<b>2050 SSP5-8.5</b>	<b>2100 SSP2-4.5</b>	<b>2100 SSP5-8.5</b>
<b>Infrastructure &amp; Services</b>						

Stormwater Drainage	Catastrophic	Very high				
Water & Wastewater Management	Catastrophic	Very high				
Solid Waste Management	Major	High	High	Very high	Very high	Very high
Transport and Mobility	Major	High	High	Very high	Very high	Very high
Energy	Major	High	High	Very high	Very high	Very high
Economic Infrastructure	Catastrophic	Very high				
Social Infrastructure	Major	High	High	Very high	Very high	Very high
Emergency Services	Major	High	High	Very high	Very high	Very high
<b>Populations</b>						
Urban Residents	Catastrophic	Very high				
Informal Settlement Residents	Catastrophic	Very high				
Vulnerable and Marginalized Groups	Catastrophic	Very high				
<b>Natural Assets</b>						
Urban Green Infrastructure	Moderate	Medium	Medium	High	High	High
Urban Blue Infrastructure	Moderate	Medium	Medium	High	High	High
Peri-urban and Agricultural Systems	Moderate	Medium	Medium	High	High	High

#### 4.2. Climate Risk Hotspots

Climate change risks in **Kimilili Municipality** are distributed across the four wards—Kimilili, Maeni, Kibingei and Kamukuywa—though the severity, magnitude and spatial extent vary depending on settlement patterns, natural drainage systems and livelihood dependence. The major climate hazards affecting the municipality include prolonged dry spells, rising temperatures, intense thunderstorms with heavy rainfall and pluvial flooding in built-up areas.

Dry spells have led to reduced rainfall during the long rain season, resulting in drying up of crops, pastures and fodder, and reduced recharge of springs and rivers. This has contributed to encroachment into water catchment areas and riparian lands as communities search for water and farming space. In Kimilili Ward, the most affected areas include Khamulati, Matili Springs, Pasi Palm, Sitabicha, Maburu, Sango River, Misikhu River and Matili River. In Kamukuywa Ward, Masinde and Musembe springs, as well as Kamukuywa and Sosio rivers, are affected. In Kibingei Ward, impacts are evident in Kibingei, Khwiroro, Daraja Mungu, Kamusinga, Namakhele and Miruri. Dry spells also affect the entire ward of Maeni due to its strong reliance on rain-fed agriculture. Reduced rainfall has led to crop failure, pasture shortages and declining water availability for both domestic and livestock use.

Rising temperatures have compounded the impacts of dry spells across all four wards. Increased heat has accelerated evapotranspiration, reducing soil moisture and lowering crop

productivity, particularly in Maeni and Kibingei where farming is the primary livelihood. In Kimilili Ward, higher temperatures have intensified heat stress in the town centre due to expanding built-up areas and reduced tree cover, creating localized urban heat conditions. In Kamukuywa, increased daytime temperatures affect market activities and livestock, while also accelerating the drying of shallow water sources. Overall, temperature rise is amplifying water stress, reducing agricultural yields and increasing vulnerability of livelihoods throughout the municipality.

Unpredictable heavy rainfall and intense thunderstorms have also increased in frequency. These events cause destruction of infrastructure, displacement of people and livestock, and flooding of farms. Areas most affected include those along Sitabicha, Matili and Misikhu rivers, as well as Kibunde, Kitayi, Siuna, Daraja Mungu and Lutonyi. The combination of saturated soils and high runoff intensifies flood risks across the municipality.

In addition to riverine, pluvial flooding (surface water flooding) has become increasingly significant, particularly in urban and peri-urban settings. In Kimilili Ward, especially within Kimilili town centre, heavy downpours overwhelm drainage systems, leading to flooding of roads, shops and residential areas. Blocked or inadequate stormwater drains and expansion into natural drainage paths increase the severity of flooding. Similarly, Kamukuywa Market in Kamukuywa Ward experiences surface water accumulation during intense rainfall, disrupting trade and damaging informal business structures. In peri-urban and agricultural areas of Kibingei and Maeni, pluvial flooding results in waterlogging of crops, soil erosion and damage to rural access roads.

Overall, the distribution of climate hazards in Kimilili Municipality shows that dry spells and rising temperatures affect all four wards, with the greatest livelihood impacts in Maeni and Kibingei due to agricultural dependence. Urbanized areas such as Kimilili town and Kamukuywa market are more exposed to pluvial flooding due to inadequate drainage and increased impervious surfaces. River-adjacent areas across the wards remain highly vulnerable to heavy rainfall and flooding. The variation in hazard severity across the municipality is closely linked to land use patterns, settlement density, drainage infrastructure and reliance on natural resources

## 5. What's next?

### 5.1. Key Findings

The Urban Climate Risk Profile for Kimilili Municipality reveals a clear pattern of escalating climate risk driven by increasing temperatures, more intense rainfall events, recurrent drought conditions, and strengthening convective storms. The interaction between these hazards and existing urban vulnerabilities significantly amplifies potential impacts across infrastructure systems, natural assets, and populations.

Several critical findings emerge:

First, water and wastewater management systems represent the most climate-sensitive infrastructure category. Both pluvial flooding and meteorological drought pose catastrophic risks under current and future scenarios. Flood events threaten contamination and infrastructure damage, while prolonged dry spells reduce water availability and increase system strain. Without structural upgrades and diversified water sourcing, future climate conditions will severely compromise service reliability.

Second, informal settlement residents and vulnerable groups consistently rank in the catastrophic risk category across multiple hazards. High-density housing, limited drainage, insecure tenure, low-income levels, and minimal adaptive capacity combine to create disproportionate climate exposure. Climate impacts in these areas are not only environmental but socio-economic and public health crises.

Third, stormwater drainage systems are under-designed for projected rainfall intensities. Even under moderate emission scenarios, extreme rainfall frequency increases significantly by mid-century. Existing open channels, undersized culverts, and unplanned development along drainage corridors elevate flood risk.

Fourth, temperature rise represents a cross-cutting hazard affecting nearly all urban elements. Heat stress exacerbates water loss, degrades infrastructure materials, reduces economic productivity, and intensifies health risks. By 2050 and especially by 2100 under SSP5-8.5, heat-related risks shift from moderate to high and very high across most categories.

Fifth, peri-urban agricultural systems face compounding risks from both drought and intense rainfall. Yield instability, soil erosion, and livestock stress threaten food security and income stability, reinforcing urban poverty dynamics.

Finally, adaptive capacity across sectors remains moderate to low. While institutional structures exist, climate-proofing standards, early warning systems, dedicated contingency financing, and preventive maintenance programs remain insufficient.

Collectively, these findings confirm that climate risk in Kimilili Municipality is systemic, multi-sectoral, and projected to intensify without deliberate intervention.

### 5.1.1 Hazards and trends:

Average annual temperatures are projected to increase by approximately +1.8 °C to +2.3 °C under SSP2-4.5 and +2.2 °C to +2.8 °C under SSP5-8.5 by 2050, with further warming toward the end of the century under high-emission pathways.

### 5.1.2 Populations and assets at risk:

Vulnerable groups—particularly residents of informal settlements, low-income households, women-headed families, the elderly, and persons with disabilities—are disproportionately exposed due to inadequate housing, limited resources, and restricted access to services. Physical assets at highest risk include storm-water and transport infrastructure, water and sanitation networks, markets, health facilities, and energy lines. Natural assets such as rivers, wetlands, and urban vegetation are being degraded by both floods and droughts, reducing their protective functions.

### 5.1.3 Future-intensifying trends:

Rising heat combined with shrinking green cover will worsen the urban-heat-island effect. Expanding built-up areas without sufficient drainage will aggravate flooding, while population pressure along riparian zones will heighten health and livelihood risks. Drought-driven water scarcity is projected to increase competition for limited resources, and weak institutional coordination will magnify multi-hazard impacts unless adaptive infrastructure and early-warning systems are strengthened.

**Table 24 Summary of climate risks affecting urban elements for kimilili municipality**

Category	List of Key Hazards		
	Current	Mid-term (2050)	Long-term (2100)
<b>Infrastructure &amp; Services</b>			
Stormwater Drainage	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> <li>• Surface temperature increase</li> </ul>	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> <li>• Surface temperature increase</li> </ul>	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> <li>• Surface temperature increase</li> </ul>
Water & Wastewater Management	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> <li>• Surface temperature increase</li> <li>• Drought</li> </ul>	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> <li>• Surface temperature increase</li> <li>• Drought</li> </ul>	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> <li>• Surface temperature increase</li> <li>• Drought</li> </ul>

Category	List of Key Hazards		
	Current	Mid-term (2050)	Long-term (2100)
Solid Waste Management	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> </ul>	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> <li>• Surface temperature increase</li> <li>• Drought</li> </ul>	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> <li>• Surface temperature increase</li> <li>• Drought</li> </ul>
Transport and Mobility	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> </ul>	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> </ul>	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> </ul>
Energy	Thunderstorms	Thunderstorms, pluvial flooding (scenario 8.5)	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> </ul>
Economic Infrastructure	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> </ul>	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> <li>• Drought</li> <li>• Surface temperature increase</li> </ul>	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> <li>• Drought</li> <li>• Surface temperature increase</li> </ul>
Social Infrastructure	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> <li>• Drought</li> <li>• Surface temperature increase</li> </ul>	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> <li>• Drought</li> <li>• Surface temperature increase</li> </ul>	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> <li>• Drought</li> <li>• Surface temperature increase</li> </ul>
Emergency Services	<ul style="list-style-type: none"> <li>• Pluvial flooding</li> <li>• Thunderstorms</li> </ul>	<ul style="list-style-type: none"> <li>• Pluvial flooding</li> <li>• Thunderstorms</li> </ul>	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> <li>• Surface temperature increase</li> </ul>
<b>Populations</b>			
Urban Residents	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> <li>• Drought</li> <li>• Surface temperature increase</li> </ul>	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> <li>• Drought</li> <li>• Surface temperature increase</li> </ul>	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> <li>• Drought</li> <li>• Surface temperature increase</li> </ul>

Category	List of Key Hazards		
	Current	Mid-term (2050)	Long-term (2100)
Informal Settlement Residents	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> <li>• Drought</li> <li>• Surface temperature increase</li> </ul>	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> <li>• Drought</li> <li>• Surface temperature increase</li> </ul>	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> <li>• Drought</li> <li>• Surface temperature increase</li> </ul>
Vulnerable and Marginalized Groups	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> <li>• Drought</li> <li>• Surface temperature increase</li> </ul>	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> <li>• Drought</li> <li>• Surface temperature increase</li> </ul>	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> <li>• Drought</li> <li>• Surface temperature increase</li> </ul>
<b>Natural Assets</b>			
Urban Green Infrastructure	<ul style="list-style-type: none"> <li>• Drought</li> <li>• Surface temperature increase</li> </ul>	<ul style="list-style-type: none"> <li>• Thunderstorms (scenario 8.5)</li> <li>• Drought</li> <li>• Pluvial flooding (scenario 8.5)</li> <li>• Surface temperature increase</li> </ul>	<ul style="list-style-type: none"> <li>• Thunderstorms (scenario 8.5)</li> <li>• Drought</li> <li>• Pluvial flooding (scenario 8.5)</li> <li>• Surface temperature increase</li> </ul>
Urban Blue Infrastructure		<ul style="list-style-type: none"> <li>• Surface temperature increase</li> <li>• Pluvial flooding (scenario 8.5)</li> <li>• Drought</li> <li>• Thunderstorms (scenario 8.5)</li> </ul>	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Pluvial flooding</li> <li>• Drought</li> <li>• Surface temperature increase</li> </ul>
Peri-urban and Agricultural Systems	<ul style="list-style-type: none"> <li>• Drought</li> <li>• Surface temperature increase</li> </ul>	<ul style="list-style-type: none"> <li>• Thunderstorms (scenario 8.5)</li> <li>• Drought</li> <li>• Surface temperature increase</li> </ul>	<ul style="list-style-type: none"> <li>• Thunderstorms</li> <li>• Drought</li> <li>• Surface temperature increase</li> </ul>

## **5.2. Climate Adaptation and Resilience Solutions**

***Table 25 Climate adaptation and resilience solutions recommended for kimilili municipality***

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
<b>Infrastructure &amp; Services</b>			
Storm water Drainage	<ul style="list-style-type: none"> <li>De-silting and clearing of existing drains in high-risk areas, such as the central business district and market zones, to ensure that water flows freely and reduces flooding.</li> <li>Installation of temporary flood barriers, like sandbags and coir logs, at key vulnerable points to prevent immediate water ingress during heavy rains.</li> <li>Community-driven clean-up initiatives to remove debris and waste from drains, ensuring that stormwater can flow without obstruction.</li> <li>Implementation of small rain gardens in public spaces, which help absorb and filter stormwater, reducing runoff and enhancing local greenery.</li> <li>Integrate green infrastructure, such as vegetated swales, with traditional drainage systems to promote natural water infiltration and reduce flood risks.</li> <li>Conduct public awareness</li> </ul>	<ul style="list-style-type: none"> <li>Develop a comprehensive Drainage Master Plan, integrating climate projections to 2050, ensuring that all new infrastructure is designed to handle future rainfall and storm intensity.</li> <li>Construct large-scale retention basins and underground storage tanks to manage peak stormwater and reduce flooding risks.</li> <li>Upgrade existing drainage infrastructure with climate-resilient materials and improved designs, ensuring longevity and performance under future climate conditions.</li> <li>Expand urban wetlands and restore riparian buffers to naturally filter and absorb stormwater, reducing runoff and enhancing biodiversity.</li> <li>Implement green roofs and green walls on public buildings and</li> </ul>	<ul style="list-style-type: none"> <li>Construct extensive underground stormwater storage systems that can handle extreme rainfall events and reduce urban flooding. These systems can include large cisterns and tunnels that store and gradually release water, preventing overflow.</li> <li>Upgrade roads and transportation networks with climate-resilient materials and elevated designs to prevent flooding and maintain connectivity.</li> <li>Implement zoning regulations that prevent construction in high-risk flood zones and promote the development of green spaces that can absorb excess water.</li> <li>Design multifunctional landscapes, such as parks and wetlands, that can both provide recreational spaces and function as natural flood control.</li> <li>Protect and restore upstream catchments, including forests and wetlands, to reduce runoff and improve water quality. This approach helps in maintaining the natural hydrology and buffering against extreme weather.</li> <li>Expand green infrastructure, such as</li> </ul>

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
	<p>campaigns to educate residents on the benefits of these combined approaches and encourage community participation.</p>	<p>commercial structures to manage stormwater at the source and reduce heat island effects.</p> <ul style="list-style-type: none"> <li>• Increase urban tree canopies throughout the municipality to help intercept rainfall and improve water infiltration.</li> </ul>	<p>large-scale urban forests and native grasslands, that naturally manage stormwater and provide ecosystem services.</p> <ul style="list-style-type: none"> <li>• Implement advanced green-grey hybrid systems, combining engineered solutions with nature-based elements. For instance, integrating permeable pavements with urban green spaces to maximize water infiltration and reduce runoff.</li> <li>• Empower local communities through education and participatory planning, ensuring that residents are active stakeholders in resilience-building.</li> <li>• Promote climate adaptation awareness campaigns to foster a culture of resilience and preparedness.</li> </ul>
Water & Waste water Management	<ul style="list-style-type: none"> <li>• Rehabilitate existing water supply and wastewater lines damaged by floods and blockages; seal leaks to minimize losses.</li> <li>• Map and fence critical water points and sewer ponds to prevent contamination during floods (World Bank 2023 – Urban Resilient Infrastructure Guideline).</li> <li>• Install emergency boreholes and</li> </ul>	<ul style="list-style-type: none"> <li>• Expand piped-water network coverage using climate-resilient materials (PVC-HDPE) and elevated storage tanks to safeguard against flood contamination</li> <li>• Integrate smart water-metering and leakage-detection technologies to improve efficiency and reduce non-revenue water.</li> <li>• Implement watershed-scale catchment</li> </ul>	<ul style="list-style-type: none"> <li>• Transition to integrated urban water management (IUWM) that couple's stormwater, potable water, and wastewater systems for circular reuse and efficiency</li> <li>• Construct large-capacity, dual-purpose reservoirs and infiltration basins upstream to store excess rainwater during wet years for dry-season use</li> <li>• Implement full wastewater recycling for irrigation and industrial use using advanced treatment</li> </ul>

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
	<p>rainwater-harvesting systems at schools, health facilities, and markets to enhance short-term water access during droughts.</p> <ul style="list-style-type: none"> <li>Strengthen routine O&amp;M programs—train municipal staff in preventive maintenance of pumps, treatment ponds, and septic systems.</li> <li>Promote household-level grey-water reuse (e.g., bucket irrigation) and public hygiene campaigns in collaboration with health officers (UN-Habitat 2018 CityRAP).</li> <li>Pilot low-cost nature-based filtration systems such as reed-bed treatment wetlands near existing wastewater ponds (GCA 2025 Nature-based Compendium).</li> </ul>	<p>protection programs—riparian buffer planting, spring protection, and afforestation of micro-catchments feeding Kimilili’s water</p> <ul style="list-style-type: none"> <li>Promote water-reuse regulations for non-potable purposes (car washing, landscaping) through municipal</li> <li>Introduce gender-responsive training for water committees to ensure equitable access and management</li> </ul>	<ul style="list-style-type: none"> <li>Restore and protect natural aquifer recharge zones through long-term zoning and land-use control; prohibit encroachment on springs and wetlands</li> <li>Establish a county-wide Water-Safety and Drought-Resilience Authority to coordinate long-term resource planning and financing</li> <li>Adopt next-generation smart monitoring with AI-driven flood and drought forecasting linked to municipal command centres</li> <li>Ensure continuous gender and social inclusion mainstreaming in policy, planning, and budgeting for water services</li> </ul>
Solid Waste Management	<ul style="list-style-type: none"> <li><b>Increase collection frequency in flood-prone wards &amp; markets:</b> reprogram municipal collection rounds to prioritize high-risk wards (CBD, main market precincts, riparian informal settlements) ahead of peak rainy seasons to prevent</li> </ul>	<ul style="list-style-type: none"> <li><b>Develop and implement a municipal integrated solid waste management plan (ISWMP):</b> incorporate climate risk screening, routing optimization, protected transfer stations, phased closure and</li> </ul>	<ul style="list-style-type: none"> <li><b>Construct engineered sanitary landfill with full climate resilience:</b> develop one or more regional engineered sanitary landfills outside floodplains with composite liners, leachate collection and treatment plants, landfill-gas capture and utilization (energy</li> </ul>

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
	<p>drain blockages and reduce vector risks.</p> <ul style="list-style-type: none"> <li>• <b>Designate and equip emergency waste storage sites:</b> identify elevated, accessible temporary emergency stockpiles for flood events (lined with tarpaulin &amp; covered skips), with standard operating procedures for rapid deployment and safe removal after the event.</li> <li>• <b>Rapidly upgrade choke-point collection infrastructure:</b> install raised, lockable skips and covered containers at markets and bus termini to prevent spillover during storms and reduce littering. Ensure containers have drainage protection to avoid leachate escape.</li> <li>• <b>Community waste-management brigades &amp; informal sector integration:</b> formalize and train informal waste pickers into paid or stipend-based brigades for clean-ups, segregation at source, and drain clearing; equip with PPE and simple tools. Use cash-for-work during rainy season.</li> <li>• <b>Immediate anti-dumping enforcement &amp;</b></li> </ul>	<p>rehabilitation plan for dumpsites, and integration with drainage plans to avoid co-location of critical assets in floodway.</p> <ul style="list-style-type: none"> <li>• <b>Construct decentralized material recovery facilities (MRFs) &amp; recycling value chains:</b> scale up community MRFs to divert organics and recyclables; provide equipment (baling, shredders) and develop local markets for recycles,</li> <li>• <b>Leachate management via hybrid systems:</b> build constructed reed-bed wetlands or phytoremediation basins as part of transfer station</li> <li>• <b>Institutional strengthening &amp; formal contracts:</b> professionalize service delivery via performance-based</li> <li>• <b>Spatial planning &amp; by-laws:</b> update municipal bylaws to require on-site waste storage design for new developments, prohibit dumping in waterways, and mandate waste buffering zones around drains; integrate into building permit checks.</li> <li>• <b>Market &amp; institutional waste</b></li> </ul>	<p>recovery), and permanent green buffer zones</p> <ul style="list-style-type: none"> <li>• <b>Integrate waste systems into circular economy at scale:</b> build industrial-scale recycling &amp; composting hubs, waste-to-energy</li> <li>• <b>Major institutional &amp; financing reforms:</b> establish a dedicated Solid Waste Resilience Fund (blended finance: county allocations, user fees, climate funds) for capital investments, O&amp;M trust, and community grants; formalize long-term PPP frameworks for service delivery with social inclusion safeguards.</li> <li>• <b>Advanced leachate &amp; air pollution controls:</b> implement advanced leachate treatment</li> <li>• <b>Institutionalized circular economy &amp; producer responsibility:</b> enforce Extended Producer Responsibility (EPR) schemes and producer take-back for packaging to drastically reduce municipal solid waste entering drains and waterways</li> <li>• <b>Long-term community resilience &amp; livelihoods:</b> scale social enterprises around recycling and composting, with training, microfinance and guaranteed procurement channels for recycled products to support inclusive livelihoods</li> </ul>

Category	Recommended Solutions		
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	<p><b>awareness:</b> run targeted behavior-change campaigns (markets, schools, kiosks) and enforce temporary fines for dump blocking of drains; publicize collection schedules and reporting hotlines.</p> <ul style="list-style-type: none"> <li>• <b>Temporary elevation/relocation of critical small waste sites:</b> where small transfer points sit in floodplain, elevate the pad with compacted aggregates or relocate to proximate higher ground as an emergency measure</li> <li>• <b>Health &amp; environmental monitoring during floods:</b> rapid post-flood inspections for hazardous wastes, vector breeding, and contamination of water bodies; issue public health advisories and coordinate with clinics for vaccination/medical outreach.</li> </ul>	<p><b>minimization programs:</b> implement food-waste reduction and organic diversion at markets via composting hubs</p> <ul style="list-style-type: none"> <li>• <b>Behavioral change &amp; school curriculum:</b> mainstream waste segregation and environmental stewardship into school curricula and market vendor licensing programs to shift behaviors long term.</li> </ul>	
<b>Transport and Mobility</b>	<ul style="list-style-type: none"> <li>• <b>Rapid vulnerability screening of key corridors:</b> conduct a desk + field assessment to identify roads, bridges, footpaths and crossings frequently inundated or blocked during storms (CBD →</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Climate-proof road design standards:</b> adopt municipal technical standards requiring increased carriageway camber, larger culverts sized to 2050 extreme rainfall projections, raised low-lying sections, and</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Strategic re-routing and network redundancy:</b> design and progressively implement alternative strategic arterial routes placed outside multi-hazard hotspots so that by 2100 the urban network maintains connectivity under extreme events (1-in-100</li> </ul>

Category	Recommended Solutions		
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	<p>markets → health centres).</p> <ul style="list-style-type: none"> <li>• <b>Emergency clearing &amp; temporary repairs:</b> deploy rapid-response road crews to clear culverts, stabilize washed shoulders, fill potholes with compacted material, and install temporary raised walkways at low points to sustain pedestrian access during wet spells</li> <li>• <b>Protect critical access to emergency services:</b> map and sign alternate emergency routes; mark and maintain them before rainy seasons to preserve response times to clinics and fire/police posts</li> <li>• <b>Low-cost drainage retrofits for roads:</b> install simple side-drains, drop-inlet grates, and aggregate-filled infiltration trenches adjacent to key unpaved roads to reduce surface ponding and erosion</li> <li>• <b>Community awareness &amp; gender-sensitive mobility planning:</b> run targeted messaging for women, older people and PWDs about safe routes and service points during extreme events; ensure female</li> </ul>	<p>embankment armouring for priority routes. Update procurement &amp; contract specifications accordingly.</p> <ul style="list-style-type: none"> <li>• <b>Upgrade critical corridors to all-weather standards:</b> reconstruct primary access roads with improved sub-base, sub-surface drainage, sealed surfacing where feasible, and reinforced shoulders to resist scour under intense rainfall events.</li> <li>• <b>Construct resilient bridges and culverts:</b> replace undersized culverts with box/arched culverts or small-span bridges designed for 2050 hydraulic loads</li> <li>• <b>Multimodal, resilient public transport infrastructure:</b> invest in elevated bus stops, hardened staging areas for matatus/buses and secure parking for boda-bodas above flood lines to reduce service disruption and protect informal sector livelihoods.</li> <li>• <b>Safe route design for vulnerable users:</b> redesign pedestrian networks with raised crossings, ramped walkways, tactile</li> </ul>	<p>to 1-in-200-year events under SSP5-8.5).</p> <ul style="list-style-type: none"> <li>• <b>Green-grey transport corridors at scale:</b> institutionalize linear parks and multifunctional transport corridors with engineered wetlands, terraced retention basins and infiltration galleries that detain and treat major runoff while providing green connectivity and cooling for urban heat mitigation.</li> <li>• <b>Long-term maintenance endowments &amp; resilience funds:</b> establish dedicated infrastructure resilience funds (capital + endowment for perpetual O&amp;M) to ensure long-term upkeep of climate-proofed transport assets</li> <li>• <b>Retreat, re-use and land-use transformation:</b> where corridors cannot be protected economically, plan managed retreat with reallocation of former transport rights-of-way into water conveyance corridors, green spaces, or adaptive land uses that reduce hazard exposure.</li> <li>• <b>Inclusive mobility &amp; livelihood protection:</b> long-term programs to formalize and transition informal transport workers into resilient systems (training, credit access, protected commercial spaces) with social protection for climate shocks.</li> <li>• <b>Standards &amp; regulatory framework updates:</b> codify climate-resilient transport standards into</li> </ul>

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
	<p>participation in route planning.</p> <ul style="list-style-type: none"> <li>• <b>Quick-win greening for micro-infiltration:</b> plant shallow-rooted verge vegetation and grass strips along shoulders of key roads to intercept runoff and reduce erosion in small catchments.</li> <li>• <b>Short-term asset registers and simple M&amp;E:</b> compile a prioritized asset register (critical links, condition, exposure) and basic KPIs (days inaccessible per year, no. of emergency repairs) to inform mid-term planning.</li> </ul>	<p>paving and lighting to maintain safe mobility for women, children, elderly and PWDs during floods and heat waves</p> <ul style="list-style-type: none"> <li>• <b>Finance and PPP models for upgrades:</b> structure mid-term investment packages using blended finance (county funds, GCA/World Bank grants, concessional loans) for corridor upgrades; include lifecycle O&amp;M budgeting.</li> </ul>	<p>municipal building codes and procurement law, requiring life-cycle greenhouse gas and resilience assessments for major projects</p>
Energy	<ul style="list-style-type: none"> <li>• <b>Rapid assessment of critical energy assets:</b> map and inspect all existing substations, transformers, powerlines, and backup systems vulnerable to floods, lightning strikes, or erosion. Prioritize areas around markets, hospitals, and schools.</li> <li>• <b>Immediate reinforcement of vulnerable power infrastructure:</b> elevate and protect ground-mounted transformers or generators in flood-prone zones; clear vegetation and debris</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Grid resilience upgrading program:</b> climate-proof substations and distribution lines by elevating platforms, strengthening poles and anchorage, using insulated aerial cables, and relocating assets away from recurrently flooded corridors</li> <li>• <b>Develop decentralized renewable energy systems:</b> establish solar PV mini-grids, micro-hydro (if feasible near MUNICIPALITY RIVERS), and</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Transition to 100% resilient, renewable, and decentralized energy systems:</b> achieve full shift to renewable sources (solar, biogas, micro-hydro, wind) for municipal and household energy demand, ensuring redundancy and zero-carbon growth</li> <li>• <b>Construct regional energy resilience hubs:</b> large-scale solar farms or hybrid renewable hubs strategically located on elevated land supplying local micro-grids with climate-proofed substations</li> <li>• <b>Undergrounding or weather-resilient cabling systems:</b> progressively convert overhead</li> </ul>

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
	<p>near poles to prevent short circuits</p> <ul style="list-style-type: none"> <li>• <b>Install lightning arrestors and surge protection devices:</b> especially on critical municipal and health buildings to reduce damage from recurrent thunderstorms</li> <li>• <b>Promote short-term alternative power solutions:</b> distribute portable solar lamps and solar-powered streetlights for informal settlements and public spaces to enhance safety during grid outages</li> <li>• <b>Implement emergency energy backup systems:</b> procure and install solar mini-grids or hybrid generators for essential facilities (clinics, water pumps, disaster centers)</li> <li>• <b>Community awareness and quick training:</b> conduct local campaigns on energy safety during storms—avoiding illegal connections and educating on safe generator use</li> <li>• <b>Routine O&amp;M of existing assets:</b> introduce monthly inspections, vegetation management, and preventive maintenance schedules to reduce failure during heavy rains</li> </ul>	<p>community biogas plants to diversify supply and ensure redundancy during main-grid outages.</p> <ul style="list-style-type: none"> <li>• <b>Integrate clean energy into municipal infrastructure:</b> retrofit public buildings with rooftop solar and energy-efficient systems (LED lighting, solar water heating).</li> <li>• <b>Upgrade street and public lighting to solar-powered smart systems:</b> install solar LED lights with smart timers and motion sensors along major roads and vulnerable settlements for reliable, low-cost illumination</li> <li>• <b>Enact resilient energy and building codes:</b> require elevated placement of electrical components and flood-safe design in new developments; integrate renewable energy readiness requirements into planning approvals</li> <li>• <b>Promote inclusive access:</b> develop subsidized connection schemes for low-income and informal areas using flexible payment models to reduce</li> </ul>	<p>powerlines in densely populated or high-risk areas to underground insulated cables, minimizing storm-related failures</p> <ul style="list-style-type: none"> <li>• <b>Advanced storage and smart-grid integration:</b> implement large battery storage systems, AI-driven load management, and predictive maintenance for real-time climate adaptation and grid balance</li> <li>• <b>Ecosystem integration for cooling and resilience:</b> expand urban green belts around energy hubs to lower ambient temperature, improve panel efficiency, and reduce stormwater run-off risks</li> <li>• <b>Circular economy and waste-to-energy systems:</b> develop clean waste-to-energy facilities using advanced emissions controls for residual waste fractions, ensuring no air or water pollution)</li> <li>• <b>Institutional and policy reforms:</b> establish a Municipal Energy Resilience Authority responsible for climate-smart energy planning, financing, and community inclusion</li> <li>• <b>Gender-responsive renewable energy programs:</b> long-term empowerment programs for women and youth in renewable energy entrepreneurship and technical training</li> <li>• <b>Continuous adaptive management:</b></li> </ul>

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
	<ul style="list-style-type: none"> <li>• <b>Pilot decentralized clean cooking solutions:</b> promote adoption of improved cookstoves and biogas in urban and peri-urban households to reduce indoor emissions and pressure on fuelwood</li> </ul>	<p>illegal connections and energy poverty</p> <ul style="list-style-type: none"> <li>• <b>Nature-based support systems:</b> use vegetated buffer strips, soil stabilization and shade trees near energy corridors to reduce erosion, improve microclimate, and protect cables from overheating.</li> <li>• <b>Capacity building and technical training:</b> train local technicians on installation and maintenance of renewable systems and resilient grid infrastructure</li> <li>• <b>Monitoring and data systems:</b> establish GIS-based asset inventory and vulnerability monitoring for power infrastructure</li> </ul>	<p>periodically update design standards and operational procedures for all energy assets to reflect emerging climate data (heat extremes, storm frequency)</p>
Economic Infrastructure	<ul style="list-style-type: none"> <li>• <b>Rapid vulnerability audit of economic nodes:</b> carry out a focused, desk field audit of priority economic infrastructure (central market, agro-trading yards, banks, cold stores, kiosks) to identify immediate flood, heat, power and access vulnerabilities. Produce a prioritized action list for emergency protection</li> <li>• <b>Quick retrofits for market resilience:</b> install raised plinths for market stalls,</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Climate-proof market infrastructure upgrades:</b> reconstruct main market halls, cold rooms and storage facilities with flood-resilient foundations, elevated service platforms, sealed flooring, and resilient roofing (high wind resistance). Design spaces for easy drainage and rapid clean-up</li> <li>• <b>Integrated market drainage &amp; runoff management:</b> redesign market</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Transform market precincts into climate-resilient economic hubs:</b> construct permanently climate-proofed market complexes with elevated, modular stalls, integrated waste and drainage systems, centralized cold-chain facilities powered by renewables, and multifunctional public spaces that double as water detention during extreme events.</li> <li>• <b>Advanced climate-smart value chains &amp; processing:</b> invest in large-scale, low-emission processing and storage</li> </ul>

Category	Recommended Solutions		
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	<p>covered elevated walkways, and temporary raised platforms for critical vendor areas to reduce direct flood damage and maintain trade continuity during storms</p> <ul style="list-style-type: none"> <li>• <b>Temporary shading &amp; cooling interventions:</b> deploy low-cost shading (shade nets, reflective canopies) in open markets and trading areas to reduce heat stress on traders and perishable goods; provide temporary cold-chain boxes or ice-pack support for essential perishables.</li> <li>• <b>Emergency business-continuity kits for SMEs:</b> distribute guidance + simple kits (portable solar chargers, flood-proof document sleeves, emergency cash-transfer contacts) to small enterprises and market associations to reduce immediate operational losses</li> <li>• <b>Protect critical access and drainage serving markets:</b> clear drains adjacent to market precincts, install temporary diversion channels and place sandbags at known ingress points to prevent stall inundation.</li> </ul>	<p>precinct drainage using green-grey solutions — permeable paving in courtyards, vegetated bioswales at perimeters, and underground storage tanks sized to 2050 projections to detain peak runoff</p> <ul style="list-style-type: none"> <li>• <b>Upgrade commercial energy &amp; water services:</b> ensure markets and processing hubs have protected power connections, backup solar microgrids, and elevated water storage to maintain refrigeration and hygienic services during outages or drought</li> <li>• <b>Formalize resilient tenancy standards and vendor licensing:</b> update market bylaws to require flood- and heat-resilient stall design, safe storage, and waste management practices as conditions for licensing; include incentives for compliance.</li> <li>• <b>Establish business-continuity training &amp; insurance pools:</b> develop municipal-led SME resilience training (business continuity planning, inventory protection) and promote</li> </ul>	<p>(controlled-atmosphere storage, industrial-scale solar drying, mechanized cold storage) that buffer shocks to food supply and stabilize market prices</p> <ul style="list-style-type: none"> <li>• <b>Long-term land-use transformation for hazard avoidance:</b> institutionalize land-use zoning that permanently removes high-exposure commerce from floodways and establishes economic clusters in low-risk corridors, coupled with resettlement and livelihood transition programs for affected traders</li> <li>• <b>Economic resilience funds &amp; business continuity insurance at scale:</b> establish a municipal/regional resilience fund and catastrophe insurance facility to underwrite rapid recovery for commercial sectors and support business continuity after extreme events</li> <li>• <b>Green infrastructure at city scale supporting economic assets:</b> implement city-wide NBS (urban forests, constructed wetlands, major retention basins) that reduce runoff, cool urban cores and protect commercial zones—integrating these into tourism and recreational investments for co-benefits.</li> <li>• <b>Technology &amp; data integration for market resilience:</b> deploy real-time market-impact early-warning systems, demand</li> </ul>

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	<ul style="list-style-type: none"> <li>• <b>Short-term finance &amp; microcredit relief:</b> activate emergency microgrants or flexible repayment windows (via municipal finance or partner MFIs) for traders affected by floods/heat-damage to restart operations quickly</li> <li>• <b>Public health &amp; food safety measures:</b> rapid inspection of market food hygiene after flood/storm events; distribute hygiene kits and guidance to vendors to prevent disease outbreaks</li> <li>• <b>Pilot market-level waste and drainage integration:</b> implement pilot green drainage strips and raised collection bays integrated with market layouts to reduce clogging and improve runoff management near economic hubs</li> <li>• <b>Simple M&amp;E &amp; reporting:</b> collect baseline KPIs (days market closed per year, % stalls elevated, % traders with business-continuity plan) for iterative monitoring</li> </ul>	<p>community-based micro-insurance or mutual-risk pools for traders.</p> <ul style="list-style-type: none"> <li>• <b>Promote value-chain adaptation for peri-urban agriculture:</b> invest in cold-chain corridors, climate-smart aggregation centres and post-harvest storage (solar dryers, evaporative coolers) for farmers supplying Kimilili markets to reduce losses from extreme heat and rainfall variability.</li> <li>• <b>land-use safeguards:</b> where markets lie in persistent flood paths, plan phased relocation to higher ground with integrated transport access and protected service yards; apply social safeguards and staged reallocation to protect livelihoods.</li> <li>• <b>Green business &amp; circular economy incubation:</b> scale MRFs, composting for market organics, and market-led recycling enterprises; provide technical assistance and guaranteed procurement channels for recycled outputs</li> <li>• <b>Secure long-term financing &amp; PPP</b></li> </ul>	<p>forecasting linked to climate forecasts, and digital platforms for rapid coordination of logistics and emergency supply routing</p> <ul style="list-style-type: none"> <li>• <b>Sustainable procurement &amp; local economic diversification:</b> adopt municipal procurement that prioritizes local, climate-resilient suppliers and circular-economy SMEs, stimulating long-term inclusive economic transformation</li> <li>• <b>Monitoring, standards &amp; review:</b> establish long-term indicators (market downtime reduction, % supply chain climate-protected, income stability metrics) and institutionalize periodic reviews (every 5–10 years) to align economic infrastructure investments with emerging climate scenarios to 2100.</li> </ul>

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
		<p><b>frameworks:</b> mobilize blended finance (county budget, climate funds, concessional loans) for major market upgrades, ensuring O&amp;M lines are budgeted</p> <ul style="list-style-type: none"> <li>• <b>Inclusive participation &amp; gender-responsive programming:</b> ensure women traders and informal vendors are represented in upgrade designs, financing terms, and training programs; provide targeted grants/technical support for women-led microenterprises</li> </ul>	
Social Infrastructure	<ul style="list-style-type: none"> <li>• <b>Assess schools, clinics, and community centers:</b> check which buildings get flooded, leak during rain, or become too hot. Mark them as high or low risk.</li> <li>• <b>Quick repairs and drainage improvements:</b> unblock nearby drains, raise doorsteps, patch leaking roofs, and make small flood walls or embankments around the most affected buildings.</li> <li>• <b>Install water tanks and handwashing stations:</b> place rainwater tanks and simple handwashing areas at schools and</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Upgrade key schools and health centers:</b> rebuild or renovate using stronger materials, higher foundations, and climate-resilient roofs and windows. Design buildings that stay cool and dry.</li> <li>• <b>Include climate-resilient design in new public buildings:</b> ensure all new schools and clinics follow building codes that protect them from floods, strong winds, and heat.</li> <li>• <b>Build safe access roads and walkways:</b> raise or pave paths leading to schools and hospitals so that</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Build fully climate-proof public facilities:</b> construct new generation schools, hospitals, and halls with raised floors, reinforced foundations, and solar-powered systems designed to withstand extreme weather to 2100.</li> <li>• <b>Develop smart, multi-purpose community hubs:</b> combine schools, clinics, and disaster shelters in one complex that serves education, health, and emergency needs.</li> <li>• <b>Create resilient education and health networks:</b> connect facilities with reliable roads, water supply, and renewable energy grids to make them self-sufficient during climate shocks.</li> </ul>

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
	<p>health centers to improve hygiene during droughts or after floods.</p> <ul style="list-style-type: none"> <li>• <b>Provide solar lighting and backup power:</b> put solar lamps or small solar systems in schools and clinics to keep them running when power fails.</li> <li>• <b>Set up temporary learning or treatment shelters:</b> use tents or portable classrooms when main buildings are damaged by floods.</li> <li>• <b>Health awareness and safety campaigns:</b> educate communities on disease prevention after floods and heatwaves (cholera, malaria, dehydration).</li> <li>• <b>Train caretakers and teachers:</b> basic training on how to protect buildings before heavy rain, safe water use, and energy saving.</li> <li>• <b>Plant trees around compounds:</b> provide shade and reduce surface temperature while improving the beauty and comfort of school and clinic grounds.</li> <li>• <b>Prepare emergency contacts and simple action plans:</b> every school or clinic should know who to call and what to do in case of storm or drought.</li> </ul>	<p>people can still reach them during rainy seasons.</p> <ul style="list-style-type: none"> <li>• <b>Improve water and sanitation systems:</b> install solar-powered water pumps, improved toilets, and proper waste disposal systems to prevent contamination during floods.</li> <li>• <b>Strengthen public health and emergency services:</b> equip health centers with mobile clinics, emergency kits, and storage for medicine during long droughts or floods.</li> <li>• <b>Introduce environmental education:</b> teach climate change and hygiene topics in schools to build awareness from a young age.</li> <li>• <b>Create a social infrastructure maintenance plan:</b> schedule regular repairs, roof inspections, and tree maintenance around public facilities.</li> <li>• <b>Promote community ownership:</b> involve local committees in maintaining and protecting facilities to ensure sustainability.</li> <li>• <b>Encourage inclusive planning:</b> make sure people with disabilities,</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Expand health systems for future risks:</b> include heatwave management units, flood treatment wards, and improved storage for vaccines and medicine.</li> <li>• <b>Digital learning and telemedicine:</b> equip all schools and clinics with internet access and solar backup to support remote education and tele-health services during climate disruptions.</li> <li>• <b>Institutionalize public building maintenance:</b> ensure every institution has a maintenance fund and annual inspection plan to stay in good condition.</li> <li>• <b>Large-scale urban greening:</b> develop connected green corridors linking schools, hospitals, and open spaces to reduce heat, improve air quality, and provide safe walking routes.</li> <li>• <b>Resilient social policies:</b> strengthen social safety nets, disaster relief programs, and inclusive community insurance to protect vulnerable people when climate disasters occur.</li> <li>• <b>Train next-generation professionals:</b> establish partnerships with universities and training centers to build local capacity in resilient architecture, disaster management, and public health.</li> <li>• <b>Continuous improvement and monitoring:</b> every 10 years, review how public</li> </ul>

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
		<p>women, and the elderly can access public buildings safely, with ramps and handrails.</p> <ul style="list-style-type: none"> <li>• <b>Greening programs for institutions:</b> establish green spaces with native trees, small gardens, and shaded playgrounds around all public buildings</li> </ul>	<p>buildings are coping with climate risks and update designs and materials using the latest science.</p>
Emergency Services	<ul style="list-style-type: none"> <li>• <b>Assess and map risks:</b> identify which, police posts, and health centers are most exposed to floods, or blocked roads.</li> <li>• <b>Stock emergency equipment:</b> provide rain gear, first-aid kits, life jackets, portable water pumps, and stretchers for local response teams.</li> <li>• <b>Establish an emergency communication system:</b> use radio, mobile alerts, and community noticeboards to quickly share warnings and instructions during storms.</li> <li>• <b>Train community response teams:</b> form volunteer groups in each ward for first aid, rescue, and early warning communication.</li> <li>• <b>Create simple emergency plans:</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>Build or upgrade permanent emergency operation centers (EOCs):</b> ensure each sub-county or municipality has a fully equipped control room with communication and power backup.</li> <li>• <b>Upgrade fire and rescue facilities:</b> rebuild or expand fire stations above flood levels, install modern pumps and trucks, and train specialized staff for urban and rural response.</li> <li>• <b>Strengthen coordination among departments:</b> link police, fire, health, and environment offices through a clear command structure for faster decision-making.</li> <li>• <b>Introduce digital early-warning systems:</b> connect rainfall sensors, river gauges, and weather updates to send alerts to phones and local radios.</li> <li>• <b>Develop and test evacuation routes:</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>Construct a regional emergency coordination center:</b> a modern facility for disaster management, rescue operations, and climate monitoring serving the wider Kimilili region.</li> <li>• <b>Adopt smart emergency systems:</b> use drones, satellite maps, and real-time data dashboards to guide search and rescue and direct resources efficiently.</li> <li>• <b>Develop permanent multi-hazard shelters:</b> build large, strong buildings designed to withstand floods, strong winds, and heat waves, doubling as community centers in normal times.</li> <li>• <b>Integrate emergency response into all infrastructure plans:</b> ensure every new road, bridge, hospital, and school is designed with access for rescue vehicles and evacuation routes.</li> <li>• <b>Create long-term training centers:</b> establish a county disaster management institute to train responders, youth volunteers, and professionals on climate-related emergencies.</li> </ul>

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
	<p>ensure every school, clinic, and market knows where to evacuate and who to contact in case of danger.</p> <ul style="list-style-type: none"> <li>• <b>Set up small emergency shelters:</b> identify safe public buildings (schools, halls, churches) that can be used temporarily during floods.</li> <li>• <b>Improve access to key facilities:</b> clear and maintain emergency access roads leading to hospitals, police, and fire stations before rainy seasons.</li> <li>• <b>Coordinate with local transport providers:</b> agree on vehicles that can help evacuate people or deliver supplies when needed.</li> <li>• <b>Public awareness:</b> run short campaigns to teach residents how to prepare emergency bags, store documents safely, and help neighbours in danger.</li> <li>• <b>Recordkeeping:</b> collect data on past disasters, damages, and response times to guide future improvements</li> </ul>	<p>plan safe roads and pedestrian paths to shelters and test them through regular community drills.</p> <ul style="list-style-type: none"> <li>• <b>Establish permanent community disaster committees:</b> one in each ward to coordinate between local residents and municipal officials during emergencies.</li> <li>• <b>Provide basic insurance and relief funds:</b> set up emergency funds and small insurance schemes to help families rebuild after floods or storms.</li> <li>• <b>Include emergency planning in school and health programs:</b> train teachers, nurses, and students in first aid and evacuation drills every term.</li> <li>• <b>Promote green infrastructure for protection:</b> plant vegetation on slopes and around public buildings to reduce erosion and stormwater runoff near emergency sites.</li> <li>• <b>Ensure energy and water backup:</b> install solar panels and backup tanks in fire and rescue centers so they stay functional during outages.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Expand early-warning systems:</b> connect local alerts to the national meteorological network for accurate, location-specific warnings.</li> <li>• <b>Institutionalize emergency funds:</b> set up a permanent municipal disaster fund supported by county and donor resources to sustain quick response and recovery.</li> <li>• <b>Enhance health-based disaster response:</b> equip hospitals with trauma units, emergency supplies, and mobile medical teams for rapid deployment.</li> <li>• <b>Greening and resilience:</b> create protective green belts and buffer zones around high-risk zones and major infrastructure to reduce hazard impacts naturally.</li> <li>• <b>Inclusive and gender-sensitive response:</b> ensure women, children, the elderly, and persons with disabilities are prioritized in shelter design, rescue drills, and information sharing.</li> </ul>
<b>Populations</b>			
Urban Residents	<ul style="list-style-type: none"> <li>• <b>Raise public awareness:</b> hold community meetings and radio talks on how to prepare for floods,</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Promote climate-resilient housing:</b> support building codes that require raised floors, strong roofs, and</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Develop sustainable neighborhoods:</b> build modern, safe, and green residential estates with strong</li> </ul>

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
	<p>manage waste, and save water during dry seasons.</p> <ul style="list-style-type: none"> <li>• <b>Promote household water harvesting:</b> encourage people to install small rainwater tanks and gutters to reduce water shortages.</li> <li>• <b>Support proper waste disposal:</b> provide bins and collection points to keep drains clear and reduce flooding in residential areas.</li> <li>• <b>Tree planting and compound greening:</b> give residents seedlings to plant around homes for shade and cooling.</li> <li>• <b>Encourage roof and wall repairs:</b> small home improvements like sealing leaks and raising doorsteps help prevent flood entry.</li> <li>• <b>Community emergency contact groups:</b> form neighborhood watch or response groups that share alerts and assist during disasters.</li> </ul>	<p>good ventilation for future weather changes.</p> <ul style="list-style-type: none"> <li>• <b>Expand access to clean energy:</b> promote solar home systems and clean cooking to reduce indoor smoke and dependency on firewood.</li> <li>• <b>Improve solid waste services:</b> expand municipal collection routes to cover all residential zones and reduce illegal dumping.</li> <li>• <b>Create safe green parks:</b> develop public parks and open spaces that serve as flood buffers and cooling zones.</li> <li>• <b>Strengthen local planning:</b> involve residents in settlement planning and ensure roads and drainage are designed to withstand floods.</li> <li>• <b>Develop health and sanitation programs:</b> ensure each estate has access to clean water and sanitation to prevent disease outbreaks after floods.</li> <li>• <b>Establish community savings groups:</b> encourage small savings and micro-insurance for recovery after disasters.</li> </ul>	<p>drainage, solar power, and tree cover.</p> <ul style="list-style-type: none"> <li>• <b>Integrate nature-based flood protection:</b> use green corridors, urban forests, and infiltration parks to reduce flood and heat risks in residential areas.</li> <li>• <b>Smart early-warning systems:</b> connect households to digital alerts and apps showing rainfall and flood forecasts.</li> <li>• <b>Promote inclusive housing policy:</b> ensure all future urban housing projects include affordable, climate-resilient units for low-income families.</li> <li>• <b>Continuous community training:</b> maintain education programs on disaster preparedness, health, and environmental care.</li> <li>• <b>Encourage circular living:</b> promote recycling, water reuse, and energy efficiency in all homes.</li> </ul>
Informal Settlement Residents	<ul style="list-style-type: none"> <li>• <b>Drainage clearance and cleanup:</b> organize community clean-ups to open blocked drains and collect solid waste to reduce flood risk.</li> <li>• <b>Temporary flood protection:</b> use sandbags and raised</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Planned upgrading:</b> introduce better roads, drainage, toilets, and waste management in informal settlements while keeping residents on-site where possible.</li> <li>• <b>Secure tenure and inclusion:</b> work with</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Full integration of upgraded settlements:</b> ensure all former informal areas have proper drainage, paved roads, power, water, and waste services.</li> <li>• <b>Climate-resilient urban housing:</b> redevelop high-risk areas into modern, affordable,</li> </ul>

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
	<p>walkways in high-risk informal areas before heavy rains.</p> <ul style="list-style-type: none"> <li>• <b>Emergency water and sanitation:</b> install shared water points and toilets on higher ground to avoid contamination during floods.</li> <li>• <b>Provide solar lights and safe cooking:</b> reduce fire accidents and improve safety with clean cooking stoves and solar lamps.</li> <li>• <b>Support health outreach:</b> mobile clinics to provide treatment and health education during and after flood events.</li> <li>• <b>Mapping and registration:</b> document all households and risk zones to guide service delivery and future upgrading.</li> </ul>	<p>landowners and residents to formalize occupancy and ensure fair relocation if needed.</p> <ul style="list-style-type: none"> <li>• <b>Community-managed green areas:</b> plant trees and small gardens to absorb runoff and create safe recreational spaces.</li> <li>• <b>Access to clean energy and water:</b> install shared solar micro-grids and communal water systems that are flood-safe.</li> <li>• <b>Improve housing standards:</b> encourage low-cost, flood-resilient building materials and training for local masons.</li> <li>• <b>Create community-based savings and insurance schemes:</b> support residents to save and insure their homes or small businesses against climate shocks.</li> </ul>	<p>and safe housing with renewable energy and green open spaces.</p> <ul style="list-style-type: none"> <li>• <b>Inclusive relocation programs:</b> for settlements that cannot be protected, relocate families safely with full compensation and new infrastructure.</li> <li>• <b>Permanent social services:</b> ensure every upgraded neighborhood has schools, clinics, and safe community centers.</li> <li>• <b>Community-led governance:</b> establish resident committees that manage services and monitor climate and safety risks.</li> <li>• <b>Smart and green infrastructure:</b> install underground utilities, solar lighting, and community gardens that improve comfort and reduce climate impacts.</li> </ul>
Vulnerable and Marginalized Groups	<ul style="list-style-type: none"> <li>• <b>Identify and register vulnerable people:</b> create lists of elderly, persons with disabilities, women-led households, and orphans for priority support.</li> <li>• <b>Provide direct assistance:</b> distribute clean water, food packs, and health items during flood or drought emergencies.</li> <li>• <b>Accessible shelters:</b> prepare safe shelters with ramps, lighting, and separate areas for women and children.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Strengthen social protection programs:</b> expand county cash transfers, school feeding, and medical coverage to help vulnerable people recover faster.</li> <li>• <b>Promote livelihood training:</b> offer skills and micro-loans for small businesses to improve income stability.</li> <li>• <b>Inclusive planning:</b> involve marginalized groups in town planning meetings and climate discussions.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Full social inclusion in climate planning:</b> ensure vulnerable groups have representation in municipal boards and resilience committees.</li> <li>• <b>Permanent welfare programs:</b> establish sustainable safety nets—social insurance, emergency grants, and free medical care for the most at risk.</li> <li>• <b>Empowerment and education:</b> create scholarship and entrepreneurship programs for youth, women, and persons with disabilities.</li> </ul>

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
	<ul style="list-style-type: none"> <li>• <b>Community awareness on inclusion:</b> train responders and leaders on how to assist persons with special needs during emergencies.</li> <li>• <b>Health and nutrition support:</b> ensure mobile clinics reach vulnerable households after floods or during heatwaves.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Build accessible infrastructure:</b> ensure all new public buildings and facilities have ramps, wide doors, and safe pathways.</li> <li>• <b>Community centers and day shelters:</b> build safe spaces where vulnerable people can access services during extreme weather.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Climate-resilient housing and services:</b> build specialized, safe housing clusters for elderly and disabled persons.</li> <li>• <b>Technology for accessibility:</b> use digital tools (alerts, apps, assistive tech) to help vulnerable people get early warnings and emergency help.</li> <li>• <b>Continuous advocacy and review:</b> monitor equity and inclusion indicators to ensure no one is left behind in adaptation efforts.</li> </ul>
<b>Natural Assets</b>			
Urban Green Infrastructure	<ul style="list-style-type: none"> <li>• <b>Carry out an inventory of all parks, trees, and open spaces:</b> map existing green areas, identify degraded sites, and mark those at risk of encroachment.</li> <li>• <b>Start community greening programs:</b> organize “Green Kimilili” days for tree planting along roads, school compounds, and market perimeters.</li> <li>• <b>Protect existing urban forests and trees:</b> put bylaws against unnecessary cutting, and replace any felled trees immediately.</li> <li>• <b>Plant drought-tolerant native species:</b> choose species that survive both heavy rains and dry seasons (e.g., Croton, Jacaranda, Grevillea).</li> <li>• <b>Create small green buffers near drains and roads:</b> plant grass and shrubs along open drains</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Develop an Urban Green Master Plan:</b> designate official green corridors, public parks, and ecological zones within the town plan.</li> <li>• <b>Create continuous green belts:</b> link parks, riverbanks, and roadside vegetation into one connected system for cooling and biodiversity.</li> <li>• <b>Introduce green roofs and walls:</b> support commercial and residential buildings to install rooftop gardens and vertical greenery.</li> <li>• <b>Expand public parks:</b> acquire land for new recreational parks with trees, benches, and walking paths.</li> <li>• <b>Train landscapers and youth in urban forestry:</b> offer short courses on tree management and climate-smart landscaping.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Expand green networks into full ecological corridors:</b> connect Kimilili’s green areas to regional ecosystems around Mt. Elgon and Rivers</li> <li>• <b>Build large urban forests and botanical gardens:</b> serve as carbon sinks, recreation spaces, and cooling zones.</li> <li>• <b>Institutionalize urban tree management:</b> establish a municipal green authority responsible for maintenance, replanting, and biodiversity protection.</li> <li>• <b>Adopt advanced green design:</b> combine rooftop gardens, vertical forests, and shaded streets across all developments.</li> <li>• <b>Integrate green spaces into flood management:</b> design large parks that also serve as detention basins during storms.</li> </ul>

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
	<p>to filter runoff and stabilize soils.</p> <ul style="list-style-type: none"> <li>• <b>Establish a municipal tree nursery:</b> produce seedlings for continuous planting and income for youth and women’s groups.</li> <li>• <b>Engage schools and churches:</b> each institution to maintain a small garden or green area for education and cooling.</li> <li>• <b>Public awareness:</b> hold community education on benefits of trees for temperature reduction, air quality, and stormwater control.</li> <li>• <b>Immediate greening of municipal buildings:</b> install potted plants, vertical gardens, and small rooftop gardens on public offices.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Create incentives for private greening:</b> reduce business rates for properties that maintain trees or gardens.</li> <li>• <b>Monitor tree survival and canopy cover:</b> use GIS and community surveys to measure yearly increases in green cover.</li> <li>• <b>Set up composting facilities:</b> use market waste to produce compost for use in parks and nurseries.</li> <li>• <b>Build shaded pedestrian walkways and bicycle lanes:</b> integrate trees into transport designs to reduce heat and pollution.</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Establish green financing programs:</b> introduce “Tree Bonds” or corporate sponsorships for green infrastructure maintenance.</li> <li>• <b>Create permanent environmental education centers:</b> train youth on climate resilience, biodiversity, and conservation.</li> <li>• <b>Regular monitoring and adaptation:</b> every 10 years, review tree health, species diversity, and ecosystem functions to adjust programs.</li> <li>• <b>Develop policy for zero net tree loss:</b> require any removed tree to be replaced by at least three new ones.</li> <li>• <b>Promote eco-tourism:</b> position Kimilili as a “green town” attracting visitors and boosting local income</li> </ul>
Urban Blue Infrastructure	<ul style="list-style-type: none"> <li>• <b>Map and clean all rivers and streams:</b> identify blocked channels, remove solid waste, and restore flow in Rivers and nearby tributaries.</li> <li>• <b>Set up community river protection groups:</b> involve residents in monitoring pollution and illegal dumping.</li> <li>• <b>Mark and protect riparian reserves:</b> enforce the 6–30m buffer zones from riverbanks as required by NEMA.</li> <li>• <b>Install litter traps and silt fences:</b> stop</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Restore degraded wetlands:</b> replant native wetland plants, fence off sensitive areas, and reestablish natural drainage.</li> <li>• <b>Construct retention and infiltration ponds:</b> capture stormwater and allow groundwater recharge.</li> <li>• <b>Integrate rivers into urban design:</b> create riverfront parks, walking trails, and green corridors.</li> <li>• <b>Develop a blue infrastructure master plan:</b> guide</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Restore full river ecosystems:</b> establish continuous green-blue corridors connecting wetlands, forests, and rivers.</li> <li>• <b>Construct large natural flood storage basins:</b> design multifunctional wetlands to absorb excess stormwater and reduce downstream flooding.</li> <li>• <b>Modernize stormwater infrastructure:</b> install underground storage and smart flow-control systems connected to blue corridors.</li> <li>• <b>Establish riverbank greenways:</b> wide, forested buffers providing</li> </ul>

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
	<p>plastics and sediment from entering rivers.</p> <ul style="list-style-type: none"> <li>• <b>Start simple riverbank planting:</b> use vetiver grass, bamboo, or reeds to stabilize soils.</li> <li>• <b>Public awareness campaigns:</b> educate locals on protecting riverbanks and wetlands from encroachment.</li> <li>• <b>Monitor water quality:</b> basic testing for pH, turbidity, and contamination by community groups.</li> <li>• <b>Repair stormwater channels:</b> unblock and reinforce drains that connect to rivers to prevent overflow.</li> <li>• <b>Promote low-cost rainwater harvesting:</b> reduce direct runoff into rivers during storms</li> </ul>	<p>river, drainage, and wetland protection as part of the municipal spatial plan.</p> <ul style="list-style-type: none"> <li>• <b>Install sustainable drainage systems (SuDS):</b> use soakaways, bioswales, and permeable pavements to manage runoff.</li> <li>• <b>Wastewater management near rivers:</b> build small treatment wetlands to filter grey water before it reaches rivers.</li> <li>• <b>Protect headwaters and springs:</b> mark and conserve key water sources feeding Rivers.</li> <li>• <b>Community-based monitoring:</b> train youth in simple river assessment tools and reporting.</li> <li>• <b>Include flood zones in planning:</b> ban new structures in active floodplains and use them as green buffer parks.</li> <li>• <b>Introduce fines and incentives:</b> penalize pollution but reward those who keep river corridors clean</li> </ul>	<p>habitat, recreation, and flood protection.</p> <ul style="list-style-type: none"> <li>• <b>Integrate river restoration into urban tourism:</b> promote eco-trails, fishing, and birdwatching along rivers.</li> <li>• <b>Permanent monitoring programs:</b> establish long-term partnerships with universities for hydrology and ecology research.</li> <li>• <b>Develop financing for blue infrastructure:</b> use climate funds, PPPs, and conservation trust funds for maintenance.</li> <li>• <b>Zero-pollution goal:</b> enforce strict wastewater standards and ensure all effluent is treated before discharge.</li> <li>• <b>Education and pride:</b> make rivers and wetlands part of Kimilili's identity — "Our Rivers, Our Life."</li> </ul>
Peri-urban and Agricultural Systems	<ul style="list-style-type: none"> <li>• <b>Promote climate-smart farming:</b> train farmers in soil conservation, mulching, crop rotation, and drought-resistant varieties.</li> <li>• <b>Control soil erosion:</b> plant vetiver</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Develop peri-urban land-use zoning:</b> protect farmland from uncontrolled urban sprawl.</li> <li>• <b>Establish cooperative irrigation schemes:</b> manage shared</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Integrated peri-urban agro-ecosystem management:</b> combine farming, forestry, and biodiversity conservation in one system.</li> <li>• <b>Adopt circular agriculture:</b> recycle all organic waste and</li> </ul>

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
	<p>grass and terraces on slopes around Kimilili's peri-urban farms.</p> <ul style="list-style-type: none"> <li>• <b>Support agroforestry:</b> encourage tree planting on farm boundaries for shade, soil fertility, and wood supply.</li> <li>• <b>Improve irrigation:</b> install small solar pumps and drip systems to save water.</li> <li>• <b>Set up local produce markets:</b> reduce transport costs and losses for farmers.</li> <li>• <b>Promote compost use:</b> use urban organic waste as fertilizer for peri-urban farms.</li> <li>• <b>Community awareness on pesticide use:</b> teach safe application to avoid river pollution.</li> <li>• <b>Protect springs and wetlands near farms:</b> fence and plant vegetation to prevent contamination.</li> <li>• <b>Collect farm data:</b> record yields, water use, and climate impacts to guide planning.</li> </ul>	<p>water resources efficiently among farmers.</p> <ul style="list-style-type: none"> <li>• <b>Construct water storage ponds and check dams:</b> store excess rainwater for dry-season irrigation.</li> <li>• <b>Introduce renewable energy in farming:</b> use solar-powered cold rooms, driers, and water pumps.</li> <li>• <b>Promote organic and regenerative agriculture:</b> reduce chemical use and improve soil carbon.</li> <li>• <b>Support farm-to-market infrastructure:</b> build rural access roads and collection centers that are flood-resistant.</li> <li>• <b>Link farmers to early warning systems:</b> provide climate and rainfall forecasts through SMS.</li> <li>• <b>Develop farmer cooperatives:</b> help farmers pool resources for inputs and climate insurance.</li> <li>• <b>Soil fertility improvement:</b> train on composting and integrate livestock waste management.</li> <li>• <b>Encourage youth participation:</b> provide start-up funds and training for green agribusiness.</li> </ul>	<p>wastewater safely for irrigation.</p> <ul style="list-style-type: none"> <li>• <b>Establish agro-industrial parks:</b> powered by renewable energy, processing local produce while minimizing emissions.</li> <li>• <b>Protect natural buffers permanently:</b> designate agricultural green belts that double as flood protection zones.</li> <li>• <b>Smart precision farming:</b> use sensors, drones, and data tools to optimize water and fertilizer use.</li> <li>• <b>Large-scale reforestation:</b> expand tree cover across catchments to stabilize climate and prevent erosion.</li> <li>• <b>Education and research farms:</b> create climate innovation hubs for farmers to learn adaptive techniques.</li> <li>• <b>Long-term water conservation programs:</b> secure river basins and aquifers through catchment protection and sustainable irrigation.</li> <li>• <b>Introduce carbon credit programs:</b> reward farmers for maintaining green cover and soil health.</li> <li>• <b>Sustainable food security planning:</b> ensure steady food supply even under future extreme weather</li> </ul>

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## Annex N2. Data Sources

Page	Data	Data Source
29	Spatial distribution of temperature increase	World Bank Climate Change Knowledge Portal (CCKP), CMIP6 projections
29	Spatial distribution of extreme rainfall and flood-prone zones	CHIRPS rainfall dataset, Kenya Meteorological Department (KMD)
29	Spatial distribution of drought-affected areas (SPI patterns)	SPEI Global Database, NDMA drought bulletins, CHIRPS rainfall data
29	Spatial distribution of thunderstorm and convective storm risk	Kenya Meteorological Department severe weather reports, RCMRD SERVIR storm-risk layers
29	Hazard overlay and risk hotspot mapping	GIS spatial analysis, hazard modelling outputs
29	Ward boundaries and administrative spatial layers	Bungoma County GIS database
29	Land use and land cover distribution	Remote sensing data, RCMRD land cover datasets
29	River systems, wetlands and drainage patterns	Hydrographic datasets, Water Resources Authority (WRA)