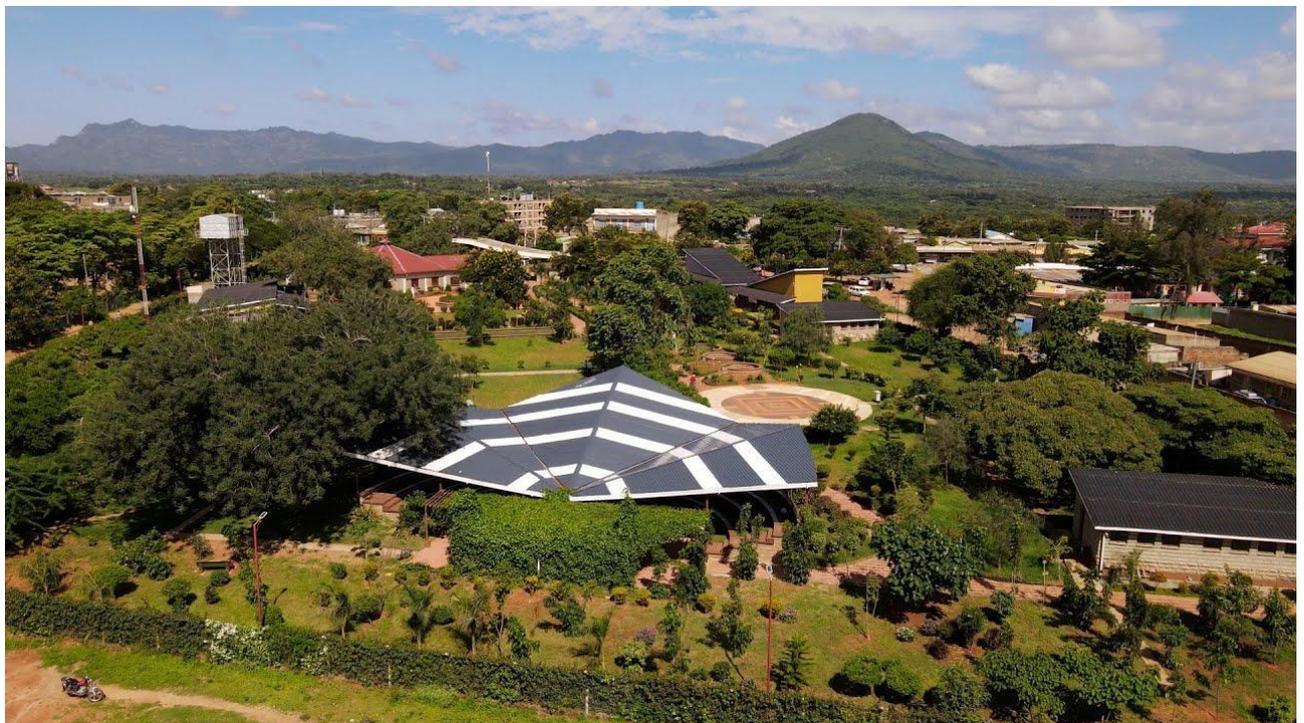


GOVERNMENT OF MAKUENI COUNTY

WOTE MUNICIPALITY



# WOTE MUNICIPALITY URBAN CLIMATE RISK PROFILE



2026

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Wote Municipality

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## **Foreword**

The growth of Wote Municipality as an administrative and economic center of Makueni County is largely influenced by the intensification of climate variability resulting into more complex and pronounced urban risks. Urbanization trends coupled with climate hazards often exacerbate the socioeconomic inequalities and disproportionately affect vulnerable households. Deliberate planning is required to reduce exposure of people, infrastructure and livelihoods to climatic hazards.

The Municipality is endowed with vast natural resources that support local social and economic development as well as ecosystem goods and services. Yet this very lifeline of the municipality has come under direct threat of climate change. The variation in rainfall intensity and duration over the years has resulted to shorter and more unpredictable leading to increased flashfloods and landslides. We are equally increasingly experiencing rising temperatures, prolonged droughts and extreme weather events.

These challenges demand urgent, decisive and collective action from government agencies, development partners, the private sector, civil society organizations and individual inhabitants of the municipality in order for us to build a truly climate-resilient future. The Wote Municipality Risk Profile provides critical insights on the risks we face as a people at different scales. It further highlights the opportunities for adaptation and mitigation pathways towards a more resilient, sustainable future.

This Risk Profile underscores the importance of building resilience, strengthening policies for climate action and mobilizing resources to safeguard human lives, livelihoods, property and ecosystem upon which we collectively depend as the people of Wote. As we navigate the increasingly complex and uncertain urban areas challenges in the 21<sup>st</sup> century where environmental degradation and climate change pose formidable threats, this Risk Profile serves as our road-map to a resilient and vibrant municipality. By embedding resilience into urban planning and development strategies, we can build urban areas that withstand shocks and stresses, thrive in uncertainty, and deliver on their goal as engines of growth and opportunity ensuring a more livable, equitable and resilient future for all.

I extend my sincere appreciation to the Municipal Environment Division for taking lead in the development process and the multistakeholder collaboration attained during the formulation process. Your dedication reflects our shared commitment to leaving a lasting legacy for generations to come. Together, let us embark on this journey towards a healthier, resilient and more sustainable Municipality. Let us all, through dedication, innovation collaboration and commitment, rise to this global challenge and create a future that we can be proud of bequeathing our future generations.



**EVERLYN MUTUA**  
**MANAGER - WOTE MUNICIPALITY**

## Executive Summary

Across the world, climate change has shifted the landscape of risk for communities, especially those living in urban areas. For municipal leaders, the best way to respond to this challenge is to understand the risks that their communities face. This risk-assessment process can help a community understand the resources it will need to invest in and how it might prioritize strategies to reduce risk. Informed and prepared communities will be more resilient to risks and will bounce back more quickly than those that are unprepared and uninformed.

Climate change poses a significant threat not only to Wote Municipality but to the wider Makueni County, with rising temperatures, unpredictable rainfall and extreme weather events increasingly impacting livelihoods and human wellbeing. Key drivers include deforestation, poor waste management, and unsustainable fossil fuel use, among others. The impacts are already evident in the form of frequent urban flooding in parts of the municipality, heat waves and cold waves, declining farm yields, destruction of infrastructure and general loss of livelihoods and rising poverty.

Climate mitigation and adaptation are essential for safeguarding community livelihoods as well as ecosystems against the vagaries of climate variability. Yet building resilience requires proactive mitigative and adaptive measures, including climate smart agriculture to secure food production, improving water management, and strengthening healthcare systems to respond to emerging and re-emerging diseases spawned by climate change. At the same time, there is need to invest in climate-resilient infrastructure that can withstand the test of floods and storms, while also adopting sustainable energy alternatives like to help reduce vulnerability and protect livelihoods.

Integrating climate adaptation into planning, policies and community initiatives within Wote Municipality can help reduce climate risks, protect people and create pathways for a more resilient and prosperous future. It is for this reason that this Risk Profile analyses the climatic conditions within the municipality, both past and present, and leverages projected future scenarios in order to foreground present and future climate action necessary to help plan, develop and deliver a more resilient, sustainable and equitable Wote Municipality moving into the future.

The main objective of this Climate Risk Profile was to assess the municipality's exposure, sensitivity and adaptive capacity to climate-related hazards in order to inform evidence-based planning, decision-making and investment towards building municipal climate resilience. The profile sought to generate localized climate risk information that integrates environmental, social and economic dimensions to guide sustainable urban development, reduce vulnerability, enhance the community's preparedness and adaptive capacity to climate change impacts.

The specific objectives are to: -

- i. Identify and characterize key climate hazards affecting Wote Municipality.
- ii. Analyze the exposure and sensitivity of critical sectors and systems.
- iii. Assess the municipality's adaptive capacity at institutional, community, and household levels, highlighting existing coping mechanisms, governance structures, and resource constraints.
- iv. Map climate vulnerability hotspots within Wote municipality.
- v. Recommend priority adaptation and mitigation measures to support integration of climate resilience into Municipal planning and development initiatives.

The key hazards identified during the analysis are:

- i. Hydro-metrological hazards: Flash floods, pluvial floods, riverine floods
- ii. Geo hazards: Gully erosion, earth tremors, mud slides and land slides
- iii. Climatological hazards: Urban droughts, Heat stress (extreme heat, heat waves, urban heat islands), wild fires

The climate risk analysis across the different climate scenarios and time horizons from Current, 2050, and 2100 under SSP2-4.5 and SSP5-8.5, most risks remain persistent rather than significantly escalating, suggesting that current vulnerabilities are already high and will continue to escalate without substantial adaptation interventions.

Climatological hazards present the most significant long-term threats. Rising surface temperatures present consistently high to very high risks for populations, especially, informal settlement residents and vulnerable groups who face catastrophic impacts with very high-risk levels across all time horizons, indicating strong exposure to heat stress due to limited adaptive capacity, inadequate housing conditions. Peri-urban and agricultural systems also face catastrophic impacts with very high-risk levels, highlighting the sensitivity of local food systems and rural livelihoods to temperature increases and water stress. Infrastructure systems, however, generally show low risk exposure to temperature rise, suggesting that the most severe impacts will be concentrated on people and natural resource-dependent sectors rather than built infrastructure.

Prolonged dry spells exacerbate climatological vulnerabilities. Water and wastewater management systems show major impacts with high risk levels across all scenarios, indicating significant pressure on municipal water supply systems. Populations, including urban residents, informal settlement communities, and vulnerable groups also face high risk levels. The most severe impacts occur in peri-urban and agricultural systems, which show catastrophic impacts and very high-risk levels across all time horizons. This suggests that agricultural productivity, food security, and livelihoods around Wote Municipality are particularly vulnerable to drought conditions.

Hydro-meteorological hazards, mainly extreme precipitation and pluvial flooding, present the most significant risks to infrastructure systems. Extreme precipitation generates catastrophic impacts for stormwater drainage, solid waste management, and transport and mobility infrastructure, all of which show very high-risk levels. These results indicate that drainage capacity and waste management systems are critical vulnerability points where intense rainfall can lead to flooding, infrastructure damage, and service disruption. Pluvial flooding produces a similar pattern, with very high risks for stormwater drainage and high risks for transport networks, water systems, and economic infrastructure. Populations in informal settlements and vulnerable groups are also exposed to high risks, reflecting the typical location of such communities in poorly drained or flood-prone areas.

Geo-hazards, present localized but significant risks to infrastructure and land systems. High risk levels are observed for stormwater drainage, water infrastructure, and transport systems, indicating that erosion processes may undermine road networks and drainage channels. Peri-urban and agricultural systems face very high-risk levels, suggesting substantial land degradation and loss of productive land if erosion processes intensify. Vulnerable and marginalized populations also face high risks, likely due to settlement in erosion-prone areas or reliance on degraded landscapes for livelihoods.

The persistence of high and very high-risk levels across both moderate SSP2-4.5 and high-emission SSP5-8.5 scenarios suggests that existing vulnerabilities are already substantial and require immediate adaptation measures. Intervention areas, strategies and solutions have been proposed for implementation in the short, medium and long-term. Priority includes: Strengthening stormwater and drainage infrastructure, establishment of bioswales, adoption of permeable pavements and green roofs to enhance runoff percolation, climate-proofing of the water supply network and water resources to address drought risks, protecting and restoring agricultural and peri-urban landscapes, and implementing targeted resilience measures for informal settlements and vulnerable populations including the enforcement of building density and zoning regulations.

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## List of Acronyms

ASALs	Arid and Semi-arid Lands
CCAP	Climate Change Action Plan
CA	Conservation Agriculture
CCF	County Climate Change Fund
CCU	Climate Change Unit
CIDP	County Integrated Development Plan
CRA	Climate Risk Assessment
CSO	Civil Society Organizations
FLLoCA	Financing Locally Led Climate Action
GBV	Gender-based Violence
GDP	Gross Domestic Product
GHG	Green House Gases
GOMC	Government of Makueni County
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Intertropical Convergence Zone
KMD	Kenya Meteorological Department
M&E	Monitoring and Evaluation
NCCC	National Climate Change Council
NGOs	Non-Governmental Organizations
OVC	Orphans and Vulnerable Children
PCRA	Participatory Climate Risk Assessment
PWD	Persons with Disability
RCP	Representative Concentration Pathways
RCRA	Rapid Climate Risk Assessment
SEKEB	South Eastern Kenya Bloc
SSP	Shared Socioeconomic Pathways
UCRP	Urban Climate Risk Profile
UNFCCC	United Nations Framework Convention on Climate Change
WCCPC	Ward Climate Change Planning Committee

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## 1.0 Background and Context

### 1.1. Situating Climate Change in National Development

Throughout the world, communities are experiencing unprecedented challenges occasioned by climate change. These challenges are often aggravated by other underlying structural factors, including poverty, minimal technological advancement and uptake, lack of capital, inequitable land distribution, under-developed public infrastructure and over-reliance on rain-fed agriculture. While climate change is happening globally, its specific impacts are often felt differently at the local level, with some areas more hit than others. As a result, initiatives geared towards mitigating and adapting to climate change are being implemented at different spatial scales.

In Kenya, climate change has a significant socio-economic impact, costing the country up to 2.8% of its annual gross domestic product (GDP).<sup>1</sup> Recent Intergovernmental Panel on Climate Change (IPCC)'s vulnerability assessment indicate that more than 85% of Kenya's land mass is extremely susceptible to climate change impacts.<sup>2</sup> As a country, our vulnerability is especially driven by the fact that the economy is largely dependent on climate-sensitive sectors such as agriculture, tourism and energy, yet our low-income status impedes our ability to adequately tackle associated impacts of climate change.

As a national strategic priority, Kenya has ratified the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol and the East African Community (EAC) Climate Change Policy Master Plan and Strategy (2011–2013). Environmental protection is a national priority as outlined in the Vision 2030. Kenya has also established a National Climate Change Response Strategy (NCCRS), a National Climate Change Action Plan (NCCAP) and the Climate Change Act of 2016. The Climate Change Act outlines a regulatory framework for a more effective action on climate change, to enhance resilience and advocate for low carbon emissions. The Act also promotes the mainstreaming of climate change responses in the design, planning and implementation for budgeting of Kenya's sustainable development. The country has also developed Nationally Determined Contributions (NDC), whose purpose is to set targets for reducing greenhouse gas emissions in line with the UNFCCC Conference of Parties (COP).

### 1.2. Development perspectives in view of Mitigation vs. Adaptation

Climate observation data point to climate changes already occurring in a warming world, and predict more dramatic climate changes further into the future. As of today, more than 2.5 billion people face food security issues. And since 2008, 21.5 million people have become climate refugees on average each year. Adapting to climate change, particularly extreme weather, is one of the main ways to reduce risk and make communities more resilient and sustainable in the coming decades.

Adaptation actions aim to help existing communities and ecosystems become resilient to climate change and reduce the vulnerability of natural and human systems. Climate change adaptation can take the form of changes in the processes, practices or structures that limit damages or create benefits from the changing climate. Adaptation can minimize the present adverse effects and prevent future risks. This entails adjusting human systems to cope, as well as building resilience to actual or anticipated climate change effects to reduce harm to populations or take advantage of the benefits it presents.

Climate mitigation on the other hand focuses on slowing the pace and direction of climate change, principally by reducing emissions of heat trapping greenhouse gases (GHGs). Communities that

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<sup>1</sup>Adeniyi, D. (2023). *Adaptation finance to local food systems in Kenya*. ECDPM Discussion paper 348. Maastricht: ECDPM.

<sup>2</sup> Odhengo, P., Atela, J., Steele, P., Orindi, V., & Imbali, F. (2019). Climate finance in Kenya: review and future outlook. *Climate Finance Policy Brief*, 1.

depend on extractive livelihood systems for example, have devised ways to adapt to climate change and variability in their local settings. However, the current speed at which climate change is taking place will modify known variability and resilience patterns in a way that communities are often less equipped to handle.

In developing countries such as Kenya, climate change impacts are more severe due to inadequate institutional and economic capacity of local communities to cope and adapt. Therefore, adaptation options ought to be formulated at community level so as to address low adaptation challenges.

### **1.3. Rationale for the Wote Municipality Climate Risk Profile**

Urban areas today face unprecedented and uncertain risks associated with climate change. Thus, risk assessment is particularly relevant for municipalities because they are becoming increasingly vulnerable to severe events. The rising global population and massive migration to urban areas tends to concentrate people in ecologically fragile areas, which are particularly prone to the risk of natural disasters linked to climate change. Furthermore, many of the new urban dwellers have little by way of financial means to recover from a disaster. As urbanizing trends increase, so too will the importance of risk assessment and resilience planning for urban areas.

Across the world, climate change has shifted the landscape of risk for communities. For municipal leaders, the best way to respond to this challenge is to understand the risks that their communities face. This risk-assessment process can help a community understand the resources it will need to invest in and how it might prioritize strategies to reduce the risk. As can be reasonably expected, informed and prepared communities will be more resilient to risks and will bounce back more quickly compared to those that are unprepared and uninformed.

The risk-assessment process begins with a Risk Profile. Such a profile is developed by identifying the types of events that could occur in the municipality, the probability that events of varying severity will occur, and the consequences of those events, including economic, infrastructure, socio-cultural, and public health losses. Total risk is calculated by summing the values of risk associated with individual events. In general, taking action to minimize damage caused by extreme weather events is the best way to reduce exposure because the probability of a natural disaster occurring is beyond the community's control.

A comprehensive risk assessment is helpful in facilitating a variety of planning and policy-making interventions. At the very least, this Risk Profile will aid Wote Municipality in assessing which wards are most and least exposed to a variety of climate change-related risks, enabling the leadership to direct growth and investment accordingly. In the same vein, evidence-based long-term plans will more precisely reflect anticipated impacts from droughts, floods, extreme heat, storms and other hazards likely impact Wote's development into the future.

### **1.4. Objective of the Climate Risk Profile**

The main objective of this Climate Risk Profile is to assess the municipality's exposure, sensitivity and adaptive capacity to climate-related hazards in order to inform evidence-based planning, decision-making and investment towards building municipal climate resilience. The profile aims to generate localized climate risk information that integrates environmental, social and economic dimensions to guide sustainable urban development, reduce vulnerability, enhance the community's preparedness and adaptive capacity to climate change impacts.

The specific objectives are to: -

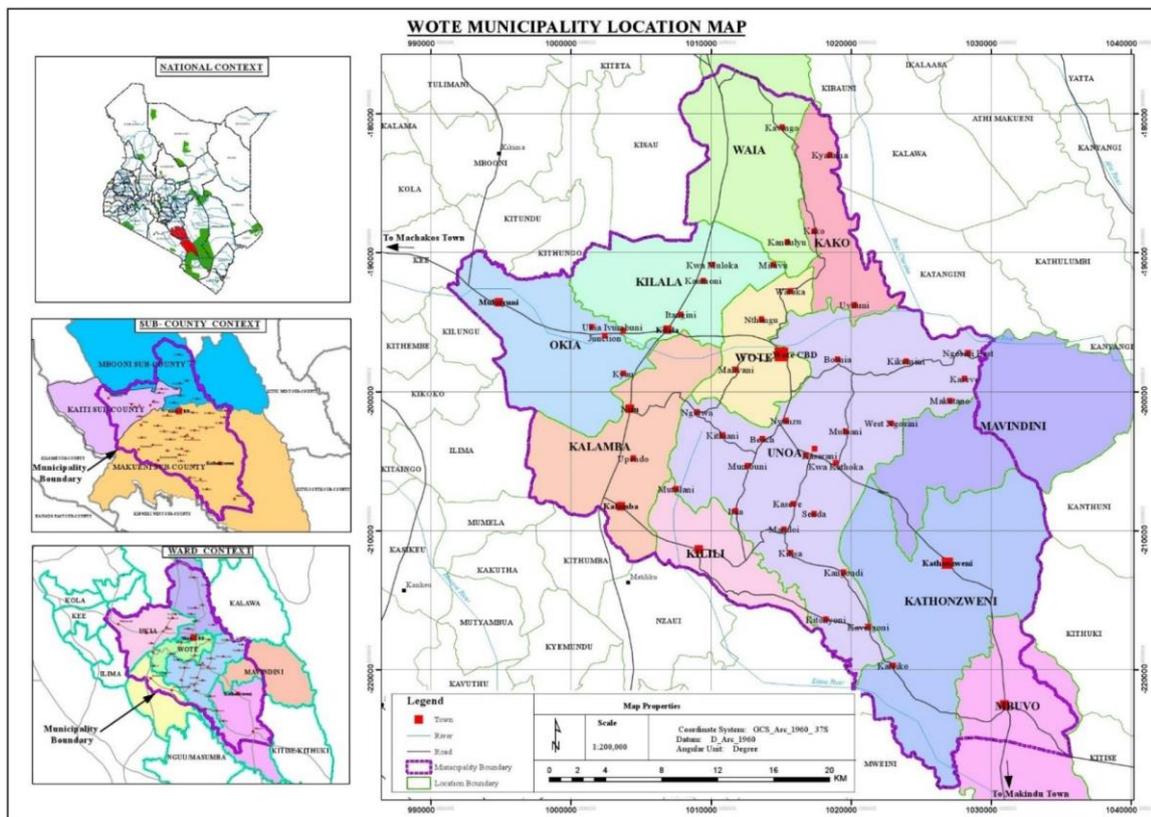
- i. Identify and characterize key climate hazards affecting Wote Municipality.
- ii. Analyze the exposure and sensitivity of critical sectors and systems.

- iii. Assess the municipality’s adaptive capacity at institutional, community, and household levels, highlighting existing coping mechanisms, governance structures, and resource constraints.
- iv. Map climate vulnerability hotspots within Wote municipality.
- v. Recommend priority adaptation and mitigation measures to support integration of climate resilience into Municipal planning and development initiatives.

## 1.5. Urban Context

### 1.5.1. Geographic location

Wote Municipality is located in Makueni County. The municipality covers sections of Makueni, Kaiti and Mbooni sub-counties, with an approximate area of 1,082 km<sup>2</sup> (Figure 1). Makueni Sub-county contributes the largest percentage area (64.34%) of the municipality, followed by Mbooni Sub-county accounting for 20.36% while Kaiti Sub-county contributes the least area (15.30%).



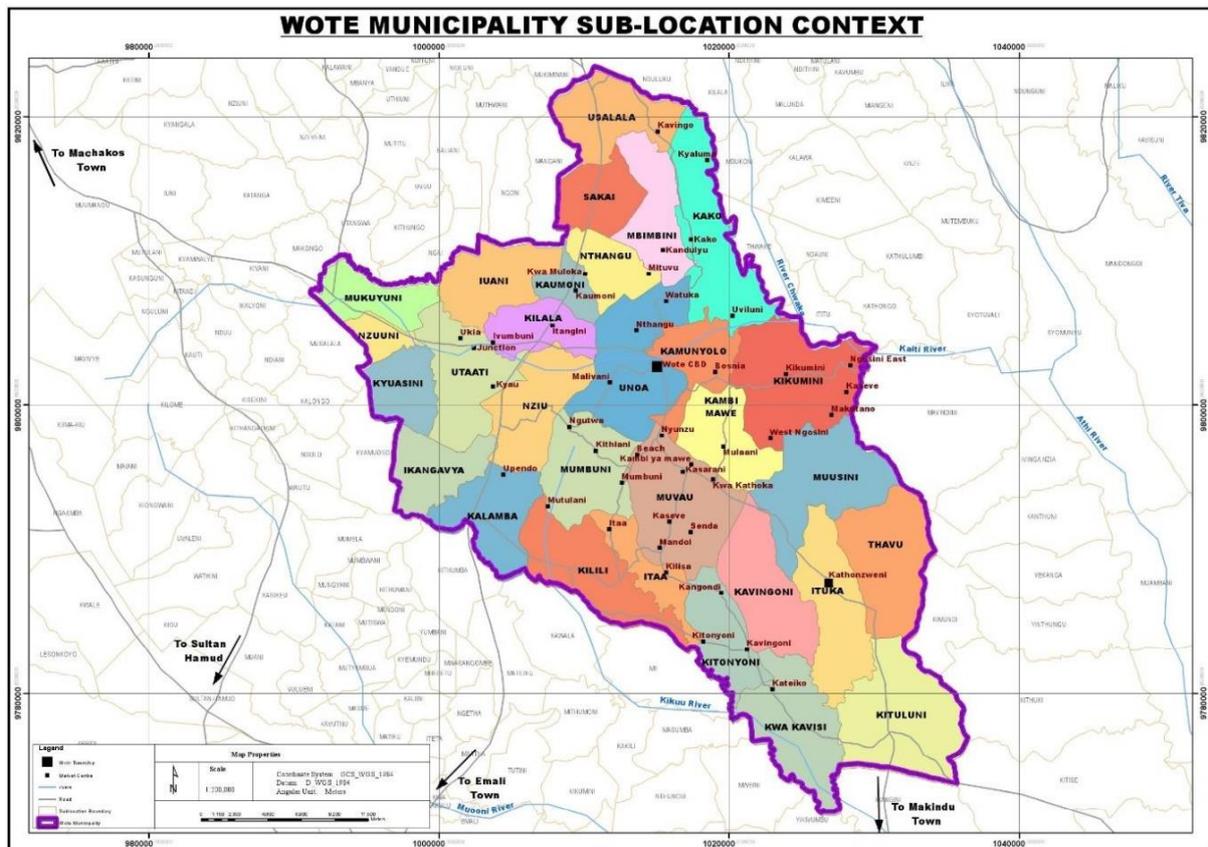
**Figure 1: Location of Wote Municipality**

The Municipality covers the entire Wote-Nziu and Muvau-Kikumini wards, and sections of Ukia, Kathonzweni, Nzaui-Kilili-Kalamba, Mavindini and Kako-Waia wards, as shown below.

**Table 1: Area coverage by ward units**

S/No.	Ward	Total Area (Km <sup>2</sup> )	Area coverage contributing to the Municipality (km <sup>2</sup> )	%age of Ward Coverage contributing to the municipality	%age coverage contributing to the Municipality
1	Wote/Nziu	97.5	97.5	100.00	9.01
2	Muvau /Kikumini	235.82	235.82	100.00	21.79
3	Ukia	210.07	204.05	97.13	18.86
4	Kathonzweni	309.67	214.85	69.38	19.86
5	Nzaui/Kilili/Kalamba	220.87	67.17	30.41	6.21
6	Mavindini	258.14	65.01	25.18	6.01
7	Waia/Kako	215.3	197.6	91.78	18.26
<b>Total</b>			<b>1082.00</b>		<b>100</b>

The municipality covers the following sub-locations; Unoa, Nziu, Kamunyolo, Ituka, Kwa Kavisi, Thavu, Kavingoni, Kituluni, Kikumini, Kambi Mawe, Muvau, Itaa, Mumbuni, Kitonyoni, Kilili, Kalamba, Usalala, Sakai, Kako, Nthangu, Kaumoni, Iuani, Mukuyuni, Nzuuni, Utaati, Kyuasini, I Kangavya, Mbimbini, Kilala and Muusini. All the listed sub-locations are 100% spatially within the municipality, as shown in Figure 2.



**Figure 2: Sub-locations within Wote Municipality**

### 1.5.2. Governance structure

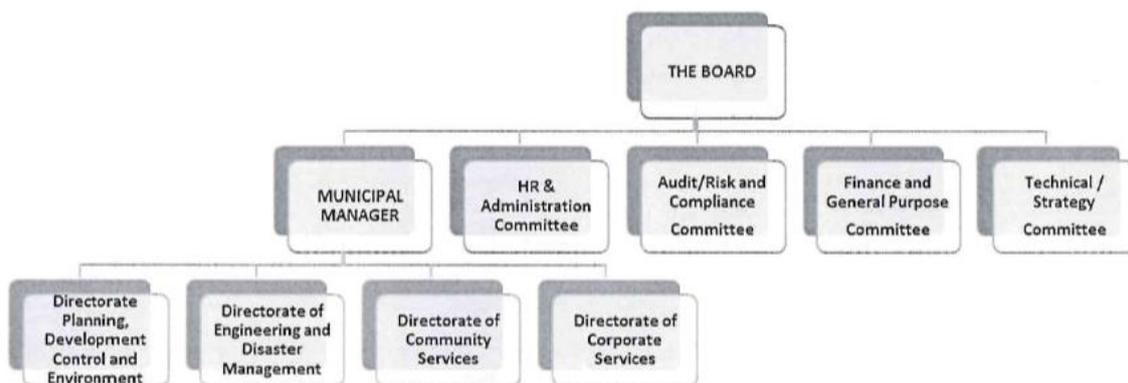
Wote Municipality was established through Wote Municipal Charter as approved by the County Assembly and assented to by H.E the Governor of Makueni County in June 2018 pursuant to the provisions of the Urban Areas and Cities Act (UACA) of 2011 (amended 2019). In accordance with the Charter, the Municipal Board is obliged to carry out a number of functions that include formulating and implementing various development plans within the municipality.

The Charter expressly spells out the following as objectives of the Municipality:

- i. To provide for efficient and accountable management of the affairs of the Municipality
- ii. To provide for a governance mechanism that will enable the inhabitants of the Municipality to participate in determining the social services and regulatory framework which will best satisfy their needs and expectations
- iii. To vigorously pursue the developmental opportunities which are available in the Municipality and to institute such measures as are necessary for achieving public order and the provisions of civic amenities, to enhance the quality of life of the inhabitants of the Municipality
- iv. To cost-effectively provide a high standard of social services to the inhabitants of the Municipality.
- v. To promote social cohesiveness and a sense of civic duty and responsibility among the inhabitants and stakeholders in the Municipality to facilitate collective action and commitment towards achieving the goal of a harmonious and stable community.
- vi. To provide services on all matters for the Municipality's benefits.
- vii. To foster the economic, social and environmental well-being of its community.

The institutional framework for the implementation of municipal functions is anchored on the structure as stipulated in the Makueni County Governments staff establishment. The framework provides a for purposes of implementing municipal functions as contained in the municipal charter. The Municipality's specialized directorates work with other departments of the County Government Departments for the successful implementation of development plans and other routine operations.

The Municipal institutional structure for Wote Municipality is shown below:



*Figure 3: Institutional structure for Wote Municipality*

### 1.5.3. Socio-demographic profile

Makueni County has an urban growth rate of around 11.8%, with significant levels of rural-urban migration elevating this percentage, especially in the urban centres. Settlement patterns in the County are influenced by soil fertility, topography, road networks, urbanization and rainfall. The population density is widely distributed among the sub-counties covering the municipality, with the average density in the County being 123 persons per square kilometer. Kaiti Sub-county is more densely populated (281 persons per square kilometer) due to the favorable climatic conditions for agriculture as compared to Makueni (159 persons per square kilometer) and Mbooni sub-counties (208 persons per square kilometer). Makueni Sub-County is the least densely populated due to relatively unfavorable climatic conditions.

Wote is the capital of Makueni County. It is an increasingly urbanized, fast-growing municipality, with a population of 161,996.<sup>3</sup> Table 2 indicates the projection of the population of the municipality up to the year 2030.

*Table 2: Population projection by sub-counties*

	Base		Projected Population					
	2019		2020		2025		2030	
Administrative Unit	100% area of Sub-County	Section within Municipality	100% area of Subcounty	Section within municipality	100% area of Subcounty	Section within municipality	100% area of Subcounty	Section within municipality
Makueni Subcounty	243,807	106,768	246,997	108,166	263,585	115,429	281,287	123,181
Mbooni Sub County	200,350	19,736	202,972	19,994	216,603	21,337	231,150	22,771
Kaiti Sub-County	111,502	35,492	112,961	35,956	120,547	38,372	128,643	40,948
Wote Municipality		161,996		164,116		175,138		186,900

### 1.5.4. Economic context

Wote's economy is still largely rural, based on farming and agro-based industries, with a rapidly growing urban informal sector. Over 83% of total land is for agricultural use, with urban small-scale cultivation and rearing of indigenous livestock. Agro-based industries include a milk processing factory, a fruit processing plant and a ginnery. Due to urban expansion, informal markets have grown. The informal sector thrives on its artisans (e.g., welders, motor mechanics), food traders, and *boda bodas* (motorcycle taxis).

Wote Township being the core business and administrative hub has the bulk of the commercial activities within the municipality. The commercial activities are grouped into two broad categories: formal and informal. Formal commercial activities include banking services, transport business, SACCOs, wholesale businesses, general shops, open-air markets, hotels and restaurants among others. Informal business activities have increasingly become the driver of the economy in Wote Township and other urban centres within the municipality. The informal

<sup>3</sup> KNBS (2019) Kenya National Population Census.

businesses include artisans (welding, motor garages, furniture making, household items and tools, tailoring, etc.), informal traders such as hawkers, fruit and vegetable vendors, shoes and clothes retailers, charcoal and miraa vendors, among others. Hawking activities are concentrated along the reserves of busy internal streets, fronting the formal businesses housed in permanent structures. The *boda boda* and taxi businesses also form part of the informal ‘hustler’ economy.

Businesses in Wote include a variety of different sizes, however the production chain is limited, with little interaction between businesses upstream and downstream. Most businesses operate locally, especially in the retail, trade, agriculture and livestock sectors, selling their produce either within Wote Town or the surrounding Municipality. Some businesses, particularly in the services sector, operate outside the Municipality in Makueni County. Similarly, the majority of businesses use local suppliers for goods to enable their business to operate effectively, with a small proportion sourcing from further afield in Nairobi and Machakos.

There has been rapid industrial development following the establishment of agro-processing factories in Wote Municipality. Agro-based industries in municipality include; ENI Agro Hub, Kathonzweni Milk Processing Factory, Makueni Dairy Farmers’ Co-operative Society, Makueni Ginnery Limited and Kalamba Fruits Processing Plant. The establishment of the Makueni fruits processing plant at Kalamba has particularly boosted mango production by reducing post-harvest losses for farmers in the municipality and beyond.

The municipality has a few mining activities which include sand harvesting which is regulated by the County Sand Conservation and Utilization Authority. There is also some quarrying activities at Unoa Hill, which supplies building stones and murrum for the local construction industry and vermiculite in Kilili area a core component in horticulture used to improve soil aeration, retain moisture, and enhance nutrient retention.

#### **1.5.5. Land use context**

The Municipality exhibits both linear and nucleated urban development patterns. Nuclear patterns can be found in the larger urban centres while linear settlements have formed along the roads leading into and out of Wote Town. Significant urban settlements such as Wote Town, Kathonzweni, Mukuyuni and Kalamba, have high population densities and high levels of rural-urban migration as those living in rural areas move towards the urban areas for better employment and education opportunities. This has presented challenges for the Municipality, as the demand for populations residing in urban areas continue to outstrip the provision of critical urban infrastructure.

While there is continued movement of people from rural to urban areas, agriculture remains the mainstay of land use across the municipality, making up 83.93% of the total land budget. The remainder of land for recreational and public use therefore pales in comparison. Overall, there is an inadequate supply of public land in the municipality, mostly due to encroachment on public land and uncontrolled urban developments in the past. Furthermore, owing to historically weak enforcement of planning guidelines, urban sprawl is increasingly becoming problematic across the municipality.

The urban centers that constitute Wote Municipality are each experiencing a high rate of urbanization. The municipality is experiencing high-density, informal, haphazard, rapid urban sprawl along major roads, particularly in Kathonzweni Market, Mukuyuni Market and Wote Township, which alone has an urban growth rate of 11.8%. Uncontrolled development is also attributed at least in part to inadequate personnel to enforce existing land use development plans. The municipality also struggles with insufficient infrastructure and services, land tenure issues, urban poverty and unemployment.

The lack of adequate water supply and sewage infrastructure continues to be problematic for residents and businesses, as well as causing contamination of groundwater. Furthermore, unsatisfactory transportation provision hampers productivity and inadequate solid waste management pollutes the environment. The roads connecting the built-up areas are mostly dirt roads, presenting challenges in efficient connections and ease of movement across the municipality, especially during heavy rains when the roads become flooded and damaged. The completion of the Thwake Dam is likely to alleviate infrastructure gaps in the water, sanitation and energy spheres.

Wote Town, the largest urban area in the municipality acts as the administrative seat of the County. There are a number of healthcare and educational facilities in the town, offering training and employment opportunities, including a Level 5 Referral Hospital. It is also home to a burgeoning financial hub, with a number of banks and insurance companies. Despite these tertiary industries, the town is heavily reliant on the agricultural industry based in the surrounding hinterland as the mainstay of its economy, with a thriving market for trading produce at the centre of the town.

#### **1.5.6. Urban Social Issues and Marginalized Groups**

Marginalization is usually manifested in the following areas: education, housing, employment, healthcare, civic engagement, gender equity and democratic participation among others.

Youth unemployment and under-employment; insecurity of land tenure within Wote Township and the other urban centres in the Municipality; people living in informal settlements lacking essential social, sanitation and infrastructural services; and people with special needs (e.g. physically challenged, sickly and elderly people) are examples of marginalized groups manifested within Wote Municipality.

#### **1.6. Key Stakeholders & Inclusiveness**

Targeted discussions and inclusive multi-stakeholder approach to ensure that the risk profile reflect both technical sector perspectives and community experiences was adopted. Further, actors were analyzed by use of an Influence/Interest Matrix in four quadrants. Engagement strategies were then tailored to suit the needs of each quadrant thereby ensuring appropriate involvement throughout the process. This participatory approach ensured that the climate risk profile integrates institutional data with local perspectives, particularly reflecting the high exposure of informal settlements, vulnerable populations, agricultural systems and other urban elements to climate hazards in Wote Municipality

**Table 3: Stakeholder mapping for Wote Municipality**

<b>POWER/INFLUENCE</b>	<p><b>High Influence - Low Interest</b></p> <ul style="list-style-type: none"> <li>• National line ministries</li> <li>• Utility service providers</li> <li>• The media</li> <li>• Development partners: World Bank, DANIDA, commercial banks</li> <li>• Wote Water and Sewerage Company</li> <li>• Kenya Power</li> <li>• Kenya National Highways Authority</li> <li>• Kenya Urban Roads Authority</li> <li>• Kenya Rural Roads Authority</li> <li>• Civil Society Organizations</li> <li>• Tanathi Water Works Development Agency</li> </ul>	<p><b>High Influence - High Interest</b></p> <ul style="list-style-type: none"> <li>• County Governor</li> <li>• County Executive</li> <li>• National Environment Management Authority</li> <li>• Wote Municipal Board</li> <li>• National Drought Management Authority</li> <li>• Kenya Meteorological Department</li> <li>• County Climate Change Steering Committee</li> <li>• County climate change technical working group</li> <li>• Members of county assembly</li> <li>• Ward Climate Change Planning Committees</li> <li>• County Climate Change Unit</li> <li>• County Line Departments</li> </ul>
	<p><b>Low Influence - Low Interest</b> <i>(Engagement approach is monitor)</i></p> <ul style="list-style-type: none"> <li>• Residents of areas adjacent to the municipality</li> <li>• Private service providers not linked to climate-sensitive sectors (e.g., salons, barbershops, small electronics repair shops)</li> <li>• Short-term visitors and transient populations</li> <li>• Businesses that operate occasionally in the municipality but are not locally established</li> </ul>	<p><b>Low Influence - High Interest</b> <i>(Engagement approach is consult and involve)</i></p> <ul style="list-style-type: none"> <li>• SMEs</li> <li>• Boda boda operators</li> <li>• <i>Jua kali</i> traders</li> <li>• National research institutions</li> <li>• Neighbourhood associations</li> <li>• Individual farmers</li> <li>• Vulnerable and marginalized groups</li> <li>• PWDs</li> <li>• Widowed households</li> <li>• Women and children</li> <li>• Elderly persons</li> </ul>
<b>Low</b>	<b>INTEREST</b>	<b>High</b>

## 2.0 Hazard Assessment

Climate risk results from the interaction between and among hazard, exposure and vulnerability. Hazard refers to the potential occurrence of climate-related physical events or trends that may cause damage and/or loss. Exposure indicates the presence of assets, services, resources and infrastructure that could be adversely affected. Vulnerability on the other hand is the propensity or predisposition to be adversely affected. A climate hazard assessment identifies, evaluates, and prioritizes the physical impacts of climate change such as floods, droughts, heatwaves, and storms on assets, communities, and ecosystems. It determines risk by analyzing the intersection of hazard severity, exposure, and vulnerability, usually to facilitate adaptation actions. The following section highlights the key climate hazards within Wote Municipality, highlighting the major concerns that should guide local climate action.

This section is critical to understanding the municipality’s vulnerability to climate change, by identifying and characterizing the most significant climate-related hazards. Based on historical data and future projections, the initial screening process (Table 5) reveals that changes in precipitation patterns, specifically those leading to flooding, water stress and mass movement, as well as changes in surface temperatures expressed in heat stress are the most pressing high-priority threats for the municipality. The key hazards thus are heat stress, flooding, water stress and mass movement typified by gully erosion, especially in areas made susceptible owing to uncontrolled sand harvesting. These risks will thus form the focus of subsequent analysis, leading to their integration into urban planning and resilience strategies for the future development planning across the municipality.

### 2.1 Key Climate Hazards

Makueni County is largely an Arid and Semi-Arid land; prone to frequent droughts due to unreliable and erratic rainfall. The county experiences two rain seasons in a year. The long rains are experienced during the March-May-April-June season with the volume of rainfall averaging at 140 MM over the last five years. Short rains are experienced during the October - December season with higher volumes of precipitation being realized with a five-year average of 300MM.

The mean annual temperatures in Makueni range from 22.7 Degrees Celsius to 24 Degrees Celsius over the past years. The following matrix (Table 4) provides a summary of the key climate hazards that characterize development in Wote Municipality.

**Table 4: Hazard screening for Wote 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	Y	Y	Y	Y
Extreme heat	Y	Y	N	N
<b>Flooding</b>				
Extreme precipitation	Y	Y	Y	Y
Pluvial (surface level) flooding, including flash flooding and urban flooding	Y	Y	Y	Y
<b>Water Stress</b>				
Drought (meteorological, hydrological)	Y	Y	Y	Y
<b>Mass Movement</b>				
Landslides	Y	N	N	N
Gully erosion	Y	Y	Y	Y

## 2.2 Climate Indicators and Hazard Thresholds

Presented in Table 5 is an indication of hazard thresholds for relevant climate indicators relevant for Wote Municipality.

*Table 5: Climate indicators and hazard thresholds selected for the assessment*

Key Hazard	Climate indicator	Data source	Threshold		
			Low	Medium	High
Average surface temperature increase	Monthly temperature anomaly since 1979 (warmer than the 30-year climate mean of 1980-2010)	<a href="https://www.meteoblue.com/">https://www.meteoblue.com/</a>	Varies per month	Varies per month	Varies per month
Extreme precipitation	#days per year with precipitation >100mm #consecutive rainfall events with a total precipitation of 150mm	<a href="https://climateknowledgeportal.worldbank.org/country/kenya/era5-historical">https://climateknowledgeportal.worldbank.org/country/kenya/era5-historical</a>	Varies per year	Varies per year	Varies per year
Pluvial flooding	#days with precipitation >50 mm	<a href="https://climateknowledgeportal.worldbank.org/country/kenya/era5-historical">https://climateknowledgeportal.worldbank.org/country/kenya/era5-historical</a>	<3 days /year	3-6 days/year	>6days /year
Prolonged dry spell	10 consecutive days with <10mm of precipitation	<a href="https://meteo.go.ke/">https://meteo.go.ke/</a>	Varies per month	Varies per month	Varies per month
Gully erosion	Vegetation coverage (VC), slope and main-branch gully ratio (MBGR)	Kimani (2024) <sup>4</sup> ; Makueni County CIDP 2023-2027			

## 2.3 Current Hazard Levels and Climate Projections

Makueni County, in which Wote is located, has in the past recorded climate variability, accompanied by a significant increase in attendant risks, as repeatedly reported in the National news media. Historic analysis of weather in Makueni County shows that both dry spells and extreme precipitation are hazards in the County. Dry spells are on average longer during the second wet season, averaging close to 50 consecutive days of moisture stress, but ranging from 35 to 80 days in any given year. The first wet season experienced about 35 consecutive days of moisture stress, ranging from about 25 to 60 days in any given year. Extreme precipitation and

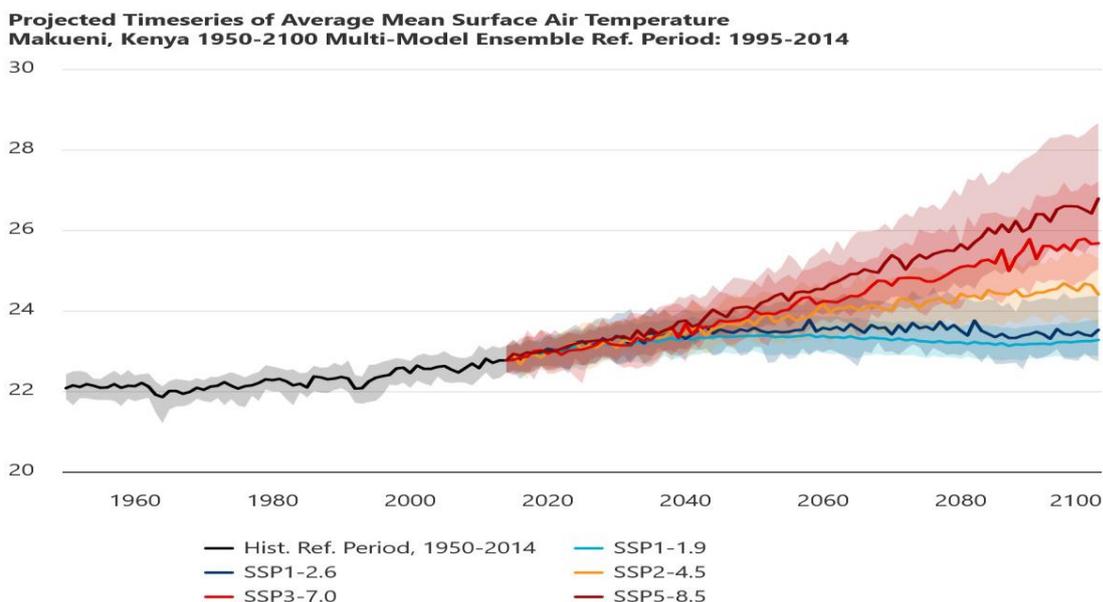
<sup>4</sup> Kimani, C. K. (2024) An assessment of the causes and effects of degradation on riparian ecosystems of the eastern semi-arid region of Kenya; A case study of Kaiti river, Makueni County. MSc Thesis, South Eastern Kenya University.

flood risks are moderate in both seasons, with most years receiving between 20 and 30 mm of precipitation on the wettest day.

Climate has already been observed to change across the county. Since 1981, the first wet season with predominant high temperature and drought risk has experienced an approximately 10°C increase in mean temperature, bringing with it associated reduction in crop cycle time and an additional 3-5 days with extreme heat stress (>35°C). Although there was no significant change in precipitation in this season, there was an increase in drought risk due to hotter temperatures. The second wet season experienced a small (< 0.5°C) change in temperature, no increase in heat stress days, and no significant change in precipitation, but continued to be affected by uncertain and highly variable rains.<sup>5</sup>

According to projections spanning the years of 2021-2065, prolonged moisture stress is expected to occur across both seasons of the year analyzed especially for first wettest season, whereas intense precipitation looks to change little. Within 30 years (by the early 2040's) temperature is projected to will have increased by 0.2°C, with the first wet season projected to experience even greater changes. And by this time, precipitation is projected to increase by 2% in the first wet season, and 17% in the second wet season. Consecutive days of moisture stress is projected to more than double in the first wet season from approximately 60 days to over 80-85 days depending on the amount of greenhouse gas emissions. In contrast, moisture stress in the second wet season is projected to reduce little on average (8% approximately). However, the second season is projected to receive more precipitation, and greater extremes in precipitation with climate change. For this season, the single day extreme rainfall is projected to increase by almost 50%. These projections of future climate change under the two climate scenarios - RCP 2.6 and RCP 8.5 - show some small differences, but generally show the same future projections, suggesting climate change impacts will be fairly similar during this time frame no matter the greenhouse gas emissions levels that occur.<sup>6</sup>

### 2.3.1 Temperature



*Figure 3: Projected average mean temperature<sup>7</sup>*

<sup>5</sup> Ibid.

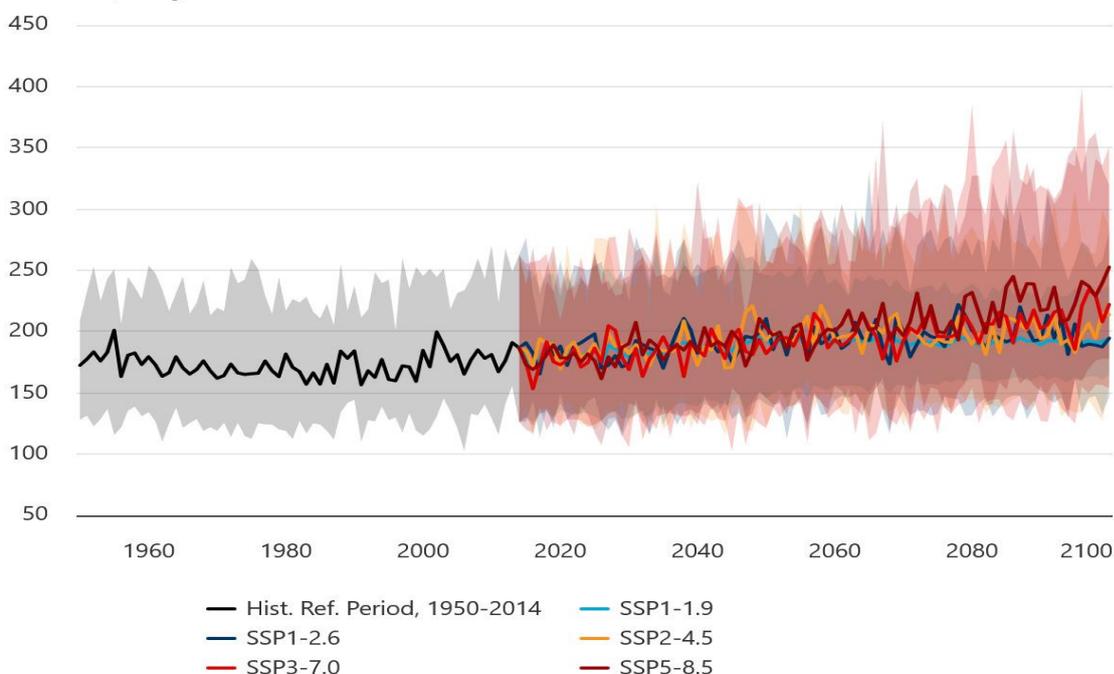
<sup>6</sup> Ibid.

<sup>7</sup> Data from: <https://climateknowledgeportal.worldbank.org/country/kenya/climate-data-projections>

Figure 3 provides a view of projected mean surface air temperature for the area up to 2100 under five different shared socioeconomic pathways (SSP) scenarios. Even with the ‘middle of the road’ (SSP2) pathway, the average temperatures still peak above 24°C, while the worst-case scenario pushes things beyond 26.4°C

### 2.3.2 Precipitation

**Projected Timeseries of Average Largest Monthly Cumulative Precipitation  
Makueni, Kenya 1950-2100 Multi-Model Ensemble Ref. Period: 1995-2014**



**Figure 4: Projected average monthly precipitation<sup>8</sup>**

Projected cumulative average monthly precipitation are presented in Figure 5. In general, the region is highly vulnerable to negative impacts of climate change due to low adaptive capacity and overreliance on rain-fed agriculture for food security and livelihoods.

Table 6 provides a summary of key hazards together with their levels of severity as experienced in Wote Municipality.

**Table 6: Current and future hazards levels for Wote 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	Low	Medium	High	Medium	High
Extreme precipitation	High	Medium	High	Medium	High
Pluvial flooding	High	High	High	High	High
Prolonged dry spell	Medium	Medium	High	Medium	High
Gully erosion	Medium	Medium	High	Medium	High

<sup>8</sup> Data from: <https://climateknowledgeportal.worldbank.org/country/kenya/climate-data-projections>

For this Urban Climate Risk Profile, hazard levels should be interpreted in accordance with the Table 7, with levels ranging from low to high.

**Table 7: Interpretation of hazard levels**

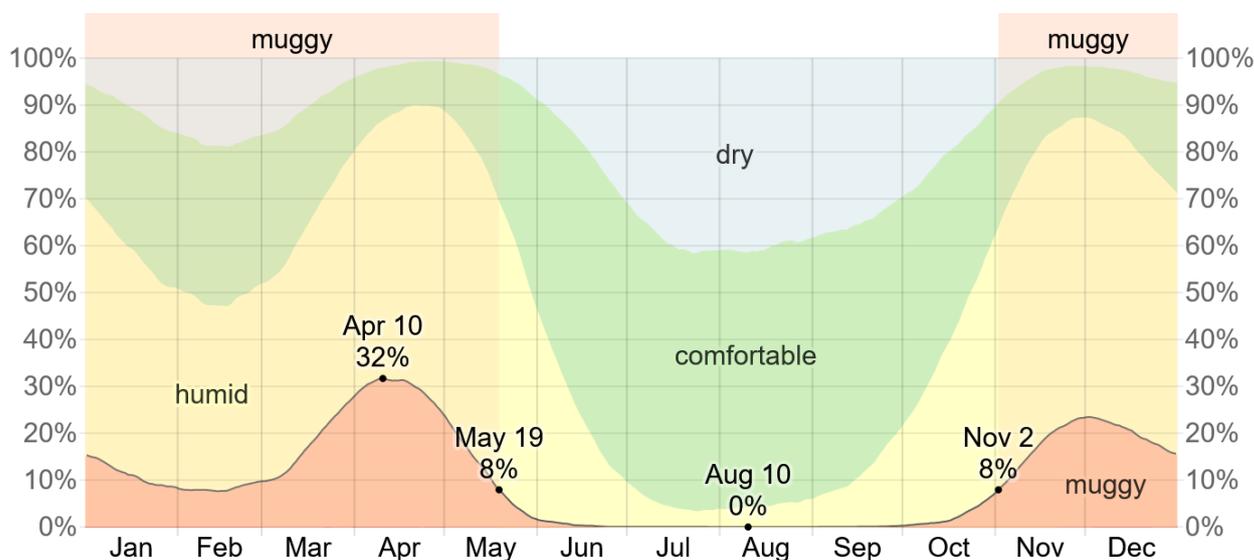
Level	Interpretation
High	Hazard events that are likely to occur with high frequency and/or intensity
Medium	Hazard events that are likely to occur with moderate frequency and/or intensity
Low	Hazard events that are likely to occur with low frequency and/or intensity

### 2.3.3 Humidity

The humidity comfort level is based on the dew point, as it determines whether perspiration will evaporate from the skin, thereby cooling the body. Lower dew points feel drier and higher dew points feel more humid. Unlike temperature, which typically varies significantly between night and day, dew point tends to change more slowly, so while the temperature may drop at night, a muggy day is typically followed by a muggy night.

Makueni experiences significant seasonal variation in the perceived humidity. The muggier period of the year lasts for 6.5 months, from November 2 to May 19, during which time the comfort level is muggy, oppressive, or miserable at least 8% of the time. The month with the muggiest days in Makueni is April, with 8.8 days that are muggy or worse.

The month with the fewest muggy days in Makueni is August, with 0.0 days that are muggy or worse.



**Figure 5: Projected average monthly Humidity comfort levels**

### 2.3.4 Wind

The wind experienced at any given location is highly dependent on local topography and other factors, and instantaneous wind speed and direction vary more widely than hourly averages. The average hourly wind speed in Makueni experiences mild seasonal variation over the course of the year.

The windier part of the year lasts for 3.1 months, from July 28 to October 31, with average wind speeds of more than 7.2 miles per hour. The windiest month of the year in Makueni is September, with an average hourly wind speed of 8.3 miles per hour.

The calmer time of year lasts for 8.9 months, from October 31 to July 28. The calmest month of the year in Makueni is June, with an average hourly wind speed of 6.1 miles per hour.

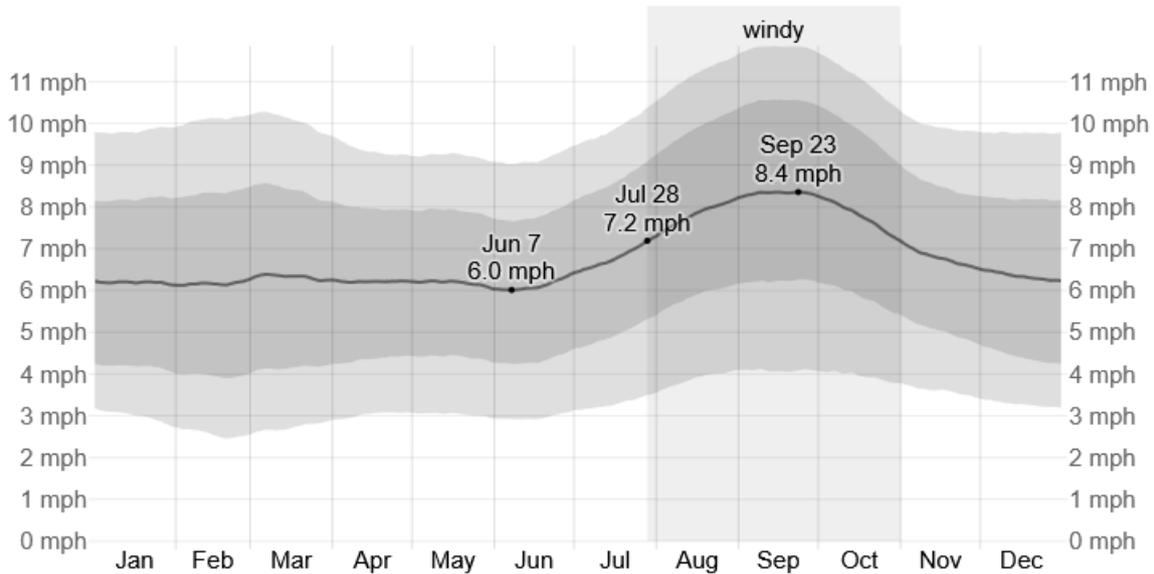


Figure 6: Average wind speed

## 2.4 Current and Future Hazard Impact Areas

The identified hazards are currently spread out across the entire municipality, with some areas experiencing higher intensities. Figure 6 and Figure 7, for example give an indication of climate risk areas in Makueni and Kaiti sub-counties, respectively.

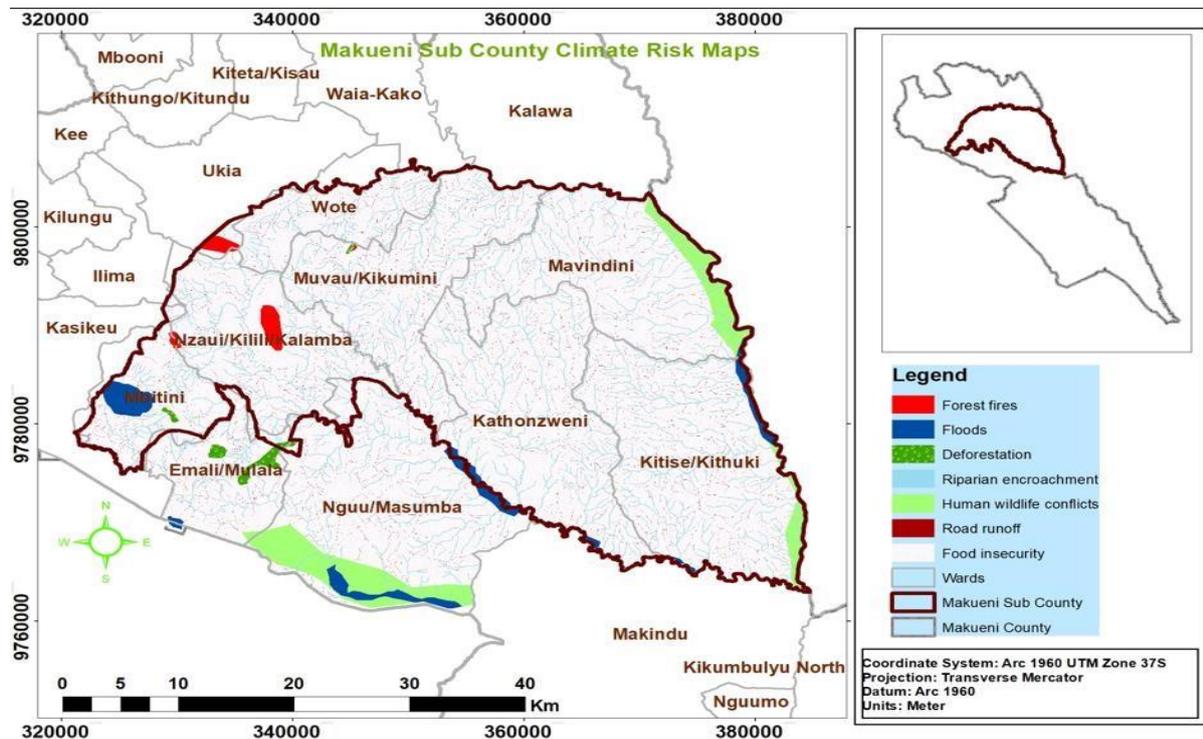
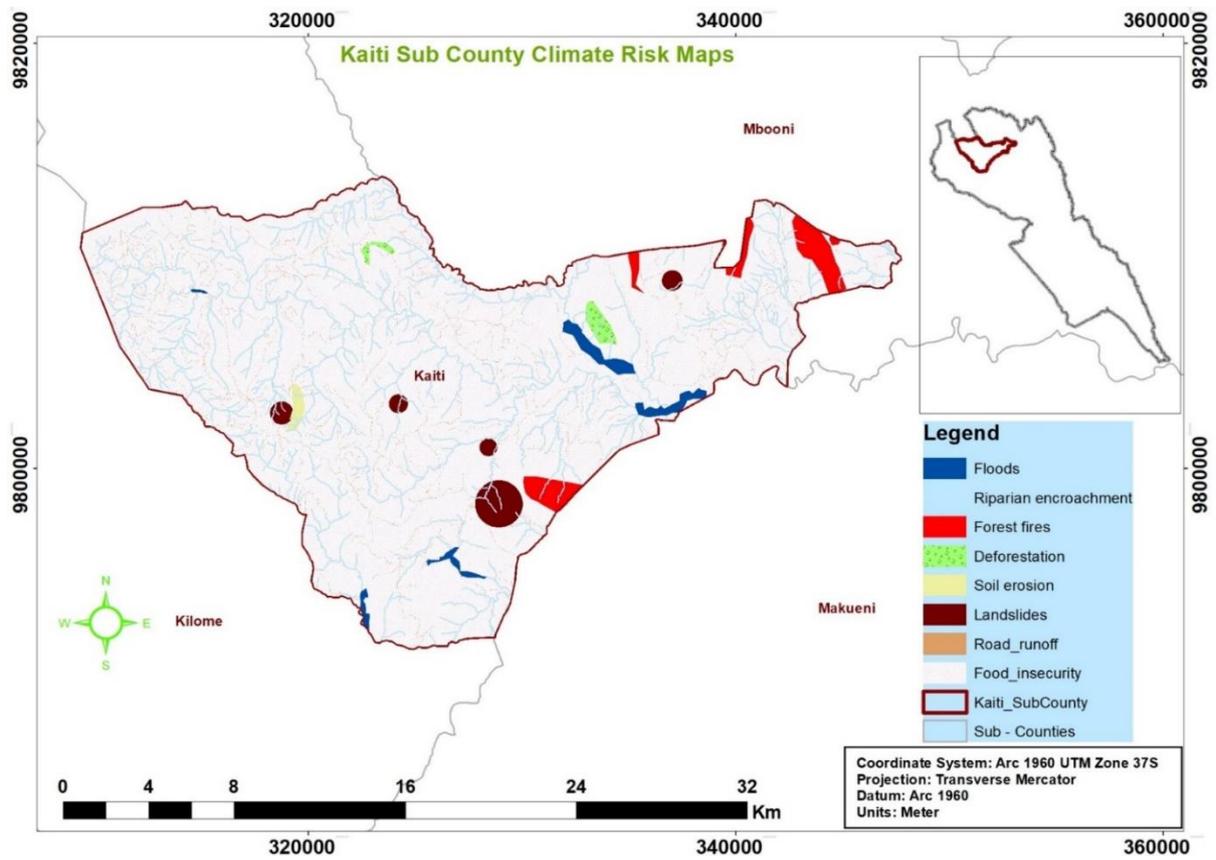


Figure 7: Climate impact areas in Makueni Sub-county



**Figure 8: Climate impact areas in Kaiti Sub-county**

The impact areas are a function of topography, hydrology and other parameters as captured in the following analysis.

### 3.0 Exposure & Vulnerability Assessment

Wote Municipality has a tropical savannah climate shaped by its varied topography. It experiences two dry seasons and two rainy seasons. The lower regions (Kathonzweni) are semi-arid, while the upper regions (Kaiti and Mbooni Sub-counties) are sub-humid. Mean temperatures range from 23.9°C to 19.3°C. The area is mostly flat with gently sloping land, hilly zones (Nthangu, Nzueni, Makuli, Mutula and Unoa hills), riparian zones along the Kaiti River, and fragile water catchment areas.

In recent years, the region’s vulnerability to climate challenges has grown due to erratic rainfall and rising temperatures. Extreme temperatures of up to 35°C, are causing heat stress, and the climate has become increasingly dry since the early 2000s. Future temperatures are expected to rise and persist longer. With time, rainy seasons have become shorter, more unpredictable, and more intense, leading to increased flashfloods and landslides, a trend likely to continue.

Rapid urbanization, population growth, and environmental degradation worsen the effects of urban floods and droughts. Poor drainage across the market centres, increases vulnerability to flashfloods, leading to severe economic impacts. Moreover, deforestation within and beyond the municipality disrupts the water cycle and contributes to frequent droughts. Poor waste management further exacerbate environmental degradation. These factors result in loss of life, property damage, water scarcity, and declines in biodiversity, livestock, and crops, contributing to food insecurity.

#### 3.1 Urban Elements

The following is an inventory of urban elements, together with their description as captured in this risk assessment (Table 8).

**Table 8: Urban elements inventory**

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
<b>Infrastructure &amp; Services</b>				
Storm water Drainage	Storm water drainage conveyance network	Y	N	Both lined and earth drains exist Mainly along bitumen standard roads within Wote Township
	Storm water storage	N	N	-
Water & Wastewater Management	Pumping stations	Y	N	Priority for Muvau-Kikumini
	Groundwater abstraction	Y	N	
	Water treatment facilities	Y	N	
	Water supply networks	Y	N	Dams, rivers and boreholes Main source of water for the Municipality is Mwaani Borehole and River Kaiti Wote Water and Sewerage Company pumps 1500,000 litres/day

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Sewer networks	Y	N	No conventional sewerage system Pit latrines, ventilated improved pit (VIP) and soak pits used
	Wastewater treatment facilities			Localized septic tanks serve main institutions and some households Wote Township generates 1,337.77 (m <sup>3</sup> /day) of wastewater Projected to increase to 1,980 m <sup>3</sup> /day by 2030
Solid Waste Management	Transfer facilities	Y	N	
	Landfills and dump sites	Y	N	Modern dumpsite to be operationalized at Kwa Kathoka
	Recycling centers	Y	N	
	Collection fleet	Y	N	Modern fleet acquired
Transport and Mobility	Road networks	Y	Y	Road network laid out in mixed radial and grid-iron pattern.
	Bridges	Y	N	
	Public transport networks (rail, bus, mini-bus, etc.)	Y	N	Matatus and boda bodas offer public transport Some 1786 motorbikes operate within Wote Township, with 15 designated stages.
	Transportation terminals	Y	N	Consist of matatu and boda boda stages
	Vehicle depots			
	Non-motorized transport networks	Y	N	Inadequate across municipality
	Freight and logistics hubs	N	N	Private courier companies like Wells Fargo, G4S, bus/matatu companies/saccos
Energy	Energy power plants	N	N	Thwake Dam currently under construction
	Poles and power lines	N	N	
	Transformers and substations	Y	N	Nthangu sub-station produces 132KV/33KV
	Street lighting	Y	N	Mostly in Wote Township
Economic Infrastructure	Markets	Y	Y	Facilities include open air markets, closed markets and livestock yards
	Businesses and commercial hubs	Y	N	Wote Township, Kathonzeni Market, Mukuyuni Market, Kilala, Nziu, Kalamba Kwa Kathoka, and Mbuve

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Industrial zones/parks and logistics parks	Y	Y	Kathonzweni Milk Processing Factory, Makueni Dairy Farmers' Co-operative Society, Makueni Ginnery and Kalamba Fruit Processing Plant
Social Infrastructure	Government buildings and service centers	Y	N	
	Education facilities	Y	Y	
	Healthcare facilities	Y	Y	
	Public spaces	Y	N	
	Faith-based buildings	N	N	
	Cultural and heritage assets	N	N	
Emergency Services	Fire stations	Y	N	One operational fire station with two fire engines
	Police stations	Y	N	Several police stations and posts
	Telecommunications networks	Y	N	Safaricom, Airtel and Telkom networks adequately cover the municipality Mobile internet connection adequate across municipality
	Early warning systems	Y	N	
	Disaster management centers and shelters	Y	N	
	Evacuation routes	N	N	
	<b>Populations</b>			
Urban Residents	Population	Y	N	161,996 (2019 census)
	Households	Y	N	4,932 households
Informal Settlement Residents	Population living in informal settlements	Y	N	
	Households lacking land tenure	Y	N	
	Households / residents lacking access to basic services	Y	N	
Vulnerable and Marginalized Groups	Low-income households	Y	N	
	Women-headed households	Y	N	
	Children and youth	Y	N	
	Elderly persons	Y	N	
	People with disabilities (PWD)	Y	N	
	Homeless populations	Y	N	Mainly street families in Wote Township and Kathonzweni Market

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Unemployed or precariously employed workers	Y	N	
	Seasonal workers / migrant laborers	N	N	
	Nomadic groups in peri-urban areas	N	N	
	Urban refugees and migrants	N	N	
	Minority ethnic groups in urban areas	N	N	
<b>Natural Assets</b>				
Urban Green Infrastructure	Urban parks and gardens	Y	Y	
	Green corridors	Y	N	
	Street landscaping	N	N	
	Urban forests and forest reserves	N	N	Nzueni Hill, Muvau Hill Nzaui Hill, Katende, Makuli
Urban Blue Infrastructure	Natural wetlands	Y	N	
	Rivers	Y	Y	Kaiti, Muunga, Kiloi, Kamunyii
	Riparian zones	Y	Y	Kaiti River reserve
	Lakes, ponds and reservoirs	N	N	
	Coastal ecosystems			
	Urban agriculture	N	N	
Peri-urban and Agricultural Systems	Peri-urban agriculture	Y	N	Prevalent in non-core areas of the municipality
	Agroforestry systems	Y	N	
	Forests and forest reserves	Y	N	Nzueni Hill, Muvau Hill Nzaui Hill, Katende, Makuli
	Protected areas and national parks	N	N	
	Savannahs and rangelands	N	N	

### 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 Table 9 below.

**Table 9: 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 (Table 10) summarizes likely impacts on each urban element by combining the assigned exposure and vulnerability levels.

**Table 10: Impact matrix**

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

*Table 11: 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>					
Storm water Drainage	<ul style="list-style-type: none"> <li>Can precipitate stronger storms accompanied by heavy downpour</li> </ul>	LOW	Sensitivity: <ul style="list-style-type: none"> <li>Low</li> </ul>	LOW	INSIGNIFICANT
			Adaptive Capacity: <ul style="list-style-type: none"> <li>Medium</li> </ul>		
Water & Wastewater Management	<ul style="list-style-type: none"> <li>Resultant storms may disrupt water distribution networks when accompanied by heavy downpour that precipitate flooding and gully erosion</li> </ul>	LOW	Sensitivity: <ul style="list-style-type: none"> <li>Low</li> </ul>	LOW	INSIGNIFICANT
			Adaptive Capacity: <ul style="list-style-type: none"> <li>Medium</li> </ul>		
Solid Waste Management	<ul style="list-style-type: none"> <li>Resultant storms may increase pluvial flooding that complicate SWM</li> </ul>	LOW	Sensitivity: <ul style="list-style-type: none"> <li>Low</li> </ul>	LOW	INSIGNIFICANT
			Adaptive Capacity: <ul style="list-style-type: none"> <li>Medium</li> </ul>		
Transport and Mobility	<ul style="list-style-type: none"> <li>Heatwaves may impede use of non-motorized transport</li> </ul>	LOW	Sensitivity: <ul style="list-style-type: none"> <li>Low</li> </ul>	LOW	INSIGNIFICANT
			Adaptive Capacity: <ul style="list-style-type: none"> <li>Medium</li> </ul>		
Energy	<ul style="list-style-type: none"> <li>Storm surges may destroy electricity distribution networks occasioning power outages</li> </ul>	LOW	Sensitivity: <ul style="list-style-type: none"> <li>Low</li> </ul>	LOW	INSIGNIFICANT
			Adaptive Capacity: <ul style="list-style-type: none"> <li>Medium</li> </ul>		
Economic Infrastructure	<ul style="list-style-type: none"> <li>Traders in open-air markets will be more exposed to heatwaves reducing productivity due to heat stress</li> </ul>	LOW	Sensitivity: <ul style="list-style-type: none"> <li>Low</li> </ul>	LOW	INSIGNIFICANT
			Adaptive Capacity: <ul style="list-style-type: none"> <li>Medium</li> </ul>		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Social Infrastructure	<ul style="list-style-type: none"> <li>Storm surges may destroy social amenities curtailing access</li> <li>Hospitals likely to experience a surge cases related to mental stress</li> </ul>	LOW	Sensitivity: <ul style="list-style-type: none"> <li>Low</li> </ul>	LOW	INSIGNIFICANT
			Adaptive Capacity: <ul style="list-style-type: none"> <li>Medium</li> </ul>		
Emergency Services	<ul style="list-style-type: none"> <li>Freak storms may curtail timely access of emergency vehicles</li> </ul>	LOW	Sensitivity: <ul style="list-style-type: none"> <li>Low</li> </ul>	LOW	INSIGNIFICANT
			Adaptive Capacity: <ul style="list-style-type: none"> <li>Medium</li> </ul>		
<b>Populations</b>					
Urban Residents	<ul style="list-style-type: none"> <li>Most exposed to heatwaves due to localized impacts of urban heat island effects</li> <li>Increased heat stress and related mental effects</li> </ul>	HIGH	Sensitivity: <ul style="list-style-type: none"> <li>High</li> </ul>	MEDIUM	MAJOR
			Adaptive Capacity: <ul style="list-style-type: none"> <li>Low</li> </ul>		
Informal Settlement Residents	<ul style="list-style-type: none"> <li>Exposure to heatwaves owing to quality of residential units</li> <li>Exposure to heatwaves owing to jobs performed in the open sun</li> </ul>	HIGH	Sensitivity: <ul style="list-style-type: none"> <li>High</li> </ul>	HIGH	CATASTROPHIC
			Adaptive Capacity: <ul style="list-style-type: none"> <li>Low</li> </ul>		
Vulnerable and Marginalized Groups	<ul style="list-style-type: none"> <li>Mostly exposed owing to precarious livelihoods often pursued in the open sun</li> </ul>	HIGH	Sensitivity: <ul style="list-style-type: none"> <li>High</li> </ul>	MEDIUM	MAJOR
			Adaptive Capacity: <ul style="list-style-type: none"> <li>Low</li> </ul>		
<b>Natural Assets</b>					
Urban Green Infrastructure	<ul style="list-style-type: none"> <li>Destruction of vegetation reducing the quality of green infrastructure</li> </ul>	HIGH	Sensitivity: <ul style="list-style-type: none"> <li>High</li> </ul>	MEDIUM	MAJOR
			Adaptive Capacity: <ul style="list-style-type: none"> <li>Low</li> </ul>		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Urban Blue Infrastructure	<ul style="list-style-type: none"> <li>Drying up of rivers, shallow well and springs</li> </ul>	MEDIUM	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Medium</li> </ul>	MEDIUM	MODERATE
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul>		
Peri-urban and Agricultural Systems	<ul style="list-style-type: none"> <li>Destruction of crops</li> <li>Loss of livestock</li> </ul>	HIGH	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>High</li> </ul>	HIGH	CATASTROPHIC
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul>		

*Table 12: Exposure, Vulnerability, and Impacts of Extreme Precipitation on Urban Elements*

**Hazard:** Extreme precipitation

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
<b>Infrastructure &amp; Services</b>					
Storm water Drainage	<ul style="list-style-type: none"> <li>Municipal storm water drainage systems is overwhelmed by surface runoff volumes</li> <li>Areas lacking drains easily become flooded</li> </ul>	HIGH	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>High due to limited drainage network coverage</li> <li>Earth drains highly sensitive to topography which increases velocity of surface runoff</li> </ul>	HIGH	CATASTROPHIC
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Low owing to inadequate maintenance</li> </ul>		
Water & Wastewater Management	<ul style="list-style-type: none"> <li>Water distribution network often damaged due to gully erosion</li> <li>Runoff contaminates surface and piped water supplies due to infiltration</li> </ul>	HIGH	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>High owing to contamination and siltation of surface water sources</li> <li>Reduced efficiency of waste water disposal facilities</li> </ul>	HIGH	CATASTROPHIC

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	<ul style="list-style-type: none"> <li>• Overflowing of septic tanks, soak pits and pit latrines due to runoff intrusion</li> <li>• Disruption of piped and surface water supplies</li> </ul>		<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>• Low due to constrained water distribution networks</li> <li>• Limited capacity of existing waste water disposal/treatment facilities</li> </ul>		
Solid Waste Management	<ul style="list-style-type: none"> <li>• Delayed solid waste collection/transfer</li> <li>• Increased potential for ground water contamination by leachate</li> <li>• Solid wastes swept into drainage systems by surface runoff leading to clogging.</li> </ul>	HIGH	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>• High due to disruption in solid waste collection</li> </ul>	HIGH	CATASTROPHIC
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>• Low</li> </ul>		
Transport and Mobility	<ul style="list-style-type: none"> <li>• Dirt roads rendered impassable during heavy rains</li> <li>• Traffic flow disrupted on all major roads curtailing regional connection and internal circulation</li> <li>• Road and bridge infrastructure damaged by gully erosion</li> </ul>	HIGH	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>• High as key infrastructure and livelihoods are directly affected</li> </ul>	HIGH	CATASTROPHIC
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>• Low due to limited livelihood and accessibility alternatives</li> </ul>		
Energy	<ul style="list-style-type: none"> <li>• Power outages caused by short-circuits and system faults in heavy storms</li> <li>• Increased transformer blow-outs owing to leakages into poorly-insulated equipment</li> </ul>	MEDIUM	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>• High due to disruption in power supply which affects the entire municipal economy</li> </ul>	MEDIUM	MODERATE
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>• Low as it takes time to restore supply following outage</li> </ul>		
Economic Infrastructure	<ul style="list-style-type: none"> <li>• Traders in open markets are forced to close shop leading to income losses</li> </ul>	HIGH	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>• High due to direct impact on livelihoods</li> </ul>	MEDIUM	MAJOR

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	<ul style="list-style-type: none"> <li>• Merchandize destroyed by rain</li> <li>• Reduced customers due to limited movement during heavy rains</li> <li>• Agro-processing plants receive reduced/poor quality produce due to disruption in transport</li> </ul>		<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>• Low due to limited livelihood alternatives</li> </ul>		
Social Infrastructure	<ul style="list-style-type: none"> <li>• Sporadic damage to social infrastructure like school and health facilities occasioned by freak storms</li> <li>• Heavy rains curtails access household access to social facilities</li> </ul>	MEDIUM	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>• High to constrained access to social services</li> </ul>	MEDIUM	MODERATE
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>• Low due to limited alternatives</li> </ul>		
Emergency Services	<ul style="list-style-type: none"> <li>• Extreme rainfall curtails emergency response when roads and bridges are cut off</li> <li>• Far-flung peri-urban areas most affected</li> </ul>	MEDIUM	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>• High</li> </ul>	MEDIUM	MODERATE
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>• Low</li> </ul>		
<b>Populations</b>					
Urban Residents	<ul style="list-style-type: none"> <li>• Resident residing in downstream locations are affected by flash floods</li> <li>• Heightened runoff volumes affect surface water sources through contamination/siltation</li> </ul>	MEDIUM	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>• High</li> </ul>	LOW	MINOR
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>• Low</li> </ul>		
Informal Settlement Residents	<ul style="list-style-type: none"> <li>• Residents experience poor drainage due to non-existent/blocked drains</li> <li>• Neighbourhoods cut off when roads become impassable</li> </ul>	HIGH	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>• High</li> </ul>	MEDIUM	MAJOR
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>• Low</li> </ul>		
Vulnerable and		HIGH	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>• High due to their powerlessness</li> </ul>	HIGH	CATASTROPHIC

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Marginalized Groups	<ul style="list-style-type: none"> <li>• These often occupy precarious locations/shelter that are most vulnerable to floods/storms</li> <li>• Have precarious livelihoods that are easily disrupted by heavy rains</li> </ul>		<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>• Low due to limited alternatives</li> </ul>		
<b>Natural Assets</b>					
Urban Green Infrastructure	<ul style="list-style-type: none"> <li>• Parks cut off during heavy rains</li> <li>•</li> </ul>	LOW	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>• Medium</li> </ul>	LOW	INSIGNIFICANT
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>• Low</li> </ul>		
Urban Blue Infrastructure	<ul style="list-style-type: none"> <li>• Households that depend on shallow wells, protected springs and rivers suffer water contamination</li> </ul>	LOW	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>• Medium</li> </ul>	LOW	INSIGNIFICANT
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>• Low</li> </ul>		
Peri-urban and Agricultural Systems	<ul style="list-style-type: none"> <li>• Loss of soil fertility due increased soil erosion and nutrient leaching</li> <li>• Destruction of crops</li> <li>• Loss of produce due to disruption in transportation networks</li> </ul>	HIGH	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>• High</li> </ul>	HIGH	CATASTROPHIC
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>• Low</li> </ul>		

*Table 13: 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>					

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Storm water Drainage	<ul style="list-style-type: none"> <li>Majority of municipal drains are not lined</li> <li>Storm water drainage system is overwhelmed by surface runoff</li> </ul>	HIGH	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>Earth drains are highly sensitive</li> <li>Lined drains are highly sensitive due to poor routine maintenance</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>Low due to limited coverage of the drainage network</li> </ul>	HIGH	CATASTROPHIC
Water & Wastewater Management	<ul style="list-style-type: none"> <li>Water distribution network often damaged due to gully erosion</li> <li>Surface runoff contaminates fresh water supply lines</li> <li>Septic tanks, soak pits and pit latrines overflow into water intake points</li> <li>Disruption of water supplies cuts of customers</li> </ul>	MEDIUM	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>Low as most water supply and waste water infrastructure is not within the pluvial flood zone</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>Low due to suboptimal distribution network and overstretched capacity</li> </ul>	MEDIUM	MODERATE
Solid Waste Management	<ul style="list-style-type: none"> <li>Littered/uncollected wastes swept into drainage channels causing blockage</li> <li>Minimal flooding at collection points, aggregation centres and disposal facility</li> </ul>	LOW	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>Low as much of SWM infrastructure is not located within the pluvial flood zone</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>High as the new facility as Kwa Kathoka presents an opportunity to modernize SWM</li> </ul>	LOW	INSIGNIFICANT
Transport and Mobility	<ul style="list-style-type: none"> <li>Roads and bridges cut off during heavy rains</li> <li>Mobility curtailed, limiting access to markets, jobs and social amenities</li> </ul>	HIGH	<p><b>Sensitivity:</b></p> <ul style="list-style-type: none"> <li>High as produce goes to waste, people loose livelihoods and fail to access social services...</li> </ul> <p><b>Adaptive Capacity:</b></p> <ul style="list-style-type: none"> <li>Low due to limited alternatives once main connecting roads are cut off</li> </ul>	HIGH	CATASTROPHIC

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Energy	<ul style="list-style-type: none"> <li>Limited disruption of energy supply</li> </ul>	LOW	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Low as much energy supplies are not affected by pluvial flooding</li> </ul>	LOW	INSIGNIFICANT
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>High as energy sources are largely out of the pluvial zone</li> </ul>		
Economic Infrastructure	<ul style="list-style-type: none"> <li>Some markets flood during heavy downpour</li> <li>Agro-processing factories starved of fresh supplies when roads are cut off</li> </ul>	MEDIUM	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>High as livelihoods are directly affected</li> </ul>	HIGH	MAJOR
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Low owing to limited livelihood alternatives</li> </ul>		
Social Infrastructure	<ul style="list-style-type: none"> <li>Some schools, health facilities cut off during heavy downpour</li> <li>Increased school absenteeism and limited access to healthcare during rainy seasons</li> </ul>	LOW	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Low as not many facilities are affected</li> </ul>	MEDIUM	MINOR
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Low as alternatives are limited by spatial fixity. People cannot access alternative schools/health facilities owing to their fixed locations</li> </ul>		
Emergency Services	<ul style="list-style-type: none"> <li>Flooding is likely to curtail access to emergency vehicles when roads are cut off</li> </ul>	MEDIUM	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Medium</li> </ul>	MEDIUM	MODERATE
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul>		
<b>Populations</b>					
Urban Residents	<ul style="list-style-type: none"> <li>Urban populations are more exposed to impacts of flooding</li> <li>Likely to experience more destruction of property and livelihoods</li> </ul>	MEDIUM	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Medium due to low numbers at risk</li> </ul>	MEDIUM	MODERATE
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul>		
	<ul style="list-style-type: none"> <li>Residents highly exposed to impacts of flooding</li> </ul>	MEDIUM	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>High</li> </ul>	MEDIUM	MODERATE

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Informal Settlement Residents			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>• Low</li> </ul>		
Vulnerable and Marginalized Groups	<ul style="list-style-type: none"> <li>• These have the most exposed owing to their precarious livelihoods</li> <li>• Inadequate protections to cushion them from the vagaries of flooding</li> </ul>	MEDIUM	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>• High</li> </ul>	HIGH	MAJOR
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>• Low due to limited livelihood alternatives</li> </ul>		
<b>Natural Assets</b>					
Urban Green Infrastructure	<ul style="list-style-type: none"> <li>• Parks and other recreational areas not significantly affected by pluvial flooding</li> </ul>	LOW	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>• Low</li> </ul>	LOW	INSIGNIFICANT
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>• High</li> </ul>		
Urban Blue Infrastructure	<ul style="list-style-type: none"> <li>• Households that depend on shallow wells and protected springs are cut off due to contamination by surface runoff</li> </ul>	MEDIUM	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>• Low</li> </ul>	LOW	MINOR
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>• Low</li> </ul>		
Peri-urban and Agricultural Systems	<ul style="list-style-type: none"> <li>• Destruction of crops on low-lying floodplains</li> <li>• Inaccessibility to markets when roads are cut off by floods</li> </ul>	HIGH	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>• High owing to largely agro-dependent livelihoods</li> </ul>	MEDIUM	MAJOR
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>• Low due to limited livelihood alternatives</li> </ul>		

*Table 14: Exposure, Vulnerability, and Impacts of Prolonged Dry Spell on Urban Elements*

**Hazard:** Prolonged dry spell

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
<b>Infrastructure &amp; Services</b>					
Storm water Drainage	<ul style="list-style-type: none"> <li>Limited implications for storm drainage</li> </ul>	LOW	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul> <b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>High</li> </ul>	LOW	INSIGNIFICANT
Water & Wastewater Management	<ul style="list-style-type: none"> <li>Drought lead to reduction in volumes of water supplied, hence reduced industrial and agricultural produce as well as lower household welfare</li> <li>Compromised livelihoods</li> </ul>	HIGH	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>High as water supply affects all sectors of the municipal economy</li> </ul> <b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Low due to limited supply alternatives</li> </ul>	HIGH	CATASTROPHIC
Solid Waste Management	<ul style="list-style-type: none"> <li>Limited implications</li> </ul>	LOW	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul> <b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>High</li> </ul>	LOW	INSIGNIFICANT
Transport and Mobility	<ul style="list-style-type: none"> <li>Pedestrians more likely to face heat stress</li> </ul>	LOW	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul> <b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>High</li> </ul>	LOW	INSIGNIFICANT
Energy	<ul style="list-style-type: none"> <li>Limited implications</li> </ul>	LOW	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul> <b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>High</li> </ul>	LOW	INSIGNIFICANT
Economic Infrastructure	<ul style="list-style-type: none"> <li>Traders in open-air markets exposed to heat stress</li> </ul>	LOW	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul>	LOW	INSIGNIFICANT

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	<ul style="list-style-type: none"> <li><i>Boda boda</i> riders exposed to heat stress</li> </ul>		<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>High</li> </ul>		
Social Infrastructure	<ul style="list-style-type: none"> <li>Hospitals may have to deal more cases of thermal stress</li> </ul>	LOW	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul> <b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>High</li> </ul>	LOW	INSIGNIFICANT
Emergency Services	<ul style="list-style-type: none"> <li>Wild fires more likely to occur</li> </ul>	LOW	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul> <b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>High</li> </ul>	LOW	INSIGNIFICANT
<b>Populations</b>					
Urban Residents	<ul style="list-style-type: none"> <li>More likely to experience heat stress due to localized urban heat island effects</li> <li>Water supply shortages</li> </ul>	MAJOR	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>High</li> </ul> <b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul>	MEDIUM	MAJOR
Informal Settlement Residents	<ul style="list-style-type: none"> <li>Residents more likely to experience thermal stress due to flimsy construction materials and livelihood pursuits that require working in the open sun</li> <li>Water supply shortages</li> </ul>	MAJOR	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>High</li> </ul> <b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul>	MEDIUM	MAJOR
Vulnerable and Marginalized Groups	<ul style="list-style-type: none"> <li>These are most exposed due to their livelihoods, shelter conditions and limited power to influence decisions</li> <li>Water supply shortages</li> </ul>	HIGH	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>High</li> </ul> <b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul>	MEDIUM	MAJOR
<b>Natural Assets</b>					
Urban Green Infrastructure		MEDIUM	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>High</li> </ul>	MAJOR	MAJOR

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	<ul style="list-style-type: none"> <li>Parks and other green areas suffer vegetation stress, hence become less appealing to users</li> <li>Overuse by populations seeking shelter from scorching heat</li> </ul>		<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul>		
Urban Blue Infrastructure	<ul style="list-style-type: none"> <li>Seasonal rivers dry up, as do shallow wells and springs</li> <li>Water supply shortages</li> </ul>	MEDIUM	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>High</li> </ul> <b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul>	MAJOR	MAJOR
Peri-urban and Agricultural Systems	<ul style="list-style-type: none"> <li>Droughts cause destruction of crops</li> <li>Loss of livestock</li> </ul>	HIGH	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>High</li> </ul> <b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul>	HIGH	CATASTROPHIC

*Table 15: Exposure, Vulnerability, and Impacts of Gully Erosion on Urban Elements*

**Hazard:** Gully erosion

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
<b>Infrastructure &amp; Services</b>					
Storm water Drainage	<ul style="list-style-type: none"> <li>Destruction of unlined earth drains</li> <li>Gullies deliver unprecedented runoff volumes that flood downstream land uses</li> </ul>	HIGH	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>High</li> </ul> <b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul>	MEDIUM	MAJOR
Water & Wastewater Management	<ul style="list-style-type: none"> <li>Destruction of water distribution networks</li> <li>Destruction of wastewater disposal facilities</li> </ul>	HIGH	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>High</li> </ul> <b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul>	MEDIUM	MAJOR

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Solid Waste Management	<ul style="list-style-type: none"> <li>Limited implications</li> </ul>	LOW	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul>	LOW	INSIGNIFICANT
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>High</li> </ul>		
Transport and Mobility	<ul style="list-style-type: none"> <li>Destruction of key transport infrastructure such as roads and bridges cutting of mobility and accessibility</li> </ul>	HIGH	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>High due to centrality of transportation in the municipal economy and welfare</li> </ul>	MEDIUM	MAJOR
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Low due to limited alternatives</li> </ul>		
Energy	<ul style="list-style-type: none"> <li>Limited implications</li> </ul>	LOW	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul>	LOW	INSIGNIFICANT
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>High</li> </ul>		
Economic Infrastructure	<ul style="list-style-type: none"> <li>Roads cut off by gully erosion curtail access to markets</li> <li>Destruction of farmlands</li> </ul>	MEDIUM	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>High</li> </ul>	MEDIUM	MODERATE
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul>		
Social Infrastructure	<ul style="list-style-type: none"> <li>Roads cut off by gully erosion curtail access to social amenities</li> <li>Destruction of social facilities</li> </ul>	MEDIUM	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Medium</li> </ul>	MEDIUM	MODERATE
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Medium</li> </ul>		
Emergency Services	<ul style="list-style-type: none"> <li>Roads cut off by gully erosion curtail access, impeding emergency response</li> </ul>	LOW	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>High</li> </ul>	MEDIUM	MINOR
			<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul>		
<b>Populations</b>					
Urban Residents	<ul style="list-style-type: none"> <li>Those living downstream are exposed to flash floods</li> </ul>	MEDIUM	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>High</li> </ul>	MEDIUM	MODERATE

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	<ul style="list-style-type: none"> <li>Residents cut off when roads and bridges are destroyed by gully erosion</li> <li>Outages in water supply when distribution networks are destroyed by gully erosion</li> </ul>		<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul>		
Informal Settlement Residents	<ul style="list-style-type: none"> <li>Neighbourhoods located downstream are exposed to flash floods</li> <li>Residents cut off when roads and bridges are destroyed by gully erosion</li> <li>Outages in water supply when distribution networks are destroyed by gully erosion</li> </ul>	MEDIUM	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>High</li> </ul> <b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul>	MEDIUM	MODERATE
Vulnerable and Marginalized Groups	<ul style="list-style-type: none"> <li>Greatly exposed when roads and water supply are cut off</li> <li>Livelihoods suffer when infrastructure and social amenities are destroyed by gully erosion</li> </ul>	MEDIUM	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>High</li> </ul> <b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul>	HIGH	MAJOR
<b>Natural Assets</b>					
Urban Green Infrastructure	<ul style="list-style-type: none"> <li>Parks and green areas destroyed by gully erosion</li> <li>Access to these green facilities impeded when roads and access paths are cut off by erosion</li> </ul>	MEDIUM	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Medium</li> </ul> <b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Medium</li> </ul>	MEDIUM	MODERATE
Urban Blue Infrastructure	<ul style="list-style-type: none"> <li>Rivers, springs destroyed by gully erosion</li> </ul>	LOW	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>Medium</li> </ul> <b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Medium</li> </ul>	LOW	INSIGNIFICANT
Peri-urban and	<ul style="list-style-type: none"> <li>Farmlands destroyed by gully erosion</li> </ul>	MEDIUM	<b>Sensitivity:</b> <ul style="list-style-type: none"> <li>High</li> </ul>	HIGH	MAJOR

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Agricultural Systems	<ul style="list-style-type: none"> <li>Access to markets impeded when roads are cut off by gully erosion</li> </ul>		<b>Adaptive Capacity:</b> <ul style="list-style-type: none"> <li>Low</li> </ul>		

## 4.0 Climate Risk Assessment

The Municipality today faces unprecedented and uncertain risks associated with climate change. The rising urban population and continued migration into the municipality tends to concentrate people in ecologically fragile areas, which are particularly prone to the risk of natural disasters linked to climate change. Furthermore, many of the new urban dwellers have little by way of financial means to recover from a disaster. As urbanizing trends increase, so too will the importance of risk assessment and resilience planning across the municipality. Risk assessment process can help a community understand the resources it will need to invest in and how it might prioritize strategies to reduce the risk. The assessment proceeds by identifying the types of events that could occur in the municipality, the probability that events of varying severity will occur, and the consequences of those events, including economic, infrastructure, socio-cultural, and public health losses.

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 16: 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 Table 17 below.

**Table 17: 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.

## Current and Future Climate Risks on Urban Elements

Below is summary of the current and future climate risks elements as experienced in Wote Municipality.

*Table 1: Summary of average surface temperature increase risks for Wote Municipality*

	Time Horizon & Climate Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level					
Categories	Impact	Risk Levels				
		Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
<b>Infrastructure &amp; Services</b>						
Storm water Drainage	<b>INSIGNIFICANT</b>	Low	Low	Low	Low	Low
Water & Wastewater Management	<b>INSIGNIFICANT</b>	Low	Low	Low	Low	Low
Solid Waste Management	<b>INSIGNIFICANT</b>	Low	Low	Low	Low	Low
Transport and Mobility	<b>INSIGNIFICANT</b>	Low	Low	Low	Low	Low
Energy	<b>INSIGNIFICANT</b>	Low	Low	Low	Low	Low
Economic Infrastructure	<b>INSIGNIFICANT</b>	Low	Low	Low	Low	Low
Social Infrastructure	<b>INSIGNIFICANT</b>	Low	Low	Low	Low	Low
Emergency Services	<b>INSIGNIFICANT</b>	Low	Low	Low	Low	Low
<b>Populations</b>						
Urban Residents	<b>MAJOR</b>	High	High	High	High	High
Informal Settlement Residents	<b>CATASTROPHIC</b>	Very high	Very high	Very high	Very high	Very high
Vulnerable and Marginalized Groups	<b>MAJOR</b>	High	High	High	High	High
<b>Natural Assets</b>						
Urban Green Infrastructure	<b>MAJOR</b>	Medium	Medium	Medium	Medium	Medium
Urban Blue Infrastructure	<b>MODERATE</b>	Medium	Medium	Medium	Medium	Medium
Peri-urban and Agricultural Systems	<b>CATASTROPHIC</b>	Very high	Very high	Very high	Very high	Very high

**Table 2: Summary of extreme precipitation risks for Wote Municipality**

	Time Horizon & Climate Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level					
Categories	Impact	Risk Levels				
		Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
<b>Infrastructure &amp; Services</b>						
Storm water Drainage	<b>CATASTROPHIC</b>	Very high	Very high	Very high	Very high	Very high
Water & Wastewater Management	<b>CATASTROPHIC</b>	High	High	High	High	High
Solid Waste Management	<b>CATASTROPHIC</b>	Very high	Very high	Very high	Very high	Very high
Transport and Mobility	<b>CATASTROPHIC</b>	Very high	Very high	Very high	Very high	Very high
Energy	<b>MODERATE</b>	Medium	Medium	Medium	Medium	Medium
Economic Infrastructure	<b>MAJOR</b>	High	High	High	High	High
Social Infrastructure	<b>MODERATE</b>	Medium	Medium	Medium	Medium	Medium
Emergency Services	<b>MODERATE</b>	Medium	Medium	Medium	Medium	Medium
<b>Populations</b>						
Urban Residents	<b>MINOR</b>	Medium	Medium	Medium	Medium	Medium
Informal Settlement Residents	<b>MAJOR</b>	High	High	High	High	High
Vulnerable and Marginalized Groups	<b>CATASTROPHIC</b>	High	High	High	High	High
<b>Natural Assets</b>						
Urban Green Infrastructure	<b>INSIGNIFICANT</b>	Low	Low	Low	Low	Low
Urban Blue Infrastructure	<b>INSIGNIFICANT</b>	Low	Low	Low	Low	Low
Peri-urban and Agricultural Systems	<b>CATASTROPHIC</b>	High	High	High	High	High

*Table 3: Summary of pluvial flooding risks for Wote Municipality*

	Time Horizon & Climate Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level					
Categories	Impact	Risk Levels				
		Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
<b>Infrastructure &amp; Services</b>						
Storm water Drainage	<b>CATASTROPHIC</b>	Very high	Very high	Very high	Very high	Very high
Water & Wastewater Management	<b>MODERATE</b>	High	High	High	High	High
Solid Waste Management	<b>INSIGNIFICANT</b>	Medium	Medium	Medium	Medium	Medium
Transport and Mobility	<b>CATASTROPHIC</b>	High	High	High	High	High
Energy	<b>INSIGNIFICANT</b>	Low	Low	Low	Low	Low
Economic Infrastructure	<b>MAJOR</b>	High	High	High	High	High
Social Infrastructure	<b>MINOR</b>	Medium	Medium	Medium	Medium	Medium
Emergency Services	<b>MODERATE</b>	Medium	Medium	Medium	Medium	Medium
<b>Populations</b>						
Urban Residents	<b>MODERATE</b>	High	High	High	High	High
Informal Settlement Residents	<b>MODERATE</b>	High	High	High	High	High
Vulnerable and Marginalized Groups	<b>MAJOR</b>	High	High	High	High	High
<b>Natural Assets</b>						
Urban Green Infrastructure	<b>INSIGNIFICANT</b>	Very low	Very low	Very low	Very low	Very low
Urban Blue Infrastructure	<b>MINOR</b>	Low	Low	Low	Low	Low
Peri-urban and Agricultural Systems	<b>MAJOR</b>	High	High	High	High	High

*Table 4: Summary of prolonged dry spell risks for Wote Municipality*

	Time Horizon & Climate Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level					
Categories	Impact	Risk Levels				
		Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
<b>Infrastructure &amp; Services</b>						
Storm water Drainage	<b>INSIGNIFICANT</b>	Low	Low	Low	Low	Low
Water & Wastewater Management	<b>CATASTROPHIC</b>	High	High	High	High	High
Solid Waste Management	<b>INSIGNIFICANT</b>	Low	Low	Low	Low	Low
Transport and Mobility	<b>INSIGNIFICANT</b>	Low	Low	Low	Low	Low
Energy	<b>INSIGNIFICANT</b>	Low	Low	Low	Low	Low
Economic Infrastructure	<b>INSIGNIFICANT</b>	Low	Low	Low	Low	Low
Social Infrastructure	<b>INSIGNIFICANT</b>	Low	Low	Low	Low	Low
Emergency Services	<b>INSIGNIFICANT</b>	Low	Low	Low	Low	Low
<b>Populations</b>						
Urban Residents	<b>MAJOR</b>	High	High	High	High	High
Informal Settlement Residents	<b>MAJOR</b>	High	High	High	High	High
Vulnerable and Marginalized Groups	<b>MAJOR</b>	High	High	High	High	High
<b>Natural Assets</b>						
Urban Green Infrastructure	<b>MAJOR</b>	Medium	Medium	Medium	Medium	Medium
Urban Blue Infrastructure	<b>MAJOR</b>	High	High	High	High	High
Peri-urban and Agricultural Systems	<b>CATASTROPHIC</b>	Very high	Very high	Very high	Very high	Very high

*Table 5: Summary of gully erosion risks for Wote Municipality*

	Time Horizon & Climate Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level					
Categories	Impact	Risk Levels				
		Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
<b>Infrastructure &amp; Services</b>						
Storm water Drainage	<b>MAJOR</b>	High	High	High	High	High
Water & Wastewater Management	<b>MAJOR</b>	High	High	High	High	High
Solid Waste Management	<b>INSIGNIFICANT</b>	Low	Low	Low	Low	Low
Transport and Mobility	<b>MAJOR</b>	High	High	High	High	High
Energy	<b>INSIGNIFICANT</b>	Very low	Very low	Very low	Very low	Very low
Economic Infrastructure	<b>MODERATE</b>	High	High	High	High	High
Social Infrastructure	<b>MODERATE</b>	Medium	Medium	Medium	Medium	Medium
Emergency Services	<b>MINOR</b>	Low	Low	Low	Low	Low
<b>Populations</b>						
Urban Residents	<b>MODERATE</b>	Medium	Medium	Medium	Medium	Medium
Informal Settlement Residents	<b>MODERATE</b>	Medium	Medium	Medium	Medium	Medium
Vulnerable and Marginalized Groups	<b>MAJOR</b>	High	High	High	High	High
<b>Natural Assets</b>						
Urban Green Infrastructure	<b>MODERATE</b>	Low	Low	Low	Low	Low
Urban Blue Infrastructure	<b>INSIGNIFICANT</b>	Very low	Very low	Very low	Very low	Very low
Peri-urban and Agricultural Systems	<b>MAJOR</b>	Very high	Very high	Very high	Very high	Very high

#### 4.1 Climate Risk Hotspots

Climate risks vary between different sub-counties and wards across the municipality. This spatial variation in risk spread has significant implications in times prioritization and targeting of climate action across the municipality. Figure 8 for example provides an indication of risks spread across Makueni Sub-county, with floods mostly experienced in Mbitini and southern boundaries of Kathonzweni. Figure 9 many of this risks are correlated with the topographical formation of the various wards, with forested areas likely to experience forest fires, while downstream locations are likely to experience pluvial flooding (see Figure 10).

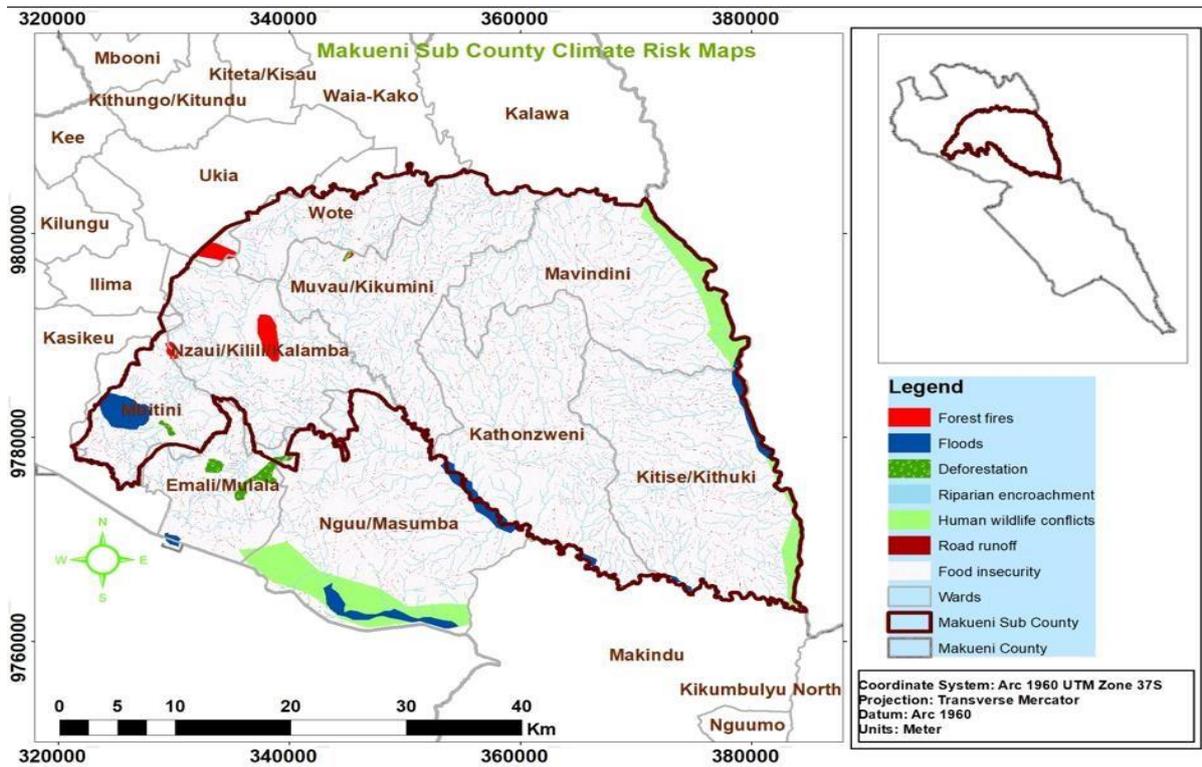


Figure 9: Climate risk hotspots in Makueni Sub-county

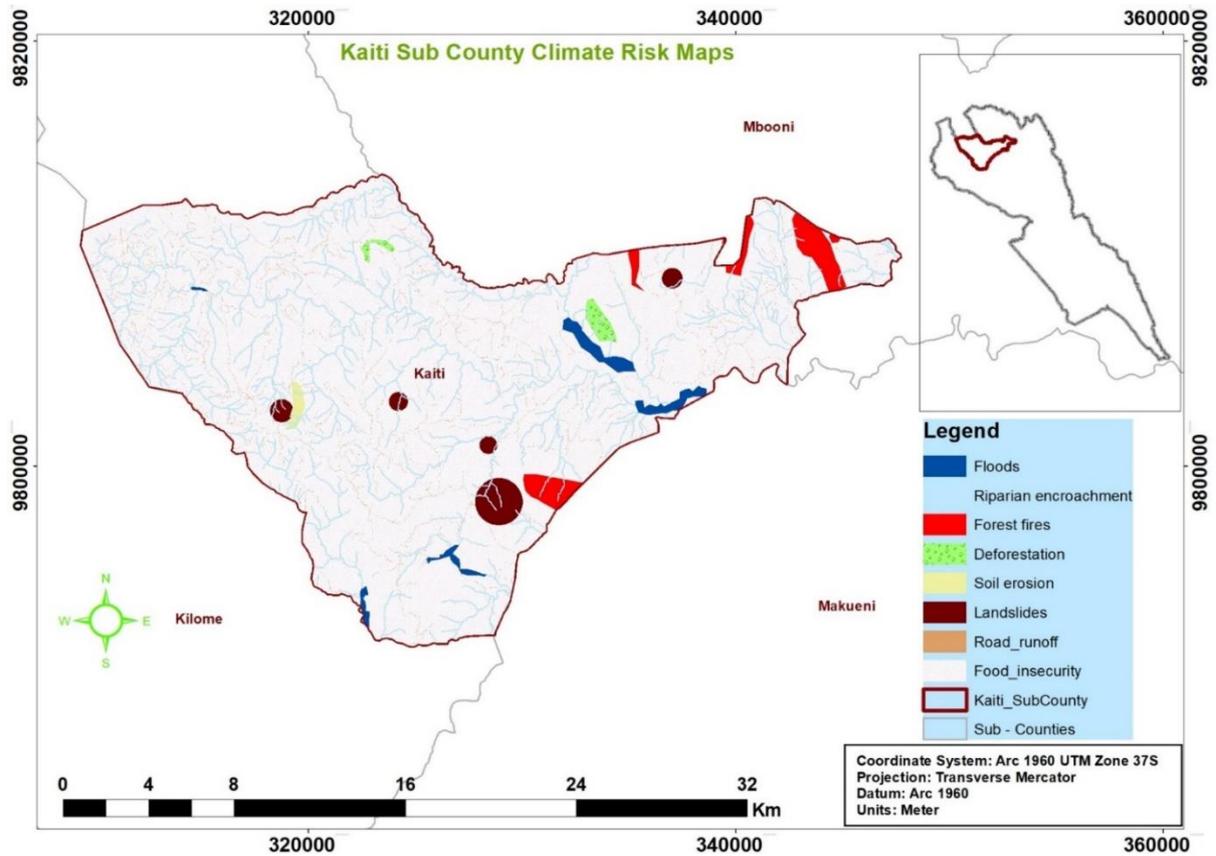


Figure 10: Climate risk hotspots in Kaiti Sub-county



## 5.0 Climate Adaptation and Resilience

### 5.1 Key Findings

Following the foregoing analysis, below is a summary of the hazards in Wote Municipality, including those that are associated with higher risks, populations and assets that are most at risk, as well as trends that are most likely to intensify in the future, referring back to the future trends recorded.

*Table 6: Summary of climate risks affecting urban elements for Wote Municipality*

Category	List of Key Hazards		
	Current	Mid-term (2050)	Long-term (2100)
<b>Infrastructure &amp; Services</b>			
Storm water Drainage	<ul style="list-style-type: none"> <li>• Extreme precipitation</li> <li>• Pluvial flooding</li> </ul>	<ul style="list-style-type: none"> <li>• Extreme precipitation</li> <li>• Pluvial flooding</li> </ul>	<ul style="list-style-type: none"> <li>• Extreme precipitation</li> <li>• Pluvial flooding</li> </ul>
Water & Wastewater Management	<ul style="list-style-type: none"> <li>• Extreme precipitation</li> <li>• Pluvial flooding</li> <li>• Gully erosion</li> </ul>	<ul style="list-style-type: none"> <li>• Extreme precipitation</li> <li>• Pluvial flooding</li> <li>• Gully erosion</li> </ul>	<ul style="list-style-type: none"> <li>• Extreme precipitation</li> <li>• Pluvial flooding</li> <li>• Gully erosion</li> </ul>
Solid Waste Management	<ul style="list-style-type: none"> <li>• Extreme precipitation</li> <li>• Pluvial flooding</li> </ul>	<ul style="list-style-type: none"> <li>• Extreme precipitation</li> <li>• Pluvial flooding</li> </ul>	<ul style="list-style-type: none"> <li>• Extreme precipitation</li> <li>• Pluvial flooding</li> </ul>
Transport and Mobility	<ul style="list-style-type: none"> <li>• Extreme precipitation</li> <li>• Pluvial flooding</li> <li>• Gully erosion</li> </ul>	<ul style="list-style-type: none"> <li>• Extreme precipitation</li> <li>• Pluvial flooding</li> <li>• Gully erosion</li> </ul>	<ul style="list-style-type: none"> <li>• Extreme precipitation</li> <li>• Pluvial flooding</li> <li>• Gully erosion</li> </ul>
Energy	<ul style="list-style-type: none"> <li>• Extreme precipitation</li> </ul>	<ul style="list-style-type: none"> <li>• Extreme precipitation</li> </ul>	<ul style="list-style-type: none"> <li>• Extreme precipitation</li> </ul>
Economic Infrastructure	<ul style="list-style-type: none"> <li>• Extreme precipitation</li> <li>• Gully erosion</li> </ul>	<ul style="list-style-type: none"> <li>• Extreme precipitation</li> <li>• Gully erosion</li> </ul>	<ul style="list-style-type: none"> <li>• Extreme precipitation</li> <li>• Gully erosion</li> </ul>
Social Infrastructure	<ul style="list-style-type: none"> <li>• Extreme precipitation</li> </ul>	<ul style="list-style-type: none"> <li>• Extreme precipitation</li> </ul>	<ul style="list-style-type: none"> <li>• Extreme precipitation</li> </ul>
Emergency Services			
<b>Populations</b>			
Urban Residents	<ul style="list-style-type: none"> <li>• Average surface temperature increase</li> <li>• Extreme precipitation</li> <li>• Pluvial flooding</li> </ul>	<ul style="list-style-type: none"> <li>• Average surface temperature increase</li> <li>• Extreme precipitation</li> <li>• Pluvial flooding</li> </ul>	<ul style="list-style-type: none"> <li>• Average surface temperature increase</li> <li>• Extreme precipitation</li> <li>• Pluvial flooding</li> </ul>

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

Based on the key hazards identified, together with the urban elements/sector that they impact mostly, a myriad of interventions have been proposed to inform climate action in Wote, spanning the short-, medium and long-term horizons. These are provided in Section 5.2 below.

## 5.2 Climate Adaptation and Resilience Solutions

Here, we provide a summary list of adaptation and resilience solutions that will address the key hazards for each urban element category listed in the previous Section 5.1.

*Table 7: Climate adaptation and resilience solutions recommended for Wote Municipality*

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
<b>Infrastructure &amp; Services</b>			
Stormwater Drainage	<ul style="list-style-type: none"> <li>• Desilting/cleaning up clogged drainage channels</li> <li>• Opening up of earth drainage channels in areas of need</li> </ul>	<ul style="list-style-type: none"> <li>• Establishment of infiltration trenches in flood-prone public areas</li> <li>• Stone-pitching of unlined earth drains to prevent formation of gullies</li> <li>• Establishment of retention ditches</li> </ul>	<ul style="list-style-type: none"> <li>• Establishment of bioswales along public streets and other drainage courses</li> <li>• Incorporate on-site runoff management systems for new residential and institutional developments</li> <li>• Adoption of permeable pavements and green roofs to enhance runoff percolation</li> <li>• Enforcement of building density and zoning regulations to control the amount of buildable space per development site</li> </ul>
Water & Wastewater Management	<ul style="list-style-type: none"> <li>• Inspection and repair flood-damaged pipes and treatment facilities</li> <li>• Promotion of water use efficiency</li> </ul>	<ul style="list-style-type: none"> <li>• Development of waste water infrastructuresystems to curb waste water overflow, especially during the rainy season</li> <li>• Adoption of roof catchment and water harvesting systems for homes and institutions</li> </ul>	<ul style="list-style-type: none"> <li>• Map, survey and develop standard and accommodative waste water management system</li> <li>• Elevation or relocation of waste water infrastructure in high-risk zones</li> <li>• Installation of bulk rainwater harvesting systems</li> <li>• Climate-proofing of the water supply network</li> </ul>

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
Solid Waste Management	<ul style="list-style-type: none"> <li>• Clearing drains of solid wastes ahead of the rainy season</li> <li>• Enforcement of SWM policy across the municipality</li> </ul>	<ul style="list-style-type: none"> <li>• Conduct public awareness campaigns on SWM</li> <li>• Relocate waste collection and transfer sites away from riparian areas and flood-prone zones</li> <li>• Installation of appropriate waste receptacles in public spaces</li> <li>• Develop a Public Private Partnership model for waste management</li> </ul>	<ul style="list-style-type: none"> <li>• Adopt the circular economy model to encourage more efficient SWM practices</li> <li>• Construction of material recovery centres across the municipality</li> <li>• Institutionalize waste separation and recycling to reduce waste volumes</li> </ul>
Transport and Mobility	<ul style="list-style-type: none"> <li>• Installation of temporary barriers to control entry into flooded areas</li> <li>• Provision of alternative crossing points across rivers cut off by floods</li> </ul>	<ul style="list-style-type: none"> <li>• Upgrading of critical road sections and bridges to withstand higher flood water volumes</li> </ul>	<ul style="list-style-type: none"> <li>• Adoption of flood-proof design concepts in the construction of roads and bridges</li> <li>• Opening of alternative access routes to enhance mobility during rainy weather</li> </ul>
Economic Infrastructure	<ul style="list-style-type: none"> <li>• Provision of trader sheds in municipal markets</li> </ul>	<ul style="list-style-type: none"> <li>• Support traders to embrace nature-based solutions as alternative livelihood pursuits</li> <li>• Sensitization of traders to utilize climate information to minimize disruption and losses</li> </ul>	<ul style="list-style-type: none"> <li>• Erection of modern markets complete with requisite utility supplies</li> <li>• Relocation of markets situated in flood-prone locations</li> <li>• Improvement of road conditions connecting farmers to markets and agro-processing factories</li> </ul>
Social Infrastructure	<ul style="list-style-type: none"> <li>• Provide alternative temporary access for those cut off during floods</li> </ul>	<ul style="list-style-type: none"> <li>• Retrofit all social facilities destroyed by floods</li> <li>• Relocate facilities in flood-prone zones</li> </ul>	<ul style="list-style-type: none"> <li>• Develop long-term disaster management plans for all municipal facilities</li> <li>• Adopt climate-proof designs for all social amenities</li> </ul>
<b>Populations</b>			
Urban Residents	<ul style="list-style-type: none"> <li>• Dissemination of real-time flood warning using multiple channels and platforms</li> </ul>	<ul style="list-style-type: none"> <li>• Promotion of rain harvesting systems to promote self-sufficiency and reduce runoff</li> </ul>	<ul style="list-style-type: none"> <li>• Review, implement/enforce zoning regulations to ensure appropriate development control, especially in flood-risk areas</li> </ul>

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
Informal Settlement Residents	<ul style="list-style-type: none"> <li>Dissemination of real-time flood warning using multiple channels and platforms</li> </ul>	<ul style="list-style-type: none"> <li>Installation of communal water points in elevated areas</li> </ul>	<ul style="list-style-type: none"> <li>Upgrading of settlements through adequate infrastructure provision</li> <li>Relocation of settlements when they are situated in flood-risk areas</li> </ul>
Vulnerable and Marginalized Groups	<ul style="list-style-type: none"> <li>Prioritization of targeted assistance for the elderly, disabled, widows, and households headed by women</li> </ul>	<ul style="list-style-type: none"> <li>Operationalization of ward climate change planning committees to spearhead local climate action</li> </ul>	<ul style="list-style-type: none"> <li>Integration of climate action into social protection and poverty reduction programming</li> </ul>
<b>Natural Assets</b>			
Urban Green Infrastructure	<ul style="list-style-type: none"> <li>Removal of debris and sediments from urban parks post-flooding</li> </ul>	<ul style="list-style-type: none"> <li>Rehabilitation and expansion of existing green spaces to facilitate percolation of surface runoff</li> <li>Establishment of high-value assorted tree nurseries</li> </ul>	<ul style="list-style-type: none"> <li>Adoption of nature-based solutions in municipal development planning</li> </ul>
Urban Blue Infrastructure	<ul style="list-style-type: none"> <li>Map and document blue infrastructure</li> <li>Fence off protected springs and shallow wells to protect them from runoff intrusion</li> </ul>	<ul style="list-style-type: none"> <li>Establishment of constructed wetlands to help manage flood risk in sensitive areas</li> </ul>	<ul style="list-style-type: none"> <li>Restoration of natural meanders and degraded vegetation on riparian reserves</li> <li>Establishment of riverine parks as part of the municipal green/blue infrastructure</li> </ul>
Peri-urban and Agricultural Systems	<ul style="list-style-type: none"> <li>Dissemination of real-time agro-climate/weather information using multiple channels and platforms</li> <li>Awareness creation and capacity building on climate resilient actions</li> </ul>	<ul style="list-style-type: none"> <li>Provision of certified seeds and other farm inputs attuned to climate change</li> <li>Dissemination of climate-appropriate farming techniques</li> </ul>	<ul style="list-style-type: none"> <li>Implementation of watershed management plans</li> <li>Promotion of climate-resilient farming practices</li> <li>Promotion of climate insurance to cushion farmers from climate-induced losses</li> </ul>

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## Annex N1. Data Sources

Data	Data Source
Climate projections	<a href="https://climateknowledgeportal.worldbank.org/country/kenya/climate-data-projections">https://climateknowledgeportal.worldbank.org/country/kenya/climate-data-projections</a>
Average surface temperature indicators	<a href="https://www.meteoblue.com/">https://www.meteoblue.com/</a>
Extreme precipitation indicators	<a href="https://climateknowledgeportal.worldbank.org/country/kenya/era5-historical">https://climateknowledgeportal.worldbank.org/country/kenya/era5-historical</a>
Pluvial flooding indicators	<a href="https://climateknowledgeportal.worldbank.org/country/kenya/era5-historical">https://climateknowledgeportal.worldbank.org/country/kenya/era5-historical</a>
Prolonged dry spell indicators	<a href="https://meteo.go.ke/">https://meteo.go.ke/</a>
Gully erosion indicators	Kimani (2024) <sup>9</sup> ; Makueni County CIDP 2023-2027
Integrating Hazard and Risk Information into Urban Planning	World Bank. 2025. The Handbook for Livable and Resilient Cities. Integrating Hazard and Risk Information into Urban Planning. Washington, DC: World Bank.
Hours of Daylight and Twilight in Makueni	<a href="https://weatherspark.com/y/100129/Average-Weather-in-Makueni-Kenya-Year-Round#Sections-Sun">https://weatherspark.com/y/100129/Average-Weather-in-Makueni-Kenya-Year-Round#Sections-Sun</a>
Drought assessment for Wote town	<a href="https://spei.csic.es/spei_database/#map_name=spei01#map_position=1475">https://spei.csic.es/spei_database/#map_name=spei01#map_position=1475</a>
Seasonal variation in the perceived humidity	<a href="https://weatherspark.com/y/100129/Average-Weather-in-Makueni-Kenya-Year-Round#Sections-Humidity">https://weatherspark.com/y/100129/Average-Weather-in-Makueni-Kenya-Year-Round#Sections-Humidity</a>
The average hourly wind vector (speed and direction) in Makueni	<a href="https://weatherspark.com/y/100129/Average-Weather-in-Makueni-Kenya-Year-Round#Sections-Wind">https://weatherspark.com/y/100129/Average-Weather-in-Makueni-Kenya-Year-Round#Sections-Wind</a>

<sup>9</sup> Kimani, C. K. (2024) An assessment of the causes and effects of degradation on riparian ecosystems of the eastern semi-arid region of Kenya; A case study of Kaiti river, Makueni County. MSc Thesis, South Eastern Kenya University.