



REPUBLIC OF KENYA
COUNTY GOVERNMENT OF
NYANDARUA



ENGINEER
MUNICIPALITY
URBAN CLIMATE
RISK PROFILE
(UCRP)

2026



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Foreword

The Urban Climate Risk Profile for Engineer Municipality provides a vital framework for understanding, assessing, and responding to the growing climate-related risks that affect our municipality. This document serves as an evidence-based guide to inform planning, investment, and policy decisions towards building a climate-resilient and sustainable urban future for the Engineer.

This Profile comes at a time when the impacts of climate change ranging from erratic rainfall and flooding to prolonged droughts and shifting agricultural patterns pose increasing challenges to urban growth and service delivery. With rapid urbanization and expanding infrastructure needs, there is a clear and urgent need to integrate climate resilience into all levels of municipal planning and management.

Anchored in Kenya's national climate change frameworks, the Sustainable Development Goals, and the County Integrated Development Plan (CIDP) 2023-2028, this Climate Risk Profile complements ongoing planning efforts such as the Engineer Municipality Integrated Strategic Urban Development Plan (ISUDP), Engineer Municipality Integrated Development Plan (IDeP) and sectoral development plans and strategies. It provides a critical knowledge base that identifies climate vulnerabilities, maps potential hazards, and highlights adaptation and mitigation opportunities tailored to Engineer's unique context.

The preparation of this document has been guided by the principles of public participation, inclusivity, and sustainability. It reflects the voices and priorities of local stakeholders, communities, and institutions, and demonstrates our collective resolve to strengthen resilience against climate shocks while advancing our socio-economic development aspirations.

This Urban Climate Risk Profile identifies priority interventions to reduce vulnerability across key sectors within the Municipality; water, agriculture, housing, infrastructure, health, and ecosystems while promoting low-carbon urban growth and sustainable livelihoods. Implementing these interventions will require collaboration between the County Government, the National Government, development partners, civil societies, and the private sector.

The County Government of Nyandarua is committed to leading this process by mainstreaming climate action into urban planning, governance to ensure that Engineer evolves into a safe, livable, and climate-smart municipality. Together, we can transform climate risks into opportunities for innovation, green investment, and long-term prosperity.

I wish to express my sincere appreciation to all partners who supported the development of this Urban Climate Risk Profile, including the World Bank, the Kenya Urban Support Programme, the Technical Working Group and all the stakeholders who contributed their insights and expertise.

My administration remains steadfast in our commitment to fostering climate resilience and sustainability in the Engineer Municipality. I invite all stakeholders to join us in implementing the recommendations of this Profile, as we work towards a climate-resilient, inclusive, and thriving future for our municipality.



Tabitha Wambui,
Chairperson, Engineer Municipal Board

ACKNOWLEDGEMENT

The preparation of the Urban Climate Risk Profile for Engineer Municipality represents a major step toward strengthening our municipality's resilience to climate change and ensuring sustainable, inclusive urban growth. This document provides a solid foundation for understanding climate-related vulnerabilities, assessing potential hazards, and guiding effective adaptation and mitigation strategies that safeguard the wellbeing of our residents and the sustainability of our urban systems.

On behalf of the Engineer Municipal Board and Secretariat, I wish to express my sincere appreciation to all institutions and stakeholders who contributed to the development of this Profile. Special gratitude goes to the World Bank, the State Department for Housing and Urban Development, and the Kenya Urban Support Programme- County Program Coordinating Team for their technical and financial support, which made this initiative possible. Their collaboration continues to strengthen our capacity to address the growing impacts of climate change within our municipality.

We equally acknowledge the leadership and support of the County Government of Nyandarua under the stewardship of His Excellency the Governor Dr. Moses Kiarie Badilisha, whose vision for a resilient and modern Engineer Municipality has been central to this process. Appreciation is also extended to the County Department of Lands, Physical Planning and Urban Development, Municipal Board Members, technical officers and other partners for their invaluable contributions throughout the preparation of this document.

Our gratitude also goes to community members, civil society organizations, residents' associations, and private sector representatives for their active participation and insights. Your engagement ensured that this Profile reflects the true priorities and aspirations of the people of Engineer Municipality.

The implementation of this Urban Climate Risk Profile will require continued collaboration and commitment from all stakeholders. As a municipality, we remain dedicated to mainstreaming climate resilience into all our planning and service delivery processes, ensuring that Engineer Municipality becomes a climate-smart, livable, and prosperous urban center for present and future generations.



Njoki Gatuhi
Municipal Manager, Engineer Municipality

Preface

This Rapid Climate Risk Assessment Report for Engineer Municipality has been developed in recognition of the urgent need to understand, plan for, and respond to the growing impacts of climate change at the local level. As climate-related risks continue to intensify manifesting in increasingly frequent droughts, erratic rainfall, floods, and changing temperature patterns. Engineer, like many other municipalities across Kenya, finds itself at a critical juncture where proactive planning is essential to safeguard lives, livelihoods, and development gains.

The primary objective of this report is to provide a comprehensive overview of the key climate risks facing Engineer Municipality, grounded in both scientific evidence and community-level insights. It identifies vulnerable sectors, populations, and systems, and offers initial recommendations for building local resilience through adaptation and risk mitigation strategies. This assessment is intended to support informed decision-making among municipal leaders, planners, and stakeholders, and to serve as a foundational resource for integrating climate risk considerations into urban development, infrastructure planning, natural resource management, and social service delivery.

This work is aligned with national and county climate policy frameworks, including Kenya's National Climate Change Action Plan (NCCAP) 2023–2027 and the Nyandarua County Climate Change Action Plan (2023-2027). It also supports the broader goals of sustainable urban development, environmental stewardship, and socio-economic resilience as envisioned in Kenya's Vision 2030 and the Sustainable Development Goals (SDGs).

We acknowledge the valuable contributions of Technical Working Group, Stakeholders, and development partners who participated in the assessment process. Their input has enriched the findings and ensured that the report reflects the lived realities and priorities of Engineer Municipality residents.

We hope this report will catalyze further actions, investments, and collaborations to build a climate-resilient future for Engineer Municipality.

Executive Summary

Kenya's rapid urbanization, projected to reach 50% of the population by 2050, is driving growth in towns like Engineer, Ndunyu Njeru, and Murungaru, which are becoming key economic hubs. However, this expansion increases vulnerability to climate-related hazards such as floods, droughts, frost, and extreme heat, which threaten people, infrastructure, and ecosystems. To mitigate these risks and build long-term resilience, Engineer Municipality must integrate climate risk considerations into urban planning, investment decisions, and service delivery to enhance preparedness and adaptive capacity.

Objectives of the Engineer Municipality rapid climate risk assessment are;

1. To determine community needs and align them to the requirements of the constitution and other relevant climate policies
2. To inform decision-making process of both the County and the Municipality in identifying and climate proofing projects
3. Through the established mechanisms for citizen participation, define and identify climate risks, hazards and climate actions
4. To undertake climate risk assessment and impacts on the current socio-cultural, economic and environmental parameters to inform priority interventions.
5. To ensure protection and promotion of the interests and rights of minorities and vulnerable groups and communities

From the stakeholder engagement held, four key hazards were identified in Engineer Municipality and mapped as follows;

Table 1: Key Risks in the Engineer Municipality

Hazard	Engineer	North Kinangop	Gathara	Murungaru	Parameter Used
Floods	✓	✓	✓	✓	Rainfall in mm
Drought	✓	✓	✓	✓	Temperature in Degrees Celsius
Extreme cold temperatures	✓	✓	✓	✓	Temperature in Degrees Celsius
Frost	✓	✓	✓	X	Diameter and Mass of Hailstones

Source: Multi-Stake Holders Engagement

Risk results summary filled for each of the key hazard are presented below;

Table 2: Summary of Floods risks for Engineer Municipality

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

Natural Assets						
Urban Green Infrastructure	Low	Low	Low	Medium	Medium	High
Urban Blue Infrastructure	Low	Low	Medium	High	High	Very High
Peri-urban and Agricultural Systems	High	High	Very High	Very High	Very High	Very High

Source: Multi-Stake Holders Engagement

Table 3: Summary of Drought risks for Engineer Municipality

Categories	Impact	Risk Levels				
		Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
Infrastructure & Services						
Stormwater Drainage	Low	Low	Low	Low	Low	Low
Water & Wastewater Management	High	High	High	Very High	Very High	Very High
Solid Waste Management	Medium	Medium	Medium	Medium	Medium	Medium
Transport and Mobility	Medium	Medium	Medium	Medium	Medium	Medium
Energy	Medium	Medium	Medium	Medium	Medium	Medium
Economic Infrastructure	High	High	Very High	Very High	Very High	Very High
Social Infrastructure	Low	Low	Low	Low	Low	Low
Emergency Services	Medium	Medium	Medium	Medium	Medium	Medium
Populations						
Urban Residents	Medium	Medium	Medium	Medium	Medium	Medium

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

Source: Multi-Stake Holders Engagement

Table 4. Summary of Extreme cold risks for Engineer Municipality

Categories	Impact	Risk Levels				
		Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
Infrastructure & Services						
Stormwater Drainage	Low	Low	Low	Medium	Medium	High
Water & Wastewater Management	High	Medium	Medium	Medium	Medium	Medium
Solid Waste Management	Medium	Medium	Medium	High	High	High
Transport and Mobility	Medium	Medium	Medium	Medium	High	High
Energy	High	Medium	Medium	Medium	Medium	Medium
Economic Infrastructure	Medium	Medium	Medium	Medium	High	High
Social Infrastructure	Medium	Medium	Medium	Medium	Medium	Medium

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

Source: Multi-Stake Holders Engagement

Table 5. Summary of Frost risks for Engineer Municipality

Categories	Impact	Risk Levels				
		Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
Infrastructure & Services						
Stormwater Drainage	Medium	Medium	High	High	Very High	Very High
Water & Wastewater Management	Medium	High	High	High	Very High	Very High
Solid Waste Management	High	High	Very High	Very High	Very High	Very High
Transport and Mobility	Low	Medium	Medium	High	High	High
Energy	Low	Medium	Medium	High	High	High

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

Source: Multi-Stake Holders Engagement

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

To mitigate the increasing risks of floods, drought, frost, and extreme cold, the Engineer Municipality should prioritize integrated climate adaptation measures that strengthen urban resilience. This includes improving stormwater drainage and enforcing proper land-use planning to reduce flood impacts, promoting water harvesting, storage, and efficient irrigation to manage drought, and supporting climate-smart agriculture and early warning systems to help communities prepare for frost and cold spells. Additionally, enhancing green infrastructure, protecting natural buffers such as wetlands and forests, and investing in climate-resilient infrastructure and energy-efficient housing can significantly reduce vulnerability while sustaining livelihoods and ecosystem health.

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ABBREVIATIONS AND ACRONYMS

CIDP	County Integrated Development Plan
CMIP	Coupled Model Intercomparison Project
GoK	Government of Kenya
IDEP	Integrated Development Plan
ISUDP	Integrated Strategic Urban Development Plan
KISIP	Kenya Informal Settlement Program
KMD	Kenya Meteorological Department
KNBS	Kenya National Bureau of Statistics
KUSP	Kenya Urban Support Program
NEMA	National Environment Management Authority
NCCAP	National Climate Change Action Plan
NCG	Nyandarua County Government
NCCAP	Nyandarua County Climate Action Plan
NGO	Non-Governmental Organisation
PLWD	Persons Living with Disability
RCP	Representative Concentration Pathway
SDG	Sustainable Development Goals
SACCO	Savings and Credit Cooperative
SE	Stakeholder Engagement
SSP	Shared Socioeconomic Pathways
UACA	Urban Areas and Cities Act, 2011
UCRA	Urban Climate Risk Assessment
UCRP	Urban Climate Risk Profile
VMGs	Vulnerable and Marginalized Groups
WBG	World Bank Group

CHAPTER ONE

1. Context

Kenya is urbanizing rapidly, with 31% of the population living in urban areas as of 2019, a figure projected to rise to about 50% by 2050. This growth is particularly pronounced in small and medium-sized towns such as Engineer, Ndunyu Njeru and Murungaru which are emerging as key centers of economic activity and population expansion.

While urbanization drives economic development and improves living standards, it also heightens exposure to climate-related hazards including flooding, drought, frost and extreme heat. These hazards are increasing in frequency and intensity, posing significant risks to people, infrastructure and ecosystems.

To safeguard lives, livelihoods, and critical assets, urban decision-makers in Engineer Municipality must integrate climate risk understanding into spatial planning, investment priorities and service delivery. Doing so, will not only enhance preparedness for climate shocks but also support adaptation and strengthen long-term urban resilience.

1.1. Objective

This Urban Climate Risk Profile aims;

1. To comply with National, County and Municipal legal frameworks to address current and future climate risks.
2. To integrate climate resilience into the planning, design and implementation of the Municipal Development process in the next five years.
3. To plan and deliver climate resilient infrastructure that withstands current and future climate impacts and minimizes climate risks.

The specific objectives are:

1. To determine community needs and align them to the requirements of the constitution and other relevant climate policies
2. To inform decision-making process of both the County and the Municipality in identifying and climate proofing projects
3. Through the established mechanisms for citizen participation, define and identify climate risks, hazards and climate actions

4. To undertake climate risk assessment and impacts on the current socio-cultural, economic and environmental parameters to inform priority interventions.
5. To ensure protection and promotion of the interests and rights of minorities and vulnerable groups and communities

1.2. Urban Context

This section provides an overview of the municipality's strategic location and regional linkages, the legal status, its extent in size, climate and geology. It provides a synopsis on the municipality's drainage, climate, terrain and geographic features. In addition, it explores the demographic, socio-economic characteristics and settlement patterns of the Municipality.

1.2.1. Geographic area

Engineer Municipality is located in Kinangop Sub-County in Nyandarua County. It's headquartered in Engineer township located along the Ol'Kalou-Njabini Road. Engineer Township is primarily an agro-based urban centre mainly supported by horticulture and dairy farming. Its growth can greatly be attributed to its history as the centre where members of the public could access government services such as post office, Cooperatives Union banking services, central government administration, etc. Its location in the Nairobi-Ol'Kalou, Nyahururu circuit as well as proximity to Naivasha which is the second largest town in Nakuru County have also contributed to its growth. Engineer is 60 km from Ol'Kalou town which is Nyandarua County headquarter and accessible through the Ndudori-Engineer-Njabini road.

County Context:

In terms of regional connectivity Nyandarua County is relatively well connected by a number of roads to major cities and towns in Kenya, hence enjoying a regional advantage for investments. Engineer Municipality lies along the Ol'Kalou-Njabini and Engineer-Kirima-Naivasha roads. The municipality is well connected to Naivasha, Njabini, Ol'Kalou and Nairobi.

Local Context:

The Municipality lies at latitude 0.0003390°N and longitude 36.4182880°E in the southern part of Nyandarua County. It is located west of Aberdare Ranges and approximately 120km West of Nairobi. The municipality covers an area of 531 sq.km which include four wards namely Gathara, Engineer, North Kinangop and Murungaru wards. It borders Kipipiri, Aberdare ranges, Nyeri and Nakuru Counties.

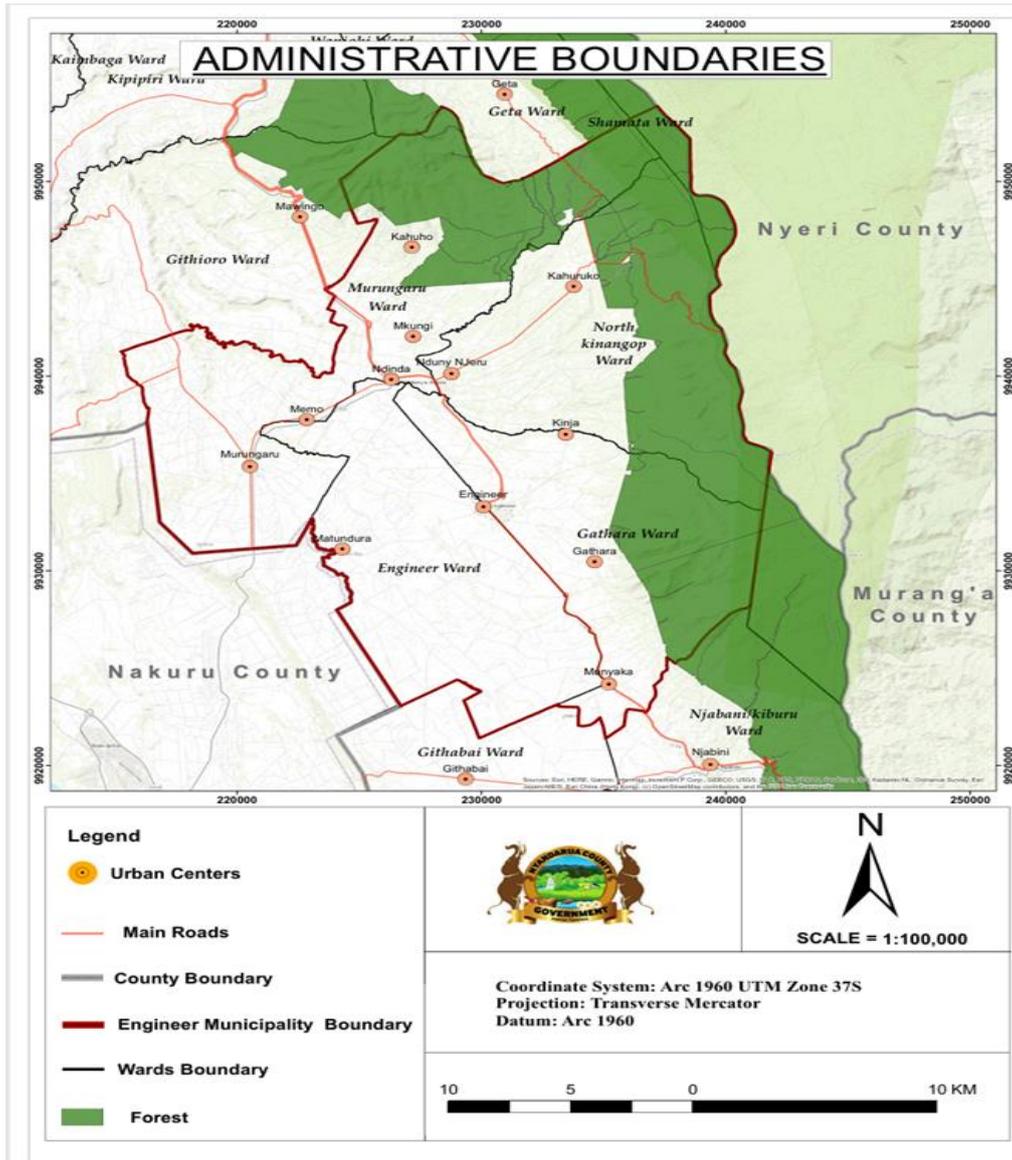


Figure 1: Administrative boundaries of Engineer Municipality

1.2.2. Governance Structure

Engineer town is the headquarter of Kinangop Sub County and it is located in the Municipality. The town hosts several national government and state agencies’ offices including Engineer Law Courts.

The municipality has a functional board of 9 members appointed as per Section 14 of the Urban Areas and Cities Act, 2011 (amended in 2019). The members are appointed by the Governor and approved by the County Assembly with powers and mandate to execute the following functions;

1. Promotion, regulation and provision of refuse collection and solid waste management services;
2. Promotion and provision of water and sanitation services and infrastructure (in areas within the Municipality not served by the Water and Sanitation Provider);
3. Construction and maintenance of urban roads and associated infrastructure;
4. Construction and maintenance of storm drainage and flood controls;
5. Construction and maintenance of walkways and other non-motorized transport infrastructure;
6. Construction and maintenance of recreational parks and green spaces;
7. Erection and maintenance of street lighting;
8. Maintenance and regulation of traffic controls and parking facilities;
9. Construction and maintenance of bus stands and taxi stands;
10. Regulation of outdoor advertising;
11. Construction, maintenance and regulation of municipal markets and abattoirs;
12. Maintenance of fire stations; provision of fire-fighting services, emergency preparedness and disaster management;
13. Regulation and provision of animal control and welfare;
14. Enforcement of municipal plans and development controls;
15. Municipal administration services (including maintenance of administrative offices);
16. Promoting infrastructural development and services within municipality;
17. Any other functions as may be delegated by the County government.

Municipal Management

The office of municipal manager is charged with the responsibility of implementing the decisions and functions of the board of the municipality and is answerable to the board of the municipality. The municipal manager shall be fully responsible for the proper conduct of the executive, administrative and affairs of the municipality and shall thereby have the responsibilities of;

- a) Supervision and coordination of departments and agencies of the municipality,
- b) Guide the implementation of the municipal charter, regulations and other applicable laws,
- c) Exercise such other powers as may be prescribed by the charter, regulations and applicable laws.
- d) Other duties include inter-alia

- a. Ensuring execution of the decisions of the board,
 - Secretary to the municipal board and keep all records of the board.
 - Prepare the annual estimate of revenue and expenditure for approval by the board,
 - Ensuring working relations and partnerships between the board, private sector, civil society and the community

Units in the Municipality

- Finance, Economic planning and administration
- Land, Physical Planning and infrastructure
- Public health, environment, trade and tourism
- Community development and social services
- Legal, audit and research services

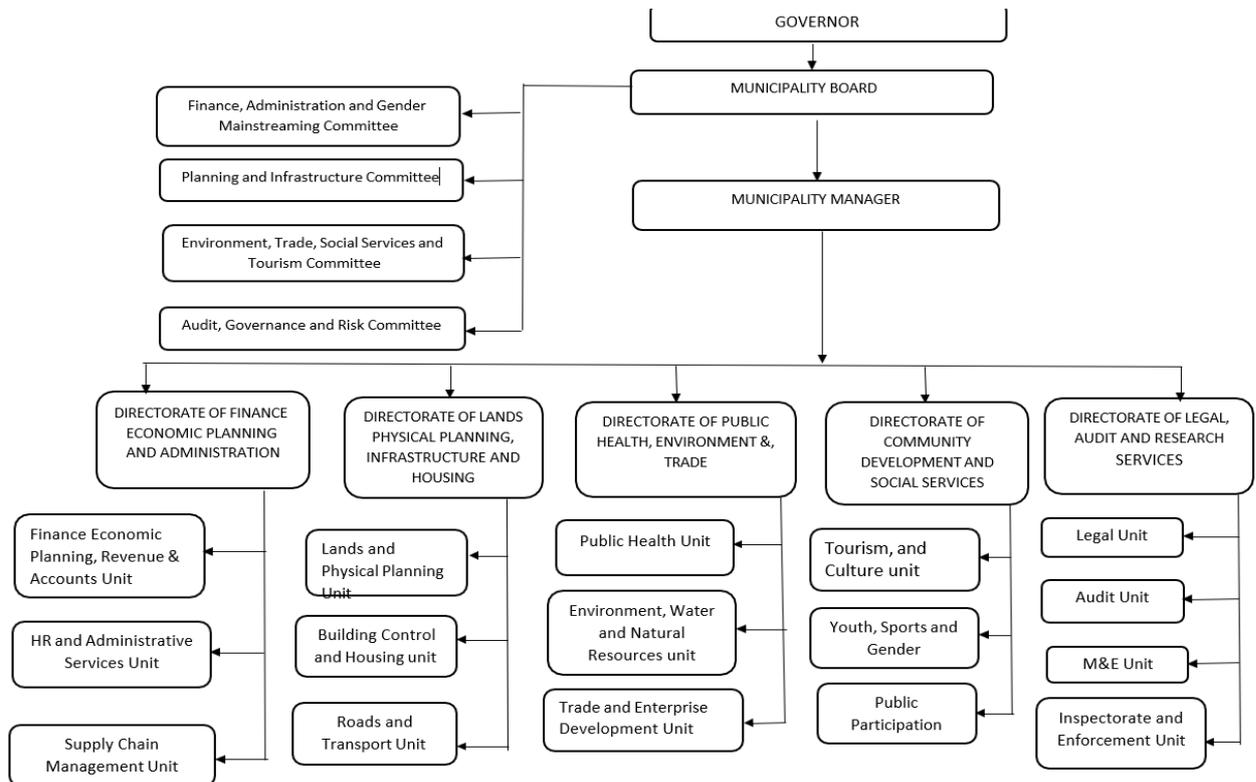


Figure 2: Engineer Municipality Organogram

1.2.3. Socio-economic Context

Population Distribution in Engineer Municipality

The population distribution within Engineer Municipality varies across different areas (KNBS, 2019). Engineer Township is the most densely populated area, with a total population of 34,671 and a density of 795 persons per square kilometer. In contrast, Murungaru has a population of 16,536 and a density of 326 persons per square kilometer, while Kitiri has 17,363 residents with a density of 313 persons per square kilometer. North Kinangop has a population of 25,300, with a density of 367 persons per square kilometer. Overall, it has a total population of 93,870, composed of 46,157 males and 47,713 females. The average household size is five members, and the municipality's average population density is around 363 persons per square kilometer (Source; Engineer ISUDP, 2025-2035)

This data highlights the uneven population distribution within the municipality, with Engineer Township being more densely populated than other areas like Murungaru and Kitiri. These differences in density are likely influenced by factors such as land use, infrastructure, and the availability of services, which vary across the municipality. Understanding these variations is essential for planning and resource allocation to meet the diverse needs of the population across different locations.

Table 6: Population distribution by various aspects

Location	Total Population	Male Population	Female Population	Households	Density (persons /sq km)
Engineer	34,671	16,157	18,514	8,304	795
Murungaru	16,536	7,013	9,523	2,047	326
Gathara	17,363	7,072	10,291	2,215	313
North Kinangop	25,300	11,294	14,006	2,278	367
Total	93,870	46,157	47,713	25,822	363.07

Source: 2019 Population Census

This table summarizes the population figures, gender distribution, number of households and population density for each ward within Engineer Municipality.

Population Distribution by Age

The demographic structure of the Municipality is notably youthful, with a significant portion of the population, 55.46% falling within the 0-24 age range. This indicates a high fertility rate and suggests that the area is likely to experience continued population growth in the coming years. The youthful demographic highlights the importance of focusing on services such as education, healthcare, and job creation, which are vital for supporting this growing segment of the population. Moreover, the presence of a young population could have long-term impacts on the labor market and economic development of the municipality.

Population Density

Population density averages at 363 people per square kilometer, though this figure varies across different sub-locations. The density varies significantly with areas like Engineer and North Kinangop, Murungaru and Gathara, which have infrastructure and services, showing higher densities. Conversely, regions such as Mikaro and Kambata, characterized by rugged terrain and scarce water resources, experience lower densities.

The variation in population density suggests that some areas may face more pressure on resources and infrastructure than others, necessitating targeted interventions to manage population distribution and maintain quality of life across the municipality. Understanding these density patterns is essential for effective urban planning and resource allocation, particularly in areas experiencing rapid population growth.

Population Projections

The growth rate of the population in Engineer Municipality is projected to be 4.1% per annum, which is higher than the national growth rate of 2.2% per annum. This reflects the urban nature of the area and indicates a significant increase in population over time.

The population of the Municipality is currently on a growth trajectory, with projections indicating an increase from 93,870 individuals to 131,418 by the year 2034. This expected growth underscores the need for proactive planning to accommodate the rising number of residents. As the population expands, it is crucial to consider the implications for housing, infrastructure, and public services to ensure sustainable development.

Settlement Patterns

The settlement patterns in the Municipality exhibit a clear distinction between urban and rural areas. Urban centers within the municipality are densely populated, with clustered settlements due to better infrastructure, social facilities, and economic opportunities, attracting those seeking commercial and residential spaces. In contrast, rural areas have more dispersed settlements, as households interested in agriculture settle in regions with larger, more suitable land for farming, typically located outside urban fringes.

Settlement patterns are also shaped by land suitability, with fertile areas and favorable topography supporting higher population densities, while challenging terrains lead to sparser settlements, limiting social and economic activities. Infrastructure availability plays a crucial role, as well-served urban areas attract more residents, while rural areas often struggle to provide adequate services, resulting in lower population growth.

Economic opportunities further influence settlement trends, with regions offering more jobs, particularly in agriculture and small businesses, attracting residents, while those with limited economic activities experience out-migration. As the municipality faces rapid population growth, strategic planning for compact development is essential to manage these patterns and ensure sustainable growth and service delivery.

1.2.4. Economic Context

The main economic activities within Engineer Municipality include Agriculture, retail and wholesale, financial institutions, quarrying, educational establishments. Agricultural land covers the biggest proportion of the municipality land mass with agricultural activities mainly done in all the wards.

Trade and Industry

Trade and Commerce is a major player to the economic growth of an urban area through creation of formal and informal employment and generation of revenue to the government. Trade within the municipality encompassed existing open-air markets (Engineer, Murungaru, Munyaka & Ndunyu Njeru), wholesale and retail traders, financial institutions like banks, SACCOs and mobile money agents and other small-scale enterprises like hardware, agrovets, pharmaceuticals and liquor stores.

Most of the industries deal in value addition of agricultural products including milk, potatoes, French beans and wool processing. There are 34 registered industries and cooperative

societies across the municipality. There is a need for value addition initiatives to refine and package the end products to realize optimum returns and create more employment opportunities.

Agriculture

Engineer Municipality is situated in agriculturally viable land endowed with a variety of food and horticultural crops. Food crops mainly consist of potatoes, cabbages, maize, beans and French beans. Livestock production comprises dairy cattle, pigs, goats, sheep, rabbits and chicken. The sector however is experiencing several challenges such as shortage of certified seedlings and fertilizer, poor infrastructure service development, poor market values, lack of National Cereal Board and cold storage facilities.

Micro, Small and Medium Enterprise (MSME)

Majority of the businesses within the Municipality fall under the MSME Category and are spread across with a good percentage of them being sole proprietorships and family businesses. There are over 2,500 licensed MSMEs in the Municipality.

Financial services

There are 2 commercial banks in the municipality (Cooperative and Equity Bank), 2 main SACCOS (Tower and Muki SACCOS) and over 20 Micro-finance institutions (Kenya Women Finance Trust, Juhudi Kilimo, Platinum Credit, Premier Credit among others)

Tourism and Hospitality

Tourism in Engineer Municipality is defined by the hotels, restaurants and the recreational areas. Notable Hotels include Elmer resort and spa, Golden ark hotel, Musan Garden, Olempus garden. Other tourist attraction sites include the Abardare National Park, Rumeria Hills, 12 apostles, 7 ponds, Kinangop plateau, Mt Kinangop, Maumau Caves, Plovers Eco camp and Kinyahwe museum.

1.2.5 Land-use Context

The existing land use distribution is as shown in the map below

1.3. Key Stakeholders & Inclusiveness

In order to develop the content of the Engineer Municipality Urban Climate Risk Profile, the Municipality appointed a multi-sectoral Technical Working Group comprising of representatives from the Board, Municipal Manager, KMD, Climate Change, Office of the County Attorney, Finance, Environment, Natural Resources, Infrastructure and Public works, Public Administration, Physical Planning and Urban Development.

The TWG conducted a thorough stakeholder analysis to map key stakeholders for engagement during the Urban Climate Risk Assessment, Scenario Mapping and Data Collection exercise.

The identified stakeholders were as follows:

- ❖ Ward Committee Members (9 members from each of the 4 wards)
- ❖ Local administrators (Chief)
- ❖ Community Health Promoters
- ❖ Faith Based Organization Rep
- ❖ Business Community Reps (Male & Female)
- ❖ Sub-County Education Officer
- ❖ Cooperatives Rep
- ❖ Tree Nurseries Rep
- ❖ Senior elders above 75years (Male & Female)
- ❖ Farmers Reps (Male & Female)
- ❖ Traders Reps (Male & Female)
- ❖ Informal Waste Handlers
- ❖ Sub-County Administrator
- ❖ Water Officer
- ❖ Sub-County Agricultural Officer (Crop and Livestock)
- ❖ Sub-County Social Development Officer
- ❖ Director Public Participation

Table 7: Stakeholder mapping for Engineer Municipality

High	<p>High Influence – Low Interest</p> <ul style="list-style-type: none"> ● Local chief (NGAO) ● Community Health Promoters ● Faith based Organization Reps ● Cooperatives Rep ● Sub-County Administrator 	<p>High Influence – High Interest</p> <ul style="list-style-type: none"> ● Ward Committee members ● Farmers ● Water Officer ● Director Public Participation
	<p>Low Influence – Low Interest</p> <ul style="list-style-type: none"> ● Business Community Reps ● Sub-County Education Officer ● Senior elders above 75years (Male & Female) ● Traders Reps (Male & Female) ● Informal Waste Handlers 	<p>Low Influence – High Interest</p> <ul style="list-style-type: none"> ● Tree Nurseries Rep ● Sub-County Agricultural Officer (Crop and Livestock) ● Sub-County Social Development Officer
Low		High





Plate 1: Stakeholder Engagement Forum held on 18th September 2025

Validation Exercise

The Validation Workshop was held on 12th November 2025 with an aim of:

- Authenticating findings of the UCRA,
- Ensuring stakeholder ownership, and
- Confirming feasibility of adaptation strategies.

2. Validation Process

The validation exercise was conducted as follows:

- Presentation of hazard mapping including floods, drought, extreme cold temperatures, and frost.
- Review of exposure methodology and infrastructure audits.
- Group sessions verifying hazard distribution and updating data.
- Cross-sector insights from water, roads, environment, and community groups.

3. Key Validation Outcomes

- Flood, drought, extreme cold, and frost risk areas confirmed.
- Recommendation to update land-use and integrate community projects.
- Key hazards prioritized: floods, drought, extreme cold, frost.
- Adaptation measures endorsed: slope stabilization, drainage upgrades, reforestation, land use management.

4. Stakeholder Recommendations

- Integrate geotechnical assessments into planning.
- Enhance community awareness on safe settlement.
- Align UCRA with county frameworks for resource mobilization.
- Add sustainability indicators for monitoring.

5. Conclusion

Validation confirmed alignment with on-ground realities. Document approved subject to edits.



Plate 2: Stakeholder Validation Forum held on 12th November 2025

CHAPTER TWO

2. HAZARD ASSESSMENT

Climate hazard assessment constitutes a critical component of climate risk analysis and adaptation planning. It is a systematic, evidence-based process aimed at identifying, characterizing, and quantifying the potential occurrence and magnitude of climate-induced hazards and their spatial and temporal distribution. The assessment provides the analytical foundation for understanding how climatic variables and extreme events interact with physical, ecological, and socio-economic systems to produce adverse outcomes.

The outcomes of climate hazard assessment forms the basis for comprehensive vulnerability and exposure assessments, enabling the estimation of overall climate risk. When integrated into policy formulation, development planning, and disaster risk management, such assessments enhance the capacity of institutions and communities to anticipate, mitigate, and adapt to climate-induced threats.

In summary, climate hazard assessment provides a robust framework for evaluating the dynamic interactions between climate processes and socio-environmental systems. It is an indispensable tool in designing targeted climate adaptation, resilience-building, and risk-informed development strategies at local, national, and regional scales.

2.1 Key Climate Hazards

Floods, drought, extreme cold and frost were identified as the key hazards in the municipality

Table 8: Key Climate Hazards in Engineer Municipality

Hazard	Engineer	North Kinangop	Gathara	Murungaru
Floods	✓	✓	✓	✓
Drought	✓	✓	✓	✓
Extreme cold temperatures	✓	✓	✓	✓
Frost	✓	✓	✓	X



Plate 4: Climate Change Impacts in Enginer Municipality

Table 9. Hazards screening for Enginer Municipality

Hazard	Hazard Likely (Y/N)	Significant Impact (Y/N)	High Priority (Y/N)	Key Hazard (Y/N)
Heat Stress				
Average surface temperature increase	N	N	N	N
Average ocean temperature increase	N	N	N	N
Extreme heat	N	N	N	N
Marine heatwaves	N	N	N	N
Cold Stress				
Average surface temperature during winter	N	N	N	N

Hazard	Hazard Likely (Y/N)	Significant Impact (Y/N)	High Priority (Y/N)	Key Hazard (Y/N)
Extreme cold (e.g., cold spells, frost)	Y	Y	Y	Y
Snowfall and ice storms	N	N	N	N
Flooding				
Changes in precipitation patterns	Y	Y	Y	Y
Pluvial (surface level) flooding, including flash flooding and urban flooding	Y	Y	Y	Y
Fluvial (river) flooding	Y	Y	Y	N
Sea level rise	N	N	N	N
Coastal flooding, including storm surges	N	N	N	N
Waterlogging	Y	Y	Y	Y
Water Stress				
Drought (meteorological, hydrological)	Y	Y	Y	Y
Groundwater salinization	N	N	N	N
Saline intrusion	N	N	N	N
Wildfire				
Wildfires & bushfires	Y	Y	N	Y
Storms				
Extreme wind	Y	Y	Y	Y
Tropical cyclones	N	N	N	N
Sand and dust storms	N	N	N	N
Hailstorms	Y	Y	Y	N
Mass Movement				
Landslides	N	N	N	N
Coastal erosion	N	N	N	N
Gully erosion	Y	Y	Y	Y
Marine Conditions				
Ocean acidification	N	N	N	N
Geophysical*				
Subsidence	N	N	N	N

Hazard	Hazard Likely (Y/N)	Significant Impact (Y/N)	High Priority (Y/N)	Key Hazard (Y/N)
Earthquakes	N	N	N	N
Volcanos	N	N	N	N

The hazards have impacts and need to inform urban planning.

2.2. Climate Indicators and Hazard Thresholds

Key climate indicators and hazard thresholds were derived from the assessment undertaken in the municipality

Table 10. Climate indicators and hazard thresholds selected for the assessment

Key Hazard	Climate indicator	Data source	Threshold		
			Low	Medium	High
Floods	Excessive Rainfall	MET/ SE			✓
Drought	Depressed Rainfall	MET/ SE			✓
Extreme cold	Low temperatures	MET/ SE			✓
Frost	Frequency and intensity of occurrence	MET/ SE		✓	

* MET -Meteorology, SE- Stakeholder Engagement

2.3. Current Hazard Levels and Climate Projections

In this section is an analysis of hazards levels and climate projects informed by multiple data sources from the Kenya Meteorology Department, (2024).

Temperature patterns:

The historical data on temperature shows a positive increase for both the maximum and minimum temperatures in Engineer municipality. The rate of increase on the minimum temperature is more compared to the rate of increase on the maximum temperature under the two scenarios RCP4.5 and RCP8.5 emission. The annual fluctuations of temperature show the existence of extreme temperatures during the period. The temperature ranges from a minimum of 6-14 degrees Celsius to a maximum of between 20-25 degrees Celsius.

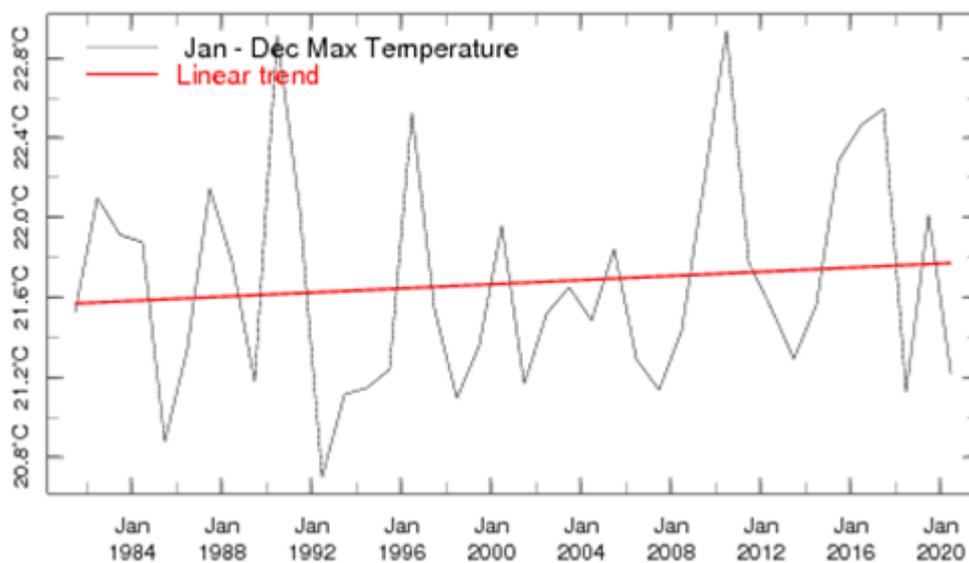


Figure 4: Annual Maximum temperatures from 1984-2022

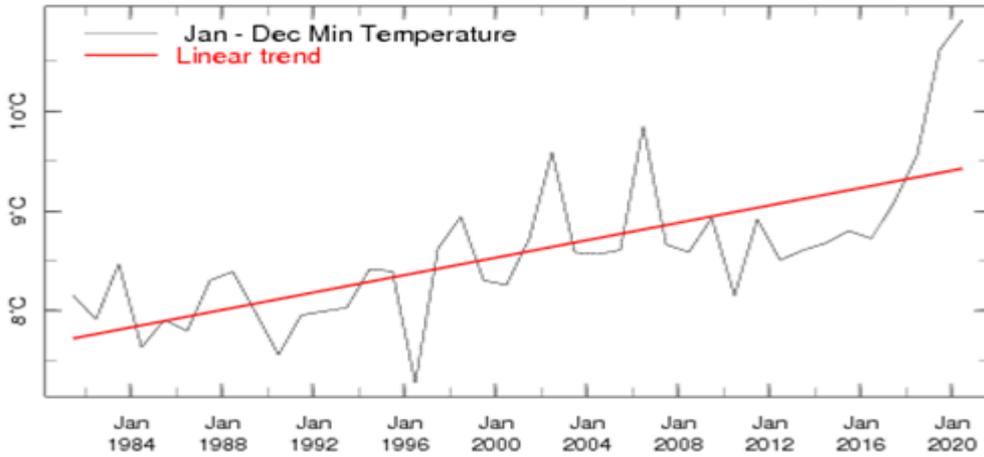


Figure 5: Annual minimum temperatures ranging from 1984 to 2022

Rainfall patterns

The historical data from the Engineer municipality indicates a positive increase of both the annual rainfall and the seasonal rainfall (MAM, JJA, and OND). The annual rainfall ranges from about 800 mm up to a maximum of about 1700 mm and an annual mean of about 1300 mm. The fluctuations depict years of extreme rainfall both positive and negative.

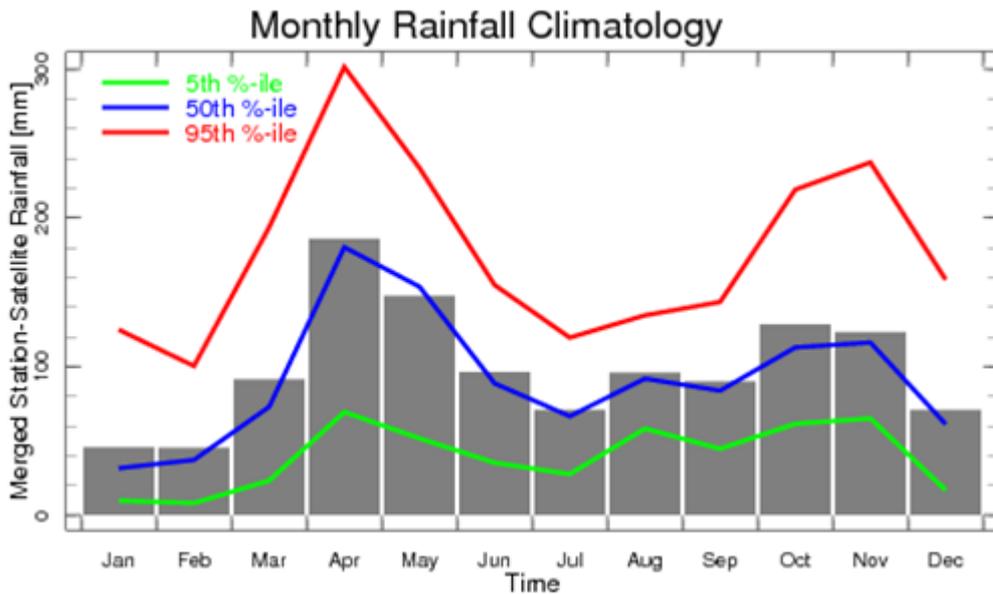


Figure 6: Monthly Rainfall Pattern

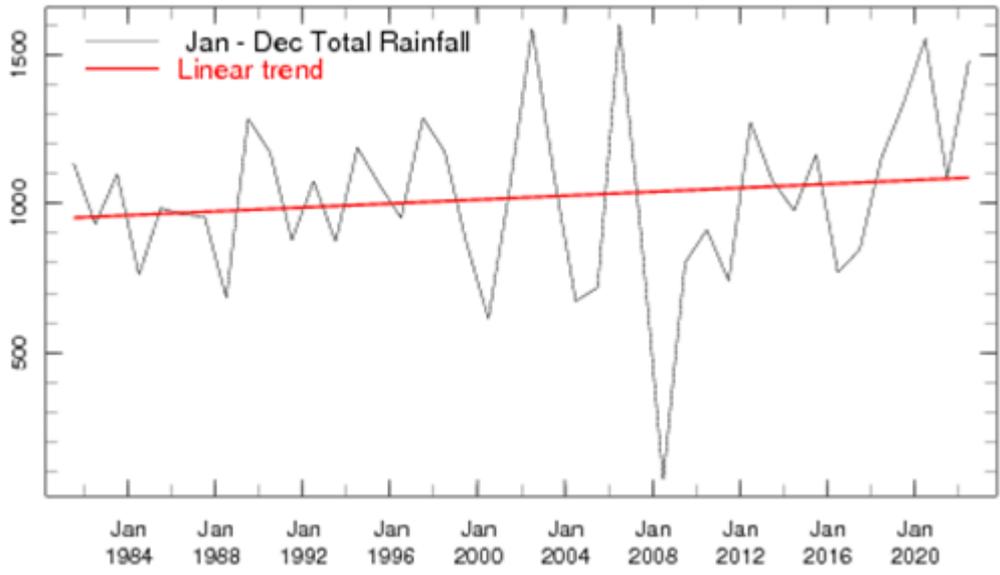


Figure 7: Annual rainfall pattern ranging from 1984 to 2022

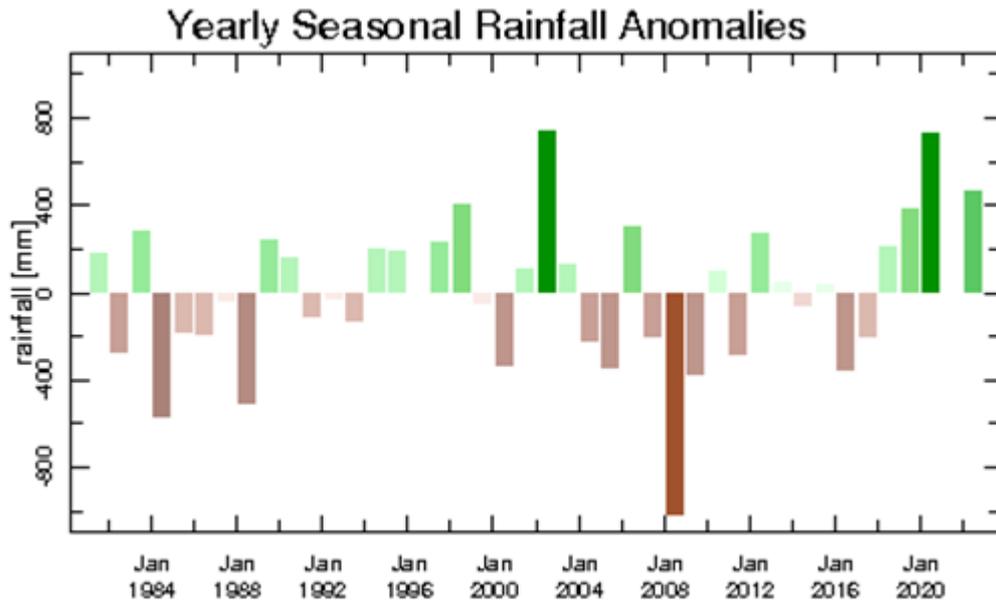


Figure 8: Yearly seasonal rainfall anomalies

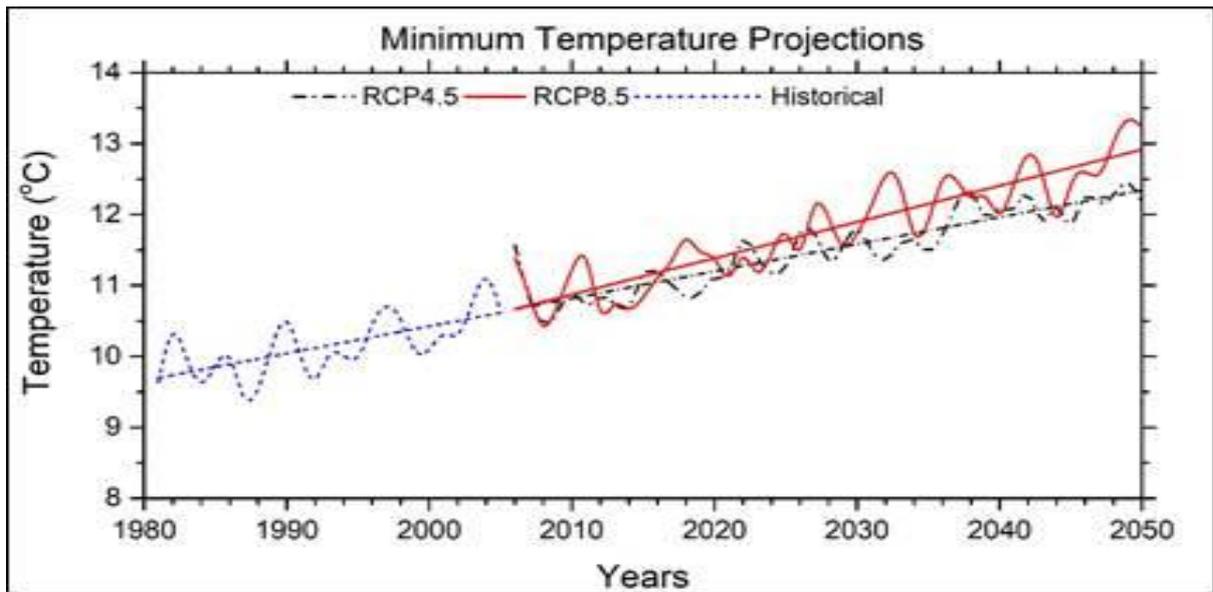


Figure 9: Minimum Temperature Projection to the Year 2050

Observed minimum temperature from 1980 to 2006 and future minimum temperature projection from 2006 to 2050 obtained from CMIP5 model under the RCP4.5 and RCP8.5 scenarios.

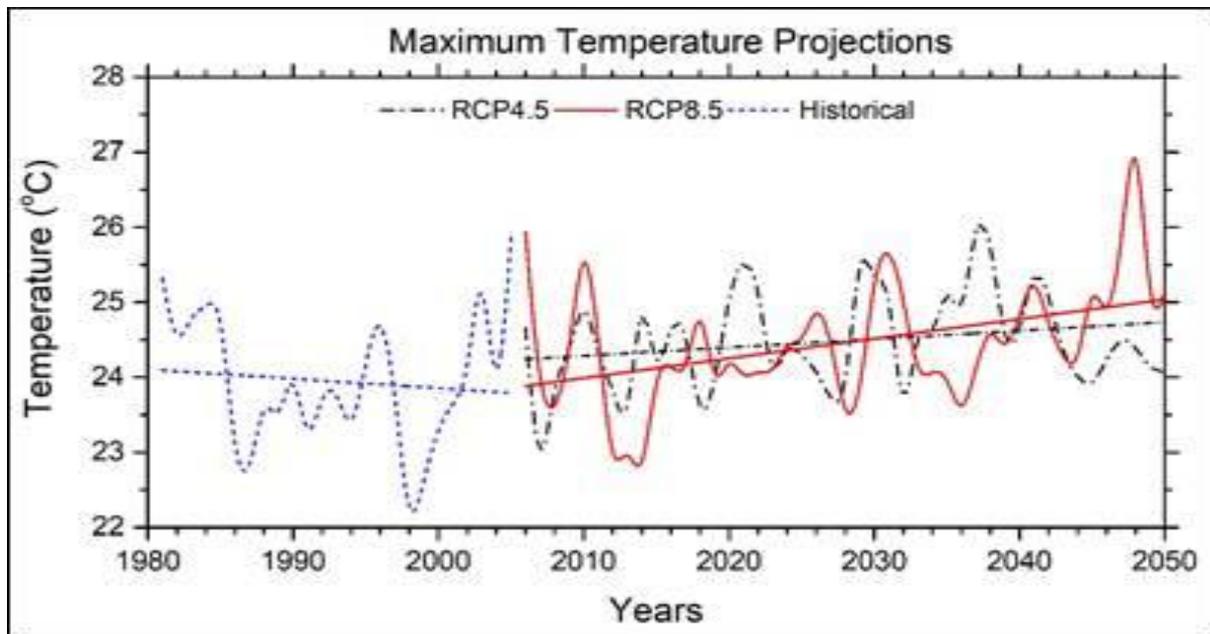


Figure 10 : Maximum Temperature Project to the Year 2050

Observed maximum temperature from 1980 to 2006 and future maximum temperature projection from 2006 to 2050 obtained from CMIP5 model under the RCP4.5 and RCP8.5 scenarios.

Temperature Projection summary

At the national level, under the worst case RCP8.5 scenario:

- Average temperatures nationally are expected to continue rising by 1.7% by the 2050s and by 3.5% at the end of the 21st century.
- The number of hot days and hot nights will increase, with hot days projected to occur on 19%- 45% of days by mid-century. Hot nights are expected to increase even more rapidly, projected to occur on 45%-75% of nights by 2050.

Cold days and nights are expected to become increasingly rare.

Table 11. Current and future hazards levels for Engineer Municipality

Hazard	Hazard Level				
	Current (Baseline)	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
Floods	High	High	Very High	Very High	Very High
Drought	High	High	Very High	Very High	Very High
Extreme cold	High	High	Very High	Very High	Very High
Frost	Medium	Medium	High	High	Very high

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

Table 12. Interpretation of hazard levels

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

2.4. Current and Future Hazard Impact Areas

Current Hazard Impact Areas (2023) – Spatial Extent & Severity

Frost

Spatial Extent	Predominantly affects high-altitude, agricultural plateau areas, specifically North Kinangop, Engineer, Gathara and Murungaru Wards . These wards are within the cooler highlands and were highlighted by participants as frost hotspots
Frequency	Frost events occur repeatedly during colder months and are associated with night-time radioactive cooling under clear skies
Severity	High, due to substantial destruction of crops and pasture, reported as a key climate hazard for livelihood in these wards
Impact Sector	Agriculture (potatoes, vegetables), livestock feeds, and smallholder livelihoods

Drought / Prolonged Dry Spells

Spatial Extent	Widespread across Nyandarua County, including Murungaru and Gathara , though most intense in lower and drier zones. Drought hazards also affect much of the County's agrarian landscape
Frequency	Increasing frequency and duration of dry spells have been reported countywide
Severity	High hence reduced soil moisture, crop failure, water stress for both households and livestock
Impact Sector	Intersects with frost zones (temperate dry stress) and affects water availability for irrigation in all focal wards

Flooding & Extreme Rainfall

Spatial Extent	Flood risk is more prominent in lower-lying and valley areas of the county, but some parts of Gathara and Murungaru may experience surface water flooding associated with intense rainfall and poor drainage
Frequency	Occasional but significant when heavy rains occur
Severity	Moderate to high where present causing soil erosion, waterlogging of fields and infrastructure damage
Impact Sector	Flood risk may overlap with drought cycles due to erratic rainfall patterns (heavy bursts followed by dry spells)

Extreme Cold

Spatial Extent	Widespread across Engineer Municipality, affecting high-altitude agricultural areas in Gathara, North Kinangop, Engineer and Murungaru wards
Frequency	Seasonal and recurrent, occurring mainly during cooler months under clear night conditions

Severity	High, due to significant crop losses (especially potatoes and vegetables), reduced household incomes and increased health risks for vulnerable groups
Impact Sector	Commonly overlaps with drought and dry spells, compounding agricultural stress and food insecurity

Table 13: Summary of Current and Future Hazard Impact Areas

Climate Hazard	Spatial Extent	Current Frequency	Current Severity	Future Trend	Hazard Overlap
Frost	High-altitude agricultural areas across all wards	Seasonal	High- crop damage (potatoes, vegetables)	Continued with increased variability	Frost + drought
Drought / Dry Spells	Municipality-wide	Increasing	High - water and pasture stress	Longer and more frequent	Drought + water scarcity
Localized Flooding	Drainage lines, low-lying and built-up areas	Occasional	Moderate–High	More intense events	Flooding + erosion
Extreme Cold	Exposed areas across municipality	Occasional	Low–Moderate	Slight increase	Cold + frost damage

2.5 Future Hazard Scenarios (Projected)

Climate Change Trends Across the Wards of Engineer Municipality

Across Nyandarua County, including these wards, future projections indicate the following broad trends:

- **Increased Moisture Stress (Drought Intensity & Duration):** Projections show longer dry periods in both wet and dry seasons, meaning moisture deficits will intensify over time.
- **Unchanged or Slightly More Intense Precipitation Extremes:** High-intensity rainfall events may not substantially increase in frequency but could cause greater flooding impacts when they occur due to soil saturation and terrain runoff.
- **Temperature Increase:** Rising temperatures are expected, increasing heat stress on crops and livestock, and possibly elevating frost variability (warmer nights could reduce frost frequency but raise daytime heat stress).

CHAPTER THREE

3. Exposure & Vulnerability Assessment

Engineer Municipality, like many growing urban centers, is increasingly exposed to the impacts of climate change, including irregular rainfall, flooding, prolonged dry spells, and rising temperatures. These changes threaten urban infrastructure, water resources, livelihoods, and overall municipal development. Understanding exposure and vulnerability within the municipality is therefore critical for building long-term climate resilience.

This assessment identifies the degree to which people, infrastructure, and economic activities in Engineer Municipality are exposed to climate-related hazards, and how social, economic, and environmental factors influence their vulnerability. The findings help identify priority areas and populations that are most at risk, guiding evidence-based adaptation interventions.

The assessment aligns with the objectives of the County Integrated Development Plan (2023-2028) Integrated Development Plan (IDeP) and the ISUDP-2023-2032 for Engineer Municipality, both of which emphasize sustainable urban growth, improved service delivery, and climate-resilient infrastructure. By integrating climate risk considerations into these planning frameworks, the municipality strengthens its capacity to anticipate, prepare for, and respond effectively to climate impacts-supporting the realization of a safe, inclusive, and sustainable urban environment.

3.1. Urban Elements

In the table below are categories and subcategories of urban elements from the assessment 'Y' indicating the units and assets in the municipality that are included while 'N' for those .

Table 14. Urban elements inventory

Category	Subcategory	Include d in the RCRA (Y/N)	Availabl e in GIS format (Y/N)	Description
Infrastructure & Services				
Stormwater Drainage	Stormwater drainage conveyance network	Y	Y	Storm water drains mainly in Engineer town and main market centers on the road reserve
	Stormwater storage	Y	N	Most of the storm water flows into streams, water ways and reservoirs
Water & Wastewater Management	Pumping stations	N	N	None.
	Groundwater abstraction	Y	Y	The main sources of water for the municipality include boreholes, intakes, water pans and dams
	Water treatment facilities	N	N	No treatment facilities in the municipality
	Water supply networks	Y	Y	Water supply in the municipality is managed by Community Based Organisations(Self - Help Groups)
	Sewer networks	N	N	No sewer networks in the municipality
	Wastewater treatment facilities	N	N	Private at individual facilities -North Kinangop hospital
Solid Waste Management	Transfer facilities	N	N	The Municipality is in the process of establishing the facilities

Category	Subcategory	Include d in the RCRA (Y/N)	Availabl e in GIS format (Y/N)	Description
	Landfills and dump sites	Y	Y	The municipality does not have a dumpsite, uses one leased in neighboring sub county
	Recycling centers	Y	N	Informal recycling centers
	Collection fleet	Y	N	One truck is shared between the municipality and three neighboring sub-counties.
Transport and Mobility	Road networks	Y	Y	The municipality has approximate 208 Kms of Bitumen roads and 287 Kms of murrum roads
	Bridges	Y	N	There is one bridge within the municipality namely Ciondo-Chobe Bridge
	Public transport networks (rail, bus, mini-bus, etc.)	Y	Y	Existing Engineer-Engineer-Njabini road, Engineer-Naivasha road Matatus, Bus and Mini bus serving the Municipality and beyond. Bodaboda transport is growing rampantly
	Transportation terminals	Y	Y	Main bus terminal in Engineer and others in market centre-Ndunyu Njeru town serves the entire municipality.
	Vehicle depots	N	N	N/A

Category	Subcategory	Include d in the RCRA (Y/N)	Availabl e in GIS format (Y/N)	Description
	Non-motorized transport networks	N	N	None in municipality
	Freight and logistics hubs	N	N	N/A
Energy	Energy power plants	N	N	N/A
	Poles and power lines	Y	Y	Managed by Kenya Power Lighting Company
	Transformers and substations	Y	N	Transformers Scattered within the Municipality and managed by KPLC
	Streetlighting	Y	N	Floodlights within main urban centers of the municipality Streetlights are within Engineer town, Ndunyu Njeru, Ndinda, Murungaru
Economic Infrastructure	Markets	Y	Y	3 Main market operational(Engineer, Murungaru and Ndunyu Njeru) and new one under construction Informal Roadside markets across the municipality being very susceptible to climate impacts
	Businesses and commercial hubs	Y	Y	Commercial activities located in satellite towns and shopping centers in the rural setup

Category	Subcategory	Include d in the RCRA (Y/N)	Availabl e in GIS format (Y/N)	Description
	Industrial zones/parks and logistics parks	Y	Y	Refer to the Municipal Spatial Plan
Social Infrastructure	Government buildings and service centers	Y	Y	County and National Government offices are within Engineer township. Other Administrative offices within the satellite centers
	Education facilities	Y	Y	55 ECDEs, 47 Primary schools, 46 Junior secondary 28, Secondary Schools 3 Tertiary.
	Healthcare facilities	Y	Y	1 County Level 4 Hospital, 6 health centers, 14 dispensaries, 41Community units (level1) and several private and faith based health facilities such as North Kinangop Mission Catholic Hospital
	Sporting Facilities	Y	Y	20 Playing fields.
	Faith-based buildings	Y	Y	Numerous across the Municipality
	Cultural and heritage assets	Y	Y	There are 4 Cemeteries across the municipality
	Emergency Services	Fire stations	Y	N
Police stations		Y	Y	3 Police Stations and 5 police posts

Category	Subcategory	Include d in the RCRA (Y/N)	Availabl e in GIS format (Y/N)	Description
	Telecommunications networks	Y	Y	Major Networks (Safaricom, Airtel and Telecom) Wireless networks (Fiber)
	Early warning systems	Y	N	Meteorological forecasts
	Disaster management centers and shelters	N	N	None in the municipality
	Evacuation routes	N	N	Main facilities have fire exit and fire assembly points
Populations(
Urban Residents	Population	Y	Y	The municipality population structure has a broad base of young and growing people and a narrow top of old and ageing people
	Households	Y	N	Average household size of 5 members
Informal Settlement Residents	Population living in informal settlements	Y	N	Data not up to date
	Households lacking land tenure	Y	N	Some of the urban areas facing insecurity of tenure include Gathara, Matopeni, Memo, Weru
	Households / residents lacking access to basic services	Y	Y	Majority of the settlements depict informal characteristics such as inadequate physical and social infrastructure
Vulnerable and	Low-income households	N	N	Data not available

Category	Subcategory	Include d in the RCRA (Y/N)	Availabl e in GIS format (Y/N)	Description
Marginalized Groups	Women-headed households	N	N	Data not available
	Children and youth	Y	N	Data not up to date
	Elderly persons	Y	N	Data not up to date
	People with disabilities (PWD)	Y	N	Data not up to date
	Homeless populations	N	N	Data not available
	Unemployed or precariously employed workers	Y	Y	The analysis are provided in the municipal spatial plan
	Seasonal workers / migrant laborers	N	N	Data not available
	Nomadic groups in peri-urban areas	N	N	Data not available
	Urban refugees and migrants	N	N	Data not available
	Minority ethnic groups in urban areas	Y	N	Data not available
Natural Assets				
Urban Green Infrastructure	Urban parks and gardens	Y	Y	
	Green corridors	Y	Y	
	Street landscaping	N	N	
	Urban forests and forest reserves	Y	Y	
	Natural wetlands	Y	Y	

Category	Subcategory	Include d in the RCRA (Y/N)	Availabl e in GIS format (Y/N)	Description
Urban Blue Infrastructure	Rivers	Y	N	<p>Murungaru Ward-Turasha, Kinja, Seasonal Ming'otyo</p> <p>North Kinangop Ward-Kawamaitha Stream, Kitiri, Mukungi</p> <p>Gathara Ward-Turasha</p> <p>Engineer Ward-Turasha, Mingotyo, Karoroha</p>
	Riparian zones	Y	Y	Many riparian zones along streams, rivers and water pans. However many have been encroached into farmlands and eucalyptus

Category	Subcategory	Include d in the RCRA (Y/N)	Availabl e in GIS format (Y/N)	Description
	Lakes, ponds and reservoirs	Y	Y	Murungaru Ward -Gaciri, KKY, Michinda, Hughes, Olmagogo, Baru, Tony Evans, Dirisha, Githabai, Kinanda, Munoru
				North Kinangop Ward - Mukungi, Kitogo
				Gathara Ward-Mutamayu, Muhindi, Nelson Northing Colt Lee
				Engineer Ward-Ruka, Kargan, Matundura, Upper Mingutyo, Lower Mingoty, Makumi
	Coastal ecosystems	N	N	N/A
	Urban agriculture	Y	Y	Despite the zonation agriculture practiced in the urban centers
Peri-urban and Agricultural Systems	Peri-urban agriculture	Y	Y	Mixed agriculture practiced
	Agroforestry systems	Y	N	Extensively practiced in the municipality
	Forests and forest reserves	Y	Y	North Kinangop Forest
	Protected areas and national parks	N	N	N/A
	Savannahs and rangelands	N	N	N/A

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

For this Urban Climate Risk Profile, exposure and vulnerability levels and impacts identified in tables 17 to 20 should be interpreted in accordance with the information in tables [15 and 16](#) below.

Table 15. Interpretation of exposure and vulnerability levels

Level	Exposure Level Interpretation	Vulnerability Level Interpretation
High	Few or no critical urban elements lie within the hazard footprint or area of impact.	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	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 minimally vulnerable to the climate hazard due to limited sensitivity and/or a high degree of adaptive capacity.

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

Table 16. Impact Matrix

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

Table 17. Exposure, Vulnerability, and Impacts of Floods on Urban Elements

Hazard: Floods

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Infrastructure & Services					
Stormwater Drainage	<ul style="list-style-type: none"> • Clogging • Siltation • Destruction of drains 	High	<p>Sensitivity:</p> <ul style="list-style-type: none"> • High during flooding <p>Adaptive Capacity:</p> <ul style="list-style-type: none"> • Functional directorate dealing with surveillance and regular maintenance of drains 	High	High
Water & Wastewater Management	<ul style="list-style-type: none"> • Infrastructure destroyed • Pollution; Wastewater mix with domestic water 	High	<p>Sensitivity:</p> <ul style="list-style-type: none"> • High during floods • No common sewerage system and residents depends on individual units 	High	High

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			Adaptive Capacity: <ul style="list-style-type: none"> • Low • Lack of sewerage treatment plant • Encourage uptake of biodigesters instead of septic tanks 		
Solid Waste Management	<ul style="list-style-type: none"> • Inaccessible Disposal sites • Indiscriminate disposal of waste • Contamination of water resources including streams • Residents prone to Health risks 	High	Sensitivity: <ul style="list-style-type: none"> • High • Residents in the neighborhood susceptible to impacts of poor waste management 	High	High
			Adaptive Capacity: <ul style="list-style-type: none"> • Enhance Integrated solid waste management • Limited 		
Transport and Mobility	<ul style="list-style-type: none"> • Infrastructure destruction • Accessibility is cut off 	Medium	Sensitivity: <ul style="list-style-type: none"> • High • Ripple effect 	Medium	Medium

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	<ul style="list-style-type: none"> Mechanical break down and extended travel time Post-harvest losses and disruption of livelihood 		Adaptive Capacity: <ul style="list-style-type: none"> Limited Enhance construction of climate proofed infrastructure 		
Energy	<ul style="list-style-type: none"> Little to no effect 	Low	Sensitivity: <ul style="list-style-type: none"> Low 	Low	Low
			Adaptive Capacity: <ul style="list-style-type: none"> High since residents are dependent on alternative energy sources 		
Economic Infrastructure	<ul style="list-style-type: none"> Destruction of infrastructure Service disruption Increased maintenance cost 	High	Sensitivity: <ul style="list-style-type: none"> High Infrastructure Susceptible to damage Backbone of livelihoods and economy in the municipality 	High	Medium
			Adaptive Capacity: <ul style="list-style-type: none"> Low Inadequate drainage channels. Diversified sources of livelihood Directorate of Social Services and emergency fund kitty 		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Social Infrastructure	<ul style="list-style-type: none"> • Subsidence of graveyards • Inaccessible and waterlogged facilities playing fields • Destruction of infrastructure. 	Medium	Sensitivity: <ul style="list-style-type: none"> • Medium • Kinyahwe museum and <i>Muti wa Kenyatta</i> in Engineer • Social infrastructure not relied upon by majority of the urban residents 	Low	Low
			Adaptive Capacity: <ul style="list-style-type: none"> • High • Alternatives available 		
Emergency Services	<ul style="list-style-type: none"> • Delayed response • Death and loss of livelihood 	Low	Sensitivity: <ul style="list-style-type: none"> • Low • Not regularly required 	Low	Low
			Adaptive Capacity: <ul style="list-style-type: none"> • High • Multisectoral Municipal Flood Response team 		
Populations					
Urban Residents	<ul style="list-style-type: none"> • Inaccessibility and mobility challenges • Disruption of livelihoods 	Low	Sensitivity: <ul style="list-style-type: none"> • Low • Infrastructure relatively resilient 	Low	Low

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			Adaptive Capacity: <ul style="list-style-type: none"> High Improved drainage systems, road networks, and waste management infrastructure 		
Informal Settlement Residents	<ul style="list-style-type: none"> Loss and disruption of livelihoods Pollution and contamination of Water sources Temporal displacements 	High	Sensitivity: <ul style="list-style-type: none"> High Livelihoods not diversified Adaptive Capacity: <ul style="list-style-type: none"> Limited Municipality implementing various projects to improve resilience 	High	High
Minority and Vulnerable Groups	<ul style="list-style-type: none"> Mobility of PWDs, school going children, elderly Displacement of resource poor households 	High	Sensitivity: <ul style="list-style-type: none"> High Low independence Adaptive Capacity: <ul style="list-style-type: none"> Medium Emergency rescue and services 	High	Medium
Natural Assets					

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Urban Green Infrastructure	<ul style="list-style-type: none"> Urban Green infrastructure is not heavily exposed; it acts as a shock absorber allowing excess water to percolate to the ground. Also acts as a carbon sink 	Low	Sensitivity: <ul style="list-style-type: none"> Low Acts as a buffer to the impacts of flooding 	Low	Low
			Adaptive Capacity: <ul style="list-style-type: none"> High Acts as a buffer to the impacts of flooding 		
Urban Blue Infrastructure	<ul style="list-style-type: none"> Siltation of Douglas dam Spread of <i>Salvinia molesta</i> an invasive species 	Low	Sensitivity: <ul style="list-style-type: none"> limited No blue infrastructure in the municipality. 	Low	Low
			Adaptive Capacity: <ul style="list-style-type: none"> limited No blue infrastructure in the municipality. 		
Peri-urban and Agricultural Systems	<ul style="list-style-type: none"> Post-harvest loss Crop destruction 	High	Sensitivity: <ul style="list-style-type: none"> High Agriculture is the major livelihood source 	High	High

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			Adaptive Capacity: <ul style="list-style-type: none"> • Medium • Diversified livelihoods 		

Table 18. Exposure, Vulnerability, and Impacts of Drought on Urban Elements

Hazard: Drought

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Infrastructure & Services					
Storm water Drainage	<ul style="list-style-type: none"> • Drying and cracking of drainage channels • Accumulation of solid waste due to reduced runoff 	Low	Sensitivity: <ul style="list-style-type: none"> • Low -drainage systems underutilized during drought • Reduced flow causes silt build-up Adaptive Capacity: <ul style="list-style-type: none"> • High - regular maintenance possible during dry seasons 	Low	Low

Water & Wastewater Management	<ul style="list-style-type: none"> • Declining water levels in storage and supply systems • Reduced recharge of boreholes and springs • Water rationing and scarcity 	High	Sensitivity: <ul style="list-style-type: none"> • High -overreliance on groundwater and rain-fed sources 	High	High
Solid Waste Management	<ul style="list-style-type: none"> • Scattered dry waste. • Odor and fire risks increase 	Medium	Sensitivity: <ul style="list-style-type: none"> • Medium- operational challenges in waste management. 	Medium	Medium
Transport and Mobility	<ul style="list-style-type: none"> • Dust pollution and road degradation from dryness • Increased maintenance costs 	Medium	Sensitivity: <ul style="list-style-type: none"> • Medium - unpaved roads affected by dust. 	Medium	Medium
Energy	<ul style="list-style-type: none"> • Reduced hydropower generation nationally • Reliance on biomass and alternative energy 	Medium	Sensitivity: <ul style="list-style-type: none"> • Medium - dependent on national grid 	Medium	Medium
			Adaptive Capacity: <ul style="list-style-type: none"> • High - diversification to solar and biogas 		

Economic Infrastructure	<ul style="list-style-type: none"> • Decline in productivity and income in agro-based businesses • Increased cost of goods and services 	High	<p>Sensitivity:</p> <ul style="list-style-type: none"> • High - agriculture-dependent economy <p>Adaptive Capacity:</p> <ul style="list-style-type: none"> • Medium - cooperatives and social safety nets 	High	High
Social Infrastructure	<ul style="list-style-type: none"> • Reduced functionality of social amenities due to dryness • Decline in aesthetics and comfort 	Medium	<p>Sensitivity:</p> <ul style="list-style-type: none"> • Low - facilities remain usable <p>Adaptive Capacity:</p> <ul style="list-style-type: none"> • High -irrigation or rehabilitation possible 	Low	Low
Emergency Services	<ul style="list-style-type: none"> • Increased demand for water trucking and firefighting • Resource strain on response teams 	Medium	<p>Sensitivity:</p> <ul style="list-style-type: none"> • Medium -moderate increase in demand. <p>Adaptive Capacity:</p> <ul style="list-style-type: none"> • High - county emergency units operational 	Medium	Medium
Populations					
Urban Residents	<ul style="list-style-type: none"> • Reduced water availability for domestic use • Increased cost of living and health risks 	Medium	<p>Sensitivity:</p> <ul style="list-style-type: none"> • Medium -dependent on -municipal water. <p>Adaptive Capacity:</p> <ul style="list-style-type: none"> • Medium –storage facilities and drilling of boreholes 	Medium	Medium

Informal Settlement Residents	<ul style="list-style-type: none"> • Acute water scarcity • Poor sanitation and hygiene • Increased disease burden 	High	<p>Sensitivity:</p> <ul style="list-style-type: none"> • High -limited storage and poor access <p>Adaptive Capacity:</p> <ul style="list-style-type: none"> • Low - donor and NGO reliance (KISIP II) 	High	High
Vulnerable and Marginalized Groups	<ul style="list-style-type: none"> • Dehydration, mobility challenges for PWDs, elderly • Health risks 	High	<p>Sensitivity:</p> <ul style="list-style-type: none"> • High — low adaptive ability <p>Adaptive Capacity:</p> <ul style="list-style-type: none"> • Medium — targeted social support . 	High	High
Natural Assets					
Urban Green Infrastructure	<ul style="list-style-type: none"> • Vegetation loss and drying of urban parks • Reduced shading and ecosystem services 	High	<p>Sensitivity:</p> <ul style="list-style-type: none"> • High -dependent on rainfall. <p>Adaptive Capacity:</p> <ul style="list-style-type: none"> • Medium -municipal reforestation 	High	High
Urban Blue Infrastructure	<ul style="list-style-type: none"> • Reduction of Lake Ol Bolossat levels • Loss of aquatic biodiversity • Spread of invasive species 	High	<p>Sensitivity:</p> <ul style="list-style-type: none"> • High - fragile ecosystem <p>Adaptive Capacity:</p> <ul style="list-style-type: none"> • Medium -lake restoration and catchment protection 	High	High
	<ul style="list-style-type: none"> • Crop failure, livestock loss, food insecurity • Decline in farm income 	High	<p>Sensitivity:</p> <ul style="list-style-type: none"> • High - reliant on rainfall agriculture 	High	High

Peri-urban and Agricultural Systems			Adaptive Capacity:		
			<ul style="list-style-type: none"> • Medium-irrigation, crop diversification 		

Table 19: Exposure, Vulnerability, and Impacts of Extreme cold on Urban Elements

Hazard: Extreme cold

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Infrastructure & Services					
Stormwater Drainage	<ul style="list-style-type: none"> • Material damage • Structural stress due to pressure fluctuation. 	Low	<p>Sensitivity:</p> <ul style="list-style-type: none"> • Medium • Infrastructure relatively resilient <p>Adaptive Capacity:</p> <ul style="list-style-type: none"> • High • Improved drainage systems, road networks, and waste management infrastructure 	Medium	Low

Water & Wastewater Management	<ul style="list-style-type: none"> • Reduced microbial activities • Effect on settling • Increased pathogenic risks • Corrosion and blockages 	High	<p>Sensitivity:</p> <ul style="list-style-type: none"> • High • Lack of a common sewer system and a sewerage treatment plant 	High	High
			<p>Adaptive Capacity</p> <ul style="list-style-type: none"> • Low • Residents rely on individual septic tanks 		
Solid Waste Management	<ul style="list-style-type: none"> • Increased fire hazard • Increased decomposition resulting to increased GHGs • Worsened air quality • Operational challenges 	High	<p>Sensitivity:</p> <ul style="list-style-type: none"> • High • Residents in the neighborhood susceptible to poor waste management 	High	Medium
			<p>Adaptive Capacity:</p> <ul style="list-style-type: none"> • Low • Enhanced integrated solid waste management • Lack of an operational public dumpsite. 		

Transport and Mobility	<ul style="list-style-type: none"> • Infrastructural damage • Operational disruption • Health hazard to travellers 	Low	<p>Sensitivity:</p> <ul style="list-style-type: none"> • Low • Limited effect on transport and mobility 	Medium	Medium
			<p>Adaptive Capacity:</p> <ul style="list-style-type: none"> • High • Adaptive to diversified mode of transport 		
Energy	<ul style="list-style-type: none"> • Deforestation • Low temperatures affect solar powered systems. 	High	<p>Sensitivity:</p> <ul style="list-style-type: none"> • High • Majority of the residents are dependent on wood fuel as a primary source of energy 	High	High
			<p>Adaptive Capacity:</p> <ul style="list-style-type: none"> • medium • Diversified energy sources 		
Economic Infrastructure	<ul style="list-style-type: none"> • Damage of infrastructure • Operational slowdown • Economic losses 	High	<p>Sensitivity:</p> <ul style="list-style-type: none"> • Medium • • 	Medium	Medium

			Adaptive Capacity: <ul style="list-style-type: none"> • low • ... 		
Social Infrastructure	<ul style="list-style-type: none"> • Damage of infrastructure • Increased energy demand for cool and heating 	Medium	Sensitivity: <ul style="list-style-type: none"> • Medium • Social infrastructure not relied upon by majority of the urban residents 	Medium	Medium
			Adaptive Capacity: <ul style="list-style-type: none"> • High • Alternative available 		
Emergency Services	<ul style="list-style-type: none"> • Unexpected incidences • 	Low	Sensitivity: <ul style="list-style-type: none"> • Medium • Emergency services due to extreme temperatures are not frequent. 	Low	Low
			Adaptive Capacity: <ul style="list-style-type: none"> • Surveillance and early warning • Deployment of emergency resources • Multi stakeholder coordination 		
Populations					
Urban Residents	<ul style="list-style-type: none"> • Health hazards • Increased mortality risks • Impacts on infrastructure • Mental health 	High	Sensitivity: <ul style="list-style-type: none"> • High • Many cases of Arthritis among the residents 	High	High

	<ul style="list-style-type: none"> Immigration 		<p>Adaptive Capacity:</p> <ul style="list-style-type: none"> Limited Majority of urban residents are opting to migrate to warmer Naivasha areas. 		
Informal Settlement Residents	<ul style="list-style-type: none"> Increased heat and cold stress Worsened air quality Health problems Increased risks from electrical faults Fire hazards Mental health 	High	<p>Sensitivity:</p> <ul style="list-style-type: none"> High Poor housing condition <p>Adaptive Capacity:</p> <ul style="list-style-type: none"> Limited Poor resource households and livelihoods not reliable 	High	High
Vulnerable and Marginalized Groups	<ul style="list-style-type: none"> Increased illness and mortality Disproportionate impact Mental health Reduced productivity Maladaptation 	High	<p>Sensitivity:</p> <ul style="list-style-type: none"> High Affected by extreme cold and high temperatures affecting their mobility <p>Adaptive Capacity:</p> <ul style="list-style-type: none"> Limited Mobility and resilience affected due to their independence 	High	High

Natural Assets

Urban Green Infrastructure	<ul style="list-style-type: none"> • Reduced cooling effect • Increased stress 	Low	<p>Sensitivity:</p> <ul style="list-style-type: none"> • Low • Little to no effect on urban infrastructure <p>Adaptive Capacity:</p> <ul style="list-style-type: none"> • Medium • Few green spaces in the Municipality 	Low	Low
Urban Blue Infrastructure	<ul style="list-style-type: none"> • No blue infrastructure 	low	<p>Sensitivity:</p> <ul style="list-style-type: none"> • low • Not applicable <p>Adaptive Capacity:</p> <ul style="list-style-type: none"> • Low • No blue infrastructure in the Municipality 	Low	Low
Peri-urban and Agricultural Systems	<ul style="list-style-type: none"> • Reduced crop production • Increased stress for both crops and farmworkers 	Medium	<p>Sensitivity:</p> <ul style="list-style-type: none"> • High • Crop productivity affected by extreme cold temperatures <p>Adaptive Capacity:</p> <ul style="list-style-type: none"> • High • Crop and livelihood diversification 	Medium	Medium

Table 19. Exposure, Vulnerability, and Impacts of Frost on Urban Elements

Hazard: Frost

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Infrastructure & Services					
Stormwater Drainage	Drainage system present, cool climate but freezing events not extremely common in Engineer Municipality	Very Low	<p>Sensitivity:</p> <ul style="list-style-type: none"> • Medium • Weak drainage infrastructure, blockages, unplanned settlements especially on encroachment of Aberdare Forest increase susceptibility <p>Adaptive Capacity:</p> <ul style="list-style-type: none"> • High • Occurrence rarely affect the storm water drains 	Low	Low

Water & Wastewater Management	Non-negligible exposure to freeze/frost risk	Moderate	<p>Sensitivity</p> <ul style="list-style-type: none"> • High • Pipes, storage tanks, pumps in boreholes can be damaged by freezing • Low temperatures conditions can slow down biological processes in waste water treatment 	Moderate	Moderate
Solid Waste Management	Frequency and intensity of frost hazards on solid waste is relatively low	Moderate	<p>Sensitivity:</p> <ul style="list-style-type: none"> • High • Vehicles (waste becoming frozen in trucks) and workers operating in frost conditions may face higher risks <p>Adaptive Capacity:</p> <ul style="list-style-type: none"> • High • Ensuring that the pipelines are buried deeper below the frost line 	High	High

			<ul style="list-style-type: none"> Limited infrastructure resilience for frost-specific risk 		
Transport and Mobility	Most roads in Engineer Municipality are earthed or lightly surfaced hence become susceptible to adverse effects of col/freeze	High	<p>Sensitivity:</p> <ul style="list-style-type: none"> High Unpaved roads which are susceptible to cracking of surfaces, surface water freezing Mobility is affected by slippery surfaces, freeze of puddles, early morning ice 	High	High
			<p>Adaptive Capacity:</p> <ul style="list-style-type: none"> High Improvement of infrastructure plans and purchased road machinery to improve roads in conjunction with the County 		

Energy	Reliance on renewable energy-solar panels covered by frost, batteries subjected to low temperatures	Moderate	<p>Sensitivity:</p> <ul style="list-style-type: none"> • High • Solar panels and batteries maybe less efficient at very low temperatures • Transformers, poles, cables and rural electrification maybe sensitive to extreme temperatures <p>Adaptive Capacity</p> <ul style="list-style-type: none"> • Moderate • Specific frost resilience is limited 	High	High
Economic Infrastructure	Storage facilities (coolers)processing units, market buildings and value chain infrastructure	Moderate	<p>Sensitivity:</p> <ul style="list-style-type: none"> • High • Damage of stored crops, freezing of water in processing and cleaning systems • Less comfortable environment for traders and customers <p>Adaptive Capacity:</p> <ul style="list-style-type: none"> • High 	High	High

			<ul style="list-style-type: none"> • Construction of a modern market that will be environmentally friendly 		
Social Infrastructure	Schools, health centres, community halls-poorly insulated walls/roofs, single-glazed windows	High	<p>Sensitivity:</p> <ul style="list-style-type: none"> • High • Limited maintenance whereby there's lack of heating/insulation/frost-protection measures <p>Adaptive Capacity:</p> <ul style="list-style-type: none"> • Low • Budget constrains-competing priorities hence frost specific adaptive actions may not be considered 	High	High
Emergency Services	Ambulances, fire and rescue vehicles are affected by slippery surfaces, freezing of water, reduced vehicle traction	Moderate	<p>Sensitivity:</p> <ul style="list-style-type: none"> • High • Access delays because of frost on roads or frozen trucks 	Low	Low

			Adaptive Capacity: <ul style="list-style-type: none"> • Low • Little evidence that emergency services have dedicated frost preparedness plan 		
Populations					
Urban Residents	Human health-increased respiratory illnesses	High	Sensitivity: <ul style="list-style-type: none"> • High • Increased discomfort, increased heating costs, cold indoor conditions 	High	High
			Adaptive Capacity: <ul style="list-style-type: none"> • High • Cold weather adaptation (insulation, heating, awareness) 		
Informal Settlement Residents	Less well constructed, less insulated houses increase health risks	High	Sensitivity: <ul style="list-style-type: none"> • High • Lack of insulation, minimal heating, thin walls that may leak cold air hence increase cold stress 	High	High

			Adaptive Capacity: <ul style="list-style-type: none"> • Low • Some are coping but there's limited formal infrastructure support and limited resources 		
Minority and Vulnerable Groups	Resource poor households, persons living with disabilities, the elderly and children-their bodies may have reduced ability to regulate temperature, increased risk of respiratory and circulatory problems	High	Sensitivity: <ul style="list-style-type: none"> • High • Lower income, less secure housing, poorer insulation, less access to heating 	High	High
			Adaptive Capacity: <ul style="list-style-type: none"> • High • Community health awareness through mobile clinics by CHVs • Warm clothing to children and school going children 		
Natural Assets					
Urban Green Infrastructure	Damage on tree seedlings, trees, grass and degradation	Moderate	Sensitivity: <ul style="list-style-type: none"> • High • Freezing of vegetation 	Moderate	High

			<p>Adaptive Capacity:</p> <ul style="list-style-type: none"> • High • Establishment of more resilient plant species 		
Urban Blue Infrastructure	<p>Freezing may cause cracking of slabs thus leading to faster deterioration of storm drains</p> <p>Frost reduce biological activities in water hence affect aquatic life in rivers and dams</p>	High	<p>Sensitivity:</p> <ul style="list-style-type: none"> • High • Underdevelopment prone blockages • Reduced oxygen increases turbidity 	High	High
			<p>Adaptive Capacity:</p> <ul style="list-style-type: none"> • Low • Drainage systems not designed for frost resilience 		
Peri-urban and Agricultural Systems	<p>Damage of crops, soil and agricultural infrastructure</p> <p>Agricultural yield reduction</p>	High	<p>Sensitivity:</p> <ul style="list-style-type: none"> • High • Young and sick animals and plants are more sensitive to cold stress 	High	High

			<p>Adaptive Capacity:</p> <ul style="list-style-type: none">• High• Agricultural extension services awareness on frost risks		
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CHAPTER FOUR

4. Climate Risk Assessment

The Engineer Municipality Climate Risk Assessment examines the current and projected climate-related hazards affecting the area, including floods, droughts, frost and extreme cold. This assessment aims to identify the municipality’s key vulnerabilities and the potential impacts of these hazards on livelihoods, infrastructure, and essential services. The findings provide a foundation for informed decision-making, guiding the development of effective adaptation and resilience strategies to safeguard the community and support sustainable urban growth.

For this Urban Climate Risk Profile, tables 23 to table 26 should be interpreted in line with provisions in table 21, which summarizes overall risk for each urban element by combining the assessed hazard level and the estimated impact level and table 22 which presents how to interpret risk levels..

Table 21: 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

Table 22. Interpretation of risk levels

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

4.1. Current and Future Climate Risks on Urban Elements

Table 23: Summary of Floods risks for Engineer 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
Infrastructure & Services						
Stormwater Drainage	High	High	High	Very High	Very High	Very High
Water & Wastewater Management	High	High	High	Very High	Very High	Very High
Solid Waste Management	High	High	High	Very High	Very High	Very High
Transport and Mobility	Medium	Medium	High	High	Very High	Very High
Energy	Low	Low	Low	Medium	Medium	High
Economic Infrastructure	Medium	Medium	High	High	Very High	Very High
Social Infrastructure	Low	Low	Medium	Medium	High	High

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

Table 24: Summary of Drought risks for Engineer 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
Infrastructure & Services						

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

Table 25: Summary of Extreme cold temperatures risks for Engineer 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	
Infrastructure & Services							
Stormwater Drainage	Low	Low	Low	Medium	Medium	High	
Water & Wastewater Management	High	Medium	Medium	Medium	Medium	Medium	
Solid Waste Management	Medium	Medium	Medium	High	High	High	
Transport and Mobility	Medium	Medium	Medium	Medium	High	High	
Energy	High	Medium	Medium	Medium	Medium	Medium	
Economic Infrastructure	Medium	Medium	Medium	Medium	High	High	
Social Infrastructure	Medium	Medium	Medium	Medium	Medium	Medium	
Emergency Services	Low	Low	Low	Low	Low	Low	
Populations							
Urban Residents	Low	Medium	Medium	Medium	Medium	Medium	
Informal Settlement Residents	High	High	High	High	Very High	Very High	
Vulnerable and Marginalized Groups	High	High	High	High	Very High	Very High	
Natural Assets							

Urban Green Infrastructure	Low	Low	Low	Medium	Medium	High
Urban Blue Infrastructure	Low	Low	Low	Medium	Medium	High
Peri-urban and Agricultural Systems	Medium	Medium	Medium	High	High	Very High

Table 26: Summary of Frost risks for Engineer Municipality

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

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

4.2. Climate Risk Hotspots

Engineer Municipality is exposed to multiple climatic hazards, notably floods, droughts, extreme cold temperatures, and frost. These hazards already affect infrastructure, livelihoods, and natural systems, and are projected to intensify by 2050 and 2100 under both SSP2-4.5 (moderate) and SSP5-8.5 (high) emission scenarios.

Spatial Distribution of Climate Risks

The severity of climate risks varies across the municipality's wards:

- **Engineer Ward:**

This is the main urban and commercial hub, characterized by high population density and extensive built-up areas. Flood risk is very high, particularly in low-lying zones with inadequate stormwater drainage. Urban infrastructure such as roads, drainage, and waste systems experience frequent flooding events. Drought risk is moderate due to dependence on piped water and groundwater sources, while frost and extreme cold events occasionally disrupt mobility and small-scale horticulture.

- **North Kinangop Ward:**

Located in higher elevation zones, this area experiences severe frost and cold

temperature impacts, affecting agricultural productivity and local water systems. Flood risks are moderate due to better drainage, but drought risk remains high, especially during prolonged dry spells impacting livestock and irrigation-dependent farmers.

- **Gathara Ward:**

This ward is highly sensitive to flooding and drought, with rural settlements and agricultural areas exposed to alternating water extremes. Poor soil drainage and deforestation around riparian zones increase flood vulnerability. The area's economic infrastructure and agricultural systems face very high flood and drought risks by 2050 and beyond.

- **Murungaru Ward:**

Experiences recurrent frost and cold temperature stress, which threatens vegetable and dairy production. The frost hazard is projected to rise sharply under SSP5-8.5 by 2100. Flood risk is moderate, but drought impacts on water availability and crops are expected to intensify.

Key Risk Hotspots

- **Flood-prone zones:** Central Engineer town, Gathara river valleys, and parts of North Kinangop with poor drainage.
- **Drought-sensitive zones:** North Kinangop and Murungaru's agricultural belts.
- **Cold and frost hotspots:** Northern and higher altitude parts of North Kinangop and Murungaru.
- **Vulnerable populations:** Informal settlement residents and marginalized groups across Engineer and Gathara wards consistently face high to very high risk levels due to exposure and low adaptive capacity.

Temporal Trends

- **Current (Baseline):** Floods and droughts already pose high risks to infrastructure and livelihoods.
- **2050 (SSP2-4.5 & SSP5-8.5):** Flood and drought risks increase, with cold and frost events expanding in range.
- **2100 (SSP5-8.5):** Nearly all hazard categories reach very high risk levels, particularly for informal settlements, agriculture, and natural assets such as green infrastructure.

CHAPTER FIVE

5. What's Next?

In this chapter is a summary of key findings, and recommended climate adaptation and resilience solutions for Engineer Municipality.

5.1. Key Findings

During Stakeholder engagement and data collection as outlined in the Engineer Municipality RCRA, the following key hazards came out strongly;

- Floods
- Drought
- Extreme cold temperatures
- Frost

These hazards occur frequently affecting different sections of the municipality differently. Floods affect the informal sectors, exposing them to health risks as well as disrupting their livelihoods. The larger part of the Municipality practices Agriculture which is negatively affected by both floods and drought. Crop destruction leading to crop failure as a result of flooding is a serious phenomena affecting the Municipality. Drought also exacerbates crop failure due to water shortage. Death of livestock has also been witnessed leading to the disruption of people's economic activities and livelihoods.

Critical assets like road networks are adversely affected by floods affecting the vulnerable groups within the municipality especially PLWD, School going children, resource poor households and the elderly

According to KMD, it is projected that the frequency of both flooding and droughts will increase, affecting critical infrastructure assets. In realization of the above this RCRA aims at addressing key climate interventions to mitigate the impacts associated with the two hazards.

Table 27: Summary of climate risks affecting urban elements for Engineer Municipality

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

5.2. Climate Adaptation and Resilience Solutions

Table 28: Climate adaptation and resilience solutions recommended for Engineer Municipality

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
Infrastructure & Services			
Stormwater Drainage	Unclogging of blocked drains and continuous surveillance	Climate proofing the drains by allowing excessive water to percolate to the ground enhancing underground recharge	Construction of dams and reservoirs to store excess storm water for future use.
Water & Wastewater Management	Enhance surveillance and maintenance of water and waste water infrastructure Continuous capacity development of community members on Community water projects governance and management	Enhanced integration of real time tracking and monitoring systems. Maximizing sewerage connectivity within Engineer town	Development of a comprehensive Water and Waste Water Master Plan Development of sewer systems across other market centers within the municipality
Solid Waste Management	Purchase of Skip loader Development of relevant policies	Develop the dumping site and ensure compliance with NEMA in waste management and transportation	Develop a sustainable Landfill Enhance capacity of the residents to improve on waste handling at the source

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
Transport and Mobility	Improving Drainage Channels Developing climate proofed non motorized walkways	Climate Proofing the transport infrastructure to enhance resilience and sustainability Greening and creating urban spaces to regulate urban heat island	Climate Proofing the transport infrastructure to enhance resilience and sustainability Greening and creating urban spaces to regulate urban heat island Enhancing the Sponge City Concept to allow
Energy	Advocating for alternative sources of energy	Developing alternative energy for the Municipality especially utilization of the available solar energy	Integrating Renewable energy into municipality development and developing a solar mini grid for the municipality
Economic Infrastructure	Capacity building Municipality residents to understand the power of diversifying economic ventures	Use of climate proofed materials for developing the infrastructures like markets.	Integration of economic infrastructure in the climate screening and planning
Emergency Services	Institutionalizing Emergency services within the Municipality systems, plans, projects and programs	Developing hotline numbers to enhance emergency response	Develop an emergency response strategy and emergency department within the municipality
Populations			

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
Informal Settlement Residents	Enhancing climate proofed projects like road network and drainage channels amongst others	Continuous engagement of the informal sectors in key decision making and implementation	Working to formally formalize the informal sectors noting key climate hotspots within the settlement
Vulnerable and Minority Groups	Providing a conducive climate resilient opportunity for the engagement and participation of VMGs	Providing Climate proofed opportunities allowing the integration of VMGs within the municipality	Develop and implement a framework on VMGs
Natural Assets			
Urban Green Infrastructure	Enhancing Nature Based Solutions within the urban infrastructure	Enhancing the Sponge city approach to allow water percolation while enhancing aesthetic beauty. Enhancing and implementing the green building codes to allow sustainability	Increasing Green urban spaces Enhancing and implementing the green building codes to allow sustainability
Urban Blue Infrastructure	Developing water storage systems to enhance urban agriculture	Developing water storage systems to enhance urban agriculture	Developing water storage systems to enhance urban agriculture
Peri-urban and Agricultural Systems	Integration of Climate Smart Agriculture within the peri urban areas.	Developing water storage systems to enhance urban agriculture	Zonation of key areas within the municipality

Bibliography

Global Center on Adaptation (GCA). (2025). *Urban Climate Risk Profile: Preparation Guidelines*. Global Center on Adaptation, Rotterdam.

Government of Kenya. (2010). *The Constitution of Kenya*. Government Printer, Nairobi.

Government of Kenya. (2016). *Climate Change Act, No. 11 of 2016*. Government Printer, Nairobi.

Government of Kenya. (2023). *National Climate Change Action Plan (NCCAP) 2023–2027*. Ministry of Environment, Climate Change and Forestry, Nairobi.

Kenya Meteorological Department (KMD). (2024). *Observed and Projected Climate Data for Nyandarua County*. KMD, Nairobi.

Kenya National Bureau of Statistics (KNBS). (2019). *2019 Kenya Population and Housing Census*. KNBS, Nairobi.

Nyandarua County Government. (2023). *County Integrated Development Plan (CIDP) 2023–2028*. Nyandarua County Government,

Nyandarua County Government. (2023). *Nyandarua County Climate Change Action Plan (2023-2027)*

Nyandarua County Government. (2025). *Draft Integrated Strategic Urban Development Plan (ISUDP) 2025–2035 for Engineer Municipality*. Nyandarua County Government.

World Bank Group. (2021). *Climate Risk Country Profile: Kenya*. World Bank, Washington, DC

Annex N1: Historical Climate Hazard Events

Purpose:

This annex documents significant climate-related hazard events that have affected Engineer Municipality over the past decade. The information supports the hazard assessment in Chapter Two and validates stakeholder-reported risks.

Table N1.1: Historical Climate Hazard Events in Engineer Municipality (2015–2025)

Hazard Type	Date / Period	Location	Intensity & Description	Key Impacts
Flooding	Apr–May 2018 Mar–Apr 2020 Mar–Apr 2024	Municipality-wide especially towns of Engineer and Ndunyu Njeru	Prolonged heavy rainfall causing riverine and surface flooding	<ul style="list-style-type: none"> Displacement of households Infrastructural damages including roads and drainages Post-harvest crop losses
Drought	2016–2017 Short occurrences between Dec and February of every year	Municipality-wide	Extended rainfall deficit and high evapotranspiration	<ul style="list-style-type: none"> Water shortages Crop failure Livestock losses Soil degradation he reduced agricult productivity