URBAN CLIMATE RISK PROFILE

FOR

MUNICIPALITY OF EMBU

2025

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Foreword

Climate change poses an increasing challenge to sustainable urban development, affecting livelihoods, infrastructure, ecosystems and the overall well-being of residents. Municipality of Embu, as a growing urban center and economic hub, is increasingly exposed to climate-related risks such as droughts, flooding, and extreme weather events, which threaten development gains and strain public services.

This Climate Risk Profile provides a comprehensive assessment of the municipality's climate hazards, exposure and vulnerabilities, and highlights priority areas for action to strengthen resilience. It is intended to support informed decision-making by county and municipal authorities, development partners, the private sector, and communities by integrating climate risk considerations into planning, investment, and service delivery.

The preparation of this profile reflects a collaborative effort involving technical officers, stakeholders, and community representatives, whose contributions are gratefully acknowledged. It is our expectation that this document will serve as a practical tool to guide climate-resilient development, enhance adaptive capacity, and promote a safe, inclusive, and sustainable future for Municipality of Embu.

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CECM for Urban Development

Executive Summary

This Rapid Climate Risk Assessment (RCRA) for Embu Municipality evaluates current and future climate hazards, exposure, vulnerability, and risks to urban systems, populations, and natural assets. The objective is to inform climate-resilient urban planning and investment decisions.

Objective(s) of the rapid climate risk assessment,

This Urban Climate Risk Profile aims to:

- To guide development of policies and strategies that address current and future climate risks at the municipality level.
- To inform development controls standards for sustainable development.
- To guide development plans by adoption of programs and projects that integrate resilience measures.
- To facilitate planning and implementation of climate resilient infrastructure that withstand current and future climate impacts and minimizes climate risks for citizens.

- **List of key hazards identified,**
  - Pluvial (surface level) flooding, including flash flooding and urban flooding
  - Fluvial (river) flooding
  - Drought (meteorological, hydrological)
  - Gully erosion
  - Changes in precipitation patterns
  - Average surface temperature increase
- **Key takeaways on what can be done to mitigate the higher risks.**

- The climate risk assessment for the Municipality of Embu identifies pluvial flooding, fluvial flooding, and drought as the key climate hazards affecting the urban area, with pluvial flooding emerging as the most significant long-term risk.
- While most hazards currently present low risk levels, future projections, particularly toward 2100, indicate increasing risks for stormwater drainage systems, solid waste management infrastructure, and informal settlement residents, especially under pluvial flooding scenarios. Informal settlements such as Grogon, Kathangari, and Shauri Moyo are disproportionately affected due to inadequate drainage, poor housing conditions, and limited access to basic services.
- Drought poses persistent medium-level risks to water and wastewater management systems and urban green infrastructure, with implications for water security and ecosystem health. Overall, the findings highlight the need for proactive, climate-resilient planning,

strengthened infrastructure maintenance, and targeted interventions for vulnerable populations to prevent escalation of future climate risks.

- **Risk results summary filled for each key hazard**

Table 1: Summary of Pluviual risks for Municipality of Embu

	Time Horizon & Climte Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level	Low	Low	Low	Low	Medium
				Risk Levels		
Categories	**Impact**	**Current**	**2050 SSP2-4.5**	**2050 SSP5-8.5**	**2100 SSP2-4.5**	**2100 SSP5-8.5**
Infrastructure & Services						
Stormwater Drainage	Major	Medium	Medium	Medium	Medium	High
Water & Wastewater Management	Insignificant	Very Low	Very Low	Very Low	Very Low	Low
Solid Waste Management	Major	Medium	Medium	Medium	Medium	High
Transport and Mobility	Moderate	Low	Low	Low	Low	Medium
Economic Infrastructure	Insignificant	Very Low	Very Low	Very Low	Very Low	Low
Social Infrastructure	Moderate	Low	Low	Low	Low	Medium
Emergency Services	Insignificant	Very Low	Very Low	Very Low	Very Low	Low
Populations						
Informal Settlement Residents	Major	Medium	Medium	Medium	Medium	High

Vulnerable and Marginalized Groups	Moderate	Low	Low	Low	Low	Medium
Natural Assets						
Urban Blue Infrastructure	Insignificant	Very Low	Very Low	Very Low	Very Low	Low

Table 2: Summary of Fluvial flooding risks for Municipality of Embu

	Time Horizon & Climate Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level	Low	Low	Low	Low	Medium
				Risk Levels		
Categories	**Impact**	**Current**	**2050 SSP2-4.5**	**2050 SSP5-8.5**	**2100 SSP2-4.5**	**2100 SSP5-8.5**
Infrastructure & Services						
Water & Wastewater Management	Minor	Low	Low	Low	Low	Low
Solid Waste Management	Insignificant	Very Low	Very Low	Very Low	Very Low	Low
Transport and Mobility	Minor	Low	Low	Low	Low	Low
Economic Infrastructure	Insignificant	Very Low	Very Low	Very Low	Very Low	Low
Emergency Services	Moderate	Low	Low	Low	Low	Medium
Populations						
Informal Settlement Residents	Minor	Low	Low	Low	Low	Low

Vulnerable and Marginalized Groups	Insignificant	Very Low	Very Low	Very Low	Very Low	Low
Natural Assets						
Urban Green Infrastructure	Insignificant	Very Low	Very Low	Very Low	Very Low	Low
Urban Blue Infrastructure	Minor	Low	Low	Low	Low	Low

Table 3: Summary of Drought risks for Municipality of Embu

	Time Horizon & Climate Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level	Low	Low	Low	Low	Low
				Risk Levels		
Categories	**Impact**	**Current**	**2050 SSP2-4.5**	**2050 SSP5-8.5**	**2100 SSP2-4.5**	**2100 SSP5-8.5**
Infrastructure & Services						
Water & Wastewater Management	Major	Medium	Medium	Medium	Medium	Medium
Transport and Mobility	Insignificant	Very Low	Very Low	Very Low	Very Low	Very Low
Economic Infrastructure	Insignificant	Very Low	Very Low	Very Low	Very Low	Very Low
Social Infrastructure	Insignificant	Very Low	Very Low	Very Low	Very Low	Very Low
Populations						
Urban Residents	Insignificant	Very Low	Very Low	Very Low	Very Low	Very Low

Vulnerable and Marginalized Groups	Moderate	Low	Low	Low	Low	Low
Natural Assets						
Urban Green Infrastructure	Major	Medium	Medium	Medium	Medium	Medium
Urban Blue Infrastructure	Minor	Low	Low	Low	Low	Low
Peri-urban and Agricultural Systems	Minor	Low	Low	Low	Low	Low

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List of Acronyms

CBD	Central Business District
CBO	Community-Based Organization
EWASCO	Embu Water & Sanitation Company
RCRA	Rapid climate risk assessment
MoE	Municipality of Embu
ECG	Embu County Government
FLLoCA	Financing Locally-Led Climate Action
GIS	Geographic Information System
ICTA	Information and Communications Technology Authority
ISUDP	Integrated Strategic Urban Development Plan
KENHA	Kenya National Highways Authority
KERRA	Kenya Rural Roads Authority
KISIP	Kenya Informal Settlements Improvement Project
KMD	Kenya Meteorological Department
KNBS	Kenya National Bureau of Statistics
KURA	Kenya Urban Roads Authority
KPLC	Kenya Power and Lighting Company
NCA	National Construction Authority
NDMA	National Drought Management Authority Act
NEMA	National Environment Management Authority
NGANWASCO	Ngandori Water & Sanitation Company PLC
PWD	People With Disabilities
RCRA	Rapid Climate Risk Assessment
SSP	Shared Socio-Economic Pathways
UTaNRMP	Upper Tana Catchment Natural Resources Management Project
WRA	Water Resources Authority

Table 4: List of Acronyms

1. Context

1.1. Objective

This Urban Climate Risk Profile aims to:

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

1.1.1. Urban Context

1.1.2. Geographic area

Embu Municipality is located in Embu County, eastern Kenya, on the southeastern slopes of Mt. Kenya. It includes dense urban wards and peri-urban agricultural zones.

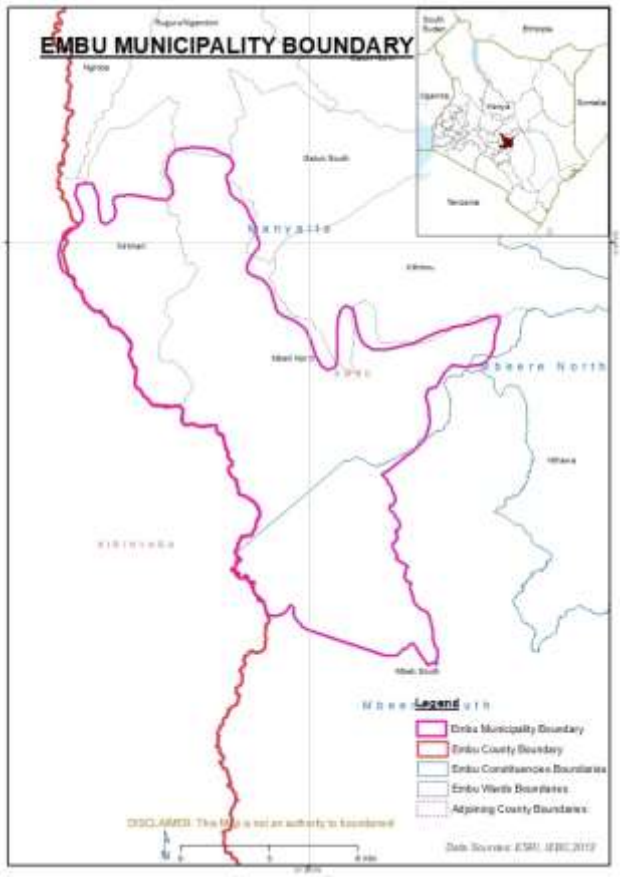

Figure 1: Embu Municipality Boundary Map

1.1.3. Governance Structure

The governance structure of Embu Municipality operates within the devolved system of government established under the Constitution of Kenya, 2010, and functions under the authority of the County Government of Embu. The municipality is administered by a Municipal Board, which provides oversight and policy guidance, and is responsible for promoting efficient service delivery, public participation, and sustainable urban development. Day-to-day operations are managed by the Municipal Manager, supported by technical and administrative departments aligned with county sector functions such as planning, environment, public works, health, and finance. The governance framework emphasizes transparency, accountability, interdepartmental coordination, and citizen engagement in decision-making processes.

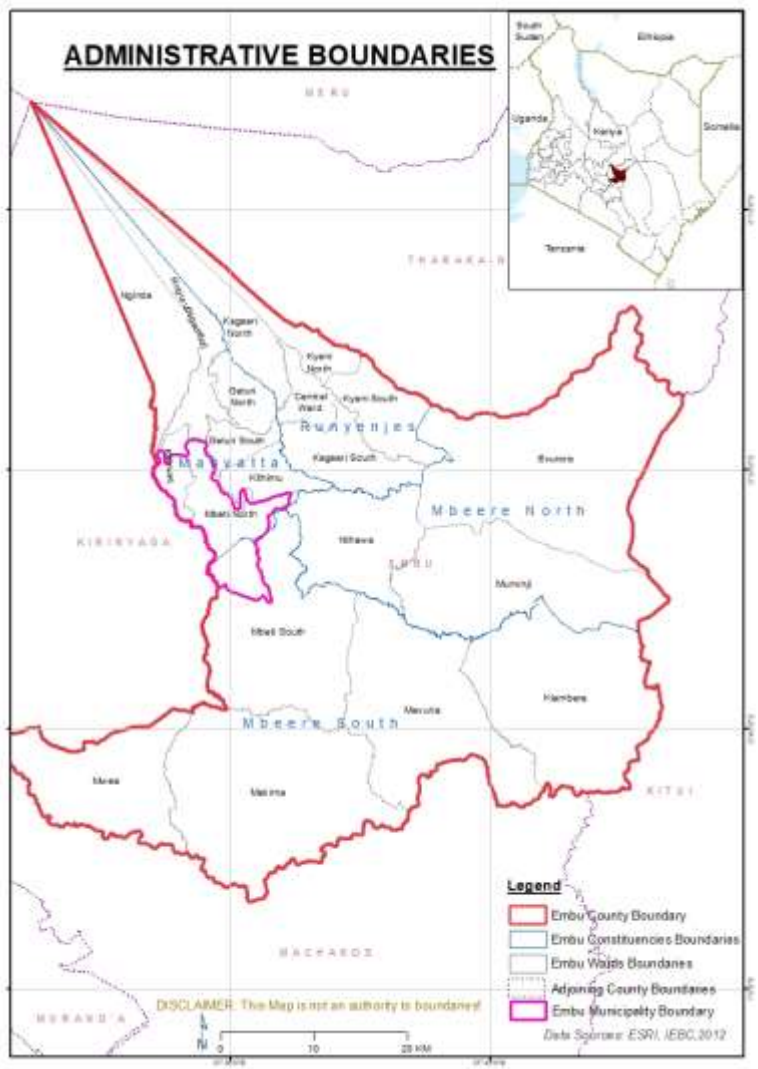

Figure 2: Administrative Boundaries Map

1.1.4. Socio-economic Context

The socio-economic context of Embu Municipality is characterized by a mixed urban and peri-urban economy driven mainly by trade, education, agriculture, and small-scale manufacturing. The municipality serves as a commercial and administrative hub for the surrounding rural areas, supporting a diverse population engaged in formal and informal employment. Agriculture—particularly coffee, tea, and food crop production—remains a key livelihood activity in the peri-urban zones, while trade and service industries dominate the urban core. The presence of learning institutions stimulates demand for housing, transport, retail, and other social services. Despite steady economic activity, sections of the population face challenges related to unemployment, informal settlements, and access to adequate infrastructure and social amenities, shaping the overall socio-economic dynamics of the municipality.

1.1.5. Economic Context

The economy of Embu Municipality is primarily driven by trade, education, agriculture—particularly coffee, tea, and food crop production—and small-scale manufacturing, all of which play a central role in employment creation and income generation. Commercial activities are concentrated within the central business district and surrounding markets, while the presence of educational institutions supports service industries such as housing, retail, and transport. Agricultural activities in the surrounding hinterlands supply raw materials and food to the municipality, strengthening rural–urban linkages, while small-scale manufacturing and agro-processing contribute to value addition and local economic growth.

1.1.6. Land-use Context

The land use context of Embu Municipality reflects a mix of urban, peri-urban, and agricultural uses shaped by rapid population growth and urbanization. The central areas are predominantly characterized by commercial, institutional, and high-density residential developments, while surrounding zones comprise low- to medium-density residential areas, public utilities, and social infrastructure such as schools, health facilities, and administrative offices. Peri-urban areas support agricultural activities, including coffee, tea, and food crop farming, which coexist with emerging residential developments. Open spaces, riparian reserves, and environmentally sensitive areas are present but face increasing pressure from development, underscoring the need for integrated land use planning to promote orderly growth and sustainable land management.

1.2. Key Stakeholders & Inclusiveness

Stakeholder engagement in Municipality of Embu is carried out through periodic surveys, stakeholders' fora and focus group discussions.

High Influence – Low Interest	**High Influence – High Interest**
• KERRA • Ministry of Interior and National Administration-County Commissioner • WRA • EWASCO • KPLC • Kenya Meteorological Department • NGANWASCO • Rupingazi Weru Irrigation Scheme • Wimwaro Fm • Mwendani Fm • Inooro Fm • Ngemi Fm • Kimuri Fm	• County Governor • County Executive • County Government Departments- Water, Climate Change Unit, Disaster Risk Management, Agriculture • Members of the County Assembly • Municipal Manager • Municipal Board • State department for Urban Development • Council of Governors • NEMA • NCA • NDMA • KURA • KENHA
Low Influence – Low Interest	**Low Influence – High Interest**
• Faith Based Organizations	• Development partners • Institutions of higher learning • Community Based Organizations (CBO) • Embu Chambers of Commerce

Table 5: Stakeholder mapping for Municipality of Embu

2. Hazard Assessment

A climate hazard assessment identifies and analyzes the probability, intensity, and location of climate-related events, such as floods, droughts, and extreme temperatures. It is a key component of a broader climate risk assessment, which also considers a community's vulnerability and exposure to these hazards, ultimately informing climate change adaptation strategies and plans.

2.1. Key Climate Hazards

Table 6: Hazard screening for Municipality of Embu

Hazard	Hazard Likely (Y/N)	Significant Impact (Y/N)	High Priority (Y/N)	Key Hazard (Y/N)
Heat Stress				
Average surface temperature increase	Y	Y	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	Y
Waterlogging	Y	N	N	N
Water Stress				
Drought (meteorological, hydrological)	Y	Y	Y	Y
Mass Movement				
Gully erosion	Y	Y	N	N

** These hazards, if present, can be highly impactful and are therefore included in the screening step, as they may significantly influence the urban planning informed by this urban climate risk profile.*

2.2. Climate Indicators and Hazard Thresholds

Table 7: Climate indicators and hazard thresholds selected for the assessment

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

2.3. Current Hazard Levels and Climate Projections

Table 8: Current and future hazards levels for Municipality of Embu

	Hazard Level				
Hazard	**Current (Baseline)**	**2050 SSP2-4.5**	**2050 SSP5-8.5**	**2100 SSP2-4.5**	**2100 SSP5-8.5**
Pluvial (surface level) flooding, including flash flooding and urban flooding	LOW	low	low	low	medium
Fluvial (river) flooding	LOW	Low	Low	low	medium

Drought (meteorological, hydrological)	LOW	Low	Low	Low	Low

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

Table 9: Interpretation of hazard levels

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

2.4. Current and Future Hazard Impact Areas

3. Exposure & Vulnerability Assessment

The exposure and vulnerability assessment for Embu Municipality indicates that communities, infrastructure, and economic activities are increasingly exposed to environmental and climate-related risks due to rapid urbanization and changing land use patterns. Flood-prone areas, particularly along river corridors and low-lying zones, expose settlements, roads, and drainage systems to periodic flooding, while steep slopes are vulnerable to soil erosion and landslides. Vulnerability is heightened among low-income households, informal settlements, and small-scale traders who have limited capacity to cope with and recover from shocks. Inadequate drainage, pressure on social services, and reliance on climate-sensitive livelihoods such as agriculture further increase susceptibility, emphasizing the need for targeted risk reduction and resilience-building measures.

3.1. Urban Elements

Table 10: Urban elements inventory

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
Infrastructure & Services				
Stormwater Drainage	Stormwater drainage conveyance network	Y	Y	Storm water drainage network for Dallas and Moi Stadium areas.
	Stormwater storage	N	N	N/A
Water & Wastewater Management	Pumping stations	N	N	N/A
	Groundwater abstraction	Y	Y	Public and private boreholes
	Water treatment facilities	Y	Y	Ewasco-Kangaru storage tanks and treatment facility.
	Water supply networks	Y	Y	Ewasco, Nganwasco, Rupingazi Weru networks
	Sewer networks	Y	Y	Ewasco serving Embu Town

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Wastewater treatment facilities	Y	Y	EWASCO-Old stadium and Emma
Solid Waste Management	Transfer facilities	N	N	N/A
	Landfills and dump sites	Y	Y	Kangunga Dumpsite
	Recycling centers	N	N	N/A
	Collection fleet	Y	NA	County Government and Private Waste management vehicles.
Transport and Mobility	Road networks	Y	Y	Tarmac and gravel roads
	Bridges	Y	Y	Bridges and box culverts
	Public transport networks (rail, bus, mini-bus, etc.)	Y	Y	Bus, tuktuk, boda-boda, taxi and minibus
	Transportation terminals	Y	Y	Bus parks 1st ,2nd and 3rd
	Vehicle depots	Y	Y	3 Vehicle yards
	Non-motorized transport networks	Y	Y	2 pedestrian walkways
	Freight and logistics hubs	N	N	NA
Energy	Energy power plants	N	N	NA
	Poles and power lines	Y	N	KPLC
	Transformers and substations	Y	N	KPLC
	Streetlighting	Y	N	County government
Economic Infrastructure	Markets	Y	N	National government and County Government.
	Businesses and commercial hubs	Y	N	Private businesses
	Industrial zones/parks and logistics parks	Y	Y	Embu ISUDP.

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
Social Infrastructure	Government buildings and service centers	Y	Y	National and county government
	Education facilities	Y	Y	Public Institutions
	Healthcare facilities	Y	Y	Public Institutions
	Public spaces	Y	y	Embu monument and Talent Academy,Child play park Majengo, Ewasco Library park.
	Faith-based buildings	Y	N	Christian , Muslim, Hindu
	Cultural and heritage assets	Y	N	Embu Cultural Centre
Emergency Services	Fire stations	Y	Y	Embu fire stations serving the entire county.
	Police stations	Y	N	National police service
	Telecommunications networks	Y	N	Telcos,ICTA
	Early warning systems	Y	N	KMD and NDMA
	Disaster management centers and shelters	Y	N	County Disaster Management Unit
	Evacuation routes	N	N	N/A
Populations				
Urban Residents	Population	Y	N	KNBS
	Households	Y	N	KNBS
Informal Settlement Residents	Population living in informal settlements	Y	N	Grogon and Kathangari
	Households lacking land tenure	Y	Y	Grogon and Kathangari
	Households / residents lacking access to basic services	Y	N	Grogon,Kathita shauri yako, Kimangaru, Kathangari,

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
Vulnerable and Marginalized Groups	Low-income households	Y	N	Dallas Swahili, Emma,Kathita, shauri, Kathangari,Mradi
	Women-headed households	Y	N	No data available
	Children and youth	Y	N	No data available
	Elderly persons	Y	N	No data available
	People with disabilities (PWD)	Y	N	No data available
	Homeless populations	Y	N	No data available
	Unemployed or precariously employed workers	Y	N	No data available
	Seasonal workers / migrant laborers	Y	N	No data available
	Nomadic groups in peri-urban areas	N	N	N/A
	Urban refugees and migrants	Y	N	No data available
	Minority ethnic groups in urban areas	Y	N	No data available
Natural Assets				
Urban Green Infrastructure	Urban parks and gardens	N	N	N/A
	Green corridors	N	N	N/A
	Street landscaping	Y	N	Embu monument, Road reserves
	Urban forests and forest reserves	Y	N	Njukiri forests and Shauri KFS
Urban Blue Infrastructure	Natural wetlands	Y	N	Kiambuthi, Kariari 1& 2,
	Rivers	Y	Y	Embu isudp

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Riparian zones	Y	N	Matakari,
	Lakes, ponds and reservoirs	Y	Y	Kariari 1& 2,
	Coastal ecosystems	N	N	N/A
	Urban agriculture	Y	Y	In ISUDP
Peri-urban and Agricultural Systems	Peri-urban agriculture	Y	Y	In ISUDP
	Agroforestry systems	Y	Y	In ISUDP
	Forests and forest reserves	Y	Y	In ISUDP
	Protected areas and national parks	Y	Y	Njukiri Forest
	Savannahs and rangelands	N	N	N/A

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

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

Table 11: Interpretation of exposure and vulnerability levels

Level	Exposure Level Interpretation	Vulnerability Level Interpretation
High	A large number and high-value urban elements (e.g., critical infrastructure, dense neighborhoods, major economic assets) are located within the hazard footprint.	The urban element is vulnerable to the climate hazard due to high natural sensitivity – considering physical and non-physical characteristics – and limited adaptive capacity.
Medium	A moderate number or a mix of low- and medium-value urban elements are located within the hazard footprint.	The urban element is somewhat vulnerable to the climate hazard due to moderate sensitivity and adaptive capacity.

Low	Few or no critical urban elements lie within the hazard footprint or area of impact.	The urban element is minimally vulnerable to the climate hazard due to limited sensitivity and/or a high degree of adaptive capacity.

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

Table 12: Impact Matrix

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

Table 13: Exposure, Vulnerability, and Impacts of Pluvial flooding

Hazard: Pluvial flooding

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Infrastructure & Services					
Stormwater Drainage	• Approximately 45% of storm drains are within the footprint area of pluvial flooding. • The municipality lacks a storm water drainage plan • There are no drain wayleaves in slum areas. The worst affected are Grogon and Shauri Moyo because of their hilly terrain • The drainage channels are narrow and inadequate to accommodate the volume of stormwater • Approximately 20% of the drainage system in the pluvial prone areas is earth drain rendering it susceptible to collapsing.		**Sensitivity:** • The storm drains are inadequate • The municipality lacks storm drainage plan **Adaptive Capacity:** • Regular unclogging of storm drains and especially before rainy season onsets.		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Water & Wastewater Management	• Damage of water and waste water pipes by debris at Majimbo Mradi.		**Sensitivity:** • The pipelines are not adequately haunched **Adaptive Capacity:** • Regular inspection and maintenance of the pipeline		
Solid Waste Management	• The solid waste management system in areas prone to pluvial flooding is inadequate. • In slums and informal settlement areas, haphazardly dumping of solid waste leads to clogging of existing storm water drainage system.		**Sensitivity:** • Inadequate number of solid waste collection points and inadequate solid waste fleet • Absence of transfer stations • Absence of segregation of solid waste at source **Adaptive Capacity:** • Regular maintenance of solid waste management fleet • Availability of transit points withing the commercial areas		
Transport and Mobility	• Approximately 15% of road network is within the pluvial flood hazard footprint.		**Sensitivity:** • Most of the roads are not upgraded to bitumen standards		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	• In slums, informal settlements and areas where roads are earthen, accessibility and movement for NMT is hindered by pluvial flooding. • Pluvial flooding leads to damage of roads and transport termini.		**Adaptive Capacity:** • Regular road maintenance of roads by KURA		
Economic Infrastructure	• The main fresh produce market and parts of the CBD area are located within the pluvial hazard footprint. • Pluvial flooding destroys produce and hinders access to fresh produce market and some commercial buildings and industrial zones.		**Sensitivity:** • Poor design of the fresh produce market • Poor drainage system in Jua Kali area **Adaptive Capacity:** • Routine maintenance of drainage systems in Jua kali and fresh produce market		
Social Infrastructure	• A number of schools, faith-based buildings, public toilets and health facilities are located within the hazard footprint.		**Sensitivity:** • Most of the recreational facilities are in poor condition • Lack of design for most of the children play grounds		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	• Access by school going children is hindered by pluvial flooding. • Damage of church structures in slums and informal settlements. • Access by patients to health facilities and public toilets is hindered by pluvial flooding. • Recreational facilities in schools are degraded by pluvial flooding.		**Adaptive Capacity:** •		
Emergency Services	• Possible evacuation routes and Telecommunication networks within the hazard footprint are affected. • Possible Evacuation routes especially back lanes are rendered impassable by pluvial flooding. • Control boxes and inspection chambers for telecommunication networks are clogged by pluvial flooding.		**Sensitivity:** • Absence of mapped evacuation routes • Poor siting of telecommunication network **Adaptive Capacity:** • Existence of a draft disaster management policy • Routine inspection of telecommunication networks		
Populations					

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Informal Settlement Residents	• Residents in informal settlement are affected by pluvial flooding • Sanitation conditions are worsened by pluvial flooding. • Pluvial flooding worsens access to basic services.		**Sensitivity:** • High number of low-income residents in informal settlements • Squalid housing conditions in informal settlements • Poor conditions of roads, social facilities and sanitation in informal settlements **Adaptive Capacity:** • Existence of water kiosks and standing water points provided by EWASCO. • Planning of informal settlement under KISIP 2 program.		
Vulnerable and Marginalized Groups	• Livelihoods for Low-income households are disrupted by pluvial flooding. • Seasonal displacement from places of informal trading.		**Sensitivity:** • High number of vulnerable residents in the affected area. • Low level of awareness on early warning system.		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	• Children and youth are unable to access recreational spaces due to pluvial flooding. • Elderly persons and PWDS mobility and access to basic services is affected by pluvial flooding.		**Adaptive Capacity:** • Existence of a gender inclusion framework. • Existence of weather warning advisory from the meteorological department. • Existence of settlement executive committee and settlement grievance redress committee.		
Natural Assets					
Urban Blue Infrastructure	• Natural wetlands within the hazard footprint are affected by siltation and pollution due to pluvial flooding. • Deposition of debris in Rivers.		**Sensitivity:** • The natural wetlands are already stressed • Degraded riparian zones.		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	• Soil erosion on Riparian zones		**Adaptive Capacity:** • Pegging of riparian zones • Existence of a draft land policy which proposes protection of riparian land. • Rehabilitation and protection of springs by the County government. • Existence of Embu County Climate Action plan		

Table 14: Exposure, Vulnerability, and Impacts of Fluvial flooding on Urban Elements

Hazard: Fluvial flooding

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Infrastructure & Services					

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Water & Wastewater Management	• Fluvial flooding results in Turbidity of our rivers. • Damage of water and waste water pipes by debris.		**Sensitivity:** • Contaminated rivers in affected areas • Damaged water and waste water reticulation infrastructure **Adaptive Capacity:** • Routine maintenance of water and waste water reticulation systems		
Solid Waste Management	• Fluvial flooding affects mobility of the garbage fleet in, matakari.		**Sensitivity:** • Delayed garbage collection during fluvial floods **Adaptive Capacity:** • Use of alternative routes		
Transport and Mobility	• Fluvial flooding renders some roads impassable. • Damage of road surfaces and supporting infrastructure.		**Sensitivity:** • Poor road conditions in affected areas • Most roads are not up to bitumen standards		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			Adaptive Capacity: • Routine road maintenance in affected areas		
Economic Infrastructure	• Flooding of commercial hubs like Winter villa, Kathmos, Arcriverline hotels.		**Sensitivity:** • Proximity of commercial hubs to riparian zones • Diversion of water courses **Adaptive Capacity:** • Regulation by NEMA and WRA		
Emergency Services	• Possible Evacuation routes especially back lanes are rendered impassable by Fluvial flooding.		**Sensitivity:** • Lack of mapped evacuation routes • Poor state and encroachment of back lanes. **Adaptive Capacity:** • Existence of municipal enforcement and development control teams • …		
Populations					

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Informal Settlement Residents	• Fluvial flooding affects accessibility to basic services for example matakari area.		**Sensitivity:** • Diverted river course at matakari area **Adaptive Capacity:** • Realignment of the water course by construction a box culvert at matakari road crossing		
Vulnerable and Marginalized Groups	• Fluvial flooding affects Vulnerable and marginalized groups access to basic services for example matakari area.		**Sensitivity:** • Diverted river course at matakari area • Inadequate social infrastructures **Adaptive Capacity:** • Realignment of the water course by construction a box culvert at matakari road crossing		
Natural Assets					

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Urban Green Infrastructure	• Destruction of trees and vegetation		**Sensitivity:** • Anthropogenic activities along riparian zones **Adaptive Capacity:** • Existence of environmental management and coordination (water regulations) 2009		
Urban Blue Infrastructure	• Natural wetlands, Rivers within the hazard footprint are affected by siltation and pollution. • Fluvial flooding affect biodiversity • Soil erosion leads to degradation of riparian zones.		**Sensitivity:** • poor agricultural practices • poor solid waste management **Adaptive Capacity:** • Existence of agricultural extension offices to train farmers on best farming practices • Zoned areas for urban agriculture and riparian areas.		

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

Hazard: Drought

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Infrastructure & Services					
Transport and Mobility	• Prolonged high temperatures lead to failure of bituminous road surfacing as a result of bleeding. • Dust pollution in earth roads.		**Sensitivity:** • High cost of road maintenance • Respiratory diseases due to increased dust on earth roads **Adaptive Capacity:** • Upgrading of earth roads to bitumen standards incorporating maximum temperatures for material specifications • Routine maintenance of upgraded roads • Routine maintenance of earth roads with gravel		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Water & Wastewater Management	• Drought leads to water scarcity. • Drought affects ground water levels.		**Sensitivity:** • Reduced water supply by service providers • Degraded and stressed rivers and wetlands • Lowering of water levels in boreholes and shallow wells • Lowering of spring discharge • Increased conflicts due to water abstraction upstream **Adaptive Capacity:** • Water rationing • Rain water harvesting • Controlled water abstraction through WRA • Spring protection and conservation. Eg through FLLoCA programme and UTaNRMP		
Economic Infrastructure			**Sensitivity:** • Increased energy cost • Frequent power outages		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	• Drought leads to running cost increase such as of air conditioning and refrigeration.		**Adaptive Capacity:** • Power rationing • Use of green energy (solar and biogas) as alternative source of energy		
Social Infrastructure	• Drought leads to running cost increase such as of air conditioning and refrigeration e.g. hospitals and morgues.		**Sensitivity:** • Increased energy costs • Frequent power outages **Adaptive Capacity:** • Power rationing • Use of green energy (solar and biogas) as alternative source of energy		
Populations					
Urban Residents	• Droughts affect urban populations livelihood and nutrition. • Poor sanitation due to low water supply		**Sensitivity:** • High cost of farm produce • Poor nutrition • Increased water borne diseases **Adaptive Capacity:** • Promotion of urban agriculture • Engagement of community health promoters in awareness creation		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Vulnerable and Marginalized Groups	• Droughts affect children, elderly, PWDs, women headed households, unemployed and low-income household in terms of livelihood interruption and lack of proper nutrition.		**Sensitivity:** • High cost of farm produce • Poor nutrition • Increased water borne diseases **Adaptive Capacity:** • Engagement of community health promoters in awareness creation • Government relief food. Eg school feeding programme • Tax exemption for PWDs • Cash Transfer Programme for the elderly		
Natural Assets					
Urban Green Infrastructure	• Drought leads to loss of vegetation in green corridors		**Sensitivity:** • Loss of aesthetic value • Encroachment of green spaces by informal businesses/shelters. • Increased terrestrial radiation		

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			Adaptive Capacity: • Promotion of urban greening through the department of environment and municipal board. • Corporate Social Responsibility by the private sector		
Urban Blue Infrastructure	• Desiccation of wetlands and draw down of river water levels		**Sensitivity:** • Endangered aquatic lives • Decline in overall water quality due to algal blooms harms biodiversity **Adaptive Capacity:** • Spring and wetland protection and conservation • Controlled water abstraction		
Peri-urban and Agricultural Systems	• Crop failure • Increase in crop production cost		**Sensitivity:** • Reduced harvests • High cost of farm produce **Adaptive Capacity:** • Subsidized government fertilizer • Government donated certified seeds		

4. Climate Risk Assessment

The Climate Risk Assessment for the Municipality of Embu integrates the results of the hazard assessment with the exposure and vulnerability analysis of key urban elements. This section evaluates both current and projected climate risks under different time horizons and climate scenarios, highlighting how hazards such as pluvial flooding, fluvial flooding, and drought translate into varying levels of risk for infrastructure, populations, and natural assets. The assessment provides an evidence-based foundation for identifying priority risk areas and informing targeted adaptation and resilience planning.

For this Urban Climate Risk Profile, the following matrix summarizes overall risk for each urban element by combining the assessed hazard level and the estimated impact level.

Table 16: Risk matrix

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

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

Table 17: Interpretation of risk levels

Level	Interpretation
Very High	Very high risks are unacceptable. Risk should be avoided, reduced or transferred. Immediate planning and implementation of risk reduction measures is required. Allocate resources and coordinate interventions to prevent or minimize impact.
High	High risks should be actively addressed. Develop and implement mitigation actions promptly. Monitor environmental indicators and ensure readiness of emergency or adaptation measures.
Medium	Medium risks should be managed. Plan and implement mitigation activities to reduce them to acceptable levels. Regularly review climate data and risk levels.

Low	Low risks are acceptable under current conditions. Minimal control or monitoring is needed, provided they remain stable and do not escalate.
Very Low	Very low risks are negligible in terms of likelihood and consequences. No immediate action is required beyond routine monitoring and periodic review.

4.1. Current and Future Climate Risks on Urban Elements

Table 18: Summary of Pluviual risks for Municipality of Embu

	Time Horizon & Climate Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level	Low	Low	Low	Low	Medium
				Risk Levels		
Categories	**Impact**	**Current**	**2050 SSP2-4.5**	**2050 SSP5-8.5**	**2100 SSP2-4.5**	**2100 SSP5-8.5**
Infrastructure & Services						
Stormwater Drainage	Major	Medium	Medium	Medium	Medium	High
Water & Wastewater Management	Insignificant	Very Low	Very Low	Very Low	Very Low	Low
Solid Waste Management	Major	Medium	Medium	Medium	Medium	High
Transport and Mobility	Moderate	Low	Low	Low	Low	Medium
Economic Infrastructure	Insignificant	Very Low	Very Low	Very Low	Very Low	Low
Social Infrastructure	Moderate	Low	Low	Low	Low	Medium
Emergency Services	Insignificant	Very Low	Very Low	Very Low	Very Low	Low
Populations						

Informal Settlement Residents	Major	Medium	Medium	Medium	Medium	High
Vulnerable and Marginalized Groups	Moderate	Low	Low	Low	Low	Medium
Natural Assets						
Urban Blue Infrastructure	Insignificant	Very Low	Very Low	Very Low	Very Low	Low

Table 19: Summary of Fluvial flooding risks for Municipality of Embu

	Time Horizon & Climate Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level	Low	Low	Low	Low	Medium
				Risk Levels		
Categories	**Impact**	**Current**	**2050 SSP2-4.5**	**2050 SSP5-8.5**	**2100 SSP2-4.5**	**2100 SSP5-8.5**
Infrastructure & Services						
Water & Wastewater Management	Minor	Low	Low	Low	Low	Low
Solid Waste Management	Insignificant	Very Low	Very Low	Very Low	Very Low	Low
Transport and Mobility	Minor	Low	Low	Low	Low	Low
Economic Infrastructure	Insignificant	Very Low	Very Low	Very Low	Very Low	Low
Emergency Services	Moderate	Low	Low	Low	Low	Medium
Populations						

Informal Settlement Residents	Minor	Low	Low	Low	Low	Low
Vulnerable and Marginalized Groups	Insignificant	Very Low	Very Low	Very Low	Very Low	Low
Natural Assets						
Urban Green Infrastructure	Insignificant	Very Low	Very Low	Very Low	Very Low	Low
Urban Blue Infrastructure	Minor	Low	Low	Low	Low	Low

Table 20: Summary of Drought risks for Municipality of Embu

	Time Horizon & Climate Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level	Low	Low	Low	Low	Low
				Risk Levels		
Categories	**Impact**	**Current**	**2050 SSP2-4.5**	**2050 SSP5-8.5**	**2100 SSP2-4.5**	**2100 SSP5-8.5**
Infrastructure & Services						
Water & Wastewater Management	Major	Medium	Medium	Medium	Medium	Medium
Transport and Mobility	Insignificant	Very Low	Very Low	Very Low	Very Low	Very Low
Economic Infrastructure	Insignificant	Very Low	Very Low	Very Low	Very Low	Very Low
Social Infrastructure	Insignificant	Very Low	Very Low	Very Low	Very Low	Very Low
Populations						
Urban Residents	Insignificant	Very Low	Very Low	Very Low	Very Low	Very Low

Vulnerable and Marginalized Groups	Moderate	Low	Low	Low	Low	Low
Natural Assets						
Urban Green Infrastructure	Major	Medium	Medium	Medium	Medium	Medium
Urban Blue Infrastructure	Minor	Low	Low	Low	Low	Low
Peri-urban and Agricultural Systems	Minor	Low	Low	Low	Low	Low

4.2. Climate Risk Hotspots

Climate risks within Embu Municipality are unevenly distributed across the urban area, reflecting differences in topography, land use, drainage infrastructure, and settlement patterns across wards.

Drought risk is more pronounced in peri-urban and less densely serviced wards of Mbeti North and Mbeti South, where households rely heavily on rain-fed agriculture, shallow wells, and surface water sources; prolonged dry spells reduce water availability for domestic use, urban farming, and small enterprises.

Pluvial flooding is most common in densely built-up wards within the urban core, particularly in areas with extensive impervious surfaces, inadequate storm-water drainage, and encroachment on natural waterways, leading to frequent surface runoff and localized flooding during intense rainfall events. This is mainly experienced with town and surrounding informal and slums settlements of Dallas in Kirimari Ward.

Fluvial flooding mainly affects wards located along river corridors and low-lying floodplains, where settlements, roads, and public utilities are exposed to river overflows during periods of

heavy and prolonged rainfall. This is mainly experienced along Matakari stream in Kirimari Ward and Itabua in Mbeti North Ward.

These spatial variations mean that informal settlements, low-income neighborhoods, and areas with weak infrastructure tend to experience higher vulnerability, underscoring the need for ward-specific climate risk management and adaptation interventions.

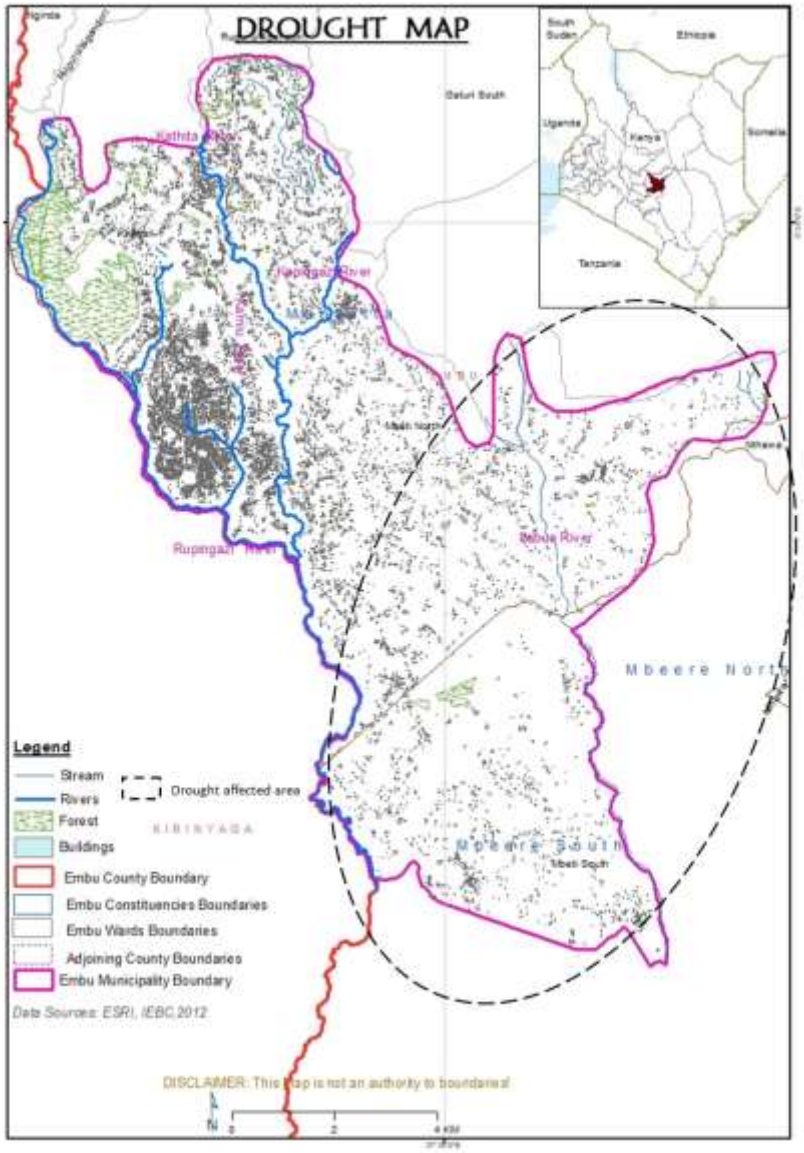

Figure 3: Drought Map

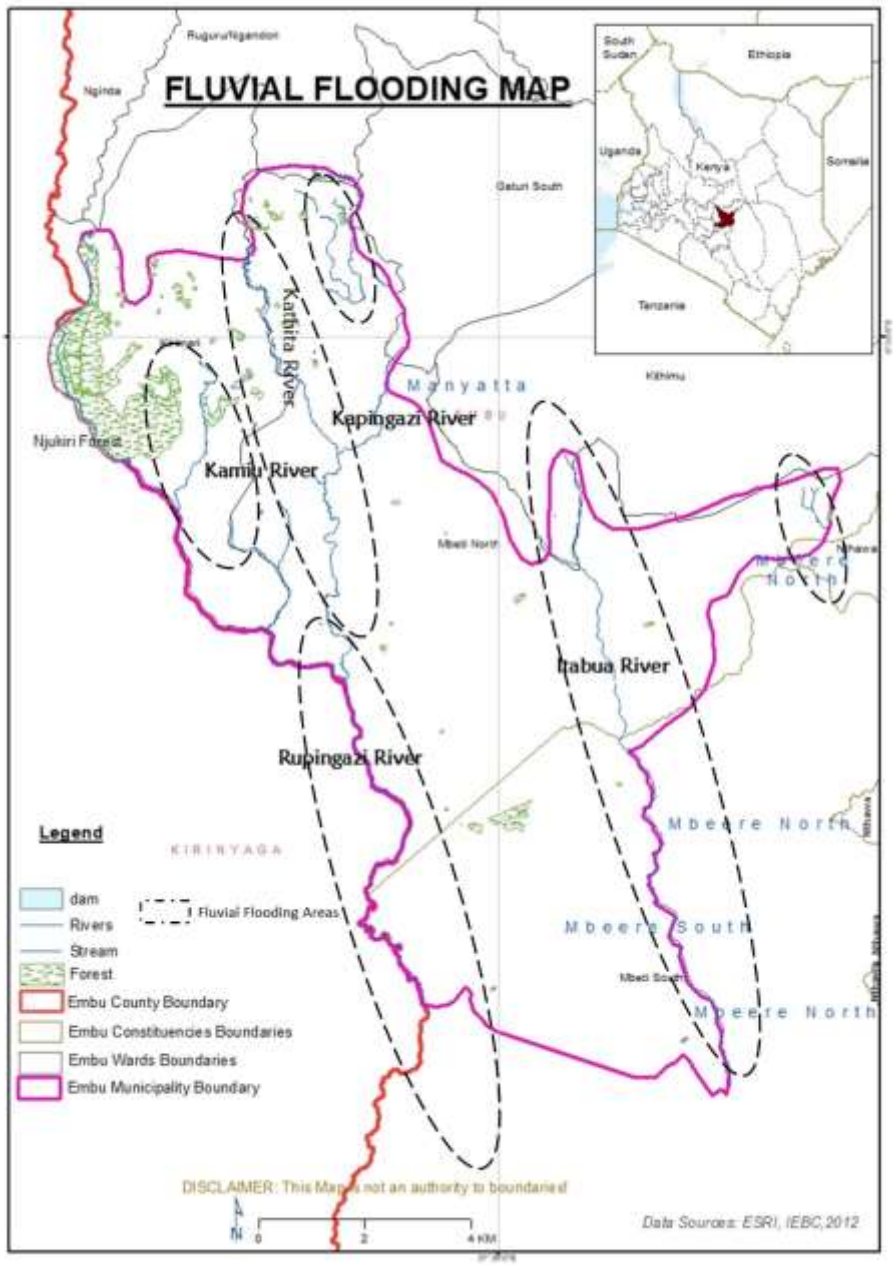

Figure 4: Fluvial Flooding Map

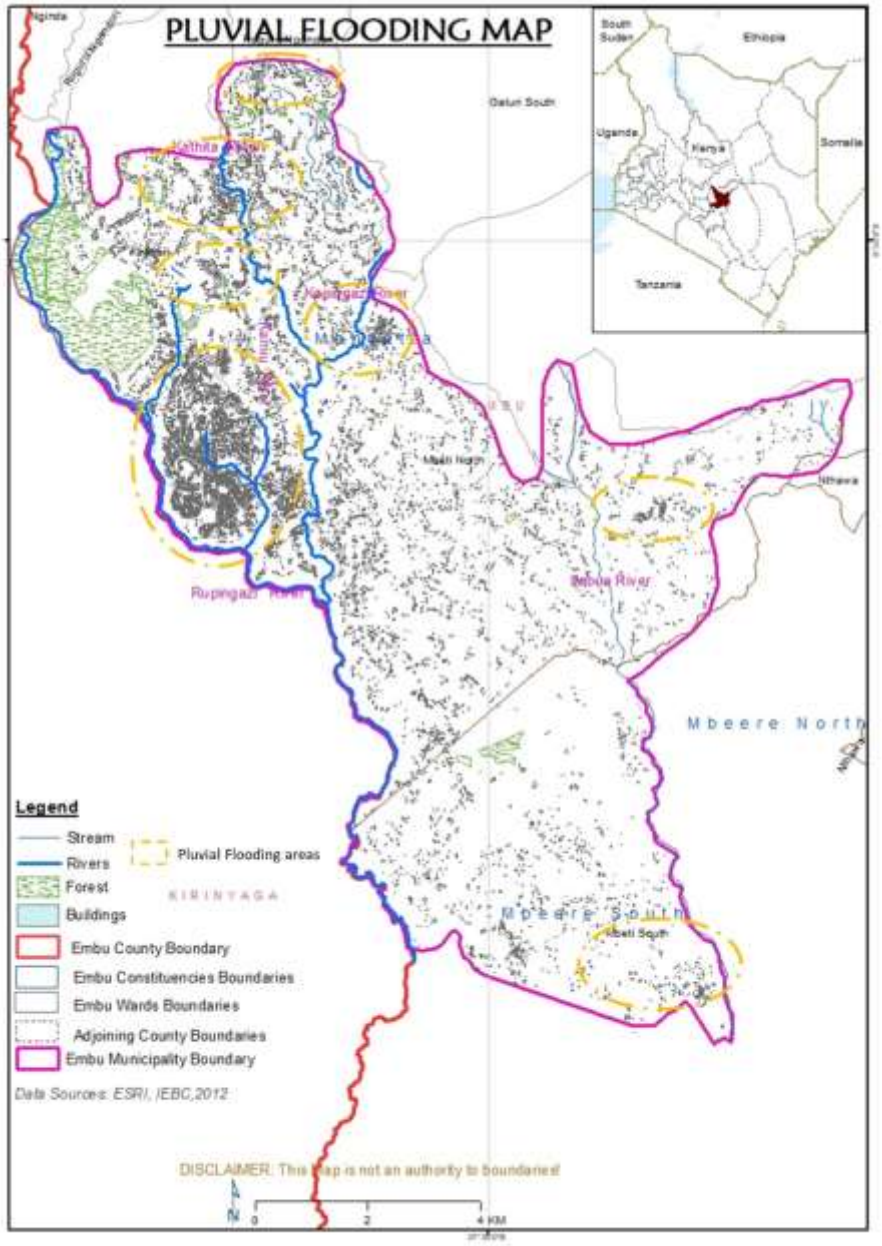

Figure 5: Pluvial Flooding Map

5. What's Next?

5.1. Key Findings

Table 21: Summary of climate risks affecting urban elements for Municipality of Embu

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

The climate risk assessment for the Municipality of Embu identifies pluvial flooding, fluvial flooding, and drought as the key climate hazards affecting the urban area, with pluvial flooding emerging as the most significant long-term risk.

While most hazards currently present low risk levels, future projections, particularly toward 2100, indicate increasing risks for stormwater drainage systems, solid waste management

infrastructure, and informal settlement residents, especially under pluvial flooding scenarios. Informal settlements such as Grogon, Kathangari, and Shauri Moyo are disproportionately affected due to inadequate drainage, poor housing conditions, and limited access to basic services.

Drought poses persistent medium-level risks to water and wastewater management systems and urban green infrastructure, with implications for water security and ecosystem health. Overall, the findings highlight the need for proactive, climate-resilient planning, strengthened infrastructure maintenance, and targeted interventions for vulnerable populations to prevent escalation of future climate risks.

5.2. Climate Adaptation and Resilience Solutions

Table 22: Climate adaptation and resilience solutions recommended for Municipality of Embu

Category	Recommended Solutions		
	Immediate	**Mid-term**	**Long-term**
Infrastructure & Services			
Stormwater Drainage	• The Municipality to develop a long-term storm water drainage plan that promotes climate resilience for design and construction • The Municipality department of Infrastructure to perform routine maintenance of the existing storm water drainage system • Redesigning the existing storm water drainage infrastructure to increase adequacy • Integrating storm water management into land use planning to control new development impacts	• The Municipality to implement the storm water drainage plan • The Municipality to develop climate-sensitive operation and maintenance guidelines for infrastructures and services • Restoration and conservation of wetlands through nature-based solutions • Securing stable resources through various mechanisms (e.g. fees, grants, taxes) for long-term maintenance and upgrades. •	• The Municipality to develop emergency response plans for extreme weather events in collaboration with the department of Disaster management • Securing stable resources through various mechanisms (e.g. fees, grants, taxes) for maintenance and upgrades. • Systematically tracking and maintaining drainage infrastructure (pipes, inlets and outfalls)

Category	Recommended Solutions		
	Immediate	**Mid-term**	**Long-term**
Solid Waste Management	• The Municipality Solid Waste Department will increase frequency of waste collection in flood-prone hotspots to prevent drains from clogging. • The Municipal Environment Department will conduct public awareness campaigns on safe waste disposal, especially targeting informal settlements, where waste dumping blocks drainage. • Development of a municipal solid waste management plan	• The Municipality Solid Waste Department will establish waste transfer stations and ensure they are flood-proof and accessible during heavy rains. • The Municipal Infrastructure, Survey and Physical Planning Department will integrate waste transport routes into climate-resilient road planning to avoid disruptions during floods. • Securing stable resources through various mechanisms (e.g. fees, grants, taxes) for long-term interventions. • Building local capacity (Municipal staff and informal waste pickers) to adapt and manage climate risks within the waste sector	• The Municipality, in coordination with County Government, will transition open dumpsites into engineered sanitary landfills with leachate and gas management systems to withstand climate extremes. • The Municipality and NEMA will develop circular economy programs (e.g., material recovery facilities, waste-to-energy, recycling hubs) to reduce waste volumes and minimize vulnerability to climate impacts. • The Municipal Environment Department to integrate green buffers around disposal sites to reduce flooding.
Populations			

Category	Recommended Solutions		
	Immediate	**Mid-term**	**Long-term**
Informal Settlement Residents	• The Municipality to disseminate early flood warning through locally effective channels such as radio and local leaders • Use of sand bags, barriers and digging of trenches to divert storm water away from household entrances • Retrofitting and elevating foundations or floor levels	• Upgrading and expanding drainage networks within the informal settlements using concrete, stone-pitching or stabilized earth. • Improving housing structure for flood resilience • Setting up of evacuation centers for flood-prone hotspots • Formalizing waste management by creating designated waste points to avoid blockages	• Construction of permanent stormwater drainage systems • Phasing out of informal settlements in flood-prone hotspots

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Annex N1. Historical Hazard Events

Historical hazard events in Embu Municipality have largely been associated with climate-related extremes, particularly droughts and flooding, which have had recurring impacts on livelihoods, infrastructure, and service delivery. Periodic droughts have resulted in water shortages, reduced agricultural productivity, and increased pressure on urban and peri-urban water supply systems, disproportionately affecting low-income households and communities reliant on rain-fed agriculture. Episodes of heavy rainfall have triggered pluvial flooding in densely built-up areas with inadequate drainage, causing damage to roads, property, and commercial activities, while fluvial flooding along river corridors has led to the inundation of adjacent settlements, erosion of riverbanks, and disruption of transport networks. These historical events highlight the municipality's exposure to climate variability and the need for improved early warning systems, resilient infrastructure, and integrated disaster risk management planning.

Figure 6: Historical Mean Annual Precipitation and Temperature for Embu County (Adopted from MoALF, 2016)

Hazard Event/Type	Drought **("Nikw'a Ngwete"** (Dying While Holding) Famine)
Date or Period	1984
Location	Lower Mbeti and North and Mbeti South Wards
Intensity	[Provide a brief narrative description of how the hazard was experienced in the urban area (e.g., flood depth, duration and location).]
Social Impacts	Total crop failure and massive livestock losses. Many residents were forced to migrate to more fertile regions, such as Garsen or other higher-altitude areas, to escape starvation

Physical Impacts	Widespread Livestock Mortality, Destruction of Vegetation, Water Scarcity and Total Crop Failure
Economic Impacts	Reduced supply of agricultural products forced up food prices, impacting inflation.
Ecological Impacts	The drought caused significant water shortages, with many natural springs, water pans, and streams drying up entirely. This induced high stress on both the vegetation and animal populations. Deforestation as local communities were forced to turn to the environment for survival, resulting in increased cutting of trees for charcoal production to earn income.