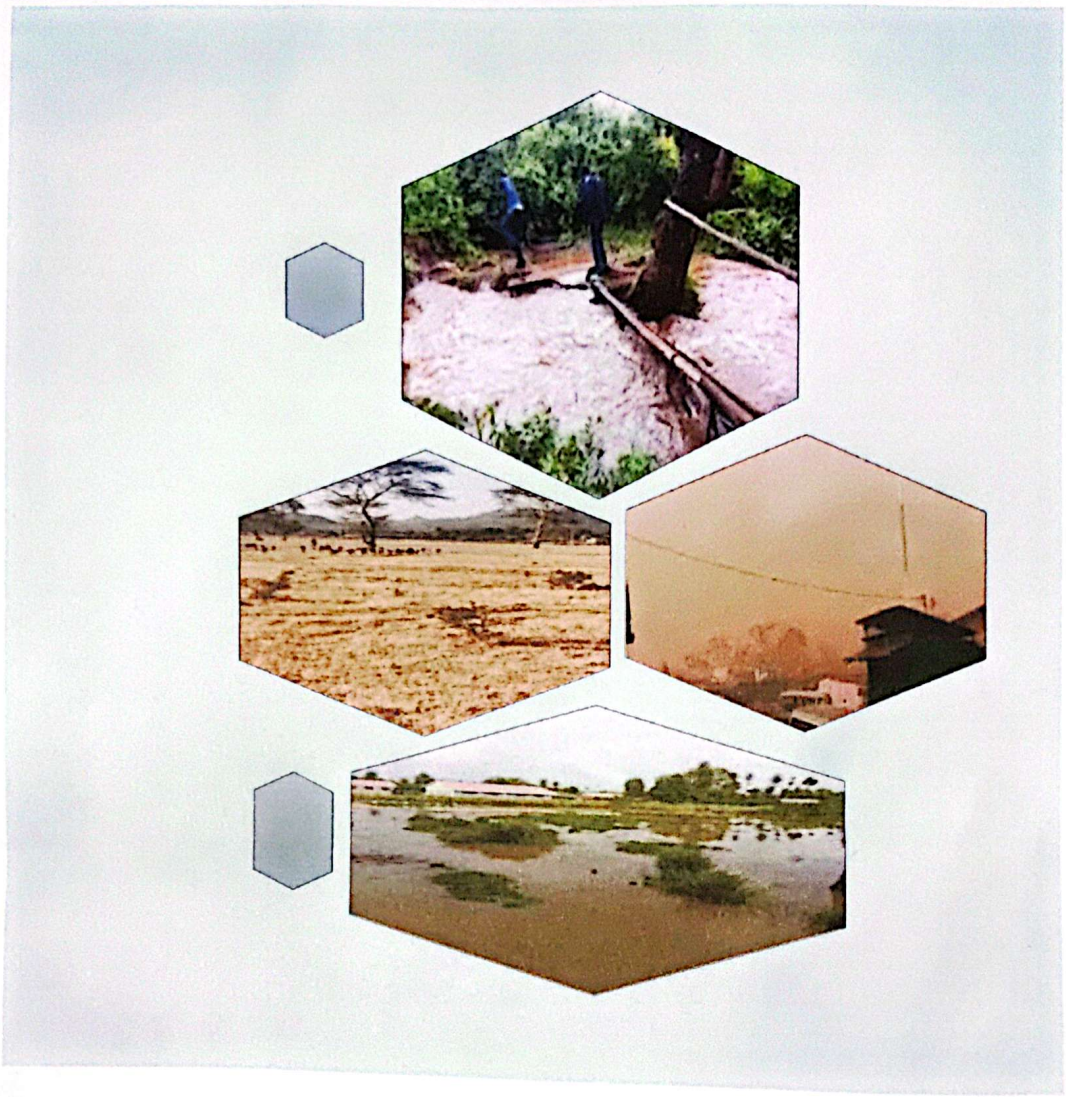

URBAN CLIMATE RISK PROFILE
FOR
GILGIL MUNICIPALITY
2024

Ministry of Lands, Public Works, Housing and Urban Development

MUNICIPALITY OF GILGIL
P. O. BOX 418-20116, GILGIL
12 MAR 2026
MUNICIPAL MANAGER

NAKURU COUNTY

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List of Acronyms

RCRA	Rapid climate risk assessment

Executive Summary

This Rapid Climate Risk Assessment (RCRA) for Gilgil Municipality was conducted to identify, analyze, and prioritize key climate hazards under current conditions and future climate scenarios (2050 and 2100 under SSP2-4.5 and SSP5-8.5). The objective of the assessment is to support evidence-based planning, guide climate-resilient investment decisions, and inform the integration of climate risks into municipal spatial planning and development frameworks. The assessment evaluates hazard levels, impact severity, and overall risk across infrastructure systems, populations, economic assets, and natural environments.

The assessment identified five priority climate hazards affecting Gilgil Municipality: drought, pluvial flooding, fluvial flooding, extreme heat, and sand and dust storms. Among these, drought presents consistently high hazard levels across all time horizons and scenarios, posing significant risks to water supply systems, agriculture, energy, and vulnerable populations. Pluvial flooding and fluvial flooding are projected to intensify due to increasing rainfall variability and more extreme precipitation events, leading to elevated risks for stormwater drainage, transport infrastructure, and settlements located in low-lying or poorly drained areas. Extreme heat is expected to increase substantially by mid-century and further by 2100, raising risks to public health, energy demand, and informal settlements. Sand and dust storms, currently assessed at moderate levels, are projected to increase in frequency and severity, largely linked to prolonged drought and land degradation.

The most at-risk urban elements include water and wastewater management systems, stormwater drainage infrastructure, transport networks, peri-urban and agricultural systems, and informal settlements. Vulnerable and marginalized groups face disproportionately higher risks due to limited access to resilient housing, services, and adaptive resources. Natural assets, including urban green and blue infrastructure, are also under increasing stress from heat, drought, and flooding dynamics.

Overall, climate risks are projected to intensify over time, particularly under the high-emissions SSP5-8.5 scenario. Without proactive intervention, the Municipality may face escalating service disruptions, infrastructure damage, public health impacts, and economic losses. To mitigate the risks, priority actions include strengthening water security systems, upgrading stormwater and flood management infrastructure, integrating nature-based solutions, enhancing early warning and emergency preparedness systems, and mainstreaming climate resilience into land-use planning and capital investment decisions. Proactive and coordinated adaptation measures will be essential to safeguard sustainable urban development and enhance long-term resilience in Gilgil Municipality.

Table 1. Summary of Pluvial Flooding risks for Gilgil 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	major	high	high	Very high	Very high	Very high
Water & Wastewater Management	Major	High	High	Very high	Very high	Very high
Solid Waste Management	Moderate	Medium	Medium	High	High	High
Transport and Mobility	Major	High	High	Very high	Very high	Very high
Energy	Moderate	Medium	Medium	Medium	High	High
Economic Infrastructure	Major	High	High	Very high	Very high	Very high
Social Infrastructure	Moderate	Medium	Medium	High	High	High
Emergency Services	Major	High	High	Very high	Very high	Very high
Populations						
Urban Residents	Moderate	Medium	Medium	High	High	High
Informal Settlement Residents	Major	Very high	Very high	Very high	Very high	Very high
Vulnerable and Marginalized Groups	Moderate	Medium	Medium	High	High	High
Natural Assets						
Urban Green Infrastructure	Minor	Low	Low	Medium	Medium	Medium
Urban Blue Infrastructure	Major	High	High	Very high	Very high	Very high
Peri-urban and Agricultural Systems	Major	High	High	Very high	Very high	Very high

Table 2. Summary of Drought risks for Gilgil 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	minor	medium	medium	medium	medium	medium
Water & Wastewater Management	major	Very high	Very high	Very high	Very high	Very high
Solid Waste Management	minor	medium	medium	medium	medium	Medium
Transport and Mobility	moderate	high	high	high	high	high
Energy	moderate	high	high	high	high	high
Economic Infrastructure	major	Very high	Very high	Very high	Very high	Very high
Social Infrastructure	Moderate	high	high	high	high	High

Emergency Services	major	Very high	Very high	Very high	Very high	Very high
Populations						
Urban Residents	Moderate	high	High	high	high	High
Informal Settlement Residents	Major	Very high	Very high	Very high	Very high	Very high
Vulnerable and Marginalized Groups	Major	Very high	Very high	Very high	Very high	Very high
Natural Assets						
Urban Green Infrastructure	Minor	medium	medium	medium	medium	medium
Urban Blue Infrastructure	moderate	high	high	high	high	High
Peri-urban and Agricultural Systems	Major	Very high	Very high	Very high	Very high	Very high

Table 3. Summary of Sand and Dust Storms risks for Gilgil 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	Minor	low	low	medium	Medium	Medium
Water & Wastewater Management	Moderate	Medium	Medium	High	High	High
Solid Waste Management	Minor	Low	Low	Medium	Medium	Medium
Transport and Mobility	Moderate	Medium	Medium	High	High	High
Energy	Moderate	Medium	Medium	High	High	High
Economic Infrastructure	Moderate	Medium	Medium	High	High	High
Social Infrastructure	Moderate	Medium	Medium	High	High	High
Emergency Services	Major	High	high	high	Very high	Very high
Populations						
Urban Residents	Moderate	medium	medium	High	high	high
Informal Settlement Residents	major	high	high	Very high	Very high	Very high
Vulnerable and Marginalized Groups	major	high	high	Very high	Very high	Very high
Natural Assets						
Urban Green Infrastructure	minor	low	low	medium	medium	Medium
Urban Blue Infrastructure	moderate	medium	medium	high	high	High
Peri-urban and Agricultural Systems	major	high	high	Very high	Very high	Very high

Table 4. Summary of fluvial flooding risks for Gilgil 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	Major	High	High	Very high	Very high	Very high
Water & Wastewater Management	Major	High	High	Very high	Very high	Very high
Solid Waste Management	Moderate	Medium	Medium	high	High	High
Transport and Mobility	Major	High	High	Very high	Very high	Very high
Energy	Moderate	Medium	medium	high	High	high
Economic Infrastructure	Major	high	high	Very high	Very high	Very high
Social Infrastructure	Moderate	medium	medium	high	high	High
Emergency Services	Major	High	High	Very high	Very high	Very high
Populations						
Urban Residents	Moderate	medium	medium	high	high	high
Informal Settlement Residents	Major	high	high	Very high	Very high	Very high
Vulnerable and Marginalized Groups	major	high	high	Very high	Very high	Very high
Natural Assets						
Urban Green Infrastructure	minor	low	low	Medium	medium	medium
Urban Blue Infrastructure	major	high	high	Very high	Very high	Very high
Peri-urban and Agricultural Systems	major	high	high	Very high	Very high	Very high

Table 5 Summary of Extreme heat risks for Gilgil 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	minor	Medium	medium	high	high	high
Water & Wastewater Management	moderate	medium	medium	high	high	high
Solid Waste Management	minor	medium	medium	high	high	high
Transport and Mobility	moderate	medium	medium	high	high	high
Energy	major	high	high	Very high	Very high	Very high
Economic Infrastructure	major	high	high	Very high	Very high	Very high
Social Infrastructure	moderate	medium	medium	high	high	high
Emergency Services	major	high	high	Very high	Very high	Very high
Populations						
Urban Residents	Moderate	medium	medium	high	high	high
Informal Settlement Residents	major	high	High	Very high	Very high	Very high
Vulnerable and Marginalized Groups	major	high	high	Very high	Very high	Very high

Natural Assets						
Urban Green Infrastructure	Minor	medium	medium	high	high	high
Urban Blue Infrastructure	minor	medium	medium	high	high	high
Peri-urban and Agricultural Systems	major	high	high	Very high	Very high	Very high

1.Context

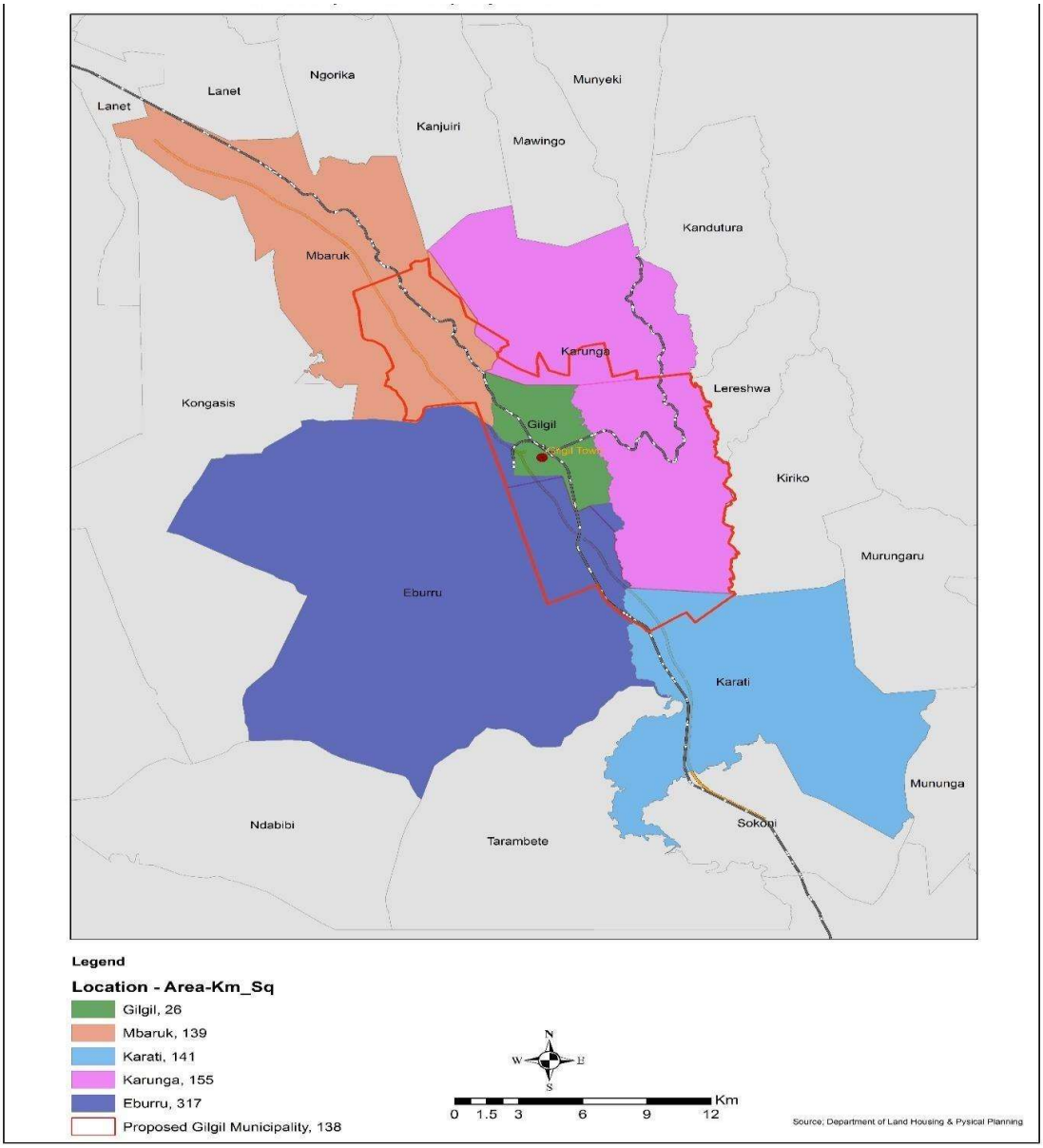
1.1.Objective

This Urban Climate Risk Profile aims to provide a comprehensive assessment of the climate-related hazards, vulnerabilities, and risks affecting Gilgil Municipality. It seeks to inform evidence-based decision-making by identifying key exposure areas, at-risk populations, critical infrastructure, and natural assets. The profile also aims to guide the development of adaptation and resilience strategies, integrate climate considerations into urban planning and development processes, and support sustainable, climate-resilient growth for the municipality.

1.2.Urban Context

1.2.1. Geographic area

Gilgil town is located between Naivasha town and Nakuru Town along the Nakuru- Nairobi Highway. It is to the west of Gilgil river which flows south to feed Lake Naivasha. The coordinates for the municipality are **Latitude:** 0° 12' 60.00" N **Longitude:** 36° 15' 60.00" E with a height of 7523ft above sea level. The town has three sublocations namely; Gilgil, Kikopey and Langalanga with a total population of 80,079 as per the KPHC 2019. It transcends the wards of Gilgil and Karunga.The importance of Gilgil town as an important commercial hub with various tourist attraction sites and corresponding facilities makes it an integral center to the growth of Nakuru County.



1.2.2. Governance Structure

[Refer to Step-1.2. to provide a brief overview and/or an organogram that demonstrates the key parties responsible for the urban area, including departments or units that are responsible for developing the Urban Climate Risk Profile, and subsequently the Integrated Development Plan.]

The Municipal organizational structure is in line with the Urban Areas and Cities (Amendment) Act of 2019. The current structure includes a Municipal manager and members of the city board who report to the County Governor. Under the City management are the different technical directorates including finance and economic planning; administration; urban planning and infrastructure; social services and community development; water, sanitation, and environment.

The Municipal Manager is Mandated ensures that all the programs in the integrated development plan of a town are executed effectively, efficiently and with timelines set out

in the Municipal Development plan and resolutions of the Municipal Boards.

The devolved departmental units at Gilgil Municipal level represent almost all the departments of the county. This includes Finance, Land, Housing and physical planning, Environment, Social Services, Roads and among others. The departments are headed by relevant staff deployed from the respective departments and administer the Projects and Programs of the departments as guided by the integrated development plan and other sectorial plans.

The county assembly is a legislative arm of the county government and its core responsibility is appropriation of county Budget and legislation of laws and regulations for efficient and effective performance of the county government. It is the oversight entity of the county. The county assembly constitutes committees responsible for each of the departments of the county government

i. Oversee affairs of the Municipality;

ii. Prepare and submit its annual budget estimates to the relevant department for consideration and submission to the county executive for subsequently to County Assembly for approval as part of the annual County Appropriation Bill;

iii. As may be delegated by the department, promote and undertake infrastructural development and services within the town.

iv. Implement applicable county legislation and departmental regulations and policies;

v. Where appropriate, be a liaison officer on town services where those services are provided by government service providers other than the county departments.

vi. As may be delegated by the county executive, collect rates, taxes, fees and charges as prescribed in the Finance Act.

1.2.3. Socio-economic Context

Current Demographic Context

According to the 2019 National Population and Housing Census, Gilgil Municipality had a population of 80,079 residents**.** The town has a notably youthful population, with over 75 percent of residents aged between 0 and 34 years. The high proportion of young people contributes to a high dependency rate**,** as approximately 55 percent of the population falls within the 0–24-year age bracket. This demographic structure indicates a substantial need for education, healthcare, employment opportunities, and other social services.

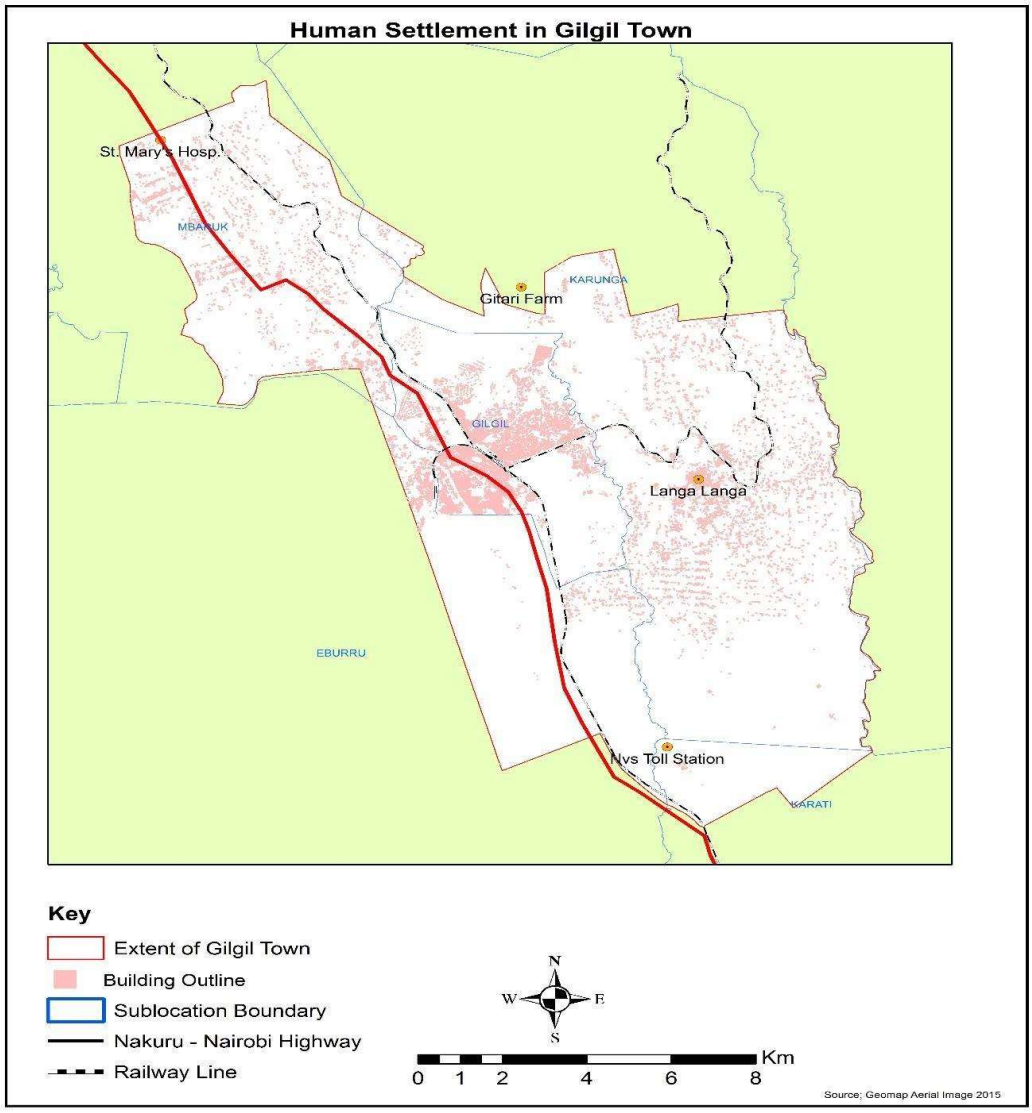
Projected Demographic Context

Using the 2009 annual growth rate of 2.9 percent, the population of Gilgil Municipality is projected to increase to 86,479 by 2023**,** representing a growth of approximately 6,400 people. If the same growth rate persists, the youthful population is likely to remain the dominant demographic group, further reinforcing the high dependency ratio. This projected growth implies an increased demand for housing, education, healthcare, and employment opportunities, as well as greater pressure on

municipal infrastructure and services. Planning for these demographic changes is critical to ensure sustainable socio-economic development in the town.

Source: **KNBS 2019 Census, KNBS -2020 Projections**

The distribution of population and densities by Sub locations is shown in Map



1.2.4. Economic Context

Current Economic Context

Gilgil Municipality is currently experiencing rapid urbanization due to its strategic location along the A8 Highway, the presence of key security installations such as the Kenyatta Military Barracks and NYS Training College, and scenic attractions including Lake Elementaita. The local economy is predominantly business-driven, with many residents relying on entrepreneurship and trade to

sustain their livelihoods. Dominant economic activities include retail and wholesale trade, agro-industrial machinery outlets, motor vehicle sales and servicing, and financial services such as banking, insurance, and credit facilities. Tourism also plays a major role, with sites like the Kariandusi Historical Site, Gilgil War Cemetery, and Lake Elementaita attracting domestic and international visitors, boosting the hospitality and service sectors. Revenue collections by county authorities reflect the vibrancy of commerce and business activities within the municipality.

Projected Economic Context

Looking ahead, Gilgil's economy is expected to continue expanding as urbanization drives higher demand for commercial services, housing, and infrastructure. Tourism is projected to grow further with enhanced promotion and improvements in infrastructure, while business diversification in sectors such as agro-processing, transport, and renewable energy is likely to stimulate local employment and attract investment. Strategic government and security-related projects are also anticipated to create additional economic opportunities. However, projected growth will need to address vulnerabilities to climate hazards, including flooding, droughts, and heatwaves as well as infrastructural gaps in drainage, transport, and energy. Integrating climate resilience and sustainable infrastructure development will be critical to ensuring that the municipality's economic expansion is both robust and sustainable.

1.2.5. Land-use Context

Current Land Use Context

Nakuru County's land use patterns are closely linked to its agricultural, urban, and natural landscapes, which are increasingly affected by extreme weather events. Seasonal rainfall has become irregular and unpredictable, with frequent droughts during the long rainy season and severe floods during the short rains (MoALF, 2016). For example, the 2011 floods nearly doubled Lake Nakuru's area (Onywere et al., 2012), and the 2015 floods destroyed over 200 homes and uprooted hundreds of acres of crops (Daily Nation, 2015), highlighting the vulnerability of both urban and agricultural lands. Droughts affect over 90% of the county, leading to water scarcity and forcing farmers and pastoralists to adopt coping mechanisms such as reduced cropping, fallowing, or migration of livestock. Since 1981, rising temperatures of 1ºC in the first wet season and 0.5ºC in the second have disrupted crop cycles and increased heat stress on vegetation, while precipitation patterns have remained largely unchanged. These climatic changes have already influenced land use decisions, including shifts from marginal croplands to more resilient farming areas, abandonment of flood-prone lands, and changes in settlement patterns to avoid hazard-prone zones.

Projected Land Use Context

Looking forward, Nakuru County is projected to experience prolonged moisture stress from 2021 to 2065, which will further influence land use planning and management. Temperature increases of approximately 0.3ºC and rainfall increases of 0.3% in the first wet season and 6% in the second wet season (MoALF, 2016) may alter crop suitability zones, intensify droughts in some areas, and increase flood risk in others. Land use adaptation measures that could support sustainable management include implementing climate-smart agriculture and livestock practices, protecting water bodies and wetlands through the National Water Master Plan, adopting soil and water conservation measures, and promoting diversified land uses that reduce pressure on fragile ecosystems. Challenges to adaptive land management include conflicts over agricultural and

pastoral land, increased demand for water due to population growth, overexploitation of wildlife habitats, and insufficient data on future water and land resource availability. Effective land use planning that integrates climate resilience and adaptive strategies will be critical to sustaining agriculture, settlements, and natural ecosystems under future climate variability.

absence of laws to support wildlife benefits to the population; loss of indigenous forest knowledge and practices that protected

At the county level, the NCCCAP 2018–2022 identifies the sectors of agriculture, livestock and fisheries, water, wildlife and tourism, forestry, transport and infrastructure, health, energy, mining, manufacturing, and trade as being key to promoting a low-carbon and climate-resilient economy and livelihoods in Nakuru County.

1.3.Key Stakeholders & Inclusiveness

The preparation of the Gilgil Urban Climate Risk Profile (CRP) adhered to the principles of participatory governance as outlined in the Kenya Constitution 2010 and the Urban Areas and Cities Act 2011, which require active involvement of the public in municipal affairs.

High Influence – Low Interest stakeholders, including private service providers, business communities, parastatals, NGOs (operationally focused), religious bodies, learning institutions, and less-engaged CBOs, were consulted to ensure their capacities and perspectives were considered, even if their active engagement was limited.

Low Influence – High Interest stakeholders, such as students and youth groups, environmental clubs, volunteer groups, and local media interested in climate awareness, contributed local knowledge and community perspectives, enriching the risk identification and adaptation recommendations.

Low Influence – Low Interest stakeholders, including small informal traders, individual households not participating in committees, local artisans, and non-registered youth groups, were recognized in the assessment to ensure no population group was overlooked, even if their direct engagement was minimal.

Community representatives were interviewed to identify the most prevalent climate-related risks, enabling the assessment of historical and current climate patterns, key hazards, and their potential impacts on sectors such as agriculture, health, water resources, infrastructure, and livelihoods. Climate change risk assessment tools, including resource mapping and historical profiling, were used to validate stakeholder inputs.

A wide range of stakeholders were engaged to ensure inclusiveness and comprehensive coverage of local climate risks. High Influence – High Interest stakeholders, such as ward climate change committees, government officials, Kenya Defence Forces (Kenyatta Barracks), community-based organizations (CBOs), community members, NGOs, faith-based organizations (FBOs), civil society organizations (CSOs), and engaged business people, played a central role in guiding the assessment and validating key findings.

There are various government, non-government (NGOs), community-based, faith-based and private organizations in Nakuru County that directly or indirectly deal with climate risks. The government institutions at the County level include the Livestock Production Department (LPD), the Agriculture Department (AD), Irrigation Department (ID), KMD, the National Environmental Management Authority (NEMA), and NCPB. The government departments and organizations are mainly for extension, input provision, and policy support. Specific interventions include extension and vaccination services by the VD, and the design, implementation, and mainstreaming of risk reduction strategies.

Other organizations working in Nakuru County in areas related to addressing food security issues, supporting agricultural development, and providing capacity building services include NGOs such as Hand-in-hand, Self-help Africa, Sustainable Practical Programme for Africa (SUPPA), and Mtakatifu Clara. Training and Research institutions such as KALRO, Egerton University and Baraka College also support climate change interventions. Faith-based organizations are also active and include the Catholic Diocese of Nakuru (CDN) and the Supreme Council of Kenya Muslims (SUPKEM) of Nakuru.

The final CRP report reflects the collective inputs of all stakeholders and secondary data, outlining identified climate risks, their potential impacts, recommended adaptation strategies, and prioritized areas for intervention. This inclusive approach promotes shared ownership of climate risk management strategies and strengthens Gilgil Municipality's capacity to plan and implement effective climate adaptation measures.

High	**High Influence – Low Interest** • Private Service Providers (PSPs) • Business Communities • Parastatals • NGOs (some operationally focused) • Religious Bodies (not directly engaged) • Learning Institutions (universities, colleges) • CBOs (less engaged in climate planning)	**High Influence – High Interest** Ward Climate Change Committees • Kenya Defence Forces (Kenyatta Barracks) • Government Officials (County & Municipal) • Community-Based Organizations (CBOs) • Community Members (representatives) • NGOs (active in climate adaptation) • Faith-Based Organizations (FBOs) • Civil Society Organizations (CSOs) • Business People (engaged in sustainability initiatives)
	Low Influence – Low Interest • Small informal traders • Individual households not participating in committees • Local artisans not engaged in climate programs • Non-registered youth groups	**Low Influence – High Interest** • Students and youth groups interested in climate action • Environmental clubs (schools and community) • Volunteer groups advocating climate awareness • Local media reporting on climate issues
Low		High

Figure 1. Stakeholder mapping for Gilgil Municipality

2. Hazard Assessment

There are 21 climate hazards currently affecting Nakuru County: rainstorms, fog, hail, severe wind, lightning/thunderstorms, extreme winter conditions, cold waves, extreme cold days, heat waves, extreme hot days, droughts, forest fires, land fires, flash/surface floods, river floods, groundwater floods, permanent inundation, landslides, rock falls, subsistence, waterborne diseases and vector-borne diseases.

Rapid risk mapping for Gilgil Municipality indicated that the five hazards with most significant impact are Pluvial Flooding, droughts, sand & Dust Storms, Fluvial Flooding & Extreme heat.

2.1.Key Climate Hazards

Rapid risk assessment mapping of Gilgil Municipality indicated that there are five hazards with most significant impact. They include Pluvial Flooding, droughts, sand & Dust Storms Fluvial Flooding & Extreme heat

Table 6. Hazard screening for Gilgil Municipality

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	Y	Y
Average ocean temperature increase	N	N	N	N
Extreme heat	Y	Y	Y	Y
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	N	N	N	N
Lake level rise	Y	Y	N	N
Waterlogging	Y	Y	Y	Y
Water Stress				
Drought (meteorological, hydrological)	Y	Y	Y	Y
Groundwater salinization	Y	Y	Y	Y
Saline intrusion	Y	Y	Y	Y
Wildfire				
Wildfires & bushfires	N	N	N	N
Storms				
Extreme wind	Y	Y	N	Y
Tropical cyclones	N	N	N	N
Sand and dust storms	Y	Y	Y	Y
Hailstorms	Y	N	N	N
Mass Movement				
Landslides	N	N	N	N
Coastal erosion	N	N	N	N
Gully erosion	N	N	N	N
Marine Conditions				
Ocean acidification	N	N	N	N

Hazard	Hazard Likely (Y/N)	Significant Impact (Y/N)	High Priority (Y/N)	Key Hazard (Y/N)
Geophysical*				
Subsidence	N	N	N	N
Earthquakes	N	N	N	N
Volcanos	N	N	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 n. Climate indicators and hazard thresholds selected for the assessment

Key Hazard	Climate indicator	Data source	Threshold		
			Low	Medium	High
Pluvial flooding	Rainfall intensity (mm/day)	Kenya Meteorological Department (KMD)	<20 mm/day	20–50 mm/day	>50 mm/day
Drought	Rainfall deficit (% of normal)	Kenya Meteorological Department (KMD)	<20% deficit	20–50% deficit	>50% deficit
Sand and dust storms	PM10 / PM2.5 concentration (µg/m³)	Kenya Meteorological Department (KMD)	<50 µg/m³	50–100 µg/m³	>100 µg/m³
Fluvial flooding	River water level / discharge (m³/s)	Kenya Meteorological Department (KMD)	<5 m³/s	5–15 m³/s	>15 m³/s
Extreme heat	Maximum daily temperature (°C)	Kenya Meteorological Department (KMD)	<30°C	30–35°C	>35°C

2.3. Current Hazard Levels and Climate Projections

Historical trends in Gilgil Municipality indicate that chronic climate hazards such as prolonged droughts, rising temperatures, and gradual changes in rainfall patterns are becoming increasingly common. Over the past decade, periods of below-average rainfall have led to extended moisture stress, reduced water availability, and declines in agricultural productivity. These chronic conditions weaken the natural and human systems, making the municipality more susceptible to acute climate hazards, such as flash floods, high-intensity storms, and extreme heat. For instance, repeated dry spells increase soil erosion and reduce vegetation cover, which exacerbates flooding when heavy rains occur. Similarly, prolonged high temperatures intensify heat stress on residents and livestock, increasing the severity of heatwave events. The interplay between chronic and acute hazards highlights the need for integrated climate adaptation measures that address both long-term stresses and sudden extreme events. Current and future impacts of these hazards on the population Gilgil

Municipality include: increase in crop failure, malnutrition, fluctuation in the water levels of rivers and lakes, depletion of aquifers, soil erosion and degradation, water pollution, loss of biodiversity, and destruction of infrastructure such as roads.

Table 7 Current and future hazards levels for Gilgil Municipality

	Hazard Level				
Hazard	**Current (Baseline 1991-2020)**	**2050 SSP2-4.5**	**2050 SSP5-8.5**	**2100 SSP2-4.5**	**2100 SSP5-8.5**
Pluvial flooding	Medium	Medium	High	High	High
Drought	High	High	High	High	High
Sand and dust storms	Medium	Medium	High	High	high
Fluvial flooding	Medium	medium	high	High	high
Extreme heat	Medium	Medium	High	High	high

Data source: World Bank Climate Knowledge Portal (CKP)

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

Table 8. 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

3. Exposure & Vulnerability Assessment

The RVA found that factors that could challenge the adaptive capacity of Gilgil Municipality include: conflict over land-use policies in the agriculture-livestock sectors; increased demand for water in other sectors and an increasing human population; incoherent and insensitive policies to deal with the over-abstraction of water and other water management issues; limited data on the current and future water situation; overexploitation of wildlife habitats due to th

absence of laws to support wildlife benefits to the population; loss of indigenous forest knowledge and practices that protected.

3.1.Urban Elements

Table 9. 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	N	Main urban drainage channels and minor streets drains.
	Stormwater storage	Y	N	Temporary retention basins / pans within municipal areas.
Water & Wastewater Management	Pumping stations	Y	N	pumping stations for groundwater and distribution.
	Groundwater abstraction	Y	N	Boreholes and wells supplying domestic and commercial water.
	Water treatment facilities	N	N	N/A
	Water supply networks	Y	N	Pipelines distributing potable water to households and businesses.
	Sewer networks	N	N	N/A
	Wastewater treatment facilities	N	N	N/A
Solid Waste Management	Transfer facilities	N	N	N/A
	Landfills and dump sites	N	N	N/A
	Recycling centers	N	N	N/A
	Collection fleet	Y	N	Private garbage collectors operating in the municipality.
Transport and Mobility	Road networks	Y	N	Main roads, feeder roads, and municipal streets.
	Bridges	Y	N	Key bridges connecting major roads across Gilgil.
	Public transport networks (rail, bus, mini-bus, etc.)	Y	N	Mini-bus, bus, and taxi routes serving urban population.
	Transportation terminals	Y	N	Bus parks and drop-off points in central areas.
	Vehicle depots	N	N	N/A
	Non-motorized transport networks	Y	N	Limited pedestrian paths and bicycle lanes within CBD.

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Freight and logistics hubs	N	N	N/A
Energy	Energy power plants	N	N	N/A
	Poles and power lines	Y	N	Medium-voltage poles and overhead distribution lines.
	Transformers and substations	Y	N	Local electricity distribution substations.
	Streetlighting	Y	N	Municipal streetlights along main and secondary roads.
Economic Infrastructure	Markets	Y	N	Municipal market and trading centers.
	Businesses and commercial hubs	Y	N	Shops, offices, and small commercial clusters.
	Industrial zones/parks and logistics parks	N	N	N/A
Social Infrastructure	Government buildings and service centers	Y	N	Municipal offices, administrative buildings.
	Education facilities	Y	N	Primary and secondary schools, vocational institutions.
	Healthcare facilities	Y	N	Hospitals, health centers, and clinics.
	Public spaces	Y	N	Open spaces for community gatherings.
	Faith-based buildings	Y	N	Churches, mosques, and other religious institutions.
	Cultural and heritage assets	Y	N	Kariandusi museum and heritage sites.
Emergency Services	Fire stations	Y	N	N/A
	Police stations	Y	N	Local police station
	Telecommunications networks	Y	N	Mobile towers, communication infrastructure (Safaricom BTS (Base Transceiver Station), Airtel towers, Telkom Kenya Towers, Fiber Optic Junctions.
	Early warning systems	N	N	N/A
	Disaster management centers and shelters	N	N	N/A
	Evacuation routes	N	N	N/A
Populations				
Urban Residents	Population	Y	N	All registered urban residents of Gilgil Municipality.
	Households	Y	N	Residential households mapped within municipal boundaries.
	Population living in informal settlements	Y	N	Residents in unplanned or informal settlements.

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
Informal Settlement Residents	Households lacking land tenure	Y	N	Informal households without formal land ownership.
	Households / residents lacking access to basic services	Y	N	Populations with limited access to water, sanitation, and electricity.
Vulnerable and Marginalized Groups	Low-income households	Y	N	Households below the municipal poverty threshold.
	Women-headed households	Y	N	Female-led households within urban and peri-urban areas.
	Children and youth	Y	N	Residents aged 0–35 years.
	Elderly persons	Y	N	Residents aged 60+ years.
	People with disabilities (PWD)	Y	N	Residents with physical or sensory disabilities.
	Homeless populations	Y	N	Street dwellers and temporary shelter occupants.
	Unemployed or precariously employed workers	Y	N	Individuals with unstable or informal employment.
	Seasonal workers / migrant laborers	Y	N	Temporary or migrant labor residing in municipality.
	Nomadic groups in peri-urban areas	N	N	N/A
	Urban refugees and migrants	N	N	N/A
	Minority ethnic groups in urban areas	Y	N	Ethnic groups with minority representation in Gilgil.
Natural Assets				
Urban Green Infrastructure	Urban parks and gardens	Y	N	Municipal park
	Green corridors	N	N	N/A
	Street landscaping	N	N	N/A
	Urban forests and forest reserves	N	N	N/A
Urban Blue Infrastructure	Natural wetlands	N	N	N/A
	Rivers	Y	N	Gilgil River and its tributaries within municipal area.
	Riparian zones	Y	N	Vegetated buffers along riverbanks.
	Lakes, ponds and reservoirs	Y	N	Water reservoirs and lake Elementaita.
	Coastal ecosystems	N	N	N/A
	Urban agriculture	Y	N	Small-scale urban farms and kitchen gardens.
Peri-urban and Agricultural Systems	Peri-urban agriculture	Y	N	Farming activities on municipal outskirts.
	Agroforestry systems	Y	N	Mixed tree-crop farming in peri-urban areas.

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Forests and forest reserves	N	N	N/A
	Protected areas and national parks	Y	N	Millitary barracks, NYS & ASTU
	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 10. 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 11. Impact Matrix

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

Table 12. Exposure, Vulnerability, and Impacts of Pluvial Flooding on Urban Elements

Hazard: Pluvial Flooding

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Infrastructure & Services					
Storm water Drainage	• Excess water overwhelms existing drainage channels in Gilgil CBD, Ngomongo area and Kekopey	MEDIUM	**Sensitivity:** • The municipality Lacks an intergrared Drainage Master plan • Lined drainage coverage is limited to the CBD and is not adequate to handle excess flood water **Adaptive Capacity:** • The municipality undertake periodic drainage system clean ups • Rain water harvesting.	High	Major
Water & Wastewater Management	• Water infiltrates into the existing pit Latrines and septic discharging waste water	MEDIUM	**Sensitivity:** • Overspill of faucal matter within residential and commercial zones **Adaptive Capacity:** • Promotion and use of bio digesters	High	Major
Solid Waste Management	• The uncollected waste are washed away and clogs existing drainage channels	MEDIUM	**Sensitivity:** Municipality lacks sufficient workforce, equipment and track to collect waste generated The municipality rely on a dumping site located in Naivasha	Medium	Moderate

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			Adaptive Capacity: • Municipality has partnered with private garbage collectors in collection and dumping of waste generated within the municipality • The municipality have purchased land for development of a Material Recovery facility at Thome (MRF)		
Transport and Mobility	Water overflow on the road reserve hamper pedestrian and vehicular movement	MEDIUM	**Sensitivity:** • Unpaved road network • Blocked culverts • Blocked service lanes **Adaptive Capacity:** Enhance capacity Promote water harvesting	Medium	moderate
Energy	• Flooding leads to fall power lines leading to prolonged power disruption	MEDIUM	**Sensitivity:** • Frequent power blackouts **Adaptive Capacity:** • Use of concreate and stabilized Electric poles	Medium	Moderate

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Economic Infrastructure	• Business activities are affected during flooding leading to loss of revenue	HIGH	**Sensitivity:** • Buildings on low-lying areas; inadequate drainage. **Adaptive Capacity:** • Temporary embankments • Drainage construction.	Medium	Moderate
Social Infrastructure	• Flooding disrupts persons seeking services from government offices and Gilgil Police station	HIGH	**Sensitivity:** • Absence of Drainage channels • Buildings located on low lying area below the road levels **Adaptive Capacity:** • Temporary embankments have been created to redirect water away from government facilities • Construction of drainage channels is underway to redirect storm water to Mbegi river	High	Catastrophic
Emergency Services	• Flooding affects access to Gilgil level 4 Hospital	MEDIUM	**Sensitivity:** Poor road network leading to the Hospital and absence of lined Drainage channels **Adaptive Capacity:** • Paving of access to the district hospital and development of high capacity Drainage channel.	Medium	Moderate
Populations					
Urban Residents	• Flooding disrupt normal human activities	MEDIUM	**Sensitivity:** • Poor road networks **Adaptive Capacity:** • Limited alternative access routes	Medium	Moderate

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Informal Settlement Residents	• Flooding in Ngomongo and kekopey always leading to destruction of household property	HIGH	**Sensitivity:** • Inadequate drainage channels, Temporary building material compromising stability of residential units • Congestion compromising storm water flow **Adaptive Capacity:** • Planning and tenure regularization but limited budgetary allocation hamper infrastructure development • Tree planting, civic education, annual cleanups.	High	Catastrophic
Vulnerable and Marginalized Groups	Persons living with disability elderly and young school going children are exposed to risk associated with movements limiting acces to basic services and access to learning institution	HIGH	**Sensitivity:** • Poor road networks, lack of assistive devises for persons living with disability • … **Adaptive Capacity:** • Lack of alternative access routes	High	catastrophic
Natural Assets					
Urban Green Infrastructure	• Gilgil Municipal stadium experience prolonged flooding	HIGH	**Sensitivity:** • water logging and interference of sporting activities **Adaptive Capacity:** • Development of alternative water channels redirecting storm water from NYS area towards Mbegi river stadium • Improvement and rehabilitation of storm water drainage channels	high	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Urban Blue Infrastructure	• Mbegi river experience excessive sedimentation and contamination	HIGH	**Sensitivity:** • Inadequate buffer along the riparian reserves • Lack of filtration zones to trap solid material **Adaptive Capacity:** • Annual tree planting and civic education • Annual river cleanup exercises	high	Catastrophic
Peri-urban and Agricultural Systems	• Destruction of food crops in peri-urban farms.	HIGH	**Sensitivity:** • Soil erosion • lack of irrigation • Crop loss. **Adaptive Capacity:** • Soil conservation. • Crop diversification.	Medium	Major

Table 13. Exposure, Vulnerability, and Impacts of drought on Urban Elements

Hazard: Drought

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Infrastructure & Services					
Stormwater Drainage	• The main drainage channels are located on unpaved sections of the road leading to Increased dust deposits.	Medium	**Sensitivity:** • Increased dust and debris levels on drainage channels **Adaptive Capacity:** • Limited budget allocation to facilitate regular Maintenance of Drainage channel.	Medium	Moderate

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Water & Wastewater Management	• Prolonged drought reduces water supply thus limiting access to water for domestic use.	High	**Sensitivity:** • Over Reliance on water supplied by Nakuru Rural Water & Sanitation Company • Excessive obstruction of river water for agricultural use upstream **Adaptive Capacity:** • Drilling of boreholes to supplement existing water sources.	High	catastrophic
Solid Waste Management	• Reduced water availability limits cleaning of waste collection points. • Increased illegal dumping and open burning.	Medium	**Sensitivity:** • Limited waste collection equipment and personnel • Reliance on external dumping site in Naivasha **Adaptive Capacity:** • Partnership with private garbage collectors • Proposed Material Recovery Facility (MRF) at Thome	Medium	Moderate
Transport and Mobility	• Prolonged drought contributes to cracking and degradation of unpaved roads. • increased dust levels.	High	**Sensitivity:** • increased dust levels affects pedestrian road users • increased dust levels compromise visibility contributing to road accidents **Adaptive Capacity:** • Limited budgetary allocation to finance continuous watering	Medium	Major
Energy	• Increased water demand for cooling and refrigeration	Medium	**Sensitivity:** • Grid strain and limited transformer capacity during peak demand periods …	Medium	Moderate

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			Adaptive Capacity: • Use of solar energy to supplement power supplied by Kenya power		
Economic Infrastructure	• Small and Medium enterprises operating car washes, eateries rely on cheap water supplied by Nakuru Rural Water and Sanitation Company • Water shortage results increased overhead cost as a result purchase of expensive water from private	High	**Sensitivity:** • Over reliance on limited water sources **Adaptive Capacity:** • Recycling of water and use of water efficient mechanisms for cleaning	Medium	Major
Social Infrastructure	• Prolonged droughts result to lose of greenery within school compounds contributing to increased dust levels and subsequent increase prevalence of air borne diseases • Reduced water supply results to poor hygiene	Medium	**Sensitivity:** Lack of sufficient water storage facilities **Adaptive Capacity:** • Progressive installation an acquisition of water storage tanks	Medium	Moderate
Emergency Services	• Increase incidences of fire • Prolonged droughts contribute indirectly to conflict and increased crime as a result of competitions for limited resources overwhelming the police station.	Medium	**Sensitivity:** • Limited firefighting water reserves and equipment… **Adaptive Capacity:** • Continuous drilling of boreholes but the coverage is limited budget allocation from the exchequer	High	Major
Populations					
Urban Residents	• Water rationing • Increased household expenditure on water	High	**Sensitivity:** • Heavy dependence on piped water supply • • Limited alternative livelihood options	Medium	Major

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			Adaptive Capacity: • Household water storage tanks • Purchase of water from vendors		
Informal Settlement Residents	• Severe water shortages • Reliance on expensive water vendors	High	**Sensitivity:** • Inadequate water storage facilities • Low household income • Poor sanitation infrastructure **Adaptive Capacity:** • Community boreholes (limited coverage)	High	Catastrophic
Vulnerable and Marginalized Groups	• Increased health risks • Increased food insecurity	High	**Sensitivity:** • Low-income levels • Limited access to healthcare • High dependency ratios **Adaptive Capacity:** • Government relief food programs (limited reach)	High	Catastrophic
Natural Assets					
Urban Green Infrastructure	• Drying of parks and public open spaces • Reduced tree cover	High	**Sensitivity:** • Lack of irrigation systems **Adaptive Capacity:** • Tree planting initiatives (rain-fed dependent)	Medium	Major
Urban Blue Infrastructure	• Reduced river flows • Declining groundwater recharge levels	High	**Sensitivity:** • Over-abstraction of water resources • Limited recharge areas **Adaptive Capacity:** • Riparian restoration initiatives	High	Catastrophic
Peri-urban and Agricultural Systems	• Crop failure • Livestock losses	High	**Sensitivity:** • Over reliance on rain-fed agriculture • Limited irrigation infrastructure	High	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	• Soil degradation		**Adaptive Capacity:** • Adoption of drought-resistant crops • Agroforestry practices		

Table 14. Exposure, Vulnerability, and Impacts of Sand and dust storms on Urban Elements

Hazard: Sand and dust storms

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Infrastructure & Services					
Stormwater Drainage	• Dust deposits clog open drainage channels along Gilgil CBD and Ngomongo • Wind-blown sediments from unpaved roads accumulate in culverts	Medium	**Sensitivity:** • Open and unlined drainage channels • High sediment load from nearby bare lands **Adaptive Capacity:** • Periodic manual desilting by municipality	Medium	Moderate
Water & Wastewater Management	• Dust contamination of rooftop rainwater harvesting systems • Sedimentation in shallow wells in Kekopey and peri-urban areas	Medium	**Sensitivity:** • Reliance on shallow wells and rooftop tanks • Limited filtration systems **Adaptive Capacity:** • Basic water treatment and tank cleaning practices	Medium	Moderate
Solid Waste Management	• Wind scatters waste from open collection points • Increased litter accumulation along Gilgil–Nairobi highway	High	**Sensitivity:** • Open waste storage points • Limited waste containment facilities **Adaptive Capacity:** • Engagement of private garbage collectors	Medium	Major

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Transport and Mobility	• Reduced visibility along Nairobi–Nakuru Highway • Dust-covered unpaved roads in Ngomongo and Kekopey reduce road safety	High	**Sensitivity:** • Large proportion of unpaved roads • Increased pedestrian movement without protective walkways **Adaptive Capacity:** • • Limited road watering and partial paving in CBD	High	Catastrophic
Energy	• Dust accumulation on transformers and power lines • Reduced efficiency of solar panels	Medium	**Sensitivity:** • Overhead power distribution system **Adaptive Capacity:** • Routine maintenance by Kenya Power	Medium	Moderate
Economic Infrastructure	• Reduced business activity in open-air markets due to dust • Increased cleaning and maintenance costs for shops in CBD	High	**Sensitivity:** • Open market structures • Small businesses lack protective infrastructure **Adaptive Capacity:** • Temporary coverings and enclosed shopfronts	Medium	Major
Social Infrastructure	• Schools experience high dust exposure • Health facilities report increased respiratory complaints	High	**Sensitivity:** • Limited tree cover within school compounds • Poor ventilation systems **Adaptive Capacity:** • Tree planting initiatives in schools	Medium	Major
Emergency Services	• Reduced visibility affecting emergency response time • Increased respiratory-related emergencies	Medium	**Sensitivity:** • Limited specialized respiratory response equipment **Adaptive Capacity:** • Availability of Gilgil Level 4 Hospital services	Medium	Moderate
Populations					

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

Table 15. 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					
Stormwater Drainage	• Natural surface runoff accumulates in poorly drained sections of Ngomongo and Kekopey • River overtopping during intense rainfall increases surrounding ground saturation • Open roadside drains become overwhelmed	Medium	**Sensitivity:** • Absence of integrated drainage system • Mostly unlined roadside drains • Poor maintenance **Adaptive Capacity:** • Periodic manual desilting • Small-scale drainage improvements in CBD only	Medium	Moderate
Water & Wastewater Management	• Floodwaters infiltrate shallow wells in low-lying zones • Septic tanks may overflow during prolonged river flooding	High	**Sensitivity:** • Reliance on shallow groundwater • Limited sewer coverage **Adaptive Capacity:** • Borehole drilling initiatives • Basic chlorination programs	High	Catastrophic
Solid Waste Management	• Floodwaters transport waste from informal dumping areas into natural flow paths leading toward Mbegi River	Medium	**Sensitivity:** • Open dumping practices • Limited waste containment **Adaptive Capacity:** • Private garbage collection partnerships	Medium	Moderate
Transport and Mobility	• Low-lying access roads near seasonal flow paths become impassable • Culverts blocked by debris during heavy rainfall	Medium	**Sensitivity:** • Undersized culverts • Significant proportion of unpaved roads **Adaptive Capacity:** • Ongoing culvert upgrades • Road rehabilitation efforts	Medium	Major

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Energy	• Flooding in low-lying areas threatens ground-mounted transformers • Temporary power outages during heavy rainfall events	Medium	**Sensitivity:** • Overhead power infrastructure **Adaptive Capacity:** • Elevated transformer installations in select areas	Medium	Moderate
Economic Infrastructure	• Businesses in low-lying areas experience temporary closures • Reduced access during flood events	Medium	**Sensitivity:** • Informal business structures **Adaptive Capacity:** • Temporary relocation during heavy rains		
Social Infrastructure	• Schools and public offices in low-elevation areas experience temporary access disruption	Medium	**Sensitivity:** • Buildings located below road level • Limited flood barriers **Adaptive Capacity:** • Localized embankments and drainage diversion	Medium	Moderate
Emergency Services	• Flooded access roads delay emergency response • Increase in waterborne diseases post-flooding	High	**Sensitivity:** • Limited specialized flood response equipment **Adaptive Capacity:** • Availability of Gilgil Level 4 Hospital	Medium	Major
Populations					
Urban Residents	• Surface water accumulation in residential compounds • Temporary displacement in extreme rainfall seasons	High	**Sensitivity:** • Settlement expansion in low-lying areas within catchment **Adaptive Capacity:** • Informal sandbagging and temporary channels	Medium	Major
Informal Settlement Residents	• Frequent flooding in Ngomongo and Kekopey due to natural flow accumulation • Loss of property and sanitation disruption	High	**Sensitivity:** • Temporary housing materials • High-density settlement in low-elevation zones	High	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			Adaptive Capacity: • Limited relocation options		
Vulnerable and Marginalized Groups	• Increased exposure to contaminated standing water • Elevated disease burden among children and elderly	High	**Sensitivity:** • Pre-existing health vulnerabilities • Limited mobility **Adaptive Capacity:** • Limited targeted flood protection programs	High	Catastrophic
Natural Assets					
Urban Green Infrastructure	• Riverbank erosion during overtopping events • Loss of vegetation along natural floodplain	Medium	**Sensitivity:** • Weak riparian buffer enforcement **Adaptive Capacity:** • Riparian tree planting initiatives	Medium	Moderate
Urban Blue Infrastructure	• Channel widening and sediment deposition in Mbegi River • Natural floodplain expansion during heavy rainfall	High	**Sensitivity:** • Deforestation upstream • Limited riverbank stabilization **Adaptive Capacity:** • Community river restoration activities	High	Catastrophic
Peri-urban and Agricultural Systems	• Flooding of farms located within natural floodplain • Soil erosion and crop destruction	High	**Sensitivity:** • Farming within flood-prone zones • Limited protective infrastructure **Adaptive Capacity:** • Seasonal crop adjustments.	High	Catastrophic

Table 16. Exposure, Vulnerability, and Impacts of Extreme Heat on Urban Elements

Hazard: Extreme Heat

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

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Stormwater Drainage	• Prolonged dry periods cause cracking of unlined drainage channels • Increased sediment and debris accumulation due to dry winds	Medium	**Sensitivity:** • Mostly unlined and exposed drainage channels **Adaptive Capacity:** • Periodic maintenance and desilting	Medium	Moderate
Water & Wastewater Management	• Increased water demand during hot periods • Reduced groundwater recharge levels	High	**Sensitivity:** • Heavy reliance on boreholes and Nakuru Rural Water supply • Limited water storage infrastructure **Adaptive Capacity:** • Borehole drilling and water rationing measures	High	Catastrophic
Solid Waste Management	• Accelerated decomposition of waste in open collection points • Increased odor and vector attraction	Medium	**Sensitivity:** • Open waste storage sites • Limited waste containment facilities **Adaptive Capacity:** • Private garbage collectors operating in CBD	Medium	moderate
Transport and Mobility	• Heat stress affects pedestrians and boda boda operators • Surface degradation of unpaved roads in Ngomongo and Kekopey	High	**Sensitivity:** • Limited shaded walkways • High pedestrian dependency **Adaptive Capacity:** • Limited tree cover initiatives	Medium	Major
Energy	• Increased electricity demand for cooling and refrigeration • Transformer overheating during peak heat periods	High	**Sensitivity:** • Limited transformer capacity • Overhead power infrastructure exposed to direct heat **Adaptive Capacity:** • Adoption of solar energy systems in institutions and household	Medium	Major

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Economic Infrastructure	• Reduced productivity in open-air markets (e.g., Gilgil Market) • Increased operating costs for water	High	**Sensitivity:** • Informal traders operate in open spaces without shade **Adaptive Capacity:** • Temporary shading structures and adjusted business hours	Medium	Major
Social Infrastructure	• Schools experience high indoor temperatures • Health facilities report increased dehydration and heat-related illness	High	**Sensitivity:** • Limited ventilation in classrooms • Limited green cover within compounds **Adaptive Capacity:** • Installation of water storage tanks and tree planting in schools	Medium	Major
Emergency Services	• Increased heat-related medical cases at Gilgil Level 4 Hospital • Injuries due to fire outbreaks during prolonged dry heat	Medium	**Sensitivity:** • Limited firefighting equipment and water reserves **Adaptive Capacity:** • Boreholes and hospital services available	Medium	Moderate
Populations					
Urban Residents	• Increased dehydration and heat exhaustion • Higher household expenditure on water and electricity	High	**Sensitivity:** • Limited access to cooling systems • High outdoor economic activity **Adaptive Capacity:** • Water storage and schedule adjustment	Medium	Major
Informal Settlement Residents	• Extreme indoor heat in iron-sheet structures in Ngomongo and Kekopey • Limited access to clean water during peak heat	High	**Sensitivity:** • Housing made of heat-absorbing materials • High density settlements **Adaptive Capacity:** • Minimal mitigation options	High	Catastrophic
Vulnerable and Marginalized Groups	• Children, elderly, and persons with disabilities at high risk of heat stress • Increased health complications	High	**Sensitivity:** • Pre-existing medical conditions • Limited mobility	High	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			Adaptive Capacity: • Limited targeted cooling or relief programs		
Natural Assets					
Urban Green Infrastructure	• Drying of vegetation in Gilgil Stadium and public open spaces • Increased tree mortality during prolonged heat periods.	High	**Sensitivity:** • Limited irrigation systems **Adaptive Capacity:** • Tree planting initiatives (rain-dependent)	Medium	Major
Urban Blue Infrastructure	• Reduced river flow levels in Mbegi River • Increased evaporation rates	High	**Sensitivity:** • Limited protection of riparian zones • Reduced recharge during dry periods **Adaptive Capacity:** • Community river conservation initiatives	High	Catastrophic
Peri-urban and Agricultural Systems	• Crop wilting and reduced yields • Livestock heat stress • Soil moisture loss	High	**Sensitivity:** • Heavy reliance on rain-fed agriculture • Limited irrigation coverage **Adaptive Capacity:** • Adoption of drought-resistant crops and agroforestry	High	Catastrophic

4. Climate Risk Assessment

This section presents the assessment of current and future climate risks affecting key urban elements in Gilgil Municipality. The overall level of risk for each urban element is determined by combining the assessed hazard level (likelihood and intensity of the climate hazard) with the estimated impact level (severity of consequences on infrastructure, services, populations, and natural assets). The Risk Matrix provides a structured approach for translating hazard and impact assessments into risk levels ranging from Very Low to Very High. The Interpretation Table further explains the meaning of each risk level and the corresponding urgency of action required. Using this methodology ensures that the risk ratings presented in Section 4.1 are consistent, transparent, and aligned with the overall framework of the Urban Climate Risk Profile.

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 17. 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 18. 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 19. Summary of Pluvial Flooding risks for Gilgil Municipality

	Time Horizon & Climate Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level	Medium	Medium	High	High	High
Categories	**Impact**			**Risk Levels**		
		Current	**2050 SSP2-4.5**	**2050 SSP5-8.5**	**2100 SSP2-4.5**	**2100 SSP5-8.5**
Infrastructure & Services						
Stormwater Drainage	major	high	high	Very high	Very high	Very high
Water & Wastewater Management	Major	High	High	Very high	Very high	Very high
Solid Waste Management	Moderate	Medium	Medium	High	High	High
Transport and Mobility	Major	High	High	Very high	Very high	Very high
Energy	Moderate	Medium	Medium	Medium	High	High
Economic Infrastructure	Major	High	High	Very high	Very high	Very high
Social Infrastructure	Moderate	Medium	Medium	High	High	High
Emergency Services	Major	High	High	Very high	Very high	Very high
Populations						
Urban Residents	Moderate	Medium	Medium	High	High	High
Informal Settlement Residents	Major	Very high	Very high	Very high	Very high	Very high
Vulnerable and Marginalized Groups	Moderate	Medium	Medium	High	High	High
Natural Assets						
Urban Green Infrastructure	Minor	Low	Low	Medium	Medium	Medium
Urban Blue Infrastructure	Major	High	High	Very high	Very high	Very high
Peri-urban and Agricultural Systems	Major	High	High	Very high	Very high	Very high

Table 20. Summary of Drought risks for Gilgil Municipality

	Time Horizon & Climate Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level	high	high	high	high	high

Categories	Impact	Risk Levels				
		Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
Infrastructure & Services						
Stormwater Drainage	minor	medium	medium	medium	medium	medium
Water & Wastewater Management	major	Very high	Very high	Very high	Very high	Very high
Solid Waste Management	minor	medium	medium	medium	medium	Medium
Transport and Mobility	moderate	high	high	high	high	high
Energy	moderate	high	high	high	high	high
Economic Infrastructure	major	Very high	Very high	Very high	Very high	Very high
Social Infrastructure	Moderate	high	high	high	high	High
Emergency Services	major	Very high	Very high	Very high	Very high	Very high
Populations						
Urban Residents	Moderate	high	High	high	high	High
Informal Settlement Residents	Major	Very high	Very high	Very high	Very high	Very high
Vulnerable and Marginalized Groups	Major	Very high	Very high	Very high	Very high	Very high
Natural Assets						
Urban Green Infrastructure	Minor	medium	medium	medium	medium	medium
Urban Blue Infrastructure	moderate	high	high	high	high	High
Peri-urban and Agricultural Systems	Major	Very high	Very high	Very high	Very high	Very high

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

	Time Horizon & Climate Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level	medium	medium	high	high	high
Categories	**Impact**	**Risk Levels**				
		Current	**2050 SSP2-4.5**	**2050 SSP5-8.5**	**2100 SSP2-4.5**	**2100 SSP5-8.5**
Infrastructure & Services						

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

Table 22. Summary of fluvial flooding risks for Gilgil Municipality

	Time Horizon & Climate Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level	Medium	Medium	High	High	High
Categories	**Impact**	**Risk Levels**				
		Current	**2050 SSP2-4.5**	**2050 SSP5-8.5**	**2100 SSP2-4.5**	**2100 SSP5-8.5**
Infrastructure & Services						
Stormwater Drainage	Major	High	High	Very high	Very high	Very high
Water & Wastewater Management	Major	High	High	Very high	Very high	Very high

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

Table 23. Summary of Extreme heat risks for Gilgil Municipality

	Time Horizon & Climate Scenario	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
	Hazard Level	Medium	Medium	high	high	high
Categories	**Impact**	**Risk Levels**				
		Current	**2050 SSP2-4.5**	**2050 SSP5-8.5**	**2100 SSP2-4.5**	**2100 SSP5-8.5**
Infrastructure & Services						
Stormwater Drainage	minor	Medium	medium	high	high	high
Water & Wastewater Management	moderate	medium	medium	high	high	high
Solid Waste Management	minor	medium	medium	high	high	high
Transport and Mobility	moderate	medium	medium	high	high	high
Energy	major	high	high	Very high	Very high	Very high

Economic Infrastructure	major	high	high	Very high	Very high	Very high
Social Infrastructure	moderate	medium	medium	high	high	high
Emergency Services	major	high	high	Very high	Very high	Very high
Populations						
Urban Residents	Moderate	medium	medium	high	high	high
Informal Settlement Residents	major	high	High	Very high	Very high	Very high
Vulnerable and Marginalized Groups	major	high	high	Very high	Very high	Very high
Natural Assets						
Urban Green Infrastructure	Minor	medium	medium	high	high	high
Urban Blue Infrastructure	minor	medium	medium	high	high	high
Peri-urban and Agricultural Systems	major	high	high	Very high	Very high	Very high

4.2.Climate Risk Hotspots

Climate risks in Gilgil Municipality are not uniformly distributed. They vary according to topography, proximity to rivers and Lake Elementaita, land use patterns, settlement density, and infrastructure coverage. The main spatial patterns of risk are summarized below.

Pluvial flooding risk is highest in the built-up core of Gilgil Town and in rapidly urbanizing wards where drainage infrastructure is inadequate or poorly maintained. Areas with high surface runoff, blocked road drains, and unpaved surfaces experience localized flooding during intense rainfall events. Informal and high-density residential zones are particularly exposed due to limited stormwater systems and encroachment on natural drainage channels. Under SSP5-8.5 projections for 2050 and 2100, the expansion of impervious surfaces combined with more intense rainfall is expected to increase flood risk in these wards.

Fluvial flooding risk is concentrated along riparian corridors and low-lying areas near River Mbegi and seasonal streams that drain toward Lake Elementaita. Wards located downstream or adjacent to floodplains face higher exposure, especially where settlement and agriculture extend into river buffers. Future projections indicate that high-emission scenarios will increase peak river flows, elevating the risk for adjacent infrastructure, peri-urban farms, and informal settlements located near riverbanks.

Drought risk is widespread across the Municipality but is most severe in peri-urban and agricultural wards where livelihoods depend on rain-fed farming and livestock. Areas with limited piped water coverage experience acute water stress during prolonged dry spells. Informal settlements and marginalized populations are disproportionately affected due to lower adaptive capacity and reliance on informal water vendors. Under both SSP2-4.5 and SSP5-8.5 scenarios, rising temperatures and moisture stress are projected to intensify water scarcity, particularly by 2050 and 2100.

Extreme heat risk is higher in densely built urban wards with limited tree cover and green spaces. The urban heat island effect increases surface and ambient temperatures in commercial and residential centers compared to surrounding peri-urban zones. Vulnerable groups, including the elderly, children, and low-income households in informal settlements with poor ventilation, face elevated health risks. By 2100 under SSP5-8.5, heat exposure is expected to significantly increase in these densely developed wards.

Sand and dust storm risk is more pronounced in peri-urban wards characterized by exposed soils, degraded vegetation cover, and ongoing land subdivision. Construction activities and dry agricultural fields contribute to localized dust generation during windy conditions. Climate projections indicating prolonged dry periods may increase dust frequency, particularly in outer wards transitioning from rural to urban land use.

Overall, central urban wards face higher risks related to flooding and heat due to infrastructure strain and density, while peri-urban wards face higher drought and dust risks due to land degradation and dependence on natural resources. Riparian and low-lying wards experience compounded risks from both pluvial and fluvial flooding.

For climate risk mapping, the following layers are recommended:

- Flood-prone zones (pluvial and fluvial) overlaid with ward boundaries
- Population density and informal settlement distribution
- Land use and land cover (built-up areas, agricultural land, green spaces)
- Water infrastructure coverage (piped networks, boreholes)
- Temperature anomaly projections for 2050 and 2100 under SSP2-4.5 and SSP5-8.5

These spatial overlays will help identify high-risk wards requiring priority adaptation investments and targeted resilience interventions in the Integrated Development Plan.

5. What's Next?

5.1.Key Findings

The climate risk assessment for Gilgil Municipality identifies **five key hazards**: pluvial flooding, fluvial flooding, drought, sand and dust storms, and extreme heat. Among these, **drought, pluvial flooding, fluvial flooding, and extreme heat** present the highest levels of risk.

Drought emerges as a consistently high hazard across all time horizons, with very high risks for water and wastewater management systems, peri-urban agriculture, economic infrastructure, informal settlements, and vulnerable groups. Increasing temperatures and projected moisture stress are likely to intensify water scarcity, agricultural losses, and livelihood disruption.

Pluvial and fluvial flooding pose significant risks to stormwater drainage systems, transport infrastructure, emergency services, and settlements located in low-lying or riparian areas. Under future projections, especially by 2100, flood-related risks are expected to increase due to heavier rainfall events and continued urban expansion into flood-prone zones.

Extreme heat is projected to intensify significantly by mid- and long-term horizons. Dense urban wards with limited green cover, informal settlements with poor housing conditions, and vulnerable populations (elderly, children, low-income households) are particularly exposed. Rising temperatures will also increase energy demand and strain health services.

Sand and dust storms currently present moderate risks but are projected to increase in peri-urban and degraded areas due to land use changes, vegetation loss, and prolonged dry spells.

Overall, informal settlement residents, vulnerable and marginalized groups, water infrastructure, peri-urban agricultural systems, and riparian zones are the most at-risk urban elements. Trends likely to intensify in the future include rising temperatures, increased rainfall variability, prolonged dry periods, more intense storm events, and continued land use change driven by rapid urbanization along the A8 corridor.

Table 24. Summary of climate risks affecting urban elements for Gilgil Municipality

Category	List of Key Hazards		
	Current	**Mid-term (2050)**	**Long-term (2100)**
Infrastructure & Services			
Stormwater Drainage	Pluvial Flooding; Fluvial Flooding	Pluvial Flooding; Fluvial Flooding	Pluvial Flooding; Fluvial Flooding
Water & Wastewater Management	Drought; Pluvial Flooding; Fluvial Flooding	Drought; Pluvial Flooding; Fluvial Flooding; Extreme Heat	Drought; Pluvial Flooding; Fluvial Flooding; Extreme Heat
Solid Waste Management	N/A	Pluvial Flooding	Pluvial Flooding
Transport and Mobility	Pluvial Flooding; Fluvial Flooding	Pluvial Flooding; Fluvial Flooding; Extreme Heat	Pluvial Flooding; Fluvial Flooding; Extreme Heat
Energy	Extreme Heat	Extreme Heat; Drought	Extreme Heat; Drought
Economic Infrastructure	Drought; Pluvial Flooding; Fluvial Flooding	Drought; Pluvial Flooding; Fluvial Flooding; Extreme Heat	Drought; Pluvial Flooding; Fluvial Flooding; Extreme Heat

Category	List of Key Hazards		
	Current	Mid-term (2050)	Long-term (2100)
Social Infrastructure	N/A	Extreme Heat; Pluvial Flooding	Extreme Heat; Pluvial Flooding
Emergency Services	Pluvial Flooding; Fluvial Flooding; Drought	Pluvial Flooding; Fluvial Flooding; Drought; Extreme Heat	Pluvial Flooding; Fluvial Flooding; Drought; Extreme Heat
Populations			
Urban Residents	N/A	Extreme Heat; Pluvial Flooding	Extreme Heat; Pluvial Flooding
Informal Settlement Residents	Drought; Pluvial Flooding; Fluvial Flooding; Extreme Heat	Drought; Pluvial Flooding; Fluvial Flooding; Extreme Heat	Drought; Pluvial Flooding; Fluvial Flooding; Extreme Heat
Vulnerable and Marginalized Groups	Drought; Extreme Heat	Drought; Extreme Heat; Fluvial Flooding	Drought; Extreme Heat; Fluvial Flooding
Natural Assets			
Urban Green Infrastructure	N/A	Extreme Heat	Drought; Extreme Heat
Urban Blue Infrastructure	Pluvial Flooding; Fluvial Flooding	Pluvial Flooding; Fluvial Flooding	Pluvial Flooding; Fluvial Flooding
Peri-urban and Agricultural Systems	Drought; Fluvial Flooding	Drought; Fluvial Flooding; Extreme Heat	Pluvial Flooding; Fluvial Flooding

Take Away

The climate risk assessment indicates that **drought, pluvial flooding, fluvial flooding, and extreme heat** are the dominant hazards affecting Gilgil Municipality, with risks intensifying significantly under mid-term (2050) and long-term (2100) climate scenarios.

1. Water-related risks are the most critical and systemic.
Flooding (both pluvial and fluvial) and drought consistently affect multiple urban systems simultaneously. Stormwater drainage, transport networks, water supply, wastewater systems, and emergency services are already exposed and will face higher risk levels in the future. The limited formal drainage infrastructure increases sensitivity to intense rainfall events, while prolonged dry spells threaten water availability and agricultural productivity.

2. Drought presents the most widespread and persistent risk.
Drought affects infrastructure, economic activities, peri-urban agriculture, and vulnerable populations across all time horizons. As rainfall variability increases and temperatures rise, water scarcity and livelihood insecurity are expected to intensify, making drought a long-term structural challenge.

3. Extreme heat is an emerging high-risk hazard.
While currently moderate in some sectors, extreme heat becomes a high-risk hazard by 2050 and 2100. It will increase pressure on energy systems, public health services, and water demand. Informal settlement residents and vulnerable groups (elderly, children, low-income households) face disproportionate exposure due to poor housing conditions and limited adaptive capacity.

4. Informal settlements and vulnerable groups are disproportionately at risk.
Informal settlement residents experience compounded exposure to flooding, drought, and extreme heat. Limited infrastructure, inadequate drainage, and reliance on climate-sensitive livelihoods increase their vulnerability. Vulnerable and marginalized populations consistently appear among the highest-risk groups across hazards and time horizons.

5. Economic and agricultural systems face escalating climate stress.
Peri-urban and agricultural systems are highly exposed to drought and increasingly to extreme heat and flooding. Given Gilgil's reliance on agriculture and trade along the A8 corridor, climate risks threaten food security, income stability, and municipal economic growth.

6. Risk intensity increases over time.
Under future climate projections, hazards intensify in frequency and severity. By 2100, multiple urban elements face concurrent high risks, indicating growing systemic vulnerability. Without adaptive planning, infrastructure upgrades, ecosystem restoration, and social protection measures, climate impacts may compound.

5.2. Climate Adaptation and Resilience Solutions

Table 25. Climate adaptation and resilience solutions recommended for Gilgil Municipality

Category	Recommended Solutions		
	Immediate	**Mid-term**	**Long-term**
Infrastructure & Services			
Stormwater Drainage	• Unclogging of existing Road Drains • Community sensitization • Training on Water harvesting techniques such as pan liners, water tanks and smart agriculture e.g. Kitchen gardening in every household	• Development of a Municipal Drainage Master plan • Construction and maintenance of drainage systems • Designating Ecologically fragile areas as conservation areas	• Expansion of existing Drainage channels • Construction of 3 No of water pans in Kikopey and Ngomongo • Relocation from wetlands • Establish tree nurseries in public schools to raise 200,000 assorted tree seedlings
Water & Wastewater Management	• Promote use of appropriate onsite waste water Management	• Undertake a comprehensive waste water Management feasibility study	• Development of waste water Management facility • Installation of a sewerage System • Recycling of waste water for Domestic and industrial use
Solid Waste Management	• Community awareness creations campaigns • Apply and enforce Public Health Act, EMCA etc • Procure litter/garbage separation bins	• Purchase and distribution of Liter bins • Segregation of Solid waste at household level • Development of Municipal by was Governing Solid Waste Management	• Development of Material recovery facility • Provision of adequate and accessible skips in areas with high quantities of solid waste
Transport and Mobility	• Maintenance of existing road infrastructure • Opening up of blocked service lanes	• Paving of dilapidated roads • Construction of formal sheds • Streetscape and site landscaping	• Use of eco-friendly Paving materials • Development of bicycle lanes and pedestrian-friendly corridors

Category	Recommended Solutions		
	Immediate	**Mid-term**	**Long-term**
Energy	• Promote use of solar energy	• Install solar street lighting in public spaces	• Transition municipal buildings to 100% renewable energy • Establish solar mini-grids for peri-urban communities
Economic Infrastructure	• Conduct assessment of vulnerable markets and business hubs	• Retrofit critical economic infrastructure (markets, warehouses) for climate resilience	• Diversify local economy through climate-resilient enterprises and agro-processing hubs
Social Infrastructure	• Afforestation on Municipal park • Rehabilitation of Gilgil Municipal Park	• Develop climate-resilient schools and health facilities	• Construct multipurpose community centers with flood- and heat-resistant design
Emergency Services	• Develop and disseminate local disaster response protocols	• Train community volunteers in first aid, firefighting, and flood response	• Establish fully equipped municipal emergency operations center
Populations			
Urban Residents	• Creation of awareness on the need to plant trees within their homes to act as wind breakers	• Encourage community-led greening programs	• Develop community adaptation plans integrating climate-resilient housing and green spaces
Informal Settlement Residents	• Tenure Regularization • Adopt Integrated Neighbourhood Planning Approach	• Encourage use of building materials that are accessible, affordable and available in the locality. Stabilized blocks • Establish water kiosks in the redeveloped informal settlements	• Upgrade settlements with resilient infrastructure (drainage, sanitation, green corridors)
Vulnerable and Marginalized Groups	• Identify vulnerable populations and register them in municipal databases	• Provide targeted livelihood support and climate adaptation training	• Integrate vulnerable groups into municipal climate adaptation planning and resource allocation
Natural Assets			

Category	Recommended Solutions		
	Immediate	**Mid-term**	**Long-term**
Urban Green Infrastructure	• Expansion of the piped water network to cover the entire planning area • Plant trees in public spaces	• Develop urban parks and green corridors	• Integrate green infrastructure into urban planning (green roofs, permeable pavements)
Peri-urban and Agricultural Systems	• Promote soil conservation and mulching techniques	• Support climate-smart agriculture and irrigation schemes	• Establish agroforestry zones and climate-resilient crop diversification programs

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Annex N1. Historical Hazard Events

Hazard Event/Type	**Fluvial Flooding** (River Mbegi Overflow)
Date or Period	November 2018
Location	Low-lying areas along River Mbegi, Kikopey, Ngomongo
Intensity	Floodwaters reached 0.8–1.2 m in residential zones; lasted 3–4 days
Social Impacts	Approximately120 households affected, 2 injuries reported; children and elderly most affected.
Physical Impacts	Roads submerged, 15 houses partially damaged, disruption to water supply.
Economic Impacts	Estimated KSh 8–10 million in property damage; agricultural losses in peri-urban farms.
Ecological Impacts	Erosion of riverbanks, loss of riverine vegetation

Hazard Event/Type	**Extreme heat**
Date or Period	January 2021
Location	Entire municipality
Intensity	Temperatures 38–40°C for 5 consecutive days
Social Impacts	Approximately 30 hospital visits for heat-related illness; elderly and outdoor workers most affected.
Physical Impacts	Minor structural impacts
Economic Impacts	Reduced labor productivity; small horticulture crop losses
Ecological Impacts	Drying of small water pans and shallow wells; stress on urban vegetation

Hazard Event/Type	**Sand and Dust Storms**
Date or Period	July 2017
Location	Residential areas and main highways
Intensity	Visibility <50 m; dust deposited on houses and roads
Social Impacts	Approximately 50 respiratory illness cases; mostly children and elderly
Physical Impacts	Dust accumulation on rooftops and roads; blocked drains
Economic Impacts	Transport disruptions; increased household cleaning costs
Ecological Impacts	Dust deposition affecting soil fertility; minor degradation of urban gardens

Hazard Event/Type	**Pluvial flooding**
Date or Period	March 2019
Location	Kikopey–Ngomongo lowlands
Intensity	Sudden surge 0.5–1 m; lasted <24 hrs
Social Impacts	About 80 households temporarily displaced; 5 injuries; children and elderly most affected
Physical Impacts	Partial collapse of low-cost housing; road erosion
Economic Impacts	KSh 4–6 million repair costs; loss of livestock and crops.
Ecological Impacts	Loss of topsoil; minor riverbank erosion

Hazard Event/Type	**Drought**
Date or Period	June–August 2020
Location	Peri-urban agricultural zones
Intensity	Rainfall reduced by ~60%; water pans dried
Social Impacts	Food insecurity for ~200 households
Physical Impacts	Water scarcity for domestic use; reduced borehole yields
Economic Impacts	Crop failure; livestock losses; KSh 12 million in economic losses
Ecological Impacts	Drying of wetlands; reduced vegetation cover in grazing areas