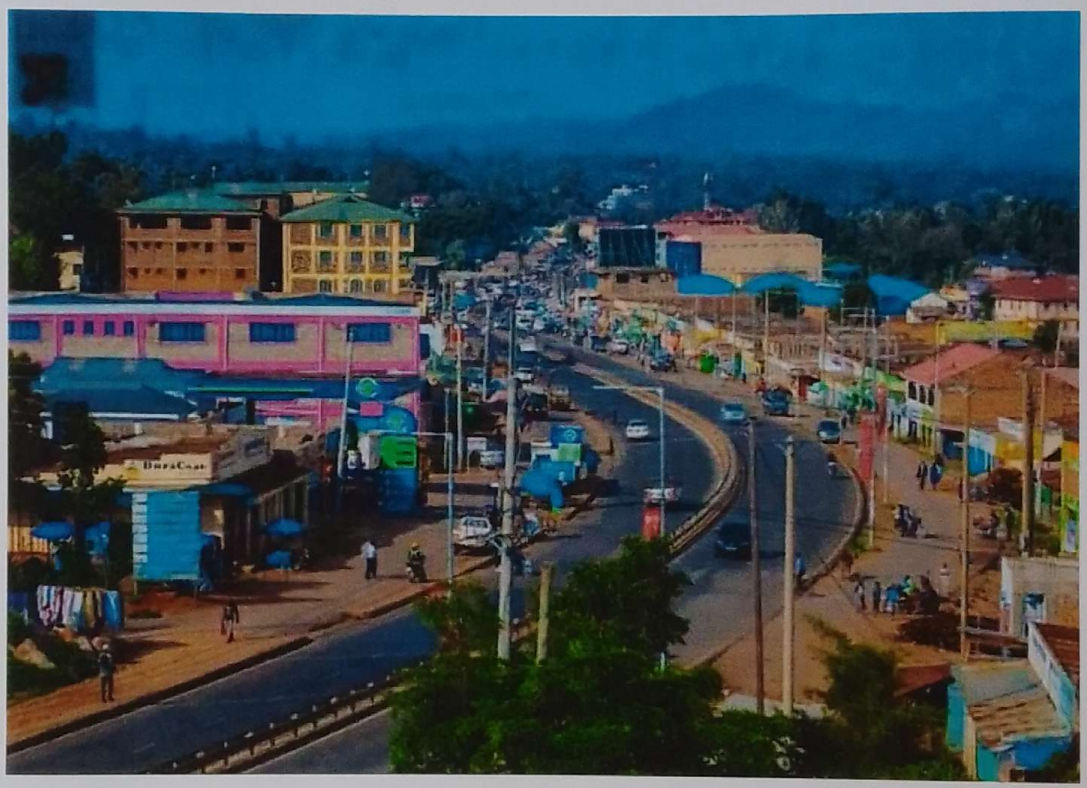
URBAN CLIMATE RISK PROFILE FOR OYUGIS MUNICIPALITY

2026



Approved.
Davis Asila
Board chair.
17/02/2026.

OYUGIS MUNICIPALITY
P. O. BOX 352 - 40222, OYUGIS
COUNTY GOVERNMENT OF HOMABAY
Date: 17/02/2026

COUNTY GOVERNMENT OF HOMA BAY: OYUGIS MUNICIPALITY

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Foreword

Oyugis Municipality is increasingly experiencing the impacts of climate variability and long-term climate change. Irregular precipitation patterns, intensified rainfall events, surface flooding, and riverine flooding are affecting our infrastructure systems, economic activities, and vulnerable populations. These challenges require structured analysis and deliberate planning. This Urban Climate Risk Profile provides a comprehensive assessment of current and projected climate risks facing the municipality under 2050 and 2100 scenarios.

The findings indicate that several critical systems—including storm water drainage, solid waste management, transport and mobility networks, and peri-urban agricultural systems—face persistent high to very high risk levels. Informal settlement residents and vulnerable groups are particularly exposed, with risk levels remaining very high across all climate scenarios assessed. The projections further demonstrate that without timely intervention, these risks will continue to intensify, especially under high-emissions pathways.

This report establishes a technical foundation for integrating climate resilience into municipal planning, budgeting, and infrastructure design. It underscores the need to strengthen drainage capacity, improve solid waste systems to reduce blockage-related flooding, enforce land-use controls in high-risk zones, protect riparian corridors, and enhance early warning and emergency response mechanisms.

As Municipal Manager, I reaffirm our commitment to mainstreaming climate adaptation into development planning and service delivery. Building resilience in Oyugis requires coordinated action among government agencies, development partners, the private sector, and the community. This document provides the evidence base necessary to guide those actions and secure a safer, more sustainable future for our municipality.

Board Chairperson,
Oyugis Municipal Board,
COUNTY GOVERNMENT OF HOMA BAY.

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Executive Summary

This Urban Climate Risk Profile presents the findings of a rapid climate risk assessment conducted for Oyugis Municipality. The results provide an evidence base for climate-resilient planning, infrastructure investment, and disaster risk reduction. The objective was to; Identify priority climate hazards affecting the municipality, Assess exposure, vulnerability, and risk across infrastructure systems, populations, and natural assets; and Project future risk levels under SSP2-4.5 (moderate emissions) and SSP5-8.5 (high emissions) scenarios for 2050 and 2100. The key hazards identified include changes in precipitation patterns, pluvial surface flooding (including flash and urban flooding), and fluvial (river) flooding. The assessment established that: First, precipitation variability and surface flooding present persistent very high risk to drainage systems, solid waste management, transport corridors, informal settlements, and agricultural systems across all time horizons. Second, water and wastewater systems show consistently low risk under precipitation change and fluvial flooding, but moderate risk under pluvial flooding, indicating localized rather than systemic vulnerability. Third, fluvial flooding, infrastructure systems largely remain at medium risk except solid waste and transport, but risk escalates in energy and economic sectors by 2100 under SSP5-8.5. Finally, priority interventions include: Upgrading storm water drainage capacity; integrating solid waste reform with flood management; protecting riparian corridors; climate-proofing transport and market infrastructure; strengthening land-use enforcement in informal and flood-prone areas; and scaling early warning and community-based disaster preparedness systems. The results indicate that without structural upgrades and regulatory enforcement, very high risk conditions will persist through 2100 across critical sectors of Oyugis Municipality.

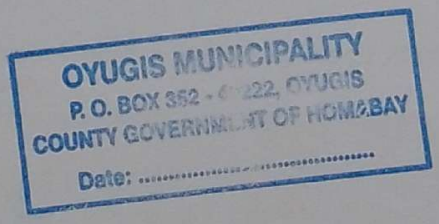

Table 1 shows the risk results summary for each hazard

Table 1. Summary of Changes in Precipitation Patterns Risks for Oyugis Municipality

Category	Risk Level				
	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
Infrastructure & Services					
Storm water Drainage	Very high	Very High	Very High	Very High	Very High
Water & Wastewater Management	Low	Low	Low	Low	Low
Solid Waste Management	Very high	Very High	Very High	Very High	Very High
Transport and Mobility	Very high	Very High	Very High	Very High	Very High
Energy	Medium	High	High	High	High
Economic Infrastructure	High	Very High	Very High	Very High	Very High
Social Infrastructure	Medium	High	High	High	High
Emergency Services	Low	Medium	Medium	Medium	Medium
Populations					
Urban Residents	High	Very High	Very High	Very High	Very High
Informal Settlement Residents	Very High	Very High	Very High	Very High	Very High
Vulnerable and Marginalized Groups	Very High	Very High	Very High	Very High	Very High
Natural Assets					
Urban Blue Infrastructure	High	Very High	Very High	Very High	Very High
Peri-urban and Agricultural Systems	Very High	Very High	Very High	Very High	Very High

Table 2. Summary of Pluvial Surface Flooding Including Flash Flooding and Urban Flooding risks for Oyugis Municipality

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

Category	Risk Level				
	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
Emergency Services	Low	Medium	Medium	Medium	Medium
Populations					
Urban Residents	High	Very High	Very High	Very High	Very High
Informal Settlement Residents	High	Very High	Very High	Very High	Very High
Vulnerable and Marginalized Groups	High	Very High	Very High	Very High	Very High
Natural Assets					
Urban Blue Infrastructure	Medium	Very high	Very High	Very High	Very High
Peri-urban and Agricultural Systems	High	Very High	Very High	Very High	Very High

Table 3. Summary of Fluvial (River) Flooding Risks for Oyugis Municipality

Category	Risk Level				
	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
Infrastructure & Services					
Stormwater Drainage	Medium	Medium	Medium	Medium	High
Water & Wastewater Management	Low	Low	Low	Low	Low
Solid Waste Management	Very High	Very High	Very High	Very High	Very High
Transport and Mobility	Very High	Very High	Very High	Very High	Very High
Energy	Medium	Medium	Medium	Medium	High
Economic Infrastructure	Medium	Medium	Medium	Medium	High
Social Infrastructure	Medium	Medium	Medium	Medium	High
Emergency Services	Low	Low	Low	Low	Low
Populations					
Urban Residents	Very High	Very High	Very High	Very High	Very High
Informal Settlement Residents	Very High	Very High	Very High	Very High	Very High
Vulnerable and Marginalized Groups	Very High	Very High	Very High	Very High	Very High
Natural Assets					
Urban Blue Infrastructure	High	High	High	High	Very High
Peri-urban and Agricultural Systems	Very High	Very High	Very High	Very High	Very High

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List of Acronyms

HOMAWASCO	Homa Bay Water and Sanitation Company
IDeP	Integrated Development Plan
KPLC	Kenya Power and Lighting Company
KEBS	Kenya Bureau of Statistics
PLUDP	Physical and Land Use Development Plan
SMEs	Small And Medium Enterprises
RCRA	Rapid climate risk assessment
SPI	Standardized Precipitation Index
SSP	Shared Socioeconomic Pathway
SSP2-4.5	Shared Socioeconomic Pathway 2" (middle-of-the-road development) combined with a "4.5" radiative forcing pathway
SSP2-8.5	Shared Socioeconomic Pathway 2" (very high emissions) combined with a "8.5" radiative forcing pathway
UCRP	Urban Climate Risk Profile

1. Context

1.1. Objective

This Urban Climate Risk Profile aims to identify, assess, and communicate current and future climate risks in Oyugis Municipality to inform climate-resilient infrastructure investment, urban planning, and policy decisions.

1.2. Urban Context

1.2.1. Geographic area

The Rapid Climate Risk Assessment (RCRA) is based on the official municipal boundary as defined in the Oyugis Municipality Delineation Report, in accordance with the Urban Areas and Cities Act, 2011 (as amended). The geographic scope of the Urban Climate Risk Profile corresponds to the urban boundary shown in Figure 1, which represents the legally recognized extent of the municipality for planning, governance, and service delivery purposes.

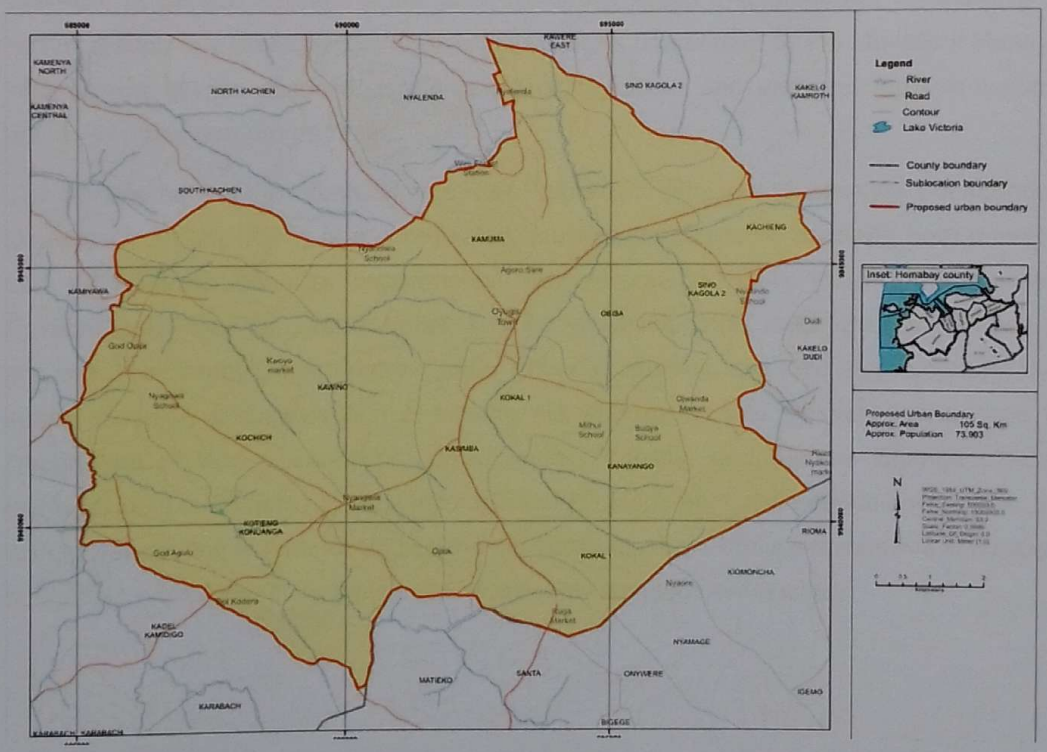


Figure 1: Oyugis Municipality Boundary

As illustrated in the map, Oyugis Municipality covers an approximate area of 105.9 km² with an estimated population of about 73,900 persons Oyugis Municipality Delineation Report,

2023). The municipal boundary encompasses Oyugis Town as the urban core and extends to surrounding residential, commercial, institutional, agricultural, and peri-urban areas that are functionally linked to the town. The key administrative units covered by the municipality include Central Kasipul, South Kasipul, West Kasipul, East Kamaga, and West Kamagak wards. South Kasipul and West Kamagak wards cover the largest part of the municipality. Other administrative units include Kamuma, Kochich, Sino Kagola 2, Kachieng', Kokal, Kawino, Kotieno Konuong'a, Kasimba, and Obisa sub-locations.

1.2.2. Governance Structure

The governance of Oyugis Municipality is established in accordance with the Urban Areas and Cities Act, 2011 (as amended) and the devolved system of government under the Constitution of Kenya and the County Government Act of 2012. Overall responsibility for the municipality rests with the County Government of Homa Bay County, which provides policy direction, oversight, and technical support for urban planning, service delivery, and development programming. At the municipal level, strategic oversight is provided by the Oyugis Municipal Board, which is responsible for policy guidance, approval of municipal policies and plans, and oversight of service delivery in line with the Urban Areas and Cities Act. The day-to-day administration and management of the municipality is undertaken by the Municipal Manager, who serves as the accounting and coordinating officer and ensures implementation of approved plans and programmes.

The development of the Urban Climate Risk Profile (UCRP) and subsequently, the Integrated Development Plan (IDeP) is a coordinated, multi-sectoral process involving both municipal and county-level technical departments. Key responsible units include the municipal Environment, Planning, Public Works, and Social Development units which spearhead the process. The County Department of Lands, Physical, Housing, and Urban Development leads spatial planning and integration of climate risk information into statutory plans while the Department of Water, Sanitation, Environment, Forestry, and Climate Change provides technical input on climate hazards, environmental management, and adaptation priorities. The county Department of Finance and Economic Planning, aligns climate-responsive actions with budgeting, capital investment planning, and county development priorities.

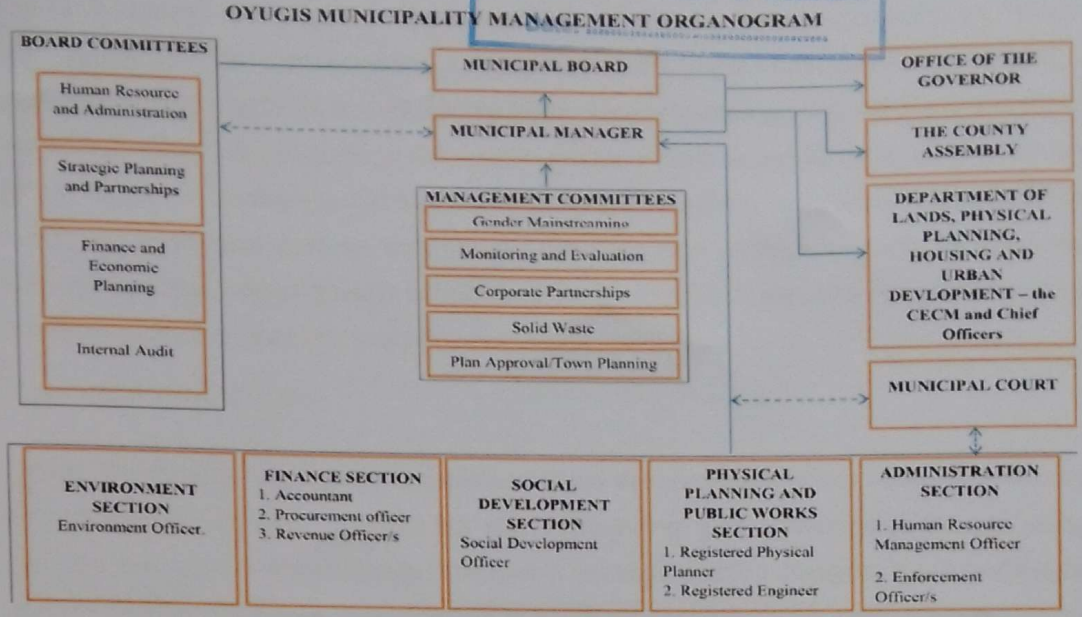


Figure 2: Oyugis Municipality Organogram.

The governance structure of Oyugis Municipality, as illustrated in Figure 2, provides the institutional framework for the preparation, validation, and implementation of the UCRP and its integration into the IDeP.

1.2.3. Socio-economic Context

According to the Oyugis Municipality Delineation report and the 2019 Housing and Population Census (KEBS, 2019), Oyugis Municipality has a total population of 73,903 spread across 15 sub-locations as listed in table 4.

Table 4. Population per Sub-Location

FID	Sub Location name	Year stat.	Sect Area	% Area covered	Covered Pop.
1	SinoKagola2	2019	2152887.875	11.90554286	762
2	Nyalenda	2019	1306622.366	8.636939454	706
3	Kachieng	2019	7032197.19	37.3581464	3,850
4	South Kachieng	2019	3359311.854	34.99542105	1,407
5	Obisa	2019	14175584.54	97.70138985	5,733
6	Kamuma	2019	14555560.14	94.93163999	8,293
7	Kawino	2019	12897460.48	82.9076924	5,835
8	Kamiyawa	2019	2371908.581	10.88990355	189
9	Kotieno Kochich	2019	10306076.67	91.69138919	8,010
10	Kokal1	2019	4925818.987	100.00	6,289
11	Kasimba	2019	4586323.92	93.13389867	3,848
12	Kanyango	2019	9076477.644	95.32069355	5,672
13	Kotieno Konuanga	2019	11951225.32	92.863638	5,436
14	Kadel Kamidigo	2019	974731.5573	3.863814242	262
15	Oyugis Town	2019		100.00	17,610
				Grand Total	**73,903**

The 2019 Housing and Population Census estimates that the population growth rate for Homa Bay County is 2.3%. Consequently, the population of Oyugis Municipality is projected to increase to 80,702 by 2030 and 89,200 by 2035. This projected growth will place increased demand on urban infrastructure, water supply, sanitation, and social services, all of which are critical factors in assessing climate vulnerability and planning adaptation measures.This demographic analysis ensures that climate risk mitigation strategies—such as improving drainage systems, securing water supply, and enhancing health services—are responsive to the municipality's current and projected population realities.

1.2.4. Economic Context

Oyugis Municipality functions as a commercial and economic hub within Homa Bay County, serving not only its own residents but also surrounding rural communities through trade, services, and agricultural exchange. The town's strategic location along the Kisumu–Oyugis–Kisii A1 Highway facilitates the movement of goods and people, reinforcing its role in regional commerce and market linkages. Although detailed municipal-level GDP data are not published separately, the economic structure of Oyugis reflects that of the wider county economy, which is heavily rooted in agriculture, trade, and small-scale industry. Agriculture in Homa Bay County engages a significant share of the labor force, with approximately 74% of the county's workforce involved in agricultural activities, though the sector contributes only about 25% to the Gross County Product. This disparity highlights structural productivity challenges and the need to expand value addition and market access.

Within the municipality, crop production and livestock rearing are major economic activities, with about 70% of households engaged directly or indirectly in farming for subsistence and commercial purposes. The primary crops include maize, cassava, sweet potatoes, groundnuts, bananas, and vegetables, with livestock farming—especially cattle, poultry, and beekeeping—providing additional income streams and food security. While the economy remains predominantly agrarian, agricultural output supports local commerce and underpins informal and formal market activity in Oyugis. Trade and commerce in Oyugis are diversified across retail, wholesale, and services sectors. The town supports a range of small and medium enterprises (SMEs), including retail shops, wholesale suppliers, service providers (banking, plumbing, and construction), microfinance institutions, and formal banking services from multiple commercial banks. The presence of four major banks and microfinance operations indicates financial intermediation that can support entrepreneurship and local investment.

Industrial activity in Oyugis remains small-scale but growing, with informal industries in the jua kali sector (metalworking, carpentry, tailoring, and workshops) and early stages of value-added processing. Recent private sector interest includes the planned sweet potato processing plant aimed at producing industrial starch, flour, and related products, which is expected to diversify income sources, create jobs, and strengthen the local economic base (Homa Bay County CIDP, 2023). Public infrastructure development and external investments also contribute to the economic context. Upgrading of the Oyugis modern market and Bus Park has created space for more than 1,300 traders, formalizing economic activity and expanding commercial density. Improved transportation infrastructure and water projects are enhancing economic efficiency, reducing transaction costs, and supporting growth in basic services.

Looking forward, several economic trends and projects are poised to shape the municipality's growth to 2035. Initiatives at the county level—such as investment in climate-resilient water supply and sanitation infrastructure, expansion of agricultural value chains, and informal settlement improvement programs like the Kenya Informal Settlement Improvement Program Phase 2 (KISIP 2) - will influence economic resilience and employment. The county's development strategy includes upgrading roads, enhancing market access, and supporting agribusiness, which will benefit Oyugis' role as a regional commercial center. The economic profile of Oyugis Municipality has direct relevance to climate risk planning. The heavy reliance on agriculture exposes the local economy to climate variability, such as droughts or floods, which can affect crop yields, livestock health, and income stability. Informal and SME sectors, which provide a substantial proportion of employment, are sensitive to infrastructure deficits and climate impacts on transport, water supply, and public services. Understanding current economic conditions and projected economic development trajectories allows planners to integrate economic resilience measures—such as diversification of value addition, climate-smart agriculture, and investment in resilient infrastructure—into the climate risk profile, ensuring that growth pathways align with sustainable development goals.

1.2.5. Land-use Context

Oyugis Municipality's land use is shaped by its role as a growing urban center with an expanding built environment and significant peri-urban agricultural areas. The *municipality's* planning area covers approximately 1,493.9 hectares, encompassing the urban core and adjacent lands where urban expansion is most active. The current land use pattern reflects a mix of residential, agricultural, commercial, public, and infrastructure zones, with residential and agricultural uses dominating the landscape.

Agriculture (pure and mixed with residential uses) accounts for the largest portion of land within Oyugis' planning area, covering approximately 33.8% for pure agriculture and an additional 43.4% when agricultural land mixed with residential uses is included. This reflects the continued importance of farming—both subsistence and smallholder cash cropping—as a land use even within peri-urban zones. Residential land constitutes around 33.6% of land use, making it the single largest developed category in terms of urban settlement areas. Other land use categories include transportation (6.7%), educational facilities (3.2%), commercial areas (2.1%), and public utilities (0.03%). Industrial uses are minimal at present (0.05%), but light and medium enterprises such as bakeries, dairy cooling, honey processing, and jua kali workshops exist and signal the potential for industrial expansion. Conservation and riparian areas (wetland and vegetation) occupy a modest portion of the planning area, highlighting the presence of sensitive environments that influence spatial distribution.

Projected land use in Oyugis Municipality is critical for understanding climate exposure and vulnerability. By 2031, residential areas are expected to expand from 33.6% to approximately 43% of the planning area, reflecting population growth and urban densification. Planned industrial zones and agro-processing areas along transport corridors will concentrate economic activity but may increase exposure to storm water and flood hazards without proper drainage. Expansion of infrastructure, roads, and utilities will intersect with peri-urban agricultural lands, which remain vital for livelihoods but are highly sensitive to climate variability, including droughts and extreme rainfall. Conservation and riparian zones are designated as buffers to protect ecosystems and mitigate flooding, emphasizing their role in climate adaptation. Integrating these projected land use changes into the climate risk profile allows planners to identify high-risk areas, prioritize resilient infrastructure, safeguard livelihoods, and guide sustainable urban expansion, ensuring that growth aligns with both development and climate resilience objectives.

1.3. Key Stakeholders & Inclusiveness

Key stakeholders were identified through a structured stakeholder mapping and analysis process conducted at the outset of the Urban Climate Risk Profile preparation. This process combined a review of existing institutional frameworks, municipal and county development plans, sector mandates, and service delivery responsibilities with consultations among municipal technical staff. Stakeholders were then categorized based on their level of influence over urban development and climate-related decision-making, and their level of interest or exposure to climate risks (Table 5).

Stakeholders with high influence, including municipal officials, county government departments, national government agencies, and the National Government Administration Officer, were identified based on their statutory mandates in urban planning, infrastructure development, water and sanitation, disaster risk management, and environmental regulation. These stakeholders were involved through technical working groups, inception and validation workshops, and bilateral meetings. Their role included providing data, validating hazard and impact assessments, and ensuring alignment of the risk profile with existing policies, plans, and regulatory requirements.

Actors such as the local media and the Homa Bay Water and Sanitation Company were identified due to their influence on public communication and essential service provision. Their involvement focused on information-sharing sessions, targeted consultations, and dissemination of key findings to support public awareness and transparency during the risk profiling process. Stakeholders with lower influence, including the business community and rural communities, were identified through local economic and spatial analyses, as well as community outreach by municipal authorities. Their involvement was mainly consultative, using public forums, stakeholder meetings, and feedback sessions to capture perceptions of climate impacts on livelihoods, markets, and rural–urban interactions.

Community-based organizations, civil society organizations, vulnerable and marginalized groups, and university and research institutions were identified through existing community networks, social development registers, and institutional partnerships. These stakeholders were involved through participatory consultations, focus group discussions, and technical inputs, particularly in relation to social vulnerability, local adaptation practices, and evidence-based risk analysis. Their engagement ensured that community perspectives and scientific knowledge informed the assessment and that inclusivity considerations were integrated into the Urban Climate Risk Profile.

Table 5. Stakeholder mapping for Oyugis Municipality

High	**High Influence – Low Interest** • Local Media • Homa Bay Water and Sanitation Company	**High Influence – High Interest** • Municipal officials • County Government Officials • National Government Agencies • National Government Administration Officer
	Low Influence – Low Interest • Business community • Peri-urban communities	**Low Influence – High Interest** • Community-Based Organizations, Community • Civil Society Organizations • Vulnerable and marginalized groups • University and Research Institutions
Low		High

2. Hazard Assessment

This section presents the hazard assessment for the Oyugis Municipality as part of the Urban Climate Risk Profile. It identifies and screens key climate-related hazards that currently affect, or are likely to affect, the municipality under present and future climate conditions. The assessment is based on a review of historical climate trends, observed environmental conditions, and projected climate variability, with particular attention to hazards that pose significant risks to people, infrastructure, service delivery, and livelihoods. The purpose of this section is to establish a clear understanding of priority climate hazards to inform subsequent analysis of exposure, vulnerability, and risk, and to guide the identification of appropriate climate resilience and adaptation measures. For a climate hazard to be considered key, it must be likely to occur, have significant impact, and be a high priority.

2.1. Key Climate Hazards

Table 6. Hazard screening for Oyugis 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	N	N	N
Average ocean temperature increase	N	N	N	N
Extreme heat	Y	N	N	N
Marine heatwaves	N	N	N	N
Cold Stress				
Average surface temperature during winter	N	N	N	N
Extreme cold (e.g., cold spells, frost)	N	N	N	N
Snowfall and ice storms	N	N	N	N
Flooding				
Changes in precipitation patterns	Y	Y	Y	Y
Pluvial (surface level) flooding, including flash flooding and urban flooding	Y	Y	Y	Y
Fluvial (river) flooding	Y	Y	Y	Y
Sea level rise	N	N	N	N
Coastal flooding, including storm surges	N	N	N	N
Waterlogging	Y	N	N	N
Water Stress				
Drought (meteorological, hydrological)	N	Y	Y	N
Groundwater salinization	Y	N	N	N
Saline intrusion	N	N	N	N
Wildfire				
Wildfires & bushfires	Y	N	N	N
Storms				
Extreme wind	Y	Y	N	N
Tropical cyclones	N	N	N	N
Sand and dust storms	N	N	N	N

Hazard	Hazard Likely (Y/N)	Significant Impact (Y/N)	High Priority (Y/N)	Key Hazard (Y/N)
Hailstorms	N	Y	N	N
Mass Movement				
Landslides	N	N	N	N
Coastal erosion	N	N	N	N
Gully erosion	Y	Y	N	N
Marine Conditions				
Ocean acidification	N	N	N	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 7. Climate indicators and hazard thresholds selected for the assessment

Key Hazard	Climate indicator	Data source	Threshold		
			Low	Medium	High
Changes in Precipitation Patterns	+ values = wet conditions - values = dry conditions	Kenya Metrological Department -SPI	-0.99 to +0.99	-1.0 to -1.49 +1.0 to +1.49	< - 2.0 > +2.0
Pluvial (surface level) flooding, including flash flooding and urban flooding	Number of days with precipitation >50mm	World Bank Climate Change knowledge 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

2.3. Current Hazard Levels and Climate Projections

Table 8. Current and future hazards levels for Oyugis Municipality

Hazard	Hazard Level				
	Current (Baseline)	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
Changes in Precipitation Patterns	Medium	High	High	High	High
Pluvial (surface level) flooding, including flash flooding and urban flooding	Low	High	High	High	High
Fluvial (river) flooding	Flooding	Flooding	Flooding	Flooding	Flooding

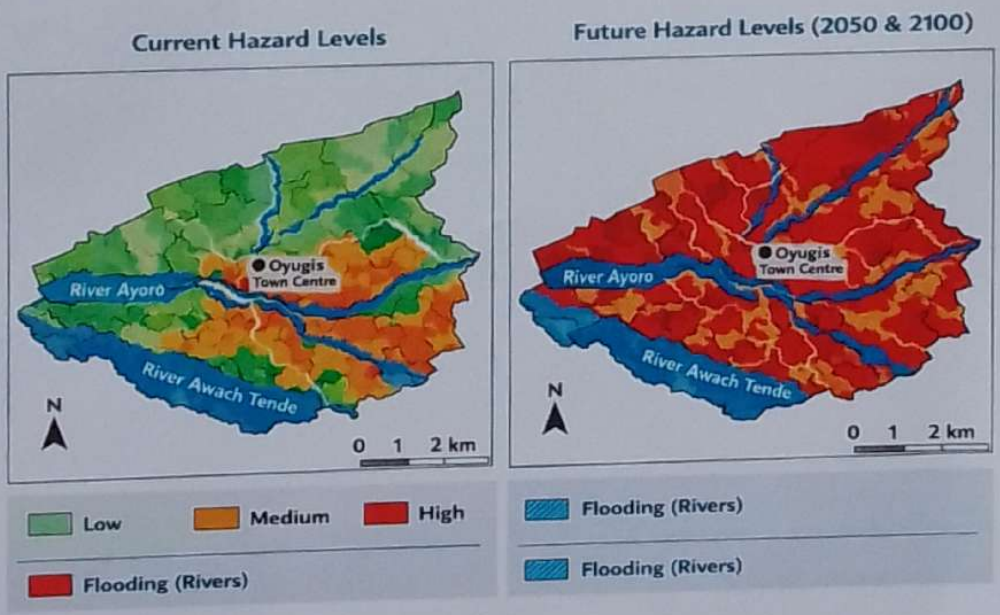
For this Urban Climate Risk Profile, hazard levels should be interpreted in accordance with the table below.

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

Figure 3. Map of Current and Future Hazard Impact Areas



The maps (Figure 3) illustrates current and projected future hazard levels for Oyugis Municipality, highlighting spatial variations in climate-related risks. Under current conditions, most areas experience low to medium hazard levels, with higher risks concentrated along major river corridors, including River Ayoro and River Awach Tende. Flood-prone zones are clearly delineated along these waterways. In future projections (2050 and 2100), hazard levels intensify significantly, with large portions of the municipality shifting to high-risk categories. The expansion of red-shaded areas indicates increased frequency and/or intensity of hazard events, while riverine flooding zones remain persistent and highly vulnerable across both current and future scenarios.

3. Exposure & Vulnerability Assessment

This section presents the exposure and vulnerability assessment for the urban area, focusing on the people, assets, systems, and services that are susceptible to the identified climate hazards. It examines the spatial distribution of exposed populations and critical infrastructure, as well as the social, economic, and environmental factors that influence their sensitivity and capacity to cope with climate-related shocks and stresses. The assessment integrates demographic, land use, infrastructure, and livelihood considerations to highlight who and what is most at risk, and why. The findings provide a basis for understanding differential impacts across the municipality and for prioritizing targeted climate resilience and adaptation interventions.

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				
Storm water Drainage	Storm water drainage conveyance network	Y	N	Open drains and walk way channels along summit line (CBD) serving key business, drainage system along A1 road, Masogo road, Kendu Bay Road, Gamba road and all marram roads linking key areas.
	Storm water storage	Y	N	Natural depressions and low-lying areas in Jua Kali, A Thousand Street, lower Masogo, and flood plains along River Ayoro and River Awach. Wetland in Pasaka and Oyugis primary school area which is a major water catchment area
Water & Wastewater Management	Pumping stations	N	N	NA
	Groundwater abstraction	N	N	NA
	Water treatment facilities	Y	N	HOMAWASCO water treatment plant in Atemo that serves the entire municipality
	Water supply networks	Y	N	HOMAWACO oyugis distribution network serving the entire municipality
	Sewer networks	N	N	NA

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Wastewater treatment facilities	N	N	NA
Solid Waste Management	Transfer facilities	N	N	NA
	Landfills and dump sites	Y	N	Nyalenda Dumpsite receive all solid waste from the municipality
	Recycling centers	Y	N	Informal waste holding sites in Onanda and Migingo area serving the entire municipal CBD. Nyalenda dumpsite serving the entire municipality.
	Collection fleet	Y	N	Municipal and private waste collection vehicles serving residential and commercial areas
Transport and Mobility	Road networks	Y	N	Primary and secondary roads connecting residential and commercial
	Bridges	Y	N	Ayaro river bridges linking Oyugis Municipal CBD to Kokal and Konyango sub-locations. Owade bridge on the A1 road
	Public transport networks (rail, bus, mini-bus, etc.)	Y	N	Informal and semi-formal matatu and motorbike routes serving daily commuter movement within the municipality and to surrounding areas.
	Transportation terminals	N	N	NA
	Vehicle depots	N	N	NA
	Non-motorized transport networks	Y	N	Footpaths and informal walkways used by all residents
	Freight and logistics hubs	N	N	NA
Energy	Energy power plants	N	N	NA
	Poles and power lines	Y	N	Electricity distribution infrastructure serving the entire municipality
	Transformers and substations	N	N	NA
	Street lighting	N	N	NA
Economic Infrastructure	Markets	Y	N	Open-air and semi-permanent markets serving large populations in Oyugis Municipality
	Businesses and commercial hubs	Y	N	Concentrated commercial areas within CBD, a Thousand street, Masogo area, Aloo Estate, and District hospital area,

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Industrial zones/parks and logistics parks	N	N	NA
Social Infrastructure	Government buildings and service centers	Y	N	Municipal Board Offices.
	Education facilities	Y	N	Schools and training institutions serving children and youth
	Healthcare facilities	Y	N	Health centers and clinics serving the municipality; flooding impairs access, service delivery, and emergency response
	Public spaces	N	N	NA
	Faith-based buildings	Y	N	Churches and other worship facilities; sometimes serve as informal shelters during flood events.
	Cultural and heritage assets	N	N	NA
Emergency Services	Fire stations	N	N	NA
	Police stations	N	N	NA
	Telecommunications networks	N	N	NA
	Early warning systems	N	N	NA
	Disaster management centers and shelters	N	N	NA
	Evacuation routes	N	N	NA
Populations				
Urban Residents	Population	Y	N	Entire municipal population exposed to climate hazards, particularly flooding and rainfall variability.
	Households	Y	N	Households living along River Ayoro and Awach, those living in Masogo estate, Aloo estate and the peri-urban areas experience serious flooding disruptions.
Informal Settlement Residents	Population living in informal settlements	Y	N	About 50% of the population live in informal settlements like Jua Kali estate, Thousand street; and Masogo
	Households lacking land tenure	Y	N	All households in Jua Kali and a few in Thousand street

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Households / residents lacking access to basic services	Y	N	No sewerage services. Some residents lack access to clean water and electricity.
Vulnerable and Marginalized Groups	Low-income households	Y	N	Form more than 50% of the entire population.
	Women-headed households	Y	N	About 25% of women-headed households
	Children and youth	Y	N	More than 50% of the entire population
	Elderly persons	Y	N	Largely within the peri-urban areas of the municipality.
	People with disabilities (PWD)	Y	N	About 5% of the population
	Homeless populations	N	N	NA
	Unemployed or precariously employed workers	Y	N	Form the majority of the population
	Seasonal workers / migrant laborers	N	N	NA
	Nomadic groups in peri-urban areas	N	N	NA
	Urban refugees and migrants	N	N	NA
	Minority ethnic groups in urban areas	N	N	NA
Natural Assets				
Urban Green Infrastructure	Urban parks and gardens	N	N	NA
	Green corridors	N	N	NA
	Street landscaping	N	N	NA
	Urban forests and forest reserves	Y	N	Kodera forest, a gazette forest
Urban Blue Infrastructure	Natural wetlands	Y	N	Seasonal wetlands along Awach floodplain and lower Masogo
	Rivers	Y	N	River Ayoro, River Awach
	Riparian zones	Y	N	Areas along River Ayoro and Owade

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Lakes, ponds and reservoirs	N	N	NA
	Coastal ecosystems	N	N	NA
	Urban agriculture	Y	N	Riverbank farming along Ayoro and Awach; backyard farming in the most estates
Peri-urban and Agricultural Systems	Peri-urban agriculture	Y	Y	Ruga, Nyangi'ela, Dol Kodera, Karabok, Sikri, Nyatindo, and Kokal areas support peri-urban agriculture
	Agroforestry systems	Y	Y	Trees with crops and/or livestock within homesteads and peri-urban farms. Common practices include boundary tree planting and fruit trees (mango and avocado)
	Forests and forest reserves	Y	N	Wire forest, a gazetted and major forest in the municipality
	Protected areas and national parks	N	N	NA
	Savannahs and rangelands	N	N	NA

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

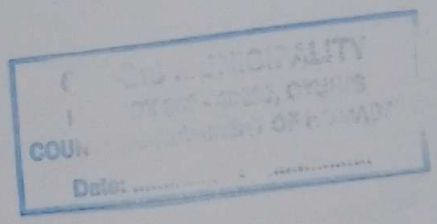
		Vulnerability Level		
		Low	**Medium**	**High**
Exposure Level	**High**	Moderate	Major	Catastrophic
	Medium	Minor	Moderate	Major
	Low	Insignificant	Minor	Moderate

Table 13. Exposure, Vulnerability, and Impacts of Changes in Precipitation Patterns on Urban Elements

Hazard: Changes in Precipitation Patterns

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Infrastructure & Services					
Storm water Drainage	• Critical drainage assets concentrated in hazard-prone CBD and road corridors; high sensitivity due to open drains and weak maintenance.	High	**Sensitivity:** • Predominantly open, undersized drains unable to convey peak rainfall • Chronic blockage from sediment and solid waste **Adaptive Capacity:** • No detention, retention, or flood storage infrastructure • Weak preventive maintenance and inadequate financing	High	Catastrophic
Water & Wastewater Management	• Few HOMAWASCO critical assets directly exposed; relatively high adaptive capacity despite absence of sewerage.	Low	**Sensitivity:** • Few critical water assets located in high-risk zones **Adaptive Capacity:** • High quality pipes • Exhaustion services for septic tanks.	Low	Insignificant
Solid Waste Management	• Waste holding sites in Onanda and Migingo areas and Nyalenda disposal site widely exposed; open	High	**Sensitivity:** • Waste storage and disposal sites located within residential and flood-prone areas • Open dumping allows rapid waste dispersion during rainfall	High	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	dumping and weak control amplify rainfall impacts.		**Adaptive Capacity:** • No engineered disposal or containment systems • Collection systems insufficient to prevent accumulation before storms		
Transport and Mobility	High-value road networks (A1, C26, D220, and C18) and most marram roads linking key areas exposed; poor surfaces and river crossings create high sensitivity.	High	**Sensitivity:** • Extensive reliance on gravel and earth roads highly vulnerable to wash-outs • River crossings without adequate hydraulic capacity **Adaptive Capacity:** • Irregular maintenance and delayed repairs	High	Catastrophic
Energy	• Moderate exposure of distribution infrastructure	Medium	**Sensitivity:** • Exposure of distribution infrastructure to both drought and flooding **Adaptive Capacity:** • Concrete poles that can withstand floods	Medium	Moderate
Economic Infrastructure	• Food and livestock markets and small businesses highly exposed to significant variation precipitation patterns.	Medium	**Sensitivity:** • Onanda market, cattle auction market, and some businesses located on slopes and flood-prone land • Predominance of informal, non-resilient structures **Adaptive Capacity:** • Minimal investment in climate-resilient infrastructure • Low access to credit and insurance	High	Major
Social Infrastructure	• Schools and health facilities intermittently affected; moderate	Medium	**Sensitivity:** • Drainage and access constraints around facilities • Service disruptions during extreme weather	Medium	Moderate



Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	sensitivity and institutional capacity.		**Adaptive Capacity:** • Institutional management structures in place.		
Populations					
Urban Residents	• Widespread but not uniform exposure; moderate adaptive capacity through food inflows.	Moderate	**Sensitivity:** • High reliance on climate-sensitive food and water systems • Limited household buffering capacity **Adaptive Capacity:** • Access to regional food markets • Social networks supporting short-term coping	Medium	Major
Informal Settlement Residents	• Residents of Jua Kali and A Thousand Street highly exposed	High	**Sensitivity:** • Poor housing quality and insecure tenure • High livelihood exposure to weather variability **Adaptive Capacity:** • Very limited savings or assets • Minimal access to formal support system	High	Catastrophic
Vulnerable and Marginalized Groups	• High exposure combined with poverty, dependency, and weak social protection.	High	**Sensitivity:** • High dependency and limited mobility • Disproportionate exposure to service disruptions **Adaptive Capacity:** • Weak and inconsistent social protection • Limited access to early warning and assistance	High	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Natural Assets					
Urban Blue Infrastructure	• Rivers and wetlands highly exposed and sensitive due to encroachment.	High	**Sensitivity:** • Encroachment reduces flood buffering capacity • Pollution degrades ecological function **Adaptive Capacity:** • Low natural regenerative potential • Weak enforcement capacity	Medium	Major
Peri-urban and Agricultural Systems	• Rain-fed systems highly exposed and highly sensitive to rainfall variability.	High	**Sensitivity:** • Rain-fed production systems with high climate dependence **Adaptive Capacity:** • Limited uptake of climate-smart agriculture • Minimal irrigation or water harvesting	High	Catastrophic

Table 14. Exposure, Vulnerability, and Impacts of Pluvial (surface level) flooding, including flash flooding and urban flooding on Urban Elements

Hazard: Pluvial (surface level) flooding, including flash flooding and urban flooding

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Infrastructure & Services					
Stormwater Drainage	• Core drainage infrastructure lies directly within flood footprint; very limited adaptive capacity	High	**Sensitivity:** • Undersized and blocked drains within flood footprint • High runoff from impervious surfaces **Adaptive Capacity:** • No engineered detention or retention.	High	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Water & Wastewater Management	• Few shallow HOMAWASCO pipes exposed to inundation	High	**Sensitivity:** • Shallow pipes, lack of sewerage **Adaptive Capacity:** • Limited emergency treatment.	High	Catastrophic
Solid Waste Management	• Open dumping and waste sites directly mobilized during floods.	High	**Sensitivity:** • Open dumps mobilized by flood water • Absence of waste transfer stations **Adaptive Capacity:** • Poor enforcement • Occasional clean-up campaigns	High	Catastrophic
Transport and Mobility	• Gravel roads linking key areas exposed; poor surfaces and river crossings create high sensitivity. Gravel roads and footpaths form primary mobility network; few alternatives during flooding.	High	**Sensitivity:** • Poor road drainage designs **Adaptive Capacity:** • Informal alternative routes. • Poor maintenance	High	Catastrophic
Energy	• Localized flooding cause outages and safety hazards due to power poles falling.	Medium	**Sensitivity:** • Exposed ground installations. **Adaptive Capacity:** • Moderate response capacity.	Medium	Moderate
Economic Infrastructure	• Markets and businesses highly exposed and poorly sensitive due to informal structures and lack of resilience.	High	**Sensitivity:** • Ground-level informal premises **Adaptive Capacity:** • Low financial buffers.	High	Catastrophic
Social Infrastructure		Medium	**Sensitivity:** • Poor access roads.	Medium	Moderate

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
	• Several facilities exposed but with some institutional coping capacity.		**Adaptive Capacity:** • Some Institutional responses		
Urban Residents	• Dense settlements in low-lying areas of Ayoro frequently inundated	High	**Sensitivity:** • High density settlement **Adaptive Capacity:** • Uneven household coping mechanisms • Minimal targeted early warning	High	Catastrophic
Informal Settlement Residents	• Concentration of informal housing in flood-prone zones that include A Thousand Street and Jua Kali	High	**Sensitivity:** • Poor housing quality **Adaptive Capacity:** • Very limited	High	Catastrophic
Vulnerable and Marginalized Groups	• High exposure combined with mobility and social constraints.	High	**Sensitivity:** • Physical and social constraints. **Adaptive Capacity:** • Week targeted support	High	Catastrophic
Natural Assets					
Peri-urban and Agricultural Systems	• Floodwater damages crops and soils near urban edges.	High	**Sensitivity:** • Floodplain farming. **Adaptive Capacity:** • Limited drainage control	High	Catastrophic

Table 15. Exposure, Vulnerability, and Impacts of Fluvial (river) flooding on Urban Element

Hazard: Fluvial (river) flooding

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Infrastructure & Services					
Stormwater Drainage	• Drainage outlets moderately affected by river backflow; no flood control.	Medium	**Sensitivity:** • Lack of flap gates or non-return valves allow reverse flow into upstream drainage networks during peak river stages. **Adaptive Capacity:** • Absence of engineered flood control structures (e.g., levees, flood gates, retention basins) limits system-wide resilience.	Medium	Moderate
Water & Wastewater Management	• Few HOMAWASCO water infrastructure near rivers	Low	**Sensitivity:** • Informal disposal sites located along riverbanks are directly mobilized during high-flow events. **Adaptive Capacity:** • High-quality, durable piping reduces breakage risk during soil saturation	Low	Insignificant
Solid Waste Management	• Few informal waste disposal sites along river banks washed into rivers	Moderate	**Sensitivity:** • Direct wash-off into rivers. **Adaptive Capacity:** • Weak enforcement of riparian setback regulations permits continued dumping.	Moderate	Catastrophic
Transport and Mobility	• Bridges and access roads near river Ayoro and Owade crossings overtopped or eroded.	High	**Sensitivity:** • Key access roads lie within river crossing zones, creating single-point failure risks. **Adaptive Capacity:** • Delayed capital investment in bridge reinforcement and embankment stabilization.	High	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Energy	• Power lines near river corridors exposed to damage	Medium	**Sensitivity:** • Pole foundations weaken under prolonged soil saturation • Overhead power lines near riparian corridors are exposed to falling trees and bank erosion. **Adaptive Capacity:** • KPLC maintain technical capacity for emergency line restoration.	Medium	Moderate
Social Infrastructure	• Facilities rely on road access vulnerable to flooding.	Medium	**Sensitivity:** • Health and education facilities rely on flood-prone access roads for service continuity. **Adaptive Capacity:** • Some contingency planning and emergency response mechanisms exist	Medium	Moderate
Emergency Services	• Limited direct exposure; alternative routes available.	Low	**Sensitivity:** • Critical facilities are generally located outside direct floodplains. • Structural standards for main facilities are comparatively robust. **Adaptive Capacity:** • Availability of alternative crossings	Low	Insignificant
Populations					
Urban Residents	• Many houses are located in flood plains.	High	**Sensitivity:** • Settlements located within active floodplains experience recurrent inundation. • Housing typologies lack elevation or flood-resistant construction features.	High	Catastrophic

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			Adaptive Capacity: • Limited formal relocation programs or land tenure security. • Low household savings and limited access to disaster risk financing.		
Informal Settlement Residents	• Insecure housing along River Ayoro and Owade directly within flood footprint.	High	**Sensitivity:** • Structures constructed from lightweight materials with weak foundations. **Adaptive Capacity:** • Minimal access to early warning systems and evacuation infrastructure.	High	Catastrophic
Vulnerable and Marginalized Groups	• Severe evacuation and safety risks due to dependency and mobility limits.	High	**Sensitivity:** • Elderly, disabled, and dependent populations face mobility constraints during flooding **Adaptive Capacity:** • Weak targeting of social protection during flood emergencies.	High	Catastrophic
Natural Assets					
Peri-urban and Agricultural Systems	• Floodplain agriculture repeatedly inundated with little protection	High	**Sensitivity:** • Cultivation within active floodplains leads to repeated crop submergence and soil erosion. **Adaptive Capacity:** • Minimal investment in flood-resilient cropping systems or elevated farming techniques.	High	Catastrophic

4. Climate Risk Assessment

This section synthesizes the results of the hazard assessment and impact analysis to determine overall climate risk levels for Oyugis Municipality. Risk is derived by combining the assessed hazard level (likelihood and intensity of the climate event) with the estimated impact level on each urban element.

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.

3.3. Current and Future Climate Risks on Urban Elements

Table 18. Summary of Changes in Precipitation Patterns risks for Oyugis Municipality

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

Table 19. Summary of Pluvial (surface flooding) risks for Oyugis Municipality

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

Table 20. Summary of Fluvial (River) risks for Oyugis Municipality

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

3.4. Climate Risk Hotspot

The climate risk profile of Oyugis Municipality demonstrates a spatially concentrated pattern of high and very high risk, shaped by hydrological corridors, low-lying terrain, infrastructure clustering, and socio-economic vulnerability. When hazard levels are combined with assessed impact levels using the adopted risk matrix, the resulting distribution of risk is not uniform

across the municipality. Instead, distinct hotspots emerge where exposure, sensitivity, and limited adaptive capacity intersect.

The Central Business District, including the Summit Line corridor, A Thousand Street, and the A1 road axis, constitutes a primary infrastructure and economic hotspot. This area contains dense commercial development, high impervious surface coverage, and critical transport corridors. Storm water drainage infrastructure is largely open, undersized, and poorly maintained, resulting in high sensitivity to intense rainfall events. Under current climate conditions, changes in precipitation patterns already produce moderate to high impacts, but under projected 2050 and 2100 scenarios (SSP2-4.5 and SSP5-8.5), hazard levels increase to high, and impacts on drainage, transport, and solid waste systems remain catastrophic. Consequently, overall risk is classified as very high. Drainage networks along A1, Masogo, Kendu Bay, and Gamba roads, together with informal markets and waste holding sites that exacerbate blockages, form a concentrated red-zone cluster in spatial risk representation. Disruption in this corridor has cascading effects on mobility, trade, and municipal service delivery.

Jua Kali Estate and A Thousand Street represent the most acute population-level hotspots. These informal settlements are located within or adjacent to flood-prone depressions and near River Ayoro. Housing typologies are structurally weak, tenure security is limited, and household adaptive capacity is minimal. Under all three hazards—changes in precipitation patterns, pluvial flooding, and fluvial flooding—hazard levels range from medium to high, while impact levels remain catastrophic due to high exposure and extreme vulnerability. The resulting risk classification is consistently very high across current and future scenarios. Limited early warning systems, constrained evacuation routes, and low savings or asset buffers compound the severity of projected impacts. These areas therefore form the core social vulnerability cluster within the municipality.

Linear hydrological hotspots are evident along River Ayoro, the Owade Bridge crossing, and River Awach corridors. These riparian zones include floodplain agriculture, informal riverbank cultivation, wetlands, and critical bridge infrastructure. For fluvial flooding, bridges and access roads near Ayoro and Owade constitute single-point failure nodes. Given the medium to high hazard levels projected for river flooding and the catastrophic impacts associated with bridge overtopping or erosion, transport infrastructure, majorly gravely roads, in these zones is categorized as very high risk. Urban blue infrastructure, including wetlands in Pasaka and lower Masogo, also exhibits high to very high risk under intensified rainfall scenarios,

particularly by 2100 under SSP5-8.5. Encroachment and degradation have reduced natural buffering capacity, increasing downstream flood peaks and compounding urban exposure.

Lower Masogo, Pasaka wetlands, and peri-urban agricultural areas form an additional belt of vulnerability at the urban–rural interface. These zones function as natural water retention systems but are increasingly cultivated or settled. Rain-fed agriculture dominates, with limited irrigation, minimal uptake of climate-smart practices, and weak extension support. Across all hazards and time horizons, peri-urban and agricultural systems are assessed as very high risk due to high exposure and high sensitivity combined with low adaptive capacity. Recurrent inundation, soil erosion, and yield variability are expected to intensify under projected increases in rainfall variability and extreme events.

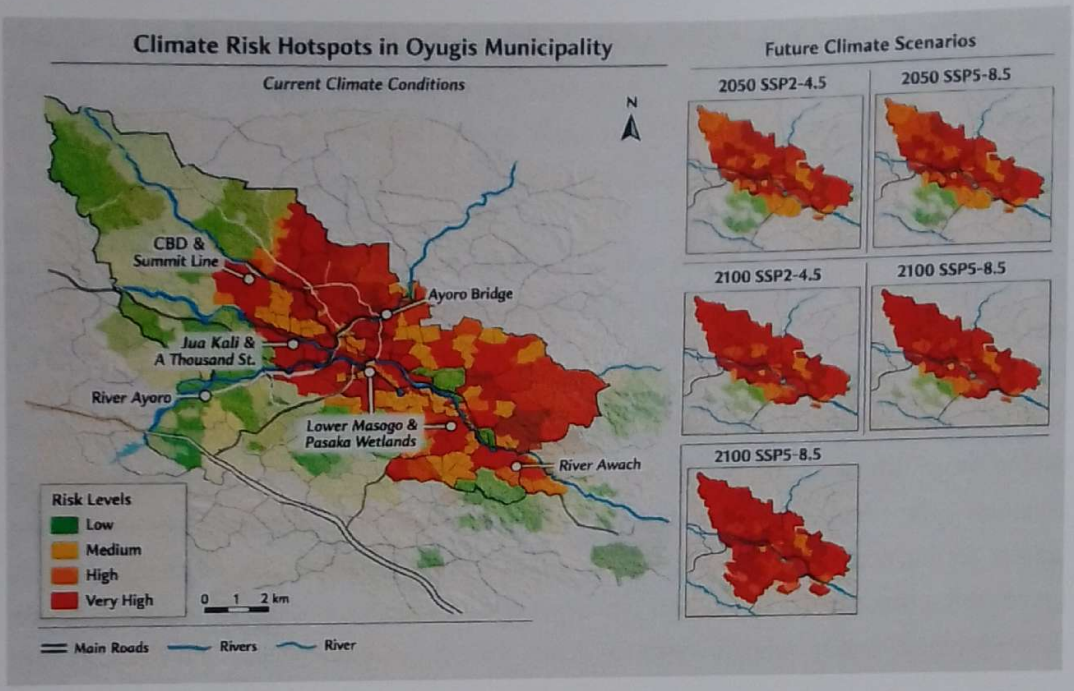
Transport networks across the municipality represent structural bottlenecks that amplify risk. The A1, C26, D220, and C18 corridors, as well as numerous marram roads linking residential zones, lack adequate drainage design and erosion protection. Under both pluvial and fluvial flooding scenarios, transport and mobility are classified as very high risk because catastrophic impacts occur when hazard levels are medium or high. Bridge abutments, low-lying road segments, and gravel road sections without culverts or side drains are particularly vulnerable. Disruption of these nodes produces secondary impacts on emergency response, school attendance, healthcare access, and market activity, demonstrating systemic interdependence across urban sectors.

Municipal service infrastructure shows a more differentiated pattern. HOMAWASCO water infrastructure, including the Atemo treatment plant and most distribution networks, generally exhibits low to moderate exposure under precipitation variability and river flooding. Durable piping and relatively robust siting reduce sensitivity in many locations. However, localized pluvial flooding affecting shallow pipelines increases risk in specific low-lying neighborhoods. Energy distribution infrastructure is spatially dispersed; while current risk is generally moderate, increasing hazard intensity under future scenarios elevates risk to high in flood-prone corridors where pole foundations weaken under soil saturation.

Overall, the dominant climate risk hotspots in Oyugis Municipality are informal settlements, river floodplains along Ayoro and Awach, the CBD drainage and transport corridor, and peri-urban agricultural zones. Current baseline risks are concentrated primarily along hydrological corridors and densely built-up commercial areas. Under 2050 and 2100 projections, particularly under SSP5-8.5, the spatial footprint of very high risk expands substantially, extending from river corridors into much of the CBD and adjacent low-lying residential areas. The trajectory indicates a transition from localized hazard impacts to structurally embedded

climate risk affecting infrastructure systems, vulnerable populations, and natural assets across the municipality.

Figure 4. Climate Risk Hotspots in Oyugis Municipality



The map presents climate risk hotspots in Oyugis Municipality under current conditions and future climate scenarios (2050 and 2100) based on SSP2-4.5 and SSP5-8.5 pathways. Risk levels are classified as low (green), medium (yellow), high (orange), and very high (red). Currently, elevated risks are concentrated along river corridors and densely developed central areas, including CBD and Summit Line, Jua Kali and A Thousand Street, Ayoro Bridge, and Lower Masogo and Pasaka Wetlands. Future projections show a marked expansion of high and very high-risk zones, particularly under SSP5-8.5, indicating intensifying climate impacts. River systems and transport corridors remain critical exposure areas across all scenarios.

4. What's Next?

4.1. Key Findings

The climate risk assessment for Oyugis Municipality identifies changes in precipitation patterns, pluvial (surface) flooding, and fluvial (river) flooding as the primary hazards influencing the urban environment. These hazards interact with topography, settlement patterns, and infrastructure placement, producing spatially heterogeneous risk patterns. The assessment shows that informal settlements, low-lying residential areas, critical infrastructure corridors, and peri-urban agricultural systems are most exposed and vulnerable.

The Central Business District (CBD) and Summit Line corridor, including A Thousand Street and the main A1 road, are highly susceptible to stormwater drainage failures, transport disruptions, and solid waste mobilization, producing very high risk to both infrastructure and economic activity. Jua Kali Estate and A Thousand Street emerge as the most critical population-level hotspots due to poor housing, lack of tenure security, and limited adaptive capacity. Riparian corridors along River Ayoro and River Awach are also high-risk zones, affecting bridges, floodplain agriculture, and wetlands. Peri-urban agricultural zones along river corridors are consistently very high risk due to recurrent inundation and limited climate-smart interventions.

Future projections (2050 and 2100, SSP2-4.5 and SSP5-8.5) indicate that hazard intensity and risk levels are expected to increase, particularly under high-emission scenarios. Very High risk areas expand spatially from river corridors and peri-urban zones to include larger portions of the CBD and low-lying residential neighborhoods, suggesting systemic exposure of infrastructure, populations, and natural assets. These trends highlight the urgency for integrated adaptation planning, focusing on flood management, resilient infrastructure design, and targeted support for vulnerable populations

Table 21. Summary of climate risks affecting urban elements for Oyugis Municipality

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

The assessment demonstrates that climate risks in Oyugis Municipality are concentrated in areas with high population density, limited adaptive capacity, and key infrastructure nodes.

Informal settlements, including Jua Kali and A Thousand Street, remain the most critical population-level hotspots, facing very high risk from all hazards across current and future scenarios. Infrastructure corridors in the CBD and along the A1, C26, D220, and C18 roads, as well as bridges across River Ayoro and Owade, are repeatedly exposed to pluvial and fluvial flooding, threatening transport, economic activity, and service delivery.

Natural assets, particularly urban blue infrastructure such as rivers and wetlands, and peri-urban agricultural systems, are highly vulnerable due to encroachment, floodplain cultivation, and limited adaptive measures. Across all urban elements, Very High and High risk levels expand spatially under future climate scenarios, emphasizing the importance of prioritizing flood management interventions, resilient infrastructure planning, and targeted support for vulnerable populations.

The trends indicate that without intervention, climate hazards will increasingly disrupt municipal operations, compromise access to services, and magnify socio-economic vulnerabilities. Integrated adaptation strategies should therefore focus on strengthening drainage infrastructure, enhancing floodplain management, promoting climate-smart agriculture, and improving social protection for residents most at risk.

4.2. Climate Adaptation and Resilience Solutions

Table 22. Climate Adaptation and Resilience Solutions Recommended for Oyugis Municipality

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
Infrastructure & Services			
Stormwater Drainage	• Clear and maintain existing open drains to improve flow. • Install temporary flood barriers in critical low-lying areas of a Thousand Street	• Construct detention and retention basins in high-risk zones. • Upgrade undersized drains along A1, Masogo, Kendu Bay, and Gamba roads.	• Implement fully engineered storm water management network with integrated urban drainage and retention ponds. • Incorporate green infrastructure (permeable pavements, bioswales) in the CBD and residential areas.
Water & Wastewater Management	• Conduct localized pipe inspections and emergency repairs of shallow HOMAWASCO pipelines. • Promote household rainwater harvesting to reduce pressure on distribution systems.	• Install flood-resistant water and wastewater infrastructure near rivers and low-lying areas	• Develop a wastewater treatment and flood-tolerant sewage systems across the municipality.
Solid Waste Management	• Implement emergency clean-up campaigns at waste holding sites. • Regularly remove waste blocking drains during rainfall events.	• Establish engineered transfer stations and secure landfill containment. • Introduce formal recycling centers with safe drainage integration. • Promote circular economy and community-based waste reduction programs.	• Develop a fully integrated municipal solid waste management system with climate-resilient collection, treatment, and disposal facilities.
Transport and Mobility	• Conduct emergency repairs on washed-out gravel roads and damaged bridges. • Establish temporary detours and pedestrian access during floods.	• Upgrade critical roads and bridges with improved drainage and resilient surfaces. • Elevate vulnerable sections of marram roads connecting residential and commercial zones.	• Upgrade gravel roads to bitumen standards • Integrate non-motorized and public transport networks with flood-resilient infrastructure.

Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
Energy	• Conduct emergency inspections and secure loose power lines in flood-prone areas. • Provide backup generators for critical facilities.	• Elevate poles and install flood-proof foundations in high-risk zones.	• Integrate renewable energy sources and smart grid systems to enhance continuity during extreme weather.
Economic Infrastructure	• Provide emergency financial support for affected traders.	• Upgrade market and business structures to be flood-resilient and elevate premises. • Introduce early warning systems for commercial zones.	• Develop climate-adaptive business hubs with reinforced infrastructure and insurance mechanisms. • Integrate urban planning to avoid siting markets in flood-prone areas.
Social Infrastructure	• Clear access routes to schools, health centers, and municipal offices during floods.	• Elevate or retrofit vulnerable facilities to withstand pluvial flooding. • Strengthen institutional contingency planning and emergency preparedness.	• Construct climate-resilient schools and health facilities with integrated flood management systems. • Ensure long-term service continuity and emergency access in all urban zones.
Emergency Services	• Train local volunteers for flood and hazard response.	• Establish community-based early warning systems and evacuation centers.	• Develop a fully integrated municipal disaster management system with permanent shelters, evacuation routes, and emergency logistics hubs. • Implement long-term risk monitoring and adaptive response planning.
Populations			
Urban Residents	• Disseminate early warning messages via SMS, radio, and community channels. • Provide basic flood preparedness education and household guidance.	• Promote community-level flood resilience plans, including elevated storage and safe zones. • Facilitate access to micro-insurance schemes.	• Support long-term relocation or urban planning interventions for high-risk neighborhoods. • Integrate social protection programs with climate risk reduction strategies.

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Category	Recommended Solutions		
	Immediate	Mid-term	Long-term
Informal Settlement Residents	• Provide emergency shelters, sandbags, and temporary relocation support. • Conduct hazard awareness campaigns tailored to informal settlements.	• Secure tenure and improve access to water, sanitation, and electricity.	• Integrate informal settlements into formal urban planning with resilient infrastructure and sustainable livelihoods.
Vulnerable and Marginalized Groups	• Target emergency assistance to elderly, disabled, and women-headed households. • Ensure access to health services and social support during hazards.	• Develop targeted adaptation programs, including flood shelters and mobility support. • Strengthen community-based social protection schemes.	• Integrate vulnerability mapping into long-term urban planning and disaster management. • Ensure inclusive infrastructure and climate-resilient social services.
Natural Assets			
Urban Blue Infrastructure	• Protect rivers, wetlands, and riparian zones from immediate encroachment and pollution. • Reinforce vulnerable riverbanks and critical wetland areas.	• Restore and expand wetlands to improve flood storage. • Introduce riverbank stabilization and riparian buffer zones.	• Develop integrated water-sensitive urban design, including restored wetlands, flood retention, and ecosystem-based adaptation. • Institutionalize long-term protection of rivers and riparian zones.
Peri-urban and Agricultural Systems	• Provide emergency support to farmers affected by flooding, including seeds and inputs. • Clear drainage channels in agricultural floodplains.	• Promote climate-smart agriculture practices, including raised beds, drought-tolerant crops, and irrigation. • Establish flood-resilient farming infrastructure.	• Implement long-term land use planning to avoid floodplain cultivation. • Develop integrated water management and agroforestry systems to enhance adaptive capacity.

Annex 1. Data Sources

Page	Data	Data Source
18	100 year return period flood depth	Aqueduct Flood
18	Number of days with precipitation >50mm	World Bank Climate Change Knowledge Portal
18	Precipitation variability	Kenya Metrological Department - SPI