URBAN CLIMATE RISK PROFILE
FOR
MANDERA MUNICIPALITY

2025

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Foreword

As the Chairperson of the Mandera Municipal Board, it is my distinct honor to present this **Urban Climate Risk Profile (CRP)** for Mandera Municipality. This document arrives at a critical juncture in our history as we transition toward a more sustainable and resilient urban future under the Second Kenya Urban Support Program (KUSP II).

Mandera is a town of immense potential, serving as a vital gateway for cross-border trade and a beacon of growth in the frontier region. However, our progress is increasingly threatened by the unpredictable hand of climate change. In recent years, our residents have navigated the grueling "triple-dip" drought, only to be met by the devastating El Niño floods of 2023. These are no longer "once-in-a-lifetime" events; they are our new reality.

This Climate Risk Profile is more than just a technical report. It is a strategic roadmap. It identifies the specific "hotspots"—from the flood-prone corridors of Barwaqo to the heat-stressed informal "bullas"—where our investment is needed most. It provides us with the evidence base to say that a road is not just a road; it must be a climate-resilient artery with integrated drainage. It reminds us that our water security depends on the health of the Daua River and our ability to harvest the rains when they come.

On behalf of the Municipal Board, I want to express our commitment to the adaptation actions outlined in this profile. We will prioritize the "climate-proofing" of our infrastructure, the greening of our public spaces, and the protection of our most vulnerable citizens. We call upon our partners, stakeholders, and the community at large to join us in implementing these solutions.

Our goal is clear: to build a Mandera that does not merely survive climate shocks but thrives in spite of them. Together, we are building a resilient gateway for the generations to come.

Chairperson,
Mandera Municipal Board
Mandera Municipality

EXECUTIVE SUMMARY

Objective of the Assessment

The primary objective of this Urban Climate Risk Profile (CRP) is to identify and analyze the specific climate-related vulnerabilities and risks facing Mandera Municipality. By integrating historical data with future climate projections (2050 and 2100), this assessment provides a strategic evidence base for the Mandera Municipal Board and the Second Kenya Urban Support Program (KUSP II). It aims to prioritize high-risk locations (hotspots) and critical infrastructure for climate-resilient investment, ensuring the municipality can sustain its urban growth in a context of extreme environmental stress.

List of Key Hazards Identified

- **Hazard 1: Chronic Drought** (High Magnitude/High Frequency)
- **Hazard 2: Flash Flooding (Pluvial)** (High Magnitude/Medium Frequency)
- **Hazard 3: Extreme Heat** (Rising Chronic Stress)
- **Hazard 4: River Flooding (Fluvial)** (Seasonal/Acute Stress)

Hazard 1: Chronic Drought

Drought is the most persistent threat to Mandera, driving a near-permanent state of water and insecurity and economic loss.

Table 1: Summary of Chronic Drought risks for Mandera 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	**High**	**High**	**High**	**High**	**High**
Water & Wastewater Management	**Very High**	**Very High**	**Very High**	**Very High**	**Very High**
Solid Waste Management	**High**	**High**	**High**	**High**	**High**
Transport and Mobility	**Medium**	**Medium**	**Medium**	**Medium**	**Medium**
Energy	**Medium**	**Medium**	**Medium**	**Medium**	**Medium**
Economic Infrastructure	**Very High**	**Very High**	**Very High**	**Very High**	**Very High**

Category	Risk Level				
	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
Social Infrastructure	**Very High**	**Very High**	**Very High**	**Very High**	**Very High**
Emergency Services	**High**	**High**	**High**	**High**	**High**
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 Green Infrastructure	**Very High**	**Very High**	**Very High**	**Very High**	**Very High**
Urban Blue Infrastructure	**Very High**	**Very High**	**Very High**	**Very High**	**Very High**
Peri-urban and Agricultural Systems	**Very High**	**Very High**	**Very High**	**Very High**	**Very High**

Key Takeaways for Mitigation:

To mitigate the **Very High** risks associated with drought, Mandera must transition from emergency water trucking to permanent water security. Key recommendations include the development of **Bulk Water Supply systems** with large-scale off-stream storage (dams) to capture seasonal river flows. Additionally, the municipality should promote **Livelihood Diversification** for urban residents to reduce the absolute reliance on the climate-sensitive livestock trade.

Hazard 2: Flash Flooding (Pluvial)

Flash flooding in Mandera is characterized by high-intensity, short-duration rainfall events that overwhelm the natural and built drainage systems. The risk is compounded by the high building density in "bullas" and the obstruction of natural seasonal streams (*lagas*) by recent infrastructure developments.

Table 2: Summary of Flash Flooding (Pluvial) risks for Mandera 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	**Very High**	**Very High**	**Very High**	**Very High**	**Very High**
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	**High**	**High**	**High**	**High**	**High**
Economic Infrastructure	**Very High**	**Very High**	**Very High**	**Very High**	**Very High**
Social Infrastructure	**Very High**	**Very High**	**Very High**	**Very High**	**Very High**
Emergency Services	**Very High**	**Very High**	**Very High**	**Very High**	**Very High**
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 Green Infrastructure	**Medium**	**Medium**	**Medium**	**Medium**	**Medium**
Urban Blue Infrastructure	**High**	**High**	**High**	**High**	**High**
Peri-urban and Agricultural Systems	**Very High**	**Very High**	**Very High**	**Very High**	**Very High**

Key Takeaways for Mitigation:

To mitigate the **Very High** risk of flash flooding, the municipality should prioritize the **restoration of natural drainage corridors**. This includes re-engineering blocked culverts (particularly near the A13 road) and implementing nature-based solutions like bioswales and permeable pavements to reduce runoff velocity. Strengthening **Solid Waste Management** is also essential to prevent waste from clogging drainage outfalls during storm events.

Hazard 3: Extreme Heat

Extreme heat is an intensifying chronic stressor in Mandera, driven by high solar radiation and the "Urban Heat Island" effect. As mean temperatures rise, the risk to public health and energy systems moves from High to **Very High** by 2050, particularly for those living in poorly ventilated informal housing.

Table 3: Summary of Extreme Heat risks for Mandera 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	**Low**	**Medium**	**Medium**	**Medium**	**Medium**
Water & Wastewater Management	**Very High**	**Very High**	**Very High**	**Very High**	**Very High**
Solid Waste Management	**High**	**Very High**	**Very High**	**Very High**	**Very High**
Transport and Mobility	**Medium**	**High**	**High**	**High**	**High**
Energy	**Medium**	**High**	**High**	**High**	**High**
Economic Infrastructure	**Very High**	**Very High**	**Very High**	**Very High**	**Very High**
Social Infrastructure	**Very High**	**Very High**	**Very High**	**Very High**	**Very High**
Emergency Services	**Medium**	**High**	**High**	**High**	**High**
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**

Category	Risk Level				
	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
Vulnerable and Marginalized Groups	**Very High**	**Very High**	**Very High**	**Very High**	**Very High**
Natural Assets					
Urban Green Infrastructure	**Very High**	**Very High**	**Very High**	**Very High**	**Very High**
Urban Blue Infrastructure	**High**	**Very High**	**Very High**	**Very High**	**Very High**
Peri-urban and Agricultural Systems	**High**	**Very High**	**Very High**	**Very High**	**Very High**

Key Takeaways for Mitigation:

Mitigating extreme heat requires a shift in urban design. Immediate priorities include a **Municipal Greening Program** to increase shade canopy and the adoption of "Cool Roof" technologies (reflective paints and improved insulation) for schools and hospitals. For the economic sector, providing **ventilated and shaded market structures** is critical to protecting the health of traders and the shelf-life of perishable goods.

Hazard 4: River Flooding (Fluvial)

River flooding in Mandera is a seasonal but high-impact hazard linked to the **Daua River**. While the municipality is currently facing a prolonged drought due to La Niña conditions (early 2026), historical data and future climate models indicate that when rains return—particularly in the Ethiopian highlands—the risk of "Very High" impact events remains severe. Projections for 2050 and 2100 under both SSP scenarios suggest enhanced interannual variability, meaning Mandera will oscillate between extreme drought and major fluvial flooding.

Table 4: Summary of River Flooding (Fluvial) risks for Mandera Municipality

Category	Risk Level				
	Current	2050 SSP2-4.5	2050 SSP5-8.5	2100 SSP2-4.5	2100 SSP5-8.5
Infrastructure & Services					

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

Key Takeaways: What Can Be Done to Mitigate Higher Risks?

To address the "Very High" risks identified across all hazards, the following strategic actions are recommended:

- **Integrated Water Resource Management:** Transition from emergency responses to long-term water security by developing **off-stream storage** (dams/pans) to capture

Daua River flows and utilizing **Managed Aquifer Recharge (MAR)** to store water underground for drought periods.

- **Climate-Resilient Infrastructure:** All new KUSP II investments must incorporate climate-proofing. This includes **elevating water intake pumps** above flood levels, redesigning the **stormwater drainage network** to remove obstructions, and using **heat-reflective materials** in public buildings.
- **Nature-Based Solutions (NbS):** Implement a massive **Urban Greening Program** using indigenous, drought-tolerant species to create "Green Corridors" along *lagas*. This will simultaneously stabilize riverbanks against erosion, reduce flash flood velocity, and mitigate extreme heat.
- **Early Warning & Community Readiness:** Establish a localized **Multi-Hazard Early Warning System (MHEWS)** that translates technical climate data into actionable community alerts, particularly for residents in informal "bullas" and riverine farming communities.
- **Proactive Land-Use Planning:** Enforce riparian buffer zones and prevent further settlement encroachment into natural drainage pathways to reduce the number of people and assets in high-exposure hotspots.

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LIST OF ACRONYMS

Acronym	Definition
AR6	Sixth Assessment Report of the Intergovernmental Panel on Climate Change
ASAL	Arid and Semi-Arid Lands
CCC	County Climate Change Committee
CCCF	County Climate Change Fund
CIDP	County Integrated Development Plan
CRP	Climate Risk Profile
Daua	Reference to the Daua River (Primary fluvial hazard source)
GCA	Global Center on Adaptation
IPCC	Intergovernmental Panel on Climate Change
KMD	Kenya Meteorological Department
KUSP II	Second Kenya Urban Support Program
Laga	Seasonal/Ephemeral stream (Local term)
MANDWASCO	Mandera Water and Sewerage Company
MCRH	Mandera County Referral Hospital
MHEWS	Multi-Hazard Early Warning System
NAP	National Adaptation Plan
NbS	Nature-based Solutions
NDC	Nationally Determined Contribution
NDMA	National Drought Management Authority
PCRA	Participatory Climate Risk Assessment
RCRA	Rapid Climate Risk Assessment
SSP	Shared Socio-economic Pathway (Climate Scenarios)
SSP2-4.5	Intermediate GHG emissions scenario (Middle-of-the-road)
SSP5-8.5	High GHG emissions scenario (Fossil-fueled development)
UNFCCC	United Nations Framework Convention on Climate Change

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1. CONTEXT

1.1. Objective

This Urban Climate Risk Profile (CRP) aims to provide a definitive, evidence-based diagnostic of the climate-related vulnerabilities and risks facing Mandera Municipality. Its primary objective is to transition the Mandera Municipal Board from a reactive cycle of crisis management to a proactive posture of strategic resilience and anticipatory governance.

Specifically, this profile is designed to:

- **Provide an Incontrovertible Evidence Base**: Quantify and characterize specific climate hazards (such as chronic drought, flash floods, and extreme heat), vulnerabilities of urban systems, and the resulting risks to the municipality.
- **Fulfill Regulatory and Programmatic Mandates**: Meet the requirements of the Second Kenya Urban Support Program (KUSP II) Performance Standard 5 (PS5), which is a prerequisite for accessing Urban Development Grants (UDG). It also ensures compliance with the Climate Change Act (2016) and the Urban Areas and Cities Act (2011).
- **Guide Strategic Investment**: Inform the design and location of future public infrastructure—particularly in water, transport, and sanitation—to ensure they can withstand climate shocks.
- **Inform Land-Use Planning**: Provide the empirical data necessary to update the Municipal Spatial Plan and zoning regulations, discouraging development in high-risk floodplains and protecting critical natural assets like the Daua River corridor.
- **Strengthen Resource Mobilization**: Act as a credible technical document to support the municipality in accessing international and national climate finance from entities such as the Green Climate Fund (GCF) and the Adaptation Fund.

1.2. Urban Context

1.2.1. Geographic area

Mandera Municipality is the administrative capital of Mandera County, strategically located in the extreme northeastern corner of Kenya at the intersection of the international borders with Ethiopia and Somalia. This unique geographic position places it at the center of a vital regional commercial hub.

- **Official Boundary and Size:** The municipality covers a total land area of approximately **599.2 km^2**. It is situated between latitudes *03°55'N* and longitudes *41°50'E*.

- **Administrative Units:** The municipality administratively spans **three wards**: Khalalio, Mandera Township, and Neboi, all within Mandera East Sub-county. These wards are further subdivided into 28 locations and 43 sub-locations.

Table 5: Administrative Ward Characteristics

Ward	No. of Locations	No. of Sub-locations	Area (km^2)
Khalalio	10	20	489.9
Mandera Township	6	9	86.0
Neboi	12	14	22.3
Total	**28**	**43**	**599.2**

- **Natural Boundaries and Landmarks:** A defining geographic feature of the municipality is its proximity to the **Daua River**, which provides a strip of fertile agricultural land utilized for irrigation and riverine farming. The municipality's terrain is characterized by its semi-arid landscape, which significantly influences its vulnerability to climate hazards such as flash floods and chronic drought.

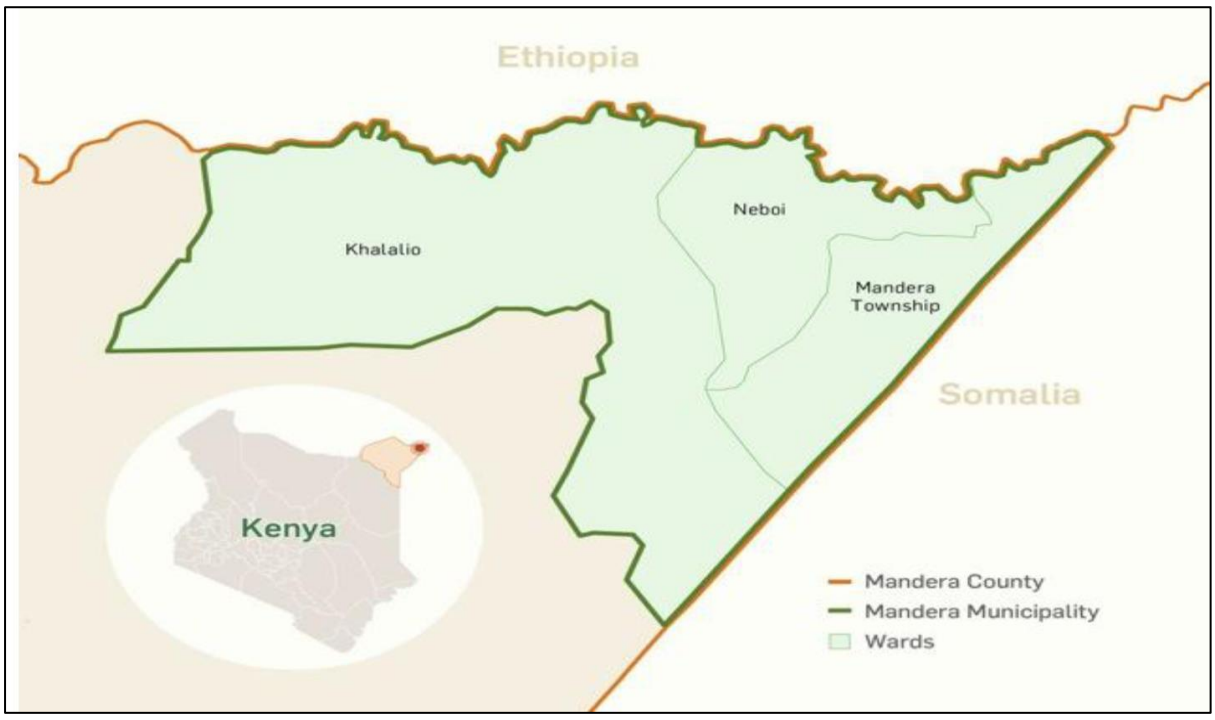

Figure 1: Administrative Map of Mandera Municipality and its proximity to the Ethiopia/Somalia borders

1.2.2. Governance Structure

The governance of Mandera Municipality is anchored in the **Urban Areas and Cities Act (2011)** and the **Mandera Municipal Charter**. The structure is designed to facilitate

integrated planning and service delivery, specifically through the development of the **Integrated Development Plans (IDeP)** and the **Urban Climate Risk Profile (CRP)**.

Key Governing Bodies and Roles

The municipality operates under a multi-layered institutional framework that coordinates with the County Government of Mandera (CGM).

- **Mandera Municipality Board:** The highest policy-making organ of the municipality, responsible for oversight, and ensuring alignment with county and national policies.
- **Municipal Manager:** Acts as the accounting officer and is responsible for the day-to-day administration, implementation of Board decisions, and coordinating the preparation of strategic documents like the CRP.
- **Department of Lands, Physical Planning, Housing & Urban Development:** The primary county-level department overseeing the municipality's development activities and providing technical guidance for climate risk assessments.
- **Technical Working Team:** A multi-sectoral team established to develop and lead data collection for the climate profiling. Key technical officers include the **Principal Environment Officer** and the **Municipality Civil Engineer**.

Institutional Responsibility for Climate Risk and Planning

Climate risk mainstreaming is coordinated through a collaborative approach involving several specialized units:

- **Environmental and Social Safeguards Unit:** Led by the Social Safeguards Officer, this unit ensures that climate risks and social impacts are mitigated during project implementation.
- **Disaster Risk Management Unit:** Responsible for mapping disaster-prone areas, recruiting skilled personnel for emergency response, and implementing mitigation measures for hazards like flash floods.
- **County Department of Economic Planning & Statistics:** Provides technical support for the Monitoring and Evaluation (M&E) framework to track the progress of climate-resilient interventions.

1.2.3. Socio-economic Context

Mandera Municipality is characterized by a rapidly expanding urban population, driven largely by climate-induced migration from surrounding pastoralist areas. This demographic

shift is placing immense pressure on the municipality's limited infrastructure and service delivery systems.

Demographic Profile and Ward-Level Distribution

As of 2019, the municipality had a total population of **159,638**, with an urban-specific population of **114,718**. The population is distributed across three wards, with **Mandera Township** acting as the primary urban core and densest administrative unit.

Table 6: Population Distribution and Density by Ward (2019)

Ward	Population (2019)	Area (km^2)	Density (Persons/km^2)
Mandera Township	82,600*	86.0	960.5
Neboi	43,200*	22.3	1,937.2
Khalalio	33,838*	489.9	69.1
Total	**159,638**	**599.2**	**266.4**

*Estimated ward breakdown based on municipal totals and urban concentration patterns.

Population Projections (2024–2028)

The municipal population is projected to grow significantly over the current IDeP period (2024–2028), fueled by both natural growth and the continued influx of families seeking refuge from chronic regional droughts.

Table 7: Municipal Population Projections

Year	Projected Population
2019 (Census)	159,638
2024 (Baseline)	185,450*
2026 (Mid-term)	197,200*
2028 (End-term)	209,680*

*Projected figures based on standard regional growth rates and historical trends.

Economic Landscape and Livelihoods

The municipality's economy is deeply intertwined with its climate-sensitive natural environment:

- **Pastoralism and Livestock:** The primary economic pillar for over **70% of households**, providing both food security and trade commodities. This sector is highly vulnerable, with the 2021–2023 drought causing livestock mortality rates exceeding 50% for some herds.

- **Riverine Farming:** Concentrated along the **Daua River**, this sector supports livelihoods through irrigated agriculture but faces constant threats from both total crop failure during droughts and infrastructure destruction during flash floods.
- **Trade and Commerce:** Leveraging its position at the border of Ethiopia and Somalia, Mandera Town serves as a regional hub for the movement of goods, which has spurred rapid, often unplanned, urbanization.

Vulnerable Populations

The socio-economic impact of climate change is not uniform. The most at-risk groups within the municipality include:

- **Internally Displaced Persons (IDPs):** Destitute pastoralist families who have lost their herds to drought and now reside in rapidly expanding informal settlements with minimal access to water or sanitation.
- **Children and Female-Headed Households:** Malnutrition rates frequently surpass emergency thresholds during prolonged dry spells, with over **65% of the municipal population** currently classified as food insecure.

1.2.4. Economic Context

Mandera Municipality serves as a critical regional commercial hub, driven by its strategic location at the borders of Ethiopia and Somalia. Its economy is fundamentally tied to climate-sensitive sectors, making it highly vulnerable to environmental shocks.

Current Economic Landscape

The municipality's economy is anchored by three primary pillars:

- **Livestock and Pastoralism:** This is the dominant economic activity, serving as the primary asset for over **70% of households**. The municipality acts as a ready market for livestock products from the broader county.
- **Trade and Commerce:** Leveraging its position as a "border town," the municipality is a major center for the movement of goods and services between Kenya, Somalia, and Ethiopia. This sector has driven rapid urbanization and the growth of **Micro, Small, and Medium Enterprises (MSMEs)**.
- **Agriculture:** High-potential riverine farming is concentrated along the **Daua River**, focusing on irrigated crop production to improve local food security.

Economic Challenges and Vulnerabilities

- **Climate Shocks:** Frequent and severe droughts (now on a 2–3-year cycle) lead to catastrophic livestock mortality. During the 2021-2023 drought, cattle losses

exceeded 50%, and milk production—a cornerstone of the local economy—fell to zero.

- **Infrastructure Gaps:** Economic growth is hindered by inadequate market infrastructure, limited access to business skills training for traders, and the intermittent closure of international borders due to regional insecurity.
- **High Inflation and Food Insecurity:** Chronic water stress and crop failures have led to acute food insecurity, affecting over **65% of the municipal population**.

Projected Economic Requirements (2024–2028)

To transition toward a resilient economy, the municipality has projected significant resource requirements under the **IDeP 2024-2028** to fund development priorities such as market construction and climate-resilient infrastructure.

Table 8: Projected Municipality Resource Requirements (Ksh. Million

Financial Year	Resource Requirement (Ksh. M)
FY 2024/25	573.4
FY 2025/26	709.2
FY 2026/27	815.9
FY 2027/28	615.2
FY 2028/29	489.7
Total (5 Years)	**3,203.4**

Future Economic Strategies

The municipality aims to spur development by:

- **Expanding Own-Source Revenue:** Implementing automated revenue collection to seal leakages and increase financial independence.
- **Market Development:** Constructing new market centers, installing solar lighting in trade areas, and providing sheds for "bodaboda" operators.
- **Value Chain Support:** Capacity building for traders and improving the resilience of riverine agriculture through better irrigation and flood control.

1.2.5. Land-use Context

The land-use patterns of Mandera Municipality are fundamentally shaped by its role as a regional trade hub and its proximity to the Daua River. However, current land use is increasingly characterized by uncontrolled urban sprawl and a lack of integrated spatial management, which elevates the area's climate vulnerability.

Current Land Use Distribution

The municipality covers a total land area of **599.2 km²**, with land use predominantly divided between high-density urban activities and climate-dependent agricultural and pastoral zones.

- **Urban and Residential:** Concentrated primarily in **Mandera Township** and **Neboi** wards, these areas host the highest population densities. Development is often rapid and spontaneous, driven by the municipality's status as an administrative and cross-border commercial center.
- **Agricultural (Riverine):** Located in a fertile strip along the **Daua River**, this land is critical for irrigated crop production and serves as the municipality's primary food basket.
- **Pastoral and Open Spaces:** The expansive hinterlands, particularly in **Khalalio Ward and parts of Neboi Ward**, are utilized for livestock grazing, which remains the backbone of the local economy.
- **Public and Institutional:** Includes administrative headquarters, the Mandera Stadium, and the recently established Mandera Museum.

Spatial Development Framework

To address "uncontrolled urban development," the municipality is transitioning toward a more structured spatial planning regime.

- **Mandera ISUDP (2015-2035):** The **Integrated Strategic Urban Development Plan** currently guides sectoral interventions, providing a 20-year framework for land use, environment protection, and traffic connectivity.
- **Khalalio Local Physical and Land Use Development Plan (2023-2033):** A specialized plan focusing on the sustainable growth of the Khalalio area.
- **Municipal Spatial Plan (Projected):** Under the **IDeP 2024-2028**, the municipality has prioritized the preparation of a comprehensive **Municipality Spatial Plan** to ensure orderly development across all three wards.

Land-Use Challenges and Climate Risks

- **Unplanned Settlements:** Rapid urbanization has led to the growth of informal settlements that often lack adequate drainage, making them highly susceptible to flash floods.
- **Encroachment on Riparian Zones:** Settlement expansion toward the Daua River increases exposure to seasonal flooding and degrades vital natural ecosystems.

- **Weak Development Control:** The current planning approval system faces challenges in enforcement, leading to insufficient provision of open spaces and buffer zones.

Table 9: Key Land-Use Planning Priorities (2024–2028)

Priority	Strategy
Orderly Spatial Development	Preparation of a GIS-based Municipality Spatial Plan.
Urban Plan Preparation	Development of urban plans for all major centers within the municipality.
Securing Public Land	Mapping and protecting public spaces from encroachment.
Flood Risk Mitigation	Implementation of land-use plans that restrict building in high-risk flood zones.

1.3. Key Stakeholders & Inclusiveness

The preparation of the Mandera Municipality Climate Risk Profile (CRP) and its parent document, the Integrated Development Plan (IDeP), follows a highly consultative, participatory, and collaborative approach. This ensures that the climate risks identified reflect the lived realities of the residents and that the proposed adaptation measures are socially inclusive and technically sound.

Stakeholder Engagement Process: The engagement process was structured in phases to maximize inclusivity:

- **Awareness and Sensitization:** Disseminating the intention to develop the risk profile and explaining the roles of various stakeholders.
- **Public Participation Forums:** Conducted across all three wards (Khalalio, Mandera Township, and Neboi) to assess community priorities and gather submissions on perceived climate hazards like droughts and floods.
- **Thematic Consultations:** Engaging technical teams and departmental heads (e.g., Environment, Water, Health, and Social Safeguards) to align institutional data with community needs.

- **Validation Workshops:** Presenting draft findings to stakeholders to ensure the proposed resilience strategies align with their specific physical, social, and economic challenges.

Stakeholder Mapping for Mandera Municipality

The following mapping categorizes stakeholders based on their influence over municipal climate planning and their interest in the outcomes of the Climate Risk Profile.

Table 10: Stakeholder mapping for Mandera Municipality

Influence / Interest	High Interest	Low Interest
High Influence	• Mandera Municipality Board • Municipal Manager & Technical Teams • County Govt. of Mandera (CGM) Depts. • KUSP II / World Bank • National Govt. Agencies (NEMA, NDMA)	• Regional Economic Blocs • Cross-border Trade Authorities • National Infrastructure Authorities (KeNHA, KURA)
Low Influence	• Community-Based Organizations • Citizens	• Casual Visitors/Commuters • External Commercial Suppliers • Distant National Parastatals

2. HAZARD ASSESSMENT

The Hazard Assessment identifies and analyzes the specific climate-related threats that impact Mandera Municipality. By synthesizing historical climate data (1990–2024) with future climate projections (to 2050), this section establishes the physical context of risk. It focuses on the frequency, intensity, and spatial distribution of primary hazards—specifically extreme heat, chronic drought, and flash flooding—within the municipal boundaries. Understanding these hazards is a prerequisite for determining the exposure of urban assets and the vulnerability of the municipality's socio-economic systems, ultimately guiding the prioritization of resilience-building interventions under the KUSP II framework

2.1. Key Climate Hazards

The identification of key climate hazards for Mandera Municipality is based on a rigorous screening of historical meteorological trends (1990–2024) and future climate projections to 2050. The following table summarizes the hazard screening process, prioritizing those with the highest likelihood and most significant impact on the urban area's social, economic, and ecological systems

Table 11: Hazard screening for Mandera 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**
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**

Hazard	Hazard Likely (Y/N)	Significant Impact (Y/N)	High Priority (Y/N)	Key Hazard (Y/N)
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**	**Y**	**N**	**N**
Water Stress				
Drought (meteorological, hydrological)	**Y**	**Y**	**Y**	**Y**
Groundwater salinization	**N**	**N**	**N**	**N**
Saline intrusion	**N**	**N**	**N**	**N**
Wildfire				
Wildfires & bushfires	**N**	**N**	**N**	**N**
Storms				
Extreme wind	**Y**	**N**	**N**	**N**
Tropical cyclones	**N**	**N**	**N**	**N**
Sand and dust storms	**Y**	**Y**	**N**	**N**
Hailstorms	**N**	**N**	**N**	**N**
Mass Movement				
Landslides	**N**	**N**	**N**	**N**
Coastal erosion	**N**	**N**	**N**	**N**
Gully erosion	**Y**	**N**	**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**

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2.2. Climate Indicators and Hazard Thresholds

The selection of climate indicators and thresholds for Mandera Municipality is based on historical meteorological data (1990–2024) and regional drought monitoring standards. These thresholds define the "Low," "Medium," and "High" risk levels, triggering specific municipal response actions as outlined in the IDeP 2024–2028.

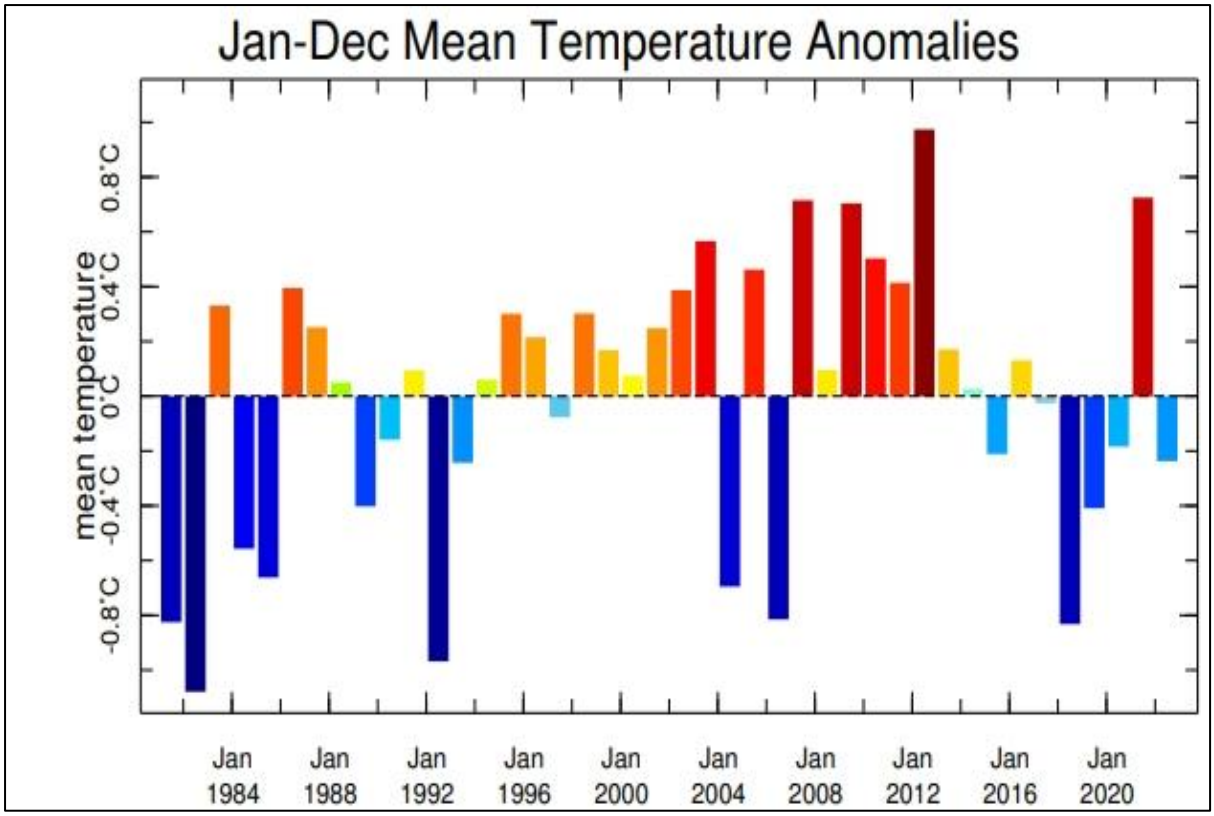

Figure 2: Historical temperature trends in Mandera Municipality (1984–2020)

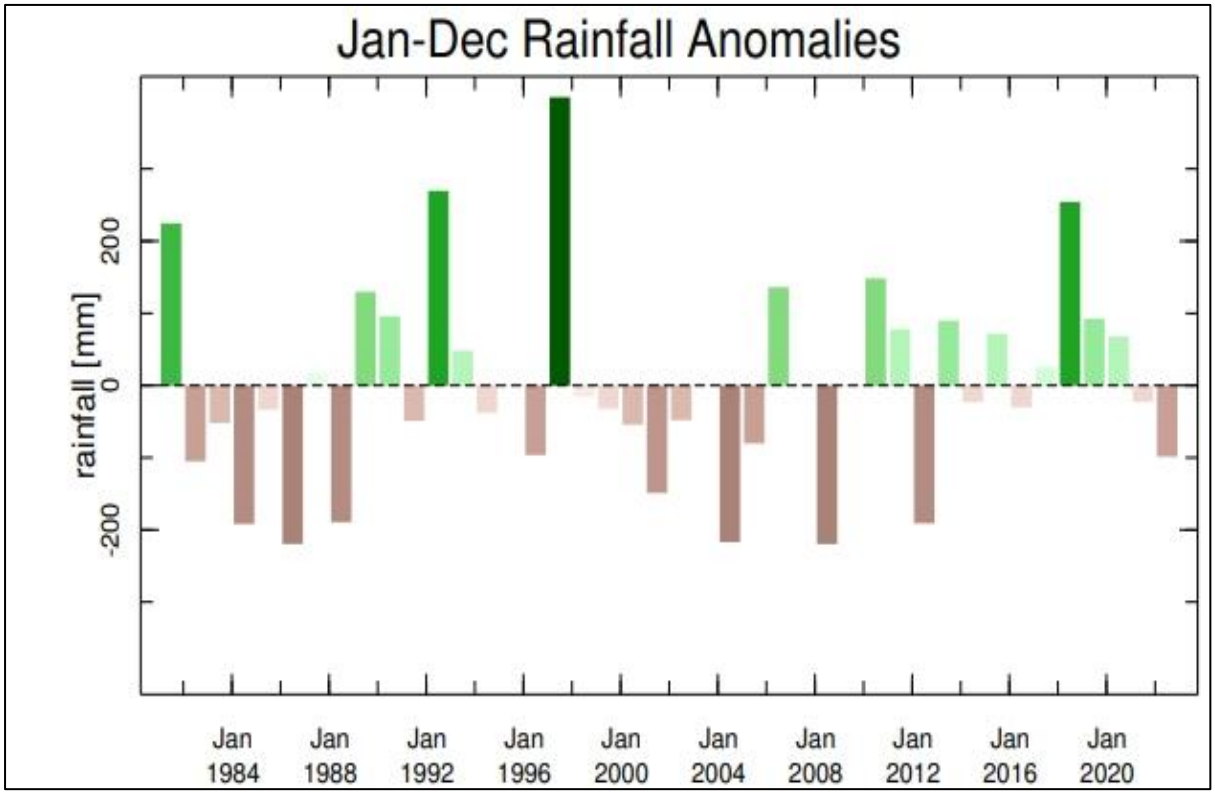

Figure 3: Historical rainfall patterns for Mandera comparing the 1990s to recent decades

Table 12: Climate indicators and hazard thresholds selected for the assessment

Key Hazard	Climate indicator	Data source	Threshold		
			Low	**Medium**	**High**
Chronic Drought	Standardized Precipitation Index (SPI) / Rainfall Deficit	NDMA / KMD	SPI -0.5 to -0.99 (Alert)	SPI -1.0 to -1.99 (Alarm)	SPI ≤ -2.0 (Emergency / 4+ failed seasons)
Extreme Heat	Daily Maximum Temperature (°C)	KMD / Satellite Data	35°C – 37°C	38°C – 40°C	>40°C (Extreme heatwave)
Flash Flooding	Daily Precipitation (mm/24h)	KMD	20mm – 40mm	41mm – 70mm	>70mm (Violent downpour)
River Flooding	Daua River Level (Meters/Discharge)	Water Resources Authority (WRA)	Below Bankfull	At Bankfull (Warning)	Overtopping Banks (Spillage)

KMD: Kenya Meteorological Department; NDMA: National Drought Management Authority.

2.3. Current Hazard Levels and Climate Projections

Mandera Municipality is experiencing an accelerating shift in its climate system, transitioning from a pattern of occasional extreme weather to a state of permanent climate volatility. Historical analysis from 1990 to 2024 reveals an unambiguous warming trend of **0.34°C per decade**. This chronic temperature increase acts as a threat multiplier, exacerbating the severity of acute hazards. Specifically, the once 5–7 year drought cycle has shortened to a **2–3 year cycle**, leading to a near-permanent state of water stress. Furthermore, while total annual rainfall remains variable, it is increasingly concentrated in shorter seasons with more **violent and unpredictable downpours**, which directly triggers high-intensity flash flooding in urban areas.

Table 13: Current and future hazards levels for Mandera Municipality

	Hazard Level				
Hazard	**Current (Baseline)**	**2050 SSP2-4.5**	**2050 SSP5-8.5**	**2100 SSP2-4.5**	**2100 SSP5-8.5**

Chronic Drought	High	High	High	High	High
Extreme Heat	Medium	High	High	High	High
Flash Flooding	High	High	High	High	High
River Flooding	Medium	High	High	High	High

Note: *SSP (Shared Socioeconomic Pathway) scenarios represent different greenhouse gas emission trajectories, with SSP5-8.5 being the high-emissions "worst-case" scenario.*

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

Table 14: 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

Mandera Municipality's hazard landscape is defined by the spatial overlap of chronic drought, extreme heat, and seasonal flooding. These hazards do not occur in isolation; their impact areas often coincide, creating zones of compound risk, particularly in the densely populated urban core and along the vital Daua River corridor.

Spatial Distribution of Key Hazards

- **Chronic Drought and Water Stress:** This hazard is geographically pervasive, affecting the entire **599.2 km^2** of the municipality. However, the severity is most acute in the pastoral hinterlands of **Khalalio Ward**, where livestock—the primary economic asset—are concentrated. During extreme drought events, such as the 2021-2023 period, the **Daua River** has been known to disappear completely, extending the impact of water stress into riverine farming areas.
- **Flash Flooding (Pluvial):** Flash flood impact areas are concentrated in the built-up zones of **Mandera Township** and **Neboi** wards. These areas suffer from "uncontrolled urban development" and a lack of integrated storm water drainage, leading to rapid surface runoff and localized inundation during violent downpours.
- **River Flooding (Fluvial):** The high-impact zone for river flooding is strictly confined to the fertile riparian strip along the **Daua River**. This area is home to

the municipality's critical "riverine farming communities," where seasonal overtopping of banks destroys irrigation infrastructure and crops.

- **Extreme Heat:** Heat stress is a municipality-wide hazard, but its intensity is amplified in the "high-density urban activities" of the township center due to the lack of green spaces and heat-absorbing building materials.

Frequency and Severity: Current vs. Future (2050)

The frequency and severity of these hazards are projected to increase significantly by 2050 under high-emissions scenarios (SSP5-8.5).

Table 15: Frequency and Severity Trends of Key Hazards

Hazard	Current Frequency/Severity	2050 Projection (SSP5-8.5)	Impact Area Implications
Drought	2–3 year cycle; High severity.	Near-permanent; Very High severity.	Expansion of "permanent water stress" zones across all three wards.
Flash Floods	Seasonal/Occasional; High impact on informal areas.	Increased frequency of "violent downpours".	Widening of flood-prone zones in Mandera Township and Neboi.
River Floods	Seasonal overtopping.	Increased frequency of "extreme rainfall events".	Frequent destruction of all irrigation infrastructure along the Daua corridor.
Extreme Heat	Increasing frequency of 40°C days.	Potential +2.5°C increase in mean temperature.	Chronic public health risk across all urban and peri-urban settlements.

Overlap and Multi-Hazard Risk Zones

The most critical multi-hazard risk zones in Mandera Municipality are:

1. **The Riparian Corridor:** High risk of river flooding and drought-induced crop failure.
2. **Informal Urban Settlements:** Overlapping risks of flash flooding due to poor drainage and extreme heat due to high population density and lack of green cover.

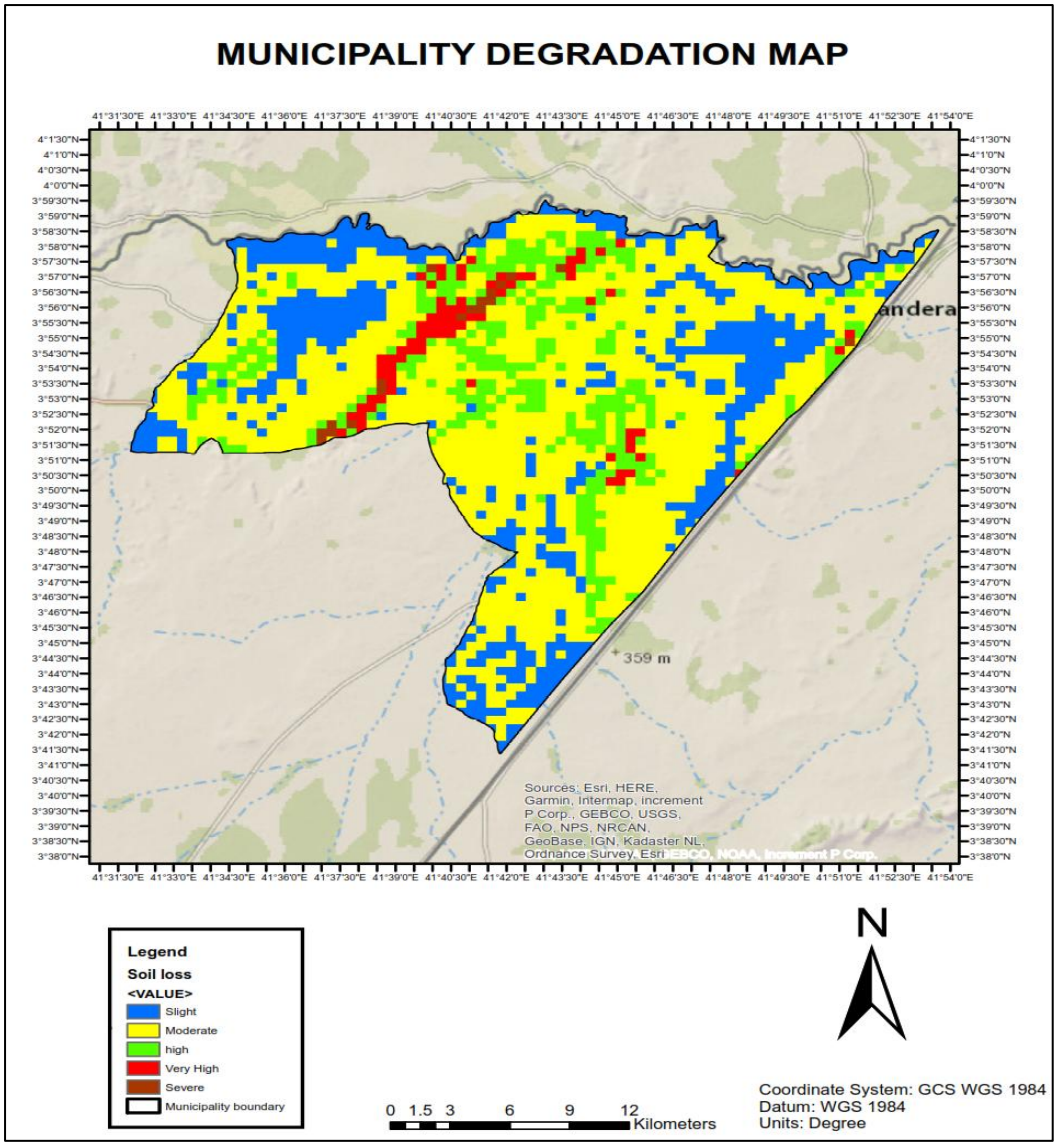

Figure 4: Municipality degradation exposure

3. EXPOSURE & VULNERABILITY ASSESSMENT

The Exposure and Vulnerability Assessment provides a critical link between climate hazards and their actual human and economic impacts within Mandera Municipality. This section evaluates how the municipality's physical assets, socio-economic systems, and diverse populations are positioned in relation to identified hazards like chronic drought, extreme heat, and flash flooding. By analyzing the **sensitivity** of urban systems—such as water supply, food production, and public health—alongside the **adaptive capacity** of the community and local institutions, this assessment identifies why certain groups and sectors are more at risk than others. Ultimately, this data-driven analysis moves beyond identifying hazards to understanding the "lived reality" of risk, providing the evidence base needed to prioritize resilience-building interventions under the KUSP II framework.

3.1. Urban Elements

This section provides a detailed inventory of the urban elements in Mandera Municipality that are analyzed within the Rapid Climate Risk Assessment (RCRA). These elements are categorized into infrastructure and services, populations, and natural assets, detailing their current state and strategic importance to the municipality's resilience.

Table 16: Urban elements inventory

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
Infrastructure & Services				
Stormwater Drainage	Stormwater drainage conveyance network	**Y**	**Y**	Existing networks are primarily localized in the urban core of Mandera Township. Large sections are currently unlined or earthen, leading to high maintenance needs.
	Stormwater storage	**Y**	**N**	Limited to small-scale localized pans; lacks integrated municipal-scale storage for flood mitigation.
Water & Wastewater Management	Pumping stations	**Y**	**Y**	Includes critical river-bank intake stations along the Daua River that are highly vulnerable to both siltation and flooding.
	Groundwater abstraction	**Y**	**Y**	Numerous shallow wells and several deep boreholes serving as the primary water source during dry seasons.
	Water treatment facilities	**Y**	**Y**	Centralized treatment plant at the river intake, often compromised during high turbidity/flooding events.

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Water supply networks	**Y**	**Y**	Piped network covering approximately 40% of the urban area; remaining areas rely on water kiosks and bowser delivery.
	Sewer networks	**N**	**N**	Currently, Mandera Municipality lacks a centralized waterborne sewerage system; residents use septic tanks and pit latrines.
	Wastewater treatment facilities	**N**	**N**	n/a
Solid Waste Management	Transfer facilities	**Y**	**N**	Small-scale neighborhood collection points; often overflow during rainy seasons.
	Landfills and dump sites	**Y**	**Y**	Includes the primary municipal dumpsite, which lacks modern lining and poses contamination risks to groundwater.
	Recycling centers	**N**	**N**	Limited to informal "waste picking" activities; no formal municipal centers.
	Collection fleet	**Y**	**N**	Comprises a limited number of specialized trucks and tractors managed by the Environment department.

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
Transport and Mobility	Road networks	**Y**	**Y**	Mixture of bitumen (main corridors), gravel, and earth roads; earth roads become impassable during flash floods.
	Bridges	**Y**	**Y**	Key bridge connections across seasonal lagas and the main international bridge to Ethiopia.
	Public transport networks (rail, bus, mini-bus, etc.)	**Y**	**N**	Dominated by "Boda Boda" (motorcycle) operators and "Tuk Tuks" for local transit.
	Transportation terminals	**Y**	**Y**	Includes the main Mandera Bus Park and Boda Boda sheds.
	Vehicle depots	**N**	**N**	n/a
	Non-motorized transport networks	**Y**	**N**	Limited designated walkways along major bitumen roads.
	Freight and logistics hubs	**Y**	**Y**	Commercial hubs near the border entry points facilitating trade with Somalia and Ethiopia.
Energy	Energy power plants	**Y**	**Y**	Mandera Thermal Power Station (Diesel generators) and the Mandera Solar Power Plant (off-grid).
	Poles and power lines	**Y**	**Y**	Extensive overhead network; highly exposed to windstorms and falling trees.
	Transformers and substations	**Y**	**Y**	Key distribution nodes across the three wards.

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Streetlighting	**Y**	**Y**	Recent installation of solar streetlights in markets and "bullas" to enhance security.
Economic Infrastructure	Markets	**Y**	**Y**	Includes the Central Market, livestock market, and neighborhood kiosks.
	Businesses and commercial hubs	**Y**	**Y**	Concentrated in the central business district (CBD) of Mandera Township.
	Industrial zones/parks and logistics parks	**N**	**N**	n/a
Social Infrastructure	Government buildings and service centers	**Y**	**Y**	County headquarters, Municipal Board offices, and departmental offices.
	Education facilities	**Y**	**Y**	Includes primary schools, secondary schools, and the Mandera Technical and Vocational College.
	Healthcare facilities	**Y**	**Y**	Mandera County Referral Hospital and several Ward-level health centers.
	Public spaces	**Y**	**Y**	Includes public parks and open grounds used for gatherings and sports.
	Faith-based buildings	**Y**	**Y**	Mosques and churches across all wards.
	Cultural and heritage assets	**Y**	**Y**	Local historical sites and community cultural centers.
Emergency Services	Fire stations	**Y**	**Y**	One central fire station with limited rapid-response capacity.

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Police stations	**Y**	**Y**	Regional police headquarters and ward-level stations.
	Telecommunications networks	**Y**	**Y**	Mobile network towers (Safaricom/Airtel/Telkom).
	Early warning systems	**Y**	**N**	Includes NDMA drought sirens and community radio systems.
	Disaster management centers and shelters	**Y**	**Y**	Designated emergency shelters (often schools) during flood events.
	Evacuation routes	**Y**	**N**	Identified high-ground routes in the Municipal Spatial Plan.
Populations				
Urban Residents	Population	**Y**	**Y**	Approximately 159,638 residents across Khalalio, Township, and Neboi wards.
	Households	**Y**	**Y**	Densely packed urban households with an average size of 6-8 persons.
Informal Settlement Residents	Population living in informal settlements	**Y**	**Y**	Significant population in unplanned "bullas" with poor infrastructure.
	Households lacking land tenure	**Y**	**N**	High percentage of residents in newer settlements lacking formal titles.
	Households / residents lacking access to basic services	**Y**	**N**	Populations in the outskirts of Neboi and Khalalio with no piped water access.

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
Vulnerable and Marginalized Groups	Low-income households	**Y**	**N**	Households reliant on precarious daily labor or small-scale trade.
	Women-headed households	**Y**	**N**	Increased vulnerability during drought due to limited asset ownership.
	Children and youth	**Y**	**N**	High youth population; susceptible to water-borne diseases post-flooding.
	Elderly persons	**Y**	**N**	Highly vulnerable to extreme heat events.
	People with disabilities (PWD)	**Y**	**N**	Face mobility challenges during flash flood evacuations.
	Homeless populations	**N**	**N**	Minimal identified; nomadic movement often masks homelessness.
	Unemployed or precariously employed workers	**Y**	**N**	Impacted heavily by climate-driven trade disruptions.
	Seasonal workers / migrant laborers	**Y**	**N**	Cross-border laborers from Ethiopia and Somalia.
	Nomadic groups in peri-urban areas	**Y**	**N**	Pastoralists moving into urban edges during severe drought.
	Urban refugees and migrants	**Y**	**N**	Populations displaced by regional conflict and climate stressors.
	Minority ethnic groups in urban areas	**N**	**N**	n/a
Natural Assets				

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
Urban Green Infrastructure	Urban parks and gardens	**Y**	**Y**	Limited formal parks; some gardens at government institutions.
	Green corridors	**N**	**N**	n/a
	Street landscaping	**Y**	**N**	Recent efforts to plant drought-resistant trees along main avenues.
	Urban forests and forest reserves	**N**	**N**	n/a
Urban Blue Infrastructure	Natural wetlands	**Y**	**Y**	Seasonally flooded depressions (pans) and swamps.
	Rivers	**Y**	**Y**	The Daua River, forming the international border.
	Riparian zones	**Y**	**Y**	Critical fertile zones for riverine farming.
	Lakes, ponds and reservoirs	**Y**	**Y**	Community water pans in Khalalio and Neboi.
	Coastal ecosystems	**N**	**N**	n/a
	Urban agriculture	**Y**	**Y**	Small-scale vegetable production within the urban core.
Peri-urban and Agricultural Systems	Peri-urban agriculture	**Y**	**Y**	Significant farming activity on the outskirts of the built-up area.
	Agroforestry systems	**Y**	**N**	Mixed fruit trees and crop systems along the river.
	Forests and forest reserves	**N**	**N**	n/a
	Protected areas and national parks	**N**	**N**	n/a

Category	Subcategory	Included in the RCRA (Y/N)	Available in GIS format (Y/N)	Description
	Savannahs and rangelands	**Y**	**Y**	Vast grazing lands surrounding the urban settlements.

The map below shows the exposure level in the three wards. Township area has the lowest level of exposure as compared to Neboi and Khalalio.

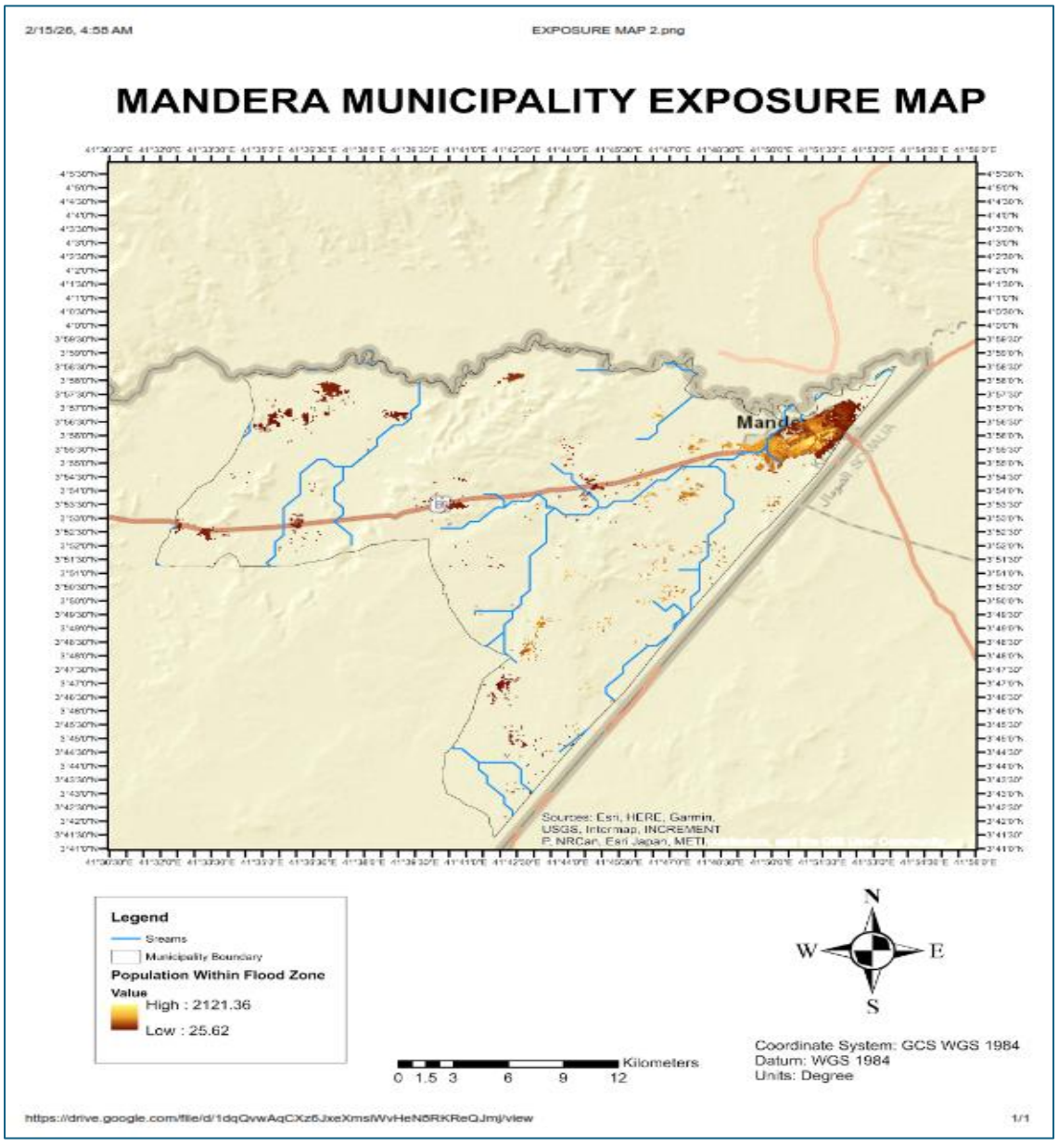

Figure 5: Exposure and vulnerability Map

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 17: 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 18: Impact Matrix

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

Table 19: Exposure, Vulnerability, and Impacts of Chronic Drought on Urban Elements

Hazard: Chronic Drought

Chronic drought in Mandera Municipality has shifted from a 5–7 year cycle to a 2–3 year cycle, leading to a near-permanent state of water stress. During extreme events, surface water sources like the Daua River have been known to disappear completely.

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Infrastructure & Services					
Stormwater Drainage	• High exposure as prolonged dry periods lead to sedimentation and blockage of unlined channels by wind-blown dust and solid waste.	**Medium**	**Sensitivity:** • High sensitivity of earthen/unlined channels to erosion and siltation during the dry-wet transition **Adaptive Capacity:** • Low; limited maintenance budget and lack of integrated storage.	**Medium**	**Moderate**
Water & Wastewater Management	• Extreme exposure; the entire municipal water supply relies on the Daua River and groundwater, both of which are depleted during chronic drought.	**High**	**Sensitivity:** • High natural sensitivity due to reliance on surface water that disappears during drought. **Adaptive Capacity:** • Very Low; current infrastructure lacks large-scale storage or advanced desalination.	**High**	**Catastrophic**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Solid Waste Management	• Exposure is related to the accumulation of waste in "bullas" during dry seasons, which poses a health risk when the first rains arrive.	**Medium**	**Sensitivity:** • Inadequate collection fleet leads to waste piles that become breeding grounds for disease. **Adaptive Capacity:** • Moderate; plans exist to increase collection trucks and bins.	**Medium**	**Moderate**
Transport and Mobility	• Low direct exposure, though dust storms during drought reduce visibility and road safety.	**Low**	**Sensitivity:** • Earth roads are sensitive to wind erosion and degradation during dry spells **Adaptive Capacity:** • Moderate; ongoing paving of major urban corridors.	**Low**	**Minor**
Energy	• Medium exposure; drought limits the efficiency of thermal cooling systems and can damage poles during extreme heat.	**Medium**	**Sensitivity:** • High sensitivity of older poles/lines to heat-induced warping **Adaptive Capacity:** • High; increasing adoption of solar power which thrives in drought conditions.	**Low**	**Minor**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Economic Infrastructure	• High exposure; the livestock market (a key asset) collapses during drought due to massive livestock mortality.	**High**	**Sensitivity:** • High sensitivity as over 70% of households depend on livestock-based trade. **Adaptive Capacity:** • Low; limited alternative livelihoods or insurance mechanisms.	**High**	**Catastrophic**
Social Infrastructure	• High exposure; schools and hospitals face severe water shortages, affecting hygiene and service delivery.	**High**	**Sensitivity:** • High sensitivity of children and patients to water-borne diseases and dehydration. **Adaptive Capacity:** • Medium; some institutions have installed storage tanks, but replenishment is difficult.	**High**	**Catastrophic**
Emergency Services	• Moderate exposure; water scarcity limits fire-fighting capacity during dry-season fire outbreaks.	**Medium**	**Sensitivity:** • Limited number of fire trucks and specialized crew. **Adaptive Capacity:** • Moderate; existence of a dedicated Disaster Management Fund.	**Medium**	**Moderate**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Populations					
Urban Residents	• Entire population (159,638) is exposed to severe water stress and rising food prices.	**High**	**Sensitivity:** • High sensitivity due to lack of diverse water sources and household storage. **Adaptive Capacity:** • Medium; strong community social safety nets (Kabilas).	**High**	**Catastrophic**
Informal Settlement Residents	• Residents in "bullas" lack piped water and rely on expensive water bowsers during drought.	**High**	**Sensitivity:** • High sensitivity due to lack of land tenure and basic services. **Adaptive Capacity:** • Low; limited financial resources to purchase water.	**High**	**Catastrophic**
Vulnerable and Marginalized Groups	• Low-income and women-headed households face acute food insecurity as assets are sold off	**High**	**Sensitivity:** • High sensitivity of the elderly to heat/dehydration and youth to malnutrition **Adaptive Capacity:** • Low; high unemployment and reliance on precarious labor.	**High**	**Catastrophic**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Natural Assets					
Urban Green Infrastructure	• High exposure; parks and street trees wither due to lack of irrigation water and high evaporation.	**High**	**Sensitivity:** • Most vegetation withers before maturity due to 11 hours of daily sunshine. **Adaptive Capacity:** • Medium; recent efforts to plant drought-resistant species.	**Medium**	**Major**
Urban Blue Infrastructure	• Critical exposure; the Daua River and community pans can dry up entirely.	**High**	**Sensitivity:** • Natural wetlands and riparian zones are highly sensitive to prolonged rainfall deficits. **Adaptive Capacity:** • Low; lack of large-scale water harvesting or groundwater recharge.	**High**	**Catastrophic**
Peri-urban and Agricultural Systems	• High exposure; riverine farming and rangelands fail, leading to total crop loss and livestock death.	**High**	**Sensitivity:** • High sensitivity of crops to the cessation of river flow. **Adaptive Capacity:** • Low; farmers lack advanced irrigation tech or drought-tolerant seeds.	**High**	**Catastrophic**

Table 20: Exposure, Vulnerability, and Impacts of Flash Flooding (Pluvial)on Urban Elements

Hazard: Flash Flooding (Pluvial)

Flash flooding in Mandera Municipality is characterized by rapid onset following high-intensity, short-duration rainfall. This hazard is particularly destructive in the urban core and informal "bullas" due to the high percentage of impervious surfaces, inadequate drainage networks, and the municipality's natural topography which channels runoff through seasonal lagas (dry riverbeds).

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Infrastructure & Services					
Stormwater Drainage	• Direct and extreme exposure; existing channels are often overwhelmed or bypassed by sheet runoff during intense storms.	**High**	**Sensitivity:** • High sensitivity due to blockages from solid waste and lack of maintenance in secondary drains. **Adaptive Capacity:** • Low; current network coverage is insufficient for the expanded municipal boundaries.	**High**	**Catastrophic**
Water & Wastewater Management	• High exposure for shallow wells and boreholes which face contamination risks from surface runoff.	**Medium**	**Sensitivity:** • High sensitivity of open wells to pollution; intake pumps are sensitive to sudden debris flows.	**High**	**Major**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			Adaptive Capacity: • Medium; some boreholes are raised/capped, but the general distribution network is brittle.		
Solid Waste Management	• High exposure; flash floods wash accumulated waste from informal dumpsites into the streets and the Daua River.	**High**	**Sensitivity:** • Lack of secure landfills means waste is easily mobilized by water. **Adaptive Capacity:** • Low; limited specialized equipment to clear debris and waste post-flood.	**High**	**Catastrophic**
Transport and Mobility	• Very high exposure; earth and gravel roads in Neboi and Khalalio become impassable; bitumen roads suffer from structural scouring.	**High**	**Sensitivity:** • Low-lying road sections lack adequate culverts and cross-drainage. **Adaptive Capacity:** • Medium; the municipality has identified priority corridors for paving and culvert installation.	**Medium**	**Major**
Energy	• Medium exposure; flooding of substations or erosion around power pole foundations.	**Medium**	**Sensitivity:** • Foundation instability in waterlogged soils leads to tilted/falling poles.	**Low**	**Moderate**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			Adaptive Capacity: • High; rapid response teams for power restoration and increasing use of solar.		
Economic Infrastructure	• High exposure; market stalls and commercial goods are damaged by rising waters, especially in low-lying Township areas.	**High**	**Sensitivity:** • Small-scale traders lack insurance and flood-proof storage for inventory. **Adaptive Capacity:** • Low; limited access to credit for recovery after stock loss.	**High**	**Catastrophic**
Social Infrastructure	• High exposure; schools and health centers are often used as evacuation hubs, putting further strain on their facilities.	**High**	**Sensitivity:** • Many school buildings are built with materials sensitive to water damage (mud-brick/timber). **Adaptive Capacity:** • Medium; presence of an Emergency Response Committee at the county level.	**Medium**	**Major**
Emergency Services	• High exposure; floodwaters physically block fire trucks and ambulances from reaching affected "bullas".	**High**	**Sensitivity:** • Limited 4x4 emergency vehicle fleet. **Adaptive Capacity:** • Moderate; community-based early warning and volunteer networks exist.	**Medium**	**Major**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Populations					
Urban Residents	• Large numbers of residents are exposed to property damage and risk of water-borne diseases (cholera/typhoid).	**High**	**Sensitivity:** • High population density in the urban core increases the potential for casualties. **Adaptive Capacity:** • Medium; high community resilience and localized knowledge of flood paths.	**Medium**	**Major**
Informal Settlement Residents	• Extreme exposure; settlements often occupy low-lying areas or natural drainage paths.	**High**	**Sensitivity:** • Housing is made of non-durable materials (iron sheets, mud) easily swept away. **Adaptive Capacity:** • Low; lack of financial resources to rebuild or relocate.	**High**	**Catastrophic**
Vulnerable and Marginalized Groups	• High exposure; PWDs and the elderly face severe challenges during rapid evacuations.	**High**	**Sensitivity:** • Children are highly sensitive to drowning and post-flood health shocks. **Adaptive Capacity:** • Low; these groups are often the last to receive warning and aid.	**High**	**Catastrophic**
Natural Assets					

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Urban Green Infrastructure	• Medium exposure; street trees and parks can be uprooted or damaged by high-velocity runoff.	**Medium**	**Sensitivity:** • Newly planted saplings are highly sensitive to soil erosion. **Adaptive Capacity:** • Medium; use of silt traps and gabions in some greening projects.	**Low**	**Minor**
Urban Blue Infrastructure	• High exposure; natural pans and wetlands can overflow, leading to wider inundation.	**High**	**Sensitivity:** • **Adaptive Capacity:** Riparian ecosystems are sensitive to high sediment loads carried by floodwaters. **Adaptive Capacity:** • Medium; natural flood-attenuation capacity of the Daua floodplains.	**Low**	**Moderate**
Peri-urban and Agricultural Systems	• High exposure; flash floods cause gully erosion in rangelands and wash away topsoil.	**High**	**Sensitivity:** • **Adaptive Capacity:** Bare soils in overgrazed areas are extremely sensitive to water erosion **Adaptive Capacity:** • Low; limited implementation of soil conservation measures.	**High**	**Catastrophic**

Table 21: Exposure, Vulnerability, and Impacts of Extreme Heat on Urban Elements

Hazard: Extreme Heat

Extreme heat in Mandera Municipality is a chronic stressor characterized by a rising mean temperature trend (per decade) and an increase in the frequency of days exceeding the threshold. This hazard is driven by high solar radiation (up to 11 hours of daily sunshine) and is exacerbated in built-up areas by the urban heat island effect.

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Infrastructure & Services					
Stormwater Drainage	• Low direct exposure, though extreme heat causes cracking in concrete linings of open channels.	**Low**	**Sensitivity:** • High sensitivity of concrete structures to thermal expansion and contraction. **Adaptive Capacity:** • Low; limited use of heat-resilient materials in drainage construction.	**Medium**	**Minor**
Water & Wastewater Management	• High exposure; heat increases evaporative losses from the Daua River and open water pans, while increasing per capita demand.	**High**	**Sensitivity:** • High sensitivity of surface water sources to high evaporation rates. **Adaptive Capacity:** • Low; lack of covered storage or shade structures for water assets	**High**	**Catastrophic**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Solid Waste Management	• Medium exposure; high temperatures accelerate the decomposition of organic waste, leading to foul odors and pest breeding.	**Medium**	**Sensitivity:** • Frequent heatwaves increase the risk of spontaneous combustion at the municipal dumpsite. **Adaptive Capacity:** • Low; limited frequency of waste collection to clear organic matter quickly.	**High**	**Major**
Transport and Mobility	• Medium exposure; extreme heat causes bitumen "bleeding" on paved roads and increases mechanical wear on vehicles.	**Medium**	**Sensitivity:** • Roads in Mandera are sensitive to high surface temperatures which soften asphalt. **Adaptive Capacity:** • Low; lack of shade trees along major transport corridors for non-motorized users.	**Medium**	**Moderate**
Energy	• High exposure; increased demand for cooling (fans/AC) puts strain on the diesel-thermal grid; transformers are prone to overheating.	**High**	**Sensitivity:** • Power lines and transformers have high thermal sensitivity, leading to efficiency drops.	**Low**	**Moderate**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			Adaptive Capacity: • High; the Mandera Solar Power Plant thrives under high solar radiation.		
Economic Infrastructure	• High exposure; outdoor markets become unbearable for traders; livestock health deteriorates rapidly under heat stress.	**High**	**Sensitivity:** • Perishable goods (vegetables/milk) spoil rapidly without cold chain infrastructure. **Adaptive Capacity:** • Low; most markets lack solar-powered cooling or adequate ventilation.	**High**	**Catastrophic**
Social Infrastructure	• High exposure; classrooms and hospital wards without mechanical cooling become hazardous for occupants.	**High**	**Sensitivity:** • Buildings with iron-sheet roofing (common in Mandera) act as heat traps. **Adaptive Capacity:** • Medium; some newer government buildings incorporate high ceilings and better ventilation.	**High**	**Catastrophic**
Emergency Services	• Medium exposure; heat exhaustion among emergency responders and increased risk of urban fires.	**Medium**	**Sensitivity:** • First responders lack specialized cooling gear or mobile hydration stations.	**Medium**	**Moderate**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			Adaptive Capacity: • Moderate; fire department is trained for high-temperature environments.		
Populations					
Urban Residents	• Entire population (159,638) is exposed to chronic heat stress, particularly during the dry season.	**High**	**Sensitivity:** • High sensitivity to heat-related illnesses (heatstroke, dehydration). **Adaptive Capacity:** • Medium; traditional building styles and social coping mechanisms.	**Medium**	**Major**
Informal Settlement Residents	• Extreme exposure; residents in "bullas" live in crowded, poorly ventilated structures with no cooling assets.	**High**	**Sensitivity:** • High sensitivity due to lack of insulation and high indoor temperatures. **Adaptive Capacity:** • Low; limited financial ability to afford fans or improved housing materials.	**High**	**Catastrophic**
Vulnerable and Marginalized Groups	• High exposure; the elderly and children are physically more susceptible to thermal stress.	**High**	**Sensitivity:** • **Adaptive Capacity:** High physiological sensitivity; PWDs face challenges in moving to cooler public spaces.	**High**	**Catastrophic**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			Adaptive Capacity: • Low; these groups often lack autonomy over their living environments.		
Natural Assets					
Urban Green Infrastructure	• Extreme exposure; young trees and public gardens face high mortality rates due to desiccation.	**High**	**Sensitivity:** • **Adaptive Capacity:** High sensitivity of non-native species to sustained temperatures. **Adaptive Capacity:** • Medium; shift toward planting indigenous, drought-tolerant species.	**High**	**Catastrophic**
Urban Blue Infrastructure	• High exposure; rapid reduction in water levels in the Daua River due to evaporation.	**High**	**Sensitivity:** • **Adaptive Capacity:** Riparian ecosystems are sensitive to the rising water temperatures which affect biodiversity. **Adaptive Capacity:** • Low; no mechanism to regulate river temperature or flow.	**Medium**	**Major**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Peri-urban and Agricultural Systems	• High exposure; crops reach wilting point faster; livestock suffer from reduced grazing time and heat fatigue.	**High**	**Sensitivity:** • Local livestock breeds (Galla goats/Somali camels) are resilient but have limits. **Adaptive Capacity:** • Medium; traditional knowledge of managing livestock during peak heat hours.	**Medium**	**Major**

Table 22: Exposure, Vulnerability, and Impacts of River Flooding (Fluvial) on Urban Elements

Hazard: River Flooding (Fluvial)

River flooding in Mandera Municipality occurs when the **Daua River** exceeds its bankfull capacity, typically driven by heavy precipitation in the Ethiopian Highlands. Unlike flash floods, river flooding is seasonal and can last for several weeks, inundating the fertile riparian strip and low-lying parts of Mandera Township.

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	• High exposure for outfalls located along the riverbank, which become submerged and cause backflow into the city.	**Medium**	**Sensitivity:** • High sensitivity to siltation and structural damage from floating debris. **Adaptive Capacity:** • Low; lack of non-return valves or pumping systems to clear backflow.	**High**	**Major**
Water & Wastewater Management	• Extreme exposure; the main water intake and treatment plant are located directly on the riverbank.	**High**	**Sensitivity:** • **Adaptive Capacity:** Critical pumps are highly sensitive to submersion and high turbidity levels. **Adaptive Capacity:** • Low; current facilities are not elevated above the 50-year flood level.	**High**	**Catastrophic**
Solid Waste Management	• Medium exposure; flooding of riparian zones can wash away illegal dumpsites located near the river.	**Medium**	**Sensitivity:** • **Adaptive Capacity:** High risk of downstream contamination of water sources **Adaptive Capacity:** • Moderate; municipality efforts to move dumpsites away from the river.	**Medium**	**Moderate**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Transport and Mobility	• Medium exposure; the international bridge and river-crossing points are critical nodes that can be cut off.	**Medium**	**Sensitivity:** • **Adaptive Capacity:** Bridge approaches are sensitive to scouring and bank erosion. **Adaptive Capacity:** • High; the bridge is a high-value concrete structure designed for heavy loads.	**Low**	**Minor**
Energy	• Low exposure; most power generation assets are located on higher ground away from the riparian strip.	**Low**	**Sensitivity:** • **Adaptive Capacity:** Low sensitivity unless localized transformers near the river are reached. **Adaptive Capacity:** • High; decentralised solar assets are largely outside the flood zone.	**Low**	**Insignificant**
Economic Infrastructure	• High exposure; riverine markets and cross-border trade stores are at risk of total loss.	**High**	**Sensitivity:** • **Adaptive Capacity:** High sensitivity of stored commercial goods (sugar, cement) to water damage. **Adaptive Capacity:** • Low; lack of flood-proof warehousing in the riparian trade zone.	**High**	**Catastrophic**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Social Infrastructure	• Medium exposure; some public schools and mosques located near the riverbank are frequently flooded.	**Medium**	**Sensitivity:** • **Adaptive Capacity:** Prolonged submersion leads to structural weakening of older masonry buildings. **Adaptive Capacity:** • Medium; buildings are often used for community shelter during non-flood periods.	**Medium**	**Moderate**
Emergency Services	• High exposure; the search and rescue teams (Boats/Divers) are heavily engaged but lack sufficient equipment.	**High**	**Sensitivity:** • High sensitivity of limited rescue boats to strong river currents. **Adaptive Capacity:** • Moderate; regional cooperation with Ethiopian authorities for early warning.	**Medium**	**Major**
Populations					
Urban Residents	• High exposure for residents in the "Bulla Nguvu" and other low-lying riverside neighborhoods.	**High**	**Sensitivity:** • **Adaptive Capacity:** High sensitivity to displacement and loss of household assets.	**Medium**	**Major**

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
			Adaptive Capacity: • Medium; strong traditional early warning systems based on river level monitoring.		
Informal Settlement Residents	• Extreme exposure; many "bullas" have expanded into the riparian buffer zone despite regulations.	**High**	**Sensitivity:** • **Adaptive Capacity:** Dwellings are highly sensitive to rising water; no legal protection or insurance. **Adaptive Capacity:** • Low; poverty limits the ability to relocate to safer, higher ground.	**High**	**Catastrophic**
Vulnerable and Marginalized Groups	• High exposure; women-headed households often manage riverine farms and face total livelihood loss.	**High**	**Sensitivity:** • **Adaptive Capacity:** High sensitivity to economic shocks following the destruction of crops. **Adaptive Capacity:** • Low; limited access to alternative income during flood seasons.	**High**	**Catastrophic**
Natural Assets					

Category	Exposure (Description)	Exposure Level	Vulnerability (Description)	Vulnerability Level	Impact Level
Urban Green Infrastructure	• Medium exposure; riparian vegetation is adapted to flooding but can be uprooted by extreme discharge.	**Medium**	**Sensitivity:** • Newly planted trees are sensitive to prolonged waterlogging. **Adaptive Capacity:** • High; natural resilience of indigenous riverine species.	**Low**	**Minor**
Urban Blue Infrastructure	• Extreme exposure; the Daua River is the source of the hazard itself; riparian zones are completely inundated.	**High**	**Sensitivity:** • **Adaptive Capacity:** High sensitivity to bank erosion and loss of fertile topsoil during peak flows. **Adaptive Capacity:** • Medium; natural floodplains provide some attenuation for downstream areas.	**Medium**	**Major**
Peri-urban and Agricultural Systems	• Catastrophic exposure; over 90% of riverine farms are inundated, destroying irrigation pipes and pumps.	**High**	**Sensitivity:** • **Adaptive Capacity:** Total sensitivity of annual crops (onions, tomatoes) to submersion. **Adaptive Capacity:** • Very Low; farmers lack the capital to replace expensive solar/diesel pumps washed away.	**High**	**Catastrophic**

4. CLIMATE RISK ASSESSMENT

The Climate Risk Assessment synthesizes the findings from the hazard, exposure, and vulnerability analyses to determine the overall risk profile of Mandera Municipality. By intersecting the severity of climate hazards with the magnitude of potential impacts on specific urban elements, this section identifies the most critical areas requiring urgent intervention. This assessment serves as a strategic prioritization tool, allowing the Municipal Board and stakeholders to allocate resources toward the most "Very High" and "High" risk sectors—ensuring that climate-resilience investments under the KUSP II framework are both effective and transformative.

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 23: Risk matrix

		Hazard Level		
		Low	**Medium**	**High**
Impact Level	**Catastrophic**	High	Very High	Very High
	Major	Medium	High	Very High
	Moderate	Low	Medium	High
	Minow	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 24: 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 25: Summary of Chronic Drought risks for Mandera 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	High	High	High	High	High
Water & Wastewater Management	Catastrophic	Very High	Very High	Very High	Very High	Very High
Solid Waste Management	Moderate	High	High	High	High	High
Transport and Mobility	Minor	Medium	Medium	Medium	Medium	Medium
Energy	Minor	Medium	Medium	Medium	Medium	Medium
Economic Infrastructure	Catastrophic	Very High	Very High	Very High	Very High	Very High
Social Infrastructure	Catastrophic	Very High	Very High	Very High	Very High	Very High
Emergency Services	Moderate	High	High	High	High	High
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 Green Infrastructure	Major	Very High	Very High	Very High	Very High	Very High
Urban Blue Infrastructure	Catastrophic	Very High	Very High	Very High	Very High	Very High
Peri-urban and Agricultural Systems	Catastrophic	Very High	Very High	Very High	Very High	Very High

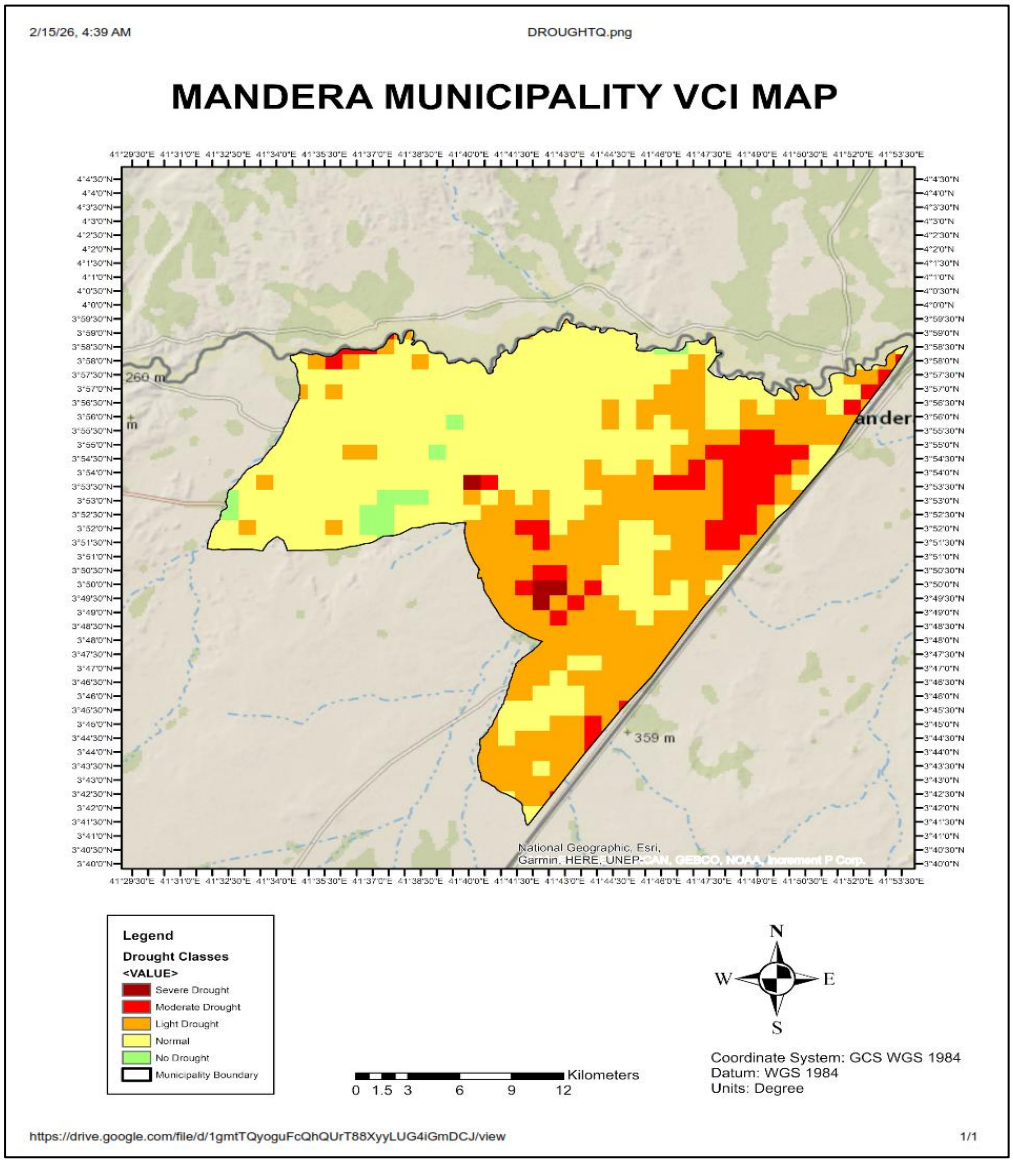

Figure 6: Drought risks for Mandera Municipality

Summary of Risk (Drought): Chronic drought presents the most pervasive "Very High" risk across Mandera Municipality. The total reliance on the Daua River for both domestic water and agricultural livelihoods means that as drought frequency increases, the risk of systemic collapse becomes permanent. Socio-economic systems are currently at a tipping point, and under all future scenarios, the risk remains at unacceptable levels without transformative water security and livelihood diversification interventions

Table 26: Summary of Flash Flooding (Pluvial) risks for Mandera 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	Very High	Very High	Very High	Very High	Very High
Solid Waste Management	Catastrophic	Very High	Very High	Very High	Very High	Very High
Transport and Mobility	Major	Very High	Very High	Very High	Very High	Very High
Energy	Moderate	High	High	High	High	High
Economic Infrastructure	Catastrophic	Very High	Very High	Very High	Very High	Very High
Social Infrastructure	Major	Very High	Very High	Very High	Very High	Very High
Emergency Services	Major	Very High	Very High	Very High	Very High	Very High

Populations						
Urban Residents	Major	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 Green Infrastructure	Minor	Medium	Medium	Medium	Medium	Medium
Urban Blue Infrastructure	Moderate	High	High	High	High	High
Peri-urban and Agricultural Systems	Catastrophic	Very High	Very High	Very High	Very High	Very High

Summary of Risk (Flash Flooding):

The risk of flash flooding is "Very High" across almost all urban categories due to the rapid-onset nature of the hazard and the structural vulnerability of the municipality's buildings and drainage. The impact on **Solid Waste Management** is particularly critical, as floodwaters mobilize uncollected waste, leading to systemic health risks. For **Informal Settlement Residents**, the risk is catastrophic, as their dwellings lack the structural integrity to withstand high-velocity runoff, leading to frequent loss of property and life.

Table 27: Summary of Extreme Heat risks for Mandera 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	Minor	Low	Medium	Medium	Medium	Medium
Water & Wastewater Management	Catastrophic	Very High	Very High	Very High	Very High	Very High
Solid Waste Management	Major	High	Very High	Very High	Very High	Very High
Transport and Mobility	Moderate	Medium	High	High	High	High
Energy	Moderate	Medium	High	High	High	High
Economic Infrastructure	Catastrophic	Very High	Very High	Very High	Very High	Very High
Social Infrastructure	Catastrophic	Very High	Very High	Very High	Very High	Very High
Emergency Services	Moderate	Medium	High	High	High	High
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						
Urban Green Infrastructure	Catastrophic	Very High	Very High	Very High	Very High	Very High
Urban Blue Infrastructure	Major	High	Very High	Very High	Very High	Very High
Peri-urban and Agricultural Systems	Major	High	Very High	Very High	Very High	Very High

Summary of Risk (Extreme Heat):

The current risk level for Extreme Heat is primarily **"High" to "Very High"** because the municipality's urban design currently lacks heat-mitigation features. As mean temperatures rise under both 2050 and 2100 scenarios, this hazard transitions from a seasonal discomfort to a chronic threat to survival. **Water & Wastewater** systems face "Very High" risk due to increased evaporation and surging demand, while **Vulnerable Groups** (children and the elderly) face unacceptable health risks in non-ventilated housing.

Table 28: Summary of River Flooding risks for Mandera 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	Major	High	Very High	Very High	Very High	Very High
Water & Wastewater Management	Catastrophic	Very High	Very High	Very High	Very High	Very High
Solid Waste Management	Moderate	Medium	High	High	High	High
Transport and Mobility	Minor	Low	Medium	Medium	Medium	Medium
Energy	Insignificant	Very Low	Low	Low	Low	Low
Economic Infrastructure	Catastrophic	Very High	Very High	Very High	Very High	Very High
Social Infrastructure	Moderate	Medium	High	High	High	High

Emergency Services	Major	High	Very High	Very High	Very High	Very High
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						
Urban Green Infrastructure	Minor	Low	Medium	Medium	Medium	Medium
Urban Blue Infrastructure	Major	High	Very High	Very High	Very High	Very High
Peri-urban and Agricultural Systems	Catastrophic	Very High	Very High	Very High	Very High	Very High

Summary of Risk (River Flooding):

The current risk for river flooding is **"High,"** but it escalates to **"Very High"** in all future scenarios. This escalation is due to the projected increase in heavy precipitation events upstream in the Daua basin. The **Water & Wastewater** sector remains at the highest risk because intake points are situated in the direct path of the flood. **Peri-urban and Agricultural Systems** face a "Very High" risk that threatens Mandera's food security, as major floods (like those in 2023/2024) frequently submerge hundreds of hectares of riverine farms in wards like Khalalio and Neboi.

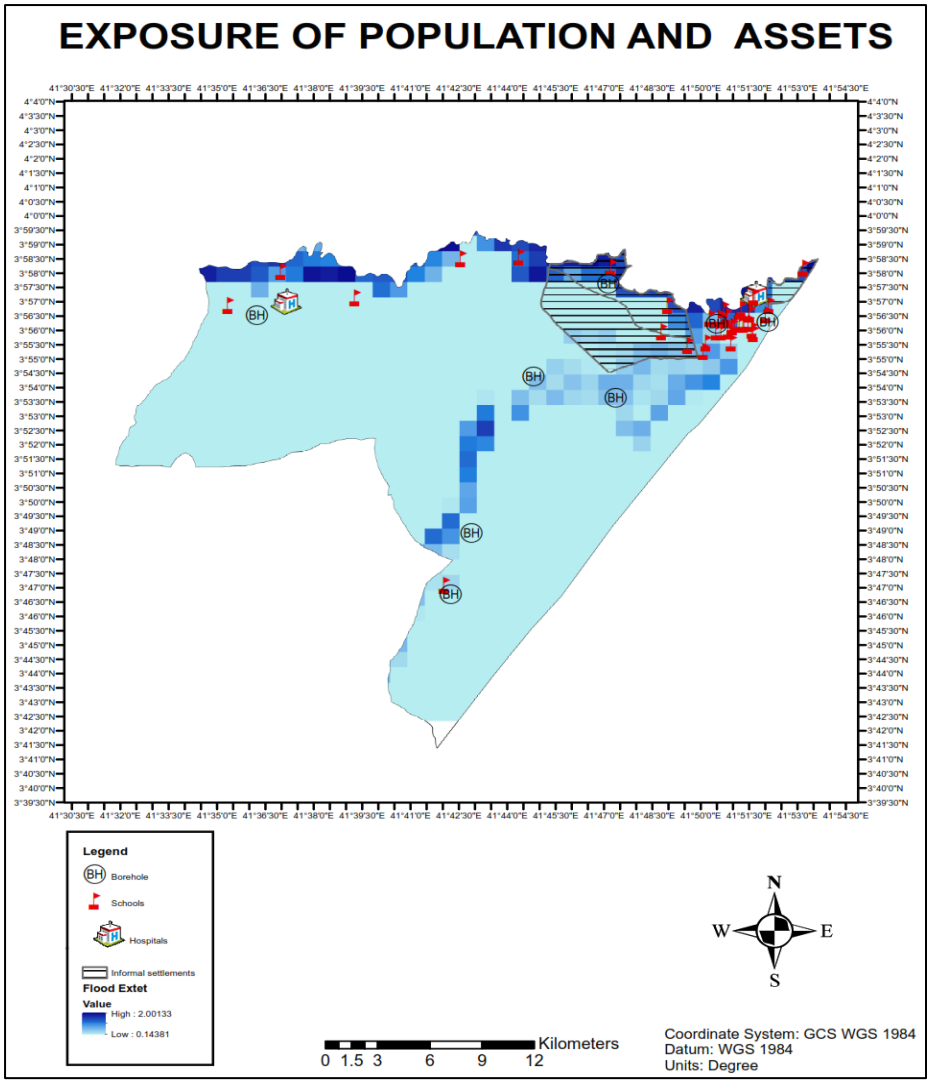

Figure 7: Flood risk exposure in the Municipality

4.2. Climate Risk Hotspots

Climate risk in Mandera Municipality is spatially concentrated in specific high-exposure locations across Mandera Township, Neboi, and Khalalio wards. The distribution of risk is strongly influenced by proximity to River Daua, seasonal lagas (ephemeral streams), settlement expansion into drainage corridors, and road infrastructure that has altered natural runoff pathways.

The dominant hazards affecting hotspot areas include:

- Flash flooding (pluvial flooding from intense rainfall)
- Riverine flooding (River Daua overtopping)
- Streambank erosion
- Infrastructure washout
- Chronic drought (pastoral hinterlands)

Hotspots identified below are based on field verification, community consultations, and review of disaster reports.

4.2.1 Mandera Township Ward – High-Intensity Urban Hotspots

Mandera Township contains the highest concentration of population, economic assets, and critical infrastructure. Several flood risks have been amplified by drainage obstruction and settlement encroachment into natural waterways.

(a) Barwaqo Settlement (Qurax Biyaha Area)

Hazard Type: Flash flooding due to obstructed drainage

Barwaqo experiences near-total inundation during heavy rainfall events. The epicenter of flooding is located at *Qurax Biyaha*. Field findings confirm that the natural Barwaqo seasonal stream (laga) was partially blocked during construction of the A13 road, reducing hydraulic conveyance capacity.

As a result:

- Runoff backs up into residential areas.
- Flood depths reach approximately 0.5–1.0 meters in severe events.
- Houses, latrines, and access roads are submerged.
- Temporary displacement of households occurs.

This represents a structurally amplified flood hotspot caused by altered drainage patterns.

Risk Classification: Extreme

(b) Greenview Stream Corridor

Hazard Type: Severe streambank erosion

The Greenview seasonal stream has experienced aggressive bank erosion during peak runoff events. Observed impacts include:

- Undercutting of residential plots.
- Loss of up to half of some riverside parcels.
- Collapse of houses along unstable banks.
- Progressive widening of the channel.

In some locations, erosion scarps exceed 1.5 meters in height. Without stabilization, further structural loss is expected under increased rainfall intensity.

Risk Classification: Very High

(c) Mandera–Neboi–Khalalio Road (Bulla Haji Segment)

Hazard Type: Road washout and embankment erosion

At Bulla Haji, multiple seasonal streams converge before draining into River Daua. During heavy rainfall:

- Culverts are overwhelmed.
- Road embankments are scoured.
- Sections of the road are overtopped.
- The corridor is nearly cut off.

This road is the primary inter-ward connector. Its failure would disrupt trade, emergency response, and service delivery.

Risk Classification: Very High (Strategic Infrastructure Hotspot)

(d) River Daua Riparian villages (Township Segment)

Settlements located along River Daua—including Bulla Haji, Boystown, Shafshafey, and Border Point One—are exposed to:

- Riverbank overtopping
- Backflow flooding
- Riverbank erosion

Heavy rainfall in the Ethiopian highlands rapidly increases discharge in River Daua, leading to floodplain inundation and agricultural loss.

Risk Classification: High to Very High

4.2.2 Neboi Ward – Flood and Public Health Hotspots

Neboi Ward contains dense, low-lying settlements intersected by seasonal lagas. Inadequate drainage infrastructure increases flood exposure.

During heavy rainfall:

- Water accumulates in depressions.
- Pit latrines collapse or overflow.
- Roads become temporarily impassable.
- Stagnant water increases waterborne disease risk.

Floodwaters draining toward River Daua also cause localized erosion and access disruption.

Risk Classification: Very High

4.2.3 Khalalio Ward – Riverine and Drought Hotspots

(a) River Daua Corridor

The riparian zone in Khalalio is exposed to both:

- Seasonal river flooding
- Inter-annual drought conditions

Flood events damage irrigation canals and farms, while prolonged dry periods reduce river discharge and agricultural productivity.

Risk Classification: High (Escalating)

(b) Pastoral Hinterlands

The northern and western areas of Khalalio experience chronic drought characterized by:

- Livestock mortality
- Borehole over-extraction
- Migration toward urban areas

This is a slow-onset climate risk affecting livelihoods and food security.

Risk Classification: Extreme (Drought Hotspot)

4.2.4 Summary of Priority Climate Risk Hotspots

Table 29: Summary of Priority Climate Risk Hotspots

Location	Dominant Hazard	Risk Level
Barwaqo (Qurax Biyaha)	Blocked-stream flash flooding	Extreme
Greenview Stream	Severe erosion	Very High
Bulla Haji Road Segment	Road washout	Very High
River Daua Riparian Bullas	Riverine flooding	High–Very High
Neboi Low-Lying Settlements	Flash flooding & sanitation risk	Very High
Khalalio Hinterland	Chronic drought	Extreme

4.2.5 Overall Hotspot Pattern

Climate risk in Mandera Municipality is:

- Concentrated in drainage corridors and riverine settlements.

- Intensified where infrastructure has obstructed natural runoff (e.g., A13 road near Barwaqo).
- Highest in densely populated urban settlements with inadequate drainage systems.
- Structurally significant where critical transport corridors intersect seasonal streams.

Under projected increases in rainfall intensity and prolonged drought cycles, these hotspots are expected to intensify and expand unless structural drainage redesign, riverbank stabilization, and climate-resilient infrastructure measures are implemented.

5. WHAT'S NEXT?

5.1. Key Findings

The climate risk assessment for Mandera Municipality reveals a landscape of overlapping "Very High" risks that necessitate urgent, multi-sectoral intervention. The key hazards driving these risks are **Chronic Drought**, **Flash Flooding**, and **Extreme Heat**, all of which are projected to intensify significantly by 2050 and 2100.

- **Key Hazards & High-Risk Drivers:** Chronic drought remains the most pervasive threat, characterized by a reduction in cycles from every 10 years to every 2–3 years. This is increasingly punctuated by acute flash floods and riverine overflows from the Daua River, which create a "yo-yo" effect of climate shocks. Extreme heat is an emerging "silent killer," with temperatures projected to exceed $40^{\circ}C$ more frequently, exacerbating water demand and health vulnerabilities.
- **Populations & Assets at Risk:** * **Informal Settlement Residents** in "bullas" like Barwaqo and Bulla Nguvu are at the highest risk due to non-resilient housing and lack of drainage.
    - **Vulnerable Groups:** Children, the elderly, and PWDs face extreme sensitivity to heatstroke and waterborne diseases (cholera/typhoid) following flood events.
    - **Economic Assets:** The agricultural strip along the Daua River (critical for food security) and the cross-border trade infrastructure are frequently crippled by fluvial floods.
- **Future Trends:** Projections for 2050 (SSP5-8.5) indicate a "certain" increase in the number of "hot days" and a likely increase in rainfall intensity. This means Mandera will likely experience more severe "wet-get-wetter" and "dry-get-drier" extremes, leading to permanent structural damage to transport and water infrastructure if not adapted.

Table 30: Summary of climate risks affecting urban elements for Mandera Municipality

Category	List of Key Hazards		
	Current	**Mid-term (2050)**	**Long-term (2100)**
Infrastructure & Services			

Category	List of Key Hazards		
	Current	**Mid-term (2050)**	**Long-term (2100)**
Stormwater Drainage	Flash Flooding, River Flooding	Flash Flooding (SSP5-8.5)	Flash Flooding (SSP5-8.5)
Water & Wastewater Management	Drought, River Flooding	Drought, Heat, River Flooding	Drought, Heat, River Flooding
Solid Waste Management	Flash Flooding	Flash Flooding, Heat	Flash Flooding, Heat
Transport and Mobility	Flash Flooding	Flash Flooding	Flash Flooding
Energy	Heat	Heat	Heat
Economic Infrastructure	Drought, River Flooding	Drought, River Flooding, Heat	Drought, River Flooding, Heat
Social Infrastructure	Heat, Flash Flooding	Heat, Flash Flooding	Heat, Flash Flooding
Emergency Services	Flash Flooding	Flash Flooding	Flash Flooding
Populations			
Urban Residents	Drought, Heat, Flooding	Heat, Drought, Flooding	Heat, Drought, Flooding
Informal Settlement Residents	Flash Flooding, Heat	Flash Flooding, Heat	Flash Flooding, Heat
Vulnerable and Marginalized Groups	Drought, Heat, Flooding	Heat, Drought, Flooding	Heat, Drought, Flooding
Natural Assets			
Urban Green Infrastructure	Drought, Heat	Heat, Drought	Heat, Drought
Urban Blue Infrastructure	River Flooding, Drought	River Flooding, Drought	River Flooding, Drought
Peri-urban and Agricultural Systems	River Flooding, Drought	River Flooding, Drought	River Flooding, Drought

Main Takeaways from the Assessment

1. **Systemic Water Insecurity:** Under both current and future horizons, the **Water & Wastewater** sector remains at a "Very High" risk level. The municipality's absolute

dependence on the Daua River makes it fragile to both its disappearance (drought) and its overflow (flood).

2. **Structural Obstruction Hotspots:** A critical finding is that modern infrastructure, specifically the **A13 road construction**, has inadvertently created new flood hotspots (e.g., Barwaqo) by obstructing natural drainage. Future projects must prioritize "Room for the River" and drainage-integrated designs.
3. **The Heat-Health Nexus:** While flooding is more visible, the transition of **Extreme Heat** to "Very High" risk by 2050 threatens to make outdoor economic activity (markets and livestock trade) unviable during peak hours, necessitating a shift toward heat-resilient urban design (green canopies and ventilated cooling centers).
4. **Inequality of Risk:** Climate risk in Mandera is a "poverty multiplier." Residents in informal settlements face catastrophic impacts from hazards that might only be "moderate" for those in planned masonry housing, highlighting the need for targeted social protection and upgrading programs.

5.2. Climate Adaptation and Resilience Solutions

Building on the identified climate risk hotspots and the summary of hazards, the following preliminary list of adaptation and resilience solutions is proposed for Mandera Municipality. These solutions are categorized by their implementation timeline: **Immediate** (1–2 years), **Mid-term** (3–10 years), and **Long-term.**

Table 31: Climate adaptation and resilience solutions recommended for Mandera Municipality

Category	Recommended Solutions		
	Immediate	**Mid-term**	**Long-term**
Infrastructure & Services			
Stormwater Drainage	• De-silting and clearing of existing drains in Barwaqo and Township. • Installation of neighborhood-level culverts at the Bulla Haji road segment.	• Engineering redesign of the A13 road drainage to restore natural stream flow. • Construction of lined primary drainage channels in Neboi and Bulla Mpya.	• Implementation of a municipality-wide Integrated Stormwater Management Plan. • Expansion of the drainage network to cover 100% of the urban core.
Water & Wastewater Management	• Distribution of household water treatment kits to prevent waterborne diseases during floods. • Emergency repair and elevation of flood-prone riverine water pumps.	• Construction of climate-resilient, elevated water storage tanks and kiosks. • Mapping and drilling of deep, climate-resilient boreholes in the Khalalio hinterland.	• Development of the Mandera Bulk Water Supply project with off-stream storage (dams/pans). • Implementation of Managed Aquifer Recharge (MAR) to replenish groundwater.
Solid Waste Management	• Identification and relocation of illegal dumpsites from seasonal lagas and the riverbank.	• Construction of a modern, flood-proof sanitary landfill with perimeter protection. • Establishing community-based waste collection points in informal bullas.	• Development of a waste-to-energy or composting facility for organic waste. • Full integration of waste management with the municipal drainage master plan.
Transport and Mobility	• Installation of high-visibility flood warning markers at road-laga intersections.	• Raising road embankments and upgrading drifts at chronic washout points (Bulla Haji).	• Paving of critical urban "spine" roads with heat-reflective and permeable materials.

Category	Recommended Solutions		
	Immediate	**Mid-term**	**Long-term**
Energy	• Installation of solar-powered streetlights to enhance safety during extreme weather events.	• Expansion of the Mandera Solar Power Plant to reduce reliance on thermal grid vulnerability.	• Mainstreaming "cool roof" technologies for all municipal and government buildings.
Economic Infrastructure	• Promotion of heat-resilient market shelters with natural cross-ventilation.	• Construction of flood-resilient, raised storage facilities for cross-border trade goods.	• Establishment of a solar-powered cold chain network for perishable agricultural goods.
Social Infrastructure	• Retrofitting schools (e.g., Madrasatul Sunnah School) with rainwater harvesting and cooling vents.	• Structural reinforcement and flood-proofing of health centers in the riparian zone.	• Implementation of "Green School" programs featuring extensive shade canopy and insulation.
Emergency Services	• Training community first responders in the Township for flash flood rescue.	• Procurement of specialized amphibious rescue equipment and mobile water tankers.	• Establishment of a Multi-Hazard Early Warning System (MHEWS) with regional coordination.
Populations			
Urban Residents	• Public awareness campaigns on heatstroke prevention and flood safety.	• Mainstreaming climate resilience into the municipal land-use and zoning laws.	• Universal access to climate-resilient social protection (e.g., insurance/cash transfers).
Informal Settlement Residents	• Community-led mapping of safe zones and evacuation routes in "bullas."	• Upgrading programs focusing on drainage and basic sanitation in Bulla Nguvu.	• Long-term voluntary relocation programs for households in "Extreme" risk flood corridors.

Category	Recommended Solutions		
	Immediate	**Mid-term**	**Long-term**
Vulnerable and Marginalized Groups	• Targeted water trucking and food assistance during peak drought periods.	• Integration of PWD-accessible cooling centers in public buildings and parks.	• Livelihood diversification programs focusing on climate-smart SMEs for women/youth.
Natural Assets			
Urban Green Infrastructure	• Expansion of the Mandera Greening Program using drought-tolerant indigenous species.	• Creation of "Green Corridors" along seasonal lagas to stabilize banks (Greenview).	• Restoration of the municipal urban forest to mitigate the urban heat island effect.
Urban Blue Infrastructure	• Regulation of riverbank cultivation to preserve the natural riparian buffer.	• Construction of nature-based riverbank stabilization structures (gabions/terracing).	• Restoration of the Daua River ecosystem through integrated basin management.
Peri-urban and Agricultural Systems	• Subsidized provision of solar-powered irrigation pumps to replace diesel sets.	• Promotion of climate-smart agriculture (drip irrigation, drought-tolerant seeds).	• Establishment of permanent fodder banks and livestock insurance for pastoralists.

Summary of Recommendations:

The priority for Mandera Municipality is the **"climate-proofing" of basic infrastructure**. Immediate actions should focus on low-cost, high-impact interventions like de-silting drains and community early warnings. However, long-term resilience will depend on significant capital investments in **off-stream water storage** and the **redesign of the drainage master plan** to accommodate the projected increase in rainfall intensity.

Bibliography

County Government of Mandera (2023). *Mandera County Integrated Development Plan (CIDP) 2023-2027.* Mandera: County Treasury. [Available at: https://mandera.go.ke/download/cidp-2023-2027/]

County Government of Mandera (2024). *Final Reviewed Participatory Climate Risk Assessment (PCRA) Report.* Maarifa Centre. [Available at: https://maarifa.cog.go.ke/sites/default/files/2024-06/Final%20Reviewed%20PCRA%20Report.pdf]

Intergovernmental Panel on Climate Change (IPCC) (2021). *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the IPCC.* Cambridge University Press.

IPCC (2023). *Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report.* [Available at: https://www.ipcc.ch/report/ar6/syr/]

Kenya Meteorological Department (KMD) (2023). *Historical Climate Data and Seasonal Forecasts for North Eastern Kenya.* Nairobi: Ministry of Environment and Forestry.

Ministry of Agriculture, Livestock and Fisheries (MoALF) (2018). *Climate Risk Profile for Mandera County. Kenya County Climate Risk Profile Series.* Nairobi, Kenya. [Available at: https://cgspace.cgiar.org/handle/10568/96279]

National Drought Management Authority (NDMA) (2025). *Mandera County Drought Early Warning Bulletins (June & July 2025).* Nairobi: NDMA. [Available at: https://knowledgeweb.ndma.go.ke/]

UN-Habitat (2025). *Technical Assistance to The Second Kenya Urban Support Program (KUSP2) Framework for Refugee-Hosting Municipalities.* IATI Datastore. [Available at: https://datastore.iatistandard.org/activity/41120-192688]

World Bank (2023). *Kenya Urban Support Program II (KUSP II) Project Appraisal Document.* Washington, D.C.: World Bank Group.

GCA, *Urban Climate Risk Profile: Preparation Guidelines*, 2025.

Annex N1. Historical Hazard Events

Event 1: El Niño Flash and Fluvial Flooding

Hazard Event/Type	Pluvial (Flash) and Fluvial (River) Flooding
Date or Period	October – December 2023
Location	**Township Ward:** Barwaqo, Bulla Nguvu, and central business areas. **Neboi & Khalalio:** Riparian farms along the Daua River.
Intensity	Exceptional rainfall intensity linked to the El Niño phenomenon. River Daua burst its banks, and poorly drained urban areas saw flood depths of **0.5m to 1.2m**. The floods lasted for over 4 weeks in low-lying zones.
Social Impacts	Mandera recorded the highest fatalities in the region (over **17 deaths** reported). Approximately **1,821 households** were displaced in Mandera East alone. Schools were closed, and over **120 toilets** collapsed, triggering a cholera alert.
Physical Impacts	Massive infrastructure damage: **80% of road infrastructure** in Mandera, including segments of the **A13 road**, was affected. The **Low drift at solar** was destroyed, and critical water intake points on the Daua were submerged.
Economic Impacts	Total loss of **221+ acres** of riverine crops. Over **1,000 livestock** were swept away. Market access was cut off for weeks, leading to a **15–25% hike** in the price of essential commodities like sugar and flour.
Ecological Impacts	Severe bank erosion along the Daua River and the Greenview Laga; loss of topsoil in the riparian agricultural strip and siltation of downstream pans.

Event 2: The Multi-Year "Triple Dip" Drought

Hazard Event/Type	Chronic Drought (Meteorological & Hydrological)
Date or Period	2020 – Early 2023
Location	Municipality-wide, with extreme stress in **Khalalio hinterlands** and peripheral settlements like **Karo**.
Intensity	Five consecutive failed rainy seasons. The Daua River reached record low levels, often drying up completely into disconnected pools. Mean temperatures were consistently **2–3°C above average**.
Social Impacts	Over **500,000 people** (half the county population) required humanitarian aid. Malnutrition (MUAC) rates in children under five climbed to **29%**. Significant "climate migration" as pastoralists moved into Mandera Township seeking aid.
Physical Impacts	Drying up of all **earth pans** (over 10 pans). Mechanical failure of over **25 boreholes** due to 24-hour over-extraction.
Economic Impacts	Massive livestock mortality: over **7,000 animals died** in September 2022 alone. Agriculture GVA growth for the county plummeted by **-18.3%** in 2023. Terms of Trade (ToT) for pastoralists collapsed as goat prices fell while cereal prices doubled.
Ecological Impacts	Near-total loss of pasture and browse in the peri-urban zones; significant degradation of the "Green Belt" and death of non-indigenous urban trees.

Annex N2. Data Sources

Data	Data Source
Demographic features, Human Development Index (HDI), and administrative units.	**Mandera County Government (2023).** *Mandera County Integrated Development Plan (CIDP) 2023-2027.*
Historical and current climate trends (1993–2019) and hazard spatial distribution.	**Maarifa Centre (2024).** *Final Reviewed Participatory Climate Risk Assessment (PCRA) Report.*
Mean annual rainfall (255 mm), drought cycles reduction (from 10 to every 2-3 years).	**MoALF (2018).** *Climate Risk Profile for Mandera County. Kenya County Climate Risk Profile Series.*
Future climate projections (2050 and 2100) under SSP2-4.5 and SSP5-8.5 scenarios.	**IPCC (2021/2023).** *Sixth Assessment Report (AR6) - Climate Change 2021: The Physical Science Basis.*
Socio-economic impacts (livestock loss, food insecurity, and water scarcity percentages).	**ResearchGate (2018).** *Risks of Climate Change to Agro-pastoral Development in Mandera County.*
Livelihood sensitivity, poverty levels (89%), and stunting rates in children (36%).	**Alliance Bioversity-CIAT (2022).** *Kenya County Climate Risk Profile Data.*
Risk matrix values and hazard level classifications (Current, 2050, 2100).	**World Bank / GCA (2023).** *Second Kenya Urban Support Program (KUSP2) Framework.*
Spatial distribution of risks (wards), specific hotspots like Barwaqo and Greenview.	**Mandera Municipality (2024).** *Field Observations and Community Consultations.*
Road washout and drainage obstruction data (e.g., A13 road impacts).	**County Department of Roads & Public Works (2023).** *Flood Impact Assessment Bulletins.*
Main water sources (River Daua 43%, Boreholes 37%) and distance to water (9.5km).	**NDMA (2025).** *Mandera County Drought Early Warning Bulletin for October 2025.*
Recommended adaptation solutions (Afforestation, Solar Power, NbS).	**Global Center on Adaptation (GCA) (2025).** *Nature-based Solutions (NbS) Compendium for Urban Resilience.*
Urban greening and forest cover impact monitoring protocols.	**AIPH Green City Case Studies (2024).** *Mandera Municipality Greening Program.*
Policy context: Climate Change Fund Act (2021) and 2% development budget allocation.	**Mandera County Government (2021).** *Mandera County Climate Change Fund Act.*
Fatality counts (17), displacement (1,821 HH), and infrastructure loss (El Niño 2023).	**NDMA / County Disaster Management Unit (2023).** *Post-Disaster Needs Assessment (PDNA).*