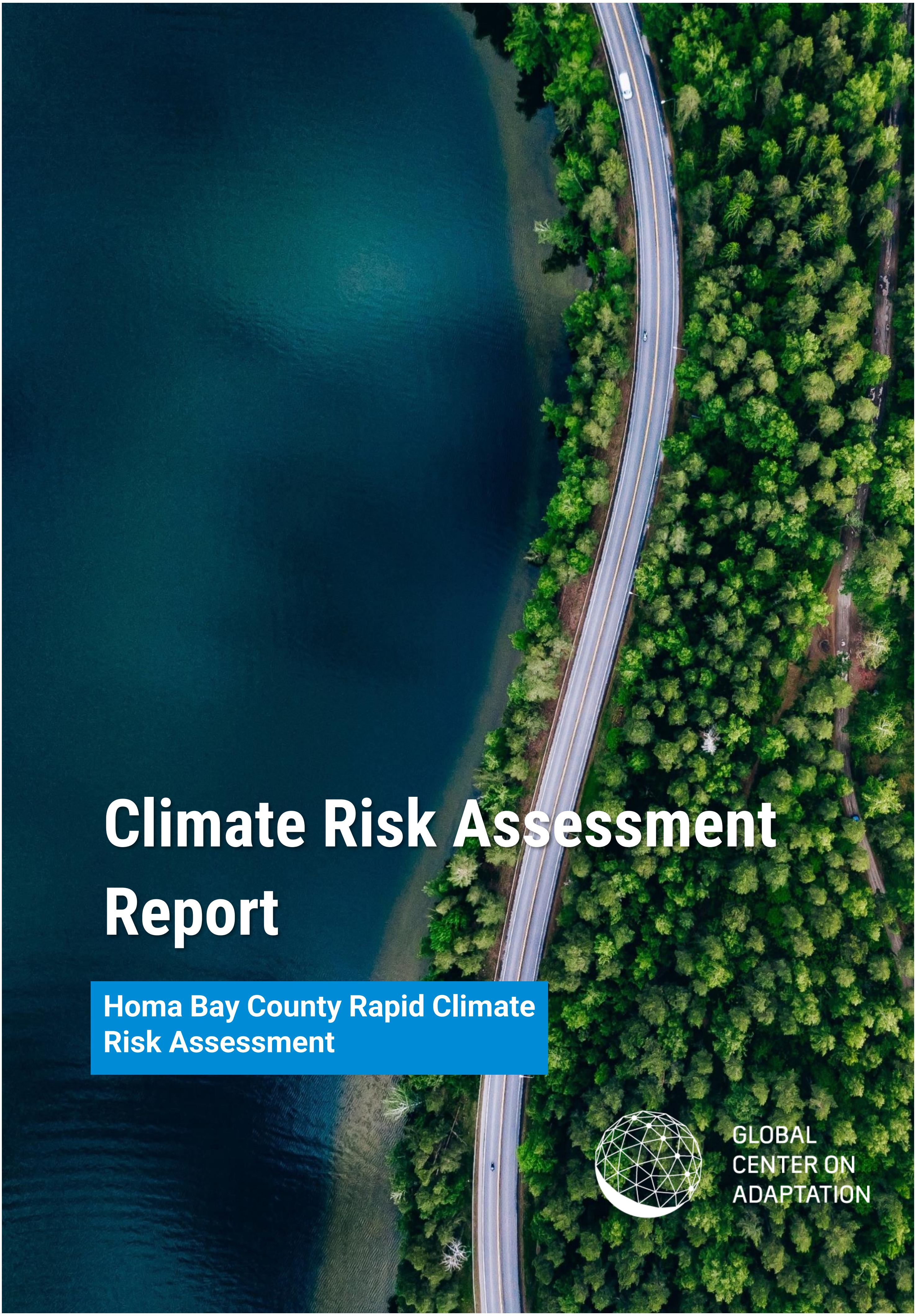


Climate Risk Assessment Report

Homa Bay County Rapid Climate Risk Assessment

GLOBAL CENTER ON ADAPTATION

AUTHORS & ACKNOWLEDGEMENTS

This report was developed by

Global Center on Adaptation:

Partnerships: Homa Bay County Government and Akiba Mashinani Trust

Consultants: Estelle ROUHAUD, Amélie AGNEL, Georgina ANDRE, Winnie ATIENO, David BILLAUD, Anthony FLORO, Diana WACHIRA

May 2025

Acknowledgements:

GLOBAL CENTER ON ADAPTATION

ABOUT THE GLOBAL CENTER ON ADAPTATION

The Global Center on Adaptation (GCA) is an international organization, hosted by the Netherlands, which works as a solutions broker to accelerate action and support for adaptation solutions from the international to the local, in partnership with the public and private sector, to ensure we learn from each other and work together for a climate resilient future.

Consultants:

suez

TABLE OF CONTENTS

TABLE OF ILLUSTRATIONS

Figures

Tables

ABBREVIATIONS

Acronyms	Definitions
AMT	Akiba Mashinani Trust
CBD	Central Business District
CCAP	Climate Change Action Plan
CCCF	County Climate Change Fund
CIDP	County Integrated Development Plan
CORDEX	Coordinated Regional Downscaling Experiment
ENSO	El Niño–Southern Oscillation
FLLoCA	Financing Locally-Led Climate Action
GCA	Global Center on Adaptation
HBM	Homa Bay Municipality
HOMAWASCO	Homa Bay Water and Sanitation Company
IFD	Intensity Frequency Duration
IOD	Indian Ocean Dipole
IPCC	Intergovernmental Panel on Climate Change
ITCZ	Inter-Tropical Convergence Zone
JF	January to February
JJAS	June to September
KISIP	Kenya Informal Settlements Improvement Project
KMD	Kenya Meteorological Department
MAM	March to May
NAP	National Adaptation Plan
NCCAP	National Climate Change Action Plan
NDC	Nationally Determined Contribution

NDMA	National Drought Management Authority
ND-GAIN	Notre Dame Global Adaptation Index
NGO	Non-Governmental Organization
OND	October to December
OSM	Open Street Map
PWD	People With Disabilities
RCRA	Rapid Climate Risk Assessment
UHI	Urban Heat Island
WB	World Bank
WRI	World Resources Institute

EXECUTIVE SUMMARY

This report presents the findings of a Rapid Climate Risk Assessment (RCRA) conducted in three informal settlements, Shauri Yako, Makongeni, and Sofia, within the municipality of Homa Bay, Kenya. Commissioned by the Global Center on Adaptation (GCA), the assessment aims to assess key climate hazards, exposure and vulnerabilities for each settlement, and propose actionable recommendations to support climate resilience at the local level.

Methodology

The methodology followed a multi-scalar and interdisciplinary approach combining secondary data review, historical and projected climate analysis, spatial mapping, and extensive field engagement. Community-based participatory workshops and stakeholder interviews ensured that local knowledge and lived experiences informed the analysis. Technical assessments included hydrologic and hydraulic modelling to evaluate flood exposure. The model was applied to subdivided catchments within each settlement, with flood depths and velocities calculated based on peak discharge estimates and adjusted for local topography and drainage assumptions. Flood extents are indicative and would need complementary topographical data to accurately represent flood depths and velocities.

Climate context and main hazards

The climate context of Homa Bay is characterized by increasing temperatures, more intense heavy precipitations and highly variable annual rainfall patterns, exacerbated by the El Niño–Southern Oscillation and the Indian Ocean Dipole.
Long-term climate projections indicate a warming trend across all emissions scenarios, with average temperatures expected to rise by +1.0°C to +2.0°C by mid-century and the number of days exceeding 35°C projected to increase significantly, potentially doubling under high-emission scenarios. Heatwave durations could extend by up to 98 days.

Meanwhile, rainfall shows no clear trend but is expected to become increasingly erratic, with heightened intensity of extreme events, already evidenced by the recurrency of flash flood episodes, which have become a critical and recurring hazard in the area. These events illustrate the growing instability of seasonal patterns and compound the vulnerability of communities already at risk due to unplanned urban expansion, inadequate infrastructure, and socio-economic inequalities.

Flooding emerged as the most significant hazard, consistently highlighted by community members as a pressing and recurring problem.

While projected climate change is not expected to drastically increase the magnitude of extreme flood events in Homa Bay, peak flood depths and flow velocities are only anticipated to rise by a few percent and the broader hydrological dynamics are likely to shift in more disruptive ways. In particular, increased inter-seasonal rainfall variability, with longer drought periods followed by intense rainfall episodes, poses a significant erosion risk. These alternating dry and wet extremes reduce soil cohesion, destabilize slopes, and intensify surface runoff, particularly in erosion-prone areas. As a result, even modest changes in flood behavior may lead to amplified erosion-related impacts in the future, with high-risk zones such as Makongeni expected to face more frequent slope failures, sediment transport, and damage to infrastructure and livelihoods.

Exposure

In parallel, the exposure assessment confirmed that critical public services and economic assets are situated in high-risk zones. Schools, health centers, roads, and markets across the settlements are frequently impacted by floods, yet few of these infrastructures are built to withstand such events. Erosion undermines physical assets, while flooding contributes to waste overflow, sewer backup, and road inaccessibility.

Vulnerable population groups, including women, youth, persons with disabilities, and female-headed households, face disproportionate impacts due to limited adaptive capacity, constrained mobility, and unequal access to resources or decision-making processes.

Although floods and droughts were identified as the primary hazards affecting the municipality, their impacts vary across the three settlements.

- Shauri Yako, the most central and densely populated settlement, experiences regular flooding due to its low-lying topography, insufficient drainage infrastructure, and urban compaction.
- Makongeni, situated on a hillside and closer to Lake Victoria, is simultaneously exposed to flash floods, severe erosion, and landslide risks, particularly near the slopes of Got Abuor Hill.
- In contrast, Sofia, located further inland and less densely built, partly due to its greater distance from Lake Victoria, is relatively less affected by floods but remains vulnerable because of infrastructural deficits, water access challenges during dry seasons, and heat-related discomfort exacerbated by poor-quality housing materials.

The participatory process revealed strong alignment between observed impacts and community perceptions. Residents of all three settlements highlighted flooding as a recurrent issue with growing severity, disrupting livelihoods, damaging homes and infrastructure, and posing public health threats. In Makongeni and Shauri Yako, annual flooding events often coincide with school closures, hospital service disruptions, and contamination of surface and drinking water. While drought was perceived more as an issue of water access and service reliability, rather than absolute scarcity, communities noted increasing unpredictability in seasonal rainfall, affecting agriculture, livestock, and food security.

Vulnerability

In contrast, the vulnerability assessment, supported as well by the participatory process, revealed a complex layering of interlinked vulnerabilities, both environmental and socio-economic in nature. The three informal settlements present varying levels of vulnerability, shaped by their geographic position, infrastructure quality, land use, and population characteristics. Within each settlement, exposure and sensitivity are not uniform: certain internal zones, such as low-lying floodplains, steep eroded slopes, or areas with poor drainage, are significantly more vulnerable than others.

Environmental factors, such as unstable soils, inadequate drainage systems, and deteriorated water infrastructure, interact with social drivers like poverty, insecure land tenure, limited access to services, and gender-based inequalities. In particular, limited land tenure security reduces residents' incentives and capacity to invest in resilient infrastructure—such as flood-resistant housing or improved sanitation—contributing to the persistence of fragile and exposed living conditions.

In fact, women face heightened vulnerability due to unequal land ownership, restricted decision-making power, and their central role in managing household water and caregiving needs, roles that become even more difficult under conditions of water scarcity or flooding. Indeed, one of the strongest insights from the community engagement was that access to water emerged not only as a key risk affected by climate hazards (floods and droughts), but also as a daily vulnerability due to infrastructure gaps, service interruptions, and management issues. Water insecurity, whether from dry-season, contamination during floods, or unreliable distribution, was consistently cited as both a stressor and a source of risk for livelihoods and health, especially among the most vulnerable groups.

These overlapping vulnerabilities reinforce one another, reducing the ability of households and communities to recover from climate shocks. Importantly, the assessment identified impact chains linking climate hazards to cascading effects across social, economic, and physical systems. For instance, a single flood event may result not only in damage to homes, but also in the closure of access roads, disruption of school attendance, overflows of sanitation systems, increased incidence of waterborne diseases, and loss of income for informal traders. These interconnected impacts reveal the systemic nature of climate vulnerability in informal urban settings and reinforce the need for cross-sectoral and integrated adaptation strategies.

As such, Shauri Yako and Makongeni emerged as the most vulnerable settlements overall, due to their dense urban form, proximity to flood-prone areas, and higher concentration of critical infrastructure exposed to recurring hazards. Sofia, while less structurally exposed, still displays significant vulnerability in its southern zones, where poor accessibility, lack of basic services, and heat exposure contribute to heightened risk.

This spatial and social variation highlights the importance of developing responses that are tailored not just to each settlement as a whole, but also to the specific areas and population groups within them. Addressing both place-based risks and the underlying social dimensions that shape vulnerability is essential for building effective and inclusive resilience strategies.

Governance context, institutional gaps and opportunities

While climate governance in Homa Bay is relatively well-developed from a planning perspective, with national and local frameworks such as the County Integrated Development Plan (CIDP), the County Climate Change Action Plan (CCCAP), and sectoral disaster risk strategies, these instruments tend to overlook the specific needs of informal settlements, where climate vulnerability is most acute.
Even where priorities are clearly identified, the capacity to implement them remains limited. This gap is among others driven by an emerging climate finance landscape, which remains insufficiently responsive to local needs and fails to deliver adequate or timely resources to the ground, especially for adaptation planning. In addition to financial constraints, institutional challenges include weak cross-sectoral coordination and limited technical capacity.

While community-level responses have emerged to address some of these gaps through self-organization and local adaptation initiatives, they remain under-supported and lack the scale necessary to meet the growing intensity of climate risks.

As a result, the disconnection between policy and practice persists, reinforcing institutional vulnerability and constraining long-term resilience-building efforts.

Main recommendations

Central to these recommendations is the application of the climate lens to all improvements of essential services as required and as expressed directly by the communities. Development of technical skills and appropriate funding must accompany all new programs and initiatives. The systematic integration of climate risk considerations into all future urban planning and infrastructure projects is important, as current examples, such as newly constructed infrastructure in flood-prone areas, underscore the urgent need for risk-sensitive design and siting. Furthermore, adaptation solutions must focus not only on direct impacts from climate hazards but also indirect impacts which can prove to be as impactful and less costly. Moreover, the analysis emphasizes the importance of moving beyond conventional zoning approaches, advocating instead for planning frameworks that reflect the functional interdependence of urban systems. Climate impacts are not confined to administratively defined high-risk zones but extends through interconnected infrastructure and services, highlighting the need for holistic and cross-sectoral planning. Specific priorities include the reinforcement of critical infrastructure against erosion and flooding, the application of resilient design standards for community facilities, the promotion of hydraulically transparent urban development along the lakeshore, and the harmonization of service delivery in more dispersed settlements like Sofia. Finally, the report calls for investment in local capacity building to ensure the long-term maintenance and resilience of essential infrastructure.

These recommendations provide a practical foundation for adaptive planning and institutional coordination in the face of accelerating climate risks in Shauri Yako, Sofia and Makongeni in particular and Homa Bay Municipality in general.

1. INTRODUCTION

This report presents the main results of a Rapid Climate Risk Assessment carried out in three informal settlements of Homa Bay Municipality in Kenya: Shauri Yako, Sofia and Makongeni. This analysis was undertaken as part of the Global Center on Adaptation (GCA) support to the African Development Bank's (AfDB) Kenya Urban National Water and Sanitation Program. The project aims to assist the Homa Bay County Government in developing People's Adaptation Plans for the settlements, thereby contributing to climate-resilient urban development through a participatory planning process. This work will feed directly into the future Local Physical and Land Use Development Plan for Homa Bay Municipality. The ambition of this project is also to strengthen data availability and accuracy while enhancing stakeholder's capacity to replicate the methodology in other contexts, thereby promoting broader resilience efforts across the region.

The methodology used was designed to overcome data scarcity challenges and provide a relevant and precise analysis deeply rooted in local realities, based on carefully selected variables and indicators and methodological tools of proven effectiveness in an informal context. It is grounded in close stakeholder engagement, using a pro-poor, gender-sensitive co-production approach to urban resilience.

This assessment is based on the analysis of an exhaustive literature review and data collection process, a hydrological and hydraulic modelling work as well as field work undertaken in Homa Bay from February to April 2025, specifically:

- Stakeholder interviews, including with representatives from Homa Bay County Government and Municipality, Homa Bay Water and Sanitation Company (HOMAWASCO), Kenya Informal Settlements Improvement Project (KISIP) and Non-Governmental Organizations (NGOs) to discuss climate hazards and impacts, main challenges and vulnerabilities, existing adaptation initiatives and additional needs.
    - In Makongeni, the workshop brought together 50 participants, including 31 men and 19 women.
    - In Shauri Yako, 53 individuals participated, consisting of 29 men and 24 women.
    - In Sofia, 44 participants attended the workshop, with 29 men and 15 women.
    - Homa Bay County officials were included in the participant counts for each workshop. In addition, separate meetings were held with county representatives, bringing together approximately 10 to 15 men and 2 to 5 women.
    - HOMAWASCO was represented by one male participant in the main workshop, and a separate side meeting was held at their boardroom with 6 additional representatives—4 men and 2 women.
    - KISIP project representatives were engaged during the field mission and included 2 men.
    - Homa Bay Municipality staff were met at their office and were represented by 3 men.
- Field observations in the three settlements to review critical assets, flooding paths and flood-prone hotspots, and physical impacts from climate hazards.
- Community validation workshops in the three settlements to map directly with the communities in a participatory way critical assets, flooding paths and flood-prone hotspots, discuss climate change perceptions, socio-economic, infrastructural and environmental challenges and possible solutions. Focus groups were organized to facilitate the discussion and were disaggregated as follows:
    - Women
    - Youth and Persons with Disabilities (PWDs)
    - Men and Elderly People

This disaggregation aimed to ensure inclusive representation and to capture the diverse experiences, needs, and priorities of different segments of the community.

The Consultant also collaborated closely with Akiba Mashinani Trust (AMT) which undertook a parallel assignment in Homa Bay, implementing the Mukuru Guide Approach, initially developed in the Mukuru settlement of Nairobi, therefore leading a community-led planning process. They specifically undertook a settlement mapping and a settlement profiling, which were used for this analysis.

This report begins by giving the broader Kenyan and local context within which analysis at the settlement level must be understood. It then continues by reviewing methodically each component of what defines a climate risk (IPCC, 2014): key hazards, exposure and vulnerabilities for each settlement. It concludes with broad recommendations which will be taken forward in the next step of the project.

2. CLIMATE CONTEXT IN HOMA BAY AND KENYA

The extent to which the three studied settlements – Shauri Yako, Makongeni and Sofia – are confronted to climate risks needs first to be understood within the broader climate context of Homa Bay Municipality and Kenya as a whole.

2.1 The climate in Kenya

Kenya has a warm, tropical climate with diverse microclimates due to varied topography. Coastal areas are hot and humid, inland regions more temperate, and about 85% of the country consists of arid and semi-arid ecosystems (County Government of Homa Bay, 2023). The climate is strongly influenced by the Inter-Tropical Convergence Zone (ITCZ), which creates two rainy seasons ("short rains" in October–December and "long rains" in March–May) and two dry seasons ("hot dry season" in January – February and "cold dry season" in June – September) (*Ibid*).

2.1.1 Temperature

According to the World Bank, the mean annual temperature is 24.3°C with average monthly temperatures ranging between 22°C (July) and 25.6°C (March). Temperature changes also vary per region, but the overall warming trend is clear, particularly since the 1950s (Figure 1). ERA5 data[1] highlights an increase of +2.2 °C in the annual average mean temperature since 1950, representing a rise of approximately 9.4%.

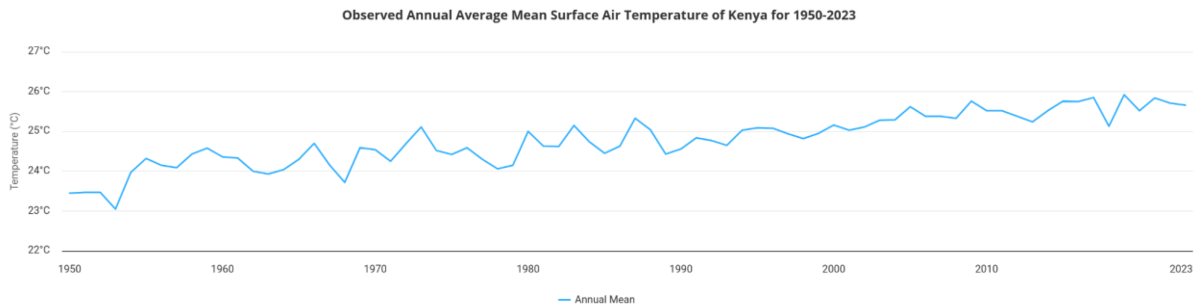


Figure 1: Observed Annual Mean Surface Air Temperature of Kenya 1950-2023 (Source: World Bank, Knowledge portal-ERA5)

2.1.2 Rainfall

Rainfall averages 668.6 mm annually but is unevenly distributed, with highlands and areas near Lake Victoria receiving more precipitation. While no clear long-term rainfall trend is observed, extreme rainfall events are increasing, complicating seasonal predictability.

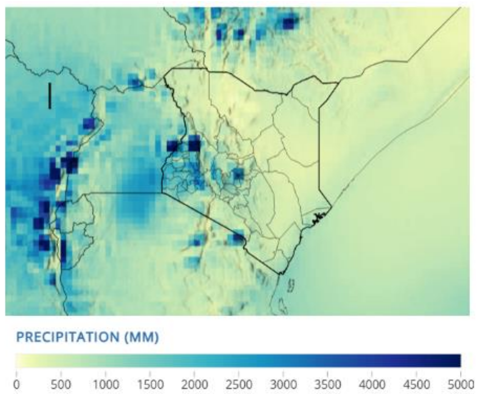


Figure 2: Observed Climatology of precipitation 1991-2020 Kenya (Source: World Bank, Knowledge portal-ERA5)

[1] ERA5 is the 5th generation reanalysis from the European Centre for Medium-Range Weather Forecasts for the global climate and weather for the past 8 decades. Reanalysis combines model data with observations from across the world into a globally complete and consistent dataset. Data is available from 1940 onwards and has a 31 km resolution.

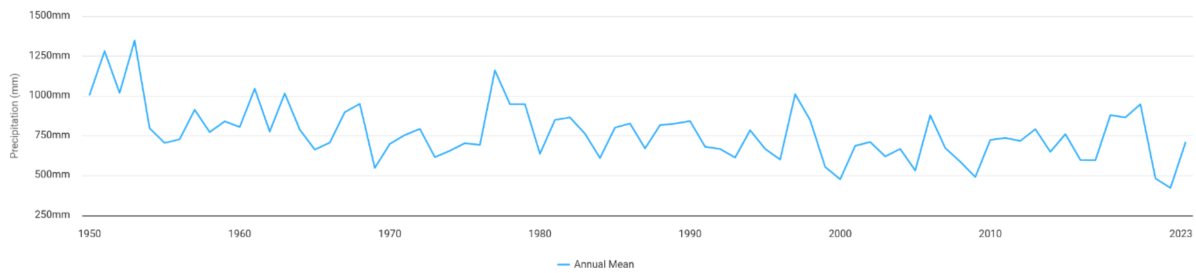


Figure 3: Observed annual precipitation of Kenya for 1950-2023 (Source: World Bank, Knowledge portal-ERA5)

2.1.3 The El Niño Southern Oscillation and the Indian Ocean Dipole: Major climatic drivers

Key climate drivers include the El Niño Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD). El Niño phases bring heavy rains and floods, while La Niña leads to drier conditions. A positive IOD can amplify these effects, causing erratic and severe weather, particularly around Lake Victoria. The recent intense 2023–2024 El Niño caused widespread flooding and over 200 deaths in Kenya, with Homa Bay especially vulnerable due to runoff from surrounding highlands (Jama, 2023).

2.1.4 Hazards

The most common hazards to which Kenya is exposed are droughts and floods (World Bank, 2021). Typically, major droughts occur approximately every ten years, and moderate droughts or floods every three to four years. They cause major socio-economic and financial impacts and the loss of lives in the country. Climate change is expected to increase the risk and intensity of flood events, while also furthering drought likelihoods for some areas across Kenya.

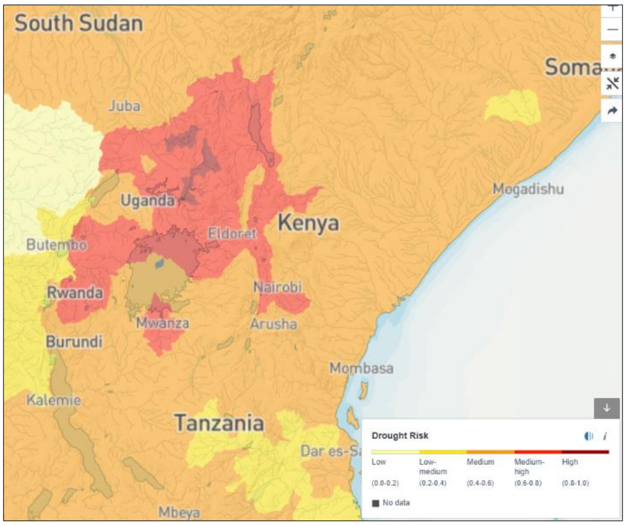


Figure 5: Drought risk in Kenya (source: Aqueduct Water Risk Atlas, WRI)

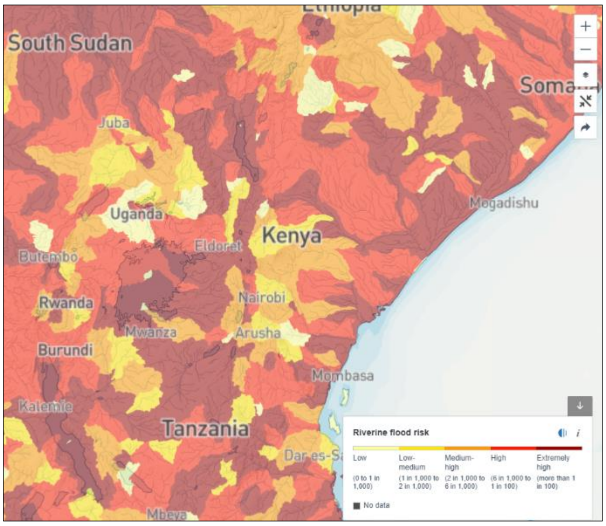


Figure 4: Riverine flood risk in Kenya (source: Aqueduct Water Risk Atlas, WRI)

2.2 Kenya's overall vulnerability to climate change

Kenya's vulnerability to climate change hazards can be evaluated using the Notre Dame Global Adaptation Index (ND-GAIN), an internationally recognized benchmark in this field. A country's ND-GAIN score consists of a **vulnerability** score and a **readiness** score, both measured through 45 indicators based on 74 variables, covering 182 UN member states from 1995 to the present (the latest data available is from 2022).

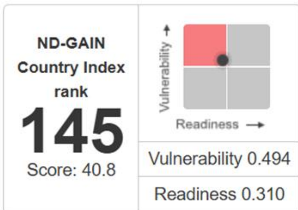


Figure 6: Score and rank ND-GAIN of Kenya

The overall index ranges from 0 to 100 (in practice, scores vary between 25.8 and 77.4), with lower scores indicating higher vulnerability. In 2022, Kenya received a ND-GAIN score of 40.8, ranking 145th globally, out of 182 countries. Compared to its neighboring countries, Kenya is in a slightly more favorable position in terms of climate vulnerability. This relative advantage is further reinforced by the fact that Kenya's vulnerability score has improved over the past two decades, with the country gaining nearly ten places in the global ranking.
In this context of vulnerability, Kenya has implemented various frameworks and strategies to address climate change adaptation and disaster risk management at the national level:

- National Climate Change Response Strategy 2010
- National Adaptation Plan (NAP) 2015–2030
- National Climate Change Action Plan (NCCAP) 2023-2027
- National Disaster Risk Management Bill 2023
- Nationally Determined Contribution 2020

These planning documents also highlight key vulnerabilities to climate change at the national level. Kenya's National Adaptation Plan (NAP) 2015–2030 serves as the country's first comprehensive framework for integrating climate adaptation into all sectors. It aims to promote resilience and sustainability in alignment with the national development blueprint, Vision 2030. The NAP highlights Kenya's increasing vulnerability to climate-related hazards—especially flooding—and outlines sector-specific risks across key areas such as oil and mineral resources, private sector and trade, fisheries, and livestock development. Notably, the NAP emphasizes the integration of climate adaptation into urban planning, with a strong focus on enhancing the resilience of urban areas, particularly for the urban poor and other vulnerable populations.
In addition, the National Climate Change Action Plan (NCCAP) 2023-2027 highlights Kenya's key climate vulnerabilities, both in terms of at-risk population groups and sensitive sectors. Indeed, the NCCAP emphasizes the heightened risks faced by informal settlements and outlines the broader impacts of climate change on critical sectors such as water, fisheries and the blue economy, manufacturing, and food and nutrition security. One striking example is the impact of floods, particularly in informal urban settlements. Although it is difficult to accurately estimate the number of people affected within these areas, the NCCAP reports that an average of 75,000 Kenyans are impacted by floods each year and the estimated costs of floods are about 5.5% of GDP every seven years (Government of Kenya, 2018). It is reasonable to assume that a significant portion of this number includes residents of urban informal settlements.

2.3 Homa Bay Municipality

Homa Bay Municipality, located along the shores of Lake Victoria in Homa Bay County, lies approximately 400 km west of Nairobi. Covering 103.1 km²—of which 9 km² comprises the Central Business District (CBD)—the municipality is surrounded by rapidly expanding peri-urban areas, including informal settlements driven by population growth, limited affordable housing, and rising living costs (Homa Bay Municipality, 2023). This urban expansion is placing increasing pressure on infrastructure and amplifying vulnerability to climate change impacts (UN-Habitat, 2008).
Historically, Homa Bay was favored by colonial administrators for its strategic location, water access, and well-drained land, establishing it as an early administrative center. Today, it serves as the county capital, coordinating governance, public services, and infrastructure management under the leadership of a Municipal Manager (UN-Habitat, 2008).
As of 2019, the municipality's population was estimated at 44,949, with approximately 30.9% (13,899 people) residing in three informal settlements (AMT, 2025). Continued rural-to-urban migration, drawn by economic opportunity and improved urban infrastructure, is driving rapid urbanization.

2.3.1 Climate

2.3.1.1 The present climate

Homa Bay County[2] experiences an inland equatorial climate, though its characteristics are also shaped by geographical factors. The climate is influenced by altitude and proximity to the lake, which results in cooler temperatures compared to typical equatorial climates. Like the rest of Kenya, Homa Bay County's climate is influenced by the seasonal migration of the ITCZ, resulting in four distinct seasons (County Government of Homa Bay,2023).

Homa Bay Town receives between 1100 and 1300 mm of precipitation per year according to the Kenya Meteorological Department (KMD) (County Government of Homa Bay, 2023), not equally distributed through the year:

- January to February (JF), the hot dry season, with an average of 100 to 150 mm in average.
- March to May (MAM), the long rainy season, with an average of 450 to 550 mm in average.
- June to September (JJAS), the cold dry season, with an average of 250 to 350 mm in average.
- October to December (OND), the short rainy season, with an average of 300 to 400 mm in average.

2.3.1.2 Future climate

Climate change projections on key indicators are available for Homa Bay Municipality. Looking at two different climate scenarios (RCP4.5 and RCP8.5) and to different time horizons (short and medium term), results show a clear warming trend whichever scenario is chosen, but no distinct trend for annual rainfall, going from less to more rain depending on the projections. However heavy precipitation intensifies slightly. Results below are taken from the model ensemble CORDEX Africa.[3]

Table 1: Climate projections for Homa Bay Municipality (source: CORDEX Africa)

Scenarios	Average temperature *(°C)*	Average rainfall *(mm/day)*	Heavy precipitation *(Nb days >20mm)*	Heatwave *(days)*	Number of days above 35°C *(days)*
RCP 4.5	Short-term: +1°C Medium-term: +1.6°C	Short-term: -3.9mm/day Medium-term: -3.6mm/day	Short-term: +0.9 days Medium-term: +1.2 days	Short-term: +38.5 days Medium-term: +72.3 days	Short-term: +1.5 days Medium-term: +4.1 days
RCP 8.5	Short-term: +1.1°C Medium-term: +2°C	Short-term: +0.2mm/day Medium-term: +0.4mm/day	Short-term: +0.6 days Medium-term: +1.3 days	Short-term: +37.8 days Medium-term: +97.8 days	Short-term: +4.5 days Medium-term: +13.3 days

[2] Homa Bay County is mentioned in this section due to the lack of downscaled data at Homa Bay Municipality level.

[3] Projections are based on the IPCC RCP scenarios used in the 5th Assessment Report published in 2014. More specifically, they are taken from the average of all the regional climate models from CORDEX Africa with a 50km resolution. Results are shown for the closest point in the grid to Homa Bay Municipality. Two different time horizons are presented: short-term corresponding to 2021-2040 et medium-term corresponding to 2041-2060. Two different climate scenarios are used: RCP 4.5 whereby emissions stabilize at a low level by the end of the century, and RCP 8.5 whereby emissions continue to rise at the current rate. The results of the median are given here and they show the change compared to the reference period, 1981-2010.

2.3.1.3 Hazards

The most common hazards at the county level are droughts and floods, which cause severe impacts: Decreased agricultural productivity; emergence of livestock and crop pests and diseases; disruption of economic and livelihood activities; destruction of critical infrastructure such as road and bridges; water scarcity; outbreak of diseases and epidemics; destruction of health facilities; and disruption of social and cultural systems (County Government of Homa Bay, 2023).

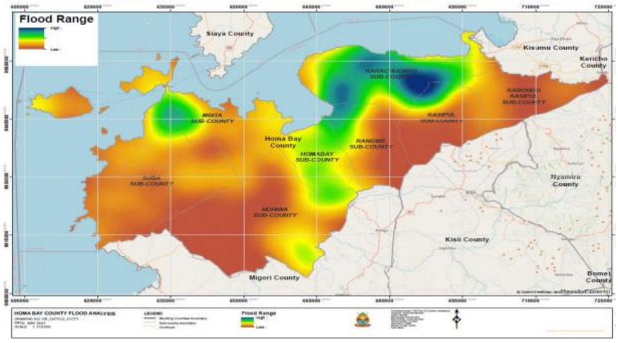


Figure 7: Flood range in Homa Bay County (source: Participatory Climate Risk Assessment Report, 2023)

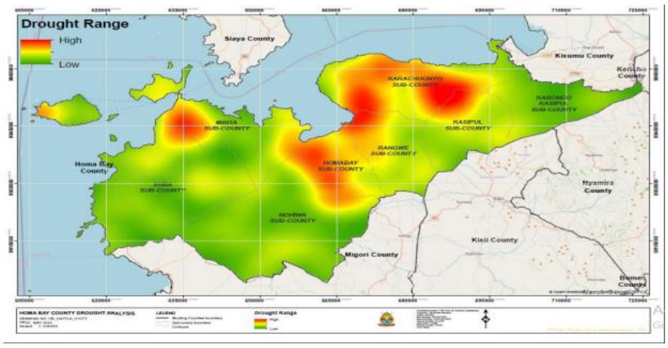


Figure 8: Drought range in Homa Bay County (source: Participatory Climate Risk Assessment Report, 2023)

Climate change is a key concern for Homa Bay County and Municipality. Even if Homa Bay Municipality does not currently have a dedicated climate change strategy of its own but relies on the well-established framework provided by Homa Bay County, which includes a Climate Change Act (2022), Climate Change Policy (2021), and a County Climate Change Action Plan 2023 – 2027.

2.3.2 Land cover and environmental characteristics

2.3.2.1 Land cover

The below land cover map of Homa Bay Municipality is based on WorldCover 2021 data[4], shows a diverse mix of urban, agricultural, and natural areas. Built-up zones are concentrated in Shauri Yako and Makongeni, reflecting dense human activity and infrastructure. Scattered tree cover provides some relief from urban heat and supports biodiversity. Surrounding the urban core, cropland and grassland dominate, highlighting the municipality's dependence on agriculture. To the southeast, shrubland marks a shift to peri-urban and semi-arid environments, characteristic of Kenya's Acacia- and Commiphora-rich ecosystems (Biodiversity Atlas of Kenya, n.d.), which support both wildlife and pastoral livelihoods.

4 The WorldCover project, initiated by the European Space Agency (ESA), has produced global land cover maps at a 10-meter resolution for 2020 and 2021, utilizing data from both Sentinel-1 and Sentinel-2 satellites. Such high-resolution data is invaluable for monitoring urban heat islands, assessing land use changes, and informing environmental and urban planning decisions. The WorldCover maps are freely accessible, supporting a wide range of applications from biodiversity conservation to climate modeling. https://esa-worldcover.org/en

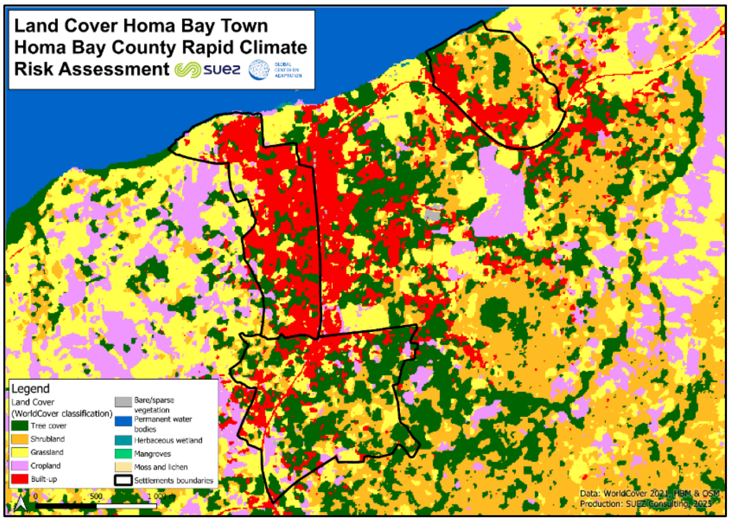


Figure 9: Land cover map of Homa Bay Town with the boundaries of the three settlements studied (Source: SUEZ Consulting, 2025)

The municipality's soil is predominantly black cotton soil, which presents various challenges. It is difficult to work with simple hand tools and becomes even more problematic during heavy rains, making farming difficult and increasing construction costs. As a result, quality housing remains scarce and unaffordable, forcing many residents into informal settlements. In contrast, the lake shore lowlands consist mainly of well-drained alluvial soils, particularly sandy loam (Homa Bay Municipality, 2023).

2.3.2.2 Topography

The topography of Homa Bay municipality, is characterized by a gently rolling terrain that flattens towards Lake Victoria, with various hills standing separately across the landscape (UN Habitat, 2008). As for the settlements, they are located on the lowland along the lakeshore, at an elevation ranging from 1,143 to 1,220 meters above sea level, forming a narrow strip of land bordering Lake Victoria (AMT, 2025). This topographical variation has direct implications for drainage, infrastructure placement, and land suitability for urban development. While the elevated portions benefit from natural drainage, the lower-lying parts may still face some flood risk, especially during heavy rainfall or lake level rise.

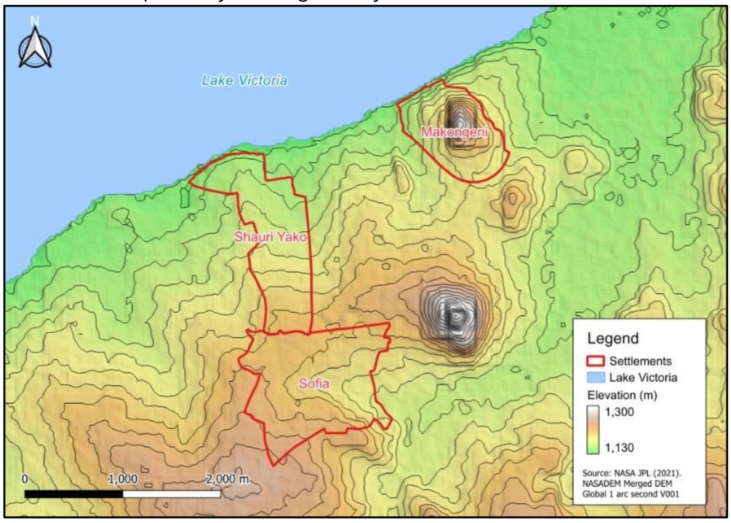


Figure 10: Homa Bay topography (Source: Suez Consulting, 2025)

2.3.2.3 Hydrography

The municipality is rich in natural resources, particularly water, with Lake Victoria forming the main hydrological source. As a result, it supplies water for industrial, commercial, and domestic use within the municipality, and its proximity eliminates the need for pumping water over long distances, resulting in shorter pipes (Homa Bay Municipality, 2023). Informal settlements are interwoven with various surface water features, including streams and drainage channels, though Lake Victoria remains the most influential water body in the area. The other influential body in the area is the Rang'wena river, flowing south of the city along an east/west axis towards the east and joining Lake Victoria 2 to 3 km east of the city.

2.3.3 Infrastructure

Homa Bay Municipality faces multiple infrastructure challenges, particularly in informal settlements. Water supply is insufficient, with existing pump-sets unable to meet demand, forcing reliance on alternative sources like shallow wells, boreholes, and lake water (Homa Bay Municipality, 2023). The sewage system covers less than 10% of the area due to high connection costs, and stormwater drainage is largely limited to the CBD and government quarters. Most other areas, including residential estates, lack functional drainage.

Electricity is the main energy source, but access is uneven, especially in informal areas lacking infrastructure. Road conditions are generally poor—many are unpaved and become impassable during rains, particularly in informal settlements.

Social infrastructure also falls short. Schools are overcrowded, and many children from informal areas must attend schools outside their communities. While the municipality has the district's highest concentration of health facilities, informal settlements still face major service gaps, often requiring residents to travel far for care (AMT, 2025).

2.3.4 Main economic activities

Economic activities in Homa Bay Municipality span both formal and informal sectors, working in tandem to sustain livelihoods and provide essential goods and services. The formal economy is anchored by the fishing industry—Lake Victoria being the main driver—not only through direct fishing, but also through supporting industries such as fish processing, equipment repair, and animal feed manufacturing.

The informal sector, known locally as Jua Kali, is equally vital. It includes small-scale, skill-based trades such as carpentry, vehicle repair, tailoring, and dressmaking. This sector plays a key role in poverty reduction by absorbing a large share of the unemployed population.

Commercial activity is also robust, with formal operations including fishing, trade, banking, and organized retail. Meanwhile, the informal commercial sector comprises small-scale agriculture, open-air markets, and street vending—critical to the resilience of vulnerable households who rely on it for income and daily needs.

KEY TAKEAWAYS

Analysis at the national and county level show the predominance of drought and flood risks which cause severe socio-economic and financial impacts. This naturally justifies the focus on drought and flood in this study for the three settlements. Climate projections in Homa Bay show a continuing warming trend and more intense rainfall but variability in annual rainfall patterns.

Kenya has a high level of vulnerability to climate change, although its score has been improving over the years. Homa Bay Municipality show various socio-economic as well as geophysical and infrastructural challenges which will increase its vulnerability in the face of climate hazards.

The three settlements evolve in this context of vulnerabilities and increasing impacts from climate change. The sections that follow will show the extent to which, by their informal characteristics, they may be more vulnerable.

3. CLIMATE RISKS IN THE THREE SETTLEMENTS

3.1 Conceptual framework used for the analysis

The conceptual framework developed by the Intergovernmental Panel on Climate Change in its 5th Assessment Report is used in this report. It defines a climate risk as the combination of a hazard, an exposure and a vulnerability.

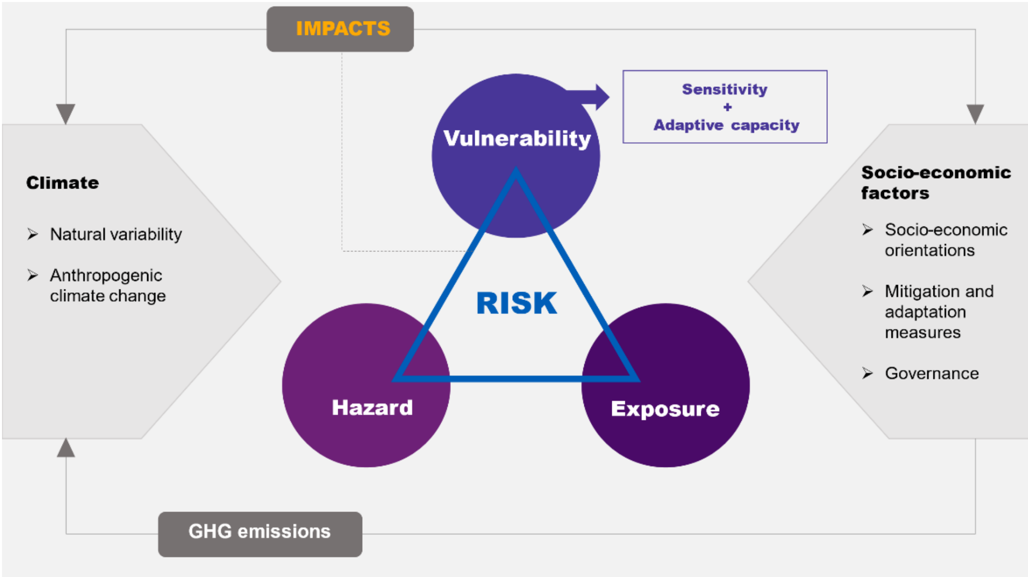


Figure 11: Climate risk definition (IPCC, 2014)

A risk occurs when there is first **exposure**, defined as the presence of people, livelihoods, species or ecosystems, environmental functions, services, resources, infrastructure, or economic, social, or cultural assets in places and settings in a given area to a **hazard**. But there must also be **vulnerability**, defined as the propensity or predisposition to suffer the negative effects of climatic hazards. This vulnerability depends in particular on the organization and planning of an area and the economy, the level and management of resources (human, natural, financial, social and physical) and the degree of preparation for these possible negative impacts. Vulnerability can be reduced by acting on the sensitivity of the system, i.e. the degree to which it can be impacted, and by reinforcing its capacity to adapt to react effectively to a hazard by mobilizing all its strengths and resources.

3.2 Hazards

The hazards concerned for this study are droughts and floods. These are indeed highlighted as the major climate hazards at the county level in the 2023 Homa Bay County Participatory Climate Risk Assessment Report and confirmed in an interview with the Department of Water, Sanitation, Environment, Energy, Forestry and Climate Change of Homa Bay County Government.

Looking at the EM-DAT database that provides an overview of the natural disaster events that have taken place around the world from the beginning of the 20th century to the present day, it can be noted however that flood comes out as the major type of climate events hitting Homa Bay. EM-DAT, among other things, lists meteorological, hydrological and climatological events that meet at least one of the following criteria:

- 10 or more deaths;
- 100 or more people affected/injured/disastered;
- The country declares a state of emergency or calls for international assistance.

The result for Homa Bay for these three types of events, based on available data since 2000, is as follows:

Table 2: Meteorological, hydrological and climatological events in Homa Bay district, 2000-2023 (Data: EM-DAT)

Year	Disaster Type	Origin
2004	Riverine flood	Heavy rains
2009-10	Riverine flood	Heavy rain
2012	Riverine flood	Torrential rain
2015	Flash flood and riverine flood	Torrential rain
2019	Flash flood	Heavy rainfall and overflowing rivers
2020	Flood	Prolonged rains
2021	Flood	"Long Rains" season
2023	Flood	Heavy rains

This finding matches the captured perception of communities in the three settlements during the community validation workshops held in April 2025, who were overall much concerned by flooding.

The issue of drought is seen by the communities as an issue of access to water, exacerbated in the dry season, rather than an issue of availability of the resources. Discussion with workshop participants revealed that access was very much connected to its management by the water supply provider, HOMAWASCO. However, they also highlighted that seasons are changing, and rains have become more unpredictable, which impact agricultural practices and livestock as very little irrigation is used, as well as alternatives sources of water for domestic use (such as water harvesting).

In an interview for the analysis, Homa Bay County Government noted indeed less record on drought events than on flood events but stressed on the recurring prolonged dry spells that disrupt agriculture, water availability and overall livelihoods.

In that same interview, flood events through many wards in the county were noted by the Government as more pronounced and more frequent and they are intensified through El Niño conditions during El Niño years. Communities also highlighted as being most impactful the recurrent flood events that occur every year during each rainy season, as opposed to more exceptional events. It was noted that generally water stagnates in the settlements for several days but then goes away.

3.2.1 Droughts

3.2.1.1 Past climate data

At the Homa Bay County level, for the period 1981 to 2022, the mean yearly rainfall has increased over the county (by a small margin, 12 mm, +1%) but with an important variability. During the period 1981-2008, records show a prevalence of drought events over flood events, while records for the more recent period (2008-2022) show the opposite (more flood events and less drought events). Regarding temperature, the analysis shows that the annual mean temperature had increased by 0.6°C during the 1981-2022 period.

On a more local scale, the areas around the lake (including Homa Bay town and the 3 studied settlements) have shown a tendency for increase in annual rainfall (between +30 and +50 mm per decade).

The hot dry season (January to February, JF), is the season most prone to drought, due to high temperature and low precipitations. Over the past 42 years (1981-2022), the temperature has increased by 0.3°C in the hot dry season, which is less than the annual mean temperature increase (+0.6°C). Consecutive dry days are varying between 25 and 100 days during the dry season.

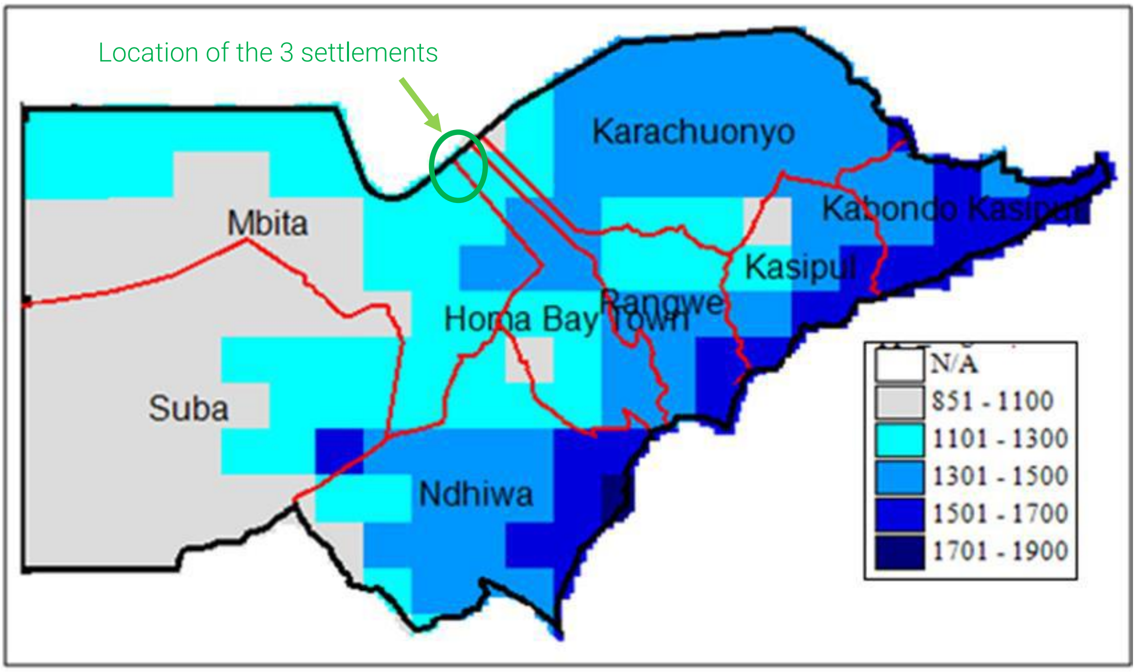


Figure 12: Average annual rainfall over Homa Bay County (source: KMD)

The most severe drought affecting Homa Bay over the recent years happened at the end of 2016 (around late November) into early 2017 (Aholi et al., 2024). This drought followed two consecutive seasons of poor rainfall (MAM 2016 and OND 2016), resulting in depletion of critical pasture and water resources. Studies showed that this drought which hit all over Kenya was connected to La Niña year (Uhe et al., 2017). This resulted in water and electricity rationing in some parts of Homa Bay county (Ibid).

3.2.1.2 Climate change impact on drought

Homa Bay County annual rainfall is projected to increase on average (about 40-50 mm by 2035 and 70-120 mm by 2050, scenarios RCP4.5 and RCP8.5). Under both RCP4.5 and RCP8.5 scenarios, the significant increase in rainfall will occurs during JF, MAM and OND seasons while minimal changes are expected during JJAS period (County Government of Homa Bay,2023).

Heat waves and heat stress are expected to increase significantly under RCP4.5 and RCP8.5 emission scenario, with an increase of the number of days with a mean temperature above 35°C expected to rise from 10 days (historical) to 15 days in the RCP4.5 scenario and 20 days in the RCP8.5 scenario.

Another parameter affecting drought is the inter-seasonal rainfall variability, with a likely increase of extreme event. Duration of dry spell are expected to increase in severity (-2 to +27% depending of scenarios RCP4.5 or RCP8.5) (County Government of Homa Bay,2023).

3.2.1.3 Lake Victoria

The 3 studied settlements rely exclusively on the Lake Victoria for industrial, commercial and domestic water. The water treatment plant, located below Asego Hills, has a total capacity of 4 000 m3 per day (County Government of Homa Bay,2023).

The closeness to the lake makes the settlement more resilient to the risk of drought, especially regarding water resources. Figure below shows the evolution of the level in Lake Victoria over the last 30 years.

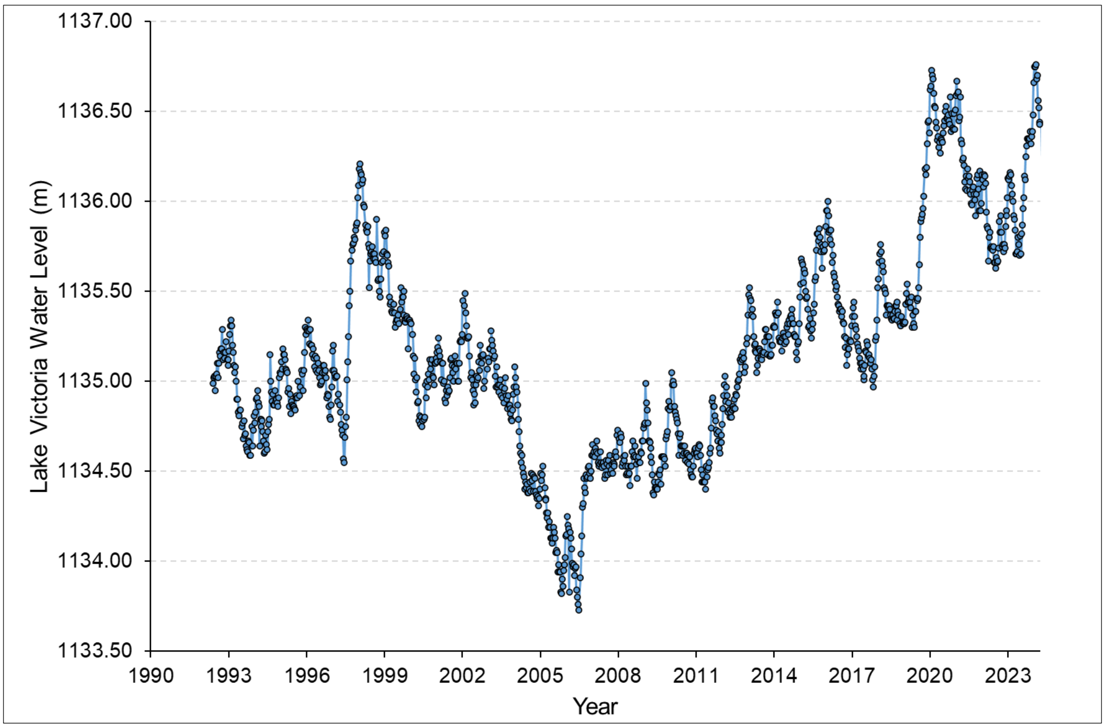


Figure 13: Lake Victoria historical water levels (Source: Dahiti Satellite, 2025)

Level in the lake varied over the past 30 years on a maximal amplitude of 3 m (between 1133.70 m and 1136.70 m). The minimal values were reached during the 2005-2008 periods while the maximum values were reached these last years (2020-2023). Lake Victoria is controlled by two hydropower dams of which the allowed discharge is dictated by the Agreed Curve, an equation relating outflow to lake level.

Regarding the projected water balance of the Lake, a detailed modelling was carried in 2018 in a scientific publication (Vanderkelen et al., 2018). The study's main output is that for two emission scenarios (RCPs 4.5 and 8.5), the decrease in precipitation over the lake and the increase in evaporation are compensated by an increase in basin precipitation leading to more inflow. The future lake level projections show that the dam management scenario (and not the emission scenario) is the main controlling factor of the future water level evolution.

There is no evidence that shows a decrease in Lake Victoria level in the previous years. Dam management policy is the main controlling factor of the future water level evolution.

KEY TAKEAWAYS

The closeness to Lake Victoria makes the 3 settlements more resilient to the risk of drought, especially regarding water resources availability. In the future, levels in Lake Victoria are expected to remain similar to those of today, with the evolution of dam management being the main impacting factor.

3.2.2 Floods

To map flood prone areas within the settlements, two approaches were used:

1. A participatory mapping was undertaken with the communities during the community validation workshops held in April 2025;
2. A hydrologic and hydraulic study was carried out to assess the flood risk on the 3 settlements. To assess the flood hazard, the 3 settlements were divided in distinct catchments and subcatchments. Peak flows (or discharge), for each flow path in these subcatchments, were estimated using usual hydrologic equations. The flood depths and velocities along these flow

paths were then estimated using different assumptions to compensate the lack of broad and accurate topographic data. Details on the methodology can be found in the appendices.

3.2.2.1 Makongeni

The three settlements are sensitive to flooding, particularly to flash flood causing significant erosion.

Figure 14: Important erosion on the side of the road – Makongeni settlement (SUEZ Consulting, 2025)

The typical scenario is an intense rainfall event following a dry period of several days. In such conditions, the hardened and dry soil has limited infiltration capacity, resulting in significant surface runoff. This runoff can lead to localized flooding and severe soil erosion, particularly on slopes, increasing the risk of landslides (Annex 2). This scenario repeats itself every year at the beginning of each rainy season, worsened by the lack of proper drainage system on the side of the roads and paths.

This is particularly relevant on the Makongeni settlement, located on the slopes of Abuor Hill, with a small catchment but with a quick response to precipitation due to steep slopes and low infiltration (urban areas and bush). The C19 road is frequently flooded, for several hours.

Other flood hotspots are located south of the C19, in the Makongeni Primary School precinct, located in the valley bottom but missing a proper drainage swale.

The maps below highlight the main flood affected areas in the Makongeni settlement as described by the residents during the community validation workshops and as per the hydraulic study.

Results of the hydraulic study show that the C19 road and the Makongeni Primary School precinct, located in the valley bottom are subject to flood depths exceeding 20 cm for extreme events (10 or 100 year return period floods).

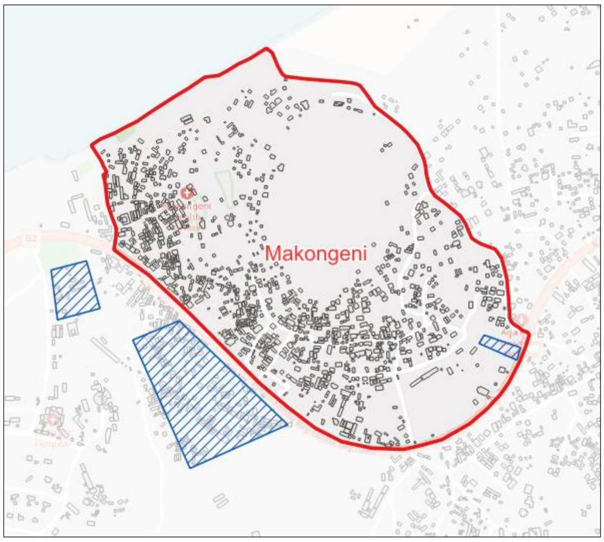


Figure 15: Flood affected areas in the Makongeni settlement based on Community Validation Workshops (source: Suez Consulting)

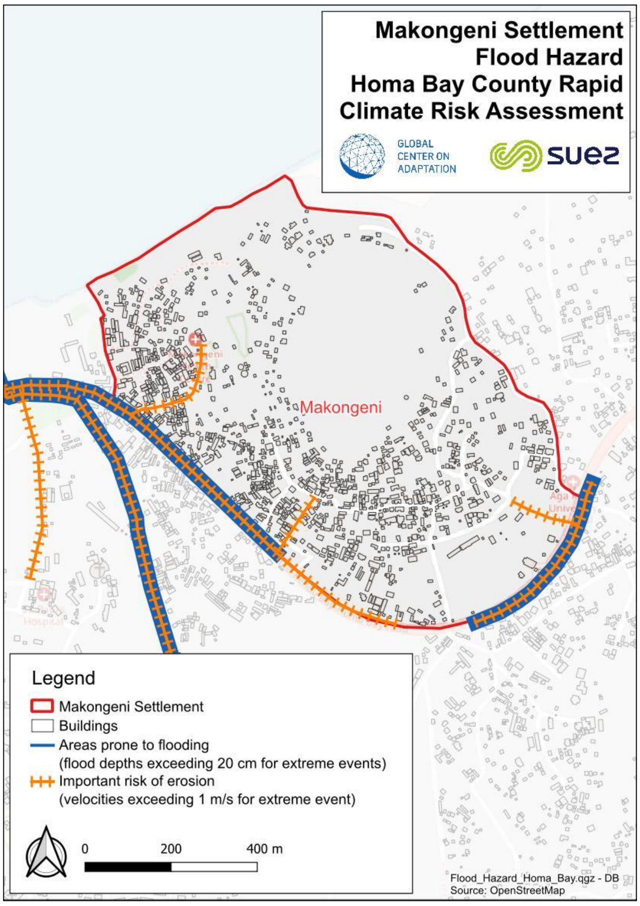


Figure 16: Flood Hazard Makongeni settlement assessed by the hydraulic study

3.2.2.2 Shauri Yako

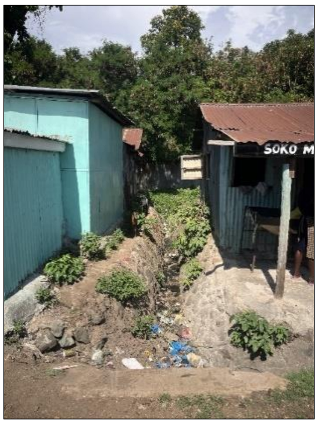


Figure 17: Drainage swale between buildings – Shauri Yako (SUEZ Consulting, 2025)

Shauri Yako is affected by flood events in similar ways. On the upper catchment (south of the settlement), the steep slopes and the lack of proper drainage system leads to water surface runoff and significant erosion. On the lower catchment, stormwater drains to two existing drainage swales.

These swales border the buildings with a risk of flooding, worsened by a possible blockage of culverts caused by debris and waste. Flooding occurs regularly near the market and has led to significant economic and social disruptions in Homa Bay, including:

- Displacement: Vendors and residents have been forced to evacuate as water levels rise.
- Income loss: Businesses experience reduced foot traffic, damaged merchandise, and disrupted supply chains.
- Inventory damage: Floodwaters often sweep away stock — especially perishable goods — resulting in substantial financial losses for traders.

The maps below highlight the main flood affected areas in the Shauri Yako settlement as described by the residents during the community validation workshops and as per the hydraulic study. Results of the hydraulic study show that the two drainage swales near the market are subject to significant flooding. The C19 road and the road leading to the pier on the north-west end of the settlement are also sensitive to flood.

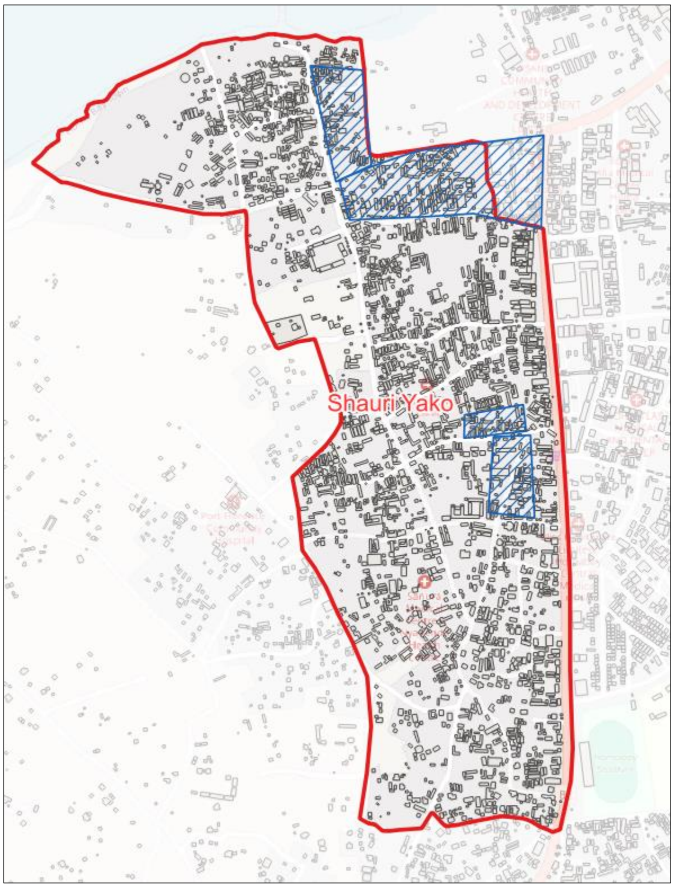


Figure 19: Flood affected areas in the Shauri Yako settlement based on Community Validation Workshops (source: Suez Consulting)

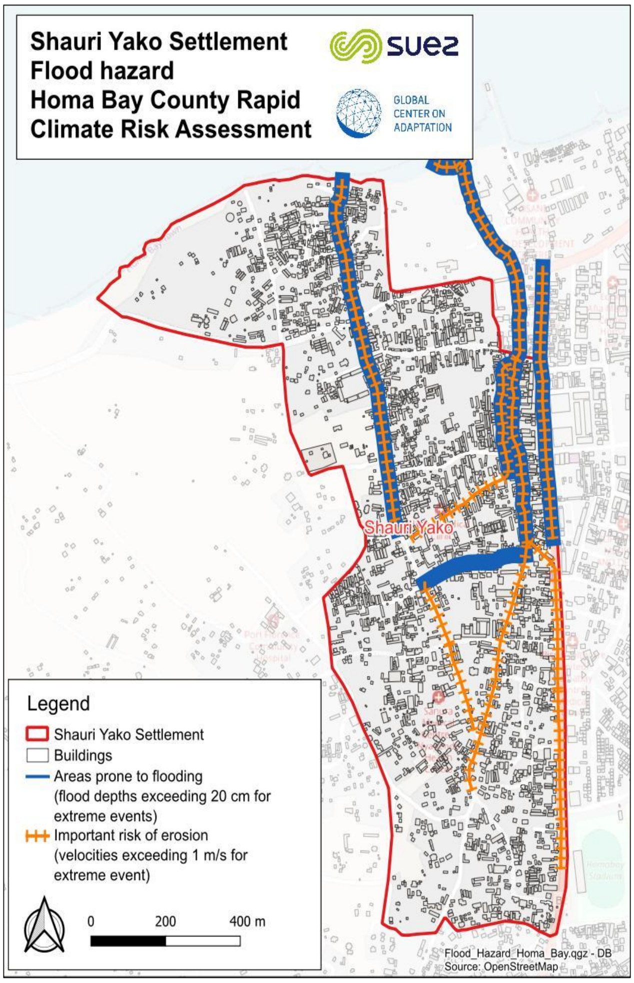


Figure 18: Flood Hazard Shauri Yako settlement assessed by the hydraulic study

3.2.2.3 Sofia

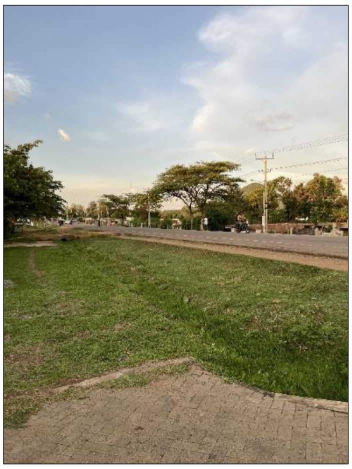


Figure 20: Drainage swale on the C19 roadside (SUEZ Consulting, 2025)

The Sofia settlement is less affected by flooding than the two previous settlements. It is located on the upstream side of different catchments in a less dense urban area. Important drainage works has been undertaken on the C19 road that split the settlement.

On the eastern slope of the catchment, there is no drainage system on the main roads and water drains to the swales on the roadside, leading to erosion caused by runoff, and even flooding on the downstream end of the settlement.

The maps below highlight the main flood affected areas in the Sofia settlement as described by the residents during the community validation workshops and as per the hydraulic study.

Results from the hydraulic study show that peak flood depths in the main flow path can exceed 50 cm, but far from any existing building.

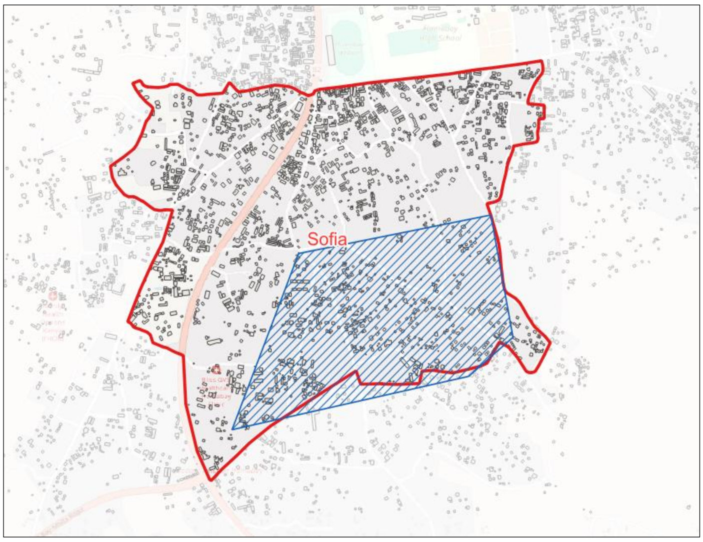


Figure 22: Flood affected areas in the Sofia settlement based on Community Validation Workshops (source: Suez Consulting)

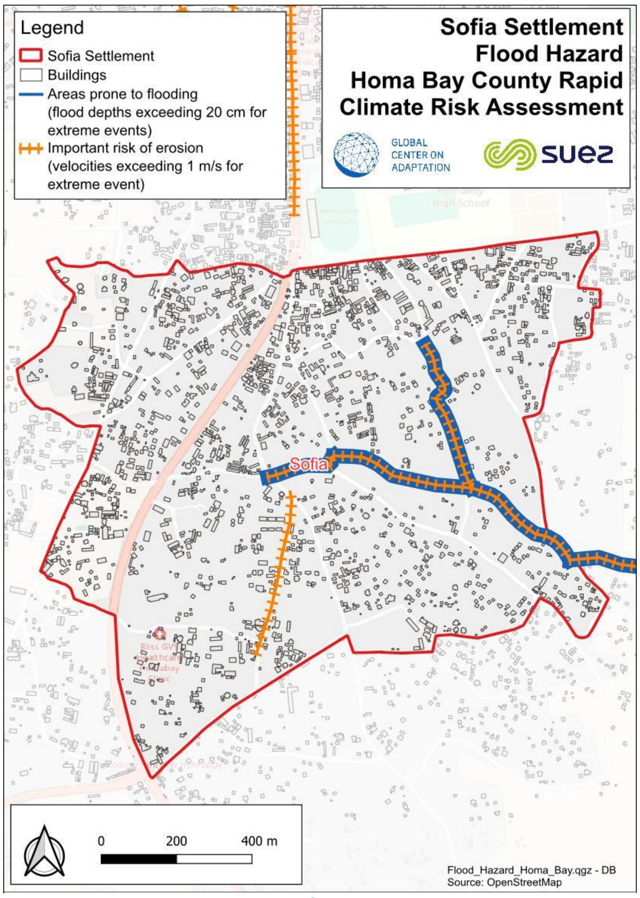


Figure 21 : Flood Hazard Sofia settlement assessed by the hydraulic study

3.2.2.4 Climate change impact on flooding

Climate models (CORDEX Africa) expect a 4% increase in extreme precipitation (maximum 1-day precipitation Rx1day) in short term and +8% increase in medium term in the region (Northeastern Africa, RCP8.5 scenario). These results are a rough estimate of the real impact of climate change on the 3 settlements, knowing that the defined region is very large, and that the climate indicator doesn't describe exactly the extremely rare events. It gives however a range of value that can help assess the impact of climate change on flood at Homa Bay.

Using these values[5], the peak flood depths and velocities were calculated and compared to present results. Impact on peak flood depths and velocity are shown in the table below.

Table 3: Impact on flood depth and velocity at short and medium term

Name	Impact (depth) Short term vs Present (%)	Impact (velocity) Short term vs Present (%)	Impact (depth) Medium term vs Present (%)	Impact (velocity) Medium term vs Present (%)
Average impact	+2.4%	+1.6%	+4.7%	+3.1%

KEY TAKEAWAYS

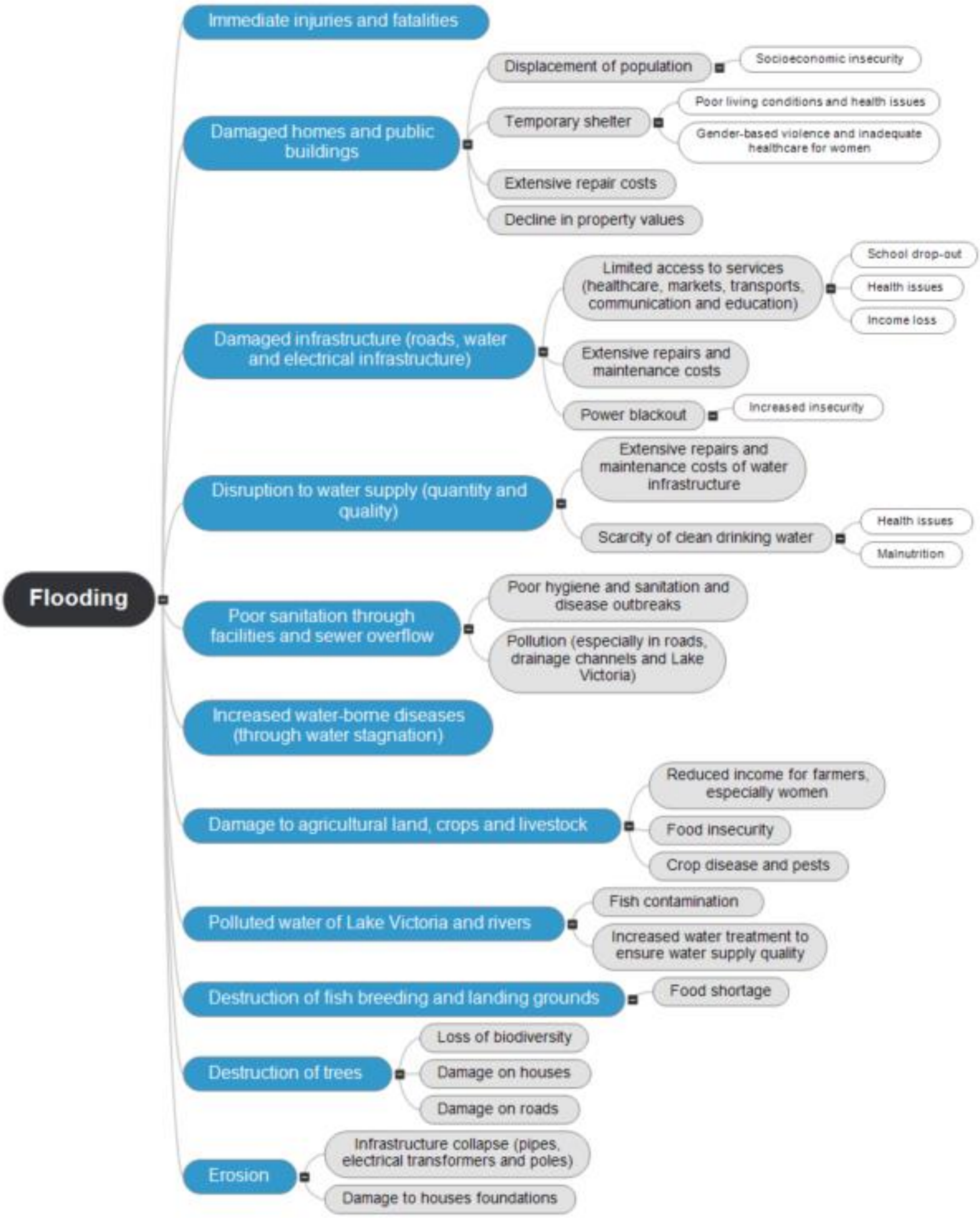
Climate change only has a relatively small impact on the amplitude of extreme flood events in Homa Bay, only increasing the peak flood depths and velocity by a few percent.

However, climate change also impacts the inter-seasonal rainfall variability, with a likely increase of drought period followed by intense floodings. These climate conditions are the most detrimental in terms of erosion risk, and one can therefore expect an amplification of the damage related to this phenomenon in the future.

[5] Increase in extreme precipitation (RX1day) short term +4%, long term +8%, RCP8.5 scenario, Northeastern Africa, CORDEX Africa

3.2.3 Chain of impacts

Through stakeholder interviews and the community validation workshops, a chain of impacts from flooding and drought in the settlements is drawn below, following the below structure:



3.2.4 Synthesis

Table 4: Summary of hazards affecting the settlements

Synthesis of the climate hazards			
Hazard	Historical trend	Future trend	Impacts *(in italics, indirect impacts)*
Flood	Increase in recent years	Going slightly upward according to climate projections (flood depth and velocity)	Public health and safety Housing Infrastructure, water supply and sanitation Agriculture and livestock Fishing Pollution Ecosystems Erosion *Livelihoods, access to services*
Drought	According to recent studies, dam management is the major concern regarding the level of water from Lake Victoria. Changes in rainfall patterns is more of a concern for agricultural purposes and alternative sources of water for the population.	Uncertain	Agriculture and livestock Fishing Access to water resources Ecosystems *Livelihoods, food security, health*

3.3 Exposure

3.3.1 Context and settlement layout

Representing a large portion of Homa Bay town, Shauri Yako, Sofia and Makongeni concentrates a high percentage of Homa Bay Municipality population with limited infrastructure and constrained access to basic services. While all three share characteristics of informality, each has distinct spatial, social, and environmental profiles.

Table 5: Settlements' spatial, social and environmental profiles (Data: AMT, Homa Bay Municipality Integrated Development Plan, WorldCover, SUEZ Consulting)

	Shauri Yako	Sofia	Makongeni
Location within HBM	Centrally located near the lakefront, is densely populated and closely integrated into the town's commercial activity	Lies in the southwestern part of the municipality, more isolated and surrounded by agricultural land	The north, is the smallest of the three and located at the edge of the urban boundary
Area (km²)	1.096	1.455	0,730
Total population	5,056	4,873	3,260
Density (persons/km²)	4,595	3,360.7	3,260
Land use	Predominantly residential	Predominantly residential in the north and agricultural in the south	Predominantly residential
Land cover	Mainly built-up area	Mainly natural area (tree cover, grassland and shrubland)	Mix of built-up area and shrubland area
Environmental settings	Proximity to Lake Victoria	Inland and adjacent to agricultural land	Proximity to Lake Victoria and surrounded by Got Abuor hill
Urban sprawl pattern	Frontal expansion along main road	Peri-urban expansion	Built-up zone below the hill, expanding eastward

3.3.2 Exposure assessment per settlement

Before delving into the exposure analysis, it is essential to clarify several underlying assumptions that inform this section.

First, we adopt the concept of critical urban infrastructure as defined by Dine and Gasmi (2024): "systems and assets vital for urban functionality, including transportation networks, utilities (water, electricity, gas), healthcare facilities, and communication systems." **These infrastructures are not standalone elements—they are highly interconnected and interdependent.** A failure in one component can have cascading effects, potentially disrupting multiple services across the settlement. As such, identifying exposure does not only involve listing assets or examining construction materials—it also requires understanding the essential services these assets provide and how their failure may compromise continuity and resilience in times of climate stress.

Second, it is important to acknowledge the limitations of relying strictly on administrative boundaries when assessing exposure. While such boundaries serve a purpose in planning, they often do not align with the way communities experience and interact with space. In each settlement assessed, residents consistently identified zones beyond the mapped perimeter as integral to their daily lives—whether for access to schools, hospitals, water sources, markets, or transport routes. This community-defined geography is critical to understanding real exposure and must be taken into account. Likewise, hazard impacts do not respect administrative lines: water runoff, waste flows, and power outages, for example, can affect surrounding areas regardless of whether they fall inside or outside official limits. Therefore, a purely boundary-based view risks underestimating exposure and overlooking functionally connected areas that are vital to community resilience.

Finally, this assessment does not aim to reduce climate risk to predefined "zones" alone. While certain areas within the settlement are indeed more physically exposed—such as floodplains or landslide-prone slopes—an area must be understood as an interconnected system. **Climate impacts do not stop at mapped boundaries, and the exposure of an asset cannot be judged solely by its direct location within a high-risk zone.** An infrastructure or service that appears to be outside of these hazard areas may still be highly exposed due to its functional interdependence with other, more at-risk systems. For example, a school may be cut off if an access road is flooded, or a health facility's operations may be disrupted by a breakdown in the nearby water or energy supply. Social dependencies, spatial connectivity, and systemic linkages all contribute to the true level of exposure—reminding us that resilience planning must consider the settlement as a whole, not as isolated parts.

In short, exposure is not only a matter of physical location—it is also about systemic and social interdependence. This means that effective climate risk planning must take into account both the spatial distribution and the operational relationships between assets and services. Settlements have been analyzed as complex, interconnected urban systems, where even indirect or functional vulnerabilities can have profound effects on resilience.

3.3.2.1 Shauri Yako

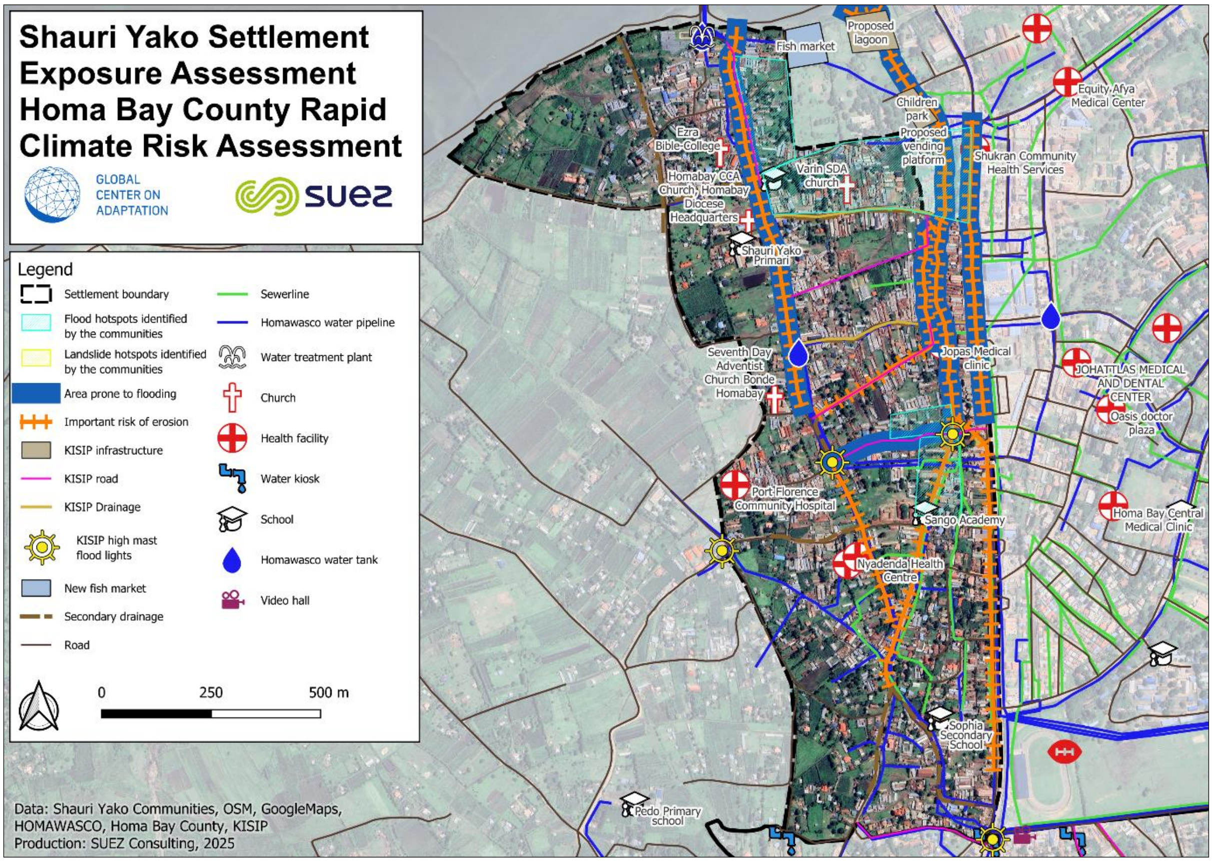


Figure 23 : Shauri Yako Exposure map (Source: SUEZ Consulting, 2025)

Shauri Yako is the most central informal settlement within Homa Bay Municipality, bordered by the lake to the north and integrated into the town's core infrastructure and commercial activity along the C19 road. The area is densely populated and highly urbanized at the east, with a wide range of facilities, and critical infrastructure concentrated within a compact space. The map above highlights that this concentration also leads to high exposure to climate-related hazards—particularly flooding.

Shauri Yako is highly exposed to flooding, especially in its northeastern and central areas. This heightened vulnerability is largely due to the settlement's topography and location—it is situated along a natural downslope that extends from the surrounding hills toward Lake Victoria. As a result, the southern part of Shauri Yako, located closer to the higher elevation, is generally less affected by flood events than the northern zones, which lie at lower altitudes and act as natural catchment areas during heavy rainfall.

Houses

As written above, Shauri Yako is the most densely populated informal settlement within Homa Bay Municipality (AMT, 2025). This high density, combined with unregulated construction in flood-prone zones and inadequate drainage infrastructure, contributes to the high exposure of housing structures to flood-related risks. During the site visit, many homes were observed to be directly affected by frequent flooding, particularly those located along natural water flow paths. Indeed, a significant number of houses have been constructed in or near informal drainage channels or low-lying flood-prone zones. This not only increases the vulnerability of the structures themselves but also contributes to the disruption of natural water flow. In many cases, buildings unintentionally obstruct runoff pathways, causing water to divert and erode the soil around house foundations, leading to structural weakening over time.

Figure 24: Photos of houses in Shauri Yako impacted by flooding and erosion (© SUEZ Consulting, 2025)

Critical urban infrastructure

Due to its central location within Homa Bay Municipality, Shauri Yako seems to have, among the three informal settlements, the highest concentration of urban infrastructure, including water, drainage, sanitation, electric and road systems. This high concentration combined with the area's exposure to climate hazards, leaves Shauri Yako urban infrastructure particularly exposed to climate change.

During the community workshops, residents reported that the existing drainage and sanitation infrastructure (pit latrines and existing sewerlines) are frequently overwhelmed during intense rainfall, resulting in sewage overflows and surface runoff. These flows spread waste and debris throughout the settlement, eventually discharging into Lake Victoria and posing serious public health and environmental risks.

These accounts were corroborated during the field visit, where several sewer lines—though mapped—were observed to be non-functional, uncovered, or severely blocked by solid waste, rendering them ineffective. In some areas, physical deterioration further compromised their performance.
As shown in Figure 25, a main water pipeline is located directly within a flood path and surrounded by accumulated waste, illustrating the critical exposure of essential infrastructure and the urgent need for coordinated maintenance, protection, and redesign of key systems to withstand future climate shocks.

Figure 25: Photo of a water pipeline in the middle of the flood path surrounded by waste in Shauri Yako (©SUEZ Consulting, 2025)

Like housing, the rapid and often unregulated development of Shauri Yako has led to the placement of critical infrastructure in areas highly exposed to climate risks (flood path area). As shown in Figure 26, an electric pole has been visibly weakened by erosion, highlighting the vulnerability of essential services to extreme climate events. This concern was also raised during the community workshop, where residents reported that during flood events, electric transformers have fallen onto roads and near schools, creating serious safety hazards.


Figure 26: Electric pole in Shauri Yako affected by erosion (©SUEZ Consulting, 2025)

Moreover, Shauri Yako hosts a relatively high concentration of health infrastructure compared to other informal settlements in Homa Bay. Within its boundaries, there are at least four medical facilities—including clinics and hospitals—which serve the densely populated community. However, several of these health centers are located adjacent to area prone to flooding and erosion, exposing them to multiple climate risks. During flood events, these facilities are vulnerable to service disruption, restricted access, and potential contamination, posing serious challenges to health service delivery when it is most needed. In addition to health facilities, another critical piece of urban infrastructure is the HOMAWASCO intake and treatment plant, located near the lakefront in Shauri Yako. This facility is essential for supplying potable water to a large portion of the municipality. While some of the plant's components were observed during the site visit to be slightly elevated—providing limited protection against minor flood events—this is not the case for all assets. The plant's overall siting in a low-lying, flood-prone area close to the lakeshore makes it vulnerable to both fluvial flooding and backflow from the lake during periods of intense rainfall. These conditions heighten the risk of service disruption and contamination, particularly during climate extremes when clean water access is most critical.

In terms of new critical urban infrastructure, KISIP is currently installing three high mast floodlights along a single road within Shauri Yako and roads. While these installations may improve night-time safety, visibility and accessibility, there is uncertainty regarding their resilience to climate impacts—such as flooding and erosion—and whether their placement has taken exposure risks into account. Moreover, the limited spatial coverage of lighting infrastructure, especially in flood-prone zones identified by residents, suggests that many vulnerable areas remain underserved, raising questions about equitable access and long-term infrastructure planning in the context of climate adaptation.

Social facilities (educational, religious and commercial facilities)

The settlement also includes a number of educational institutions, such as Shauri Yako Primary School, Sango Academy, and Sophia Secondary School, as well as numerous religious facilities embedded throughout the neighborhood. These buildings play a critical social role but are situated in or near identified flood hotspots, increasing their exposure. According to community feedback, children often miss school during heavy rainfall or flood events due to safety concerns, further impacting education outcomes.

In terms of public amenities, Shauri Yako lacks accessible recreational spaces or public parks where residents—particularly children—can safely gather, play, or rest. Although a children's park is planned under the KISIP initiative, both community input and spatial analysis suggest that its proposed location falls within a flood-prone area, raising concerns about its long-term usability and safety.

From a commercial standpoint, Shauri Yako is home to key economic infrastructure, including a central market currently being rehabilitated by KISIP, and a new fish market constructed by the county government near the lake in the northern section of the settlement. While these facilities are vital for local livelihoods and food access, they appear to be highly exposed to climate-related hazards. The rehabilitated market, for instance, is located in a known flood zone; although some elevation measures seem to have been implemented to mitigate risks, detailed design information remains unavailable.

Figure 27: Rehabilitated market by KISIP in construction (©SUEZ Consulting, 2025)

Similarly, the newly constructed fish market is positioned close to drainage lines and the lake shore, placing it at risk of inundation and erosion during extreme weather events.

Figure 28: New fish market in construction (©SUEZ Consulting, 2025)

In summary, while Shauri Yako benefits from a relatively dense network of infrastructure, the siting of many key facilities in flood-prone areas undermines their resilience and limits their capacity to serve the population during climate-related crises. Future planning and investments should prioritize risk-sensitive siting and climate-resilient design standards to safeguard essential services and community well-being.

3.3.2.2 Sofia

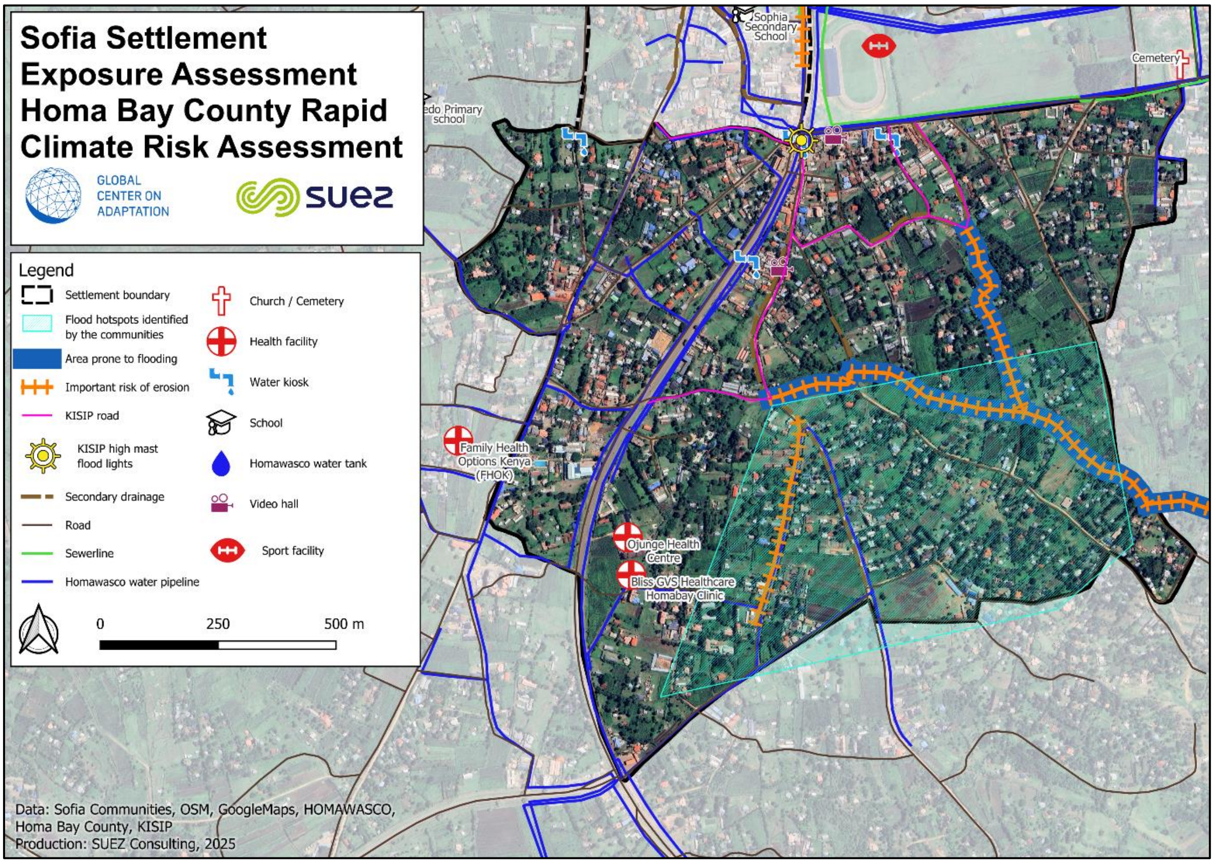


Figure 29: Sofia exposure map (Source: SUEZ Consulting, 2025)

Sofia seems to be the most spatially dispersed of the three informal settlements assessed in Homa Bay Municipality. Rather than being densely built, the settlement is scattered across a large area (1.45 km2), with clusters of housing interspersed by open or vegetated land. This pattern of development shapes both the distribution of infrastructure and the community's exposure to climate risks. Topographically, Sofia spans a small hill, with the northern section located on a relatively elevated plateau, and the southern east area sloping downward toward flood-prone zones. This natural gradient creates a clear contrast in exposure: the northern part is more developed, better connected to the city (especially near Shauri Yako and the Raila Odinga Stadium), and relatively protected from flooding. In contrast, the southern zone is low-lying and exposed, acting as a catchment for runoff during heavy rainfall.

Houses

Like in Shauri Yako, the houses in Sofia are often constructed from corrugated iron sheets, which not only offer limited protection during flood events but also exacerbate indoor heat during dry spells—a concern that was widely reported during the workshops. The choice of building materials plays a crucial role in mitigating the urban heat island effect, especially in informal settlements. Materials like corrugated iron sheets absorb and radiate heat, significantly raising indoor temperatures.

Critical urban infrastructure

One of the most pressing issues raised by residents during the community workshops was the lack of basic infrastructure. This was particularly evident in the youth and PWD focus group, where discussions began with the absence of a functioning local market, underlining broader concerns about limited-service delivery and social amenities.

While the more dispersed layout means that fewer critical assets are clustered in high-risk flood zones, this also reflects a general lack of infrastructure across the settlement. In the southern section, where flooding is most common, community members noted that the primary elements exposed include unpaved roads, homes, and trees.

Figure 30: Impacts of flood along a road in the south of Sofia (©Google Street View, November 2021)

Compared to Shauri Yako and Makongeni, Sofia's lower level of urbanization and inland location help to reduce comparatively climate impacts and exposure to certain hazards. For example, its distance from Lake Victoria minimizes risks such as wastewater discharge and flood-induced contamination of the lake, which are pressing issues in the lakeside settlements. However, this remoteness also introduces other climate-related challenges—notably water access during the dry season, as households further from urban water infrastructure rely more on vulnerable or informal sources.

In summary, although Sofia may appear less exposed due to its spatial dispersion and limited infrastructure density, the southern part of the settlement remains vulnerable to flooding, while exposure to heat is widespread across all housing clusters due to material use. The exposure profile is shaped by topography, material vulnerability, and the distribution (or absence) of infrastructure.

3.3.2.3 Makongeni

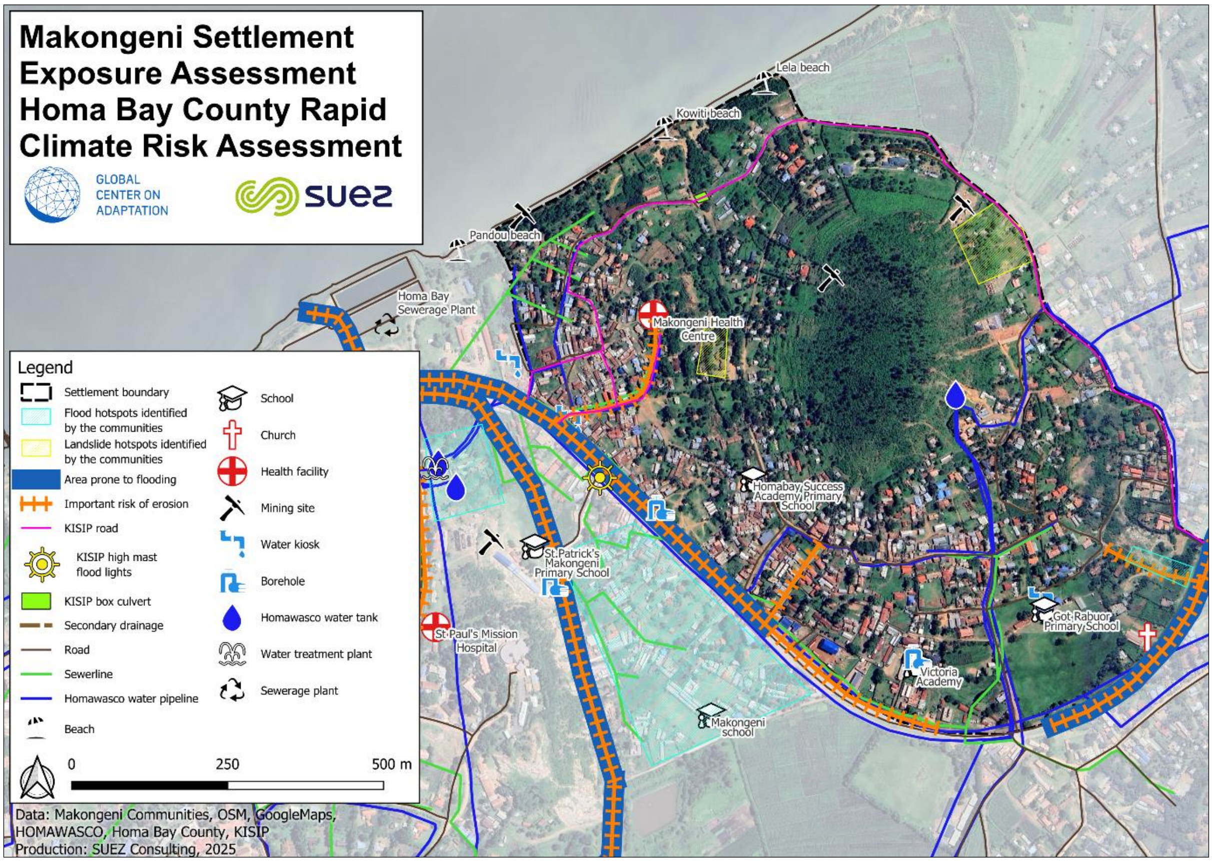


Figure 31: Makongeni exposure map (Source: SUEZ Consulting, 2025)

Makongeni is located between the slopes of Got Abuor Hill and the shoreline of Lake Victoria, a setting that combines topographic sensitivity, coastal proximity, and urban density. This positioning makes Makongeni highly exposed to a range of climate-related hazards, including flooding, landslides, and erosion, with key social and service infrastructure situated directly within or located near high-risk zones.

Peripheral exposure and community perception
In the western fringe of the settlement, just outside the formal administrative boundary, two schools and a section of the C19 Awasi–Nyandiwa Road are significantly exposed to flooding. Although technically outside Makongeni's mapped boundary, residents consistently referred to this area as part of their neighborhood during community workshops. This is where many children attend school, and the road serves as a critical access point to central Homa Bay.
During intense rainfall events, this road segment becomes impassable for up to two hours, severely disrupting mobility, school attendance, and access to services. This area should be considered in future assessments and planning interventions due to its functional integration with the community and repeated identification by residents.

Sewerage infrastructure and flood risk near the lake
The northwestern zone, near Pandou Beach, concentrates several high-risk assets, including the Homa Bay Sewerage Plant and densely settled residential clusters close to the lakeshore. This area lies within a flood buffer and is repeatedly affected by lake overflow and stormwater runoff. During community workshops and field validation, residents confirmed that flooding in this area causes the sewerage plant to overflow directly into Lake Victoria, posing serious public health and environmental contamination risks.


Figure 32: Homa Bay Sewerage Plant (Source: Global Partners for Development (left) and Kenya News(right))

Houses and economic activities sites: Hillside erosion and landslide risk around Got Abuor
Makongeni's eastern and northeastern sides, where the settlement climbs the slopes of Got Abuor Hill, are exposed to landslides and soil erosion, exacerbated by intense rainfall, steep gradients, deforestation at its peak and insufficient drainage infrastructure. As in Shauri Yako, the rapid and largely unregulated urban expansion of Makongeni—without proper land use planning—has led to the construction of homes and economic activities on terrain that is inherently vulnerable to climate-related impacts. In doing so, the urban development itself not only suffers from exposure but also contributes to amplifying the area's susceptibility to these hazards.
During the April 2025 site visits, consultants identified multiple locations across the built-up area showing clear signs of erosion and slope instability, especially where roads and homes are situated close to the hillside.

Figure 33: House at risk due to visible landslide impacts in Makongeni settlement (©SUEZ Consulting, 2025)

Workshop participants identified two specific landslide hotspots, both marked on the exposure map, with particular concern expressed for a site adjacent to a mining zone. Mining activities in this area—such as removal of vegetation cover and soil extraction—have visibly destabilized the slope, making it more prone to landslides during the rainy season.

Critical infrastructure and facilities

Makongeni contains a number of critical infrastructure and public facilities that are directly and indirectly exposed to climate-related hazards, particularly flooding, erosion, and landslides.

Health facilities

Makongeni Health Centre—the main public hospital serving Homa Bay Municipality—is located mid-slope on Got Abuor Hill. While its elevated position offers some protection from direct flooding, the facility remains highly exposed to environmental degradation due to poor waste management and its topographical context. Notably, the only access road leading to the hospital is vulnerable to erosion, which may further compromise service delivery during extreme weather events.

Figure 34: Medical waste stored in the hospital garden (©SUEZ Consulting, 2025)

During the community validation workshops, residents raised concerns about the improper handling of medical waste, particularly during heavy rainfall. They reported that runoff often carries hospital waste downslope, eventually reaching Lake Victoria. These accounts were corroborated during the site visits, where the assessment team observed that medical waste is temporarily stored in an inadequately protected outdoor area, awaiting collection (Figure 34). This lack of secure containment, combined with intense surface runoff, increases the risk of medical waste being transported toward the lake.
This situation poses serious public health and environmental risks, as Lake Victoria is a critical water source for surrounding communities. Addressing this issue requires both improved waste management practices and structural interventions to prevent runoff-related contamination.

St. Paul's Mission Hospital, located in the southwestern area, lies within a designated flood zone, making it vulnerable to inundation and possible functional interruptions during storm events. Its proximity to overlapping drainage and water pipelines also raises concerns about contamination risks and access reliability.

Education facilities

Several educational institutions, including St. Patrick's Makongeni Primary School, Got Rabour Primary School, and Victoria Academy, are situated near mapped flood paths and hotspots, especially along the southern and eastern edges of the settlement. These schools face repeated access issues, water damage, and disruption during intense rainfall events, affecting the continuity of education and safety of pupils.

Water infrastructure

The water infrastructure, including pipelines, kiosks, and a water tank on the eastern side, intersects with flood and erosion-prone zones. During flooding, these assets are susceptible to leakage, damage, or contamination, compromising access to safe drinking water at critical times.

In terms of energy infrastructure, the area has KISIP high mast floodlights and electric poles distributed across the settlement. However, erosion and slope instability, particularly on the hillside, have already caused damage to some poles—posing both safety risks and power supply interruptions.

Figure 35: Electric pole at risk due to visible landslide impacts in Makongeni (©SUEZ Consulting, 2025)

Makongeni's exposure profile is shaped by its complex topography, hydrological setting, and dense infrastructure layout. The lower western and southern areas are vulnerable to flooding and sewer overflow, while the eastern slope faces significant risks from erosion and landslides. Key infrastructure—including health, education, water, and sanitation services—is located within or near these high-risk areas.

3.3.3 Synthesis of the exposure analysis

Table 6: Synthesis of the exposure analysis based on community validation workshops, Key Informant Interviews (KII), and field observations.

	Categories of asset	Sub-categories of assets	Name of the asset	Exposure to flooding	Exposure to erosion	Exposure to drought	Exposure to heat waves
SHAURI YAKO	Habitat	Houses		☒	☒	☐	☒
	Infrastructure	Roads		☒	☒	☐	☐
		Water treatment plant		☒	☒	☐	☐
		Homawasco water tanks		☒	☐	☐	☐
		Water pipelines		☒	☒	☒	☐
		Sewerlines		☒	☒	☐	☐
		Electric poles/ transformers		☐	☒	☐	☐
		Amenity	Proposed lagoon (KISIP)	☒	☒	☐	☐
		Market	Proposed vending platform (KISIP)	☒	☒	☐	☐

		Park	Children Park (KISIP)	☒	☒	☐	☐
		Lights	KISIP high mast flood lights	☒	☒	☐	☐
	Education	School	Sango Academy	☐	☒	☐	☐
			Shauri Yako Primary	☒	☒	☐	☐
	Environment	Trees		☐	☒	☒	☐
	Religion	Church	Varin SDA Church	☐	☐	☐	☐
			Seventh Day Adventist Church Bonde Homa Bay	☒	☒	☐	☐
			Ezra Bible College	☒	☒	☐	☐
	Health	Medical centre	Jopas Medical Clinic	☒	☒	☐	☐
			Nyadenda Health Centre	☐	☒	☐	☐
SOFIA	Habitat	Houses		☒	☐	☐	☒
	Infrastructure	Water pipelines		☒	☒	☒	☐
		Roads		☒	☒	☐	☐
MAKONGENI	Habitat	Houses		☒	☒	☐	☒
	Infrastructure	Sewerage plant	Homa Bay sewerage plant	☒	☐	☐	☐
		Roads		☒	☒	☐	☐

		Homawasco water tanks		☒	☐	☐	☐
		Water pipelines		☒	☒	☒	☐
		Water treatment plant		☒	☒	☐	☐
		Water kiosks		☒	☐	☐	☐
		Boreholes		☒	☒	☒	☐
	Education	School	Makongeni School	☒	☐	☐	☐
			St. Patrick's Makongeni Primary School	☒	☒	☐	☐
	Health	Hospital	Makongeni Health Centre	☐	☒	☐	☐

3.3.4 Exposure scoring

To complement the qualitative and spatial analyses presented in this report, a quantitative assessment was undertaken to estimate the proportion of each informal settlement's surface area that is highly and directly exposed to climate-related hazards—specifically flooding, erosion, and, in the case of Makongeni, landslides (see Annex 3 for the methodology).

The result provides a high-level indication of the percentage of land within each settlement that is likely to face recurrent and significant climate impacts. While this spatial indicator does not account for every dimension of exposure (such as asset vulnerability or socio-economic dependencies), it is a useful metric for comparing risk levels across the three study sites and guiding prioritization of adaptation interventions.

The findings are as follows:

- Shauri Yako: Approximately 15.4% of the settlement's surface area is classified as highly and directly exposed to flooding and erosion. This corresponds to 0.168 km² of the total 1.096 km², based on both community mapping and hydrological data.
- Sofia: Approximately 31.5% of the settlement's surface area (0.458 km² out of 1.455 km²) is highly and directly exposed to flooding and erosion. This higher proportion reflects the southern section's low-lying topography and its role as a runoff catchment area.
- Makongeni: Approximately 2% of the settlement's surface area is highly and directly exposed to flooding, erosion, and landslides, with 0.03 km² identified as high-risk out of a total 0.730 km².

The scoring system is based on the following calculation:

Score = (% exposed surface area) × (assets score)

The score is then placed on the following scale to obtain the exposure score: from 1 (low exposure) to 4 (very high exposure).

The assets score is defined according to the density of population, the share of built-up areas and the availability of essential services.

Settlement	Surface exposed	Assets score	Exposure scoring
Sofia	31.5%	2	1
Makongeni	2%	3	1
Shauri Yako	15.4%	4	1

Table 7: Exposure scoring (Source: SUEZ Consulting, 2025)

KEY TAKEAWAYS

- **Exposure extends beyond administrative boundaries.** Throughout the analysis, it became evident that communities perceive and use space beyond formal settlement limits. Several functionally integrated areas—such as access roads, schools, and health facilities—lie just outside mapped boundaries but are deeply embedded in the daily lives of residents and should be included in risk-sensitive planning.
- **Critical infrastructure is often located in high-risk zones.** In all three settlements, essential services—such as health centers, schools, drainage lines, and water supply infrastructure—are found within or near flood paths, erosion-prone zones, or landslide hotspots. This siting undermines service continuity during climate events and increases systemic risk.
- **Topography plays a defining role in shaping exposure.** Settlements situated on slopes or along natural drainage channels, such as Makongeni and Shauri Yako, face dual risks of surface runoff and erosion.
- **Material vulnerability amplifies exposure.** Many homes across the three settlements are built using corrugated iron sheets, which not only fail under prolonged flooding but also exacerbate indoor temperatures during dry seasons.
- **Service density influences exposure impact.** Densely built areas like Shauri Yako have a greater concentration of assets in flood-prone zones, increasing the number of people and systems affected by single events. In contrast, Sofia's more dispersed form reduces direct exposure but increases isolation during disruptions.
- **Quantitative exposure metrics are valuable, but not sufficient on their own.** The percentage of highly and directly exposed area to flooding, erosion and landslides must be interpreted with caution. For example, Sofia shows the highest percentage of surface exposure (31.5%) compared to Shauri Yako (15.4%) and Makongeni (2%). However, when viewed through a qualitative lens, Sofia's lower infrastructure density and sparse development suggest that fewer people and assets are actually highly and directly impacted. This highlights the importance of combining quantitative and qualitative analysis to fully understand real-life exposure.
- **Resilience requires interconnected thinking.** The exposure of one asset can compromise others due to systemic interdependence—e.g., schools isolated by impassable roads or hospitals impacted by upstream waste runoff. Effective adaptation planning must therefore consider settlements as dynamic, interconnected systems.

3.4 Vulnerabilities

3.4.1 Social vulnerabilities

There is a strong link between social vulnerability and climate change, forming a complex relationship that deeply affects societies (Iskandar et al., 2024). Social vulnerability shapes the extent to which individuals and communities can anticipate, cope with, resist, and recover from the impacts of climate-related events such as floods or droughts (Ibid). Those already facing systemic disadvantages such as low-income populations or groups with limited access to education, healthcare, or essential infrastructure, are often more exposed and less equipped to manage these risks.

3.4.1.1 Gender

First and foremost, it is recognized that certain population groups are inherently more vulnerable to climate change due to social inequalities that expose them to increased risks. Among these vulnerable groups, women and girls are disproportionately affected by the impacts of climate change, which amplifies existing gender inequalities and poses unique threats to their livelihoods, health, and safety (UN Women, 2022). Traditional gender roles, norms, and responsibilities significantly influence vulnerability, as they affect access to resources, decision-making power, and social support networks.

Hardship to secure resources

Within the three informal settlements, women are disproportionately affected by the time and cost associated with water collection (AMT, 2025). The workshops highlighted also their role in urban farming, also called "kitchen gardens", which provides essential food to their household. Impacts such as droughts, floods, and other extreme weather events deplete essential resources like water and food which they are responsible for, exacerbating tensions within households and the burden of provision to women.

More broadly, women often bear the dual burden of providing for their families while also managing caregiving responsibilities and this even though female-headed households remain less prevalent across the settlements.

Table 8: Representation of female-headed households in Sofia, Makongeni and Shauri Yako settlements (source: AMT, 2025)

Settlements	% female-headed households
Sofia	37.14%
Makongeni	44%
Shauri Yako	33.40%

Limited employment opportunities and climate impacts on their economic opportunities

Precisely, female-headed households face heightened vulnerability due to structural inequalities, limited employment opportunities, and the burden of caregiving responsibilities. These factors significantly reduce their resilience to climate change impacts.

In **Sofia**, this vulnerability is particularly evident: women constitute 89.9% of the workforce in the informal sector (AMT, 2025), which is often characterized by low-paying and unstable jobs. Additionally, female-headed households are more likely to report no income, with 105 such households, highlighting the economic precarity faced by many single mothers (Ibid). Unemployment rates further reflect these gendered disparities. In Sofia, women represent 57% of the unemployed population, while in **Makongeni**, the female unemployment rate stands at 14.9%, compared to 10.3% for men (Ibid). **Shauri Yako** presents a more balanced picture, with unemployment affecting both men (3.83%) and women (5.18%) at relatively similar levels (Ibid).

Women often operate in climate sensitive sectors. In addition to urban farming, the workshops highlighted the fact that fish sellers are mostly women, therefore impacts from climate events on the fishing sector will greatly affect what women can sell and the income they take from it. Vendors in markets are also very often women. The lack of drainage affecting markets in the settlements will impact their possibility to sell on markets and secure income.

Land tenure insecurity

In the same vein, women face greater land tenure insecurity within the informal settlements, further exacerbating their vulnerability to climate-related disasters.

Table 9: Representation of female owning land in Sofia, Makongeni and Shauri Yako settlements (source: AMT, 2025)

Settlements	% women owning land
Sofia	31.61%
Makongeni	32%

Shauri Yako	6.34%

Without secure land tenure, female-headed households often lack the means or authority to improve housing resilience, access post-disaster compensation, or participate in decision-making processes related to climate adaptation.

Violence and support systems
Furthermore, climate disasters disrupt social support systems, leaving women and girls more isolated and vulnerable to violence (United Nations Population Fund, 2022*)*. In the informal settlements, gender-based violence remains a serious concern, with incidents of domestic violence, harassment, and discrimination reported across various communities. This vulnerability is further exacerbated by limited access to legal aid (Suez Consulting, 2025).

More health risks
Another key dimension of gender inequality in the context of climate change is the disproportionate exposure of women and girls to health risks. According to UN Women (2022), climate change exacerbates health-related vulnerabilities by increasing risks tied to maternal and child health, particularly in settings where access to healthcare is limited. In Makongeni, maternal and child healthcare services are particularly overstretched, heightening health risks for pregnant women. This situation is echoed across the other settlements, where limited access to basic services and healthcare infrastructure leaves many women without adequate support. Additionally, women are more frequently exposed to indoor air pollution due to their increased reliance on solid fuels for cooking, posing further health challenges. This intersection between gender and social vulnerability reveals stark inequalities in how climate change impacts different segments of the population.
Women often face systemic barriers to education, property ownership, financial resources, technology, and participation in political decision-making. These structural limitations significantly reduce their adaptive capacity and reinforce their vulnerability to climate-related risks.

3.4.1.2 Age

The link between ageing and vulnerability to climate change is also well established, particularly in a global context where life expectancy is rising, making older adults especially susceptible to climate-related mortality and morbidity (World Health Organization, 2022). However, the situation in Homa Bay Municipality and its informal settlements is somewhat different, as the population is predominantly young. At first glance, this might suggest a lower vulnerability to climate impacts due to greater physical resilience. Nevertheless, age remains a key factor of vulnerability, especially when it intersects with economic hardship. In fact, life expectancy in Homa Bay is significantly lower than the national average—50.5 years for men and 60.2 for women, compared to 60.6 and 66.5 years respectively at the national level *(*Homa Bay County, 2023). This suggests a generally more fragile population, facing underlying health and socioeconomic challenges that can heighten vulnerability to climate risks.

Thus, the population in the informal settlements is predominantly juvenile, with a significantly lower proportion of elderly residents.

Settlements	% of 20–24-year-olds	% of 60-year-olds
Sofia	34%	4%
Makongeni	30%	3.37%
Shauri Yako	35%	6.35%

Table 10: Age repartition in Sofia, Makongeni and Shauri Yako settlements (source: AMT, 2025)

The elderly
Nevertheless, although elderly individuals make up a small portion of the population in the settlements, they remain a significant concern due to their heightened vulnerability to climate change, which is often compounded by other social and economic factors. Many older residents lack financial security, having worked in the informal sector without access to pensions or retirement savings. Social isolation is also common, reducing their ability to seek support or respond effectively during climate-related events. Poor housing conditions add another layer of difficulty, particularly in Makongeni (AMT, 2025), where most

residents live in rental units, making elderly tenants especially vulnerable if they struggle to pay rent. In addition, limited access to healthcare further undermines their capacity to cope with the health impacts of climate stress. Together, these challenges considerably weaken the overall resilience of older adults in these informal settlements.

The youth

The youth face significant vulnerabilities due to limited economic opportunities, unstable livelihoods, and poor living conditions, all of which reduce their ability to anticipate, cope with, and recover from climate-related events. First of all, unemployment is a major issue among the youth in the settlements. The workshops highlighted the lack of opportunities, in particular industries and markets where young people could work. In Sofia, the highest unemployment rates are found among individuals aged 15-24, who account for 59.6% of the unemployed population (AMT, 2025). Similarly, in Makongeni, a significant portion of the youth population aged 18-35 remains unemployed, with the rate standing at around 25%(Ibid). All of this highlights the lack of opportunities available for young people, as well as the fact that infrastructure and services are not keeping pace with the growing number of youths entering the workforce. The predominance of young people in the population puts increasing pressure on existing systems, particularly in terms of employment opportunities which are often insufficient to meet the demand.

3.4.1.3 Poverty

In parallel, income levels in the informal settlements remain low, contributing to significant income instability and, in turn, weakening household resilience to climate shocks.

Settlements	% households earning less than 6000Ksh per month
Sofia	50%
Makongeni	55%
Shauri Yako	43.45%

Table 11 : households earning less than 6000Ksh per month in Sofia, Makongeni and Shauri Yako settlements (source: AMT, 2025)

When these figures are compared with household expenditures, it becomes clear that many families are unable to sustain a level of resilience needed to cope with climate-related risks, such as repairs or improvements on their house or securing water in the dry season. This is especially evident in Makongeni, where the average household income is 6,694 Ksh per month, significantly lower than the average monthly expenditure of 7,452 Ksh (AMT, 2025). This gap suggests that many households are living beyond their means or are forced to rely on borrowing, further increasing their vulnerability.

3.4.2 Economic vulnerabilities

3.4.2.1 Fishing

The economy of Homa Bay Municipality is divided between the formal and informal sectors and is largely driven by small-scale trading, with fish trade standing out as a key formal economic activity. It is particularly important in Makongeni and Shauri Yako due to their proximity to the lake. However, these lake-based economic activities are highly sensitive to climate change. In fact, the availability of fish stocks in the lake is directly influenced by water quality, which in turn depends on climate conditions and other environmental factors. In recent years, a decline in fish availability has been observed, most notably in 2022, when a massive fish die-off occurred. This was linked to rising lake temperatures, which triggered the decomposition of algae and water hyacinth, a process that depletes oxygen from the lakebed. These recurring episodes of low oxygen levels have inflicted severe losses on the aquaculture sector, undermining the livelihoods of many residents who depend on it (Kenya News Agency, 2023). Flooding also increases pollution into the lake by carrying all sorts of waste into the water. Let alone the fact that climate change also impacts fishing equipment. In Homa Bay, strong winds, storms, and heavy rainfall have repeatedly damaged or even submerged fishing gear, further weakening the economic resilience of communities that rely heavily on the lake for their livelihoods (Odhiambo, 2013). This means the availability of fish in the lake reduces and costs of fish increase, impacting greatly an important source of food and income for the populations. In addition, the depletion of fish stocks has also intensified competition and conflict over access to this increasingly scarce resource. In Kenya—and particularly in Homa Bay—fishing-related disputes have surged, reaching a peak recently with the death of Duncan Otenga, a student who had gone fishing. The incident has sparked fresh concern over recurring disputes among fishermen operating in Lake Victoria. These conflicts also manifest in other forms, such as the theft or sabotage of fishing equipment, underscoring deeper tensions and vulnerabilities. Such incidents raise concerns that these disputes could become more frequent and severe as climate change continues to reduce the availability of fish in the lake.

3.4.2.2 Agriculture and livestock

Although not the dominant economic activity in Homa Bay Municipality, agriculture, mainly horticulture, is still present, primarily through small-scale crop farming and livestock rearing. Kitchen gardens are most common in Sofia and Makongeni, and livestock raising—primarily small herds of cattle, goats and pigs—is widespread across the municipality.

These practices, often carried out at the household or community level, are highly sensitive to climate variability. Being essentially rainfed, crop yields and the quality of agricultural products are closely linked to climate stability, with changes in rainfall patterns, prolonged droughts, and extreme weather events directly affecting productivity. While formal irrigation systems are limited or non-existent in informal settlements, discussions during the workshops revealed that most residents had limited awareness of drought-tolerant seed varieties, even for small-scale kitchen gardening. Workshop participants stressed also that they were facing crop failure every year in the dry season by the lack of water, while flood also destroys agricultural lands. Therefore, the cost of agricultural products increases, especially in the dry season. Some workshop participants explained they were planting and harvesting only in the rainy season but with changing rainfall patterns this strategy becomes riskier. They also highlighted the lack of skills and capacities on how to do urban farming. As for livestock, the lack of available water means there is often dying off but also widespread diseases.

The informal sector in the municipality also comprises "Jua Kali" artisans, women's groups, youth groups, and self-help groups engaged in a variety of income-generating activities aimed at supporting their livelihoods. However, due to the informal nature of these activities, there is often little to no access to formal protections such as insurance or financial safety nets, therefore affecting their overall resilience in case of climate shocks.

3.4.2.3 Informality

Informality is the primary form of employment in all three settlements. In parallel, self-employment is the predominant form of work among households, including small businesses and freelancing. While self-employment can offer a certain level of flexibility and income-generating opportunities, it is often associated with income instability and a lack of access to formal social protection mechanisms. This absence of stable earnings and social security benefits further contributes to the overall vulnerability of residents.

Settlements	% in informal sector	% self-employment
Sofia	93.8%	18.9%
Makongeni	78%	37%
Shauri Yako	92.7%	32.8%

Table 12: Households in the informal sector and as self-employed in Sofia, Makongeni and Shauri Yako settlements (source: AMT, 2025)

Moreover, informal businesses in the settlements often operate without proper planning or regulation, with many being set up directly along roadsides. This lack of structured development exposes these businesses to a range of risks. Not only are roadside businesses more vulnerable to environmental hazards such as flooding but the roads themselves are often poorly developed and lack the resilience needed to withstand extreme weather events. For instance, in Shauri Yako, community members report that businesses regularly suffer from flood damage, leading to the destruction of merchandise and significant financial losses. As a result, both the physical infrastructure and the economic activities it supports are highly susceptible to climate-related disruptions. And finally, as mentioned in the section on age, unemployment rates are significant within informal settlements, particularly among the youth, especially in Makongeni, which allows to highlight the relatively uneven distribution of economic vulnerability across the settlements.

3.4.2.4 Focus on women's economic vulnerability

In addition, these economic vulnerabilities in the three settlements are particularly heightened for women. Many of them in Homa Bay are involved in the fisheries value chain as fish traders and processors, making them highly vulnerable to climate change impacts (Khalid & Adam, 2024). Further, climate-induced water scarcity forces women to spend more time fetching water, reducing the time available for income-generating activities and increasing the cycle of poverty (Suez Consulting, 2025). Discussions from Shauri Yako and Makongeni settlements further highlighted how climate change-related impacts on agriculture resulted in increased costs of food, i.e., fish and vegetables became too expensive to afford. This directly affected their ability to provide food for their families, leading to nutritional deficiencies, especially for children and pregnant women. Most of the women from the 3 settlements have less access to land ownership and credit, limiting their capacity to adapt to climate change impacts. Their low financial power is often a barrier to accessing credit, as most financial institutions demand collateral for loans, which they often don't have. This makes it very hard for women to invest in their businesses, particularly after experiencing losses from climate shocks.

3.4.3 Geophysical vulnerabilities

The natural environment is undoubtedly another key factor of vulnerability to climate change, as it underpins all aspects of society and ultimately influences every dimension of life.

3.4.3.1 Topography

First and foremost, the topography plays a crucial role in shaping human settlement patterns and serves as a mirror for climate change impacts. Overall, the topography of Homa Bay Municipality is predominantly flat, which has significant implications for how communities are affected by climate phenomena, but the municipality is also characterized by isolated hills (Homa Bay Municipality, 2023). Specifically, while the three informal settlements share similar characteristics, they also exhibit notable differences, even within the settlements themselves, with some areas being flat while others are more hilly and elevated (see map in section 2.3.2.2). As a result, certain populations and areas are more exposed to climate risks than others.

Makongeni serves as an archetypal example of how topography influences vulnerability within informal settlements. The low-lying areas have become densely populated due to their proximity to economic activities, access to water, and traditional trade routes. The flat terrain has encouraged unregulated and concentrated development, which in turn increases exposure to climate-related risks such as flooding and poor drainage. In contrast, the central part of Makongeni features more elevated terrain that remains less developed, with a more dispersed housing pattern. A significant portion of the settlement lies on gentle to moderately sloped terrain. These low-slope areas, primarily found in the southern and lakeside zones, are generally suitable for construction, road networks, and basic service infrastructure. However, this also means that they are more heavily settled and potentially more vulnerable to climate impacts. The central highland zones, on the other hand, exhibit moderate to steep slopes. These steep areas face challenges such as soil erosion, inadequate drainage, and structural instability (AMT, 2025). A notable feature is Got Rabuor Hill, a major highland area where deforestation (specifically at its peak) has removed natural vegetation that once helped retain water. As a result, during heavy rains, water now rapidly runs off the hill, which exposes the population in the direct vicinity of the hill to greater flood risks (Suez Consulting, 2025).

In parallel, Shauri Yako is characterized by an overall flat topography with some undulating terrain. The settlement features a north-south elevation gradient, with the lowest areas located along the northern boundary adjacent to Lake Victoria and the highest elevations stretching southward into the interior. This topographical layout has a direct influence on human activities, which in turn affects levels of climate vulnerability. The low-lying northern areas are particularly susceptible to waterlogging and seasonal flooding. In contrast, the higher elevations in the south offer more favorable conditions for structured urban expansion, residential development, and small-scale agriculture, thanks to their stable and well-drained terrain. As in Makongeni, most of Shauri Yako lies on gently to moderately sloped land. Nonetheless, the southern highland zones contain isolated patches of moderately to steeply sloped land, presenting challenges such as soil erosion, inadequate drainage, and structural instability. Issues that are further exacerbated by climate change, especially during episodes of heavy rainfall and flooding. These physical characteristics also shape settlement patterns. The low-lying northern plains have become densely populated due to their proximity to economic activities. These flatter zones have attracted informal, unregulated development, making them more vulnerable to climate impacts due to the higher concentration of informal housing and limited infrastructure. Conversely, the southern elevated terrain remains less developed, with more dispersed housing and open spaces, offering high potential for future planned and climate-resilient urban expansion (AMT,2025).

Finally, Sofia presents a topographical profile that leads to similar consequences. The settlement spans a varied elevation range from approximately 1,135 meters in the southeast to over 1,340 meters in the western and northern parts above sea level. The elevated northwestern areas offer a relatively stable terrain, making them more suitable for planned residential development, commercial activities, and public infrastructure. These zones are less exposed to flooding and provide greater potential for structured urban growth. In contrast, the lower southeastern parts of Sofia lie on moderate to steep slopes ranging between 15% and 24%. These areas require careful consideration when it comes to drainage planning and housing development, especially for informal constructions as they are more vulnerable to seasonal flooding, waterlogging, and soil instability. The topography thus significantly influences vulnerability within the settlement, depending on elevation and land use patterns (AMT, 2025).

3.4.3.2 Soil

Another key physical and environmental factor influencing vulnerability to climate change is soil composition, as it directly affects land use and the stability of human settlements. In Homa Bay Municipality, the predominant soil type is black cotton soil, which presents significant challenges. This type of soil is difficult to work with using simple hand tools and becomes particularly problematic during heavy rains, complicating both construction and agricultural activities (Homa Bay Municipality, 2023).

Within the informal settlements, two main types of soils are found: montmorillonitic clayey soils and interstratified clayey soils. Montmorillonitic clay soils are known for their high shrink-swell capacity—they expand when wet and contract when dry. This behavior poses serious challenges for infrastructure development, as it compromises land stability and increases the risk of structural damage. On the other hand, interstratified clayey soils offer relatively better structural support. Their well-drained nature helps reduce foundation instability, making them more suitable for building construction and offering a degree of resilience in settlement planning. These two soil types are distributed differently across the three informal settlements, further influencing vulnerability through geographical and physical factors.

Therefore, in Makongeni, only a small portion in the western part is characterized by interstratified clayey soils, while the vast majority of the settlement lies on montmorillonitic clay. This makes Makongeni particularly vulnerable, as montmorillonitic soils are prone to landslides, slope failures, and have poor load-bearing capacity, rendering them unsuitable for construction without proper soil stabilization. These soils are also subject to significant soil erosion and land degradation, exacerbated by poor drainage systems, deforestation, and unregulated development (AMT, 2025).

In contrast, Sofia has a more balanced distribution of the two soil types, with interstratified clayey soils found in the western areas and montmorillonitic soils dominating the eastern side. This mixed profile offers slightly better conditions for settlement resilience, depending on the exact location within the neighborhood (Ibid).

Finally, Shauri Yako shows a predominance of interstratified clayey soils in its southern section, with a small portion in the north characterized by montmorillonitic soils, making it, in principle, less vulnerable in this regard (Ibid). However, local communities have reported that groundwater tends to rise due to the soil's properties, indicating poor drainage capacity in these areas. This condition increases the risk of waterlogging and further highlights the vulnerability of the settlement to climate-related hazards. Once again, this underscores the spatial disparities in climate vulnerability within and across the informal settlements, deeply rooted in their natural terrain and soil composition.

3.4.3.3 Hydrology

When it comes to water and the hydrological features of the territory, this natural resource is one of the most essential for the Municipality.

At the municipal level, both surface and groundwater sources are available, with Lake Victoria standing out as the main water body (Homa Bay Municipality, 2023). Regarding the projected water balance of the Lake, no significant changes are expected in the near future (see section 3.2.1.3), dam management policy being the main controlling factor of the future water level evolution.

The other influential body in the area is the Rang'wena river, flowing south of the city along an east/west axis towards the east and joining Lake Victoria 2 to 3 km east of the city. The river flows in the valley bottom, 1 or 2 km away from the city center and the three studied settlements. According to residents, river level is slowly drying up and can no longer supply enough water to adjacent farmers.

At the 3 settlements level, the only proper stream is located in Shauri Yako near the market. This area is regularly flooded and particularly vulnerable to flooding. On all 3 catchments, the steep slopes, low infiltration and lack of proper drainage system lead to an important erosion risk and possibly landslides. Climate change impacts the inter-seasonal rainfall variability, with a likely increase of drought period followed by intense floodings. These climate conditions are the most detrimental in terms of erosion risk, making the 3 settlements vulnerable to increased erosion and flooding caused by climate change.

The artificial streams and drainage channels mainly function as drainage pathways, especially during the rainy season, playing an essential role in managing stormwater. However, they are also subject to seasonal fluctuations, with some streams drying up during prolonged dry spells, highlighting the vulnerability of these communities to drought risks (AMT, 2025).

3.4.4 Infrastructure vulnerabilities

3.4.4.1 Water Supply

Infrastructure also stands at the forefront of climate change impacts, further exacerbating the fragility of populations, particularly within informal settlements. The most pressing challenge as highlighted by the settlement's residents is the inadequacy of the water supply system, managed by HOMAWASCO, which is neither sufficiently developed nor adapted to meet their daily needs. Access to safe and reliable water remains extremely limited in the three settlements. These communities often rely on unregulated sources or shared taps, and those connected to piped water system face frequent shortages, that can last for several weeks, throughout the year and particularly during the dry season. The inadequacy of infrastructure to store, treat, and distribute water further amplifies the stress during climate-induced events such as droughts or floods. Thus, water supply faces multiple challenges that are increasingly exacerbated by the impacts of climate change.

Climate change is expected to further strain this already fragile system. Shifts in rainfall patterns, increased frequency of dry spells, and rising temperatures are likely to disrupt both surface and groundwater availability. Communities have reported that accessing water becomes significantly more difficult during the dry season. While a notable decrease in Lake Victoria's water level has not yet been observed, communities have highlighted seasonal drops and the drying of streams, a key water sources whose availability depends heavily on rainfall. Strong rains, flooding events and erosion also impact on the water pipes which burst. The issue of water also carries important social implications. Water fetching responsibilities typically fall on women and girls. As a result, they are often forced to travel long distances and wait in long queues to collect water, leading to loss of time, missed income opportunities, and increased physical fatigue.

One of the major issues is the limited access to piped water connections provided by HOMAWASCO, notably linked to the poor quality of infrastructure. Communities report that much of the water infrastructure is old and outdated, such as asbestos pipes that urgently need replacement. Additionally, HOMAWASCO pipes are made of plastic, making them highly sensitive to heat. They can easily crack under high temperatures, further compromising water supply reliability, especially in the context of climate change and the rise of temperatures (Suez Consulting, 2025). Therefore, in the informal settlements, coverage remains particularly low. As a result, residents rely on alternative sources to get HOMAWASCO water, such as water kiosks and vendors, which tend to be less reliable. Indeed, workshop participants stressed there were very few water kiosks within the settlements. Water from boreholes is also collected in the dry season but water there is salty.

Table 13 : Percentage of households connected to piped water system and facing supply disruption in Sofia, Makongeni and Shauri Yako settlements (source: AMT, 2025)

Settlements	% connected to piped water system	% facing water supply disruption
Sofia	31.2%	52.3%
Makongeni	22%	33%
Shauri Yako	20.46%	22.54%

Another major issue linked to water access is the cost, which puts additional pressure on already vulnerable households, a situation that is likely to worsen with higher temperature and changing rainfall patterns increasing demand. In Sofia, for instance, 25.5% of households spend more than 30% of their income on water, a level considered unaffordable by international standards. In Makongeni, the high cost of water, especially from private vendors, represents a significant portion of household expenditures. In Sofia, residents also report that water supplied by HOMAWASCO is particularly expensive, with the connection fee alone reaching 5,000 KES, a prohibitive amount for many low-income families (AMT, 2025). The price of water tends to rise during the dry season, when supply is more constrained and demand peaks, placing even greater strain on the financial resilience of these communities. As a result, most households in all three settlements opt to collect water directly from Lake Victoria, despite concerns around water quality.

Importantly, water quality is also a growing concern. Communities report that HOMAWASCO uses high levels of chemicals during the rainy season due to lake pollution, prompting many to prefer rainwater harvesting even if in practice few people are doing it because of the cost of water tanks. The quality of water from private vendors is often unknown and potentially unsafe, while the lake itself is increasingly polluted due to waste discharge (Suez Consulting, 2025).

Beyond physical health, water scarcity also exacerbates social and security challenges, particularly for women and girls. Fetching water, primarily the responsibility of women and girls, often requires travelling long distances and waiting in queues, frequently during early morning or late-night hours, exposing them to risks of harassment and violence. The burden of water collection also results in missed educational and economic opportunities, increasing physical exhaustion and stress. Furthermore, the destruction of livelihoods caused by climate shocks as heightened economic dependency on male partners, fueling household tensions and contributing to a reported rise in gender-based violence, including intimate partner violence. Indeed, gender-based violence and water scarcity are closely linked and were clearly expressed by the women during the Focus Group Discussions. In this context, climate change acts as a threat multiplier. It intensifies water scarcity, drives up costs, undermines water quality, and deepens existing inequalities, creating a "perfect storm" that severely heightens the vulnerability of residents in informal settlements.

3.4.4.2 Sanitation

In the same vein, sanitation is facing similar infrastructure challenges, particularly within the informal settlements, where access to private toilets is extremely limited. Sanitation is the second key challenge after water supply, as highlighted by the workshop participants. Communal sanitation, mainly in the form of pit latrines is predominant, accounting for 89.3% in Shauri Yako, 75% in Makongeni, and 93.7% in Sofia (AMT, 2025) This is notably linked to overcrowding, lack of space, and inadequate sewer infrastructure, resulting in only a small proportion of households being connected to a sewer network. Additionally, the sewer systems are largely inadequate, of poor quality and largely inexistent, as reported by the communities. In Sofia, residents frequently report burst sewers, while in Shauri Yako, the system becomes congested during flooding, worsening the situation. These conditions have direct consequences on water quality, as floodwaters often mix with sewage, contaminating clean water sources, including Lake Victoria. This has led to health issues such as skin infections, and also severely affects livelihoods. Community members reported that during such incidents, roads become blocked, women are unable to take their children to school or reach their workplaces, further increasing vulnerability and disrupting daily life (Suez Consulting, 2025).

3.4.4.3 Drainage

Rainwater management and drainage within Homa Bay Municipality remain largely inadequate or, in many cases, non-existent, further exacerbating the risks associated with flooding. At the municipal level, stormwater drainage facilities are absent along most urban roads, with the exception of the Central Business District (CBD). Even where systems do exist, many of the drains in residential areas have been covered over time by alluvial soil, significantly reducing their effectiveness (Homa Bay Municipality, 2023). Within the informal settlements, the situation is similarly challenging. Drainage infrastructure is largely insufficient, consisting of a mix of natural water flow paths and a few poorly maintained or ineffective man-made drainage channels (see exposure maps in section 3.3). These are often clogged by household waste or vegetation debris, pointing to broader issues of inadequate waste management. The impacts of poor drainage vary from one settlement to another. For instance, in Shauri Yako, low-lying zones are particularly vulnerable to flooding due to poor surface drainage and inadequately graded roads and footpaths (AMT, 2025). In Sofia, while some natural drainage channels are concentrated in the central and southern parts of the settlement, other areas remain highly exposed and lack sufficient protection from seasonal flooding (AMT, 2025).

3.4.4.4 Mobility

Precisely, mobility and related infrastructure are also increasingly threatened by climate change. Across the municipality, there is a general lack of adequate road infrastructure, with several roads often becoming impassable during heavy rains (Homa Bay Municipality, 2023). The situation is even more critical within informal settlements, where most internal roads remain unpaved, composed mainly of compacted earth, gravel, and rocky materials, resulting in uneven, unstable, and challenging conditions for both motorized and pedestrian traffic. This leads to slower travel speeds, increased transport costs, and frequent vehicle maintenance needs. In Makongeni and Sofia specifically, 89.3% of roads are earthen, making them particularly vulnerable to seasonal disruptions (AMT, 2025). During the wet season, roads often turn muddy, forcing residents to rely heavily on *boda bodas* (motorcycle taxis). However, this increased reliance raises transportation costs, further exacerbating the economic burden on low-income households. In addition, inadequate access roads were flagged as a major barrier to emergency response. During Makongeni's community validation workshop, residents recounted instances where fire engines and ambulances could not access the settlement due to poor road conditions and narrow informal pathways. This significantly compromises timely disaster response and emergency services, especially during floods or fire outbreaks (Suez Consulting, 2025).

3.4.4.5 Housing

Climate change also places severe pressure on housing, thereby exacerbating vulnerability, particularly within informal settlements where most dwellings are already inadequate.

In-migration

In-migration, especially of young people seeking employment and economic opportunities, adds pressure to already limited and congested land in Homa Bay. In some cases, migration to areas such as Makongeni is directly linked to climate impacts, as people flee rural areas due to drought-induced agricultural decline (AMT, 2025). Similarly, episodes of heavy rainfall have pushed others to relocate to settlements like Sofia, which may also increasingly host climate-displaced populations in the future. This climate-related mobility further intensifies pressure on already limited and congested land. High population densities amplify these housing challenges, with Makongeni accommodating 3,260 persons per km², Shauri Yako 4,595 per km², and Sofia 3,360 per km² (AMT, 2025). Such congestion places significant strain on available land and infrastructure, undermining both housing quality and community resilience to climate-related risks.

Land tenure

Another critical dimension of housing vulnerability lies in tenure status. In Makongeni, 83% of households live in rented units, 72.61% in Shauri Yako and 60.7% in Sofia (AMT, 2025), exposing residents to the instability of rising rental costs. These dynamics limit the ability of low-income households to invest in improving their homes, making them more susceptible to climate-related damages such as flooding or structural collapse. Furthermore, limited land tenure security, whether due to informal arrangements, lack of legal recognition, or fear of eviction, further disincentivizes long-term investment in housing quality and resilient infrastructure. When households do not have formal or secure rights over the land they occupy, they are less likely to allocate scarce resources toward structural improvements, drainage systems, or flood protections. This absence of investment perpetuates a cycle of physical vulnerability, especially in the face of increasingly frequent and intense climate hazards. More broadly, housing affordability remains a pressing concern. In Makongeni, 25.8% of households spend more than 30% of their income on rent, the situation is even more severe in Sofia, where 46.88% of households spend more than 30% of their income on rent (AMT, 2025). While informal settlements may offer relatively affordable options for very low-income earners, the overall picture highlights an alarming intersection between economic fragility and climate vulnerability in the housing sector.

House construction

Climate change threatens the structural integrity and quality of housing in the settlements, particularly the materials used for construction. While there is a shift towards more durable materials, as seen in Shauri Yako where 97.2% of residents live in permanent or semi-permanent structures (AMT, 2025), which enhances the overall resilience of the area, there is still progress to be made. Many rental and informal housing units, however, continue to be built with substandard materials, making them highly susceptible to damage from extreme weather conditions, such as heavy rains and strong winds. For example, in Shauri Yako, where iron sheets (*mabati*) account for 72.50% of roofing materials, community reports indicate that during the dry season, it becomes unbearably hot inside the houses. In some cases, this can be dangerous, forcing people to leave their homes (Suez Consuting, 2025). Moreover, iron sheet structures are at risk of fire during intense, prolonged heat. In Makongeni, the high number of reported disasters highlights the vulnerability of housing to extreme weather conditions, with 133 flooding incidents and 80 landslides/mudslides documented (AMT, 2025).

All of these challenges are further compounded by weak enforcement of legal urban planning frameworks. In areas like Shauri Yako, for example, the failure to enforce the recommended 30-meter buffer zone from the lake has led to the construction of homes in highly vulnerable locations (Suez Consulting, 2025). While the Survey Act stipulates a minimum 30-metre riparian reserve above the high-water mark for tidal water bodies (Omollo & Ogendi, 2022), this guideline is often ignored in practice, leaving residents increasingly exposed to flooding and rising water levels driven by climate change. This situation is further aggravated by the degradation of natural buffers and the overall pressure puts on vegetation. Indeed, reports indicate a widespread lack of vegetation cover along shorelines and riverbanks, despite existing provisions under the Agriculture Act (Cap 318), which prohibits farming or the clearing of vegetation within 2 meters of any watercourse (Ibid). The erosion of these protective barriers further heightens exposure to climate risks in already vulnerable neighborhoods.

3.4.4.6 Waste

Solid waste management also faces considerable challenges, largely due to insufficient infrastructure and ineffective systems. At the municipal level, Homa Bay lacks adequate equipment and a suitable site for the safe handling and disposal of solid waste, with the current disposal site located at the foot of Asego Hill. There is also no recycling or circular economy system in place (Suez Consulting, 2025).

Within informal settlements, although some designated garbage collection points exist, there remains a high prevalence of illegal dumping, reported by 71.67% of households in Shauri Yako, 87.4% in Sofia and 94% in Makongeni (AMT, 2025). This practice directly exacerbates climate change-related risks by clogging drainage and sewer systems, particularly during periods of heavy rainfall, thereby increasing the likelihood of flooding. In turn, this contributes to water pollution, which, when intensified by climate stressors, can become a major vector for waterborne diseases and other public health concerns.

3.4.4.7 Health

Health services are more than essential in these contexts, especially given the increased exposure to climate-related threats such as flooding, waterborne diseases, heat stress, and vector-borne illnesses. In informal settlements, access to healthcare is often unequal and precarious. There are critical gaps in service provision, with inadequate healthcare facilities and low health insurance coverage leaving many residents vulnerable to poor health outcomes. While healthcare infrastructure is present to some extent, through a mix of public and private providers, residents overwhelmingly depend on public facilities, which are frequently overstretched and under-resourced. One major barrier is accessibility. Many households report long and difficult journeys to reach medical care. In Sofia, 28% of residents must travel over an hour to access health services, an issue further exacerbated during extreme weather events, when flooding or road blockages hinder movement (AMT, 2025). Additionally, financial barriers significantly limit access: a large proportion of the population lacks adequate income or insurance, making it difficult to afford even basic care. The quality and capacity of existing facilities also pose challenges. In densely populated informal areas, overcrowding is common, and health centers may be ill-equipped to respond to climate-exacerbated health emergencies. Low health insurance coverage and high out-of-pocket costs continue to limit access to essential medical services.

Moreover, women in these settlements face a disproportionate burden. Not only are they more exposed to waterborne diseases due to their central role in household water management, but they also bear the primary responsibility for caring for sick family members during outbreaks of illnesses conditions that are often triggered or worsened by climate-related disruptions to water and sanitation. This dual exposure intensifies their vulnerability, both physically and emotionally, while further limiting their ability to engage in income-generating activities or education.

3.4.4.8 Education

In parallel, access to education and the infrastructure that supports it is another crucial factor to consider, especially as climate change increasingly acts as a barrier. In this regard, Homa Bay Municipality and its informal settlements are not devoid of educational structures, with facilities ranging from primary to secondary and even higher education, particularly with Tom Mboya University, which includes both public and private options. However, significant inequalities in access persist, especially within informal settlements, as illustrated by the very limited proportion of land dedicated to education. For instance, in Shauri Yako, only 0.55% of land is allocated to this use, with almost similar rates in Makongeni and Shauri Yako (AMT, 2025). These disparities are further exacerbated by the impacts of climate change. In Sofia, for example, communities report a limited number of schools within the settlement, pushing most students to attend school outside the area. This results in longer commutes, increased transportation costs, and added burdens on families (Suez Consuting, 2025). This is particularly true for women, as it further exacerbates their caregiving responsibilities within the household. Climate change-related impacts increase women's workload as they strive to care for their families amidst dwindling resources. The same applies to Shauri Yako, especially for secondary education, where access to schools within the settlement is particularly limited, posing a significant barrier to educational progression and creating an overreliance on institutions located elsewhere. All of this is of course made worse by climate change. Communities report that during flood events, floodwaters mix with sewage and block access roads, making it impossible for women to take their children to school (Suez Consulting 2025). In parallel, the quality of educational infrastructure is also a concern, particularly in Makongeni, where some facilities are hampered by outdated structures. This lack of maintenance and modernization makes them especially vulnerable to extreme climate events such as heavy rains or heatwaves, which can damage school buildings, disrupt classes, and compromise the safety of both students and staff (AMT,2025).

3.4.4.9 Energy and communications

On the other hand, energy infrastructure presents significant vulnerabilities—particularly concerning electricity, which remains the primary energy source in the informal settlements. While household connectivity is relatively high (77% in Makongeni, 71.11% in Shauri Yako, and 73.5% in Sofia; AMT, 2025), this does not guarantee reliable or safe access to electricity. In this context, vulnerability refers both to the inconsistency of energy supply and to the physical exposure of energy infrastructure to climate-related hazards.

Field observations revealed that erosion and landslides are increasingly threatening exposed infrastructure—such as electric poles—leading to frequent power outages and increasing safety risks.

Reliable electricity is especially critical during climate-related emergencies, as it ensures access to information, lighting, refrigeration, and communication. While a smaller share of households relies on solar energy (20.2% in Makongeni, 21.1% in Sofia, and 27% in Shauri Yako; ibid), these systems offer only partial resilience. Additionally, repeated community reports of vandalism on solar units further reduce the effectiveness of this alternative energy source (Suez Consulting, 2025).

This fragility is further compounded by another vulnerability factor: limited access to information, particularly in digital form. While many households in informal settlements rely on mobile phones to stay informed, the availability of reliable broadband internet remains a significant challenge due to both affordability constraints and infrastructural limitations (AMT, 2025). This digital divide restricts timely access to early warning systems, climate-related updates, and essential public services, further heightening communities' vulnerability to climate change impacts.

3.4.5 Institutional vulnerabilities

Finally, it is essential to consider vulnerabilities at the institutional level—both within local and county governments and among community structures. The ability of these actors to plan for, finance, and implement climate adaptation measures directly influences the resilience of the settlements. In Homa Bay, challenges such as limited technical capacity, fragmented coordination, and insufficient budget allocation for climate actions constrain institutional responsiveness. At the same time, there are existing entry points for action—such as active community-based organizations and ongoing partnerships with development actors—that can be leveraged. Assessing institutional vulnerability therefore helps identify both gaps that require urgent support (e.g., capacity building, data systems, planning tools) and opportunities for strengthening governance mechanisms that can drive effective, locally grounded adaptation.

3.4.5.1 Strategies and plans on adaptation and risk management

Homa Bay County Government is well equipped in terms of planning documents on climate adaptation, risk management and urban planning. This shows full awareness and organization to increase resilience in a structured manner. These documents however don't necessarily give a focus on the informal settlements' specific situation and needs. They are also fairly recent, meaning their implementation is yet to be assessed.
The Homa Bay County Climate Change Act (2022) establishes the legal framework for climate change response in the county, including the creation of the Water, Irrigation, Sanitation, Environment, Energy, Forestry, and Climate Change Committee, as well as the Climate Change Steering Committee, responsible for coordinating and overseeing climate-related activities. While the Act itself does not explicitly mention any provisions for urban informal settlements, it indirectly facilitates the development and coordination of environmental governance and climate adaptation strategies. For instance, the technical committee plays a role in prioritizing programs, projects, and activities for climate change response within the county, which could serve as a leverage point to specifically target informal settlements, or not (Homa Bay County Government, 2022).

The Homa Bay County Climate Change Action Plan 2023-2027 (Homa Bay County Government, 2023) provides a framework for addressing climate variability and change. The plan focuses on adaptation, mitigation, and implementation strategies, outlining priority actions, including those for urban areas. However, it places less emphasis on informal settlements, although the plan suggests community adaptation strategies, particularly for managing climate-related challenges such as floods and droughts.

Table 14: Adaptation strategies to climate hazards (Homa Bay County, 2023)

Floods	Droughts
Construction of drainage systems, dykes, and dams	Expansion of irrigation systems
Planting of water-absorbing trees such as eucalyptus	Tree planting initiatives
Lakefront planning and development	Construction of dams and water pans
	Sinking of water pans
Implementation of early warning systems	Drilling and equipping boreholes
	Promotion of drought-tolerant crops

The El Niño Inter-Agency Preparedness Plan (Homa Bay County Government, 2023) aims to strengthen the county's capacity to anticipate and respond to emergencies while ensuring the safety and security of vulnerable populations within Homa Bay County in the face of the El Niño phenomenon, which strikes in Homa Bay Town. The plan sets out intervention proposals for both the pre- and post-El Niño phases by sector such as:

- Construction and rehabilitation of dykes
- Develop early warning and monitoring systems
- Tree planting, etc.

Finally, the Homa Bay County Participatory Climate Risk Assessment Report 2023 (Homa Bay County Government, 2022) assess climate risks in Homa Bay by integrating community asset mapping, hazard mapping, and considerations for marginalized groups. It also identifies and highlights existing adaptation strategies and the county's investment priorities for adaptation, particularly in response to floods and droughts by sector. However, it lacks a specific focus on informal settlements, but identifies other adaptations actions such as:

- Expansion of existing water production capacity
- Establishment of more health facilities
- Investment in flood disaster early warning systems
- Building of dykes along riverbanks, etc.

3.4.5.2 Strategies and plans on urban development

Urban development in Homa Bay (county and municipality level) is guided and regulated by various strategies and plans, with the most recent ones incorporating climate change issues, highlighting the need for adequate adaptation to environmental challenges in urban areas. Key among them are: The Homa Bay County Institutional Development Strategy (2023-2026) (Homa Bay County Government, 2022) that defines the county's approach to urban management and its integration into overall county planning. This strategy aims to address urban management challenges through a detailed annual action plan and a specific budget. However, within these challenges, there is no mention of climate change issues and the need to develop adaptation measures, even less so at the level of informal settlements.

In parallel, the Homa Bay County Integrated Development Plan (2023-2027) (Homa Bay County Government, 2022) outlines a five-year development plan that integrates long-term spatial, sectoral, and urban planning with a resilience-focused approach. Among its priorities is a focus on affordable housing and slum upgrading, particularly through the provision of affordable and secure housing and the formalization of informal systems. On the other hand, there is broad recognition of the need to develop strategies to address climate change across all sectors identified in the plan. These strategies span a range of areas including:

- Economic Sector: Implementation of climate-smart agriculture projects to enhance resilience and productivity.
- Social Protection and Culture Sector: Roll-out of women-focused climate change programs aimed at strengthening gender-responsive adaptation and mitigation efforts.
- Environmental Protection, Water, and Natural Resources Sector: Greening of urban spaces to improve environmental quality and resilience. Strengthening of climate finance mechanisms and the development of a comprehensive climate finance strategy.

All these efforts are embedded within a systemic approach that integrates cross-cutting themes such as gender, poverty reduction, and social equity.

Moreover, the Annual Development Plan 2025/2026 (Homa Bay County Government, 2022) also addresses aspects of climate change governance in Homa Bay through a strategic vision of building a resilient county, while continuing to adopt a sectoral approach. To this end, the County Government aims to raise awareness of climate change and its impacts, while promoting mitigation, adaptation, and resilience measures across all departments. Many of these measures draw directly from the vision and strategies outlined in the County Integrated Development Plan (CIDP), reflecting an increasingly integrated and coordinated approach. For instance:

- In the health sector, the plan promotes sustainable waste management systems within the County and recognizes the interconnection between climate change and the increased prevalence of diseases.
- In the education sector, the County's climate change policy mandates that every department must incorporate climate change as a cross-cutting program within its activities.
- In the Environmental Protection, Water and Natural Resources Sector, there remains a strong emphasis on developing and strengthening climate finance mechanisms to support both mitigation and adaptation efforts.

However, although the absence of a program for climate resilience among the urban poor is briefly highlighted, there is no strong focus on this specific issue.

At the municipality level, the Strategic Urban Development Plan for Homa Bay Municipality (2008-2030) (UN Habitat,2008) assists the municipality in preparing a strategic spatial framework to guide the future development of Homa Bay. The strategy recognizes informal settlements and the need to develop them, particularly in terms of sustainability and infrastructure. However, it places little or no emphasis on the consequences of climate change and the importance of adaptation strategies. This relative gap may be due to the document's formulation date, which probably preceded the growing urgency and visibility of climate-related impacts. So, while the foundations of inclusive sustainable development are present, there is scope to strengthen the strategy by incorporating more explicit and forward-looking climate adaptation measures, tailored to the unique vulnerabilities of informal settlements. In contrast, the more recent Homa Bay Municipality Integrated Development Plan (2023-2027) (Homa Bay Municipality, 2023) lays even more the foundation for sustainable urban development in the municipality. The plan highlights urban development priorities and strategies, including adaptation goals such as the strategic development of plans for managing natural risks like flooding and drought. However, the concrete pathways for achieving these objectives are only outlined in broad terms, with limited detail provided, particularly when it comes to addressing the specific needs and vulnerabilities of informal settlements.
Furthermore, The Municipality is seeking to develop a Local Physical and Land Use Development Plan, which this Climate Risk Assessment will contribute to, therefore promoting climate resilient urban development.
Lastly, infrastructure improvement initiatives, notably through the Kenya Informal Settlements Improvement Project (KISIP2) (World Bank, 2020), focus on upgrading infrastructure and services in informal settlements to improve living conditions for residents. There is a recognition of the enhancement of climate change adaptation as a lever for action, notably through proper planning of urban settlements. Nevertheless, an exhaustive focus on this aspect is still lacking, revealing room for opportunities improvement.

3.4.5.3 The institutional governance

In Kenya, climate governance is devolved under the Climate Change Act (2016), which mandates county governments to integrate climate actions into their policies and plans (Ministry of Environment, Climate Change and Forestry, 2024). In Homa Bay County, this has led to the establishment of several local structures such as the Climate Change Steering Committee, the County Climate Change Technical Committee, and Ward Climate Change Committees, which together support the development and implementation of the County Climate Change Action Plan. These efforts are complemented by the Disaster and Emergency Management Council, which coordinates disaster response under the county's Disaster and Emergency Management Act.
However, despite this devolved framework, practical challenges persist. Some key sectors, such as water management, remain significantly dependent on national agencies like the Water Resources Authority. This continued centralization is often due to limited technical capacity and financial resources at the county level (Otieno, Obosi, & Magutu, 2023). As a result, while institutional mechanisms for climate action exist at both county and ward levels, their effectiveness is sometimes constrained by systemic governance limitations and cross-jurisdictional overlaps.
Therefore, although climate change governance formally occurs at both national and local levels, the cross-cutting and multisectoral nature of climate issues often complicates its execution. In practice, the centralization of key sectors such as water management undermines the ability of counties to implement integrated and locally appropriate responses. This creates friction between the intent of devolution and the actual distribution of power and resources. Moreover, coordination challenges remain a significant obstacle—both across national ministries and between national and county governments. These challenges are compounded by informational barriers, including limited communication flows and unclear delineation of roles and responsibilities, which hinder effective policy implementation and weaken overall climate action coherence (Climate Action Tracker, 2020).

Secondly, County bodies oversee the integration of climate actions into development plans and budgeting processes. In principle, governance should extend to municipalities via the Urban Areas and Cities Act, which gives them responsibilities over planning and disaster management. However, in practice, municipal governance remains weak. Many Municipal Boards lack the autonomy, capacity, or resources to act effectively, with counties often retaining control over key functions. As a result, municipalities have limited room to maneuver in addressing localized climate vulnerabilities. This weak municipal governance significantly increases vulnerability at the settlement level, especially in informal settlements. Without empowered local institutions, efforts to address climate risks—such as flood management, waste services, or early warning systems, are often delayed or poorly implemented. Strengthening municipal structures, clarifying roles, and improving coordination with county governments is essential to enable effective, context-specific responses to urban climate risks.

Lastly, another layer of governance in this ecosystem is the settlement-level leadership, represented by local chiefs who are appointed and salaried directly by the national government through the Ministry of Interior and Coordination of National Government, not by the county. As a result, they are not accountable to the county or the municipality, which can lead to parallel lines of authority and coordination challenges. This creates an additional asymmetry in the governance structure, allowing the chiefs to potentially bypass both county and municipal governments. Local chiefs play a key role in organizing settlement affairs and, notably, in allocating land within their jurisdictions. However, this land allocation process often operates in a legal grey area. In practice, land is sometimes distributed without strict adherence to official land tenure regulations or urban planning standards. This has led, in several instances, to construction on flood-prone or otherwise hazardous land (Suez Consulting, 2025). Thus, there is often a failure to meaningfully integrate local knowledge and perceptions of climate risks into planning processes. The lack of formal land titles and weak enforcement of environmental planning guidelines further compound residents' vulnerability.

3.4.5.4 Financial barriers

Climate finance available for Homa Bay is very much connected to the whole finance system at the national level. In Kenya there is a relatively broad ecosystem involving a mix of actors, public and private, international, national, and local, and a variety of financial instruments. The County Climate Change Fund (CCCF), initially piloted by the National Drought Management Authority (NDMA) in 2013, has since been institutionalized in several counties, enabling locally-led climate adaptation planning and financing. Recent evaluations highlight its role in strengthening climate resilience through participatory budgeting and devolved governance frameworks (ADA Consortium, 2017; ClimBeR/CGIAR, 2025).

In this context, in 2022, Homa Bay has established its Climate Change County Fund under the County Climate Change Act, in order to mobilize and manage financial resources to support climate adaptation projects at the county level. Therefore, the national and local climate finance operate in symbiosis, provided that the NCCF allocates funds to CCCFs to strengthen county budgets for climate action. And while CCCFs are managed locally, they remain aligned with national strategies and also incorporate local budgeting, as each county is required to allocate at least 1.5% of its development budget to climate-related projects, ensuring financing for priority interventions at the community level. While the County Climate Change Fund (CCCF) has been institutionalized in Homa Bay, detailed data on fund absorption, specific ward-level allocations, or projects implemented—particularly within informal settlements—was not publicly available at the time of this assessment.

However, while climate action is indeed a key area of investment in Kenya, significant gaps persist. First, Kenya's climate finance flows are insufficient to meet the estimated USD 62 billion needed up to 2030 for its NDC commitments. In 2018, only about USD 2.4 billion was mobilized, highlighting a critical funding shortfall to effectively address the scale of climate challenges. Secondly, over 80% of Kenya's climate budget is currently allocated to mitigation measures, despite the country's NDC policy framework placing strong emphasis on adaptation.

Counties lack adequate funding, which hinders much-needed improvements as a significant portion of national shareable funds remains controlled at the national level. In an interview with the water supply and sanitation provider in Homa Bay, HOMAWASCO, the lack of funding was stressed as a key constraint to improve its services within the settlements.

But there is a growing emergence of locally led actions in response to climate change, which are helping to strengthen the efforts of counties and communities. For example, the Financing Locally-Led Climate Action Program (FLLoCA), funded by the World Bank, focuses on providing support to rural communities and enhancing the capacity of county governments to manage climate risks, through the lens of adaptation (World Bank 2019). In 2024, Homa Bay County benefited from Sh358 million according to FLLoCA annual performance assessment appeals report (Odiwuor, 2024). For example, the FLLoCA allowed the development of the County Climate Change Action Plan as well as the Participatory Climate Risk Assessment.

3.4.5.5 Informational barriers

In parallel, organizational barriers between different entities and levels of governance also present a major challenge. Coordination efforts are often fragmented, as various government agencies and local bodies tend to operate independently. A key organizational weakness is the division of responsibilities across multiple county departments, such as Environment, Climate Change, Disaster Management, Urban Planning, and Housing. This fragmentation, combined with bureaucratic procedures, hampers program coordination, slows the enforcement of environmental and planning regulations, and impedes a unified response to climate-related challenges, as is the case in Homa Bay. As highlighted in the key stakeholder interviews, this issue is particularly evident in relation to data collection and disaster risk reduction efforts. For instance, the current systems lack the capacity for real-time data collection, making it difficult to monitor rapidly evolving hazards such as flash floods or sudden droughts. The absence of a centralized platform to consolidate and analyze data from multiple sources further limits the effectiveness of hazard identification (Homa Bay Municipality, 2023). Additionally, early warning systems remain underdeveloped. Although frameworks like the El Niño Preparedness Plan mark steps forward, existing systems often fall short in providing localized and timely alerts to at-risk communities. Limited financial resources and technical expertise hinder the deployment of advanced forecasting tools and remote sensing technologies that could improve hazard prediction capabilities. Moreover, Homa Bay County faces persistent gaps in human resources and institutional capacity when it comes to implementing climate change actions. As a result, there is a pressing need for sustained capacity building among local stakeholders to strengthen climate resilience at the community level (County Government of Homa Bay, 2021).

3.4.5.6 Community driven adaptation actions

Finally, in light of these institutional challenges and areas where there is room for improvement, it becomes important to also consider actions taking place at the community level as part of a broader strategic lens. This helps assess the extent to which communities themselves are stepping in to fill potential gaps, particularly where institutional engagement in informal settlements may be limited. That said, existing efforts on the ground tend to be highly localized, individual, and not part of a broader collective organization. In terms of adaptation actions, for instance, some residents have placed gabions around their homes to prevent water from entering, while others use sacks to stabilize soil and reduce erosion, especially near dwellings exposed to water runoff (Suez Consulting, 2025). While such practices reflect a degree of resourcefulness, they remain insufficient in the absence of wider-scale planning and targeted, coordinated measures capable of addressing climate risks more effectively. All this is also somewhat hindered by a lack of institutional support. For instance, community-led initiatives in the informal settlements, such as town clean-up efforts, struggle to sustain themselves due to the absence of technical support and integration into formal systems. Moreover, there was a clear lack of awareness among local communities about existing climate initiatives, which further hinders their ability to adapt and mitigate climate-related challenges. For example, women in the Makongeni discussion group were unaware of the Financing Locally-Led Climate Action (FLLoCA) Program by the County Government, which provides direct funding to women and youth groups to combat climate change through actions such as increasing tree cover and conserving water towers (Suez Consulting, 2025).

3.4.6 Scoring of vulnerability

A scoring system was developed to mark the level of vulnerability for each type reviewed: Social, economic, geophysical, infrastructural and institutional. The levels go from 1 (low vulnerability) to 4 (very high vulnerability). The methodology used for the scoring and the calculations are detailed in the appendices. The key metrics used for each type of vulnerabilities are the following:

- Social: number of women, number of elderly (65+), poverty rate (<6000 Khs)
- Economic: number of people working in climate-sensitive sectors (agriculture), number of people working in the informal sector
- Geophysical: topography, nature of soil, hydrology, soil sealing
- Infrastructural: water supply (connection to pipe water system), sanitation (connection to sewer system), mobility (motorable tracks), housing (use of iron sheet walls), energy (connection to the grid) and waste (access to government waste collection system)

It is important to note that metrics were chosen in part according to available data (AMT, 2025) and do not show the full extent of vulnerabilities and all the critical nuances for each type of vulnerabilities studied. Therefore, results shown below must be considered together with the narratives from the previous sections to gain a holistic view of vulnerabilities within the three settlements.

The aggregated vulnerability score per settlement is based on the following weighting system.

Type of vulnerability	Weighting
Social	25%
Economic	20%
Geophysical	20%
Infrastructural	20%
Institutional	15%

The results are as follows:

Settlement	Social	Economic	Geophysical	Infrastructure	Institutional	TOTAL
Sofia	1,7	2,5	1,0	3,0	3,0	2,2
Makongeni	2,3	2,5	3,5	3,0	3,0	2,8
Shauri Yako	1,7	2,5	3,0	3,4	3,0	2,6

Table 15: Vulnerability scoring (Source: SUEZ Consulting, 2025)

3.5 Synthesis of climate risk

Taking the IPCC definition of a climate risk, the risk score is calculated by multiplying the exposure score by the vulnerability score. As both the exposure score and the vulnerability score are scored on a four-level scale, the risk score can range from 1 to 16.
To obtain a four-level scale for the risk score, the risk score between 1 and 16 is reduced to a 4-level scale using the following breakdown:

Risk score	Vulnerability				
Exposure		4	3	2	1
	4	16	12	8	4
	3	12	9	6	3
	2	8	6	4	2
	1	4	3	2	1

Figure 36: Risk scoring methodology (Source: Suez Consulting)

Results can be found below:

Settlement	Risk scoring	Risk scoring
Sofia	2	Low
Makongeni	3	Medium
Shauri Yako	3	Medium

Table 16: Risk scoring (Source: SUEZ Consulting, 2025)

Because of its limitations, the results of the scoring must not be used alone in decision-making processes but instead it must be considered together with the full analysis on hazards, exposure and vulnerability, presented in this report.

4. SUMMARY SHEET FOR EACH SETTLEMENT

Settlement	SHAURI YAKO
Context	In the northeastern part of Homa Bay Municipality, within the Arujo Sub-Location. Covering an area of approximately 1.1 square kilometers, it is home to an estimated 5,056 residents.
Hazards	 Drought  Flood
Exposure	Houses, water and electric infrastructure, roads, market, park, schools, health facilities, churches, trees
Vulnerability	
Social	• Women at the frontline of climate stress Women and girls in Shauri Yako face heightened climate vulnerability due to entrenched gender inequalities, with droughts and floods making tasks like water collection harder. Economic precarity, especially for female-headed households (33.4%), weakens resilience, while only 6.34% of women own homes compared to 17.26% of men. Despite similar unemployment rates (5.18% vs. 3.83%), women are overrepresented in informal, unstable jobs. Gender-based violence, limited legal aid, and poor healthcare access further increase their vulnerability during and after climate shocks. • Youth and Elderly: A double-edged vulnerability Shauri Yako's population is mostly young, 35% aged 20–24, with few elderly, 6.35%. Youth face high unemployment, low incomes, and unstable livelihoods, reducing their capacity to cope with climate-related shocks. Older residents, with poor housing, no pensions, and limited healthcare, are especially exposed to climate impacts like heatwaves or floods.
Economic	• Lake based activities, highly vulnerable to lake warming Fishing and small-scale trading, is increasingly impacted by rising lake temperatures and erratic weather patterns. In recent years, massive fish die-offs, due to warming waters which have significantly disrupted livelihoods dependent on Lake Victoria. Additionally, storms and heavy rains frequently damage fishing equipment, further threatening household income. • Precarious Livelihoods, high climate exposure In Shauri Yako, economic vulnerability to climate change is driven by reliance on informal work, only 7.3% are formally employed, while 32.8% are self-employed in unregulated, exposed settings. Many businesses, set up along roadsides, face frequent flood damage, leading to merchandise loss and income instability. With no financial safety nets, poor infrastructure, and limited access to social protection, climate shocks have a direct and lasting impact on residents' livelihoods.
Geophysical	• Topography: Elevation patterns that shape exposure Shauri Yako's flat terrain, particularly in low-lying northern areas near Lake Victoria, is highly vulnerable to flooding, which worsens during heavy rainfall. The southern regions, at higher elevations, are less prone to flooding but face soil erosion and instability due to extreme weather events, particularly during climate-driven storms. • Beneath the Surface: How Shauri Yako's Soils Influence Climate Risks Predominance of montmorillonitic clay soils in the north increases the risk of landslides, erosion, and poor construction stability. Challenges intensified by rainfall variability. • Hydrology: Water dependency & seasonal variability The settlement's dependence on Lake Victoria and local streams for water sources makes it susceptible to climate-induced fluctuations in water levels. During dry spells, groundwater levels drop, while heavy rains overwhelm surface water systems, increasing flooding risk.
Infrastructure	• Drainage: A system overwhelmed by climate extremes The lack of effective drainage systems exacerbates flooding, especially in low-lying areas. Poor infrastructure, clogged drains, and unregulated urban development leave many areas exposed to waterlogging and flood risks, which are expected to increase with more erratic rainfall patterns caused by climate change. • Water Infrastructure: inadequate access & climate pressure Shauri Yako faces a critical shortage of reliable water supply. Only 20.46% of households have access to piped water, with frequent supply disruptions affecting 22.54% of residents. This leaves the community susceptible to both water scarcity during dry spells and flooding during heavy rains, all while the cost of water remains prohibitively high. • Sanitation Systems: overburdened & unsanitary

<table>
<tr><td></td><td>In Shauri Yako, 89.3% of households rely on communal pit latrines, contributing to poor sanitation. The absence of a robust sewer system means that during heavy rainfall, floodwaters often mix with waste, leading to contamination of water sources. This significantly raises the risk of waterborne diseases and undermines public health. The situation is made worse by increased flooding due to climate change, intensifying the vulnerability of residents.
• Mobility Networks: Impassable roads & delayed service responses
89.3% of roads are unpaved, making them highly vulnerable to disruptions during the rainy season. As climate change intensifies storms, these roads frequently become impassable, complicating daily commuting and increasing transportation costs.
• Housing Conditions: Overcrowded & climate-exposed
With a population density of 4,595 people per km², Shauri Yako faces severe overcrowding, straining housing and services. Over 72.61% of households rent, and nearly 73% live in homes made of vulnerable materials like iron sheets. These conditions heighten vulnerability to flooding and heatwaves, while 72.61% of households spend over 30% of their income on rent, limiting their ability to improve resilience.
• Energy Systems: unreliable & risk-prone
While 71.11% of households in Shauri Yako have electricity, the infrastructure is vulnerable to climate-induced outages due to storms damaging electric lines. 27% use solar energy, but theft and vandalism undermine its effectiveness, leaving the community with unreliable power, especially during extreme weather.
• Waste Management: Poor disposal & drain blockages
Waste management is poor, with 71.67% of households reporting illegal dumping. This clogs drainage systems, worsens flooding, and contributes to water pollution, increasing the risk of waterborne diseases.
• Essential Services: Strained health & education access
Access to healthcare and education is challenging. 28% of residents travel over an hour for medical care, and the lack of local schools forces children to commute long distances. Flooding disrupts both services, exacerbating the community's vulnerability .</td></tr>
<tr><td>Institutional</td><td>• Financial Barriers: Insufficient funding & misallocation
Climate finance in Kenya is still facing challenges, with a significant shortfall in meeting the USD 62 billion needed for NDC targets. Over 80% of funds are directed to mitigation, neglecting key sectors like water management and disaster risk reduction in informal settlements. Poor coordination and transparency further hinder effective resource allocation.
• Organizational Barriers: Coordination challenges & capacity gaps
Fragmented coordination between agencies delays climate action. In Homa Bay, inadequate data systems and weak early warning mechanisms reduce the ability to address hazards.
• Governance Barriers: Weak local governance & power struggles
Weak municipal governance and overlapping authority between national and local levels reduce climate resilience, particularly in informal settlements. National control over key sectors and fragmented local leadership hinders effective climate adaptation efforts.
• Community-driven Adaptation Actions: Local Solutions with Limited Impact
Residents take individual, but these efforts lack broader coordination and formal support. While resourceful, these initiatives need scaling and institutional backing to address larger climate risks effectively.</td></tr>
<tr><td>Exposure score</td><td>Approximately 15.4% of Shauri Yako's surface area is highly and directly exposed to flooding and erosion. An estimated 0.168 km² out of the settlement's total 1.096 km² falls within zones classified as highly and directly exposed to climate-related hazards.

Exposure score: 1</td></tr>
<tr><td>Vulnerability score</td><td><table><tr><th>Settlement</th><th>Social</th><th>Economic</th><th>Geophysical</th><th>Infrastructure</th><th>Institutional</th><th>TOTAL</th></tr><tr><td>Shauri Yako</td><td>1.7</td><td>2.5</td><td>3</td><td>3.4</td><td>3</td><td>2.6</td></tr></table></td></tr>
<tr><td>Risk score</td><td>Risk = Medium</td></tr>
</table>

Settlement	SOFIA
Context	In the northwestern part of Homa Bay Municipality, adjacent to Lake Victoria. Covering about 1.45 square kilometers, it is home to approximately 4,873 residents. The settlement's growth and environmental challenges are closely tied to its location near the lake, which exposes it to flooding and fluctuating water levels.
Hazards	Drought Flood
Exposure	Houses, roads, water infrastructure
Vulnerability	
Social	• Women at the frontline of climate stress In Sofia, climate change deepens existing gender inequalities. Women often juggle income generation with unpaid care duties, while also shouldering the burden of securing essential resources like water, tasks made harder by drought and flooding. Long collection times impact their safety and well-being. Female-headed households (37%) face major barriers: just 31.6% own land, and 89.9% work in the informal sector, where jobs are unstable and low-paying. These constraints limit their ability to adapt. • Youth and Elderly: A double-edged vulnerability Though older adults make up only 4% of Sofia's population, they face severe climate risks due to poor health, limited income, and weak support networks. Meanwhile, youth dominate demographically, but face high unemployment (59.6% for ages 15–24), low income (27% earn <6,000 Ksh/month), and unstable livelihoods, undermining their ability to cope with climate shocks despite physical resilience.
Economic	• Lake based activities, highly vulnerable to lake warming Fishing and small-scale trading, is increasingly impacted by rising lake temperatures and erratic weather patterns. In recent years, massive fish die-offs, due to warming waters which have significantly disrupted livelihoods dependent on Lake Victoria. Additionally, storms and heavy rains frequently damage fishing equipment, further threatening household income. • Precarious Livelihoods, high climate exposure Formal employment is scarce (6.2%), while most residents rely on informal, often unstable, income sources. Self-employment accounts for just 18.9%, the lowest among the three settlements. Informal businesses, many of which operate roadside, are especially exposed to climate risks like flooding, causing repeated damage and loss of income.
Geophysical	• Topography: Elevation patterns that shape exposure Sofia's topography significantly impacts its climate vulnerability. The low-lying southeastern areas are particularly vulnerable to flooding and waterlogging due to the varied terrain with slopes which creates challenges for construction and drainage. While the higher, more stable northwestern zones are better suited for planned development. • Beneath the Surface: How Sofia's Soils Influence Climate Risks Sofia's soil types create uneven vulnerability across the settlement. The eastern areas, dominated by montmorillonitic clay soils, make them susceptible to landslides and structural damage. In contrast, the western regions, with more stable interstratified clayey soils, are better suited for construction. This disparity increases the vulnerability of the southeastern, steeper zones to erosion and instability, exacerbated by changing climate conditions. • Hydrology: Water dependency & seasonal variability Influenced by its proximity to Lake Victoria and seasonal streams, Sofia is vulnerable to flooding and waterlogging. In parallel, groundwater, especially vital in the settlement's drier areas, is susceptible to seasonal fluctuations and climate change, particularly during dry spells, making Sofia highly exposed to both flooding and water scarcity • Drainage: A system overwhelmed by climate extremes Sofia's drainage infrastructure is insufficient, particularly in the low-lying southeastern areas, where poorly maintained systems and clogged flow paths worsen flooding. The lack of effective drainage increases the risk of waterlogging and flood damage, while the higher areas, though less prone to flooding, still face infrastructure challenges. Improved drainage is crucial to reducing Sofia's flood vulnerability.
Infrastructure	• Water Infrastructure: inadequate access & climate pressure 31.2% of households are connected to piped water, 52.3% endure frequent outages, especially during dry spells and aging, heat-sensitive plastic pipes struggle to meet rising demand. As a result, the community remains vulnerable to both drought and flooding, all while water costs stay high. • Sanitation Systems: overburdened & unsanitary

<table>
<tr><td></td><td>Sanitation is a major concern, with 93.7% of households relying on communal pit latrines. The lack of a reliable sewer system makes the area highly vulnerable to flooding, which is increasingly common due to climate change. Flooding mixes waste with water sources, raising the risk of waterborne diseases.
• Mobility Networks: Impassable roads & delayed service responses
With 89.3% of roads unpaved, Sofia's transport system is prone to disruptions during heavy rainfall, which is expected to increase with climate change.
• Housing Conditions: Overcrowded & climate-exposed
With a density of 3,360 people per km², Sofia endures extreme overcrowding that strains basic services and limits space for adequate homes. Nearly half of all households (47%) spend over 30% of their income on rent, leaving little for repairs, while many dwellings are built from substandard materials. This combination of high expenditures, cramped living conditions, and fragile structures sharply raises the risk of damage and displacement as floods and heatwaves grow more frequent.
• Energy Systems: unreliable & risk-prone
While 73.5% of households have electricity, the energy infrastructure is vulnerable to climate-induced power outages. Solar power, used by 21.1% of households, offers some resilience but faces issues with theft and vandalism, making it unreliable during extreme weather events.
• Waste Management: Poor disposal & drain blockages
Illegal dumping is common in Sofia (87.4% of households), clogging drainage systems and worsening flooding. Climate change intensifies this risk, as more frequent and severe storms lead to waste-contaminated water, increasing health risks.
• Essential Services: Strained health & education access
Access to essential services in Sofia is severely constrained. 28% of residents travel over an hour for healthcare, and students face similarly long commutes due to the scarcity of local schools. Flooding often renders roads impassable, disrupting both medical care and education, and heightening the community's vulnerability as extreme weather events become more frequent.</td></tr>
<tr><td>Institutional</td><td>• Financial Barriers: Insufficient funding & misallocation
Climate finance in Kenya is still facing challenges, with a significant shortfall in meeting the USD 62 billion needed for NDC targets. Over 80% of funds are directed to mitigation, neglecting key sectors like water management and disaster risk reduction in informal settlements. Poor coordination and transparency further hinder effective resource allocation.
• Organizational Barriers: Coordination challenges & capacity gaps
Fragmented coordination between agencies delays climate action. In Homa Bay, inadequate data systems and weak early warning mechanisms reduce the ability to address hazards.
• Governance Barriers: Weak local governance & power struggles
Weak municipal governance and overlapping authority between national and local levels reduce climate resilience, particularly in informal settlements. National control over key sectors and fragmented local leadership hinders effective climate adaptation efforts.
• Community-driven Adaptation Actions: Local Solutions with Limited Impact
Residents take individual, but these efforts lack broader coordination and formal support. While resourceful, these initiatives need scaling and institutional backing to address larger climate risks effectively.</td></tr>
<tr><td>Exposure score</td><td>Approximately 31.5% of Sofia's surface area is highly and directly exposed to flooding and erosion. Based on flood hotspot mapping by community members and findings from the hydrological and hydraulic study, an estimated 0.458 km² out of the settlement's total 1.455 km² falls within zones classified as highly and directly exposed to climate-related hazards.

Exposure scoring: 1</td></tr>
<tr><td>Vulnerability score</td><td><table><tr><th>Settlement</th><th>Social</th><th>Economic</th><th>Geophysical</th><th>Infrastructure</th><th>Institutional</th><th>TOTAL</th></tr><tr><td>Sofia</td><td>1.7</td><td>2.5</td><td>1</td><td>3</td><td>3</td><td>2.2</td></tr></table></td></tr>
<tr><td>Risk score</td><td>Risk = Low</td></tr>
</table>

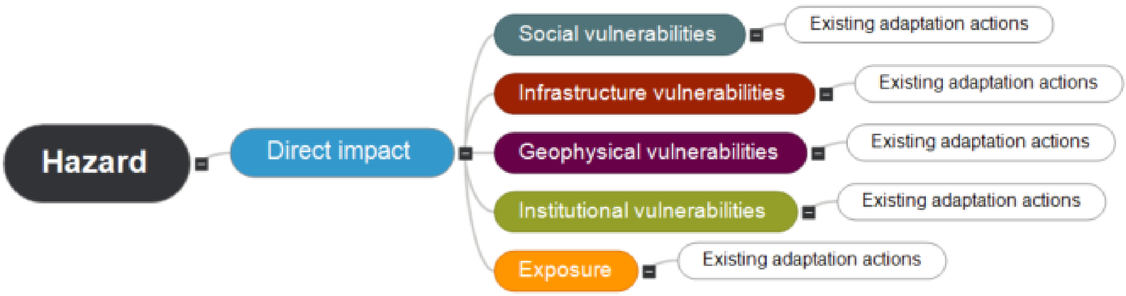
Settlement	MAKONGENI
Context	Smallest of the three informal settlements within Homa Bay Municipality, bordering Lake Victoria, with Got Abuor Hill. Spans approximately 73 hectares with an estimated population of 3,260 residents concentrated within one square kilometer.
Hazards	 Drought  Flood
Exposure	Houses, roads, water infrastructure, one school, one hospital
Vulnerability	
Social	• Women at the frontline of climate stress Women and girls face a double burden of income-generating responsibilities and unpaid caregiving work, while also being disproportionately impacted by climate-induced stress on resources like water. Women-headed households (37%) have limited access to land ownership (only 32%) and fewer economic opportunities, weakening their adaptive capacity. Moreover, climate shocks often increase domestic tensions, leading to heightened exposure to gender-based violence. • Youth and Elderly: A double-edged vulnerability Population mostly young (30% aged 20–24), high youth unemployment (25%), poor living conditions, and minimal economic prospects, reducing resilience despite physical robustness. Elderly residents (3.37%) remain highly vulnerable due to isolation, poor housing conditions, limited healthcare access, and lack of financial security, all of which compound their sensitivity to climate hazards.
Economic	• Lake based activities, highly vulnerable to lake warming Fishing and small-scale trading, is increasingly impacted by rising lake temperatures and erratic weather patterns. In recent years, massive fish die-offs, due to warming waters which have significantly disrupted livelihoods dependent on Lake Victoria. Additionally, storms and heavy rains frequently damage fishing equipment, further threatening household income. • Precarious Livelihoods, high climate exposure Only 22% of residents are formally employed, with the majority engaged in self-employment (37%) or informal activities such as petty trade, small-scale farming, and livestock rearing. These sectors are highly exposed to climate variability. Informal businesses, often unregulated and established in exposed, lack physical protection from environmental shocks. • Economic Insecurity amplified by climate risks The absence of social protection mechanisms, limited access to credit, and weak infrastructure exacerbate the economic fragility of residents. Young people, facing high unemployment (25%), are especially affected, highlighting how economic vulnerability intersects with social factors.
Geophysical	• Topography: Elevation patterns that shape exposure While central areas are moderately elevated, the southern and lakeside zones lie on flat terrain, which, due to proximity to Lake Victoria and economic activity, are densely populated. This flatness encourages unregulated settlement and suffers from poor drainage, making these areas prone to seasonal flooding. The more elevated central zone remains less developed but offers potential for climate-resilient planning. • Beneath the Surface: How Makongeni's soils influence climate risks Predominantly montmorillonitic clay, making most of the settlement highly vulnerable. This soil swells during heavy rains and shrink in dry spells, undermining foundations, triggering slope failures and severe erosion, and overwhelming drainage systems, all of which render buildings and infrastructure precarious. • Hydrology: Water dependency & seasonal variability Proximity to Lake Victoria ensures access to surface water for domestic and economic use, yet this also heightens exposure to lake-related flooding, contamination, and fluctuating water levels. Seasonal streams and drainage paths serve as natural runoff channels but dry up during droughts, underlining the community's dual vulnerability to both flooding and water scarcity. In times of heavy rain, poorly managed water systems fail to absorb runoff, increasing the risk of waterborne disease and habitat degradation. • Drainage: A system overwhelmed by climate extremes Drainage infrastructure in Makongeni is critically lacking and is mainly informal, comprising natural flow paths and a few poorly maintained trenches. These are often clogged with waste or vegetation, especially in southern lowlands, where flooding is frequent. The combination of inadequate planning, poor road grading, renders the drainage system ineffective, exacerbating flood damage during heavy rainfall.

<table>
<tr><td>Infrastructure</td><td>• Water Infrastructure: inadequate access & climate pressure
Only 22% of Makongeni households are connected to piped water, forcing many to rely on vendors or kiosks. The infrastructure is outdated. Old asbestos pipes and heat-sensitive plastic ones frequently crack, especially under rising temperatures. Water shortages are common, with 33% of households reporting irregular supply. Climate change worsens seasonal water scarcity and increases prices, deepening financial strain. Water quality is also a concern due to pollution and overuse of chemicals during treatment.
• Sanitation Systems: overburdened & unsanitary
Most households (75%) use communal pit latrines due to limited space and poor sewer infrastructure. Flooding often mixes sewage with surface water, spreading disease and disrupting daily life.
• Mobility Networks: Impassable roads & delayed responses
Nearly 90% of Makongeni's roads are unpaved, becoming muddy and unusable during rains. Poor access routes delay emergency response increasing vulnerability during climate-related disasters.
• Housing Conditions: Overcrowded & climate-exposed
High-density living (3,260 people/km²) and poor-quality rental housing leave residents vulnerable to flooding and landslides. Most structures use substandard materials, offering little protection against extreme weather. Limited land and weak regulation enforcement worsen the risks.
• Energy Systems: unreliable & risk-prone
Electricity access relatively high (77%), outages are frequent due to weather-damaged infrastructure and unsafe informal connections. Solar power offers some resilience but faces issues like theft and limited reach.
• Waste Management: Poor disposal & drain blockages
Illegal dumping is widespread (reported by 94% of households), clogging drainage and worsening flood risks during heavy rains. This contributes to water pollution and increases public health hazards.
• Essential Services: Strained health & education access
Healthcare facilities are hard to reach and under-resourced, especially during floods. Education infrastructure is weak, with outdated schools and limited availability, forcing long commutes that become nearly impossible during climate events.</td></tr>
<tr><td>Institutional</td><td>• Financial Barriers: Insufficient funding & misallocation
Climate finance in Kenya is still facing challenges, with a significant shortfall in meeting the USD 62 billion needed for NDC targets. Over 80% of funds are directed to mitigation, neglecting key sectors like water management and disaster risk reduction in informal settlements. Poor coordination and transparency further hinder effective resource allocation.
• Organizational Barriers: Coordination challenges & capacity gaps
Fragmented coordination between agencies delays climate action. In Homa Bay, inadequate data systems and weak early warning mechanisms reduce the ability to address hazards.
• Governance Barriers: Weak local governance & power struggles
Weak municipal governance and overlapping authority between national and local levels reduce climate resilience, particularly in informal settlements. National control over key sectors and fragmented local leadership hinder effective climate adaptation efforts.
• Community-driven Adaptation Actions: Local Solutions with Limited Impact
Residents take individual, but these efforts lack broader coordination and formal support. While resourceful, these initiatives need scaling and institutional backing to address larger climate risks effectively.</td></tr>
<tr><td>Exposure score</td><td>Approximately 2% of Makongeni's surface area is highly and directly exposed to flooding, erosion and landslides. An estimated 0.03 km² out of the settlement's total 0.730 km² falls within zones classified as highly and directly exposed to climate-related hazards. This percentage should be interpreted with caution. It is based strictly on the official administrative boundaries of Makongeni. However, both during the community validation workshop and site visits, as well as in the hydrological and hydraulic analysis, significant exposure concerns were raised regarding the main road that borders the settlement and the adjacent western zone. These areas, although technically outside the administrative boundary, are considered by residents to be part of Makongeni and are functionally integrated into their daily lives. As such, they represent critical exposure zones that should not be overlooked in future resilience planning.

Exposure scoring: 1</td></tr>
<tr><td>Vulnerability score</td><td><table><tr><th>Settlement</th><th>Social</th><th>Economic</th><th>Geophysical</th><th>Infrastructure</th><th>Institutional</th><th>TOTAL</th></tr><tr><td>Makongeni</td><td>2.3</td><td>2.5</td><td>3.5</td><td>3</td><td>3</td><td>2.8</td></tr></table></td></tr>
<tr><td>Risk score</td><td>Risk = Medium</td></tr>
</table>

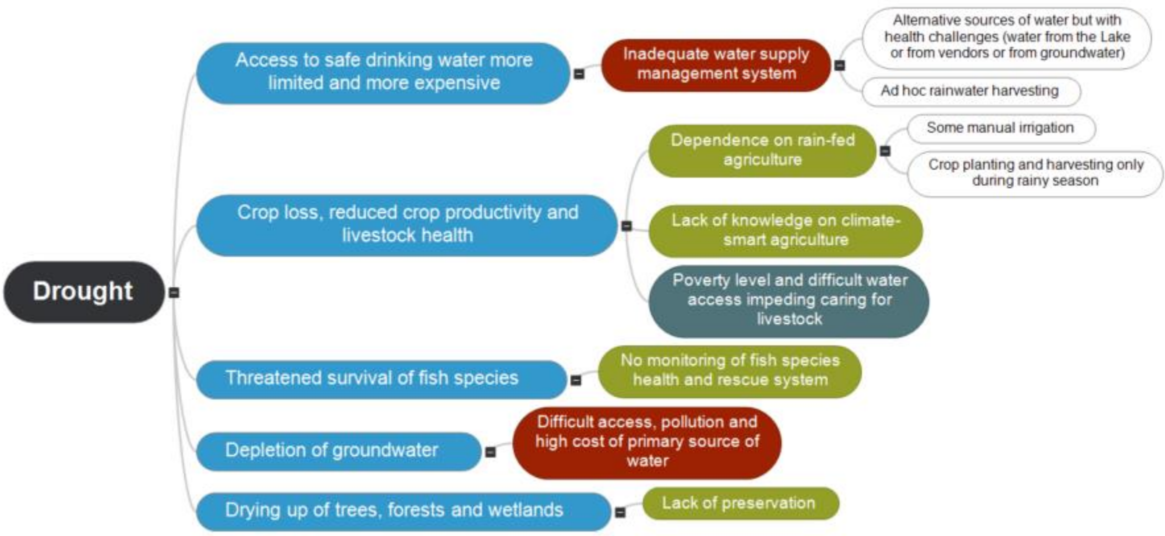
5. IMPACT-VULNERABILITY-ACTION CHAINS

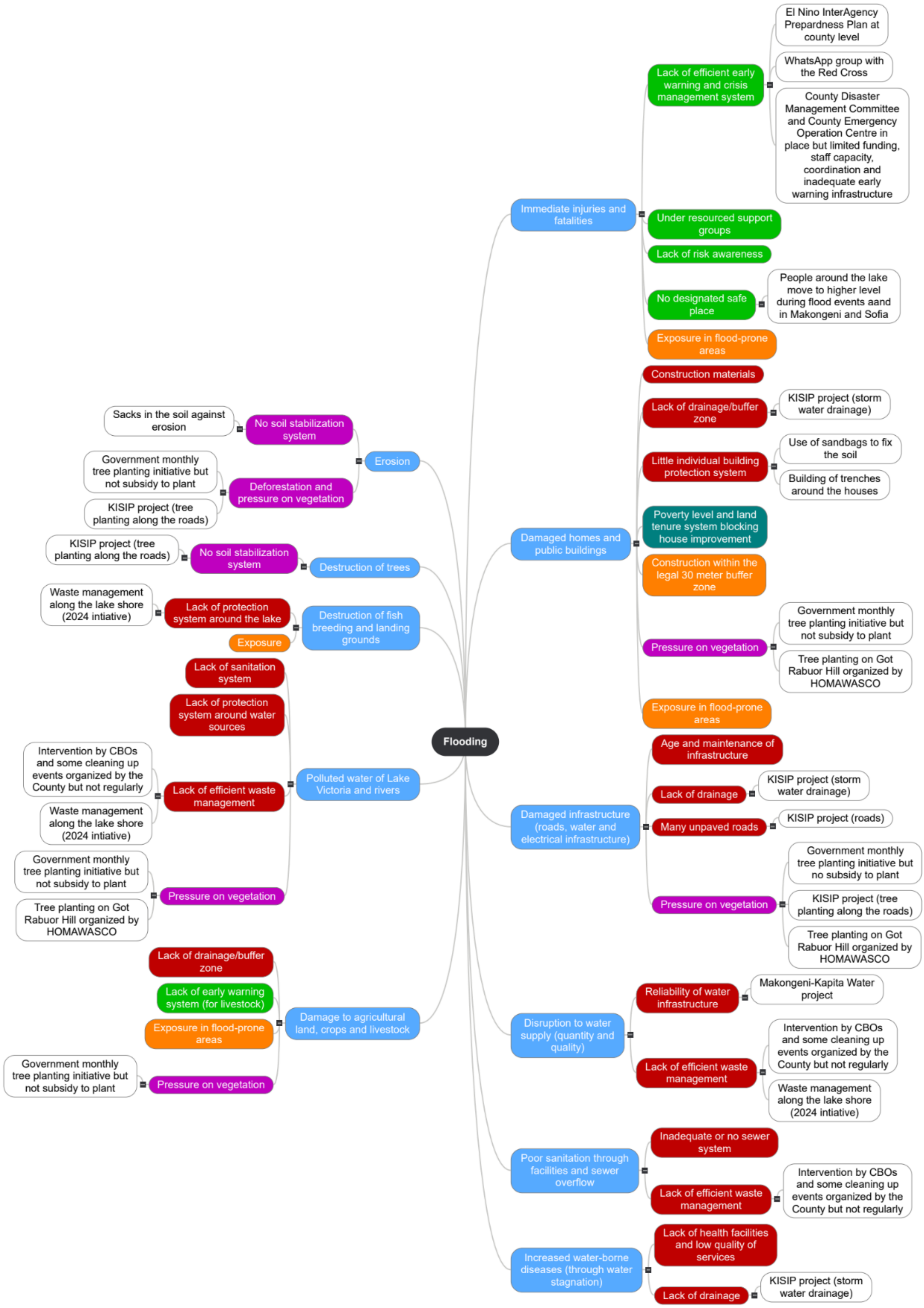
The direct impacts highlighted in section 3.2.3 are taken here with associated existing vulnerabilities/exposure and existing adaptation actions as mentioned during the community validation workshops and stakeholder interviews. They are presented as a chain to show the interlinkages and gaps to be filled as part of the future adaptation strategies of the three settlements. The chain is structured as follows:



Results can be found below. Vulnerabilities connected to drought are mainly infrastructural (water access) and institutional (in particular knowledge on climate resilient agriculture practices). When it comes to flooding, there is a predominance of infrastructure vulnerabilities: this is where adaptation actions will have to focus mostly, but other measures addressing institutional vulnerabilities, geophysical vulnerabilities (vegetation) and exposure will also have to be integrated into the future strategies. Equally, this chain doesn't take the indirect impacts from hazards, where important and cost-effective measures could also be explored.

The chain shows important gaps with no measures taken to address several vulnerabilities. Existing measures also have their own limitations, including limited scale (e.g. KISIP projects), lack of effectiveness and implementation (e.g. disaster management, tree planting) and even maladaptation (e.g. water sources being used). Cross-cutting to all these vulnerabilities is the limited capacity of institutional actors in terms of financial and human resources which impede significantly the action.




Flooding
Immediate injuries and fatalities
Lack of efficient early warning and crisis management system
El Nino InterAgency Prepardness Plan at county level
WhatsApp group with the Red Cross
County Disaster Management Committee and County Emergency Operation Centre in place but limited funding, staff capacity, coordination and inadequate early warning infrastructure
Under resourced support groups
Lack of risk awareness
No designated safe place
People around the lake move to higher level during flood events aand in Makongeni and Sofia
Exposure in flood-prone areas
Damaged homes and public buildings
Construction materials
Lack of drainage/buffer zone
KISIP project (storm water drainage)
Little individual building protection system
Use of sandbags to fix the soil
Building of trenches around the houses
Poverty level and land tenure system blocking house improvement
Construction within the legal 30 meter buffer zone
Pressure on vegetation
Government monthly tree planting initiative but not subsidy to plant
Tree planting on Got Rabuor Hill organized by HOMAWASCO
Exposure in flood-prone areas
Damaged infrastructure (roads, water and electrical infrastructure)
Age and maintenance of infrastructure
Lack of drainage
KISIP project (storm water drainage)
Many unpaved roads
KISIP project (roads)
Pressure on vegetation
Government monthly tree planting initiative but no subsidy to plant
KISIP project (tree planting along the roads)
Tree planting on Got Rabuor Hill organized by HOMAWASCO
Disruption to water supply (quantity and quality)
Reliability of water infrastructure
Makongeni-Kapita Water project
Lack of efficient waste management
Intervention by CBOs and some cleaning up events organized by the County but not regularly
Waste management along the lake shore (2024 intiative)
Poor sanitation through facilities and sewer overflow
Inadequate or no sewer system
Lack of efficient waste management
Intervention by CBOs and some cleaning up events organized by the County but not regularly
Increased water-borne diseases (through water stagnation)
Lack of health facilities and low quality of services
Lack of drainage
KISIP project (storm water drainage)
Erosion
No soil stabilization system
Sacks in the soil against erosion
Deforestation and pressure on vegetation
Government monthly tree planting initiative but not subsidy to plant
KISIP project (tree planting along the roads)
Destruction of trees
No soil stabilization system
KISIP project (tree planting along the roads)
Destruction of fish breeding and landing grounds
Lack of protection system around the lake
Waste management along the lake shore (2024 intiative)
Exposure
Polluted water of Lake Victoria and rivers
Lack of sanitation system
Lack of protection system around water sources
Lack of efficient waste management
Intervention by CBOs and some cleaning up events organized by the County but not regularly
Waste management along the lake shore (2024 intiative)
Pressure on vegetation
Government monthly tree planting initiative but not subsidy to plant
Tree planting on Got Rabuor Hill organized by HOMAWASCO
Damage to agricultural land, crops and livestock
Lack of drainage/buffer zone
Lack of early warning system (for livestock)
Exposure in flood-prone areas
Pressure on vegetation
Government monthly tree planting initiative but not subsidy to plant

6. CONCLUSION

This report has demonstrated that the informal settlements of Homa Bay Municipality, namely Shauri Yako, Sofia and Makongeni, stand at the frontline of climate change impacts. The communities inhabiting these areas are not only witnesses but daily bearers of its consequences, as evidenced by the data-driven analysis and field-based validation. The realities of climate change in Homa Bay are not distant projections, but lived experiences, shaped by the intersection of environmental fragilities and entrenched socio-economic challenges.

The analysis has shown that the municipality is already experiencing significant shifts in climate patterns. Temperature increases, both observed and projected and extreme heat becomes more frequent and prolonged. Meanwhile, rainfall displays no consistent trend in annual totals but has become markedly more erratic, with a growing incidence of extreme precipitation events and unpredictability of hazards at times resulting in severe consequences, including loss of life and significant damage on infrastructure and livelihoods.

Among them, flooding clearly emerges as the most consequential, inflicting damage not only on homes, but also on ecosystems and essential public services.

However, the analysis also clearly demonstrated that, although overall the settlements are similarly affected, they exhibit important differences primarily due to their geographic positioning, but also owing to subtle socio-economic and demographic variations. This was further illustrated through the hydrologic and hydraulic modelling, which mapped flood exposure across micro-catchments and cross-referenced it with settlement-level vulnerabilities. By simulating peak discharge scenarios and overlaying them with local topography, infrastructure layouts, and drainage conditions, the study captured the differentiated nature of flood risks, highlighting, for instance, the exposure of Shauri Yako's dense lowlands and the erosion-prone slopes of Makongeni.

In terms of exposure, the assessment reveals that schools, health facilities, roads, and infrastructure assets are frequently situated in high-risk zones, especially in Shauri Yako and Makongeni. Sofia, while less physically exposed to flooding, faces its own share of risks, most notably water access constraints and heat-related discomfort. The participatory process aligned strongly with these findings, confirming that flooding is a recurrent and intensifying challenge across all three settlements.

Yet it is not exposure alone that determines the scale of risk, but it is the complex layering of vulnerabilities that amplifies it. These include fragile housing structures, limited-service provision, insecure tenure, and deeply embedded social inequalities.

In this context, the analysis underscores the heightened importance of accounting for the differentiated needs and constraints of vulnerable groups in adaptation planning. Women, in particular, face disproportionate burdens due to unequal land rights, restricted access to decision-making spaces, and the added pressures of water collection and caregiving responsibilities. These vulnerabilities are compounded by infrastructural and institutional gaps that weaken communities' ability to cope and recover.

One of the most striking insights from the field is the central role of water, simultaneously a hazard during floods and a stressor during dry seasons. Water insecurity, whether through contamination, scarcity, or poor distribution, emerged as a major axis of both risk and daily hardship.

Beyond individual shocks, the assessment mapped chains of cascading impacts, highlighting that, despite spatial modelling and mapped risk zones, climate change does not adhere to boundaries. Water runoff, infrastructure failure, or service disruption can originate in one area and spill over into others, underscoring the interconnected nature of urban systems. With a particular emphasis on the consequences of flooding, the analysis shows how a single event can trigger road inaccessibility, school closures, disruption of health services, and significant income loss, especially for informal workers and traders. In parallel, drought, though perceived as less immediate, remains a tangible and recurrent stressor, contributing to reduced agricultural productivity, strained water access, and rising tensions around shared resources. Such interdependencies reinforce the systemic nature of climate vulnerability in informal urban settings and signal the need for holistic, cross-sectoral responses, tailored to the specific realities and informal dynamics of these settlements.

It is in this sense that the analysis has underscored that Homa Bay County, from a climate and urban governance perspective, is equipped with a number of planning frameworks that reflect a growing awareness of climate challenges. However, these tools, while ambitious in their vision, remain constrained by a series of structural challenges. They are often underfunded, insufficiently tailored to the realities of informal settlements, and difficult to implement due to institutional fragmentation and limited technical capacity, particularly at more localized scales, namely that of the municipality, where implementation capacity remains especially constrained. Most critically, the climate finance landscape remains too juvenile to effectively support timely, locally anchored adaptation.

Against this backdrop, the need for concrete, layered, and inclusive recommendations becomes clear. These should aim not only to reduce exposure to hazards and tackle systemic vulnerabilities, but also to do so in ways that put equity, community leadership, and long-term resilience at the center. Whether through infrastructure improvements, nature-based solutions, stronger institutions, or more inclusive planning processes, the path to resilience must be grounded in both scientific understanding and the lived realities of the people most affected.

7. MAIN RECOMMENDATIONS

This section outlines strategic recommendations to reduce climate-related risks and enhance the resilience of Shauri Yako, Sofia and Makongeni.

1. Improve essential services to communities with a climate lens

Overwhelming needs highlighted by the communities in the three settlements focused on water supply, sanitation and waste management. It would be a mistake to address those needs without applying a climate lens to them when working on improving these essential services. For example, developing water pipelines in flood-prone or erosive areas without incorporating climate proofed materials would undermine the sustainability of the investment. Skills must be strengthened on climate resilient techniques to ensure engineers have the know-how to develop climate-proof infrastructure.

Quick-win actionable actions
➢ Strengthen collaboration with the Kenya Meteorological Department (KMD) to ensure timely access to localized climate data, early warning alerts, and seasonal forecasts. ➢ Elevate water pipelines in flood-prone areas to reduce contamination and service disruption. ➢ Use corrosion- and flood-resistant materials for critical water and sewer lines. ➢ Install communal rainwater harvesting systems in schools and clinics. ➢ Train municipal engineers in climate-resilient WASH (Water, Sanitation and Hygiene) design.

2. Accompany future urban development with sensitization on climate risks

Homa Bay Town is developing at a fast speed. This urbanization must go hand-in-hand with regulation enforcement of the 30-meter buffer zone and the inclusion of the flood prone areas identified in this study in urban development planning. While current settlement residents are well aware of the risks and zones that are exposed, newcomers must be sensitized to the risks and resilient alternatives must be explored.

Quick-win actionable actions
➢ Include flood-risk maps in building permit procedures and enforce buffer zone regulations. ➢ Conduct quarterly community sensitization sessions for new settlers with local leaders and youth groups. ➢ Display "high-risk zone" signage in key flood-prone areas.

3. Address direct and indirect impacts from climate hazards

While future investment and planning decisions will naturally look at the direct impacts from climate hazards (on infrastructure, housing, roads, etc.), actions on the indirect impacts must not be overlooked due to high cost-benefits that are associated: early warning systems, reinforcement of community support groups, improvement of health services, income diversification, information campaign, pricing regulation, specific actions targeting women and girls, are all actions that can have positive impact at a lower cost.

Quick-win actionable actions
➢ Establish early warning systems using SMS alerts and loudspeakers in each settlement ➢ Enhanced use, access and control over land and land-related resources for women: this includes advocating for and implementing policies and practices that ensure secure land tenure and ownership rights for women ➢ Establishing accessible and gender-responsive climate finance mechanisms that promote women-led initiatives. This also includes enhancing women's access to loans, microfinance and grants to support climate adaptation initiatives such as house improvements or replacing business stock after climate-related losses ➢ Strengthen youth and women's capacity and knowledge: this includes promoting various economic empowerment programs that build women's and girls' adaptive capacities such as diversification of livelihoods which involves supporting women and girls in developing

alternative climate-resilient livelihoods that are less dependent on climate sensitive sectors such as fishing and agriculture. This could be done trough partnership with local organizations.
- Integrating gender lens in WASH infrastructure and management, particularly to address water insecurity which is a daily vulnerability risk for women and girls. In addition to prioritizing the development and upgrade of water infrastructure, this includes the involvement of women and girls in the design of these facilities to ensure they are accessible, safe and meet their various needs
- Strengthen women's leadership and participation in climate governance and decision-making through meaningful inclusion in planning processes, capacity building, design and implementation of projects. This leads to more effective and equitable climate solutions.
- Strengthen social protection and safety nets that enable vulnerable households, particularly female-headed households to cope with climate shocks. This involves the integration of GBV prevention and response mechanisms, recognizing that climate hazards exacerbate gender-based violence

4. Integrate climate risk in all new urban projects

All future urban development initiatives should undergo climate risk screening at the planning and design stages, with regularly updated hazard maps, flood buffers, and exposure data fully integrated into project design. Currently, some developing projects in Homa Bay, especially in Shauri Yako, construct infrastructure in flood-prone areas, undermining their long-term functionality and safety.

Quick-win actionable actions
- Regularly update climate risk tools.
- Mandate use of hydrological and exposure maps in feasibility studies.
- Add a climate risk review step in project approvals at municipal level.
- Train planning officers and consultants on climate risk integration (1-day practical workshops).

5. Move beyond zoning: plan for interconnected systems

Avoiding treating climate change as a spatially isolated issue is crucial. The assessment demonstrates that infrastructure, services, people, etc., across settlements are highly interconnected – functionally, socially and physically. Urban resilient planning should account for these interdependencies. Adaptation strategies must extend beyond zoning and administrative limits to reflect actual service areas, access routes, and social linkages. To this aim, the role of the municipality and the county will be essential to ensure a systemic approach.

Quick-win actionable actions
- Map inter-settlement infrastructure dependencies (e.g., shared access roads, clinics).
- Include informal settlements in broader municipal spatial plans.
- Coordinate with neighboring wards to identify shared adaptation investments.

6. Ensure flood-resilient urban design along the lakeshore

Develop and enforce lakeside development guidelines that include "hydraulic transparency" principles (e.g., permeable surfaces, natural buffers, vegetation barriers) to improve drainage and reduce flood risk. Avoid compacting soils or blocking natural runoff paths near the lake.
In lakeside settlements like Makongeni and Shauri Yako, urban projects must account for lake overflow, runoff patterns, and saturation of the surrounding soils. The failure to do so risks aggravating contamination, flooding, and erosion—especially for critical facilities like sewerage plants, markets, or health centers.

Quick-win actionable actions
- Introduce regulations requiring permeable surfaces for all new lakeside development.
- Pilot small green buffer zones (e.g., vetiver grass, tree belts) near lakeside housing.

- Audit and unblock natural drainage channels along the lakefront

7. Secure critical infrastructure against erosion and extreme events

Map, prioritize, and retrofit critical infrastructure exposed to erosion, flooding, and landslides. Consider relocating high-risk poles, burying cables where feasible, reinforcing pipeline protection, and elevating or shielding sewer junctions to withstand surface runoff and debris.
The exposure assessment highlights damage to electrical poles, sewer lines, and water pipelines—especially in erosion-prone zones around Got Abuor Hill and across Shauri Yako. The failure of these assets can trigger cascading impacts across multiple services, including power cuts, water contamination, and mobility disruptions.

Quick-win actionable actions
- Inventory at-risk electric poles and elevate or shield those near erosion zones.

8. Apply risk-sensitive standards for community services

Adopt and enforce siting guidelines that avoid placing clinics, schools, and public spaces in high-risk zones. Future facilities should be located on higher ground or built with resilient design features (e.g., raised floors, elevated toilets, water-resistant materials).
Several health and education facilities in the three settlements are located within flood paths or drainage channels. In addition to direct exposure, poor access during flood events compromises essential service delivery.

Quick-win actionable actions
- Update siting guidelines for new health and education facilities with climate risk maps.
- Add flood-resistant toilets and water tanks to existing public institutions.

9. Harmonize urban development

Prioritize infrastructure extension (such as open public places) in low-density settlements like Sofia but ensure that design and placement incorporate climate hazard maps and community inputs.
In Sofia, limited infrastructure reduces exposure concentration—but also increases the risk of service isolation during extreme events, particularly in the southern zone. Lack of piped water and sanitation systems may force residents to rely on unsafe sources, worsening vulnerability during droughts and floods.

Quick-win actionable actions
- Prioritize piped water and drainage investments.
- Use modular infrastructure (e.g., mobile toilets, community water kiosks) that can be quickly deployed or upgraded.

10. Build local capacity for operation and maintenance

Develop local maintenance protocols and training programs for landlords, community-based organizations and municipal/county staff. Strengthen the operational capacity of service providers like HOMAWASCO and promote accountability mechanisms with local stakeholders (e.g., user-reporting tools, hotline systems).
Community members repeatedly flagged poor maintenance of infrastructure—such as open sewer lines, blocked drains, and exposed electric poles—as a key risk amplifier.

Quick-win actionable actions
- Develop O&M manuals for basic WASH and electrical infrastructure.
- Set up a reporting hotline or WhatsApp group for residents to flag damaged infrastructure.
- Train youth groups in basic maintenance tasks (e.g., clearing blocked drains).

11. Secure funding to launch much-needed investments

Several funding streams are already available in Homa Bay—such as county allocations, FLLoCA, KISIP, etc. However, to ensure these investments effectively address climate risks and community priorities, it is essential to strengthen coordination across funding mechanisms, improve technical and institutional capacity for fund absorption, and ensure alignment with the resilience priorities identified in this assessment. An assessment of the current funding system in Homa Bay and support to secure additional funding must be a prerequisite.

Quick-win actionable actions ➢ Assess the current funding system in Homa Bay. ➢ Establish simple monitoring, reporting, and evaluation frameworks to track how funds are used and their impact on resilience, enabling transparency and continuous improvement. ➢ Build capacity to access and manage climate finance. ➢ Develop 3–5 "bankable" climate resilience project proposals for donor funding. ➢ Partner with NGOs or multilateral actors to co-finance local infrastructure upgrades.

12. Adopt gender-responsive climate action

Women and girls in Shauri Yako, Makongeni, and Sofia face heightened and distinct vulnerabilities to climate change due to pre-existing socio-economic inequalities, including unequal land ownership, restricted decision-making power, and their central role in managing household and caregiving needs. It is therefore imperative that climate resilience initiatives adopt a gender-responsive approach that actively and specifically address these specific challenges. This will ensure that climate resilience efforts in Homa Bay are more equitable, effective, and sustainable.za

Quick-win actionable actions ➢ Establish women's climate forums to guide gendered priorities. ➢ Design water points and sanitation facilities with gender-specific safety features. ➢ Ensure women's representation in all local resilience committees and project design reviews.

8. ANNEXES

ANNEX 1. BIBLIOGRAPHY

ADA Consortium. [Online]. Accessed 10/06/2024]. Available at: https://adaconsortium.org/about?

Aholi, J. P., Makokha, M., and Obiero, K., 2024: Extreme Weather Events in Kenya between 2011 and 2020. Kenya Meteorological Department. [Online]. [Accessed 23/04/25]. Available at: http://www.meteo.go.ke/

AMT, 2025. *Makongeni Situational Analysis Report*.

AMT, 2025. *Shauri Yako Situational Analysis Report*.

AMT, 2025. *Sofia Situational Analysis Report*.

Ara Begum, R., R. Lempert, E. Ali, T.A. Benjaminsen, T. Bernauer, W. Cramer, X. Cui, K. Mach, G. Nagy, N.C. Stenseth, R. Sukumar, and P. Wester, 2022: Point of Departure and Key Concepts. In: *Climate Change 2022: Impacts, Adaptation and Vulnerability.* Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 121–196, doi:10.1017/9781009325844.003.

Biodiversity Atlas of Kenya, n.d.: Shrublands. Biodiversity Atlas of Kenya. [Online]. [Accessed 23/03/25]. Available at: https://biodiversityatlasofkenya.org/ecosystems/shrublands/

Cardona, O.D., M.K. van Aalst, J. Birkmann, M. Fordham, G. McGregor, R. Perez, R.S. Pulwarty, E.L.F. Schipper, and B.T. Sinh, 2012: *Determinants of risk: exposure and vulnerability. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 65-108.

Castañeda Carney, I., Sabater, L., Owren, C., Boyer, A.E. and Wen, J. (2020). Gender-based violence and environment linkages. [online] portals.iucn.org. IUCN. Available at: https://portals.iucn.org/library/node/48969.

Climat Centre. (2021). Climate fact sheet Kenya. https://www.climatecentre.org/wp-content/uploads/RCCC-ICRC-Country-profiles-Kenya.pdf

County Government of Homa Bay (2023). *County Government of Homa Bay Participatory Climate Risk Assessment Report (Kenya)*: 2023

County Government of Homa Bay, 2023. County Government of Homa Bay Climate Change Action Plan (Kenya), 2023–2027

County Government of Homa Bay, 2023. County Integrated Development Plan 2023–2027.

County Government of Homa Bay, 2023. El Niño Inter-Agency Preparedness Plan 2023–2026.

County Government of Homa Bay, 2023: Homa Bay County Urban Institutional Development Strategy (CUIDS) 2023–2026

County Government of Homa Bay, 2023: Participatory Climate Risk Assessment Report (Kenya)

County Government of Homa Bay, 2025: Annual Development Plan FY 2025/2026. Homa Bay County.

Dine, Faizal & Gasmi, Skander. (2024). *Strengthening Critical Infrastructure for Enhanced Urban Resilience Against Natural Disasters*. 10.13140/RG.2.2.25565.01769.

Global Partners for Development, 2024: The Homa Bay Blueprint: A Paradigm Shift in Global Sanitation. [Online]. [Accessed 14/05/25]. Available at: https://gpfd.org/homa-bay-blueprint/

IPCC. (2022). Climate resilient development: Introduction (Chapter 1). In Sixth Assessment Report – Working Group II: Impacts, Adaptation and Vulnerability: https://www.ipcc.ch/report/ar6/wg2/chapter/chapter-1/

Iskandar, I., Anas, A., Bahri, S., Menne, F., & Baharuddin, T. (2024). Social vulnerability and climate change: a bibliometric analysis. Cogent Social Sciences, 10(1). https://doi.org/10.1080/23311886.2024.2402849

Jama, Z., 2023: How Homa Bay County has prepared for El Niño rains. Citizen Digital, 20 September 2023. [Online]. [Accessed 23/04/25]. Available at: https://citizen.digital/news/how-homa-bay-county-has-prepared-for-el-nino-rains-n327728

Kenya Meteorological Department, 2024: State of the Climate Kenya 2024. [Online]. [Accessed 23/04/25]. Available at: https://meteo.go.ke/sites/default/files/downloads/State%20of%20the%20Climate%20Kenya%202024_v1.pdf

Khalid, A.K.M. and Adam, R., 2024: Applying a Gender Lens on the Impacts of Climate Change on Fisher Communities in Kenya's Lake Victoria Zone Region. WorldFish. [Online]. [Accessed 17/03/25]. Available at: https://worldfishcenter.org/blog/applying-gender-lens-impacts-climate-change-fisher-communities-kenyas-lake-victoria-zone

KISIP, April 2024. *Environment and Social Impact Assessment of infrastructure upgrading of Sofia Informal Settlement Located in Homa Bay County*. https://www.kisip.go.ke/sites/default/files/2024-06/Sofia%20ESIA-%20Report.pdf

KISIP, April 2024. *Environment and Social Impact Assessment of infrastructure upgrading of Makongeni Informal Settlement Located in Homa Bay County*. https://www.kisip.go.ke/sites/default/files/2024-06/Makongeni%20ESIA-%20Report.pdf

KISIP, April 2024. *Environment and Social Impact Assessment of infrastructure upgrading of Shauri Yako Informal Settlement Located in Homa Bay County*. https://www.kisip.go.ke/sites/default/files/2024-06/Shauri%20Yako%20ESIA-%20Report.pdf

Langat, D., 2024: Sewerage Stench Hovers Over Homa Bay Town. Kenya News Agency for Development. [Online]. [Accessed 14/05/25]. Available at: https://www.kenyanews.go.ke/sewerage-stench-hovers-over-homa-bay-town/

ND-GAIN (Notre-Dame Global Adaptation Index). (2022). Kenya | ND-GAIN Index. Consulted on February 28, 2025. https://gain.nd.edu/our-work/country-index/rankings/

Ngoleka, S., and al., April 2018. Assessment of rural livelihoods in a lakeside community, NB, Homa Bay, Kenya. Walker Institute, HyCristal, Evidence for Development.

Odhengo, P., Korir, H., Muthini, D., Moturi, W., Mazza, F., Van Caenegem, H., Balm, A., Mwangi, C., Mwithiga, L., Njoroge, S., and Wambua, M., 2021: The Landscape of Climate Finance in Kenya: On the Road to Implementing Kenya's NDC. The National Treasury, Climate Policy Initiative, and Kenya Climate Innovation Centre, Nairobi, Kenya

Odhiambo, T. M., 2013: Effects of Weather and Climate Variability on Fishing Activities and Fishers' Adaptive Capacity in Mbita Division, Homa Bay County, Kenya. Master's thesis, Kenyatta University

Otieno, J. O., Obosi, J. O., and Magutu, J. M., 2023: The Impact of Devolution Policy on Water Service Delivery in Kenya. Journal of Public Policy and Administration, 7(3), pp. 127–140.

Owuor, S., & Foeken, D. W. J. (2012). Water interventions for the urban poor: the case of Homa Bay, Kenya. Asc Working Paper Series, (107). Retrieved from https://hdl.handle.net/1887/20247

Suez Consulting, 2025. *Risk and vulnerability assessment validation workshop notes*.

Uhe, P., Philip, S., Kew, S., Shah, K., Kimutai, J., Mwangi, E., van Oldenborgh, G. J., Singh, R., Arrighi, J., Jjemba, E., Cullen, H., and Otto, F., 2017: Attributing drivers of the 2016 Kenyan drought. Royal Meteorological Society. [Online]. [Accessed 25/04/25] Available at: https://rmets.onlinelibrary.wiley.com/doi/10.1002/joc.5389

UN Habitat. 2008. *Strategic Urban Development Plan for Homa Bay Municipality (2008–2030): Strategic Planning for Environmental Governance and Poverty Alleviation*.

UN Women, 2022: Explainer: How Gender Inequality and Climate Change Are Interconnected. [Online]. [Accessed 15/03/25]. Available at: https://www.unwomen.org/en/news-stories/explainer/2022/02/explainer-how-gender-inequality-and-climate-change-are-interconnected.

United Nations Population Fund, 2022: What Women and Girls Need Most as Climate Disasters and Displacement Wreak Havoc Across the World. News release. [Online]. [Accessed 15/03/25]. Available at: https://www.unfpa.org/news/what-women-and-girls-need-most-climate-disasters-and-displacement-wreak-havoc-across-world.

Vanderkelen, I., Van Lipzig, N. P. M., and Thiery, W., 2018: *Modelling the Water Balance of Lake Victoria (East Africa) – Part 2: Future Projections*.

World Bank Group. 2023. Kenya Country Climate and Development Report. © World Bank. http://hdl.handle.net/10986/40572 License: CC BY-NC-ND 3.0 IGO.

World Bank. (2024). *Climate Change Knowledge Portal*. Retrieved from https://climateknowledgeportal.worldbank.org/

World Bank. 2024. *Locally led Climate Action: A World Bank Operational Approach*. Washington DC.

World Bank. *Climate Risk Profile: Kenya* (2021).

World Health Organization, 2022: Ageing and Health. Fact sheet. [Online]. [Accessed 10/03/25]. Available at: https://www.who.int/news-room/fact-sheets/detail/ageing-and-health

World Resources Institute (WRI), 2024. *Aqueduct Water Risk Atlas*. Retrieved from https://www.wri.org/applications/aqueduct/water-risk-atlas/

Kenya News Agency. (2023). *Pollution blamed for mass fish deaths in L. Victoria*. [Online]. [Accessed 11/06/25], from https://www.kenyanews.go.ke/pollution-blamed-for-mass-fish-deaths-in-l-victoria/

Atieno, S. (2023). *Dwindling fish populations causing conflicts over fishing grounds in Homa Bay, Kenya*. [Online]. [Accessed 11/06/25], from https://pulitzercenter.org/stories/dwindling-fish-populations-causing-conflicts-over-fishing-grounds-homa-bay-kenya

ANNEX 2. HYDROLOGY AND HYDRAULIC STUDY

Methodology

During the inception phase, topographical data from various sources were collected. These data are very important to assess flood risk in the 3 settlements, but not accurate enough to develop a global flood model that would allow accurate flood risk mapping and to assess the impact of climate change.

The collected surveys only cover a few roads and drains, and the broader topographical data (Nasa satellite, SRTM with a resolution of 25m) is too coarse to capture drains and swales.

In order to appropriately define the areas prone to flooding and assessing the associated hazard, the following methodology was used:

- Hydrological modelling. Based on the available topographical, rainfall data and field observations, development of a simple hydrological model to assess the main flow paths and peak flows for the proposed return periods and horizons.
- Hydraulic. Based on the previous step, estimation of water depths along the different flow paths through basic theoretical calculations (using topographical data when available or assumptions when missing).
- Based on these assumptions and calculations, a set of simplified flood maps are produced, estimating the flood extent and highlighting the most problematic areas.
- An assumption on erosion is also be done, using the data from the hydrological modelling, in order to define and map the areas most vulnerable to this hazard.

Main catchments

The map below presents the main catchments and drains for the 3 settlements. To delineate these catchments, topographical data from different sources were used[6][7].

[6] Local topographical surveys provided by Homa Bay Council (Alfajiri Bonde, Shauri Yako swale, Varine Road)

[7] NASA DEM Global Digital Elevation Model. Generated from the Shuttle Radar Topography Mission (SRTM) data.

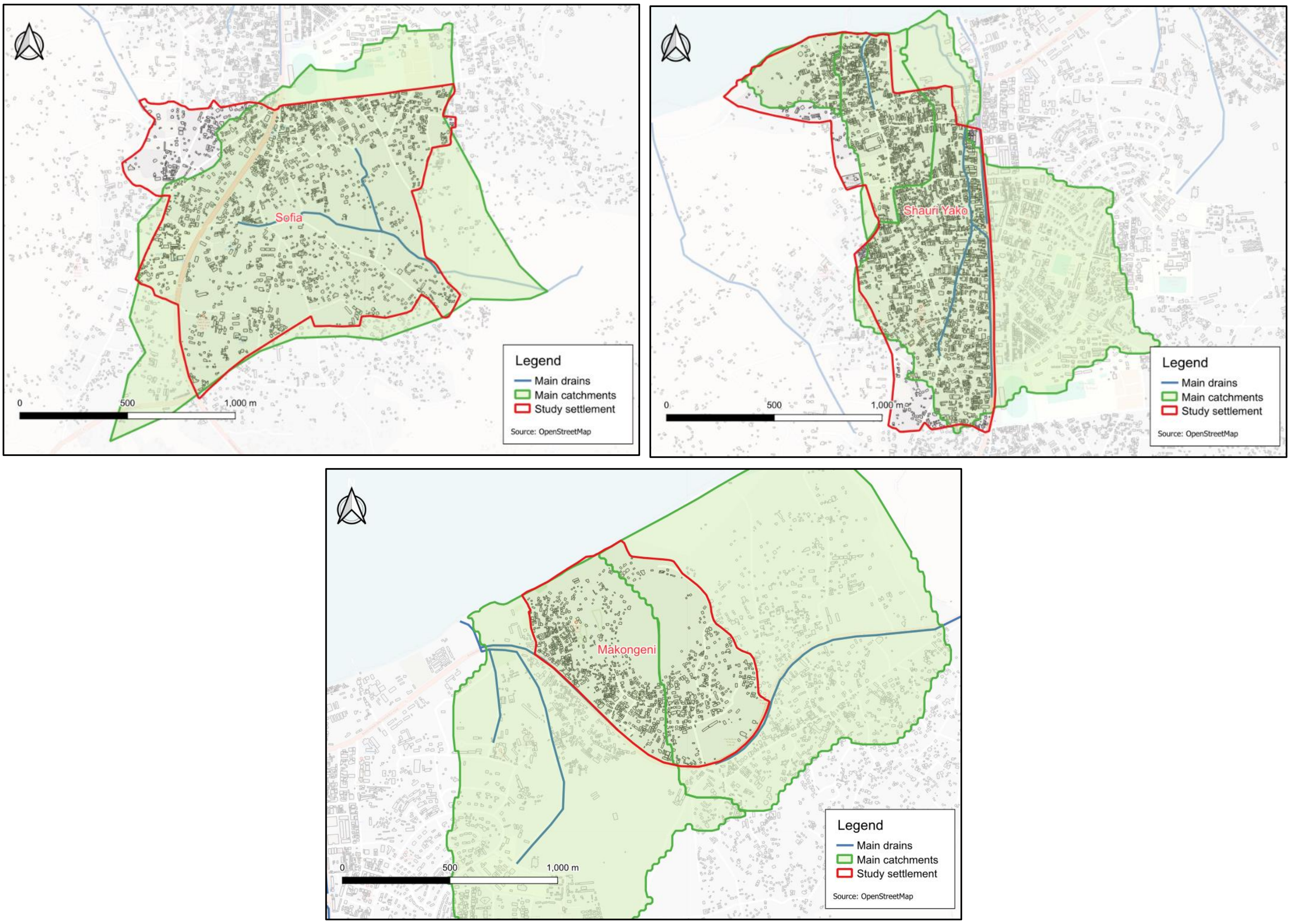


Figure 37: Main catchments and drains for the 3 settlements (Source: SUEZ Consulting, 2025)

The table below present the catchments size and other attributes.

Name	Area (km²)	Level (m) max.	Level (m) min.	Mean Slope
Makongeni East	1.71	1355	1141	10.1%
Makongeni West	1.82	1289	1138	10.7%
Shauri Yako Main	1.29	1254	1167	6.0%
Shauri Yako North	0.28	1178	1137	5.9%
Sofia Main	1.94	1227	1139	5.8%

Table 17: Main catchment attributes (Source: SUEZ Consulting, 2025)

Rainfall

Catchments are relatively small (around 1 km²) and steep (between 5% and 10%). This leads to a quick response to precipitation (from a few minutes to a couple of hours) and make them particularly vulnerable to flash flood.

KMD provided the Intensity Frequency Duration (IFD) curves for the Kisumu Airport meteorological station. This station is located on the other side of the Lake Victoria, roughly 55 km northeast of Homa

Bay City. The station environment and climatic conditions are similar to Homa Bay. Kisumu IFD curves are considered relevant for the city of Homa Bay and are used without adjustment to assess hydrologic conditions in the 3 studied catchments. IFD curves are presented below.

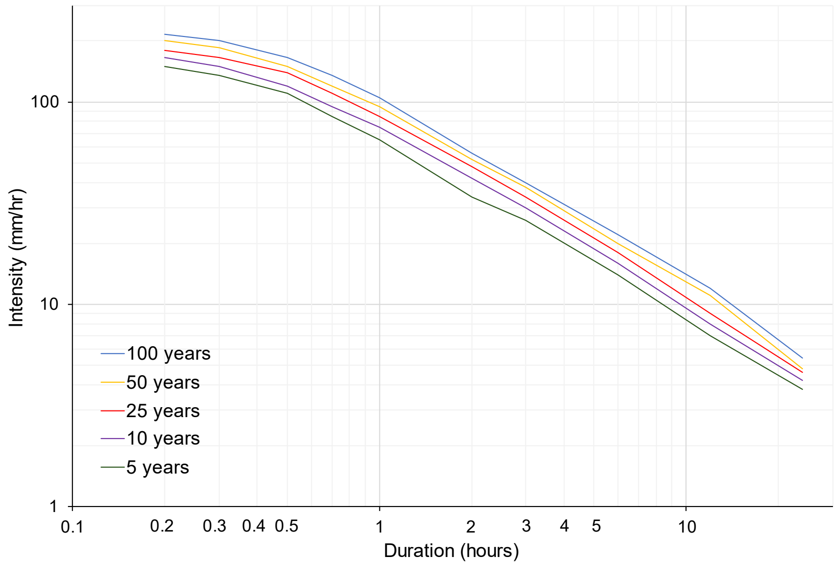


Figure 38: Intensity Frequency Duration (IDF) curves (Source: SUEZ Consulting, 2025)

Land cover

Depending on the land cover, the catchment response can vary significantly. Runoff from roads or concrete surface occurs faster than from vegetation area. This is accounted for in the hydrologic model through an estimate of the land cover, divided in 3 categories, based on satellite imagery:

- Urban areas
- Grass, shrubland
- Vegetation (bush, trees)

The map below shows this division over the studied catchments.

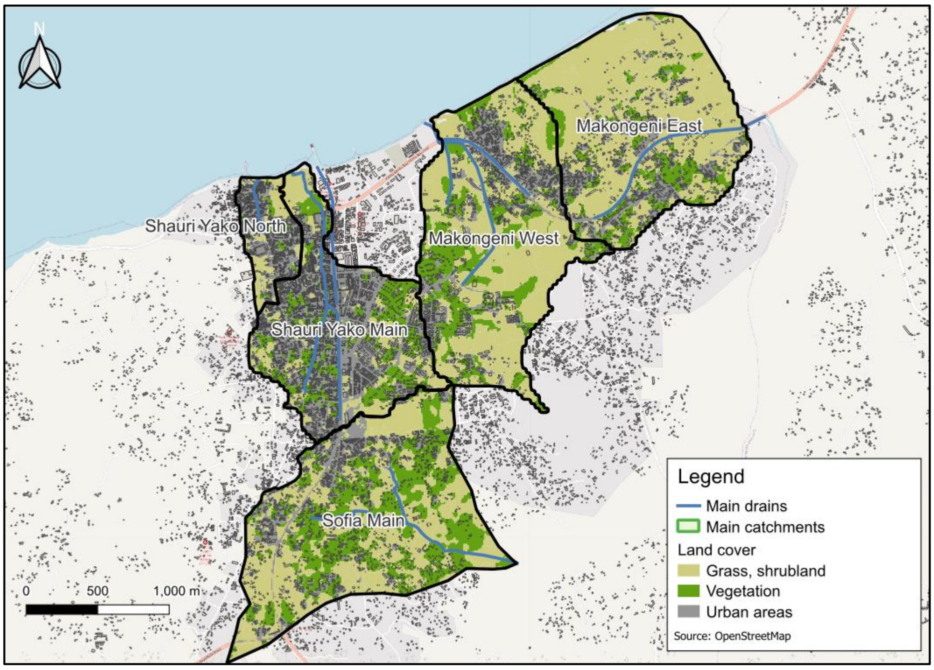


Figure 39:Land cover for the three studied catchment

The table below shows the catchment distribution among these 3 land cover classes. In average, vegetation areas cover around 50% of the total catchment, while urban and grass areas each cover around 25% of the catchments. Shauri Yako catchments are more heavily urbanized (covering about 50 to 60% of the catchments) while Sofia and Makongeni are more vegetated (only 15 to 20% of the catchment is urbanized).

Name	Area (km²)	% Urban area	% Grass, shrubland	% Bush, trees
Makongeni East	1.71	15%	16%	69%
Makongeni West	1.82	19%	26%	54%
Shauri Yako Main	1.29	55%	25%	20%
Shauri Yako North	0.28	62%	8%	29%
Sofia Main	1.94	15%	37%	48%

Table 18: Lanc cover occupation for each catchment (Source: SUEZ Consulting, 2025)

Subcatchment delineation

The 5 catchments are subdivided in several subcatchments, of an average size of 13 hectares. This relatively fine-resolution sub-catchment delineation ensures that where significant overland flow paths exist in the catchment, they are accounted for and incorporated into hazard maps. The subcatchment delineation is shown in figure below, with the associated flow paths.

Figure 40: Sub catchments and flow paths for the three settlements (Source: SUEZ Consulting, 2025)

Flow estimate and hydraulic conditions

For each flow path defined earlier, the flow is estimated for 5 return periods (5, 10, 25, 50 and 100 years) using the following assumptions:

- Time of concentration:
  Time of concentration (Tc) is defined as the time required for runoff to travel from the most remote point in the basin to the basin outlet. Tc is calculated based on the Kirpich's Equation, using the maximum length of water travel (L, in meter) and the slope of the catchment (I, %).
  $$Tc = 0.01947. L^{0.77} I^{-0.385}$$

- Rational coefficient
  Rational coefficient describes the proportion of rainfall that will convert to runoff, depending on the characteristics of the surface. It is used in the rational formula. For frequent events (1 in 5 years and 1 in 10 years, the following were used:
  - Urban areas: Cr = 0.8
  - Grass, shrubland: Cr = 0.5
  - Vegetation (bush, trees): Cr = 0.3

  For bigger events, in order to illustrate the fact that the soil's absorption capacity decreases as it becomes saturated with rain, the following formula is used:
  $$Cr(1\ in\ T) = 0.8\left(1 - \frac{P_0}{Pj(T)}\right)$$
  With Cr the rational coefficient for the T return period, Pj the maximum precipitation over one day for the T return period and P0 defined as followed :
  $$P_0 = \left(1 - \frac{Cr(1\ in\ 10\ year)}{0.8}\right) P_{\square}$$

- Peak flow:
  Peak flow (Q) is estimated using the rational formula. Rational formula relates the discharge to the drainage area (A), the rainfall intensity for the time of concentration (i), and a rational coefficient based on land cover (Cr)
  $$Q = C\ i\ A$$

- Water depth:
  Water depth (H) is estimated using the manning formula. Manning formula. The Manning formula estimate the average depth across the channel using the stream slope and a coefficient (manning coefficient). Due to the lack of accurate topographical data, the following assumptions were made:
  - The channel is assumed to be a rectangular channel, where the used width is the total width of the road (except when topographical data is available)
  - The manning coefficient is n = 0.025

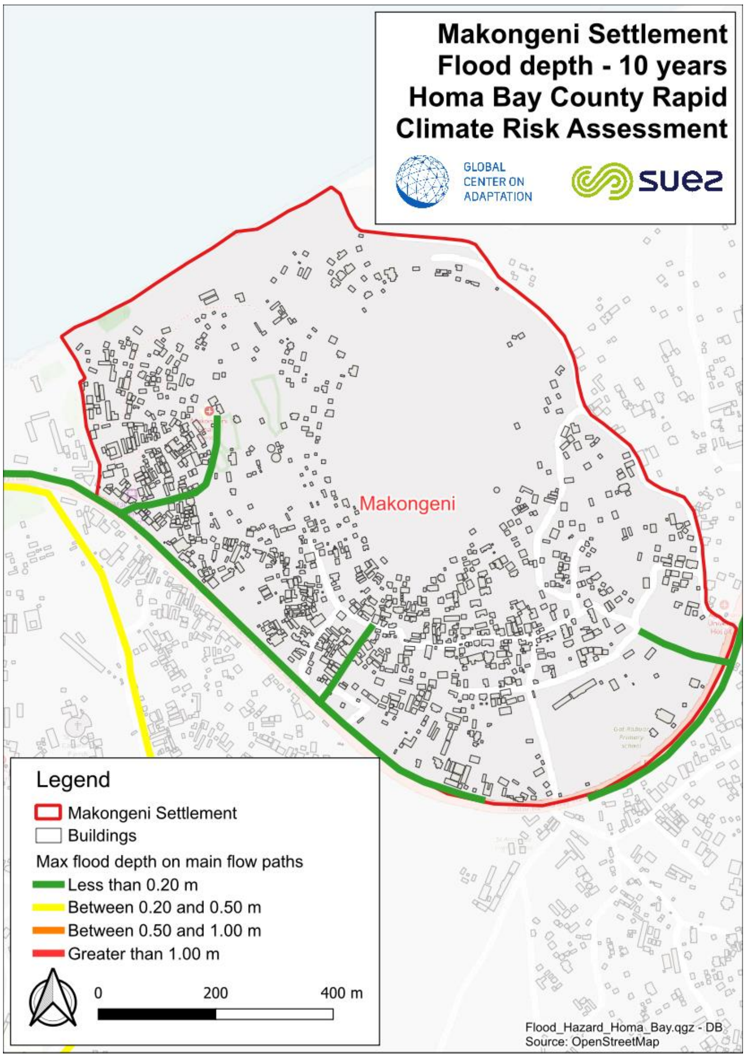
The table below presents for each flow path the peak flow discharge and water depth for each subcatchment for the different return periods.

Name	Depth 5y (m)	Velocity 5y (m/s)	Depth 10y (m)	Velocity 10y (m/s)	Depth 25y (m)	Velocity 25y (m/s)	Depth 50y (m)	Velocity 50y (m/s)	Depth 100y (m)	Velocity 100y (m/s)
Makongeni_Center1	0.06	1.16	0.07	1.20	0.07	1.21	0.07	1.23	0.07	1.26
Makongeni_Center2	0.07	2.36	0.08	2.45	0.08	2.48	0.08	2.52	0.08	2.57
Makongeni_Center3b	0.12	2.16	0.13	2.24	0.13	2.28	0.14	2.32	0.14	2.38
Makongeni_Center4	0.11	2.76	0.12	2.86	0.12	2.91	0.13	2.98	0.13	3.05
Makongeni_Center4b	0.17	2.34	0.18	2.43	0.19	2.47	0.19	2.52	0.20	2.58
Makongeni_East	0.21	2.52	0.22	2.61	0.23	2.68	0.24	2.76	0.25	2.84

Name	Depth 5y (m)	Velocity 5y (m/s)	Depth 10y (m)	Velocity 10y (m/s)	Depth 25y (m)	Velocity 25y (m/s)	Depth 50y (m)	Velocity 50y (m/s)	Depth 100y (m)	Velocity 100y (m/s)
Makongeni_East2	0.08	2.11	0.08	2.19	0.09	2.25	0.09	2.32	0.10	2.40
Makongeni_West1	0.30	3.39	0.32	3.53	0.34	3.64	0.36	3.79	0.38	3.95
Makongeni_West2	0.36	3.31	0.38	3.45	0.40	3.56	0.42	3.69	0.45	3.84
Makongeni_West3	0.12	2.39	0.13	2.48	0.14	2.58	0.15	2.71	0.16	2.84
Makongeni_West4	0.47	5.39	0.50	5.60	0.52	5.76	0.55	5.96	0.58	6.18
ShauriB2_A1	0.13	2.31	0.14	2.40	0.14	2.43	0.14	2.47	0.15	2.51
ShauriB2_A2	0.20	3.01	0.21	3.13	0.22	3.18	0.22	3.24	0.23	3.31
ShauriB2_A3	0.31	3.44	0.33	3.59	0.34	3.64	0.35	3.71	0.36	3.79
ShauriB2_A4	0.40	3.37	0.43	3.51	0.43	3.56	0.45	3.62	0.46	3.69
ShauriB2_A5	0.38	3.59	0.40	3.73	0.41	3.79	0.42	3.86	0.44	3.94
ShauriB2_B	0.27	2.89	0.28	3.00	0.29	3.05	0.30	3.11	0.31	3.18
ShauriNorth_A1	0.24	2.43	0.26	2.53	0.26	2.55	0.26	2.58	0.27	2.61
ShauriNorth_A2	0.23	4.09	0.24	4.25	0.25	4.29	0.25	4.34	0.26	4.40
ShauriWest_A1	0.14	1.76	0.15	1.83	0.15	1.84	0.15	1.86	0.15	1.88
ShauriWest_A2	0.16	2.73	0.17	2.83	0.17	2.87	0.18	2.91	0.18	2.97
ShauriWest_A3	0.18	3.03	0.20	3.15	0.20	3.19	0.20	3.24	0.21	3.30
ShauriWest_B1	0.10	2.30	0.11	2.39	0.11	2.44	0.12	2.51	0.12	2.58
ShauriWest_B2	0.15	2.49	0.16	2.59	0.16	2.63	0.17	2.69	0.17	2.76
ShauriWest_B3	0.22	1.95	0.24	2.03	0.24	2.07	0.25	2.11	0.26	2.16
ShauriWest_C1	0.19	0.92	0.20	0.95	0.20	0.96	0.20	0.97	0.21	0.99
ShauriWest_C2	0.14	2.22	0.15	2.30	0.15	2.33	0.15	2.36	0.15	2.39
ShauriWest_C3	0.24	2.29	0.26	2.38	0.26	2.40	0.27	2.42	0.27	2.45
ShauriWest_D1	0.09	1.48	0.10	1.54	0.10	1.54	0.10	1.55	0.10	1.56
Sofia_A1	0.18	2.80	0.19	2.91	0.20	3.02	0.21	3.16	0.23	3.32
Sofia_A10	0.53	2.81	0.56	2.92	0.59	3.03	0.63	3.17	0.68	3.32
Sofia_A2	0.17	1.55	0.18	1.61	0.19	1.66	0.20	1.73	0.22	1.80
Sofia_A3	0.15	1.52	0.16	1.57	0.16	1.59	0.16	1.62	0.17	1.64
Sofia_A5	0.12	1.95	0.13	2.02	0.14	2.10	0.14	2.19	0.16	2.30
Sofia_A6	0.31	4.07	0.33	4.24	0.35	4.37	0.37	4.55	0.39	4.74
Sofia_A7	0.05	1.40	0.05	1.45	0.06	1.52	0.06	1.60	0.07	1.69
Sofia_A8	0.38	3.69	0.40	3.85	0.42	3.98	0.45	4.15	0.48	4.33
Sofia_A9	0.53	4.32	0.57	4.50	0.60	4.66	0.64	4.85	0.68	5.06
Sofia_B1	0.12	1.12	0.13	1.17	0.13	1.20	0.14	1.24	0.15	1.29
Sofia_B2	0.16	1.77	0.16	1.84	0.17	1.87	0.17	1.91	0.18	1.95
Sofia_B3	0.20	3.13	0.21	3.25	0.22	3.35	0.24	3.47	0.25	3.61

Table 19: Depth and velocity at main flow paths (Source: SUEZ Consulting, 2025)

These results are also presented on the hazard maps below.



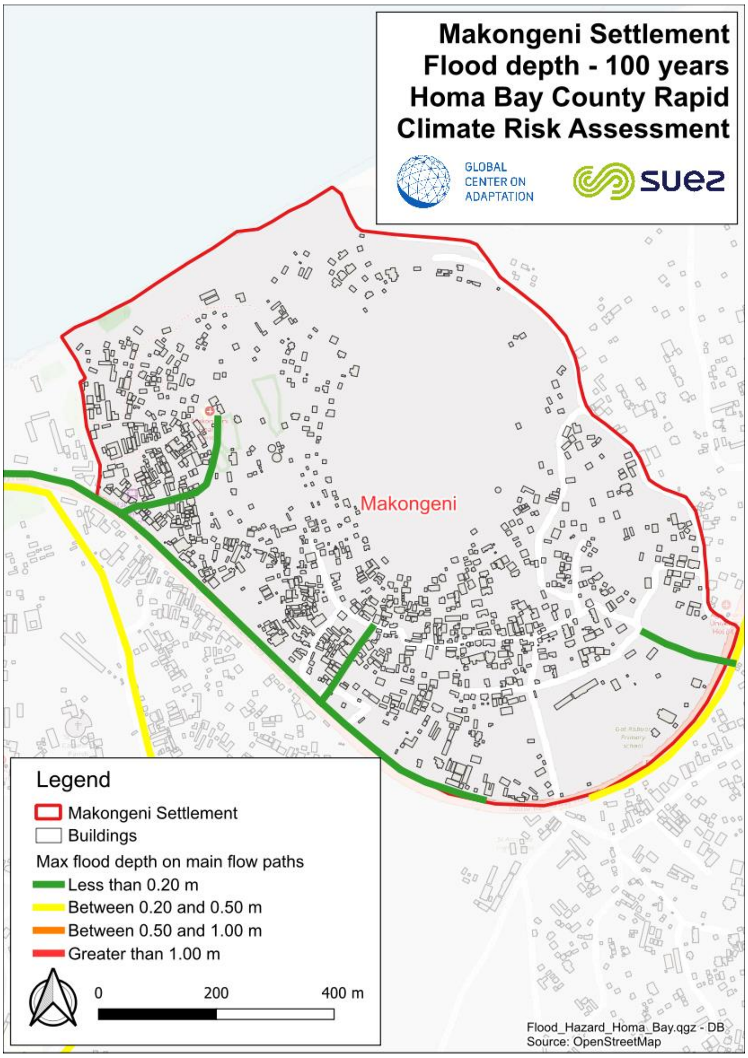
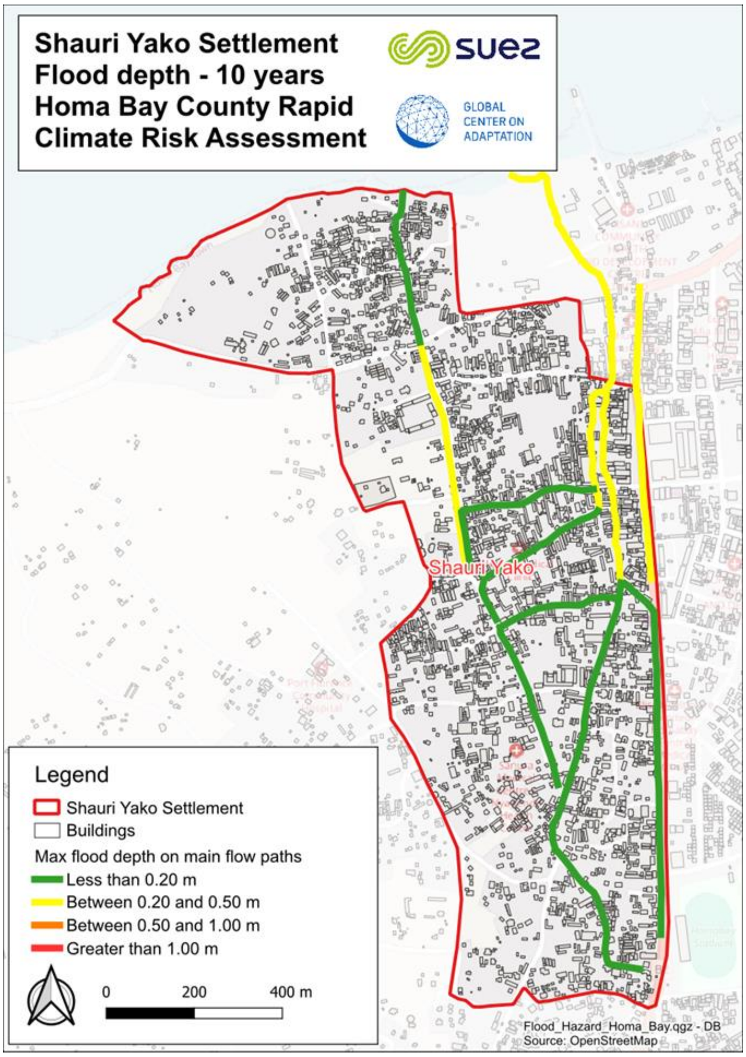


Figure 41: Peak flood depth for the 1 in 10 years event (left) and 1 in 100 years event (right) – Makongeni (Source: SUEZ Consulting, 2025)



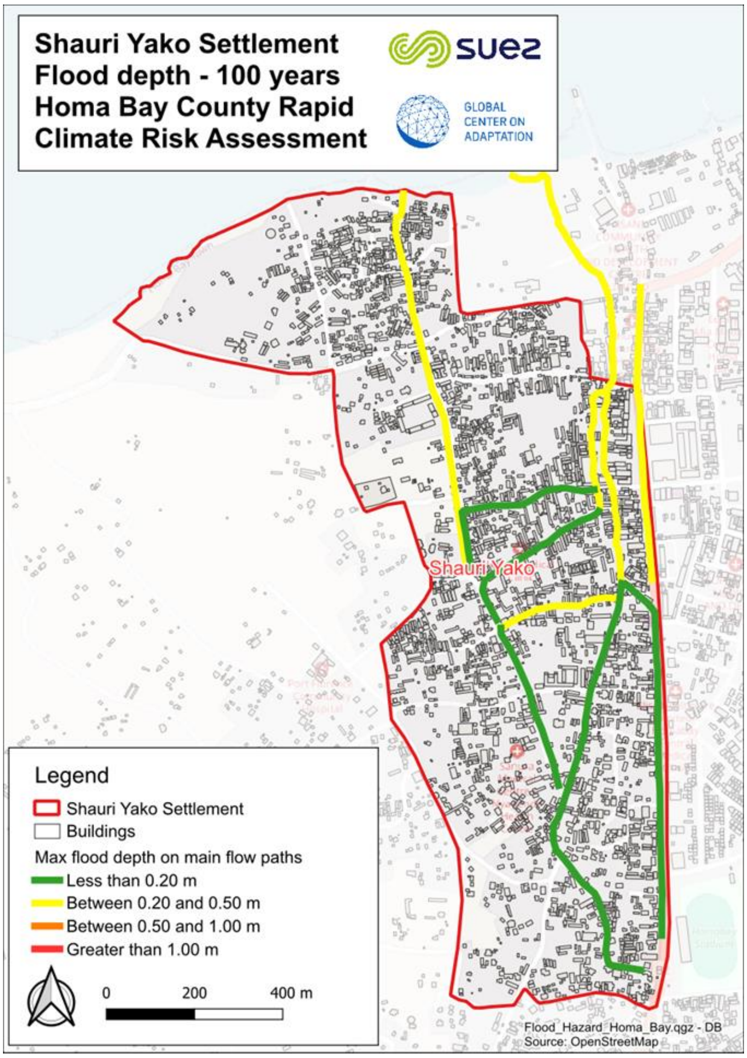


Figure 42: Peak flood depth for the 1 in 10 years event (left) and 1 in 100 years event (right) – Shauri Yako (Source: SUEZ Consulting, 2025)

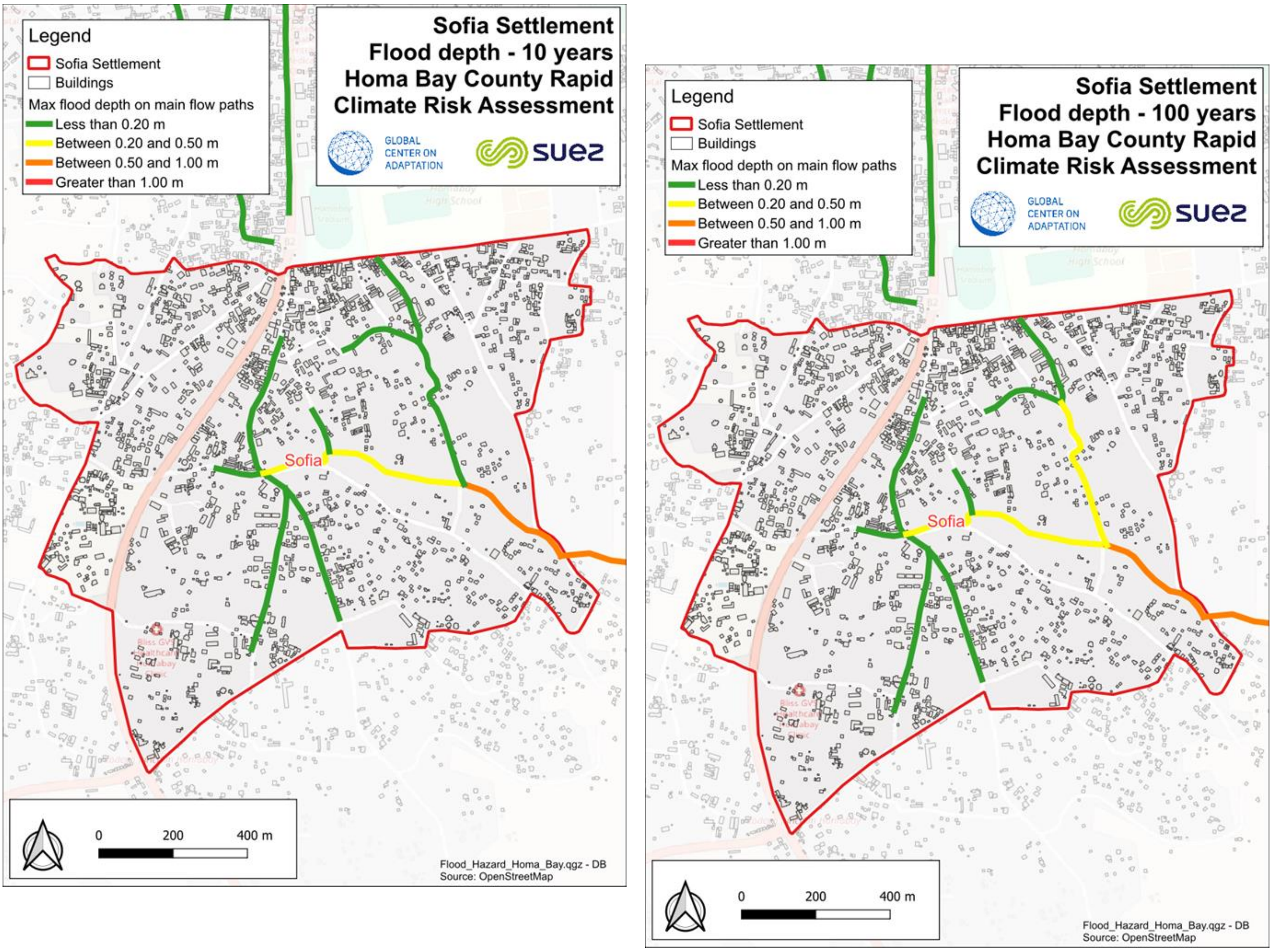


Figure 43: Peak flood depth for the 1 in 10 years event (left) and 1 in 100 years event (right) – Sofia (Source: SUEZ Consulting, 2025)

Due to the nature of flooding (stormwater on steep slopes), peak flood depths rarely exceed 20 or 30 centimetres. Between the 10-year return period flood and the 100-year return period flood, differences remain limited, the water levels only increase by a few centimetres.

Using the peak flood depths maps, some critical areas can be highlighted:

- In Makongeni settlement, the C19 road and the Makongeni Primary School precinct, located in the valley bottom are subject to flood depths exceeding 20 cm for the 100 year return period flood,
- In Shauri Yako settlement, the two drainage swales near the market are subject to significant flooding. The C19 road and the road leading to the pier on the north-west end of the settlement are also sensitive to flood,
- In Sofia settlement, peak flood depths in the main flow path can exceed 50 cm, but far from any existing building.

These statements are consistent with the observed past floods.

Erosion

On the 3 settlements, erosion is the main hazard related to flood is the important erosion, especially on sideroad.

Using the peak flood velocity calculated previously, erosion sensibility is assessed in the following maps.

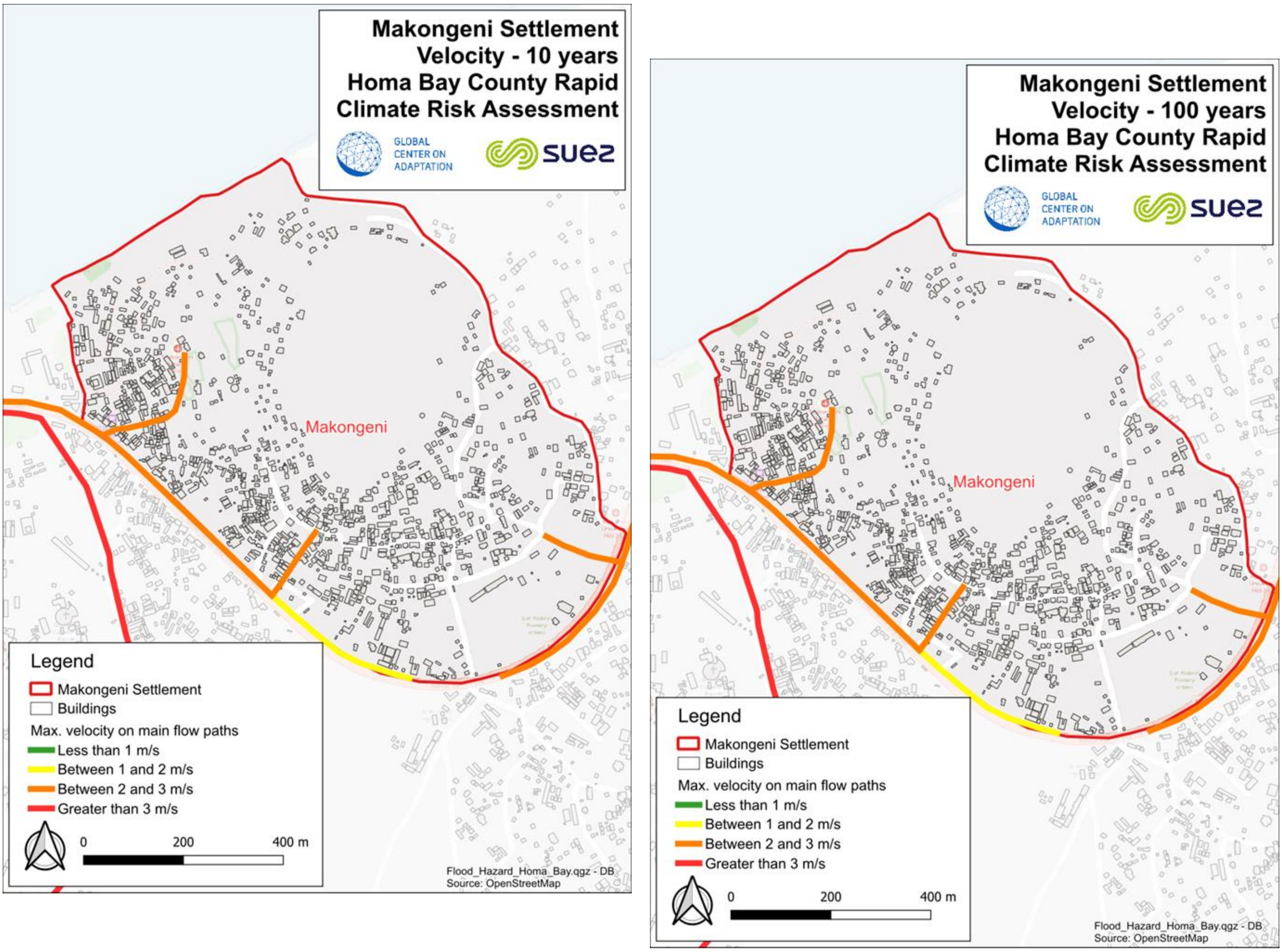
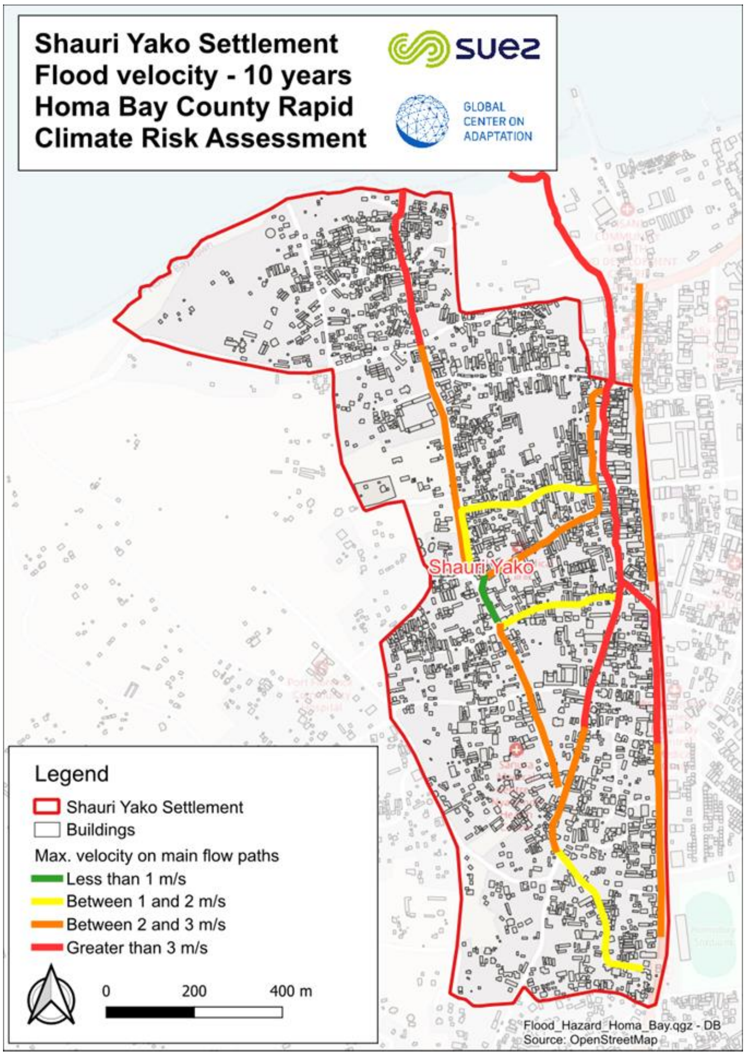


Figure 44: Peak flood velocity for the 1 in 10 years event (left) and 1 in 100 years event (right) – Makongeni (Source: SUEZ Consulting, 2025)



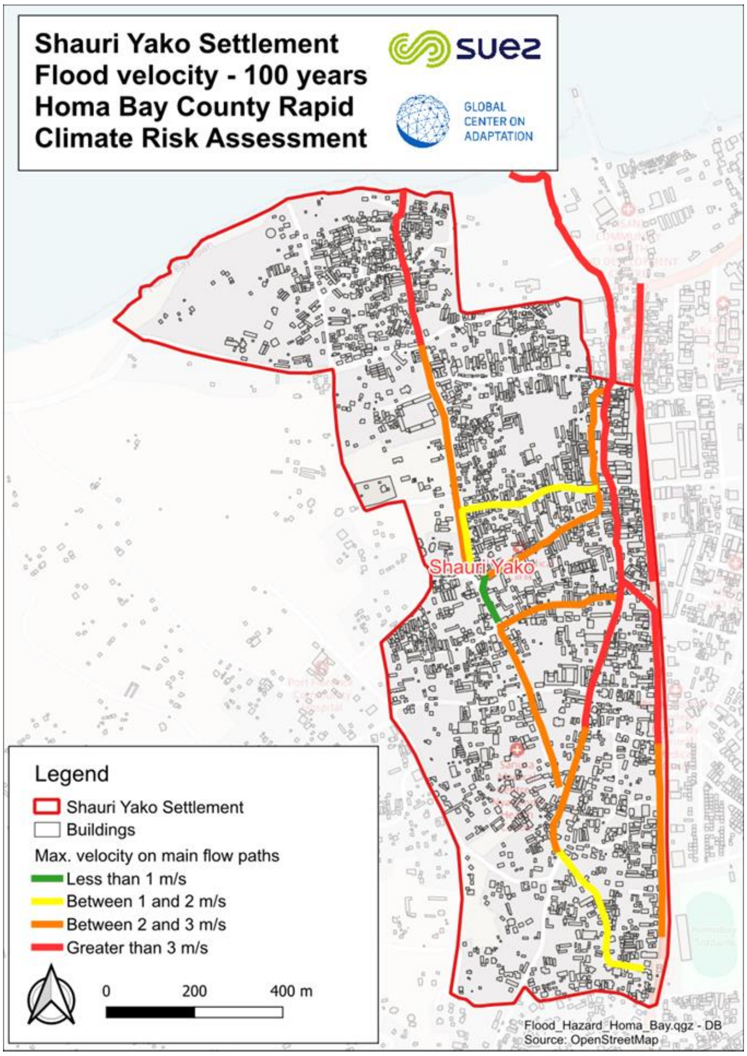


Figure 45: Peak flood velocities for the 1 in 10 years event (left) and 1 in 100 years event (right) – Shauri Yako (Source: SUEZ Consulting, 2025)

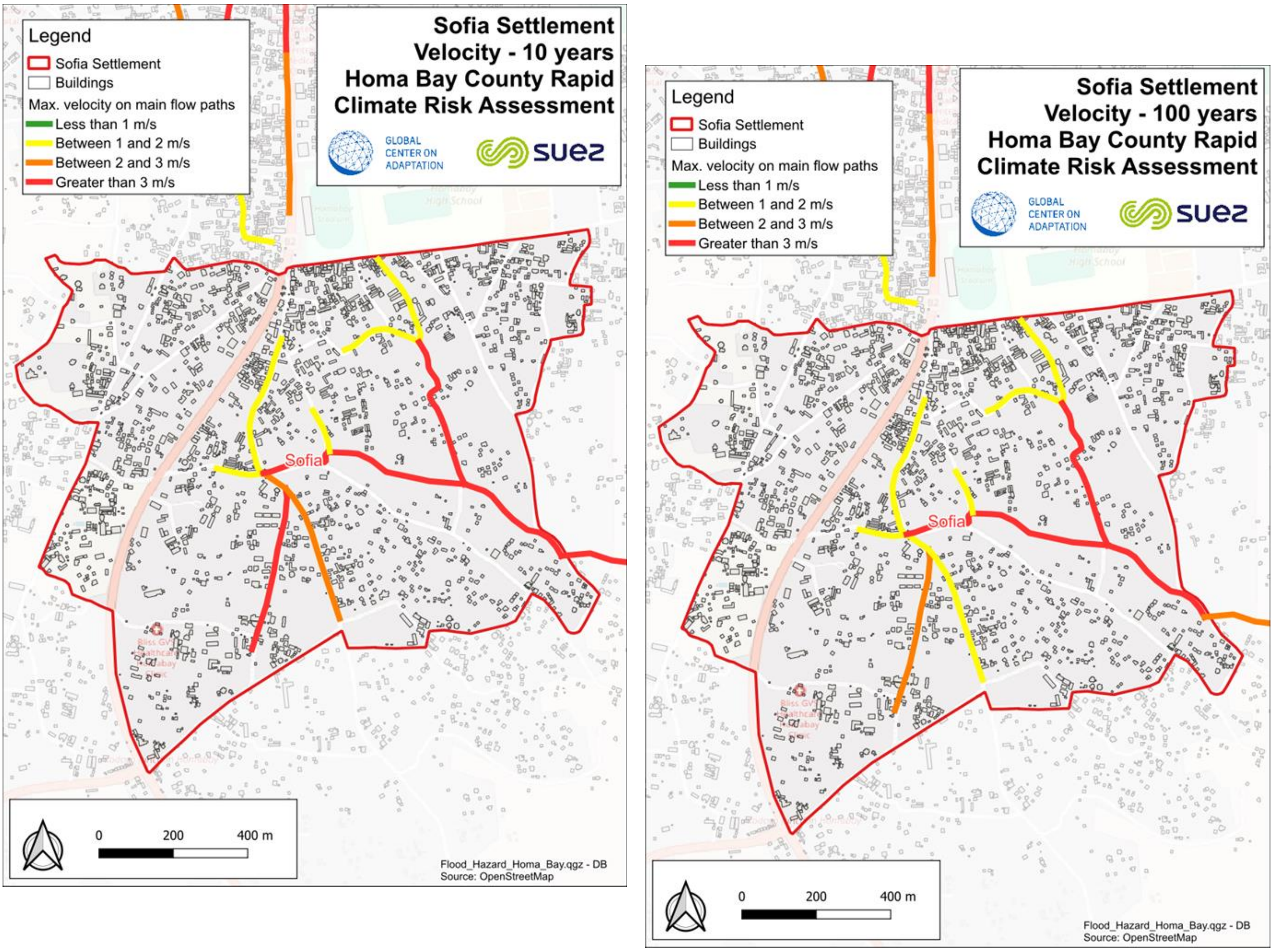


Figure 46: Peak flood velocities for the 1 in 10 years event (left) and 1 in 100 years event (right) – Sofia (Source: SUEZ Consulting, 2025)

The simple hydraulic modelling (using rough assumptions) highlights the sensibility to erosion for most of the defined flow paths, with velocities exceeding 1 m/s on almost all flow paths and even exceeding 3 m/s on a few critical sectors.

Climate change impact

Climate models (CORDEX Africa) expect a 4% increase in extreme precipitation (maximum 1-day precipitation Rx1day) in short term and +8% increase in medium term in the region (North Eastern Africa, RCP8.5 scenario). These results are a rough estimate of the real impact of climate change on the 3 settlements, knowing that the defined region is very large, and that the climate indicator doesn't describe exactly the extremely rare events. It gives however a range of value that can help assess the impact of climate change on flood at Homa Bay.ITo represent the rainfall increase, the IFD curves were updated for short term (+4%) and medium term +8%).I

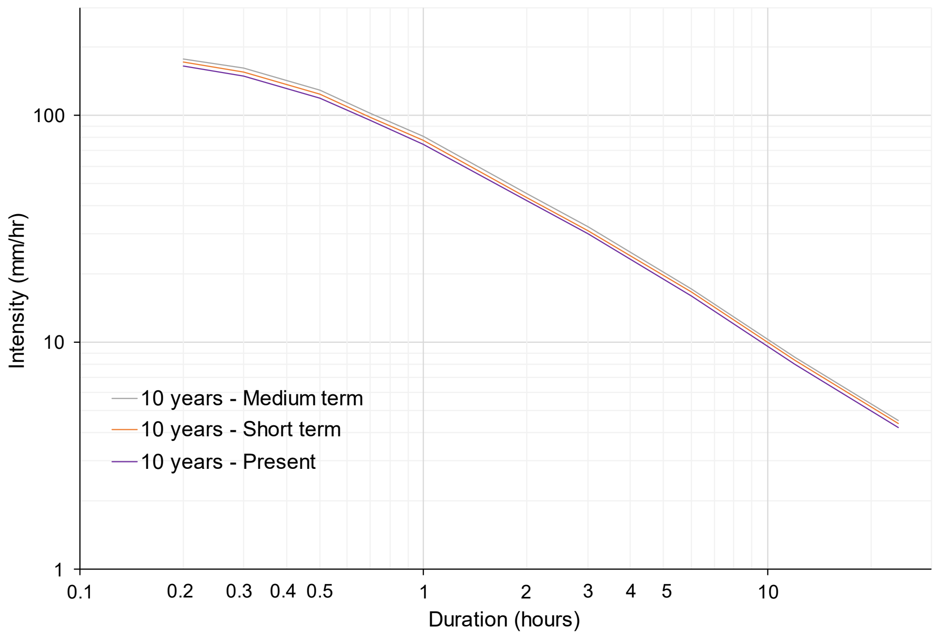


Figure 47: Intensity Frequency Duration (IFD) curves for short and medium term 10 years, compared to present (Source: SUEZ Consulting, 2025)

Using these new IFD curves, the peak flood depths and velocities were calculated and compared to present results.

Impact on peak flood depths and velocity are shown in the table below.

Name	Impact (depth) Short term vs Present (%)	Impact (velocity) Short term vs Present (%)	Impact (depth) Medium term vs Present (%)	Impact (velocity) Medium term vs Present (%)
Average impact	+2.4%	+1.6%	+4.7%	+3.1%

Table 20: Impact on flood depth and velocity at short and medium term (Source: SUEZ Consulting, 2025)

Climate change only has a relatively small impact on the amplitude of extreme flood events in Homa Bay, only increasing the peak flood depths and velocity by a few percent.

However, climate change also impacts in the inter-seasonal rainfall variability, with a likely increase of drought period followed by intense floodings. These climate conditions are the most detrimental in terms of erosion risk, and one can therefore expect an amplification of the damage related to this phenomenon in the future.

ANNEX 3. METHODOLOGY FOR THE EXPOSURE ASSESSMENT

Exposure analysis

The exposure analysis applied a multi-method approach, combining spatial analysis, community engagement, site visits, and stakeholder consultation to provide a comprehensive picture of all the different assets across the three informal settlements.

Geospatial analysis was conducted using open-source datasets to identify assets and critical infrastructure—such as health facilities, water points, and drainage systems—which were mapped and analyzed using QGIS, with most features subsequently uploaded to OpenStreetMap (OSM). This contribution aimed to improve the availability of up-to-date, publicly accessible data for the community and local authorities.

These spatial insights were enriched through community workshops (during the first field mission in April 2025), where residents—disaggregated by gender, age, and ability—shared lived experiences of climate impacts and discussed local adaptation practices. Participants identified key assets exposed to climate-related hazards—such as schools, health centers, roads, open drainage, and water access points—and described how their functionality is affected during extreme weather events.

Figure 48: Community mapping exercise during the workshop with the Sofia community (©Taylor Black, 02/04/2025)

This information helped verify and supplement geospatial data, while also highlighting unmapped or overlooked infrastructure crucial to daily life. The workshops also surfaced community-defined exposure hotspots, such as flood-prone areas, poorly drained zones, and locations where infrastructure is deteriorating due to climate impacts.

To deepen the understanding of existing assets and validate spatial information, the team also conducted on-site visits in the three settlements and held meetings with key stakeholders, including the KISIP project team and HOMAWASCO. These interactions provided additional context and insights into critical infrastructure—such as water tanks, sewer lines, and road networks—and helped ground the analysis in current planning initiatives.

Finally, existing reports and development plans were reviewed to ensure consistency with broader development strategies underway in Homa Bay Municipality.

Exposure scoring

Following the completion of the exposure analysis, we used QGIS to quantify the surface area exposed to key climate-related hazards—namely flooding, erosion, and landslides. This assessment was based on two primary data sources: (1) hazard hotspots identified by community members during participatory workshops, and (2) high-risk zones delineated through the hydrological and hydraulic study included in this Climate Risk Assessment (see Annex 2).

To translate this analysis into measurable terms, we calculated the total surface area within each settlement that intersects with one or more of these hazard zones. We then divided the exposed area by the total surface area of the respective settlement to obtain a percentage, representing the proportion of the settlement that is directly and highly exposed to climate hazards.

This percentage serves as an indicator of the physical exposure footprint within each settlement. However, it is important to recognize that when a climate-related event strikes**, the actual impact will**

likely extend beyond these zones due to the inherent interconnectivity and interdependence of urban systems. Infrastructures, services, and social dynamics are not confined to administrative or spatial boundaries. A disruption in one exposed area—such as a road, drainage system, or health facility—can quickly trigger cascading effects across the entire settlement. Thus, even a relatively small exposed area can have disproportionate consequences, reinforcing the importance of risk-sensitive urban planning that considers functional linkages and systemic vulnerabilities.

In addition, we carried out a complementary calculation for adjacent hazard-prone areas that lie just outside the official administrative boundaries but were either repeatedly identified by community members as part of their functional neighborhood or flagged through technical analysis. These peripheral zones, while not included in the final exposure percentage to maintain consistency with defined settlement boundaries, are acknowledged in the analysis. Their inclusion reflects the interconnected nature of urban systems and the lived reality of residents, helping to avoid overly rigid spatial interpretations that could misguide future planning and resilience-building efforts.

The scoring system is then based on the following calculation:
Score = (% exposed surface area) × (assets score)

The assets score is defined according to the density of population, the share of built-up areas and the availability of essential services.

Assets score	Level	Criteria
1	Low	Natural areas, sparsely populated, little infrastructure
2	Medium	Outskirts of residential areas
3	High	Dense areas, presence of public services
4	Very high	City centre, large population, hospitals, schools, markets, key infrastructure

The score is then placed on the following scale to obtain the exposure score: from 1 (low exposure) to 4 (very high exposure).

Combined score	Exposure score
0 – 0.9	Low
1 – 2.0	Medium
2.1 - 3	High
3.1 - 4	Very high

The results are as follows:

Settlement	Surface exposed	Asset scoring	Combined scoring	Exposure score
Sofia	0,32	2	0.63	1
Makongeni	0,02	3	0.06	1
Shauri Yako	0,15	1	0.62	1

ANNEX 4. METHODOLOGY FOR THE VULNERABILITY SCORING

A scoring system was developed to mark the level of vulnerability for each type reviewed: Social, economic, geophysical, infrastructural and institutional. The levels go from 1 (low vulnerability) to 4 (very high vulnerability. The key metrics used for each type of vulnerabilities are the following:

- Social: number of women, number of elderly (65+), poverty rate (<6000 Khs)
- Economic: number of people working in climate-sensitive sectors (agriculture), number of people working in the informal sector
- Geophysical: topography, nature of soil, hydrology, soil sealing
- Infrastructural: water supply (connection to pipe water system), sanitation (connection to sewer system), mobility (motorable tracks), housing (use of iron sheet walls), energy (connection to the grid) and waste (access to government waste collection system)

Data in the settlements comes from AMT's Situational Analysis Reports (2025).

Metrics were chosen in part according to available data and do not show the full extent of vulnerabilities and all the critical nuances for each type of vulnerabilities studied. Therefore, results shown below must be considered together with the narratives from the previous sections to gain a holistic view of vulnerabilities within the three settlements.

Social vulnerabilities	Sofia	Makongeni	Shauri Yako	Quartile calculation
Gender	50.2% women *Level 2*	52% women *Level 3*	28.48% women *Level 2*	+0-25%: level 1 +26-50%: level 2 +51-75%: level 3 +76-100%: level 4
Age	2% 65-year-old + *Level 1*	2% 65-year-old + *Level 1*	4.61% 65-year-old + *Level 1*	
Poverty	Under 6000 Khs 50% *Level 2*	Under 6000 Khs 55% *Level 3*	Under 6000 Khs 43.45% *Level 2*	
Social vulnerabilities scoring	Level 1.67	Level 2.33	Level 1.67	

Economic vulnerabilities	Sofia	Makongeni	Shauri Yako	Quartile calculation
Percentage of people in the settlements working in economic activities and with livelihoods that are climate sensitive (agriculture)	3% *Level 1*	7% *Level 1*	6.89% *Level 1*	+0-25%: level 1 +26-50%: level 2 +51-75%: level 3 +76-100%: level 4
Percentage of the labor force working in the informal sector	93.8% *Level 4*	78% *Level 4*	92.7% *Level 4*	+0-25%: level 1 +26-50%: level 2 +51-75%: level 3 +76-100%: level 4
Economic vulnerability scoring	Level 2.5	Level 2.5	Level 2.5	

Geophysical vulnerabilities	Sofia	Makongeni	Shauri Yako	Calculation
Flat relief	Flat land Northern section located on a relatively elevated plateau, and southern east area sloping downward toward flood-prone zones *Vulnerable*	Flat land Highland area with Got Rabuor. *Vulnerable*	Flat land Gently rolling terrain that flattens towards Lake Victoria. *Vulnerable*	Qualitative scoring. Four metrics define the geophysical vulnerabilities, one point per metric
Nature of soil	Balanced distribution of the two soil types, with interstratified clayey soils found in the western areas and montmorillonitic soils dominating the eastern side. This mixed profile offers slightly better conditions for settlement resilience *Not vulnerable*	Montmorillonitic soils are prone to landslides, slope failures, and have poor load-bearing capacity, rendering them unsuitable for construction without proper soil stabilization. These soils are also subject to significant soil erosion and land degradation *Vulnerable*	Predominance of interstratified clayey soils in its southern section, with a small portion in the north characterized by montmorillonitic soils, making it, in principle, less vulnerable in this regard *Not vulnerable*	
Hydrology	Far from Lake Vitoria and other water sources *Not vulnerable*	Along the shores of Lake Victoria + water stream near the market *Vulnerable*	Along the shores of Lake Victoria *Vulnerable*	
Soil sealing	Mainly natural area *Not vulnerable*	Mix of built-up and shrubland areas *Partly vulnerable*	Mainly built-up area *Vulnerable*	
Geophysical vulnerability scoring	Level 1	Level 3.50	Level 3	

Infrastructure vulnerabilities	Sofia	Makongeni	Shauri Yako	Quartile calculation
Water supply (not connected to pipe water system)	68.8% *Level 3*	78% *Level 4*	79.54% *Level 4*	+0-25%: level 1 +26-50%: level 2 +51-75%: level 3 +76-100%: level 4
Sanitation (not connected to sewer system)	94.8% *Level 4*	94% *Level 4*	93.98% *Level 4*	
Mobility (non- motorable tracks)	51% *Level 3*	51% *Level 3*	Missing	
Housing (iron sheet walls)	26.8% *Level 2*	Missing	72.50% *Level 3*	
Energy (not connected to national grid)	26.5% *Level 2*	23% *Level 1*	34% *Level 2*	
Waste (household with no access to government waste collection)	91.5% *Level 4*	Missing	96.09% *Level 4*	
Infrastructure vulnerabilities scoring	Level 3	Level 3	Level 3.40	

Institutional vulnerabilities	County level	Calculation
Planning documents	Well-equipped with plans and strategies on climate adaptation and urban development, although implementation yet to be assessed *Partly vulnerable*	Qualitative scoring. Four metrics define the institutional vulnerabilities, one point per metric
Governance	Institutions in place, however governance highly centralized, issue of coordination, weak municipal governance and lack of accountability between county and settlement level leadership *Partly vulnerable*	
Financial barriers	Limited Financial Resources (insufficient funding and limited budget allocations, Dependency on external funding sources)	

	Vulnerable	
Informational barriers	Low capacity for real time data collection, no centralized system to integrate and analyze hazard information comprehensively, lack of/underdeveloped early warning systems. While initiatives like the El Niño Preparedness Plan indicate progress, current early warning systems often lack the localized detail needed to alert communities promptly and accurately *Vulnerable*	
Institutional vulnerabilities scoring	Level 3	

The aggregated vulnerability score per settlement is based on the following weighting system:

Type of vulnerability	Weighting	Explanation
Social	25%	Social vulnerability is central, especially in Africa, where social inequalities amplify the impact of climate change.
Economic	20%	Local economies often depend on climate-sensitive sectors (agriculture, informal sector). Weak economic development exacerbates exposure.
Geophysical	20%	The sensitivity of the area has a major impact on initial exposure to hazards.
Infrastructural	20%	The quality of infrastructure directly affects the ability to absorb shocks (water, roads, etc.).
Institutional	15%	Less weighted because difficult to measure precisely and more indirect, but still crucial for risk management and adaptation.

ANNEX 5. REVIEW OF EXISTING ADAPTATION INITIATIVES IN HOMA BAY (BASED ON LITERATURE REVIEW)

NAME	LOCATION	SECTOR	DATE	STATUS	INFORMATION	DONOR	OWNER OF THE PROJECT	OTHER STAKEHOLDERS	SOURCES
On-and off-farm adaptation strategies	Homa Bay,County RURAL AREA	Agriculture	2020		The project aims to strengthen existing adaptation measures in the agriculture sector, including tree planting, improved soil and water conservation, the adoption of early-maturing varieties, water harvesting, post-harvest handling, and value-added processing. These measures are largely based on indigenous knowledge, such as using sawdust for grain preservation and applying salting, smoking, and drying techniques for fish. In addition, the project incorporates off-farm measures like training, capacity building, and the implementation of early warning systems, all contributing to enhanced retilience in the face of climate change.	World Bank		Republic of Kenya, Kenya Agricultural productibity programme	https://cgspace.cgiar.org/server/api/core/bitstreams/f20cfdf4-c47e-4592-8e8d-bd74a0ba7743/content
AGRICULTURE AND ENVIRONMENT PROGRAM (AEP)	Homa Bay County Agricultural/Rural Areas	Agriculture			To harness an established farmer research network to design and implement research to address priority challenges to agriculture through involvement of farmers in the development, testing, and dissemination of suitable agricultural technologies with potential to increase productivity and add value to agriculture, human nutrition and health. Farmers receive training on conservation agriculture techniques such as minimum/zero tillage, crop rotation and permanent cover using	N/A	N/A	Caritas Catholic Justice & Peace Department, in collaboration with GIZ, MoALF and Sustainable East Africa (SEA),	Program Details

					dolly corns, pigeon peas, groundnuts & tree planting campaigns. Farmers are introduced to drought-tolerant crops such as cassava, sorghum and early-maturing varieties of beans.				
Waste sensitization and collection	Homa Bay, Shauri Yako	Waste	2021		A group of 12 Community Health Volunteers (CHVs) visist 22 residential plots to sensitize about waste management and collect waste every week.	N/A	N/A		https://nation.africa/kenya/news/gender/volunteers-on-a-mission-to-keep-homa-bay-slum-clean-3271454
Labour community work to clean slums after el nino rains	Homa Bay, Informal Settlements (Shauri Yako, Makongeni,Sofia)	Post-disaster recovery	2024		Aims to mitigate the adverse effects of climate change, while addressing various socio-economic challenges. The project focuses on enhancing resilience to climate change, specifically in settlements that were severely impacted by the El Nino rains. It includes measures to control flooding, improve drainage systems, and provide essential services, such as sanitation, streetlights, and garbage collection. Additionally, it aims to improve living conditions and address issues such as inadequate housing, poverty, and insecurity in the affected slums.	N/A	N/A		https://www.the-star.co.ke/counties/nyanza/2024-02-23-homa-bay-launches-slums-cleanup-after-el-nino-destruction

Climate smart agriculture also promotes conservation of environment.	Homa Bay County	Agriculture	2024	Ongoing	Enhance food production through climate-smart agriculture by promoting the cultivation of climate-resilient crops, using environmentally friendly organic fertilizers, and providing farmers with subsidized farm inputs. This project seeks to reduce carbon emissions while increasing crop yields and ensuring food security in Homa Bay County. Additionally, it aims to encourage youth participation in agriculture through new, efficient farming technologies. Some 3,000 farmers have already received farm inputs such as seeds and organic fertilisers	European Union	Homa Bay County		Farmers benefit from donor project in Homa Bay – Kenya News Agency
Friends of the environment : Tree planting initiative (by Women/widows essentialy)	Suba South constituency, Homa Bay County	Vegetation	2023	2025	Planting tree seedings and promoting environmental conservation to combat the effects of flimate change	N/A	Kenya Forest Service (KFS)		
Construction of 46 small dams/pans to tame floods	Homa Bay & Kisumu Counties	Water infrastructure	2024		The aim of SHOFCO's project is to mitigate persistent flooding and enhance water storage capacity in Kisumu and Homa Bay counties, addressing both floods and droughts. By constructing 46 small dams in flood-prone areas, the project safeguards lives, property, and infrastructure while providing essential water for irrigation, household use, and livestock during droughts. This initiative promotes climate resilience, reduces reliance on external aid, and empowers communities through public involvement in decision-making, ensuring long-term sustainability and	Shining Hope for Communities (SHOFCO)			46 Dams to Tame Floods in Kisumu and Homa Bay — The Ankole Times & https://www.the-star.co.ke/counties/nyanza/2024-04-24-state-to-build-dykes-to-control-floods-in-homa-bay-says-cs-njeru

					self-reliance in the face of climate change challenges.				
Development of a borehole water supply system	Nyamila, Homa Bay County	Water infrastructure	2017		The purpose of the project is to develop a borehole water supply system to provide clean and safe drinking water, mitigate the effects of drought, and improve sanitation and hygiene. By reducing the time spent fetching water, particularly for women and children, the project aims to enhance education and economic opportunities while also supporting small-scale farming and livestock. Using a solar-powered pumping system, it ensures sustainability and minimizes environmental impact.	World Bank	World Bank	Lake Victoria South Water Services Bord (LVSWSB)	World Bank Document
Kodera Rachuonyo Gravity Water Project	Homa Bay, Karachuonyo, Kasipul	Water infrastructure	2014	2022	The aim of the project is to address the recurring water crisis in Karachuonyo, which has been worsened by the effects of climate change, particularly prolonged droughts. The initiative seeks to provide sustainable water solutions by damming dry gullies, de-silting strategic water pans, implementing roof-based water harvesting systems, and installing water tanks in public schools. Additionally, the project aims to contribute to environmental restoration through the planting of tree seedlings, thereby mitigating the impacts of drought and enhancing climate resilience in the region.	World Vision	World Vision	County Government	Homa Bay partners with World Vision over water - Kenya | ReliefWeb

Construction of dykes a river Tende	Rachuinyo North Sub County, Homa Bay	Protection infrastructure	2024		Construction of a dyke wall along River Tende in Rachuonyo North sub county. The project, aimed at mitigating flood risks and environmental protection, will extend towards the Riwa Economic Zone	None	Homa Bay County	National Government	Homabay County | Construction of Dyke at River Tende Begins
Homa Bay County government's prevention and mitigation strategy for El Niño rains	Homa Bay County	Multi / DRR	20223		The Homa Bay County Government’s El Niño preparedness strategy focuses on water management, flood prevention, evacuation planning, and humanitarian collaboration. It includes the construction of water pans and storage facilities to harness rainwater, particularly in black cotton soil areas, to mitigate future water shortages. The county is conducting sensitization and evacuation planning for 40,000 residents near Simbi Nyaima Lake, as rising lake levels pose a flooding risk. Identified evacuation centers (schools, social halls) will be equipped with mobile toilets and basic amenities. The government is partnering with UNICEF for emergency kits and the Kenya Red Cross for evacuation and disaster response operations, while closely monitoring meteorological forecasts to ensure timely interventions. Focus on the strategy put in place by residents to mitigate the effects of floods : dig trenches around areas that let water into their villages and redirect water from the river to the lake. The intiative is supported by kenya red cross that donates tools such as hoes and shovels to dig the trenches. Besides physical structures, the community has also regreened	N/A	Homa Bay County Government	UNICEF, Kenya Red Cross	How Homa Bay County has prepared for El Nino rains

					eroded areas by planting bamboo seedlings, which they obtained from the Kenya Forest Research Institute.This is meant to rehabilitate the degraded areas				
Flood mitigation strategies of the residents of Koala location in Rachuonyo North supported by Kenya Red Cross	Rachunoyp North, Homa Bay	Drainage and NbS	2025			N/A	N/A	Kenya Red cross	Floods mitigation strategy put in place – Kenya News Agency & https://nation.africa/kenya/health/flood-victims-dig-trenches-plant-bamboos-to-protect-homes-from-flooding-4897966
Climate Information Services Platform	Homa Bay County	Agriculture	2023		The aim of the project is to enhance climate resilience among smallholder farmers in Homa Bay County by providing accurate, real-time weather forecasts through the newly launched Homa Bay Climate Information Services Platform. By leveraging advanced Digital Climate Advisory Services (DCAS) and satellite-based geo-data, the project seeks to equip farmers—especially those without smartphones—with actionable weather insights to improve agricultural planning, productivity, and disaster preparedness in the face of climate change.	N/A	N/A	Partnership between TomorrowNow annd Homa Bay County	tomorrownow.org Unveils New Partnership With Homa Bay County Government to Support its Newly-Launched Climate Information Services Platform - TomorrowNow

Regreening Africa	Homa Bay, County RURAL AREA	NbS	2022		Helping communities in Homa Bay County, Kenya, to reverse land degradation by encouraging smallholder farmers to grow trees in their farms and revive existing ones. The trees help to increase crop yields and boost livestock production. Consequently, they help cushion communities from the adverse effects of climate change such as droughts and floods.	European Union	World Vision	World Vision Kenya, World Agro Forestry, Government of Kenya	Regreening Homa Bay: Using trees to boost food security and tackle climate change | Kenya | World Vision International
Strategic Planning for environmental governance and Poverty alleviation	Homa Bay Municipality	Strategic plan	2008		Strengthening urban development in the municipality of homa bay within an insitutitonal framework and with an emphasis on climate change. The plan therefore includes a systemic and integrated approach to urban development	UN Habitat			file:///C:/Users/TEC930/Downloads/Strategic%20Urban%20Development%20Plan%20for%20Homa%20Bay%20Municipality%20(2008-2030)%20(5).pdf
Homa Bay Sustainable Development Trust (HOSDET) Strategic Plan 2023-2028	Homa Bay County	Strategic plan	2023	2028	The main aim of the HOSDET 2023-2028 strategic plan is to facilitate the effective utilization of resources for sustainable development in Homa Bay County. This includes empowering local communities to influence development, ensuring accountability in the use of resources, and promoting sustainable projects that positively impact the lives of residents.	USAID			-

Climate change Action Plan	Homa Bay, County	Strategic plan	2023		Policy aims to mainstream climate change into development planning, focusing on sectors like agriculture, water, and energy Comprehensive framework designed to address the impacts of climate change in the county.The policy emphasizes both adaptation and mitigation measures to address climate change challenges. It seeks to enhance community and stakeholder capacity to implement these measures	World Bank	The project will be implemented under the Homa Bay Sustainable Development Trust (HOSDET), a body formed by Non-Governmental Organizations (NGOs) for promoting sustainable development in Homa Bay	Aga Khan Foundation, Tom Mboya University, local communities	Homa County Bay Climate Change Action Plan
Homa bay Climate change Unit & Climate Resilience & Innovation Hub	Homa Bay, County	Information infrastructure	2023		Coordinate and oversee climate-related activities across the county, ensuring effective adaptation and resilience strategies are implemented Climate Resilience & Innovation Hub specifically manages a call center for real-time support during climate emergencies and fosters innovation in climate change mitigation and adaptation	World Bank		In the context of the Locally Led Climate Action	https://maarifa.cog.go.ke/sites/default/files/2024-06/A%20Journey%20to%20Achieving%20Sustainable%20Climate%20Change%20Mitigation%20and%20Adaptation%20in%20Homa%20Bay%20County%2027%20%281%29.pdf
Kenya Informal Settlements Improvement Project (KISIP)	Homa Bay, County Informal Settlement	Infrastructure	2024		Enhance the living conditions of residents in informal settlements by improving access to basic services and securing tenure. Focuses on upgrading infrastructure such as roads, water reticulation, lighting, and sanitation systems	World Bank, AFD, European Union.			

Makongeni-Kapita Water Project	Homa Bay, County **Mainly informal settlements** - **Urban/Rural, Makongeni**	Water infrastructure	2024		Provides households with reliable water access, supporting domestic use, agriculture, and business activities. These water supply projects are integral to Homa Bay's climate change adaptation and urban development strategies. By securing reliable water sources, the county enhances its resilience against climate-induced challenges such as droughts and erratic rainfall patterns	N/A		Implemented by the Lake Victoria South Water Works Development Agency (LVSWWDA) and the Homa Bay County Water and Sanitation Company (HOMAWASCO)	https://homabay.go.ke/project/makongeni-kapita-water-project & https://www.homabay.go.ke/project/kogore-water-project#

Devolution and Climate Change Adaptation programme (several programs under the umbrela of the DCCA)	Homa Bay county (and Migori County)		2015	2018	- CREPP : Enhancing Climate Resilience and Adaptive Capacity for Vulnerable Communities in Kisumu and Homabay Counties : The project aims to create inform, and educate the targeted communities on climate change and its impact on livelihoods and natural resources; promote and upscale the uptake of climate change adaptation technologies and practices through community-based adaptation and resilience-building approaches; and build and sustain collaboration, partnerships, and networking with the targeted communities and relevant stakeholders to ensure collective ownership and sustainability of all climate change adaptation interventions. - Umande Trust : Adopt a stream, ignite a beach :The project aims to strengthen the link between WASH (Water, Sanitation, and Hygiene), freshwater conservation, and climate resilience, addressing real sustainability challenges in Kisumu and Homa Bay. - OSIENALA (friends of lake Victoria) : Climate Smart communities : The project aims to reduce the overuse, mismanagement, and contamination of natural resources by communities; reduce communities' vulnerability to food insecurity due to climate change; and increase county government support for climate change adaptation strategies. - Suswatch Kenya : DaCCA Advocacy : The organization is mandated to	SustainableEnergy (SE) of Denmark through DANIDA funds		SusWatch Kenya, Umande Trust, CREPP (Community Rehabilitation & Environmental Protection Programme) and OSIENALA	Devolution and Climate Change Adaptation (DaCCA) Bronchure – DaCCA

					steer the advocacy objectives of the DaCCA programme using both top-down and bottom-up approaches, through the engagement of relevant government departments in steering the climate change agenda and capacity building of the rights holders (local communities).					

Atemo Water Project Kasipul Kanbondo	Homa Bay County	Water infrastructure	2021	Complete	The aim of the Atemo Water Supply Project is to supply clean, affordable, and sustainable potable water to serve 10,000 people within Kabondo Kasipul Sub-County. Specifically, the project seeks to provide a reliable water source for Atemo Primary and Secondary Schools, God Agak Primary and Secondary Schools, the community around these schools, and Kirongo Centre.	None	Lake Victoria South Water Works Development Agency	Financed by the Government of Kenya, implemented by the Lake Victoria South Water Works Development Agency and currently managed by HOMAWASCO	Atemo Water Project Kasipul Kabondo, Homa Bay County - Lake Victoria South
Evaluation of the Mitigation Strategies for Dry Spell impacts on Livestock Production	Homa Bay County	Agriculture	2019		Study to examine mitigation strategies identified by relevant stakeholders for dry spell impact on livestock in Homa Bay. The strategies include the use of destocking during dry spellls situation to reduce the pressure on the available pasture and water. Some farmers in Homa Bay are evn force to send theur excess livestock to their relatives living in non affected or bettter regions in terms of water. There is also the use of livestock treatment as a strategy in mitigating the outbreak of diseases during dry spells. The rearing of drough tolerant livestock to mitigate dry spells such as cattle, goats and sheep. And finally the use of pasture and fodder management.	None	None	None	Evaluation of the Mitigation Strategies for Dry Spell impacts on Livestock Production in Homa Bay County, Kenya
Kimira-Oluch Smallholder Farm Improvement Project (irrigation project in drought prone area)	Homa Bay	Agriculture	2013	Complete	Environmental audit => Adapt to the impacts of climate change by ensuring sustainable water management in the face of recurring droughts and floods. It is designed to strengthen food security in local communities while improving their economic well-being. The goal was to explore irrigation developments option as an initiative to enhance	N/A	?	?	African Climate Discourse: SMALL-HOLDER IRRIGATION AS AN ADAPTATION OPTION: HOMA BAY, KENYA

					food security and boost soci-conomic status of the most vulnerable communities.				
Oyugis Water and Regenerative Agroforestry Project	Homa Bay, Oyugis	Water infrastructure and agriculture	2022		Aim to address water-related challenges and improve agricultural systems in Oyugis by combining decentralized drinking water services with regenerative agroforestry to enhance soil health, water cycles, and farmer resilience. Developing and implementing a farming system that enhances water availability, soil health, yield size, and diversity, whilst withstanding a changing climate. Development of water systems conveyed closer to farms and natural drains opened up to manage storm water during rainy seasons. Moreover, the project will encourage increased cultivation of a wide variety of crops to suffice for subsistence as well as commercial needs.	N/A	Wable (NGO dedicated to improve access to clean drinking water)	in collaboration with reNature.	Wable, Kenya - reNature
Lakefront Development	Homa Bay, County Lake Victoria front	Planning and waste	2024		Transforming its waterfront into a hub of economic and social activity by rehabilitating existing piers, improving waste management along the lake shores, and ensuring the sustainable utilization of Lake Victoria's resources.	N/A		Homa Bay County, Kenya Railways and Kenya Ports Authority, Kisumu Lake- front Development Corporation.	Homabay County | Welcome to Homa Bay County Website

Blue Print	Homa Bay County	Sanitation infrastructure	2023		Leverage advanced wastewater technology and foster local partnerships to improve water quality by 20% within three years	Global Partnership for Effective Development Co-operation & 374WATER		Homa Bay County, Local communities	The Homa Bay Blueprint: A Paradigm Shift in Global Sanitation
Improvement of two road projects	Homa Bay County	Road infrastructure	2023		Construction and improvement of key roads, such as the Mbita-Sindo-Kiabuya-Sori road and Mfangano Island Ring Roads to enhance accessibility and economic opportunities in the region. The two road projects are expected to open up the accessibility to the region and ease transportation of fish and farm produce in the county, thereby improving the livelihoods of farmers and fishermen, as well as attracting investment opportunities in the region	None		Homa Bay County	Launch of construction and improvement of two road projects in Homabay County | Ministry of Roads and Transport
Adaption strategies	Homa Bay County	Multi	2017		Highlight the adaptation measures to climate change in Homa Bay including tree planting by 95% of respondents, increasing vegetation cover, crop diversification (43.5%), and rehabilitating water storage structures (34%). Many also pay closer attention to weather forecasts to guide their actions	N/A			https://www.ijsrp.org/research-paper-0817/ijsrp-p6885.pdf

GLOBAL
CENTER ON
ADAPTATION

ANTOINE PLATEKADE 1006
3072 ME ROTTERDAM
THE NETHERLANDS
+31(0)88-088-6800
WWW.GCA.ORG