Mombasa CityLAB

FLOOD RISK AND VULNERABILITY ASSESSMENT

EXECUTIVE SUMMARY

Mombasa County, Kenya

Co-founded by:

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CONTEXT

In Kenya, climate change has intensified the severity and frequency of disasters, which present significant challenges to local communities. Kenya's National Policy on Disaster Management emphasizes the importance of government, stakeholders, and the community in disaster risk reduction. Within this framework, County Governments are also mandated to conduct risk assessments, establish early warning systems, devise response strategies, and mobilize resources for disaster management.

These efforts are particularly crucial for Mombasa County, one of Kenya's 47 counties facing distinctive challenges as a coastal region. As a signatory to the Covenant of Mayors in Sub-Saharan Africa (CoM SSA), the County Government of Mombasa made a voluntary political commitment to identify and address priority climate and energy issues in the County, aligning with broader policy objectives.

Following a Memorandum of Understanding signed between the County Government of Mombasa and CoM SSA in 2022, the partners agreed to collaborate specifically on strengthening adaptation to climate change in Mombasa. A rapid assessment undertaken by Coastal and Marine Resources Development (COMRED) identified poor solid waste management, potable water scarcity, river management and urban flooding as the major adaptation issues facing the County. Through stakeholder consultations, urban flooding emerged as the highest priority among the four issues. Its complexity and lack of obvious solutions called for a multi-sectoral, innovative, and in-depth participatory approach.

The Urban Lab approach, developed by CoM SSA in consultation with the African Centre for Cities, was identified to create solutions to combat urban flooding. This led to the launch of the Mombasa City Lab. The City Lab is an in-depth stakeholder-led process to co-design, co-create, and implement solutions to complex challenges faced by a city, using inclusive and participatory approaches.

To lay the ground for implementing the Mombasa City Lab on urban flooding, stakeholders conducted a flood risk and vulnerability assessment. The objective was to map the highest flood risks in the County's jurisdiction and identify key areas on which the Mombasa City Lab should focus.

Mombasa County Map

GEOGRAPHY

Mombasa is geographically located on the shore of the Western Indian Ocean, bordering Kilifi County to the North, Kwale County to the Southwest, and the Indian ocean to the East. The County has six constituencies: Changamwe, Jomvu, Kisauni, Nyali, Likoni, and Mvita. These constituencies are constituted of thirty Electoral Wards, thirteen (13) divisions, thirty-three (33) locations and sixty-two (62) sub-locations.

CURRENT POPULATION (2019):

610,257 Males

598,076 Females

GROWTH FORECAST:

1,208,333

2019

1,577,541

2030 (+3.51 %)

DEMOGRAPHY

The National Census of 2019 indicated that the County has a population of 1,208,333 persons, with 610,257 males and 598,076 females. Demographic projections suggest its population will reach 1,577,541 by 2030, with an annual growth rate of approximately 3.51 %

TOPOLOGY AND CLIMATE

The topography is characterised by a gentle, low-lying topography with moderately diverse relief features, which include the coastal plain, residual hills and the shoreline. Its elevation ranges between -10m to 122m above sea level. It experiences hot tropical weather influenced by the dry northeast and the moist southeast monsoon winds. Temperatures remain stable throughout the year, registering a low of 22.7 ºC in July and a high of 33.1 ºC in February, with high fluctuation in humidity ranging from 59 % to 86 %. Mombasa receives bimodal rainfall patterns, with long and short rains occurring in April – June, and the end of October-December, with an annual average of 1040mm.

GEOLOGY

Mombasa's geology is constituted of sedimentary rocks from the Jurassic to Quaternary age which contains shale, sandstones, sands, limestone, beach sands, and fringing reefs. Soil is dominated by a sandy texture, having areas identified with clay, loam, and sandy soils.

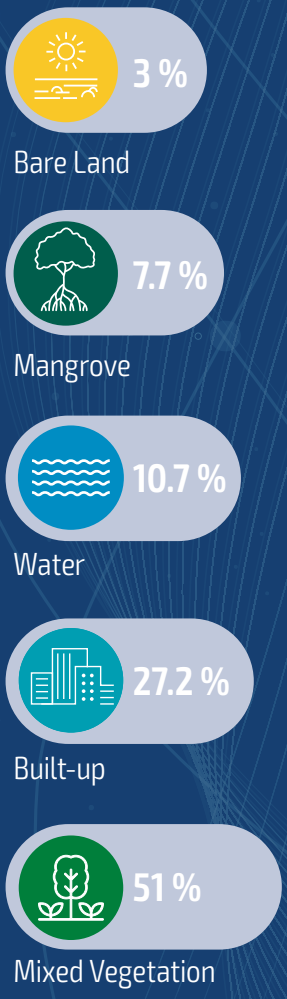
This is the administration structure through which governance and development are implemented.

The County has scanty freshwater resources, which include Mtopanga and a significant density of shallow and boreholes that serve as sources of domestic water despite the uncertainty linked to the quality of groundwater in the region. These water resources are quickly being degraded due to encroachment and pollution caused by the dense human activities in the urban areas and poor land use practices upstream. This has increased the water stress in the County, translating to increased costs for accessing potable water. Despite the decline in water resources, the Northeastern and Northwestern regions have the most intricate slopes and valleys in the County, hosting most rivers and waterways.

Mombasa's land cover includes built-up, mangrove, mixed vegetation, bare land, and water, with 27.2 %, 7.7 %, 51 %, 3 %, and 10.7 % of its land mass, respectively.

Mombasa City, © GIZ/CoM SSA 2023

MOMBASA'S LAND COVER :

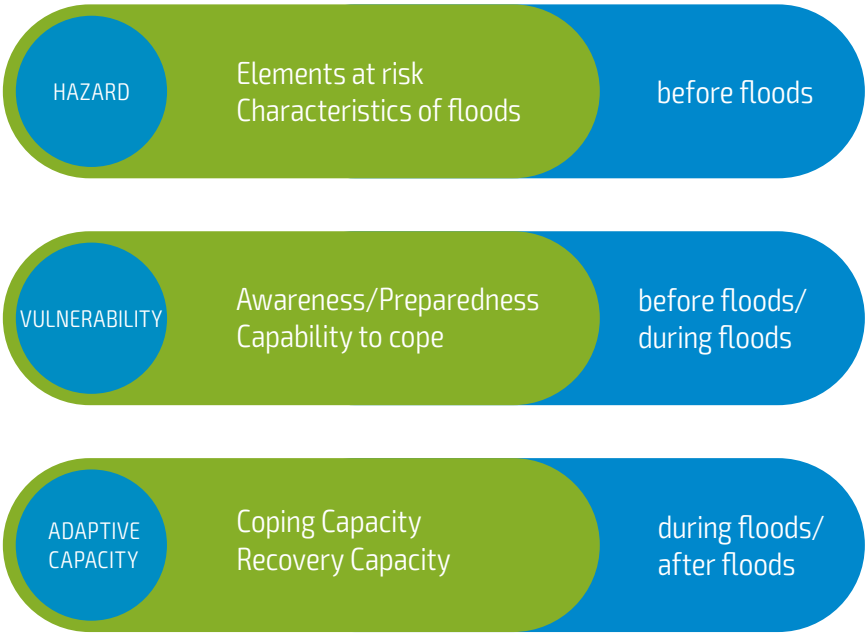


METHOD

The flood risk assessment was implemented by combining Geographic Information System (GIS), informed by inputs from stakeholders' participatory contribution. The Multi-Influencing Factor (MIF) technique was used to map the distribution of flood hazard, vulnerability, and adaptive capacity to floods.

The hazard, vulnerability, adaptation, and flood risk scores were processed for various locations and presented as qualitative maps to stakeholders for validation. The feedback from stakeholders was marked on maps, which were later digitised. The maps were enhanced in an iterative process by adjusting map layers and spatial resolution of the data. The data ranking was concluded with a sensitivity analysis using the map removal method to rationalize levels of importance of the data.

The flood risk was assessed using the potential of flood hazard[1] , vulnerability[2] and adaptive capacity[3] of the various natural and man-made assets to the manifestation of flood disaster. Secondary data was used to perform the assessment in a GIS environment



1 the likelihood of occurrence of flooding, which occurs when water either partially or totally covers land that is typically dry.
2 the state of being exposed to the possibility of being adversely impacted by a hazard.
3 the ability of a system to adjust its characteristics or behaviour, to manage and expand its coping range under the likely impact.

Mombasa City, © GIZ/CoM SSA 2023

The assessment was conducted in four stages:

1. The first stage assessed the distribution of the likelihood of flooding, which constitutes the hazard level.

2. The second stage assessed the level of exposure of natural and man-made assets to the likely flood occurrence.

3. The third stage evaluated the capacity of the biophysical environment to adjust and cope with the possible impacts that could result from the potential flood disaster.

4. The final stage summed the hazard and vulnerability map, then reduced the adaptive capacity to generate the flood risk map.

ASSESSMENT	DATA USED IN ASSESSMENT
Hazard	slope, land cover, rainfall, soil, distance to rivers, curvature, flow accumulation, total wetness index and elevation.
Vulnerability	population density (projected to 2030), settlement patterns (formal and informal), living standards (low and mid to high income), distance to unsanitary landfills, and unprotected water sources.
Adaptive Capacity	distance to all weather roads, protected water points, health facilities, evacuation centres and stormwater networks.

RESULTS
FLOOD HAZARD

The County faces a widespread flood hazard threat. Significant areas are classified as high hazard - with approximately 29.9 % of the County in high, and 13.4 % in very high hazard areas. Moderate flood hazard covers about 30.7 % of the County. In contrast, 7 % faces low risk, and 18.9 % has a very low flood hazard.

Wards in high and very high flood hazard areas: Timbwani, Shika Adabu, Majengo, Mjambere, Magongo, Kadzandani, Magogoni, Kongowea, Mikindani, Likoni, Chaani, and Junda.

Wards in low flood hazard areas: Jomvu Kuu, Miritini, Airport, Mtongwe, and Port Reitz.

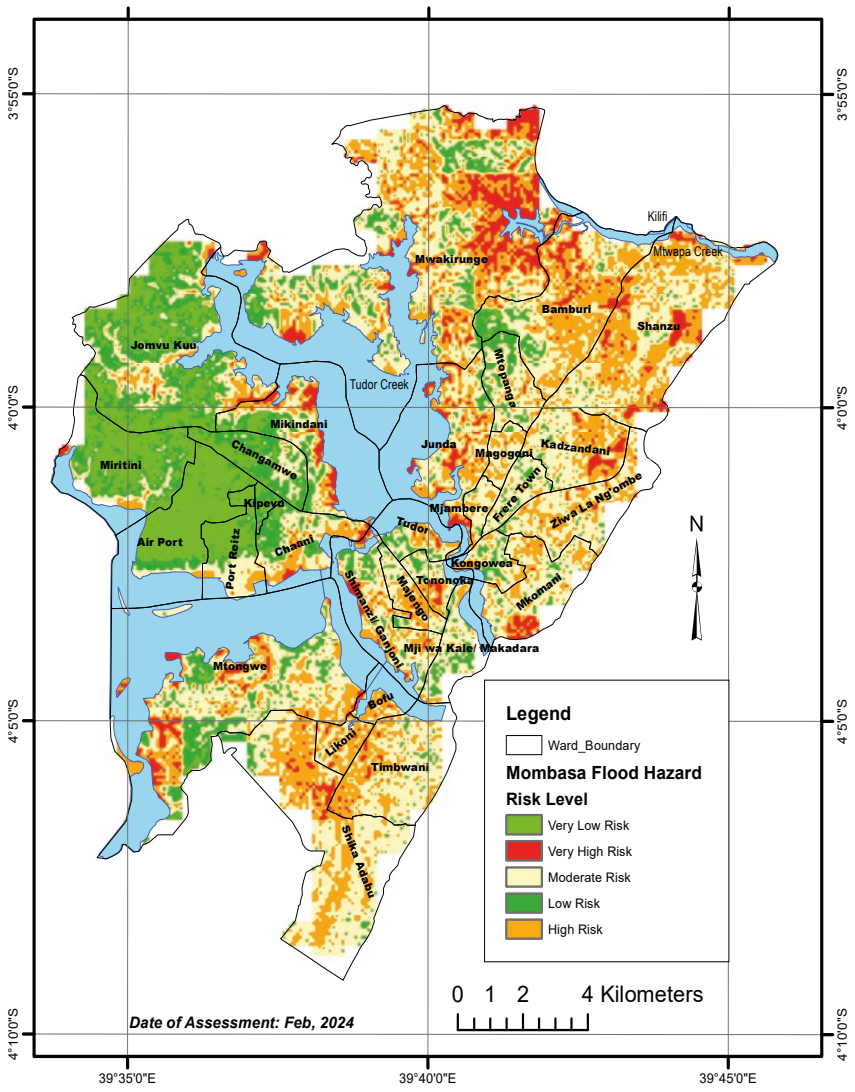


FIGURE 1: Flood hazard map

VULNERABILITY AND ADAPTIVE CAPACITY ASSESSMENT

The assessment of the vulnerability to the flood disaster shows that nearly 40.6 % of the County has low vulnerability and 12.8 % has very low vulnerability to floods. Nearly a third (30.4 %), represents moderate vulnerability, and 9.2 % and 6.9 % of the County area represent high and very high vulnerability respectively.

In terms of adaptive capacity, the majority of County areas (41 %) exhibit very high adaptive capacity, with high adaptive capacity covering 22.8 %. Moderate adaptive capacity represents 18.4 %, while low and very low adaptive capacities constitute 13.4 % and 4.3 % of the County area, respectively.

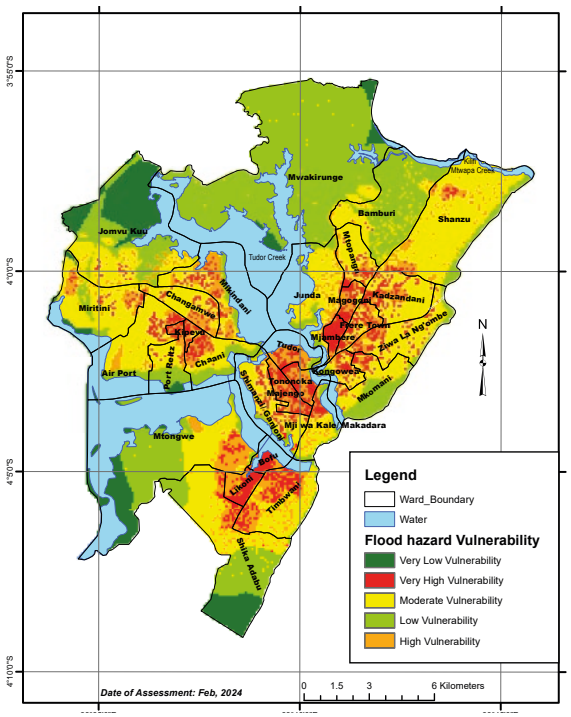


FIGURE 2: Flood vulnerability map

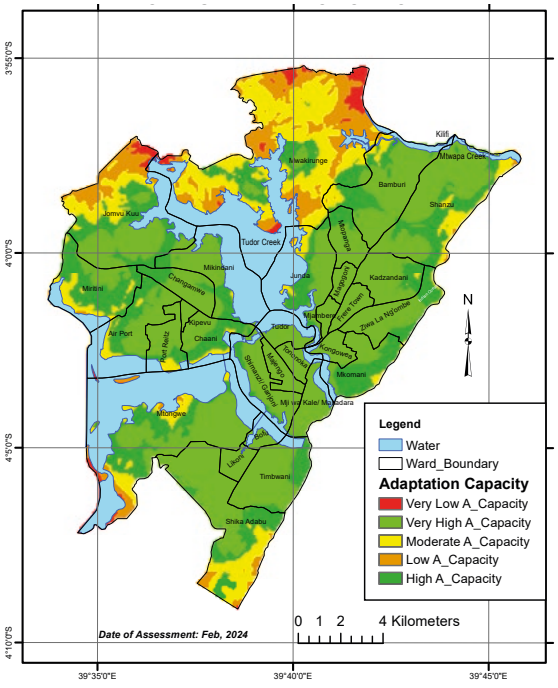
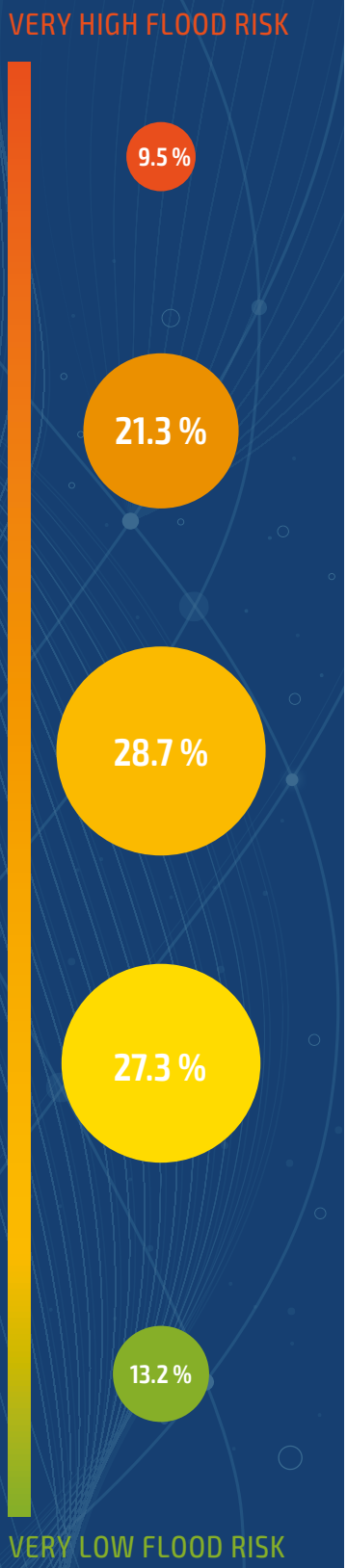


FIGURE 3: Adaptive Capacity map

A notable pattern emerges when examining vulnerability and adaptive capacity, which plays a crucial role in mitigating flood risk. Areas with low to very low vulnerability collectively make up 53.4 % of the County area, while those with high to very high adaptive capacity constitute 63.8 %. This indicates a strong ability to cope and recover from potential flood hazards, despite their widespread occurrence.

FLOOD RISK ASSESSMENT



Percentage of wards that face very low to very high flood risk.

Flood Risk was calculated by adding the Flood Hazard with the Flood Vulnerability minus the Adaptive Capacity[4]. This accounts for the likelihood of flooding with exposure, and considers the capacity of the victims in coping and recovering from its impacts. The flood risk assessment result indicates that nearly a third of the County area faces high to very high flood risk. Very high and high-risk areas constitute 9.5 % and 21.3 % of the County's land area respectively. The rest of the County area faces moderate (28.7 %), low (27.3 %), and very low (13.2 %) risk levels.

Wards falling in high to very high-risk areas: Mwakirunge, Bofu, Mikindani, Junda, Mjambere, Kadzandani, Ziwa la Ng'ombe, Kongowea, Mkomani, Tononoka, Majengo, Ganjoni, Likoni, Timwani, Shika Adabu, Chaani.

Low to very low risk areas: Jomvu, Miritini, Airport, Changamwe, Port Reitz, Bamburi, Shanzu, Makadara, and Mtongwe.

Close to all wards face small patches of moderate to high flood risk levels.

Validation Workshop © GIZ/CoM SSA 2023

A validation of flood risk assessment results was held through a participatory process involving community and other County stakeholders. The risk coverage, vulnerability and adaptation maps classification were examined by stakeholders using local knowledge. Over 90 % of the flood hazard map was approved by stakeholders with amendments

4 Flood Risk = Exposure(E)/Hazard (H) + Vulnerability/Sensitivity (V) – Adaptive Capacity (AC)

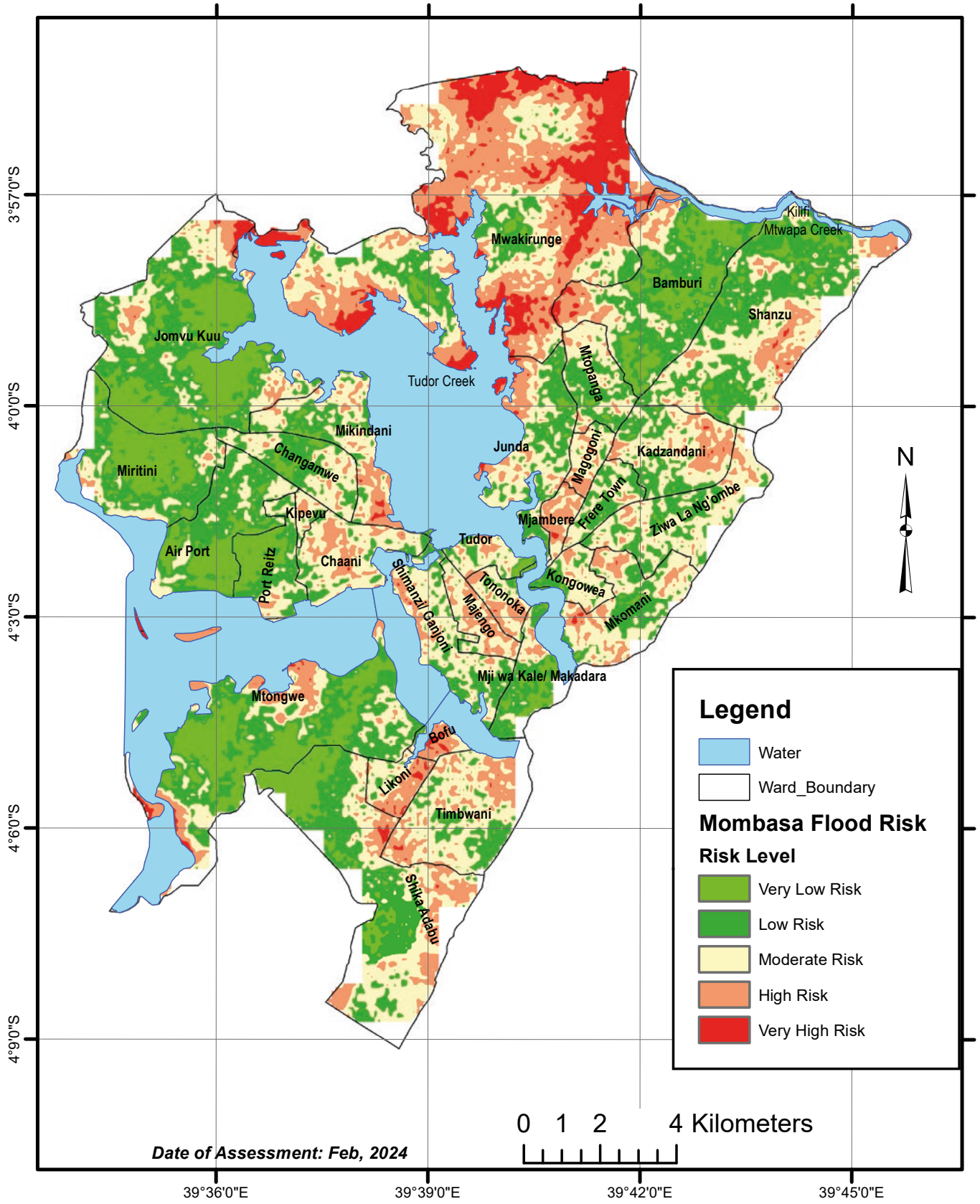


FIGURE 4: Flood risk map

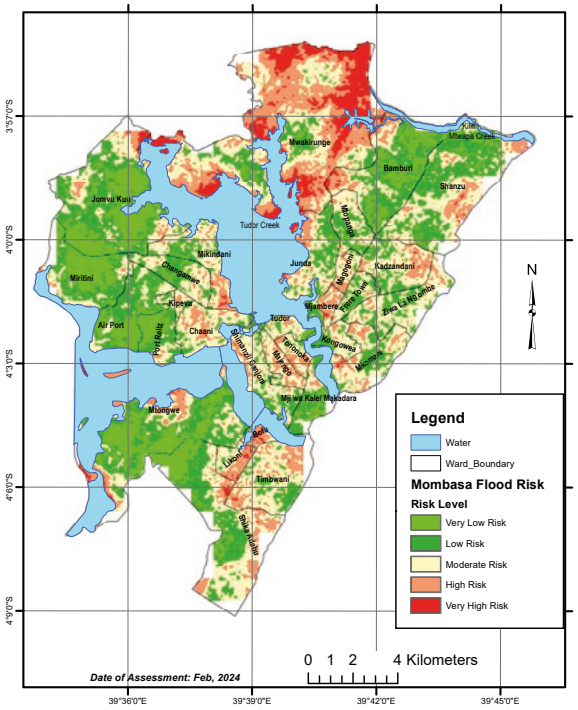


FIGURE 5: Flood risk map

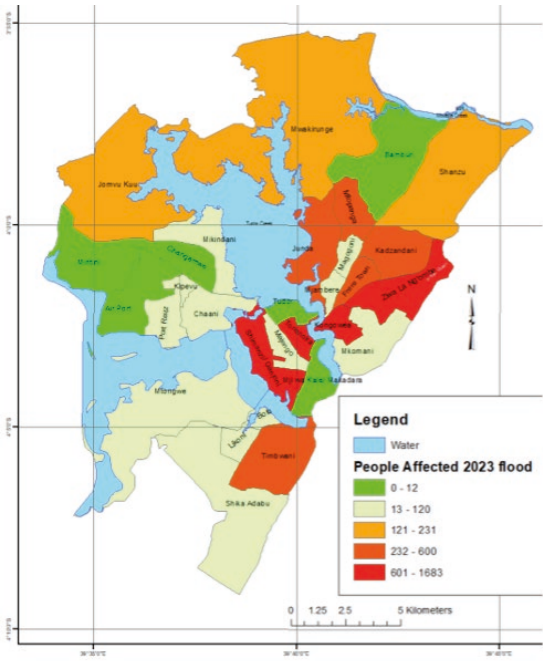


FIGURE 6: Map of number of people affected in 2023 flooding incident

adopted. The vulnerability and adaptation maps were adopted with recommendations for future improvement when more granular data is available.

The generated flood risk maps were cross-referenced with a visualisation of the number of people affected by recent floods in 2023, mapped by the County. The low flood-risk areas coincided with the impact map, confirming the accuracy of the flood-risk mapping process. For example, Bamburi, Miritini, Airport, part of Changamwe and Makadara wards recorded the lowest numbers of 0-12 people affected, aligned with the results of the flood risk assessment as low in these areas.

As shown in Figures 5 and 6, the general flood risk across the County is high, despite the low numbers of people affected in record in the recent flooding events. This can be explained by the majority being lowly vulnerable and having high access to adaptive measures.

The analysis of flood risk was limited to mapping areas that can be inundated, vulnerability level based on the level of exposure, capacity to cope and recover from the impact of flood disaster. The lack of social data limits the detailed flood impact assessment into dimensions such as gender aspects. We recognize the value of including the socio-economic data, sea level rise, dynamic flood simulation data and potential damage data to improve the analysis. Despite these limitations, the current assessment provides valuable insights into the levels of risk, vulnerability, and adaptive capacity, which can inform the strategy and development of actions for the Mombasa City Lab.

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