Towards Greener African Cities – Climate Risk and Adaptation studies

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Introduction

Rapid urbanization across Africa is increasing exposure to climate hazards, including flooding, and extreme heat. The FAO Green Cities initiative supports African countries in developing evidence-based Green City Action plans to adapt to climate change while generating co-benefits for urban communities, the environment and local economies.
Using Earth Observation (EO) tools, we assessed flood and urban heat risk in eight cities across Côte d'Ivoire, Kenya, Uganda, and Mozambique. This poster presents results for Pemba, Mozambique, a rapidly growing coastal city with high exposure to tropical cyclones.

Figure 1: Project locations

Objectives

1. **Map High risk zones** using advanced satellite data integration and machine learning downscaling techniques for urban environments.
2. **Assess Population Exposure** by quantifying temperature differentials and runoff retention values across different land cover types.
3. **Identify priority intervention areas** through high-resolution thermal and hydrological mapping to guide targeted heat and flood mitigation strategies.

Land Cover Classification

A high-resolution **Land Cover Classification map** was produced to support both the flood risk and urban heat models.

The ESA WorldCover product (10 m native resolution) was combined with OpenStreetMap (OSM) vector data to generate the land cover map. ***(Figure 2)***

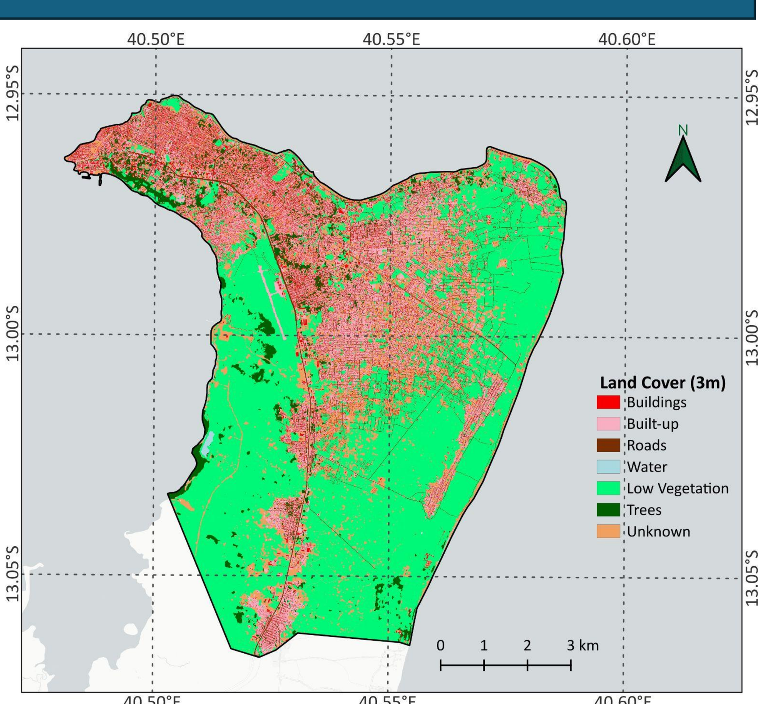

Figure 2: Land Cover Classification map for Pemba, Mozambique

Flood Risk

Pemba is highly exposed to extreme rainfall events driven by tropical cyclones. During **Cyclone Kenneth** (April, 2019) precipitation of up to six times the seasonal average was recorded, causing severe pluvial flooding across the area.

The flood risk was assessed using the InVEST Urban Flood Risk Mitigation Model, which simulates a standard **extreme rainfall event** of **100 mm**,and calculates the volume of **runoff retained** in **m³** per pixel.
Lower retention values indicate areas where water is not absorbed and flooding is more likely to occur.

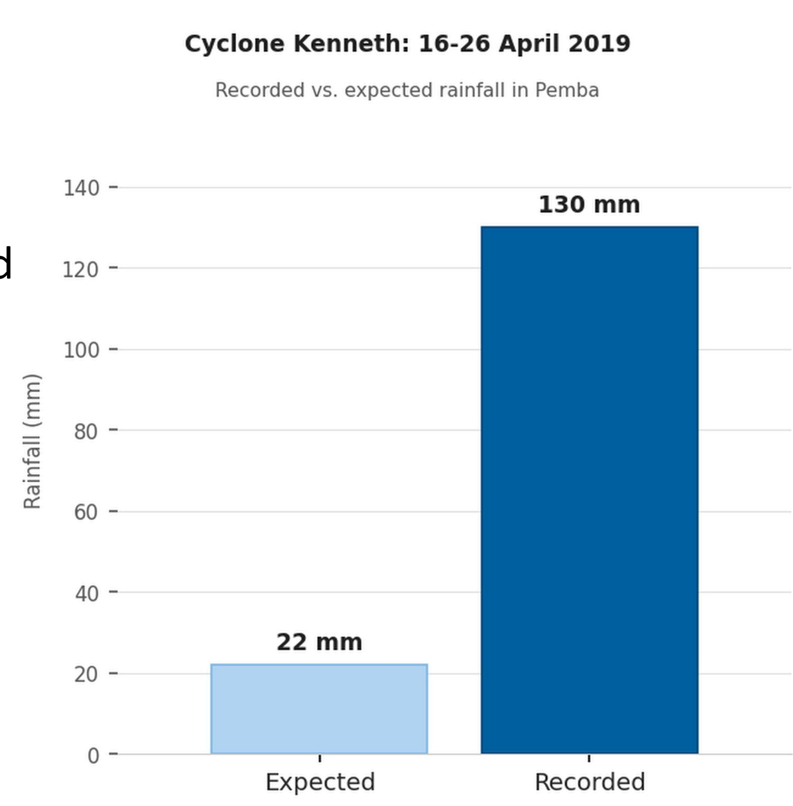

Figure 3: Recorded and expected rainfall amounts in the period of 16th-26th of April 2019 Pemba, Mozambique.

As visible in ***Figure 3,*** results reveals critically **low runoff retention** values (0-8 m³) across the entire urban area, confirming widespread vulnerability to extreme rainfall events. This is further compounded by coastal exposure: approximately 30% of the coastline presents intermediate-to-high storm surge risk, and sea level projections under the IPCC SSP3-7.1 scenario indicate a rise of 226 mm by 2050.

Lower surface retention
↓
Higher flood risk

As shown in ***Figure 4***, the **highest flood risk concentrates in built-up areas**, where impervious surfaces drastically reduce infiltration capacity and increase surface runoff. In contrast, vegetated and less urbanized zones retain substantially more water, highlighting the critical role of green infrastructure in flood mitigation.

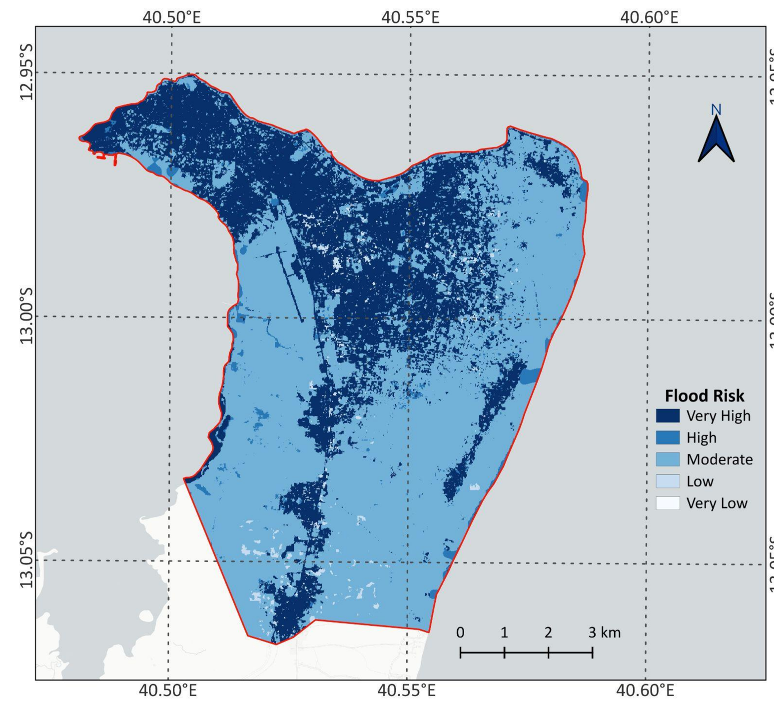

Figure 4: rainfall-induced flood risk in Pemba, Mozambique

Urban Heat

Urban heat was assessed using a downscaling algorithm that integrates ERA5 historical weather data with satellite-derived land surface temperature observations, land use classification, wind speed, rainfall, and elevation data. The system produces 70 m resolution hourly surface temperature maps.

The platform detects Urban Heat Islands (UHIs) at hourly intervals, enabling detailed analysis of their formation, spatial extent, intensity, and temporal evolution throughout the day and across seasons.

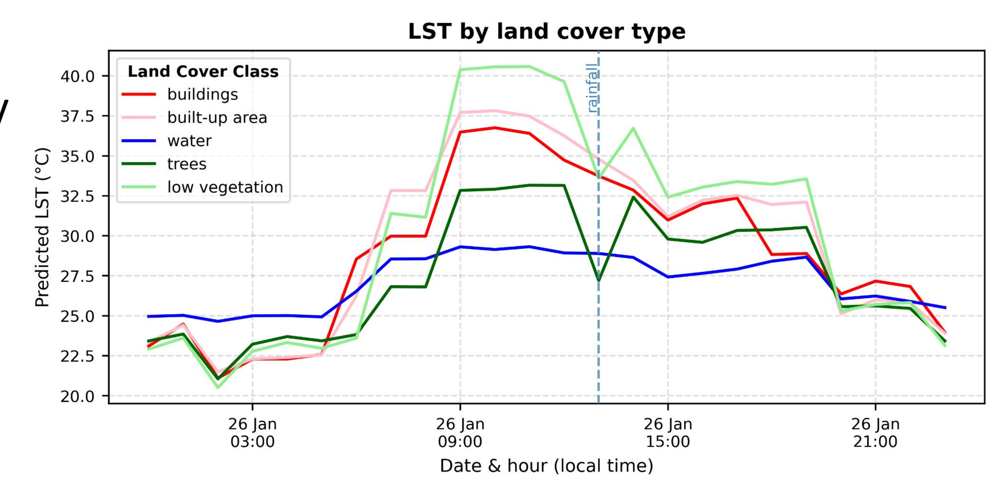

Figure 5: Predicted Land Surface Temperature by Land Cover Type in on the 26th of January 2024 in Pemba, Mozambique, Note that at 1300 a dip is visible because of a rainfall event at that time.

In ***Figure 5*** for each land cover the effects of the heat are visible. Note how low-vegetation generally shows higher temperatures while water and areas with trees generally show lower temperatures during the warmest moment of the day.

By combining hourly surface temperature maps with population density data, we generated heat risk maps (***Figure 6***) that identify the most vulnerable communities and neighbourhoods, providing a direct evidence base for targeted heat mitigation strategies and urban planning decisions.

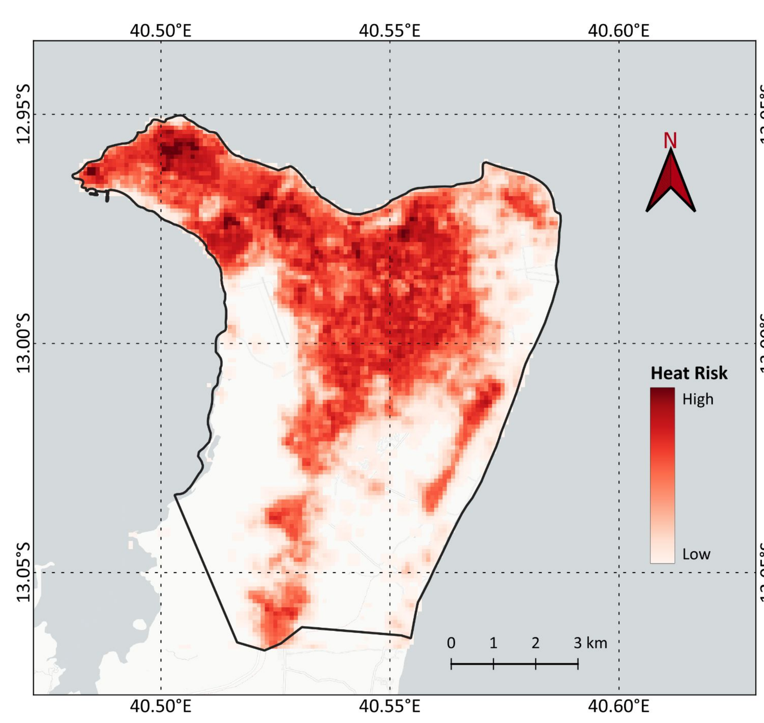

Figure 6: Heat Risk Map on the 26th of January 2024, in Pemba, Mozambique

Conclusions

The combined flood risk and urban heat assessment for Pemba reveals a critical and widespread climate vulnerability across the entire urban area, driven by rapid urbanization and high exposure to tropical cyclones.

Nature-based Solutions, in particular urban tree cover expansion and mangrove preservation, represent a promising intervention strategy for simultaneously reducing both flood risk, through increased water retention and infiltration, and urban heat island intensity, through surface shading, evapotranspiration, and coastal buffering.

Policy Implications:
- **Priority zones identified** for green infrastructure interventions
- **Evidence base** for building code modifications
- **Integration with municipal** climate adaptation plans

Future Applications:
This EO-based methodology is scalable to other African cities and can be integrated into operational urban monitoring platforms for continuous, near-real-time climate risk assessment and planning support.

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