MANGROVE ECOLOGICAL LAND SUITABILITY A TOOL FOR INTEGRATING MANGROVES CONSERVATION IN URBAN GREEN INFRASTRUCTURE IN SUB-SAHARAN AFRICAN COASTAL CITIES

A case study of Maputo, Mozambique

6th INTERNATIONAL ELECTRONIC CONFERENCE ON WATER SCIENCES

SESSION: Soft and hard interventions to adapt to and mitigate abiotic and biotic coastal change due to climate change and human interventions

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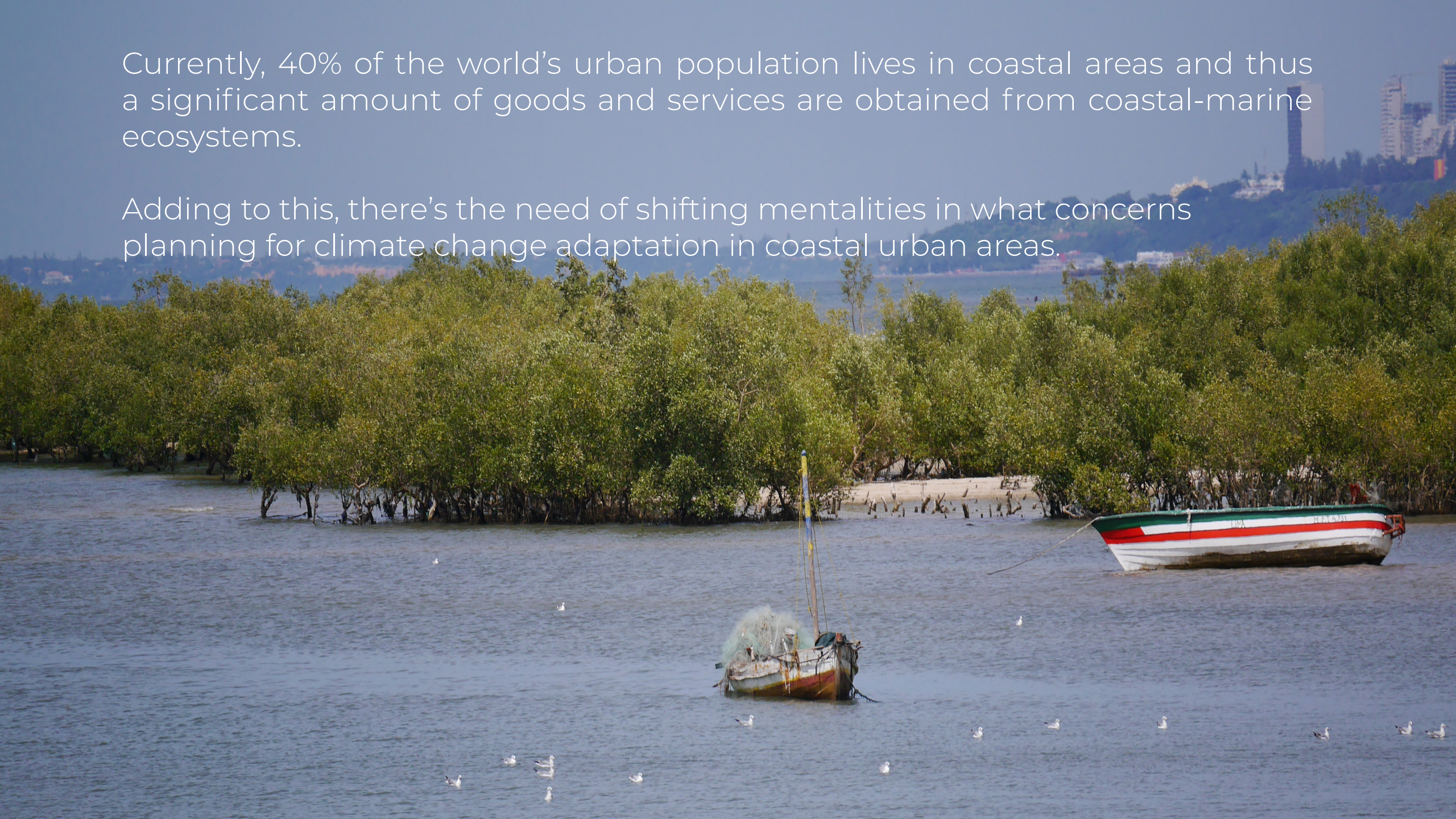
Ana Beja da Costa (ISA-UL)
Natália Cunha (ISA-UL)
Salomão Bandeira (UEM)
Wim Wambecq (FA-UL)
Luis Ribeiro (ISA-UL)

INSTITUTO SUPERIOR DE AGRONOMIA Universidade de Lisboa
LEAF LINKING LANDSCAPE, ENVIRONMENT, AGRICULTURE AND FOOD
U LISBOA | UNIVERSIDADE DE LISBOA
FCT Fundação para a Ciência e a Tecnologia MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR
UNIVERSIDADE EDUARDO MONDLANE

1. INTRODUCTION

Currently, 40% of the world's urban population lives in coastal areas and thus a significant amount of goods and services are obtained from coastal-marine ecosystems.

Adding to this, there's the need of shifting mentalities in what concerns planning for climate change adaptation in coastal urban areas.



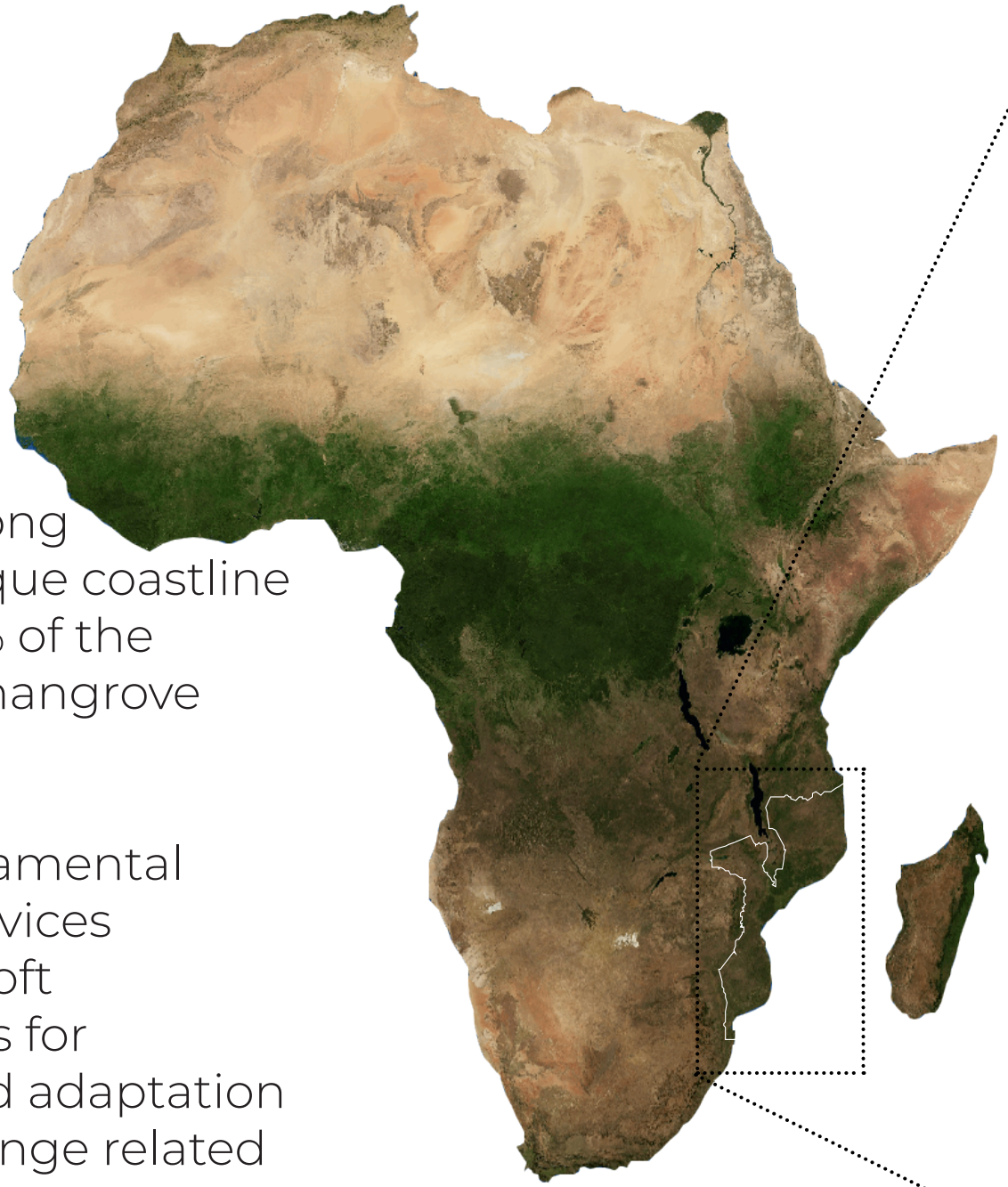
Coastal wetlands will change as a consequence of projected sea level rise.

Other increased potential impacts of climate change are to be acknowledged, such as increased intensity of floods, droughts and cyclones; coastal erosion; contaminated and decreased water resources; increased health problems related to water resources and heat stress.

Fonte: Gavíria & Vargas (2016)

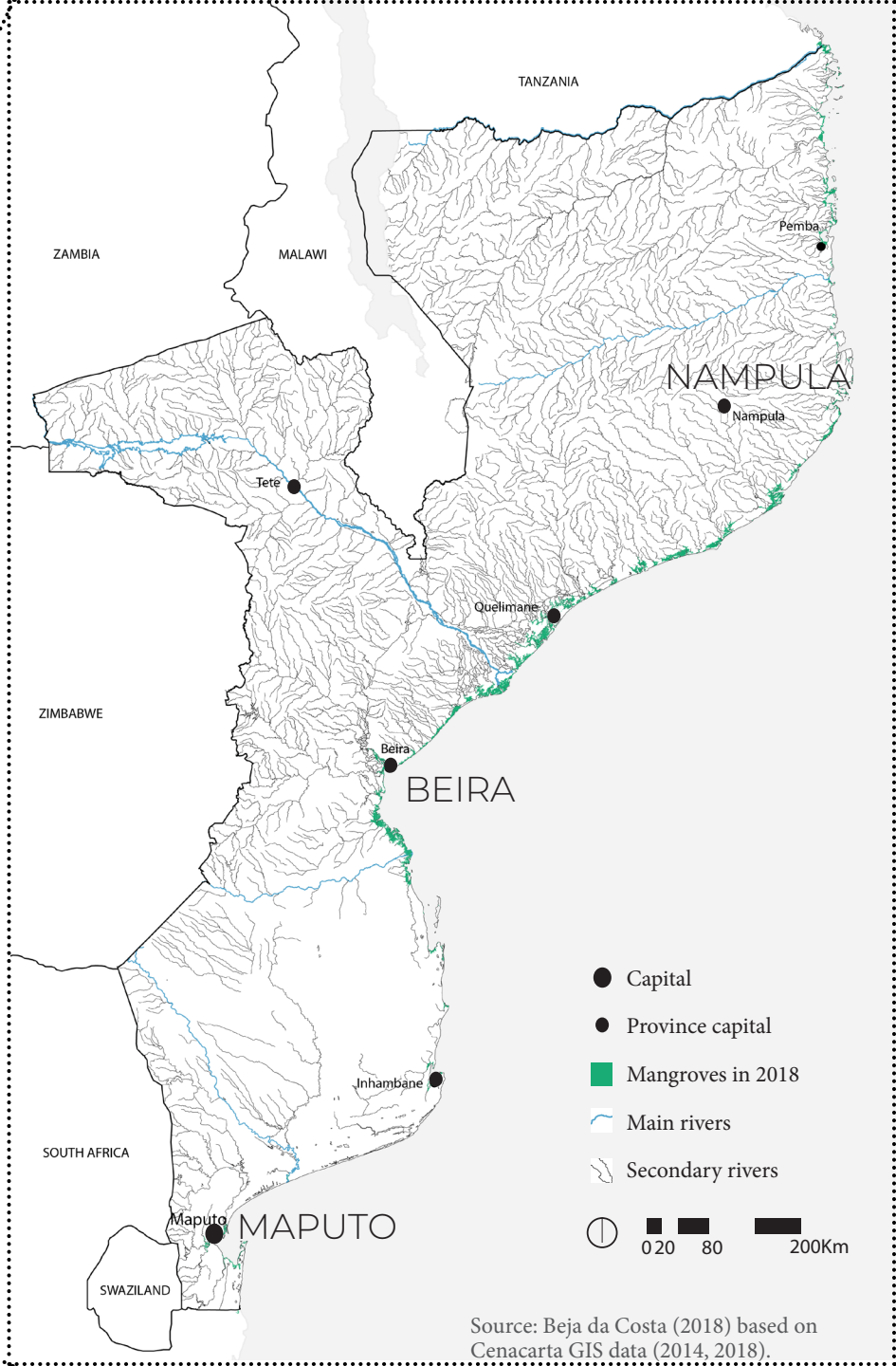
Mangroves along the Mozambique coastline represent 2.3% of the world's total mangrove area.

They are fundamental ecosystem services providers, as soft infrastructures for mitigation and adaptation to climate change related events.



0 850 km

Source: Wambecq (2009)

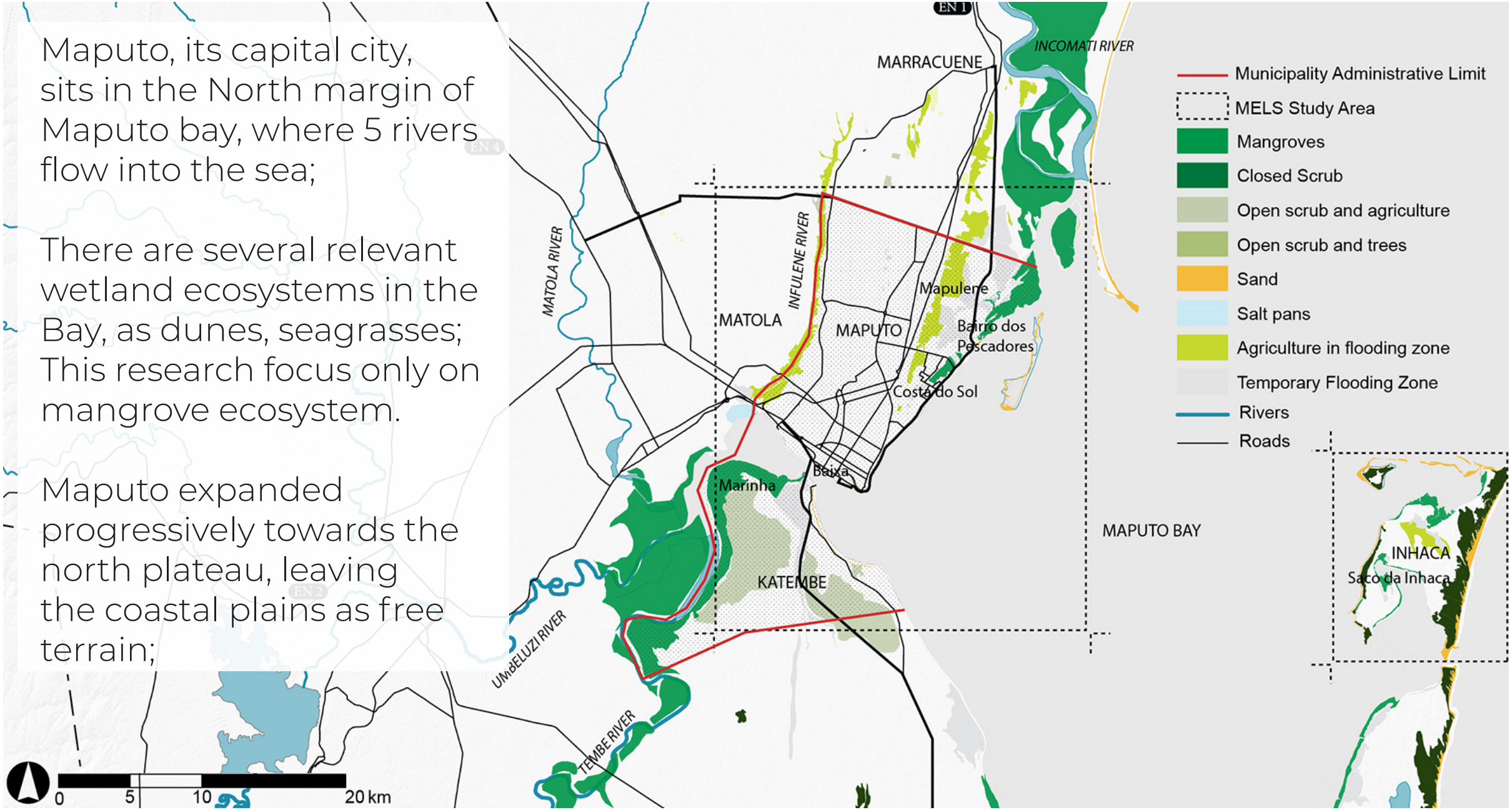


Source: Beja da Costa (2018) based on Cenacarta GIS data (2014, 2018).

Maputo, its capital city, sits in the North margin of Maputo bay, where 5 rivers flow into the sea;

There are several relevant wetland ecosystems in the Bay, as dunes, seagrasses; This research focus only on mangrove ecosystem.

Maputo expanded progressively towards the north plateau, leaving the coastal plains as free terrain;



Maputo Lat -25°57'55S Long 32°35'21E

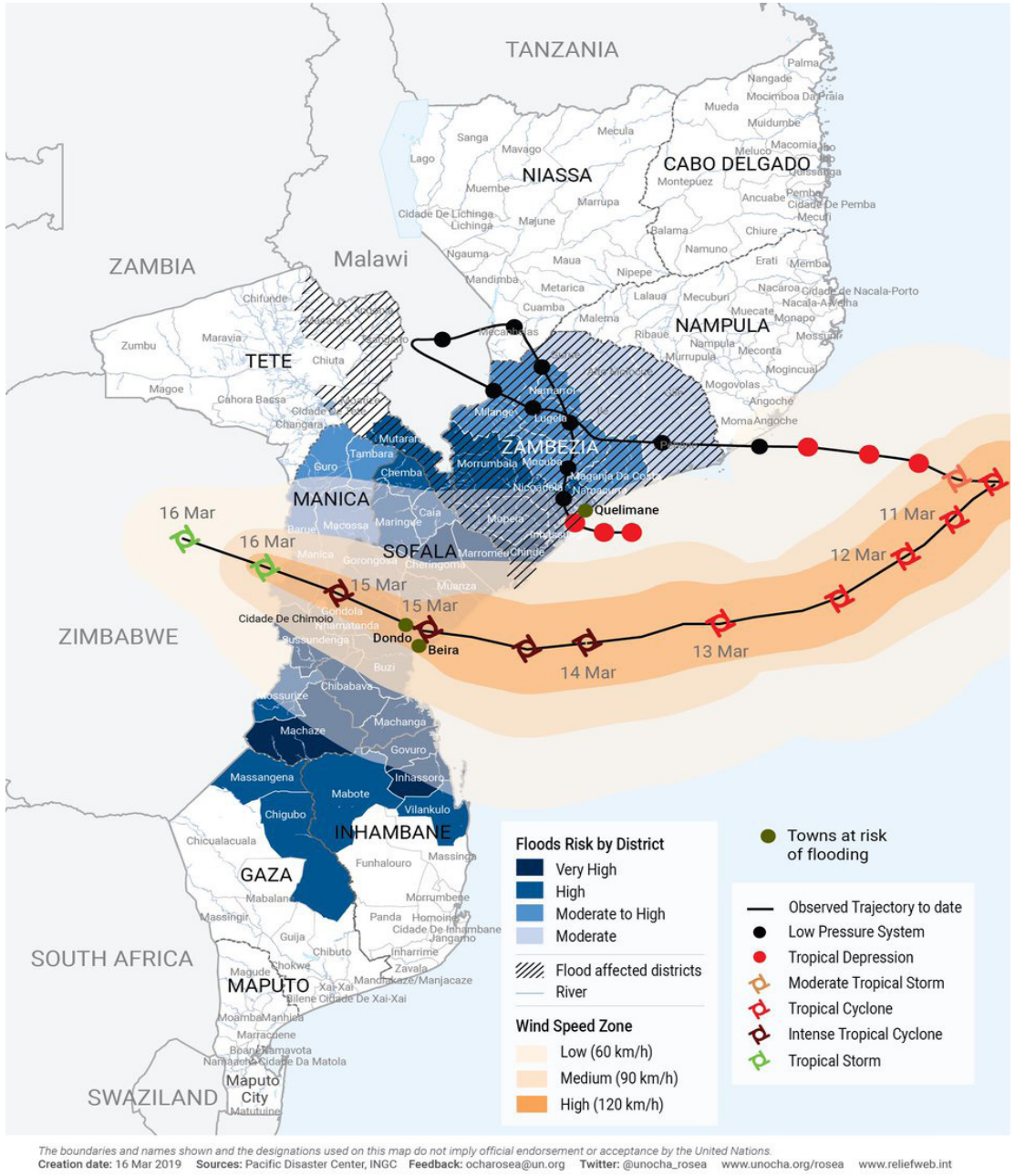
Source: Beja da Costa (2018)

Nowadays, Maputo's waterfront and coastal plains are rapidly changing due to urban sprawl and the lack of land availability on higher grounds of the Municipality;

New road infrastructure, as the Circular, cuts right through Maputo's coastal flood plains;

Along with it, massive seafront housing complexes are built and self-produced neighbourhoods are expanding in flood risk and extreme weather events prone areas.

Circular de Maputo ring-road



BEIRA Lat -19°50´36S Long 34°50’20E

Examples of such events occurred in March and April 2019, when two category 4 cyclones have seriously affected the north-eastern coast of Mozambique in a very short timeframe, damaging the urban areas of Beira and Pemba, as well as their adjacent regions at an unprecedented scale.

2. HYPOTHESIS

There is an urgent need to find practical tools that can support the identification and conservation of mangroves for their inclusion in urban strategies.

The hypothesis that mangroves can integrate urban green infrastructures (GI) is of extreme relevance, as these play a relevant role in the urban context, having a confirmed positive impact on improving cities resilience, through the creation of socio-ecological networks and as ecosystem services providers.

3. GOALS

The main goal of this study is to define a method to map the Mangrove Ecological Land Suitability (MELS) for the Municipality of Maputo, through a GIS-based model that combines multi-criteria information, focusing on its biophysical systems (MELS1).

In addition, this method is applied to map the potential Mangrove Ecological Land Suitability in a sea level rise scenario (MELS2), by adjusting criteria combinations, to foresee possibilities for urban development to accommodate such an event.

4. METHOD

The method consists of a sequence of analysis supported by a GIS assessment of the weight of each spatial component in the modelling of the mangrove suitability areas.
The model was developed following the next steps:

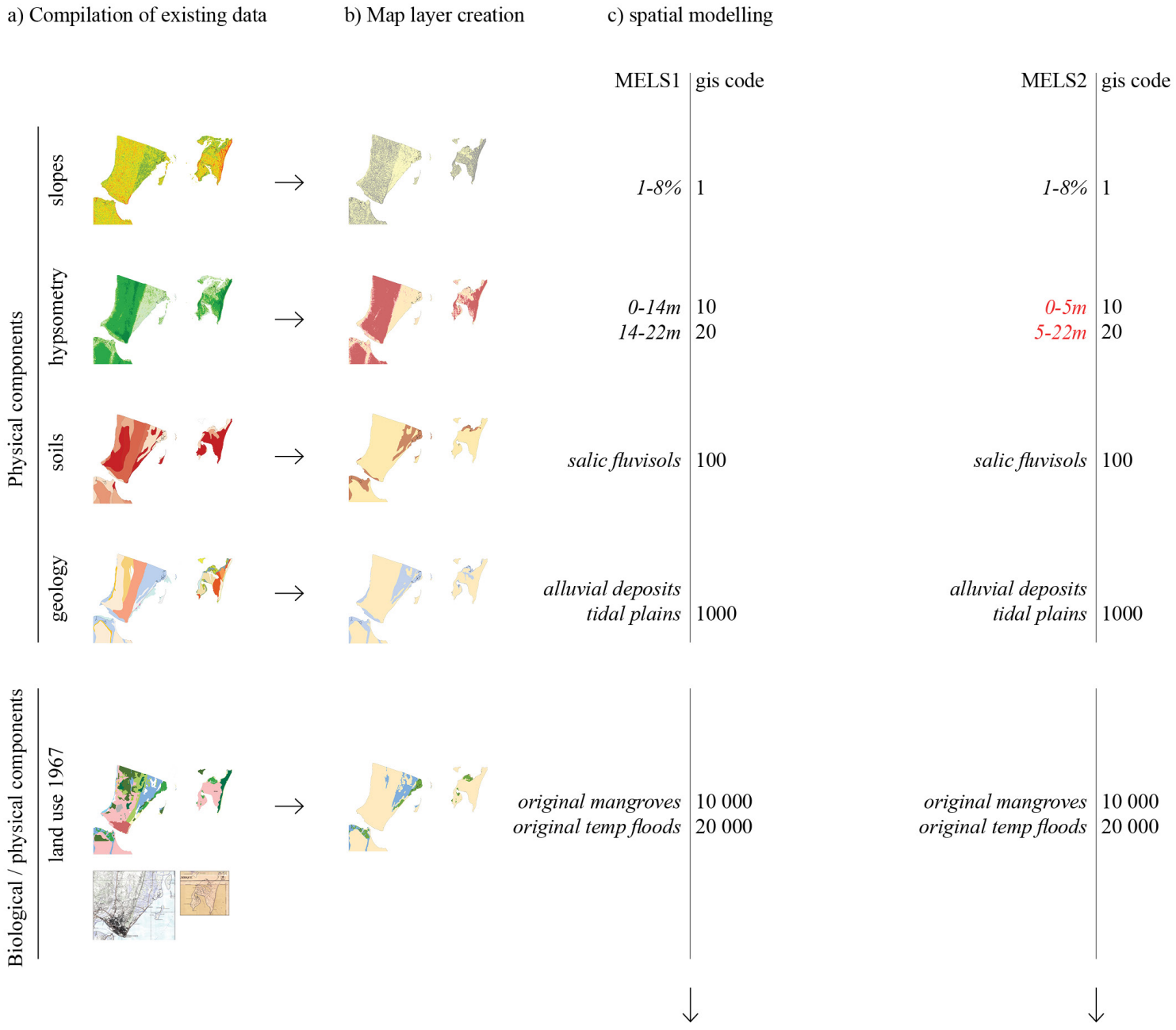
a. compilation of existing data.

b. map layer creation via data acquisition and production of georeferenced cartography of landscape components based on the ideal conditions for mangrove development.

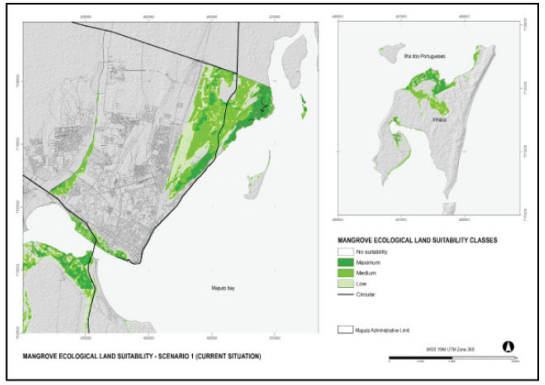
c. analysing spatial data through spatial modelling and overlaying data into two scenarios, MELS1 and MELS2.

d. comparing the two scenarios with the land use in 2017.

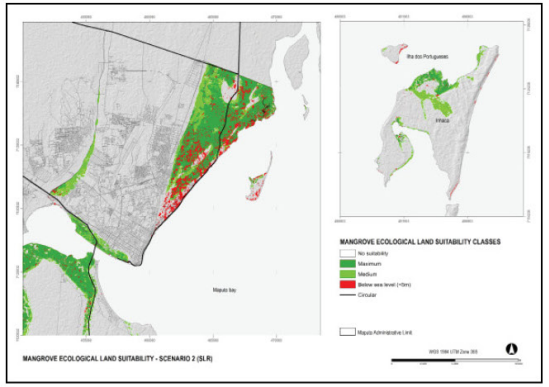
MELS MAPPING METHOD



MELS MAPPING METHOD



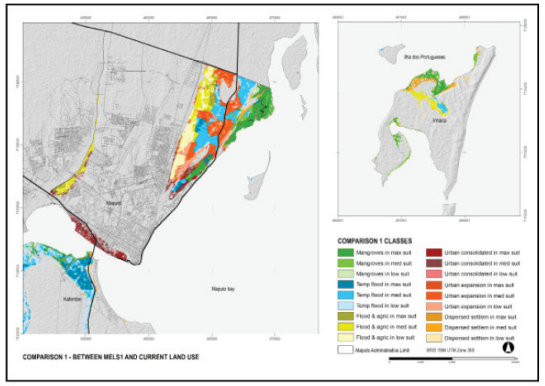
MELS 1



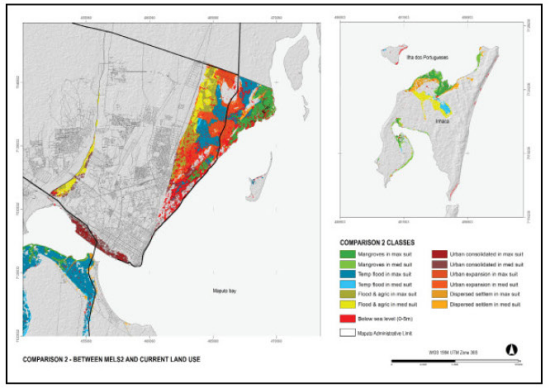
MELS 2

d) comparison with current land use

land use 2017



COMPARISON 1
MELS1+CURRENT LAND USE



COMPARISON 2
MELS 2+CURRENT LAND USE

CRITERIA COMBINATION FOR MELS 1

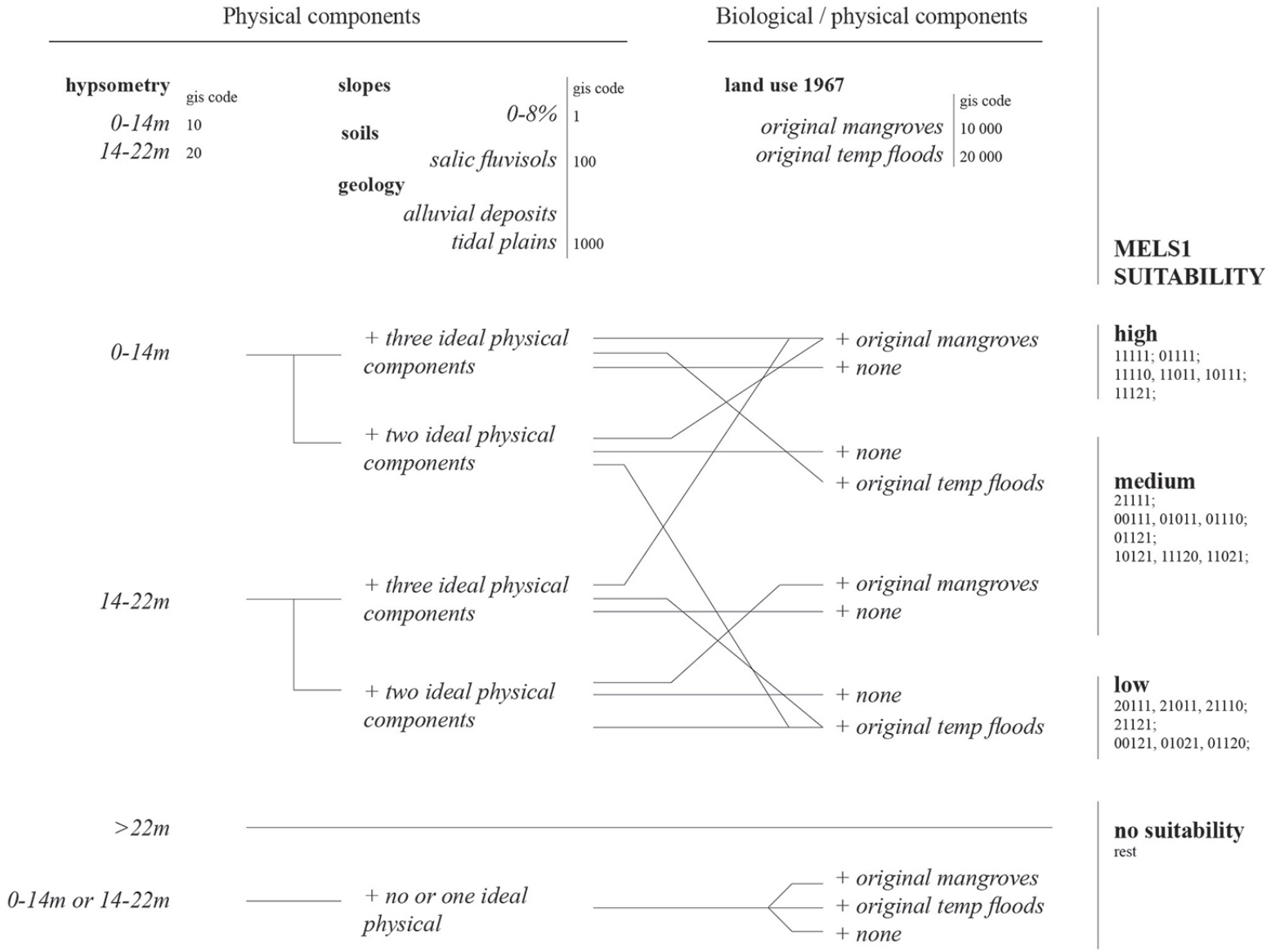
MELS1 criteria are based on the physical thresholds on which potential mangroves currently develop:

slopes between 0-8%;

hypsometry below 22m;

salic fluvisols;

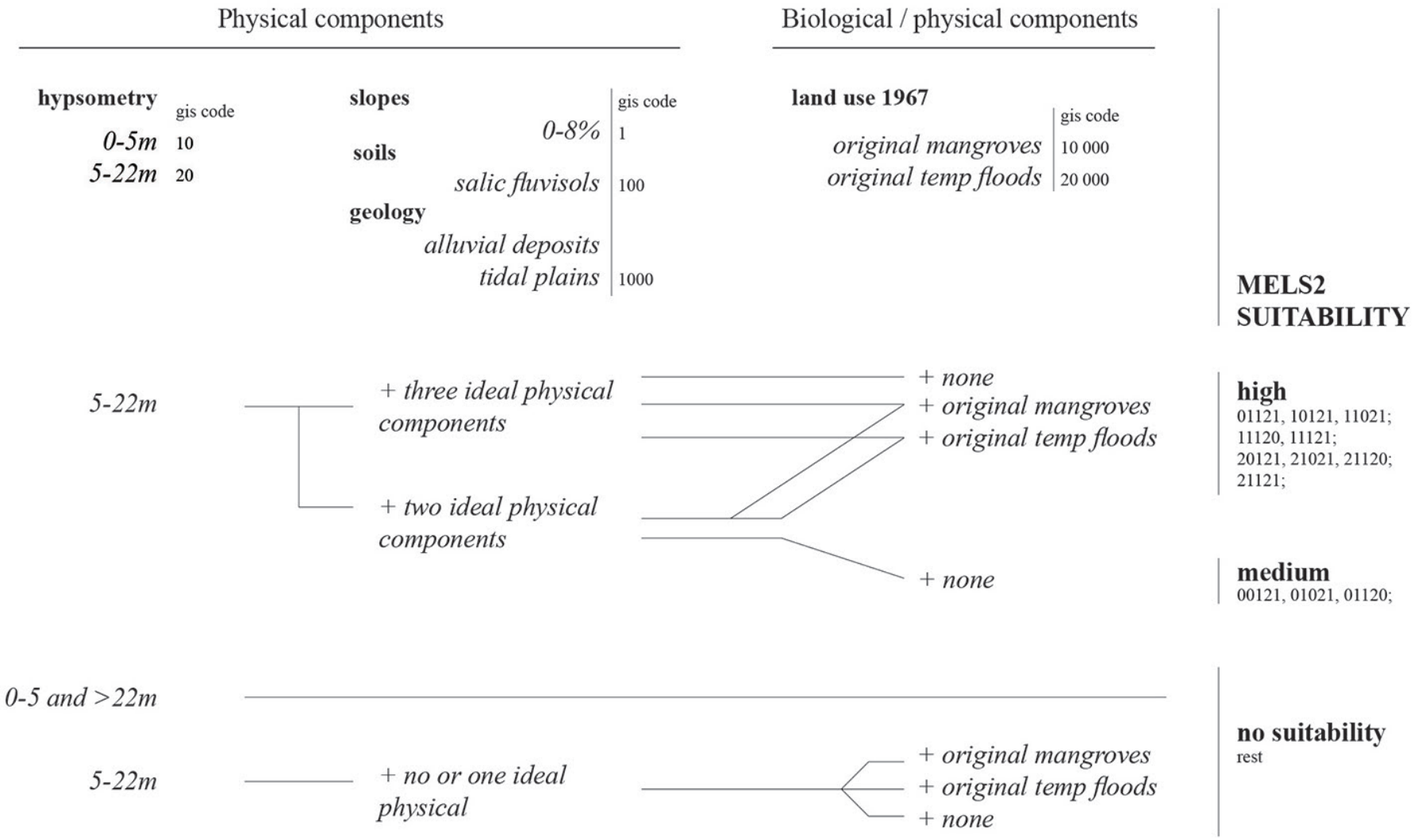
tidal plains and alluvial deposits geology;



CRITERIA COMBINATION FOR MELS 2

MELS2 takes the INGC's High SLR scenario of 5m SLR for 2100

It is an incremental projection based on MELS1.

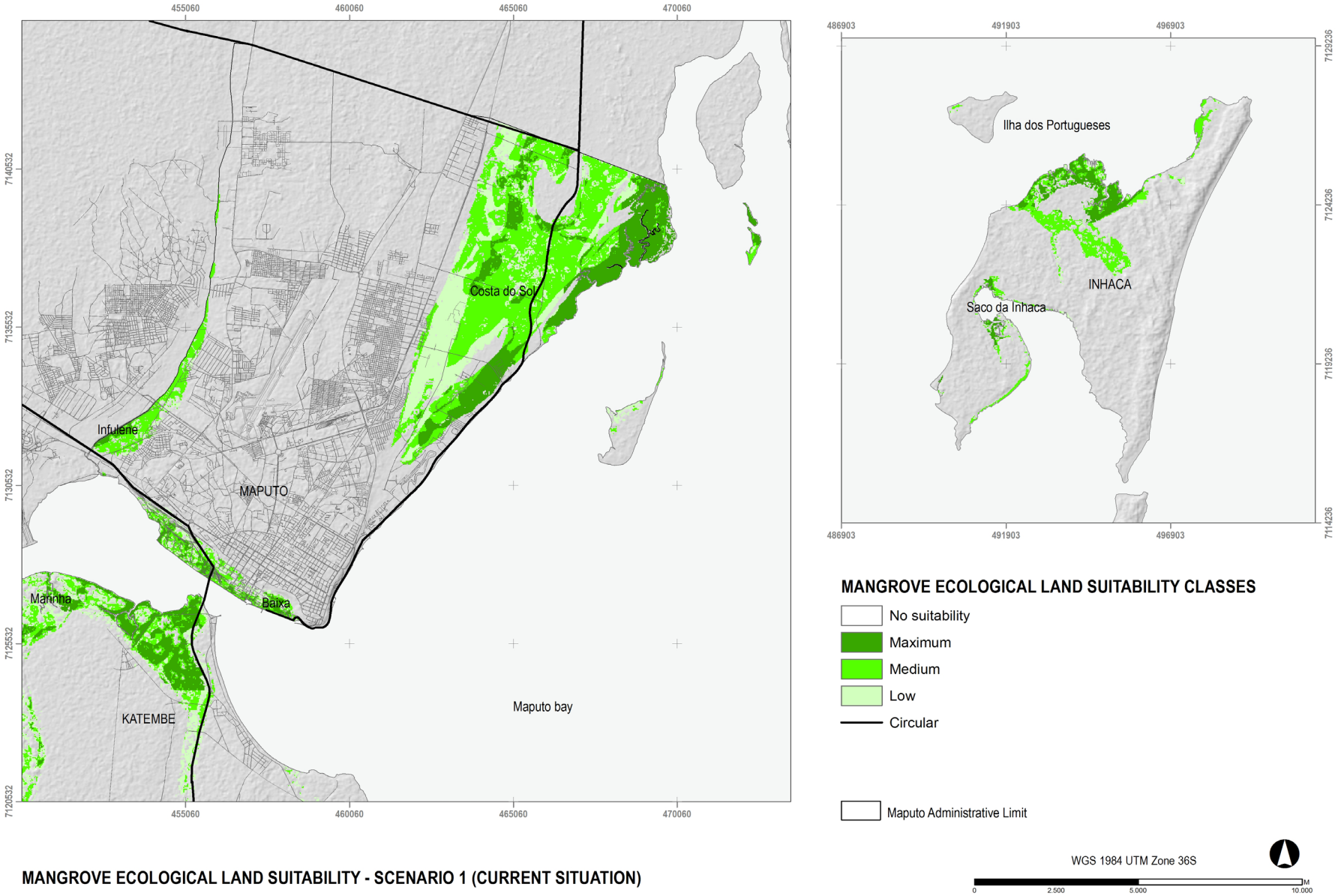


5. RESULTS & DISCUSSION

MANGROVE ECOLOGICAL LAND SUITABILITY 1 (in 2017)

MELS suitability represent 19.9% of the total area of Maputo's Municipality;

5.4% of this area coincides with the mangrove 'maximum suitability' class.



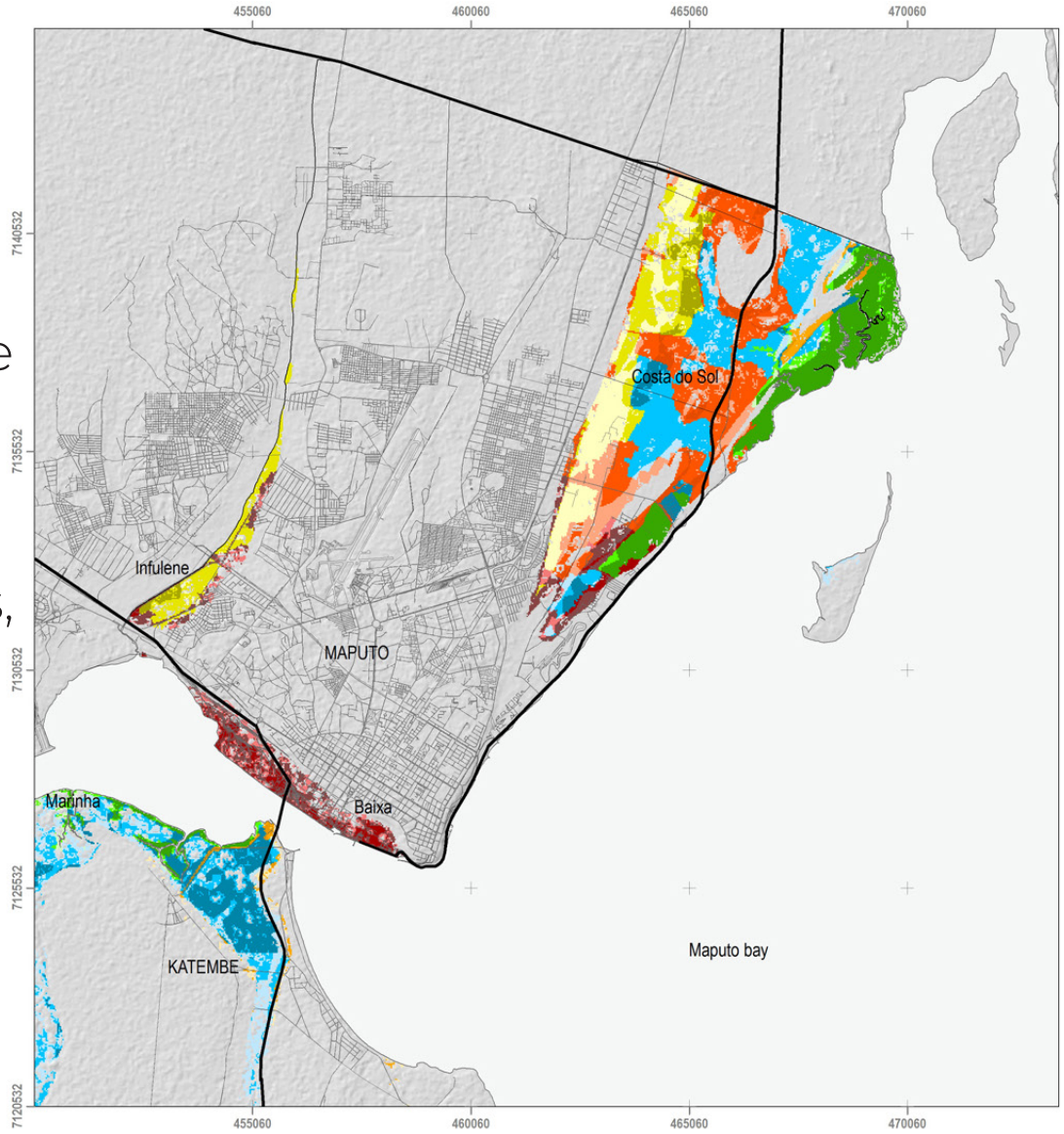
MANGROVE ECOLOGICAL LAND SUITABILITY - SCENARIO 1 (CURRENT SITUATION)

LAND USE (in 2017) overlaped with MELS 1

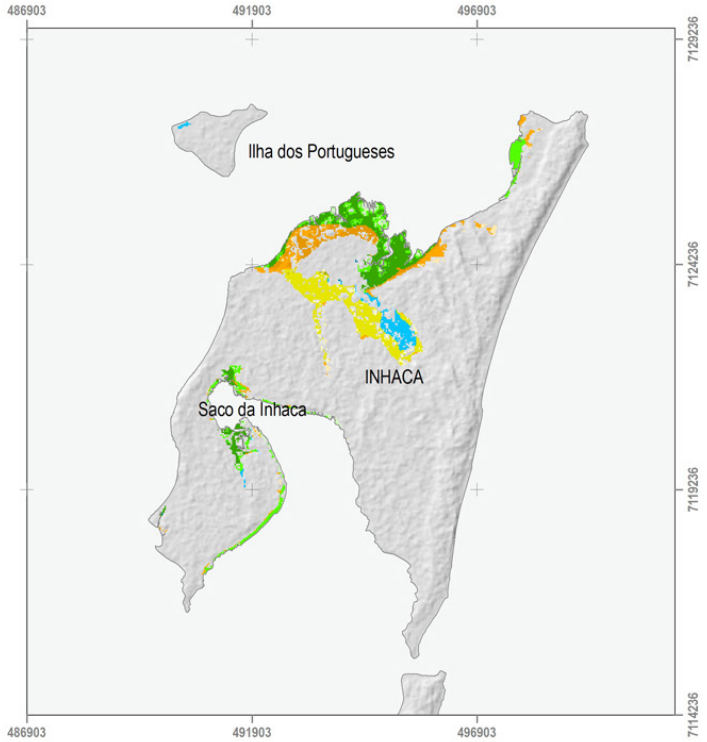
46% of high suitability areas still maintains mangrove vegetation;

One third of mangrove suitability areas (26% high, 33% medium and 30% low) are temporary flood zones, where mangrove can be implemented;

19% of any suitability is threatened by urban expansion, compromising the ecosystem's viability;



COMPARISON 1 - BETWEEN MELS1 AND CURRENT LAND USE



COMPARISON 1 CLASSES

- Mangroves in max suit
- Mangroves in med suit
- Mangroves in low suit
- Temp flood in max suit
- Temp flood in med suit
- Temp flood in low suit
- Flood & agric in max suit
- Flood & agric in med suit
- Flood & agric in low suit
- Maputo Administrative Limit
- Urban consolidated in max suit
- Urban consolidated in med suit
- Urban consolidated in low suit
- Urban expansion in max suit
- Urban expansion in med suit
- Urban expansion in low suit
- Dispersed settlem in max suit
- Dispersed settlem in med suit
- Dispersed settlem in low suit

WGS 1984 UTM Zone 36S

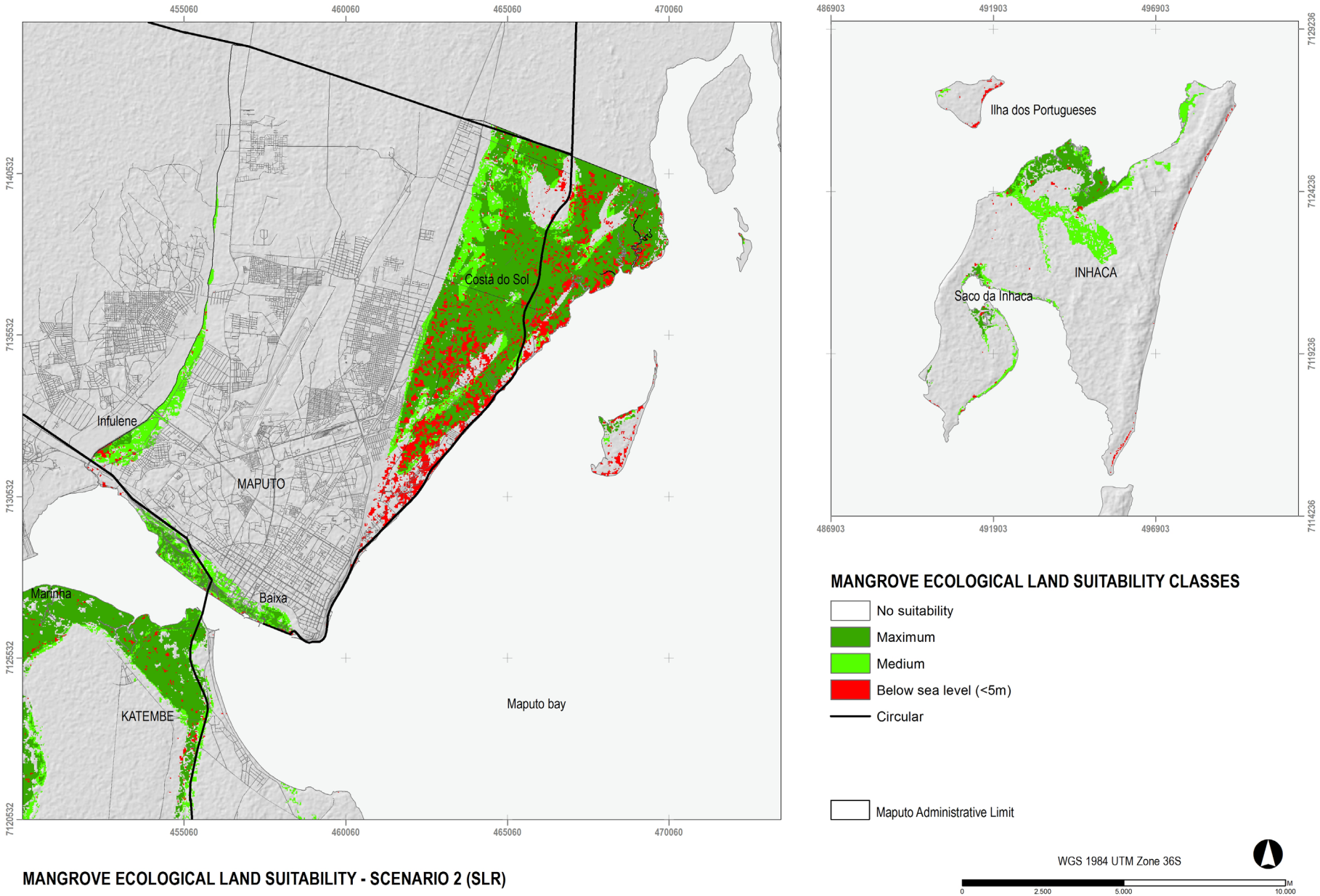
0 2.500 5.000 10.000 M

MANGROVE ECOLOGICAL LAND SUITABILITY 2 (in 2100)

MELS2 shows a decrease in the overall percentage of areas with suitability in a projected 5m SLR scenario;

3.1% of suitable areas for mangrove developmpment along the coast will become permanently submerged;

Maximum suitability areas will migrate further inland by tidal influence;



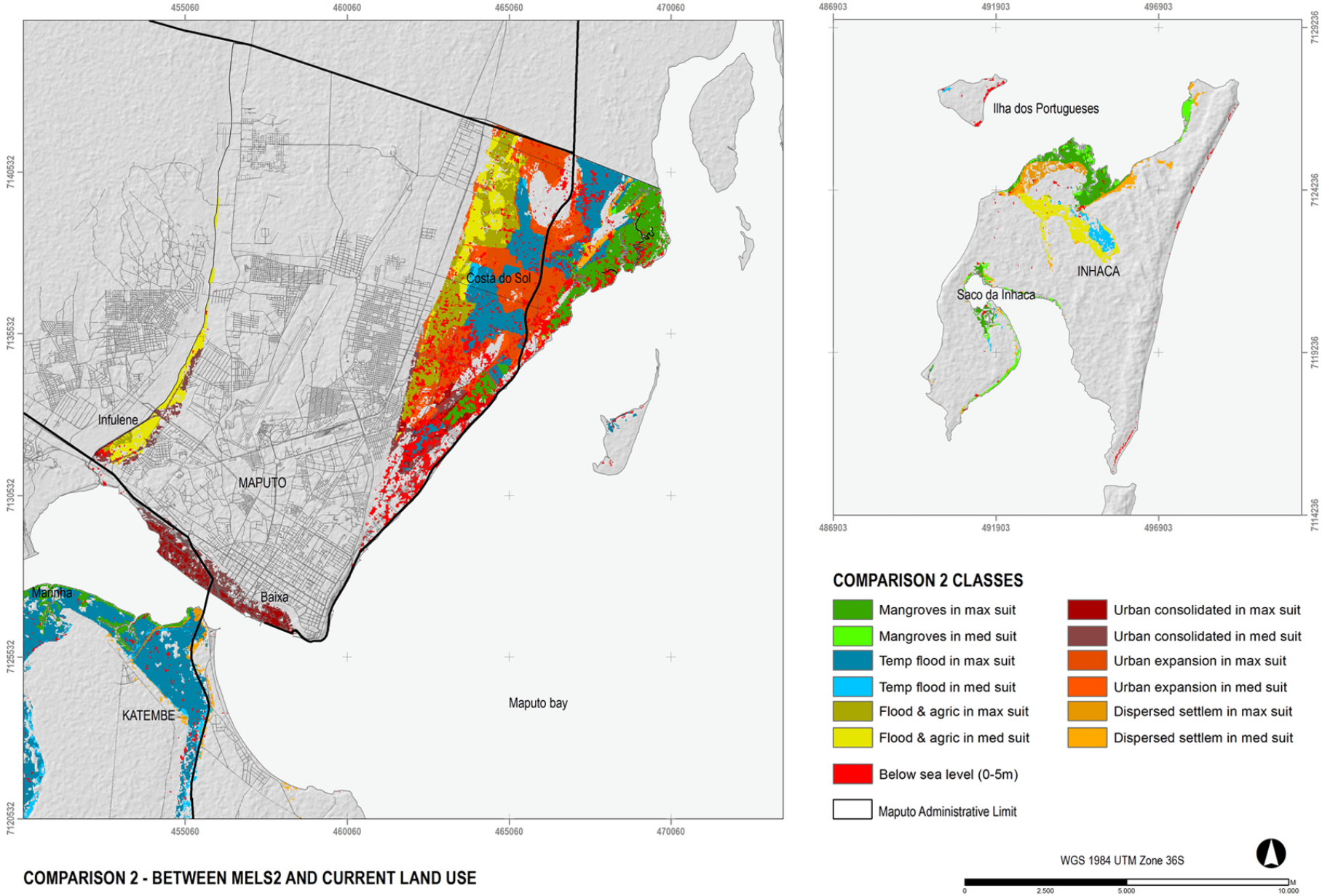
MANGROVE ECOLOGICAL LAND SUITABILITY - SCENARIO 2 (SLR)

LAND USE (in 2017) overlaped with MELS 2

10% of any suitability (4% high and 22% medium) is in urban consolidated area;

61% of Maputo's urban expansion area is either submerged (12%) or in high (39%) or low (10%) suitability;

Location of urban expansion areas are to become more problematic than in MELS1;



COMPARISON 2 - BETWEEN MELS2 AND CURRENT LAND USE

In both scenarios, urban expansion areas - expected to become consolidated urban areas in a near future - are the main threat against mangrove conservation and its further development in areas with mangrove suitability.

6. CONCLUSIONS

MELS mapping method can be a tool for the management of risk prone, and mangrove ecosystem conservation areas within the scope of climate change mitigation and adaption strategies.

A sustainable urban expansion along the coastal plains of Maputo can only be achieved through a “let-the-water-in” concept, with soft engineering solutions that include mangroves and people as part of an urban green infrastructure.

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