ONEKANA

Earth **O**bservatio**N**-based mod**E**lling
for ma**K**ing therm**A**l i**N**equality visible in **A**frican cities

Thermal Inequalities in Cities of the Global South

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Rationale

HUGE DATA GAPS IN THE GLOBAL SOUTH

Intra-city thermal inequalities mostly invisible

11 SUSTAINABLE CITIES AND COMMUNITIES

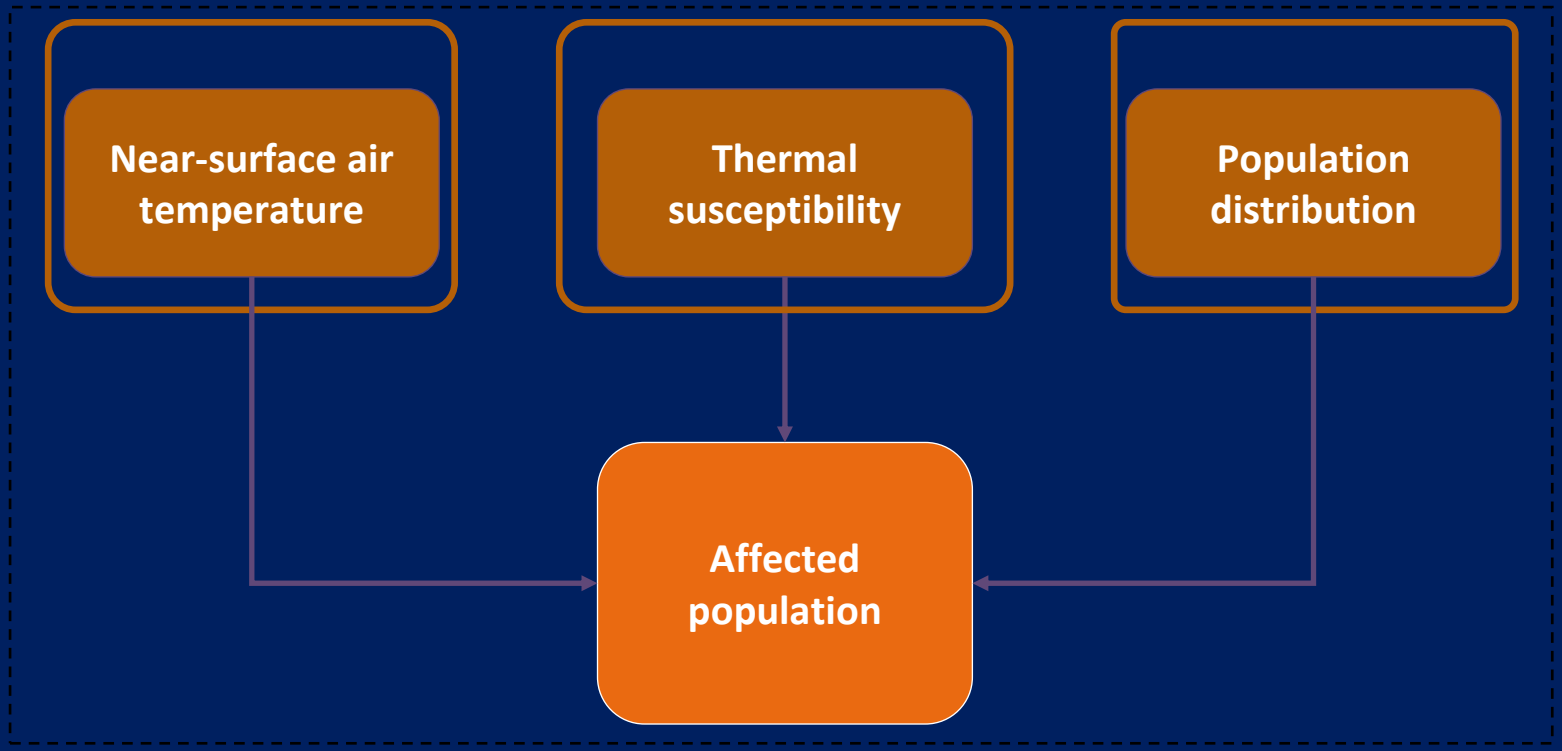
Make cities and human settlements inclusive, safe, resilient and sustainable

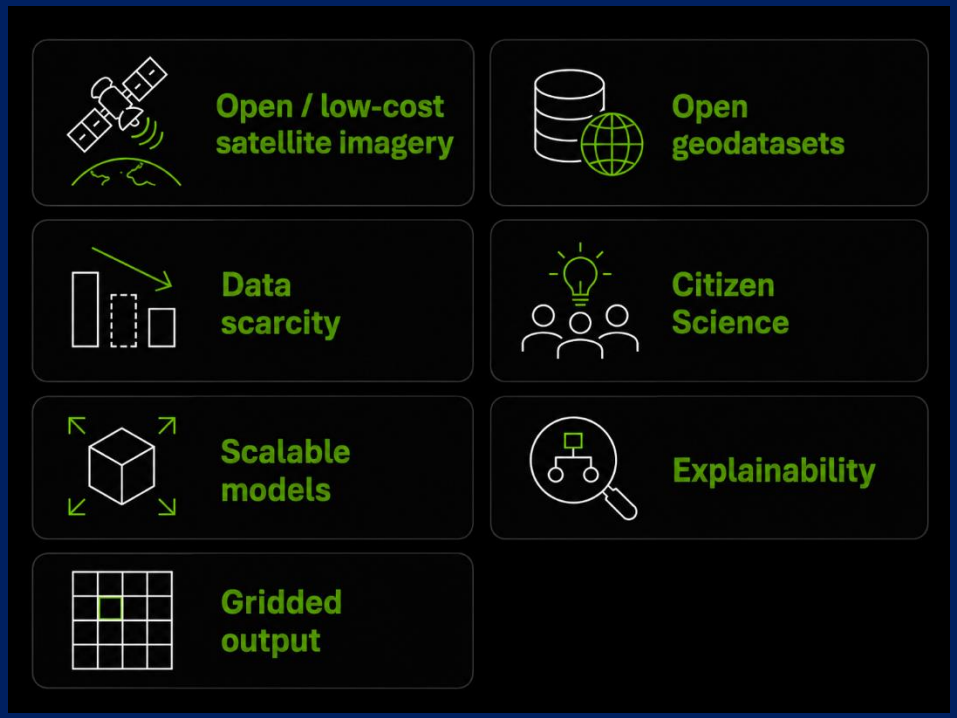
Objectives

Develop EO modelling frameworks

Narrow data gaps

Make thermal inequalities visible





Study areas

SELECTION OF DEPRIVED AREAS

- With local stakeholders
- Diversity
- Relevance
- Safety
- Local knowledge
- Accessibility

Near-Surface Air Temperature

Input covariates

Surface / spectral

- **NDVI / NDWI / NDBI**
  Sentinel-2 L2A
  Vegetation · Water · Built-up
- **LST**
  ECOSTRESS
  Surface skin temperature
- **Emissivity**
  ECOSTRESS
  Thermal surface property
- **Albedo**
  VIIRS + HLS
  Surface reflectance

Urban form

- **Building morphometrics**
  Google Open Buildings v3
  Urban form
- **Building height**
  WSF-3D
  Urban form · Sky-view factor

Topography

- **Slope / aspect**
  ALOS PALSAR DEM
  Landform

50 m grid-cell covariates

Aggregated to 50 m grid cells

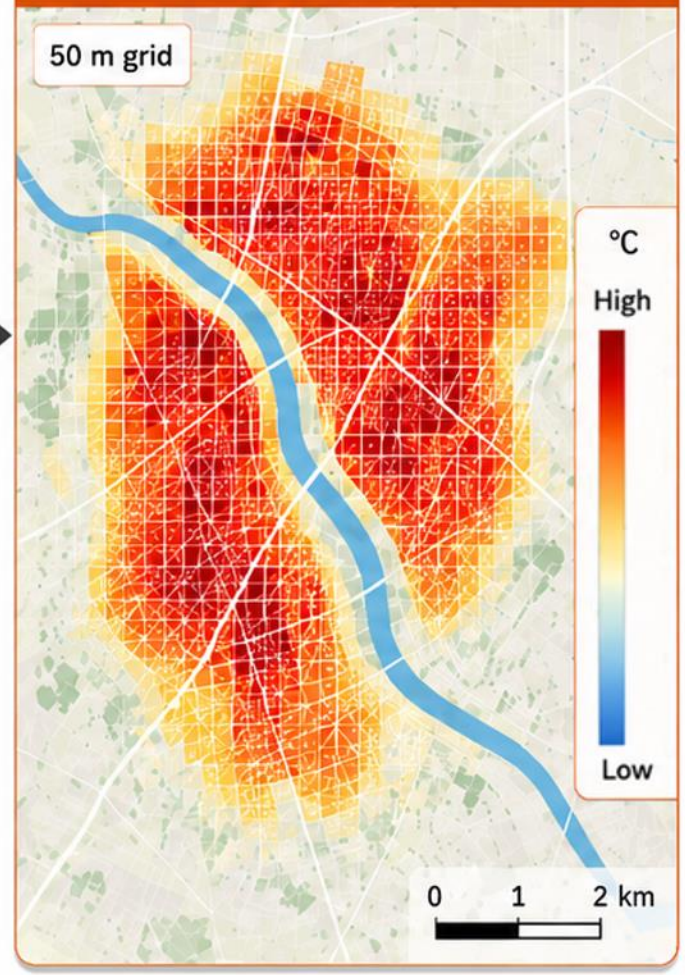
Random Forest model

In situ Tair measurements

Air temperature observations

Aggregated to 50 m grid cells

Predicted near-surface air temperature



Citizen science

BRIEFING

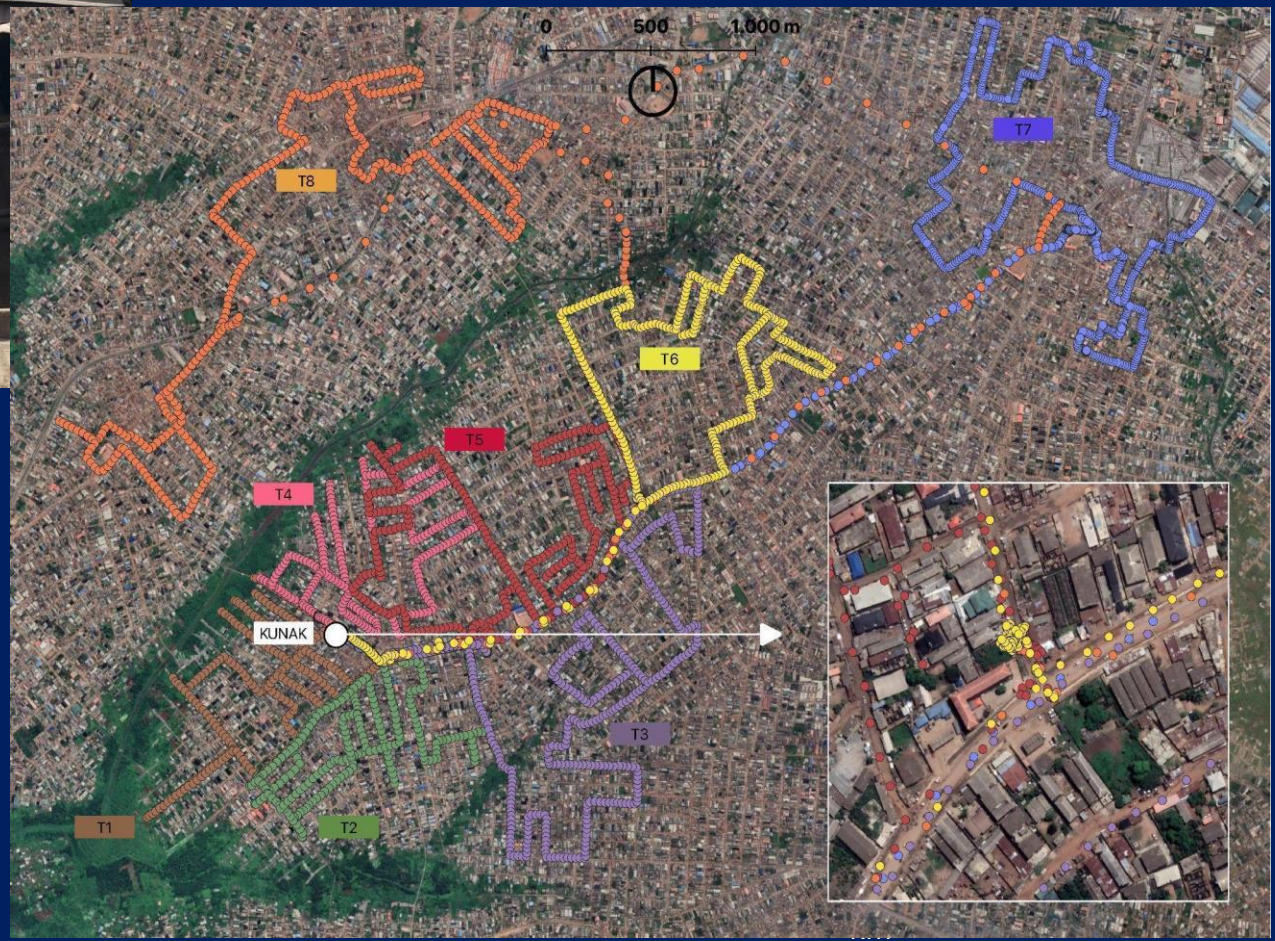
MEASURE-MENTS

FEEDBACK

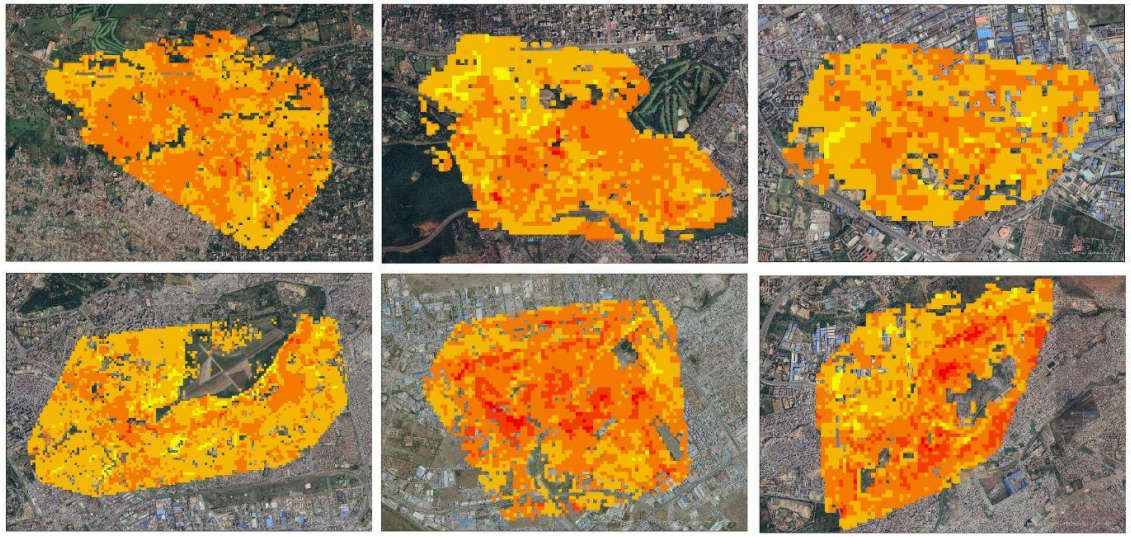
- Briefing and deployment
- Sensor Placement (14.30)
- Mobile Measurement (15.00 – 17.00)
- Feedback

In situ measurements (citizen science)

10 m



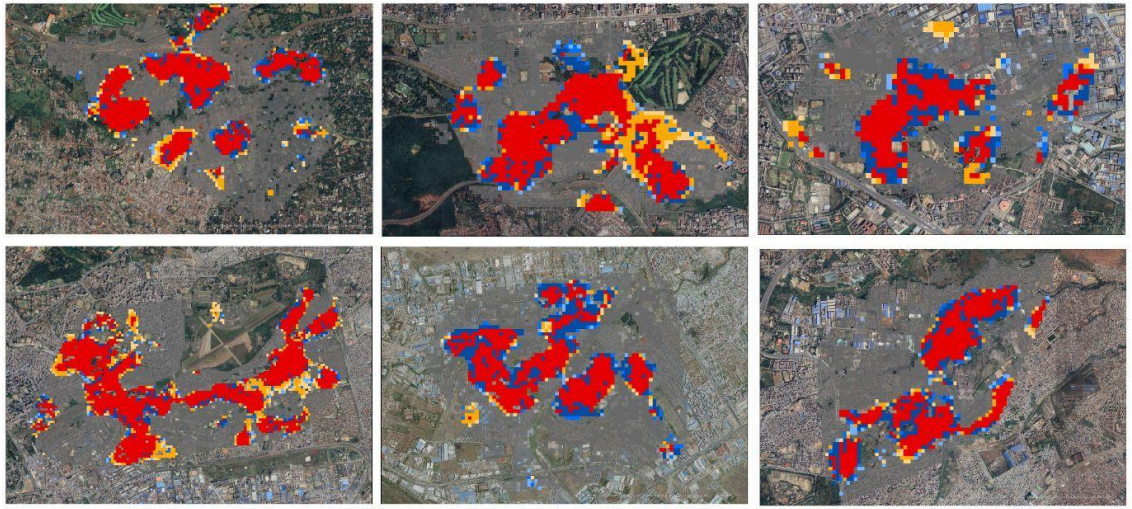
Results



Predicted Temperature (°C)

26 32

AERIAL VIEW OF HOTSPOT ZONE: KIBERA



Hotspot(99%Confidence) Coldspot(99%Confidence) Insignificant
Hotspot(95%Confidence) Coldspot(95%Confidence)
Hotspot(90%Confidence) Coldspot(90%Confidence)

AERIAL VIEW OF HOTSPOT ZONE: MUKURU

KEY PREDICTORS

- Building orientation
- Inter-building distance
- LST
- NDVI
- Building alignment
- Floor-area ratio
- Albedo

	CITY-SPECIFIC		TRANSFER	
	NAIROBI	LAGOS	LAGOS (0%)	LAGOS (10%)
MAE	0.39 °C	0.45 °C	4.90 °C	0.52 °C

Thermal susceptibility

Input covariates

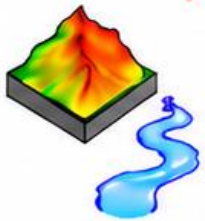
Surface / spectral

Sentinel-2 → vegetation, moisture, built-up, roof characteristics

Urban form

Open Buildings v3 + Open Buildings 2.5D → morphometrics / building height

Topography / access



COPDEM + OSM Rivers → distance and elevation difference to nearest river

OSM Roads → road density index

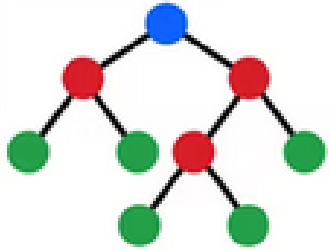
Aggregate to 100 m grid cells

Micro-surveys

LETSI

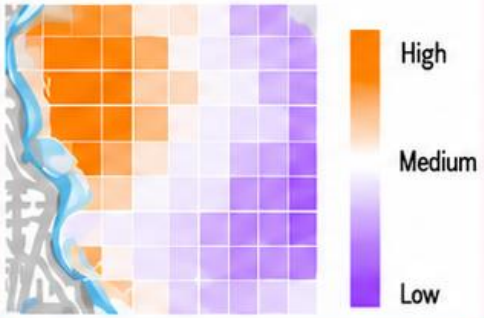
(Living Environment Thermal Susceptibility Index) derived from micro-surveys

LightGBM, RF, and HGB



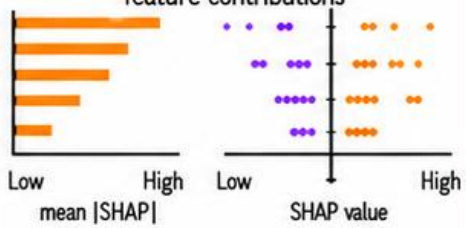
Performance assessment

Predicted thermal susceptibility LETSI



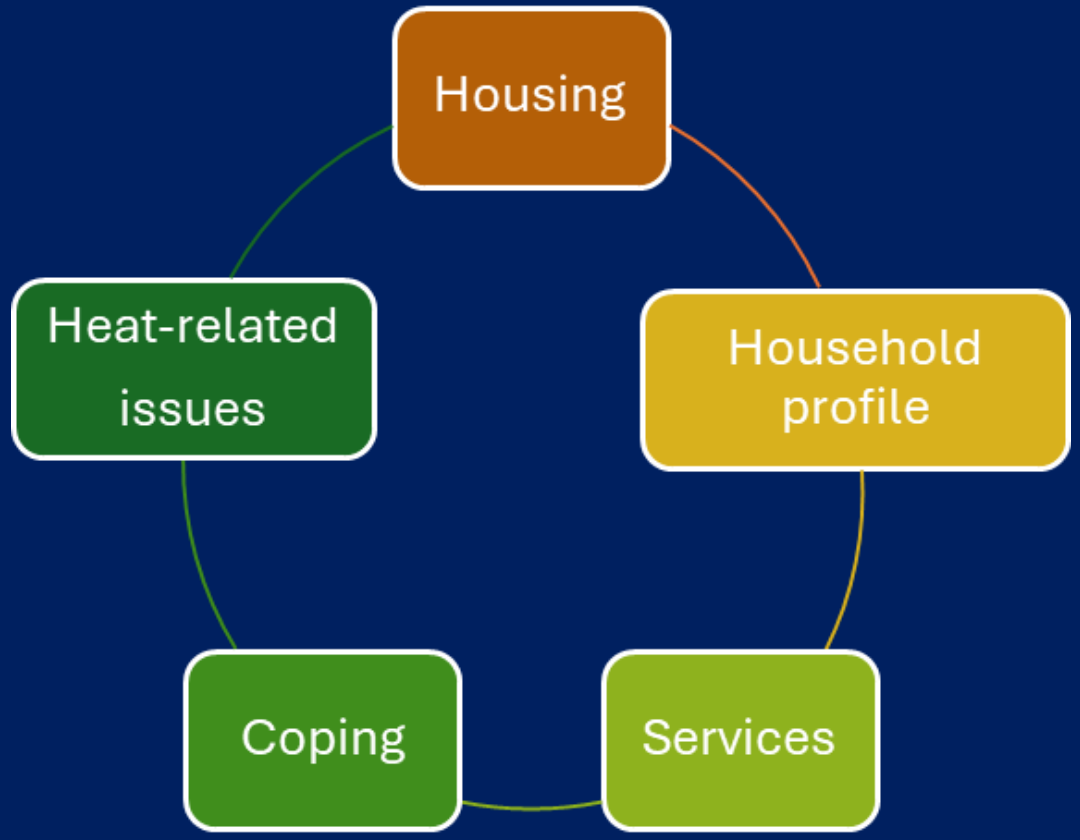
SHAP explainability

feature contributions



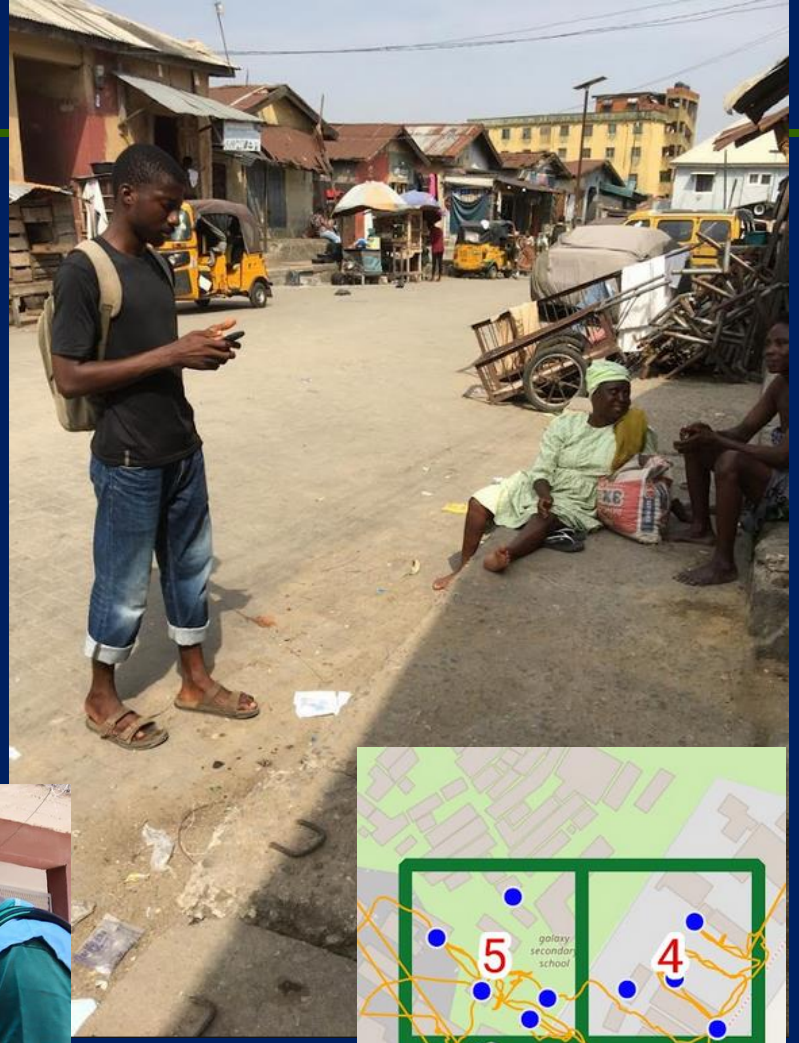
Questionnaire

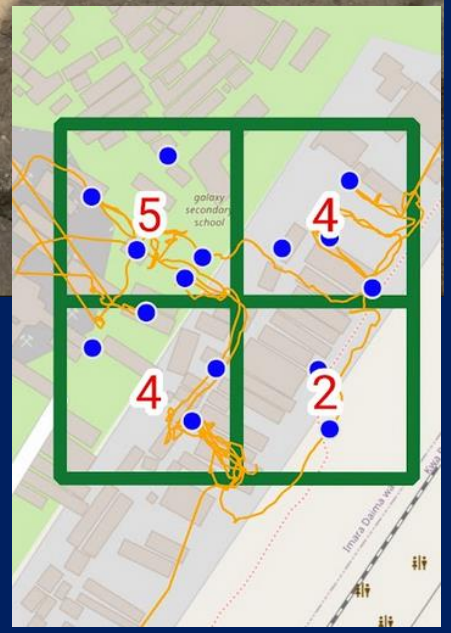
Co-designed with community leaders and local CBOs



- Observation of housing conditions
- Questionnaire : anonymous, no sensitive questions

Micro-surveys





MERGIN MAPS

HOUSING - INSIDE

In the main room, is the roof insulated?

Field must not be empty

In the main room, are the walls insulated?

Field must not be empty

In the main room, what is the main floor material?

Field must not be empty

PROFILE

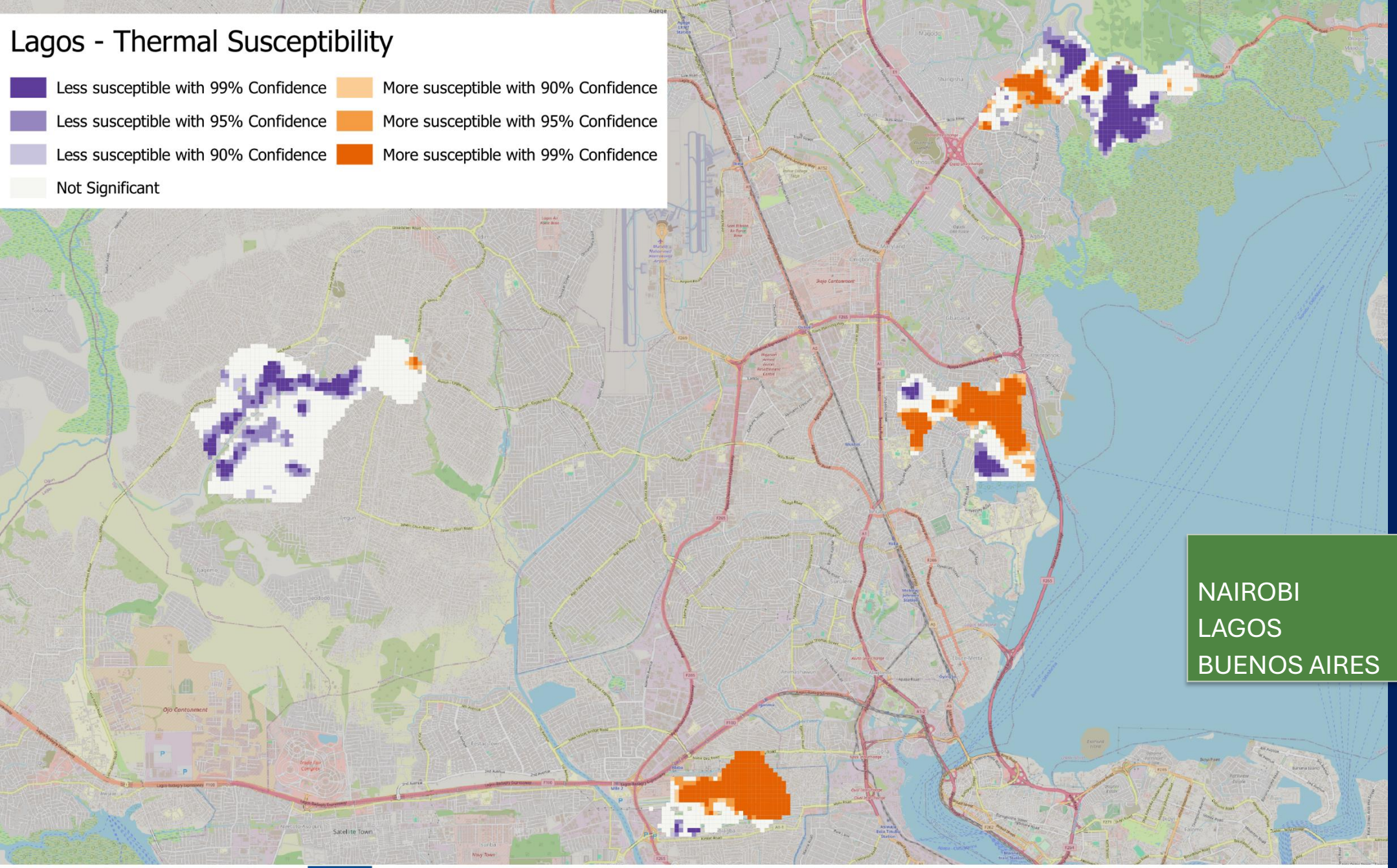
How many people are there in the household?

Field must not be empty

How much is the monthly rent?

Suprimmer

Modifier la géométrie



	KEY PREDICTORS
NAIROBI	S2 Roof CSSI
LAGOS	S2 Brightness
BUENOS AIRES	Building height

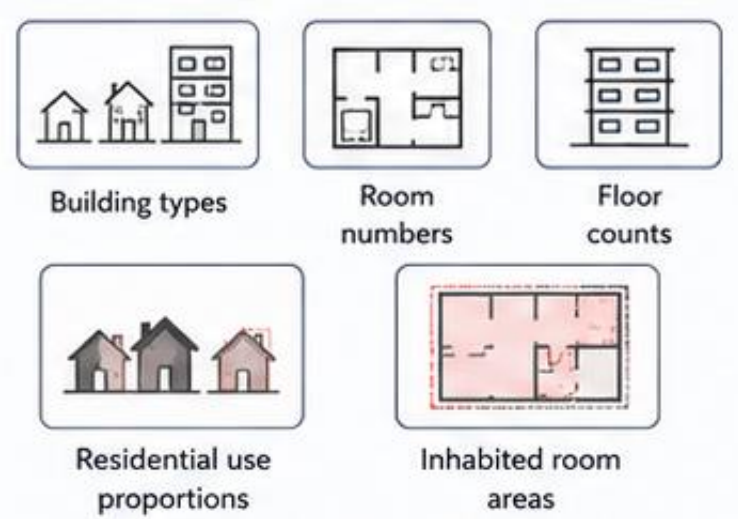
Background map: OSM

0 2,5 5 km

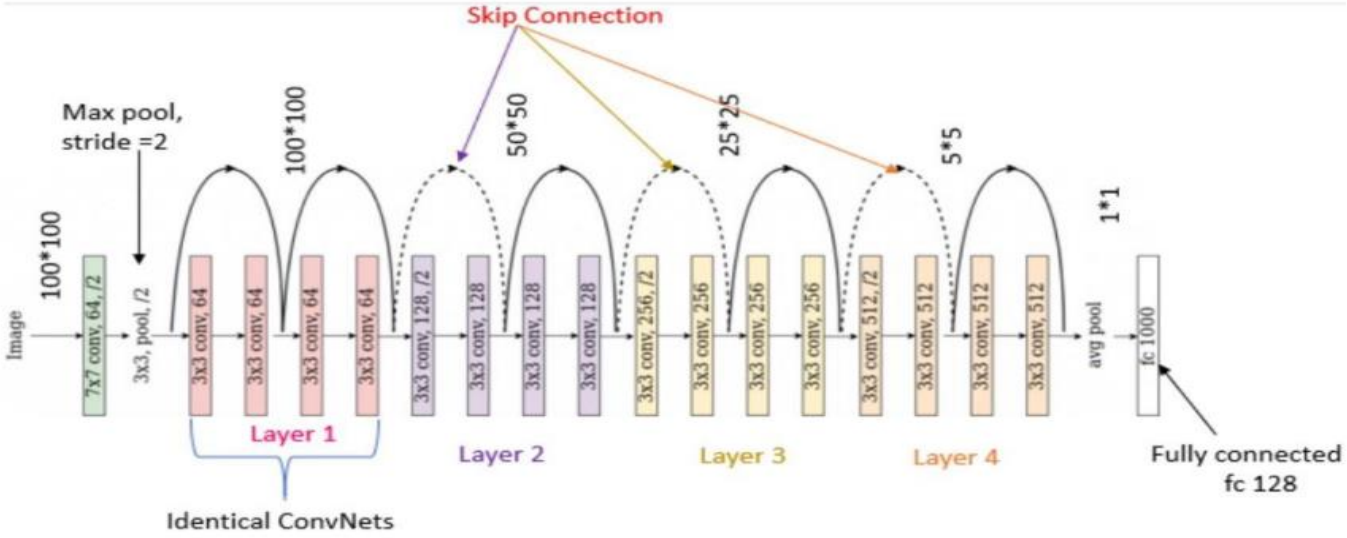
Population distribution

Population data from micro-surveys

Extrapolate to grid level

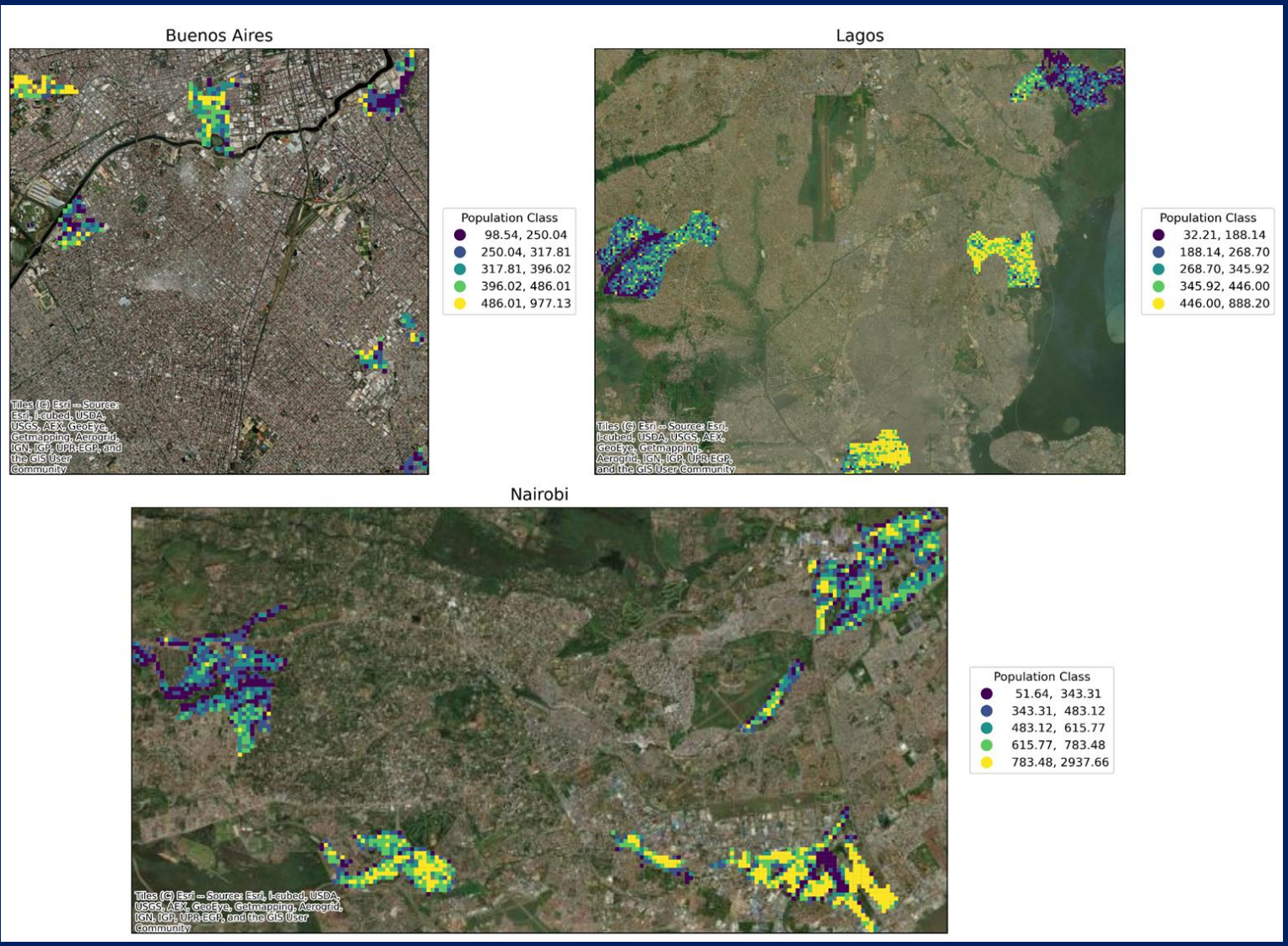


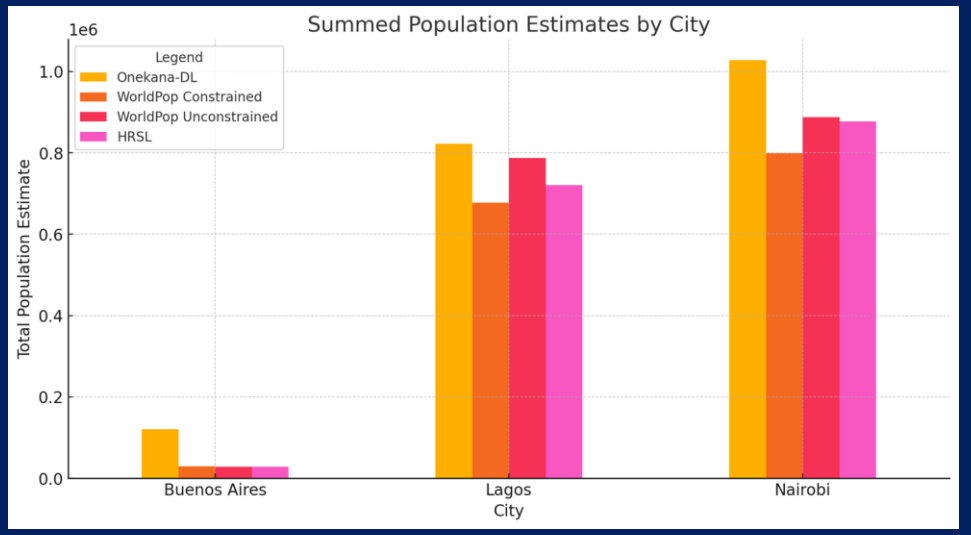
DL model

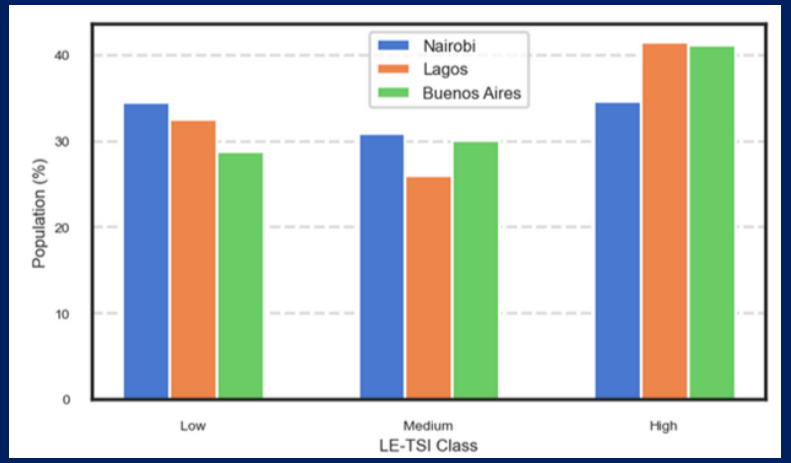


- ResNet-18 backbone with PyTorch
- 4 spectral bands from PlanetScope imagery + augmentation

Results

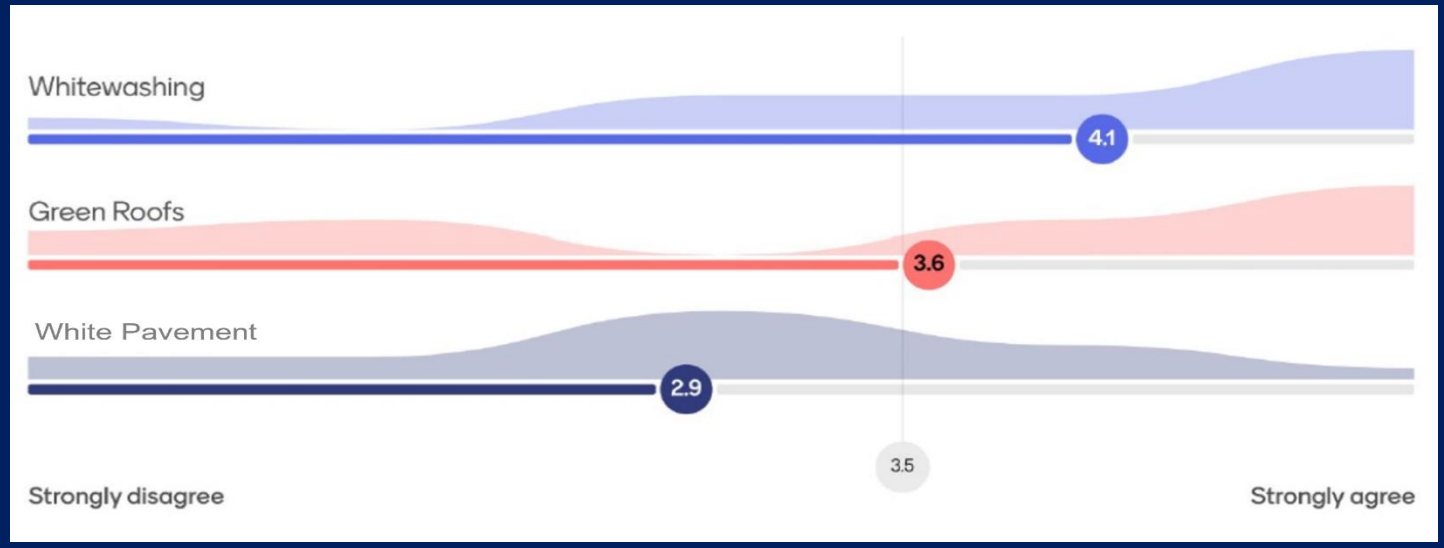

Buenos Aires
Population Class
98.54, 250.04
250.04, 317.81
317.81, 396.02
396.02, 486.01
486.01, 977.13
Lagos
Population Class
32.21, 188.14
188.14, 268.70
268.70, 345.92
345.92, 446.00
446.00, 888.20
Nairobi
Population Class
51.64, 343.31
343.31, 483.12
483.12, 615.77
615.77, 783.48
783.48, 2937.66


Summed Population Estimates by City
1e6
Legend
Onekana-DL
WorldPop Constrained
WorldPop Unconstrained
HRSL
Total Population Estimate
Buenos Aires
Lagos
Nairobi
City


Nairobi
Lagos
Buenos Aires
Population (%)
Low
Medium
High
LE-TSI Class

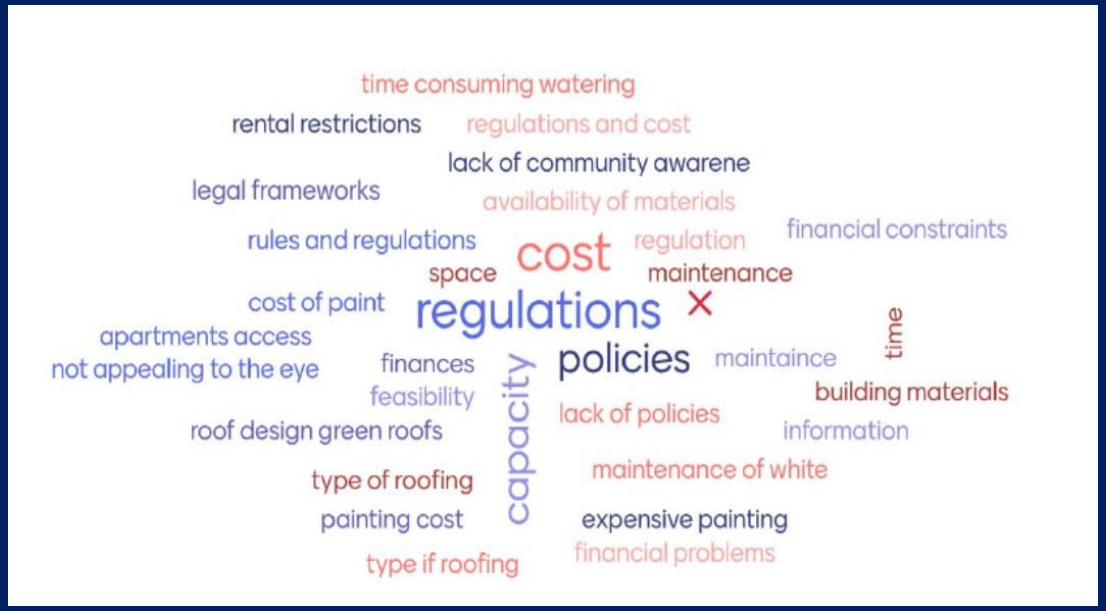
Stakeholder feedback

Most important feasible adaptation measures (from a community perspective)



11 SUSTAINABLE CITIES AND COMMUNITIES

Main barriers to the implementation of adaptation measures



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