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Modeling and predicting African Urban Population Patterns

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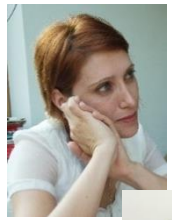
RESEARCH PROGRAMME FOR EARTH OBSERVATION “STEREO III”

Belgian Science Policy Office
belspo

The MAUPP team



ULB

SpELL

- Large-scale human pop. in Africa
- Urban extent modelling
- Spread models
- Spatial epidemiology (animal diseases)

ULB

ANAGEO

- VHRRS & OBIA applied in Africa
- Urban morphology and dynamics in Africa
- Geographical understanding of urban dynamics

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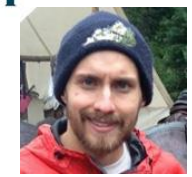
SIC-RMA

- RS signal processing
- Integration from different sensors
- Large data volume processing

WORLDPOP

- Human pop. distribution, demography and mobility
- Spatial epidemiology (human diseases)

UNIVERSITY OF Southampton

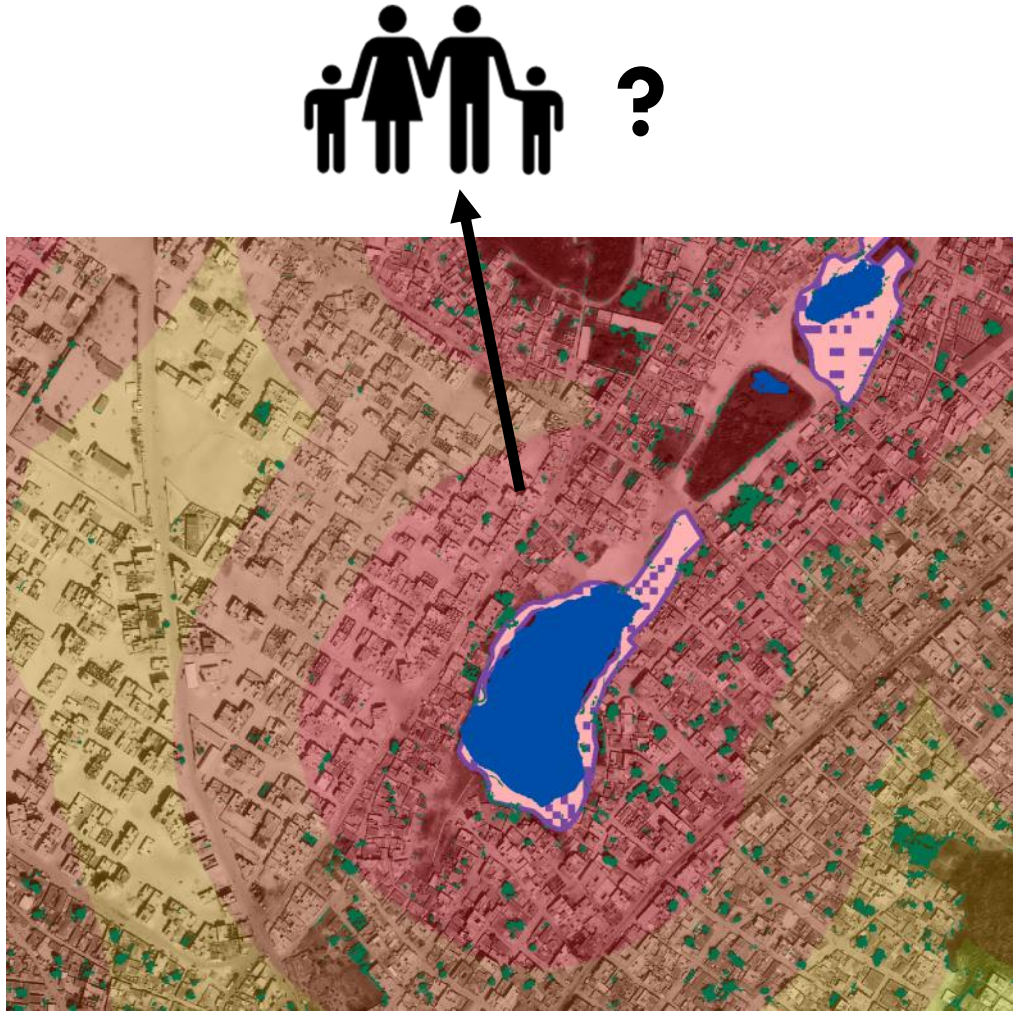


Population at risk is key

Risk assessment

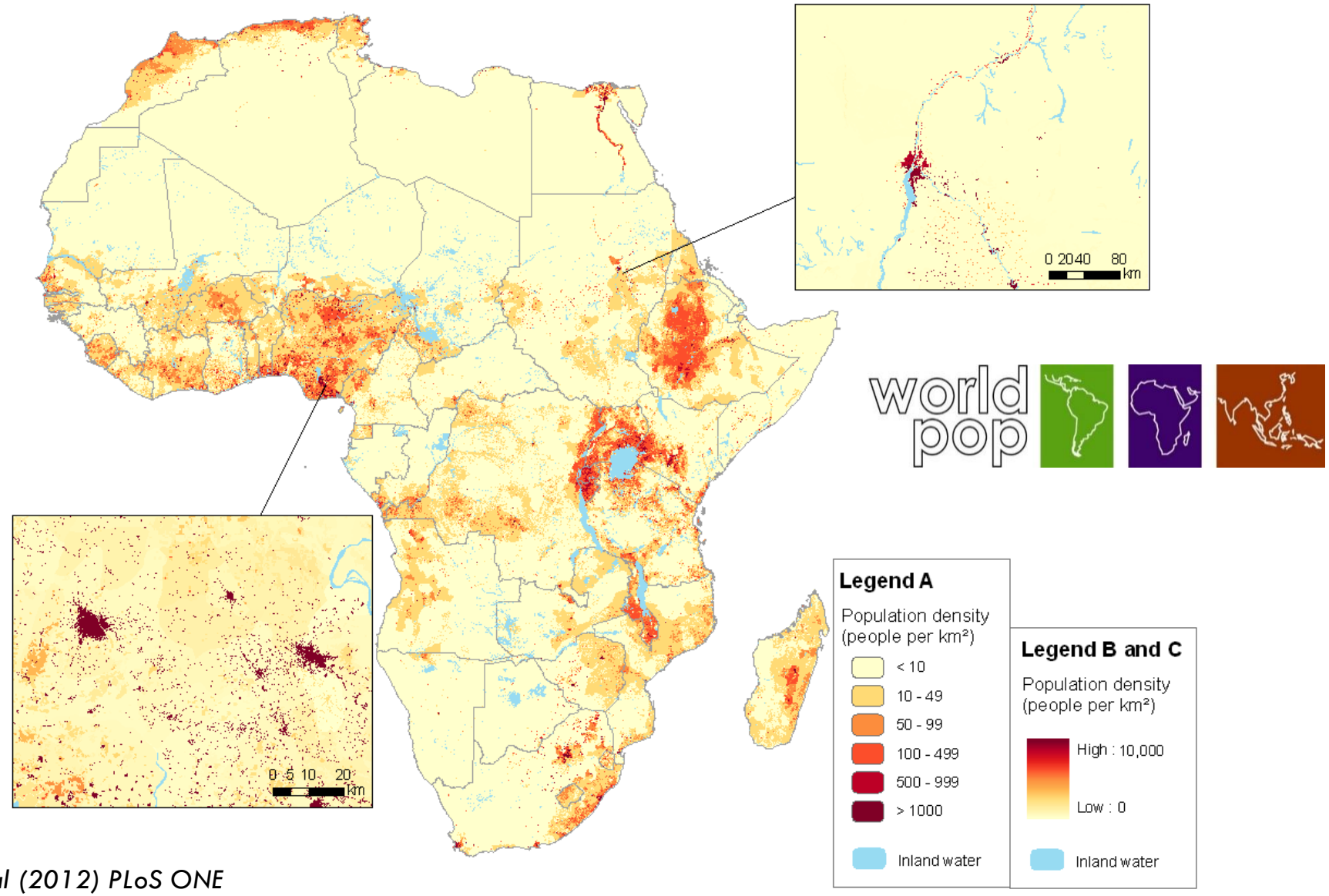
Risk = P(occurrence).Impact

Impact = f(Hpop)



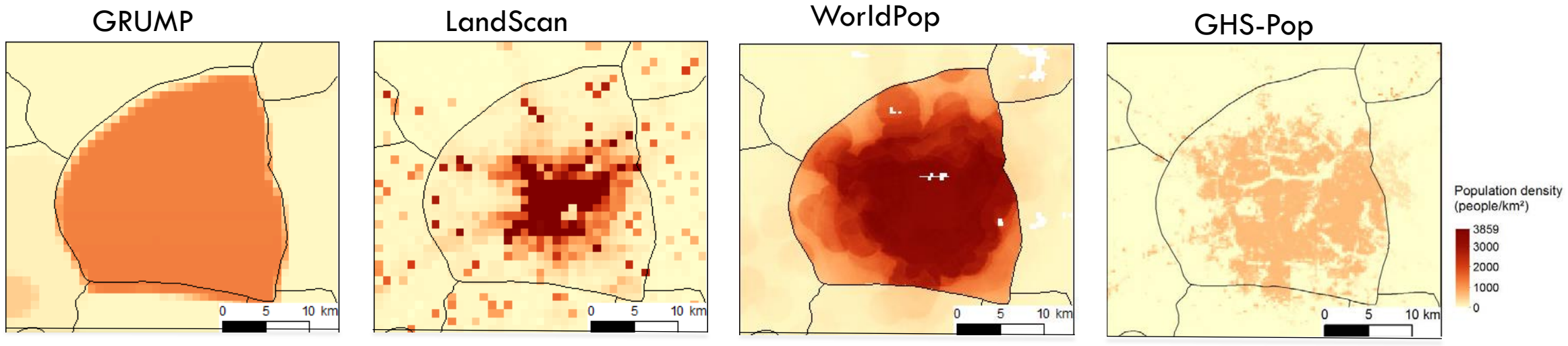
Source of image: S. Vanhuysse

Existing large-scale population distribution datasets

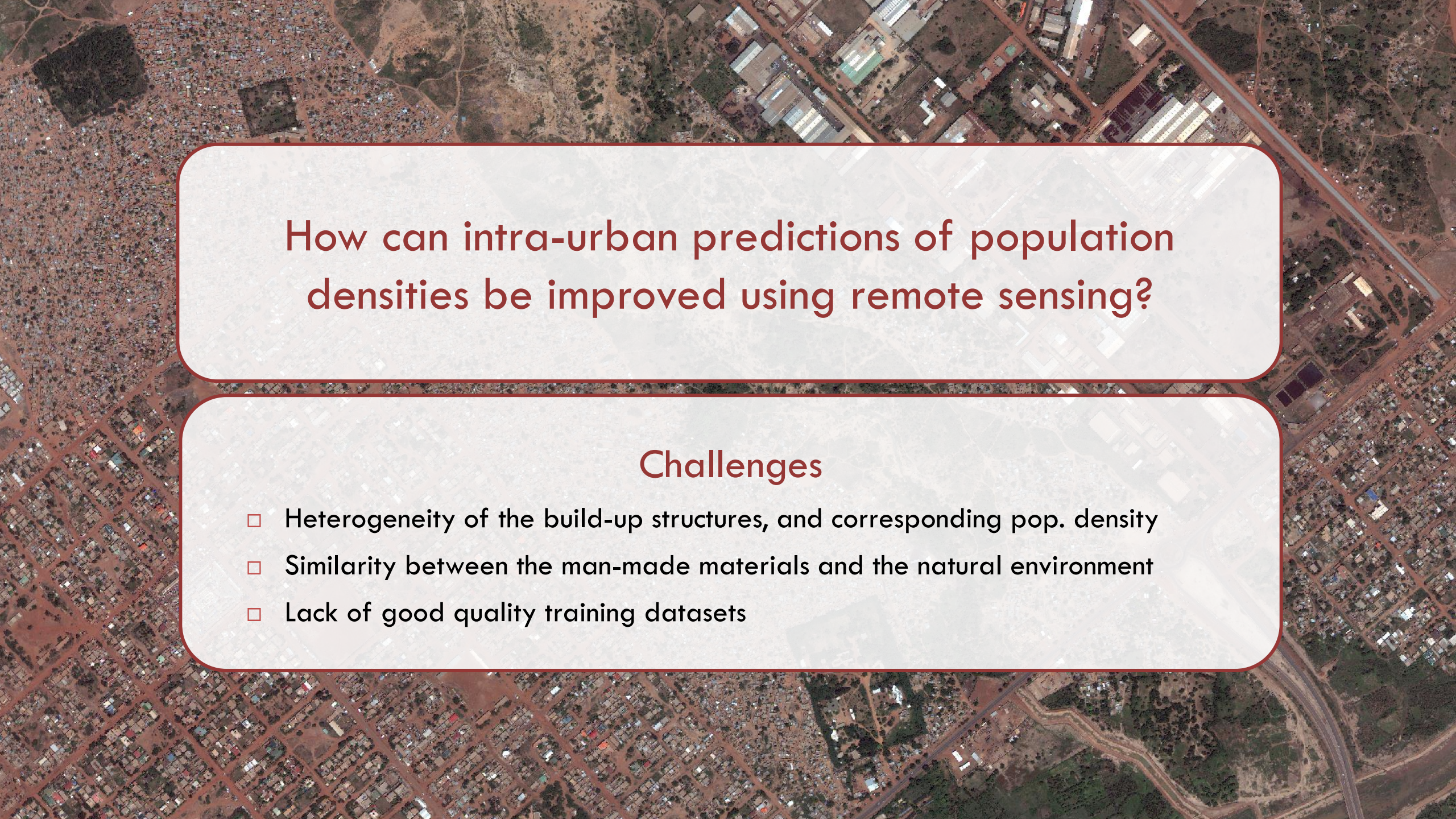


Linard et al (2012) PLoS ONE

Low intra-urban variations in population densities



Ouagadougou, Burkina Faso



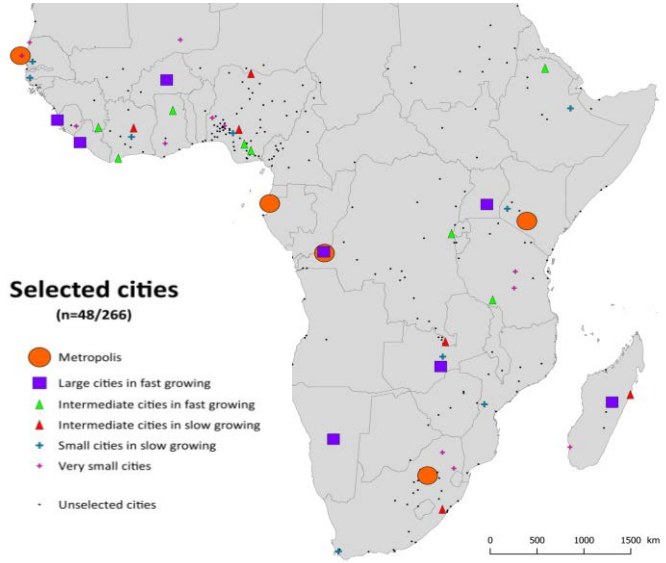
How can intra-urban predictions of population densities be improved using remote sensing?

Challenges

- Heterogeneity of the build-up structures, and corresponding pop. density
- Similarity between the man-made materials and the natural environment
- Lack of good quality training datasets

HR (30-100 m)

- 48 cities in sub-Saharan Africa
- Multi-temporal built-up density layers
- High resolution population datasets

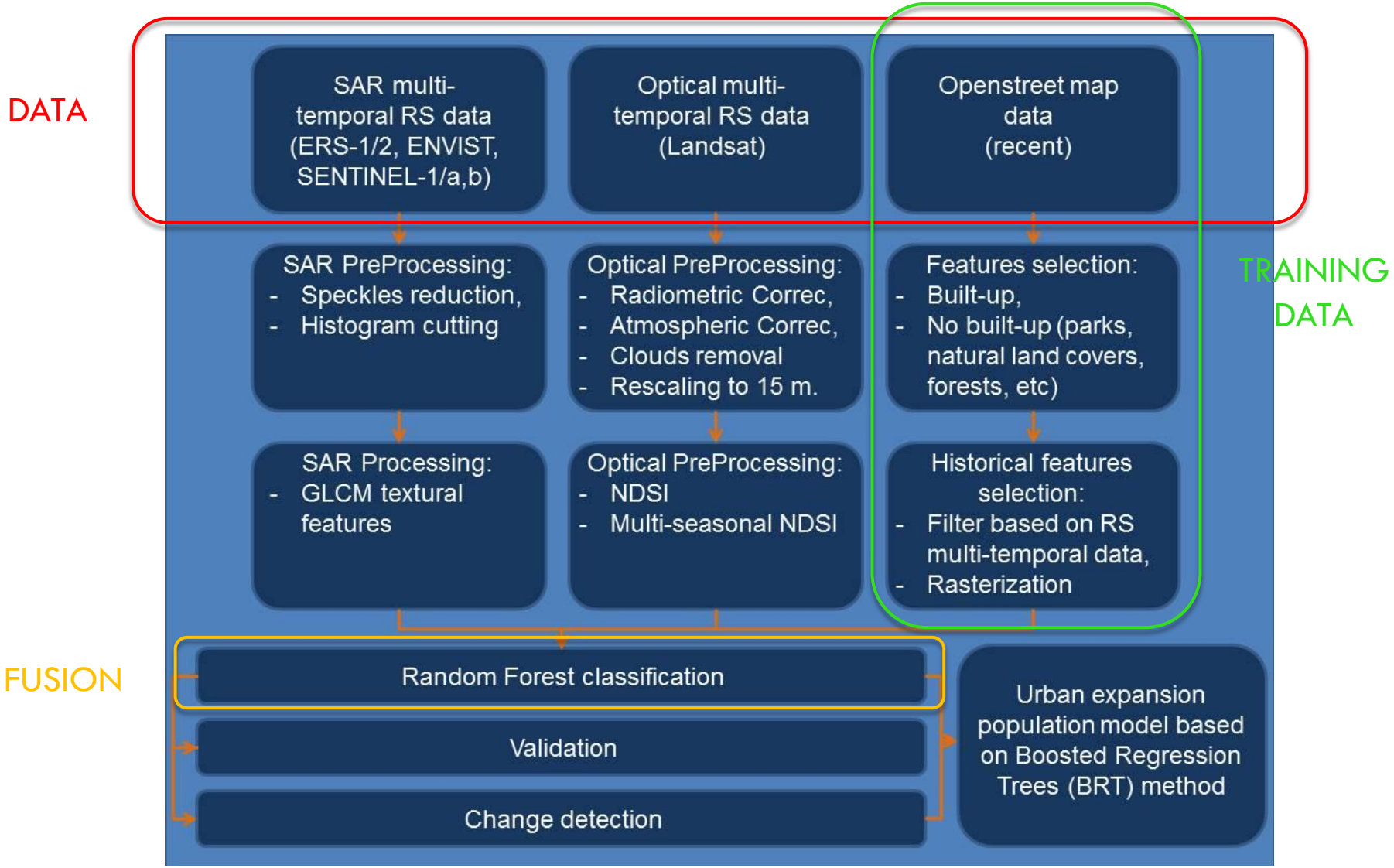


Interplay

VHR (< 5 m)

- 2 cities: Ouagadougou and Dakar
- Land cover and land use maps
- Detailed intra-urban population datasets

HR built-up density mapping



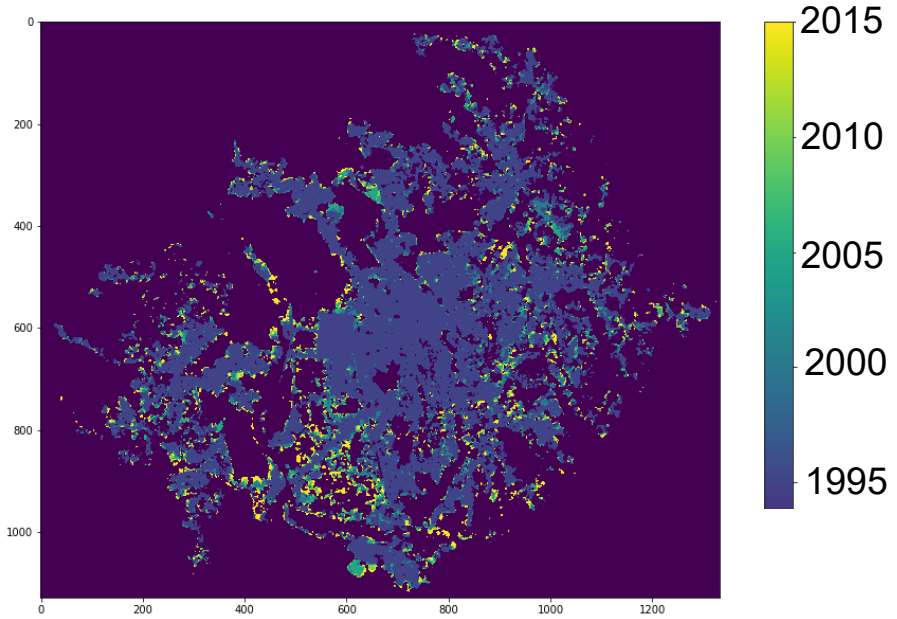
Forget et al. 2018

SAR and optical data fusion

- High average accuracy (0.93)
- Lower scores
  - in mountainous and densely vegetated areas (e.g. Bukavu, DRC).
  - as we go back in time
  - where data availability is low (satellite or OSM)

F1 Scores, Antananarivo

	2015	2005
Fusion	0.96	0.91
Optical	0.94	0.91
SAR	0.88	0.85

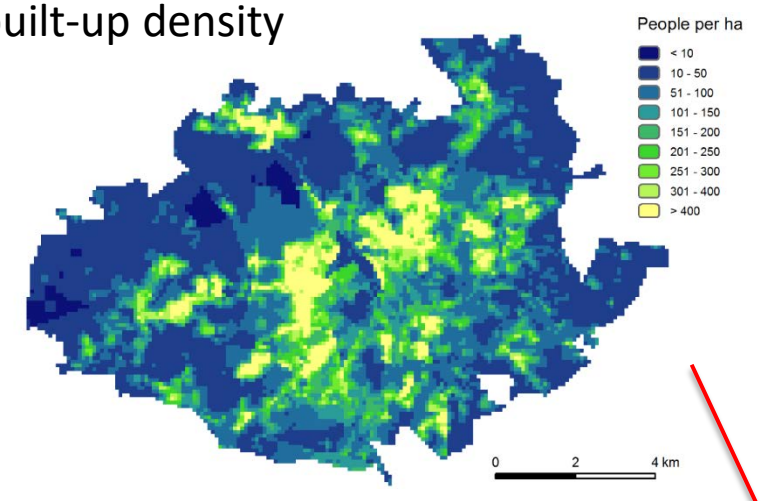


Built-up change detection

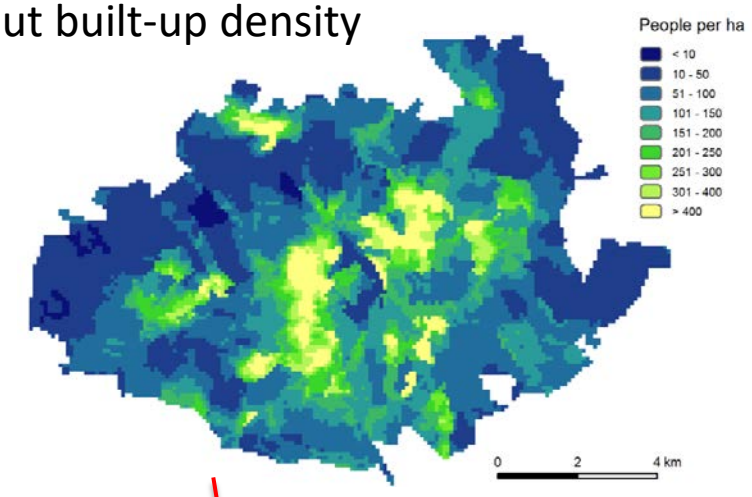
Antananarivo, Madagascar

Improved population maps

With built-up density



Without built-up density



	CN	N. units	N. units for validation	% expl. var. with built-up layers	% expl. var. without built-up layers	
Windhoek	NAM	743	223	71	63	++
Antananarivo	MDG	228	68	57	48	++
Iringa	TZA	147	44	42	43	.
Toamasina	MDG	138	41	70	69	.
Kampala	UGA	116	35	83	81	+
Mbeya	TZA	113	34	36	34	+
Nairobi	KEN	106	32	58	48	++

HR (30-100 m)

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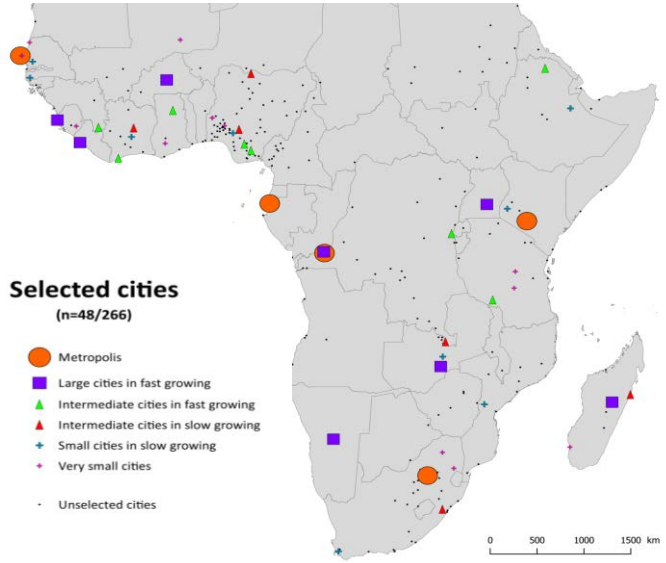

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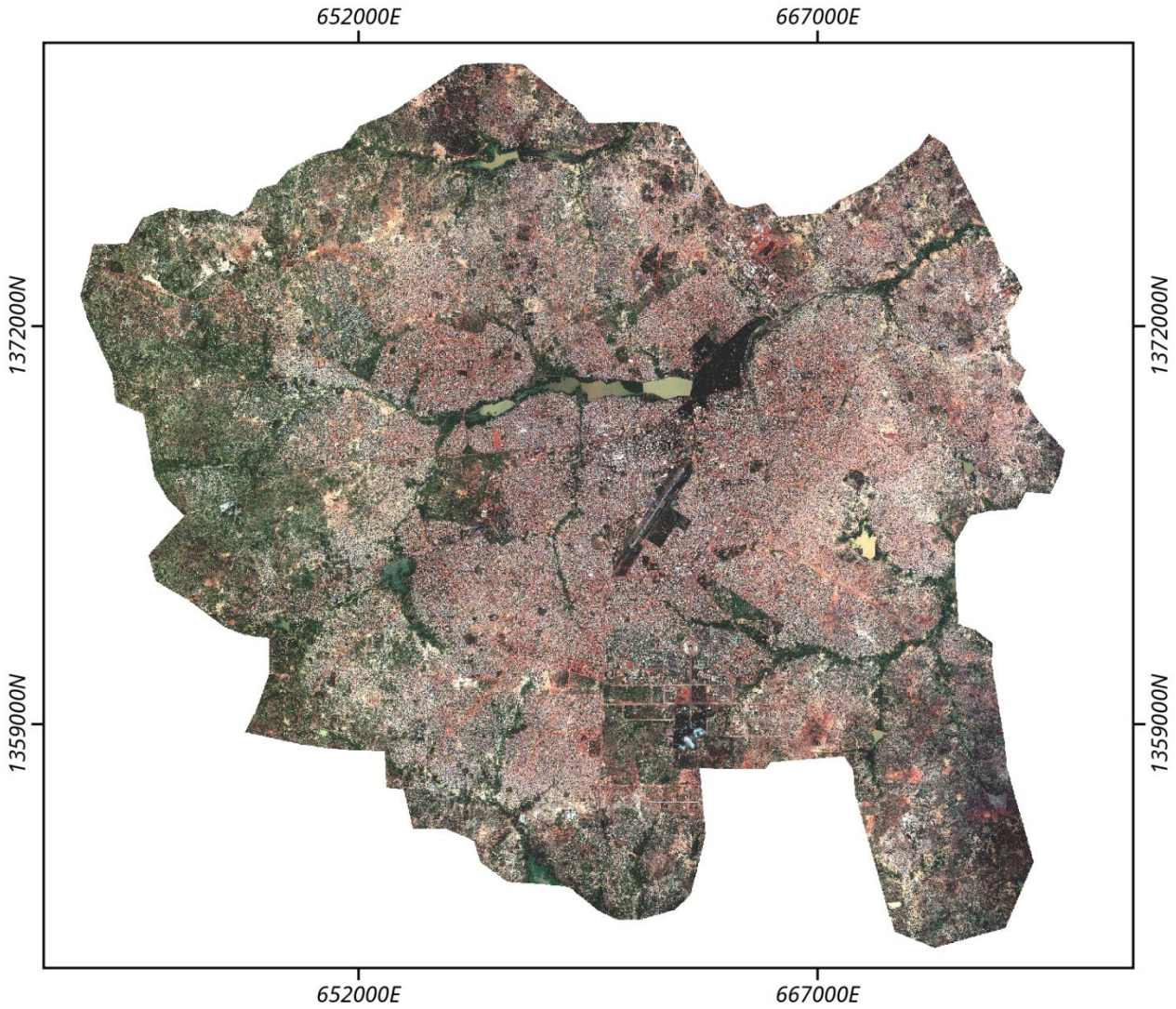
VHR WORKFLOW

Image



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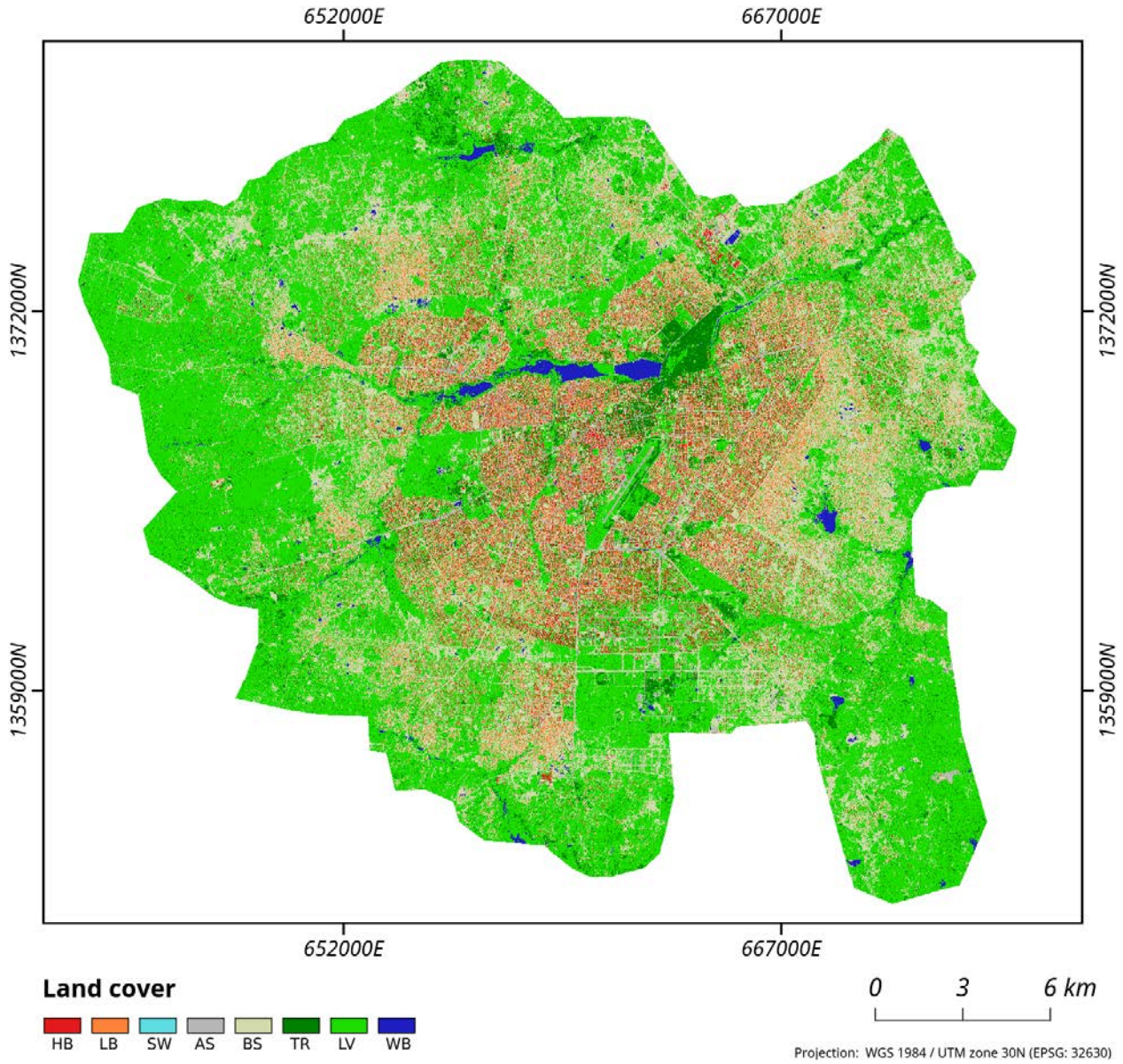
VHR WORKFLOW

Image

↓

Land cover map (OBIA)



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VHR WORKFLOW

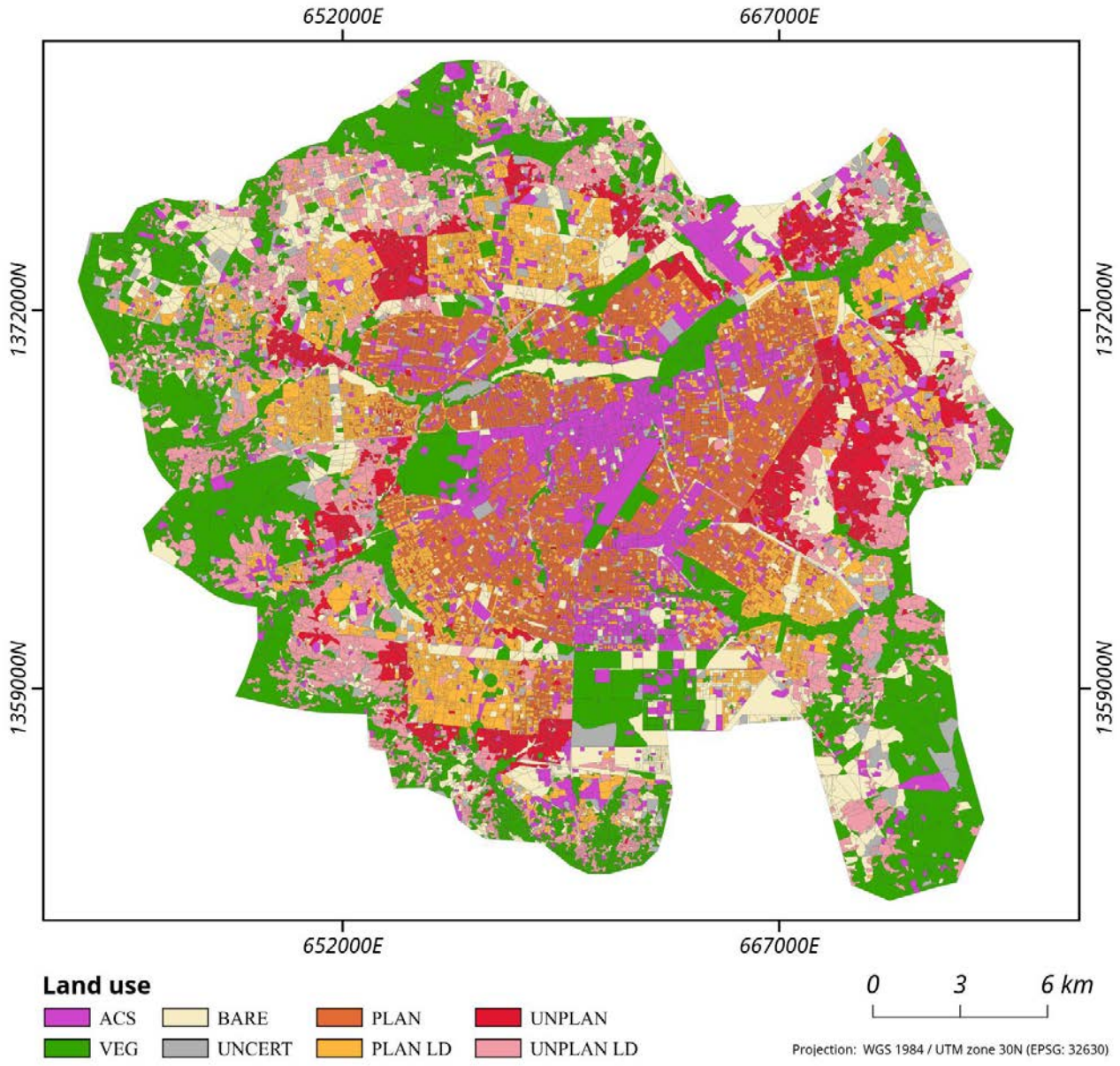
Image

↓

Land cover map (OBIA)

↓

Land use map
at street block level



VHR WORKFLOW

Image

↓

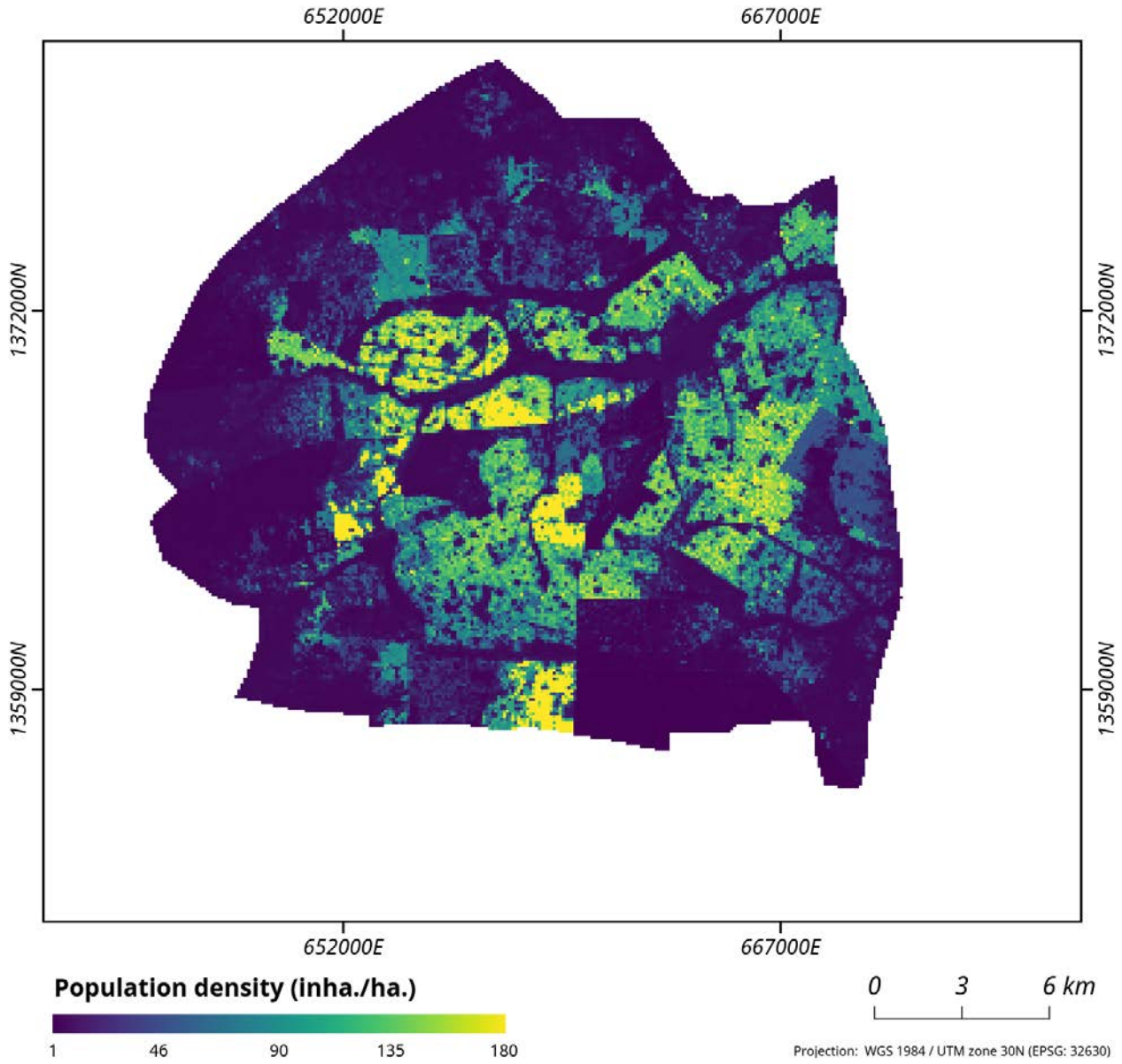
Land cover map (OBIA)

↓

Land use map
at street block level

↓

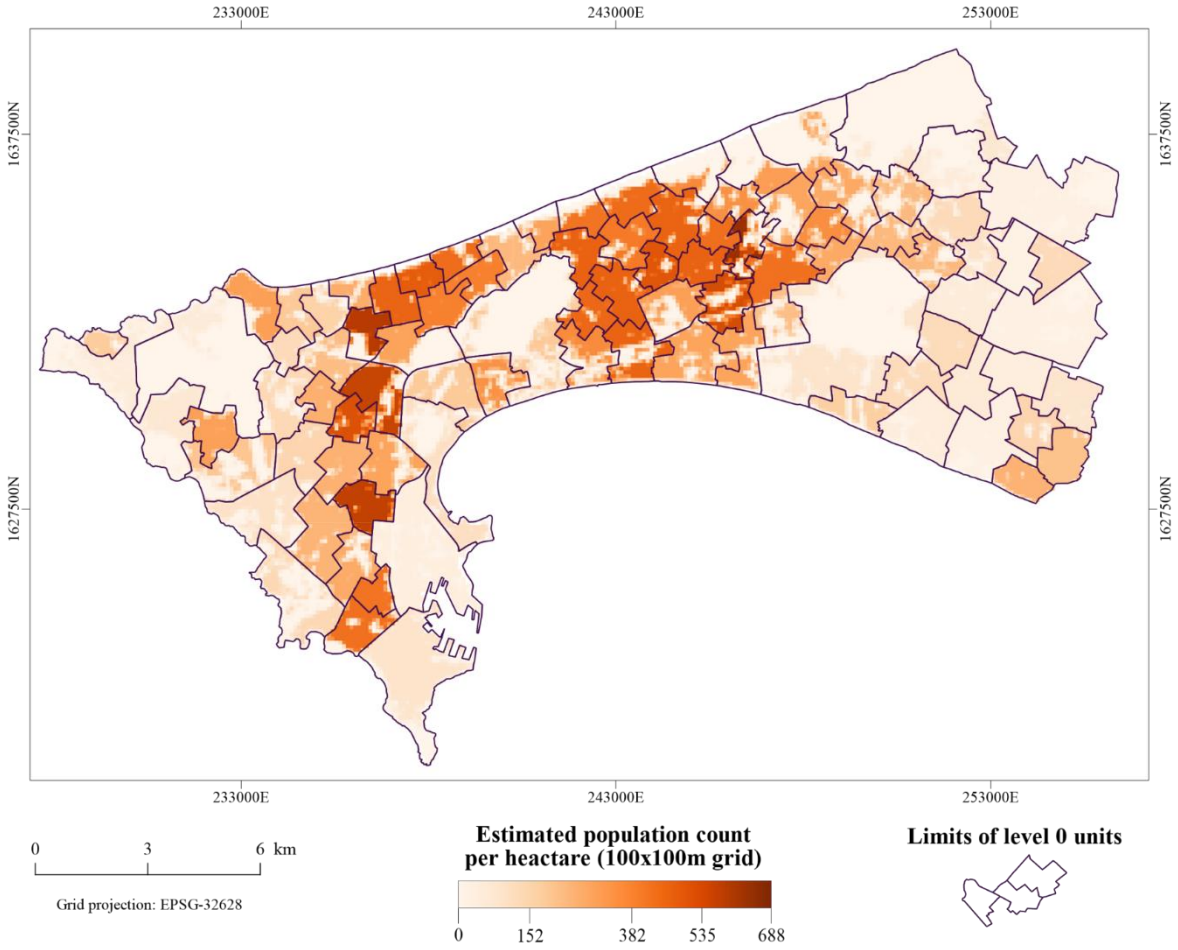
Population density

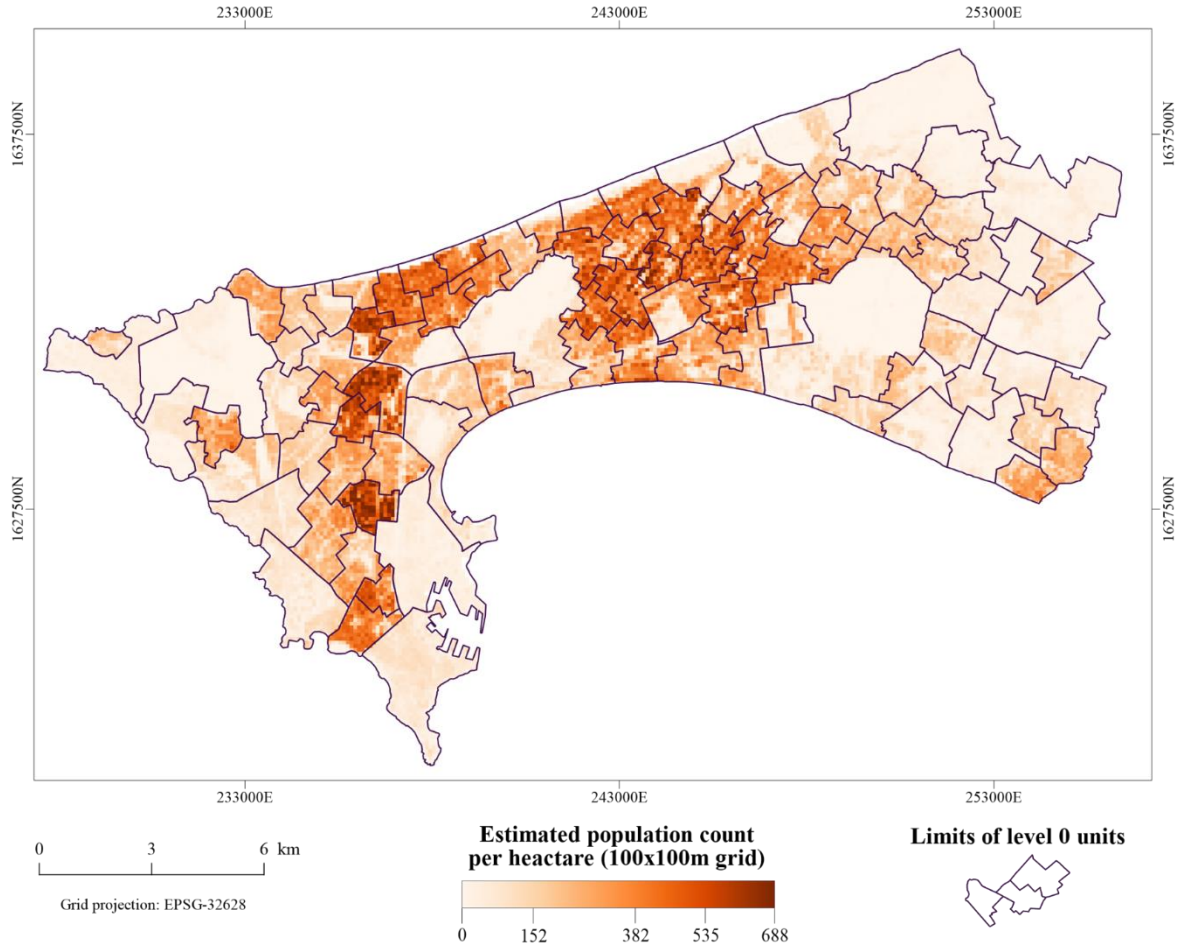


Population estimates at two spatial scales

HR →
- Less accurate
- No cost

VHR →
- More accurate
- More expensive





Summary and conclusions

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- Optical and SAR data fusion is essential for better mapping intra-urban heterogeneities in Africa
- Overall accuracy depends on the quality of the input data, the quality of the training data for the supervised classification and also the complexity of the built-up environment.
- Including built-up density layers in urban population models allow for clear improvements in prediction
- Earth Observation offers great potential in further bridging the data divide and building more spatially and temporally detailed demographic databases

Further information:

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www.worldpop.org

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