Mapping Land Cover and Land Use at Very High Spatial Resolution

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BACK TO BASICS

PREREQUISITES

LC - LU

- Land cover (LC) mapping

  related to the physical characteristics of earth surface elements (e.g., vegetation, water, built-up)

- Land use (LU) mapping

  refers to the functions and activities that humans decided to carry out in certain locations (e.g., agricultural land, residential area, industrial area)

HR - VHR

- High resolution (HR) imagery

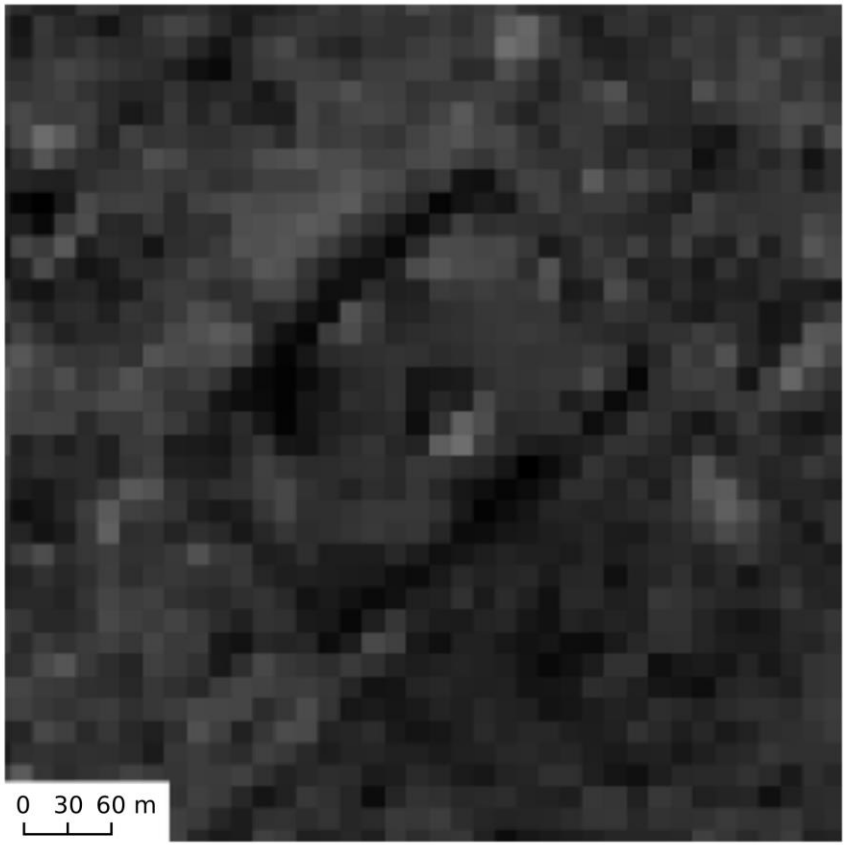
  → 10-30 meters

- Very-High resolution (VHR) imagery

  → < 1 meter

HR - VHR

High resolution



Very high resolution

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MAUPP PROJECT – VHR MAPPING

RESEARCH WORKFLOW

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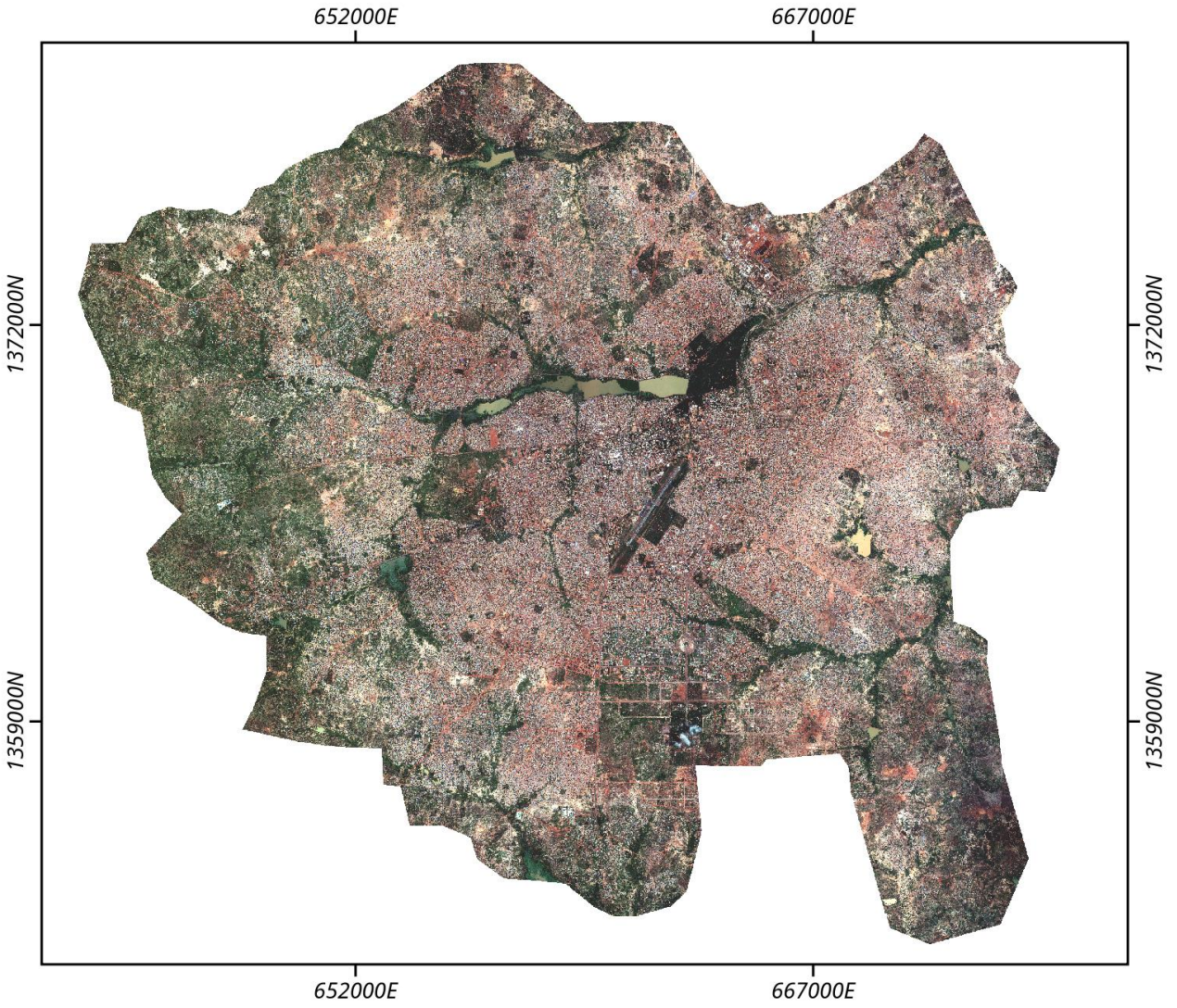
VHR WORKFLOW

Image



Optical true color composite

0 3 6 km

Projection: WGS 1984 / UTM zone 30N (EPSG: 32630)

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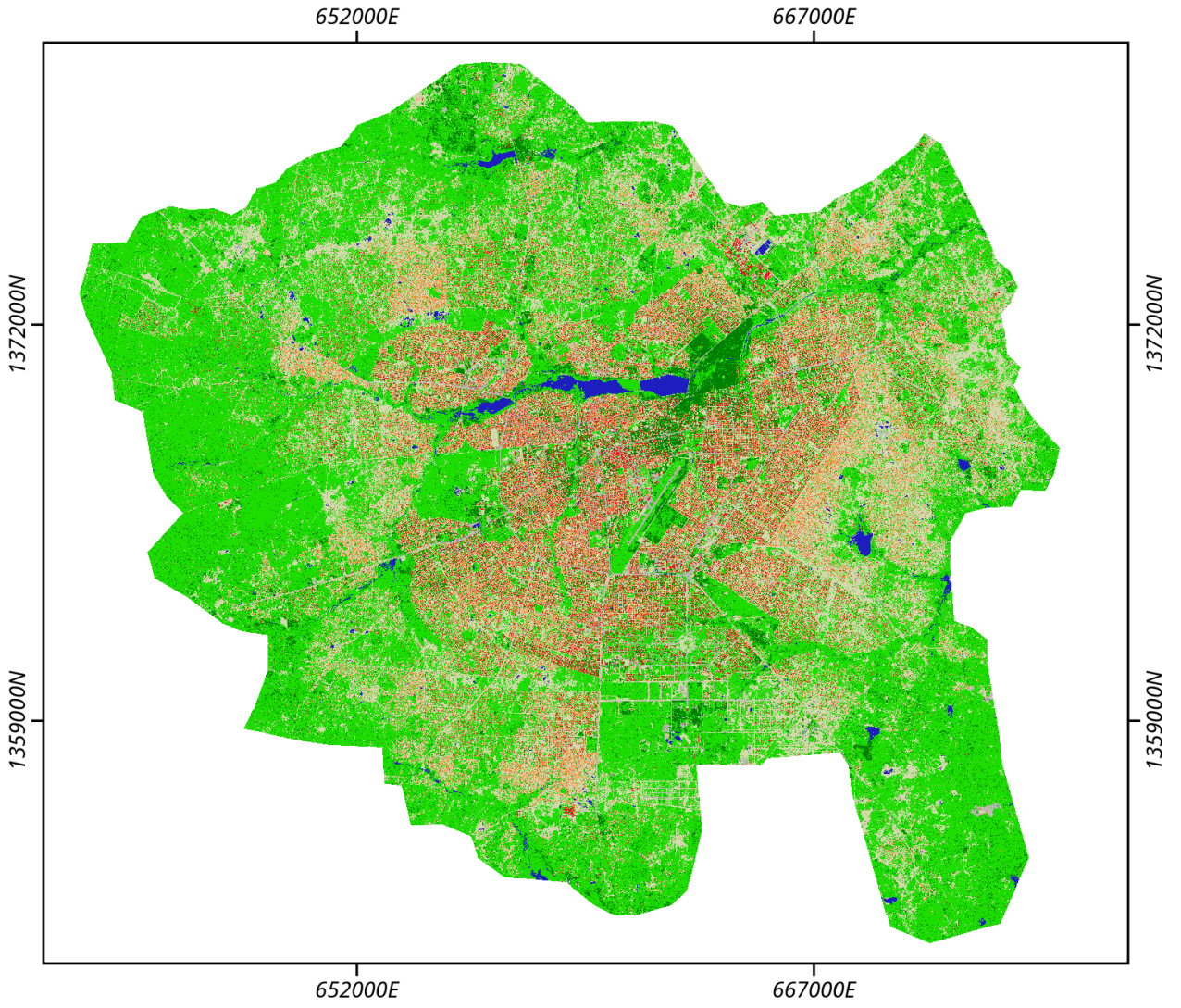
VHR WORKFLOW

Image

↓

Land cover map (OBIA)



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VHR WORKFLOW

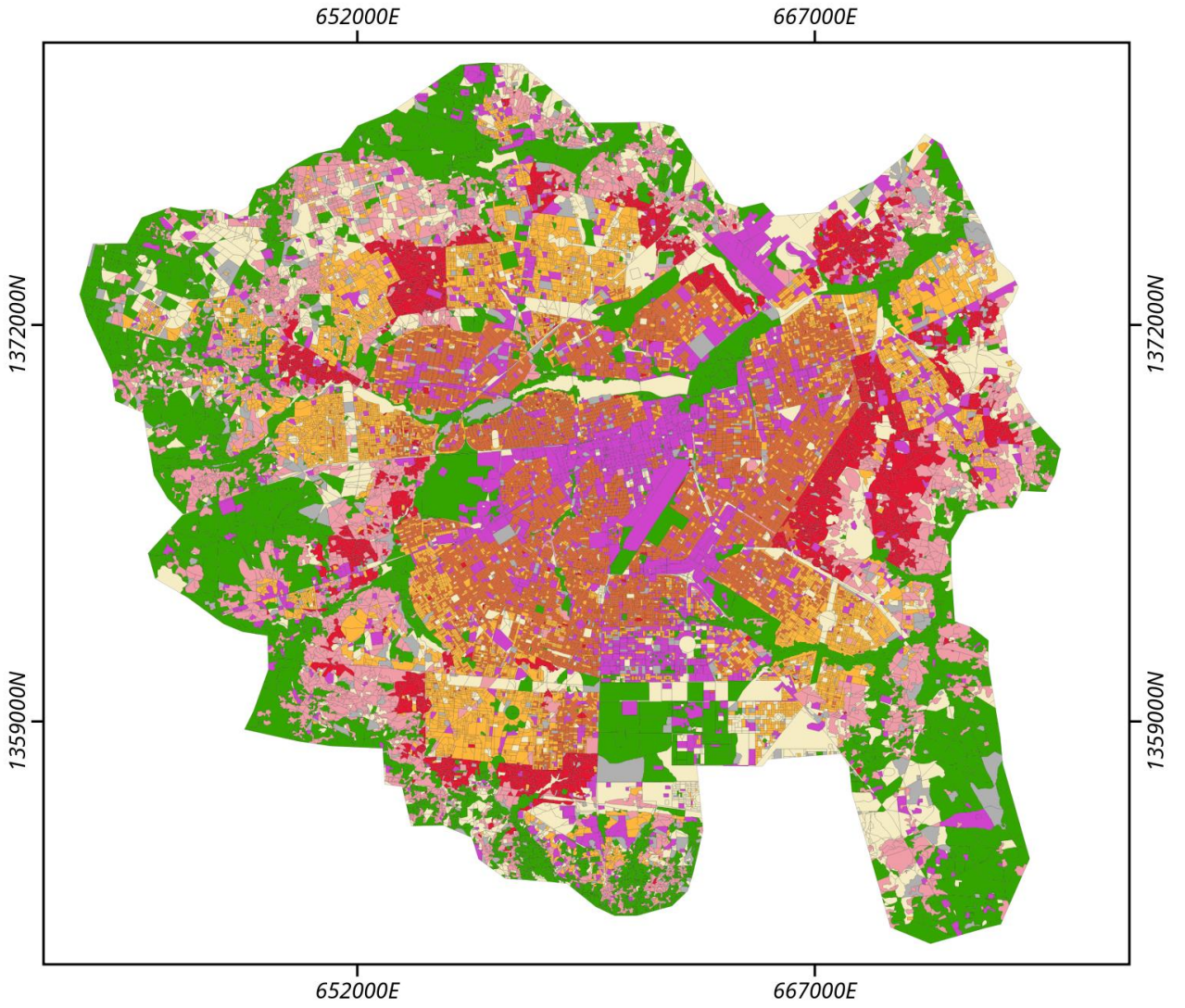
Image

↓

Land cover map (OBIA)

↓

Land use map
at street block level



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VHR WORKFLOW

Image

↓

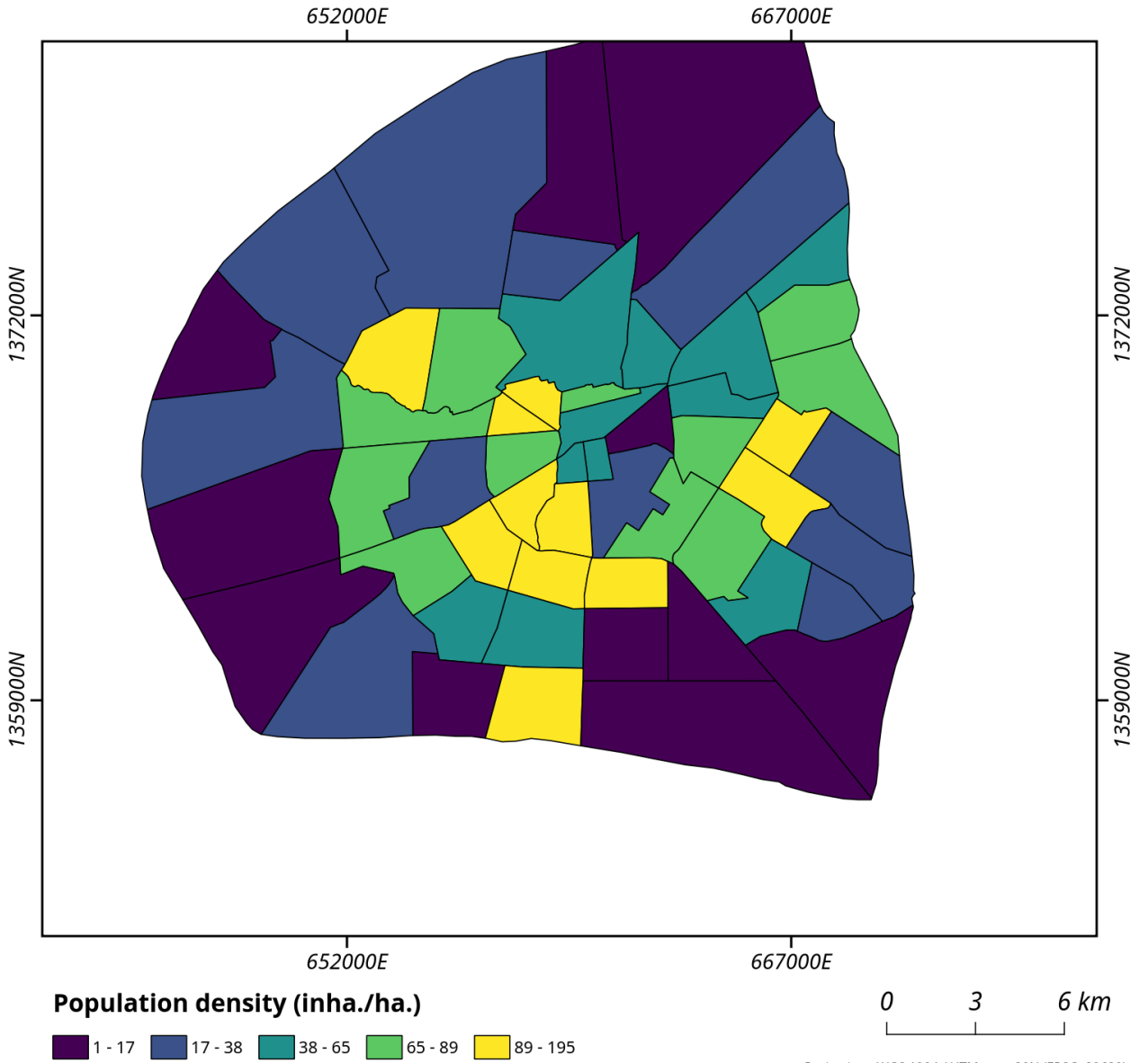
Land cover map (OBIA)

↓

Land use map at street block level

↓

Population density



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VHR WORKFLOW

Image

↓

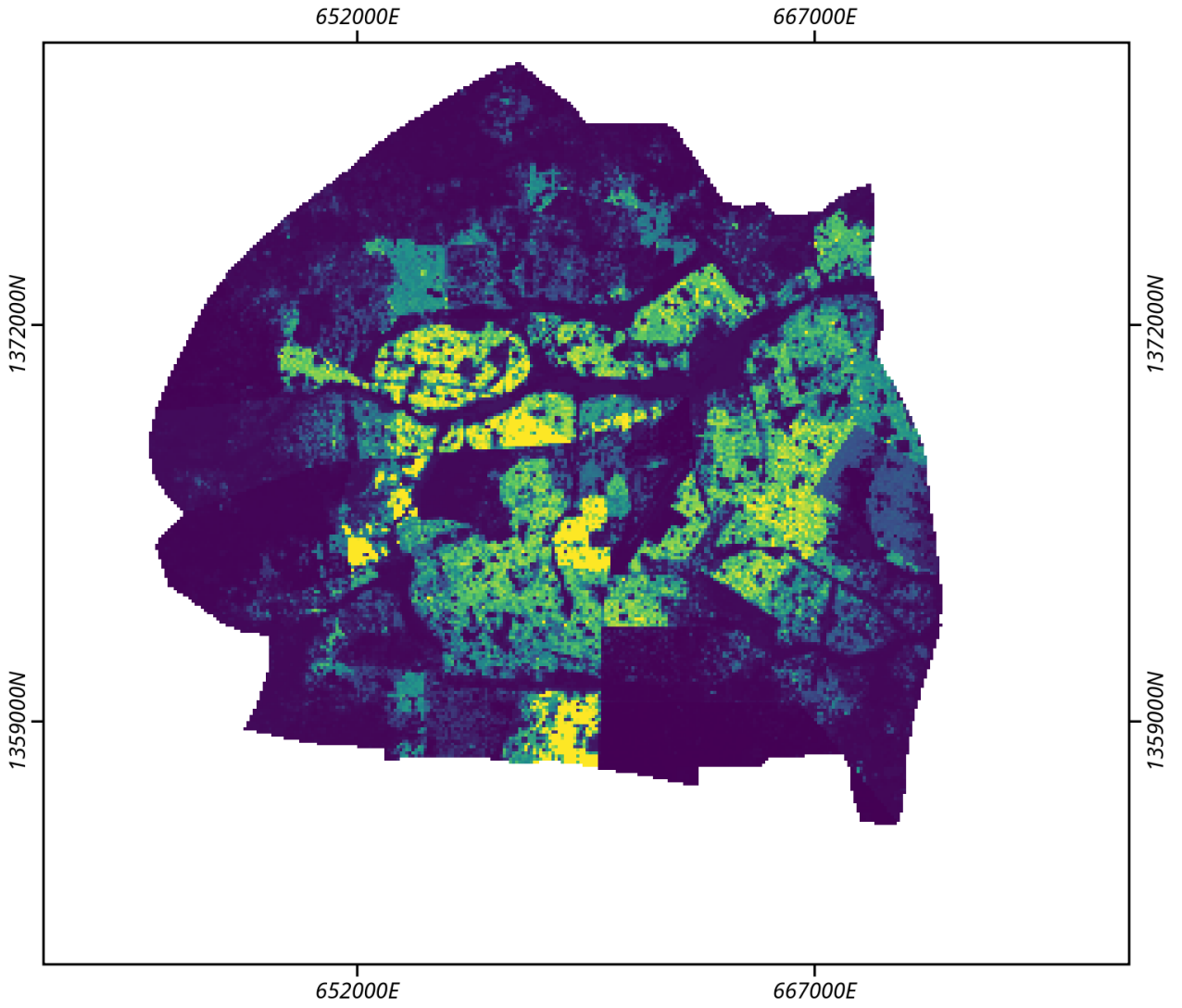
Land cover map (OBIA)

↓

Land use map at street block level

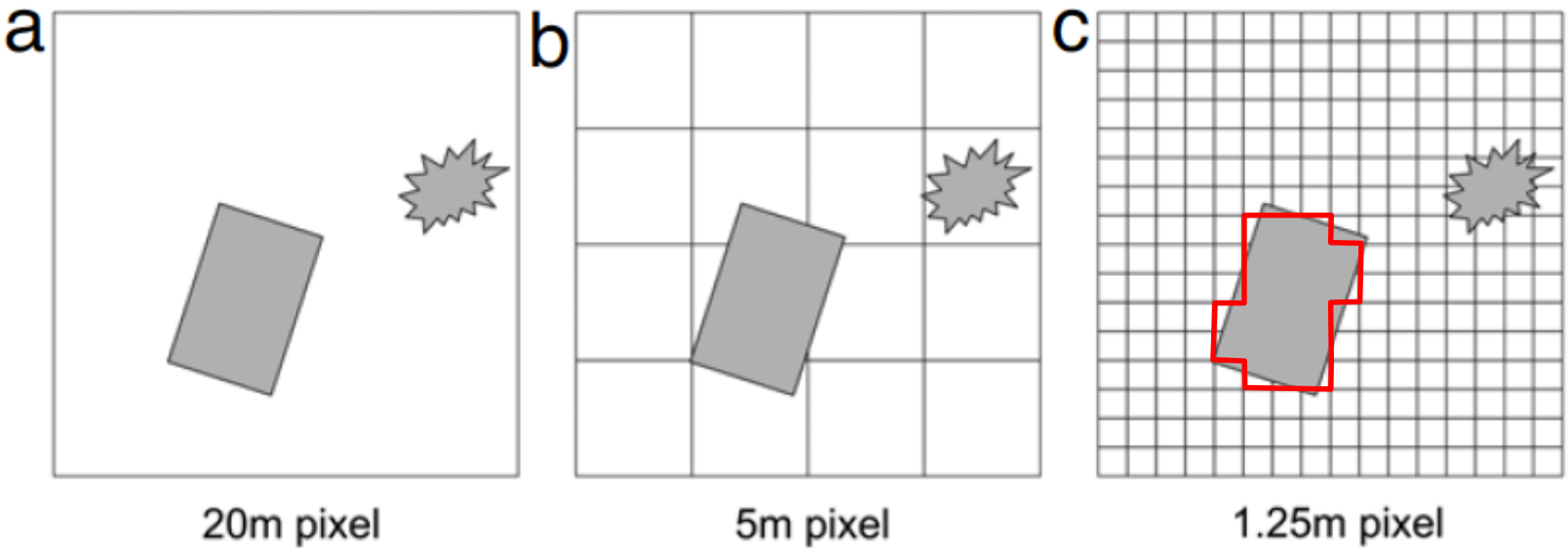
↓

Population density



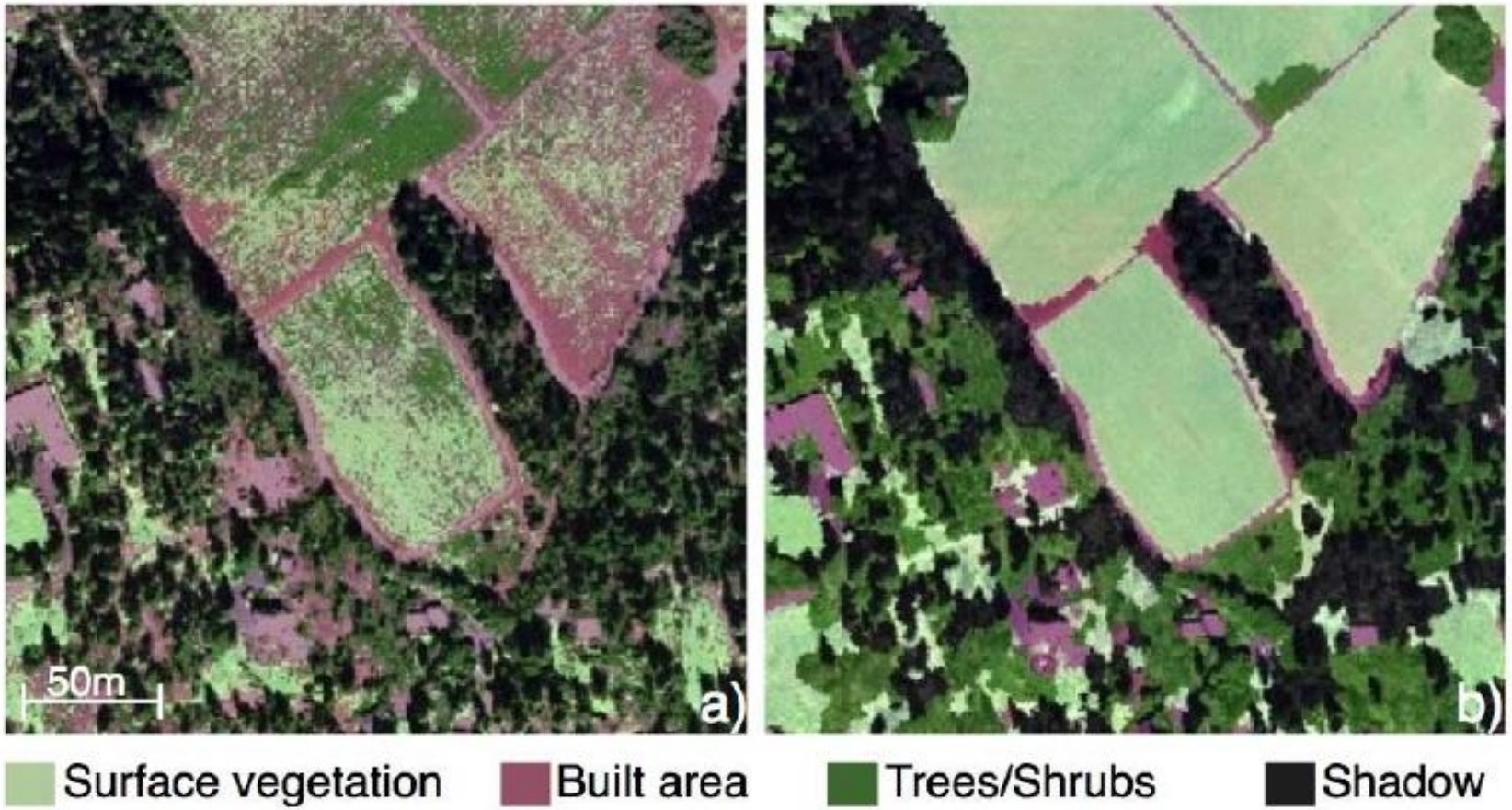
LAND COVER MAPPING

Object-based image analysis (OBIA)



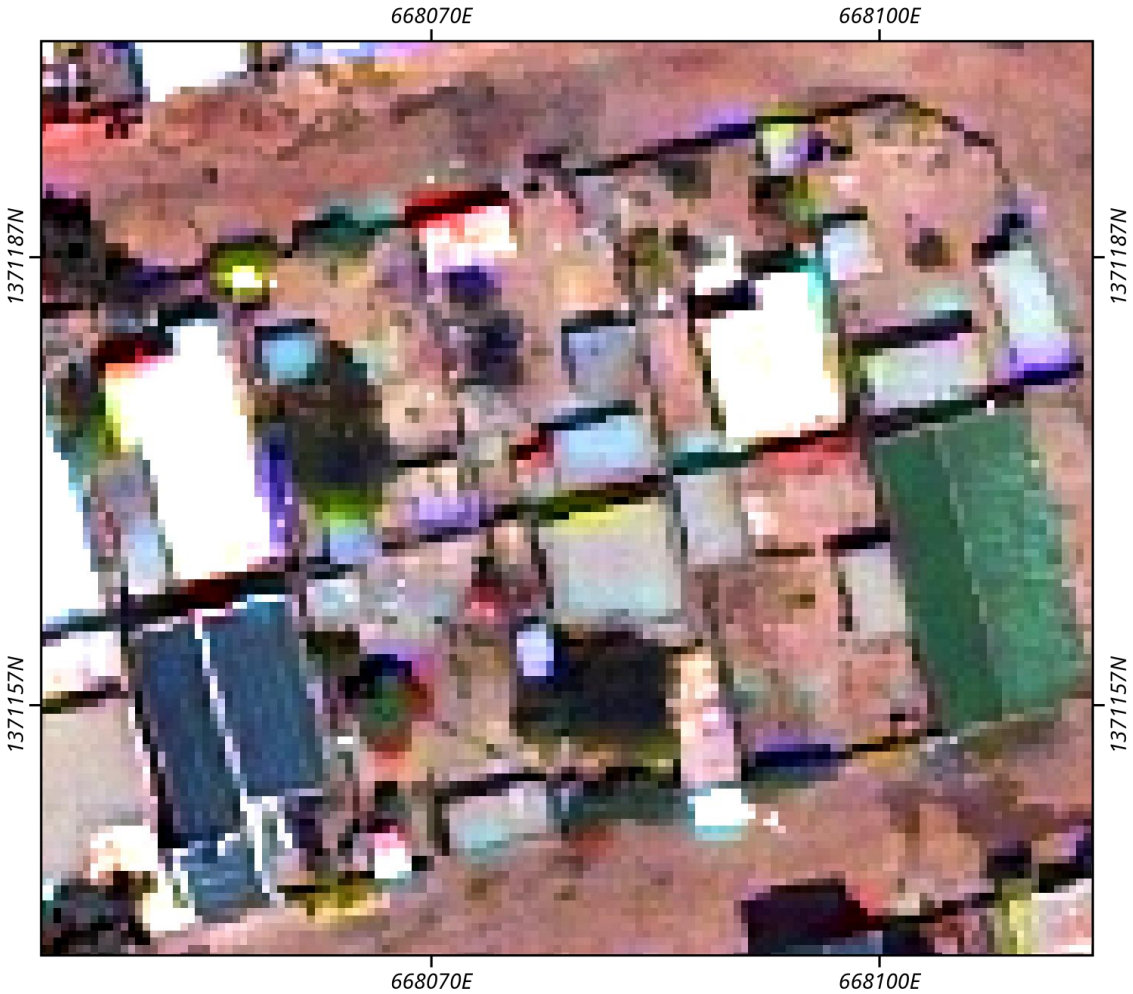
Source: Blaschke, 2010

Object-based image analysis (OBIA)



Source: Kelly, 2011

Unsupervised segmentation parameter optimization (USPO)



Projection: WGS 1984 / UTM zone 30N (EPSG: 32630)

0 5 10 m

Influence of the choice of segmentation parameters

Projection: WGS 1984 / UTM zone 30N (EPSG: 32630)

0 5 10 m

Influence of the choice of segmentation parameters

Projection: WGS 1984 / UTM zone 30N (EPSG: 32630)

0 5 10 m

Influence of the choice of segmentation parameters

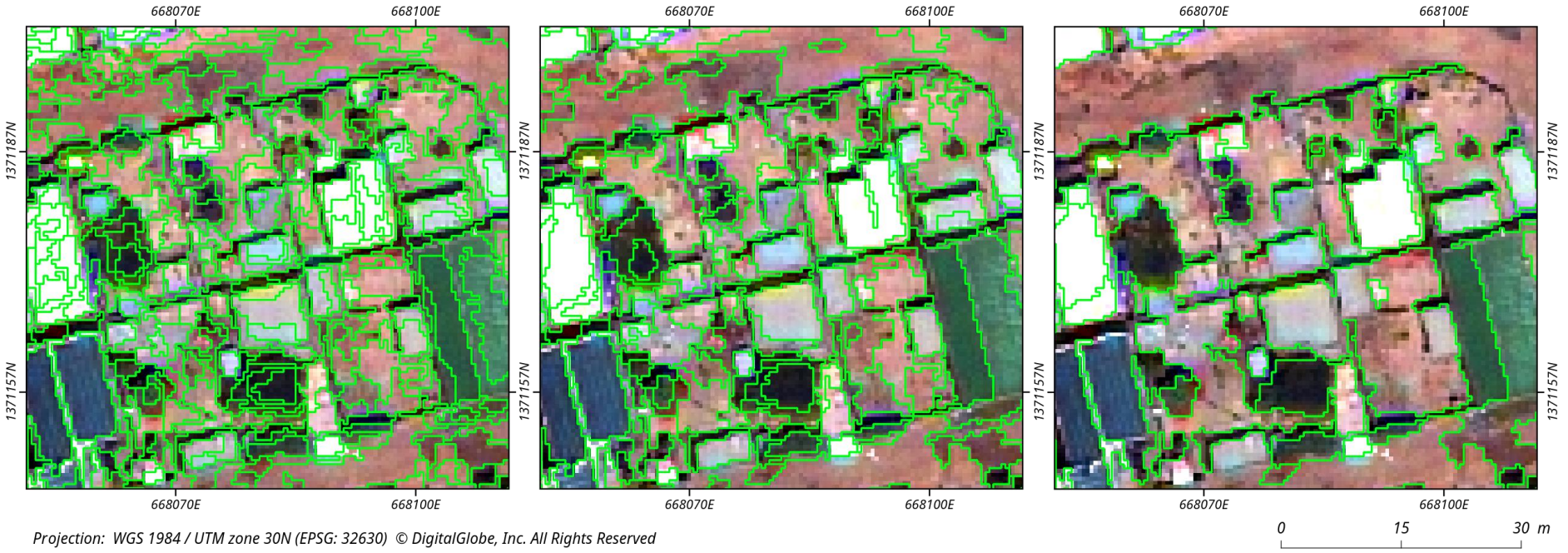
Projection: WGS 1984 / UTM zone 30N (EPSG: 32630)

0 5 10 m

Unsupervised segmentation parameter optimization (USPO)

Unsupervised

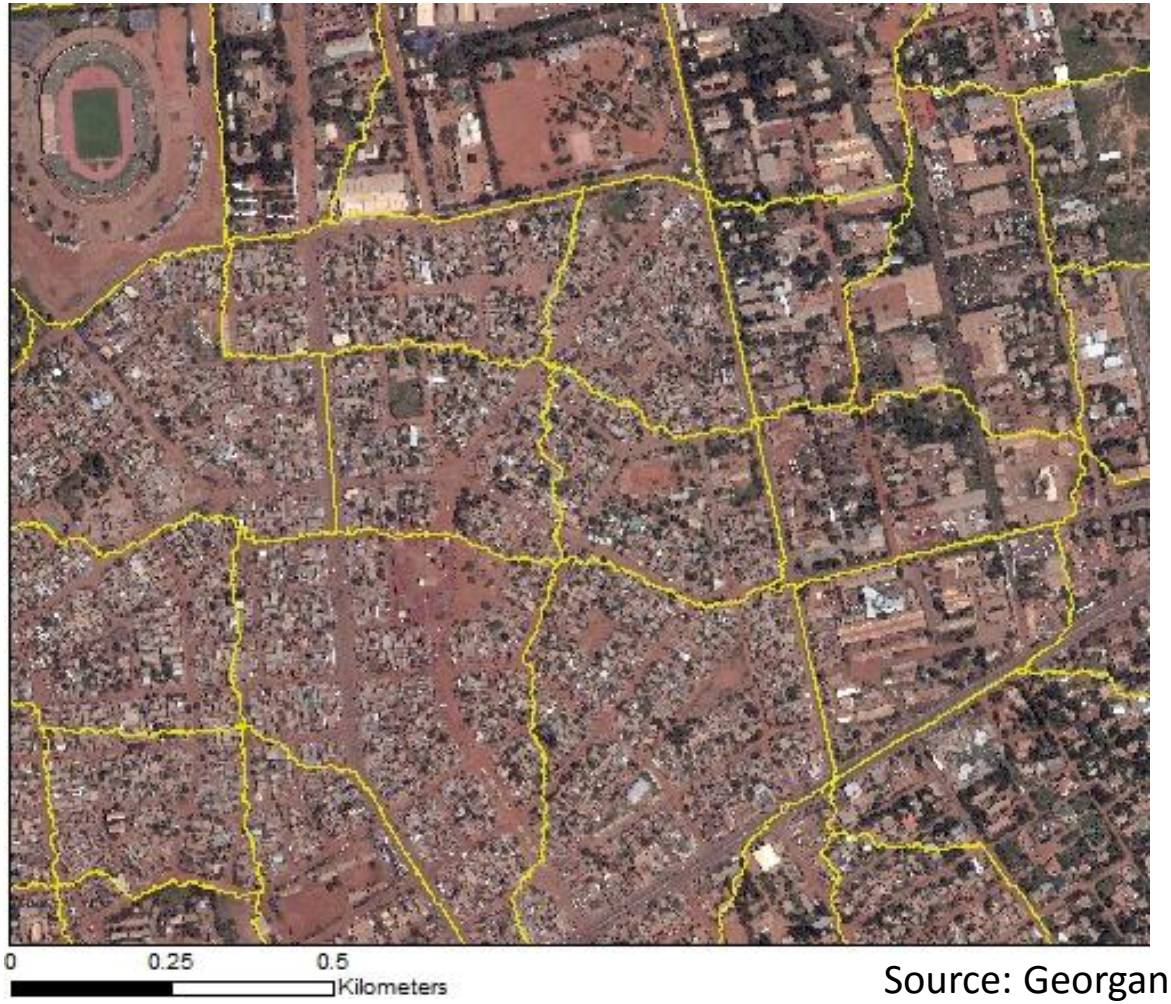
Over-segmented | Segmentation optimization | Under-segmented



Projection: WGS 1984 / UTM zone 30N (EPSG: 32630)

Local approach for USPO

Local approach for USPO

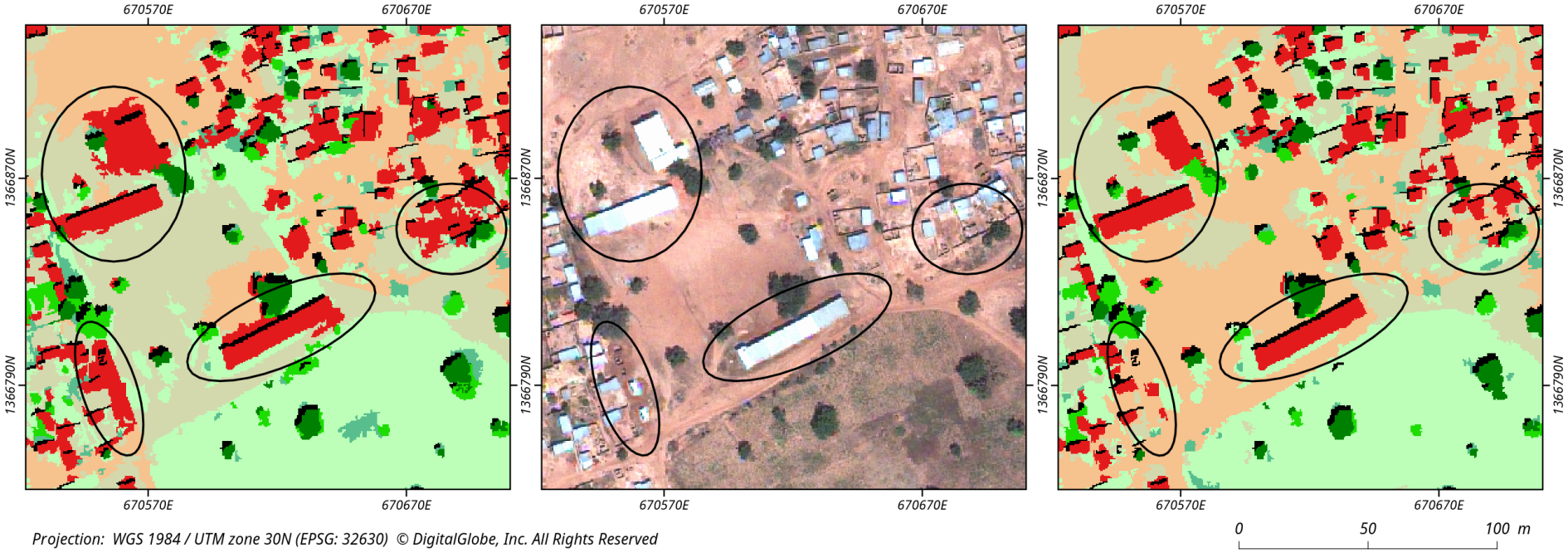


Source: Georganos, 2018

Local approach for USPO

Global approach

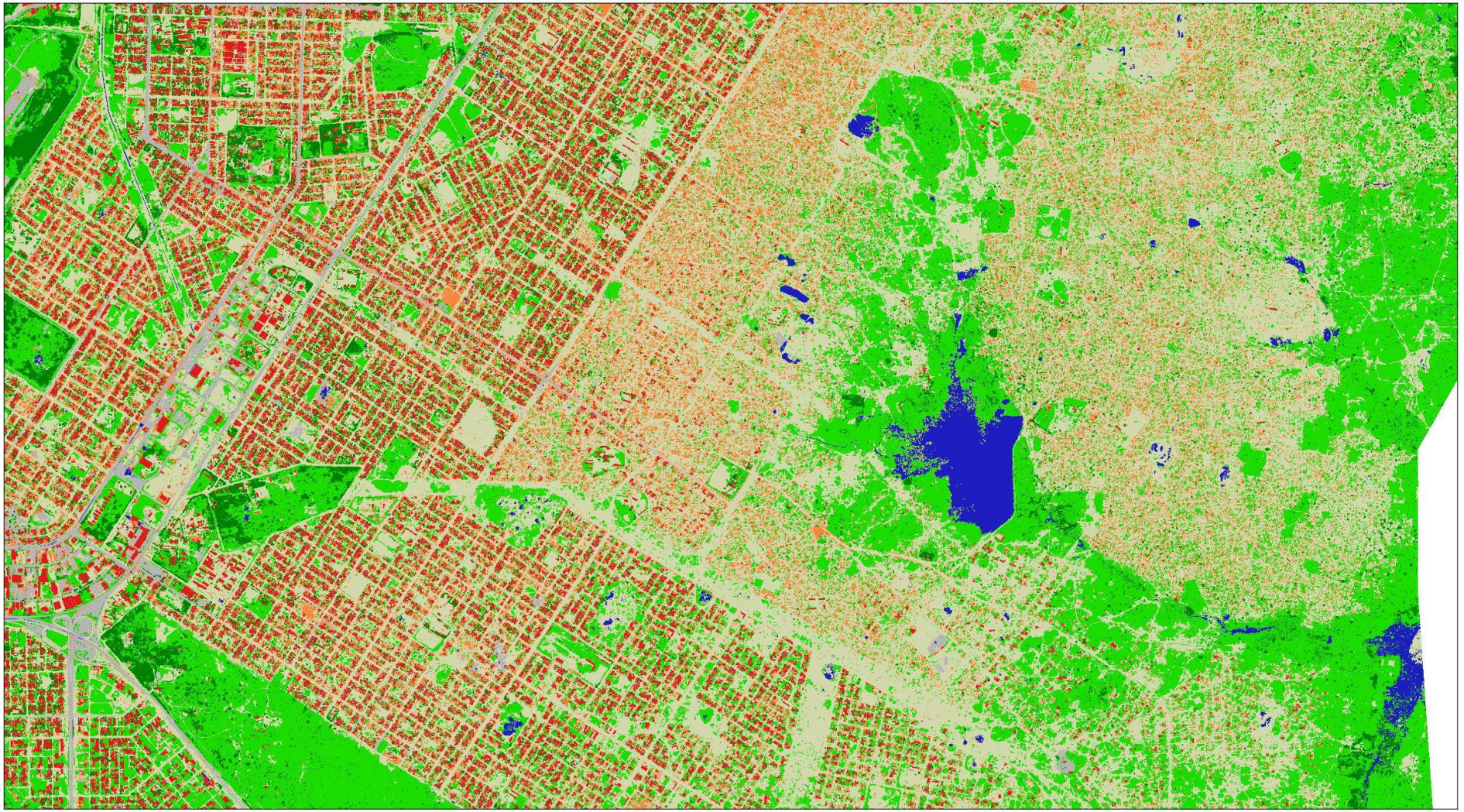
Local approach

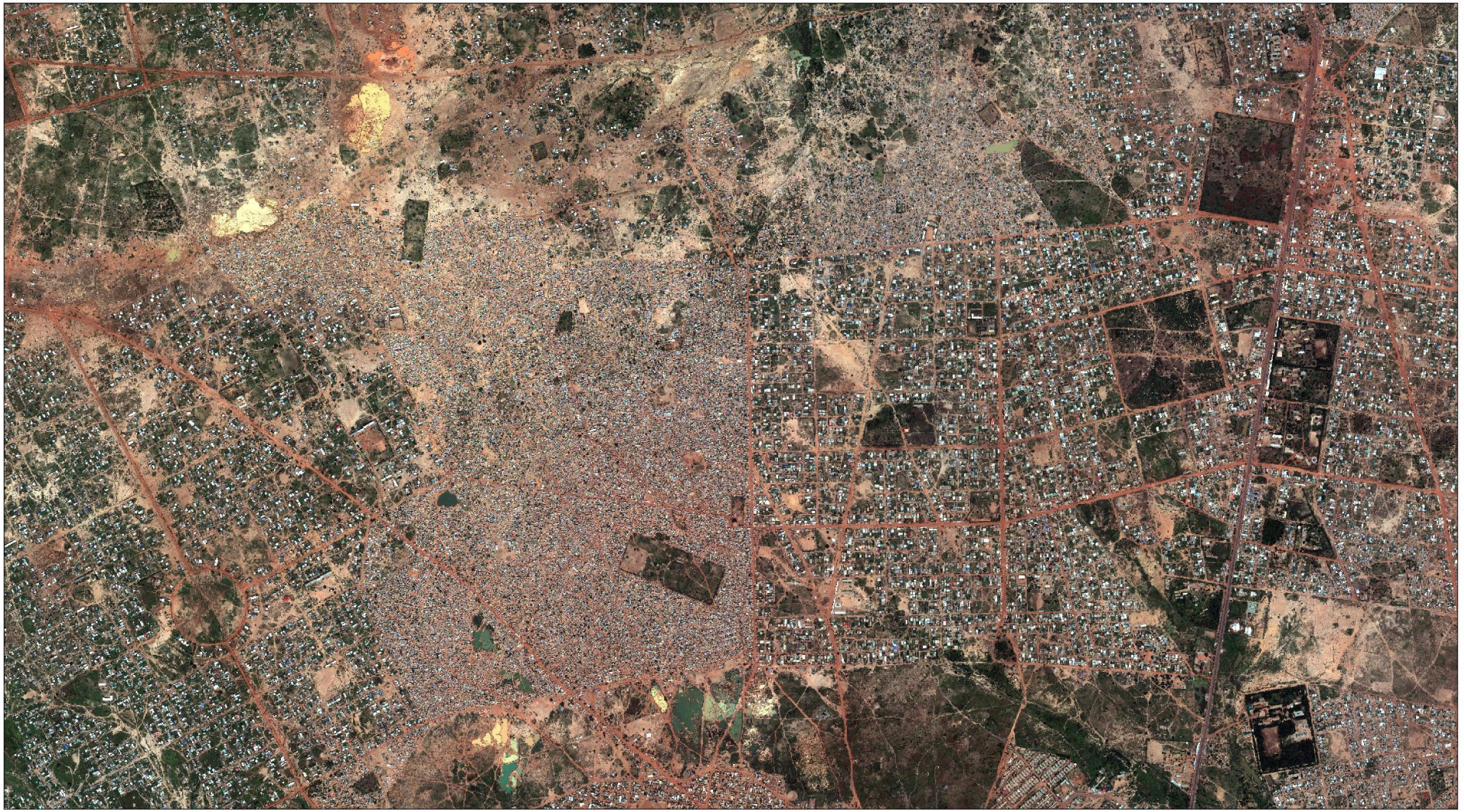


Projection: WGS 1984 / UTM zone 30N (EPSG: 32630)

Optical - True color composite

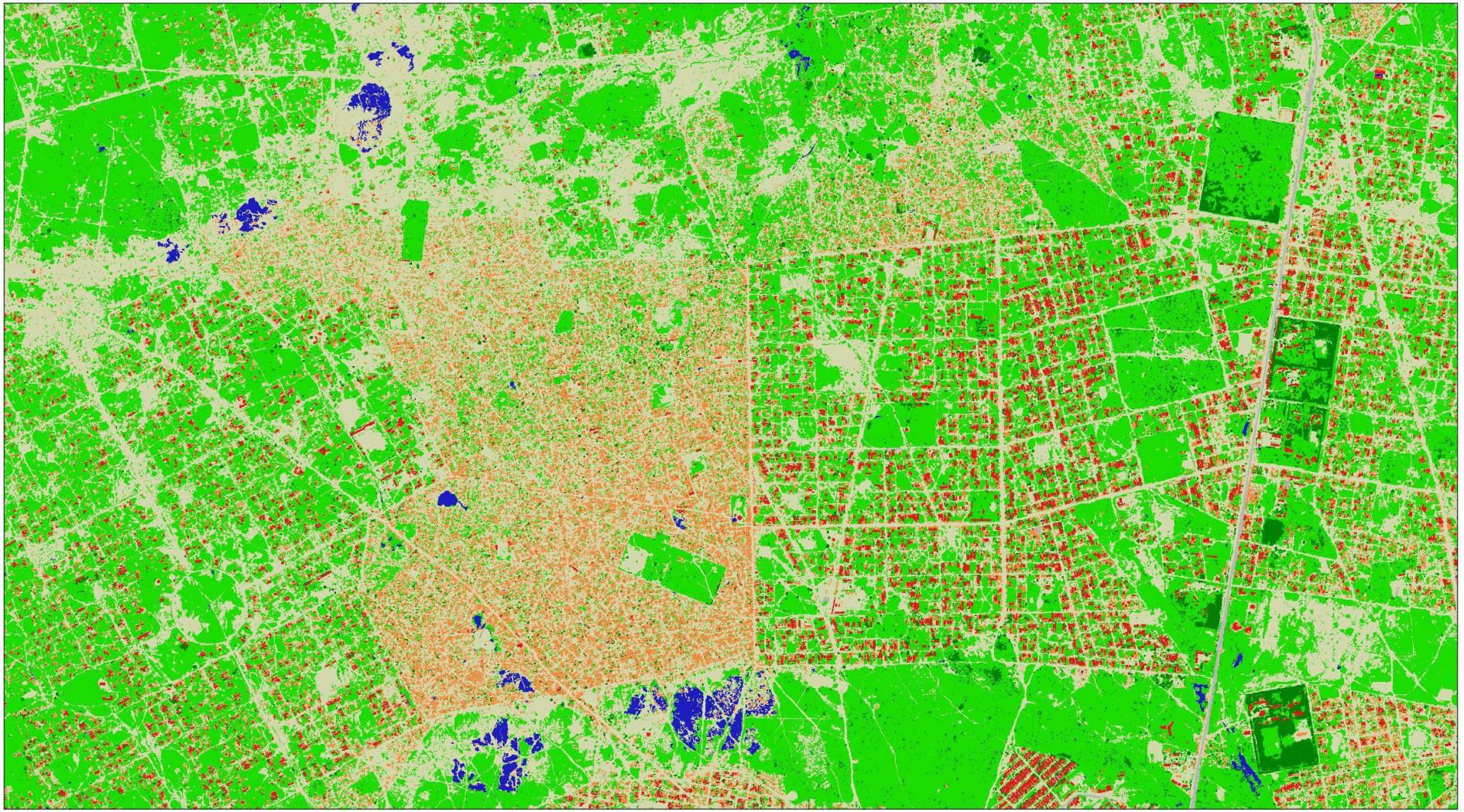
0 0.5 1 km


Land cover
0
0.5
1 km
HB
LB
SW
AS
BS
TR
LV
WB

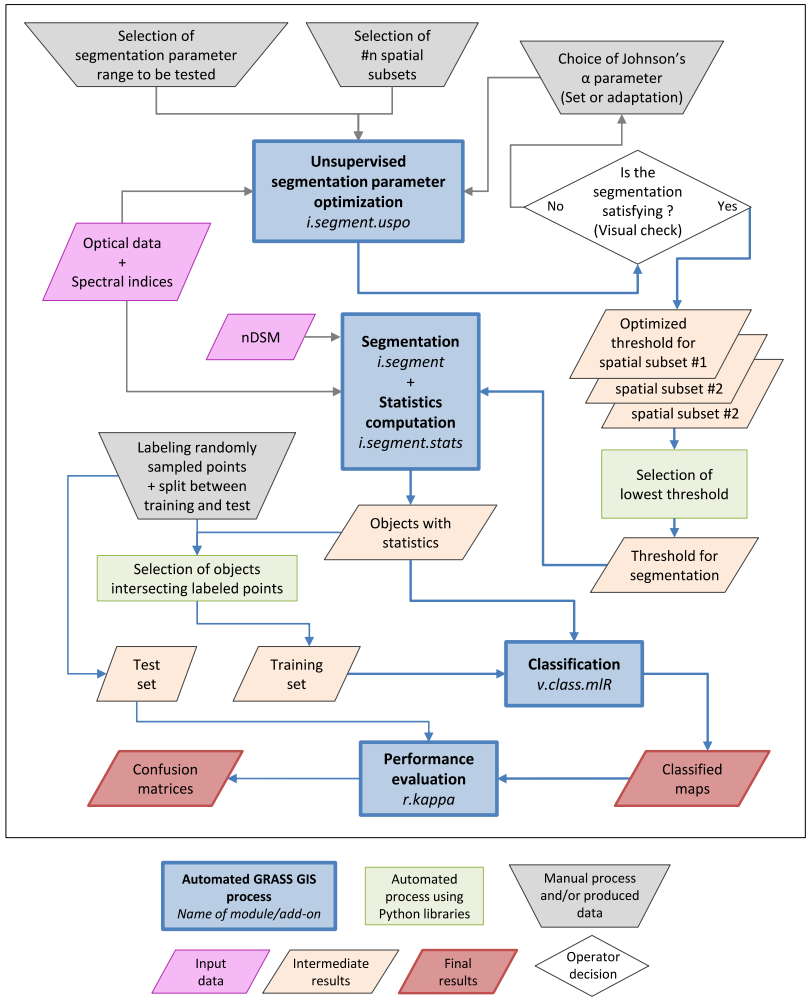


Optical - True color composite

0 0.4 0.8 km


Land cover
HB
LB
SW
AS
BS
TR
LV
WB
0
0.4
0.8 km

Semi-automated processing




```
In [ ]: ## Define computational region to match the extention of segmentation raster
grass.run_command('g.region', overwrite=True, raster="segments@CLASSIFICATION")

## Saving current time for processing time management
print ("Start computing statistics for training segments, using i.segment.stats on " + time.ctime())
begintime_isegmentstats=time.time()

## Compute statistics of objets using i.segment.stats only with .csv output (no vectormap output)
grass.run_command('i.segment.stats', overwrite=True, map="segments_training@CLASSIFICATION",
                  rasters=inputstats,
                  raster_statistics="min,max,range,mean,stddev,sum,coeff_var,first_quart,median,third_
quart,perc_90",
                  area_measures="area,perimeter,compact_circle",
                  csvfile="F:\\.....\\Classification\\i.segment.stats\\stats_training_sample.csv")

## Compute processing time and print it
print_processing_time(begintime_isegmentstats, "Segment statistics computed in :")
```

remote sensing

MDPI

Article

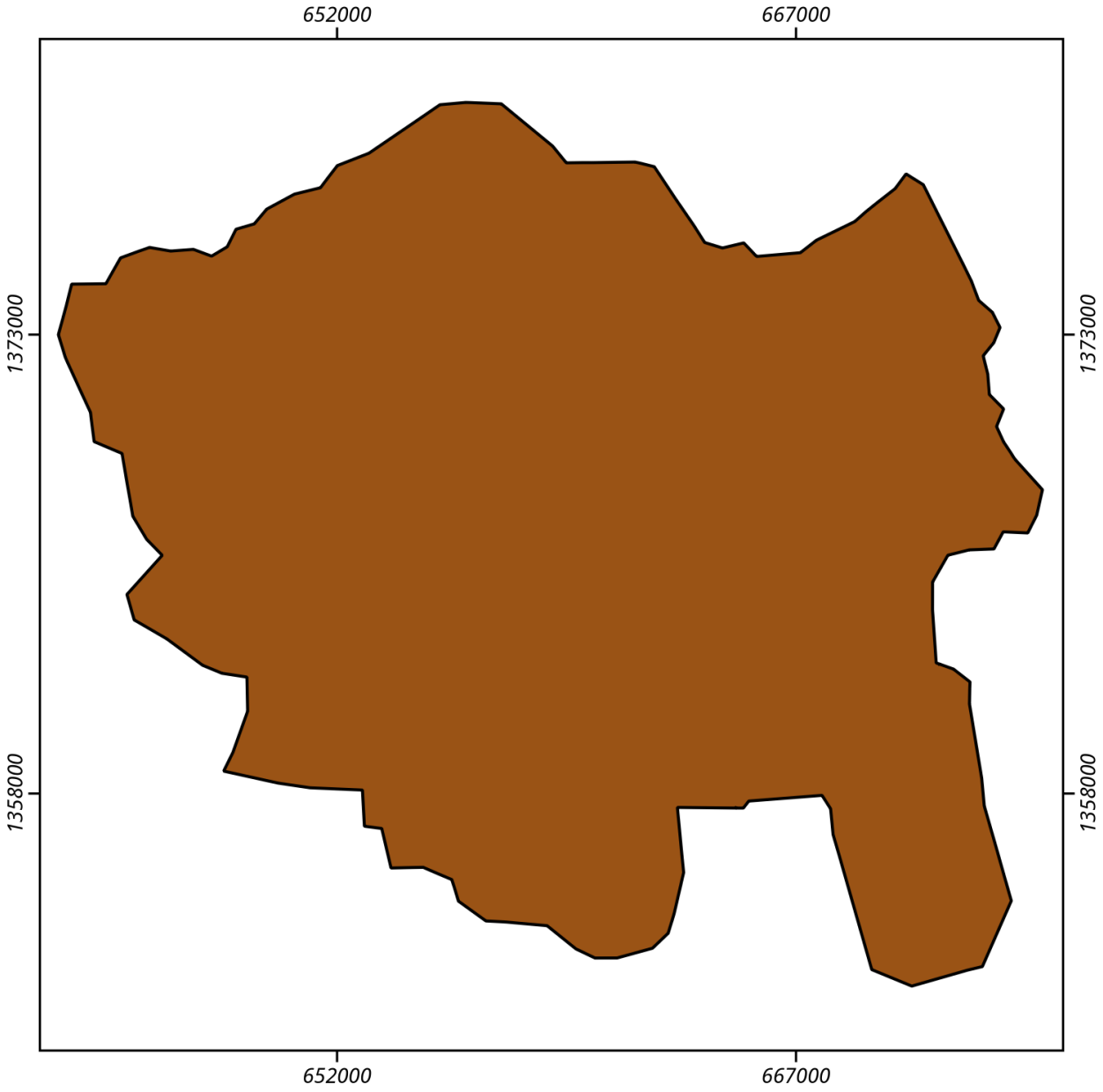
An Open-Source Semi-Automated Processing Chain for Urban Object-Based Classification

Taïs Grippa [1,*], Moritz Lennert [1], Benjamin Beaumont [1,2], Sabine Vanhuysse [1], Nathalie Stephenne [2] and Eléonore Wolff [1]

LAND USE MAPPING

Land use mapping

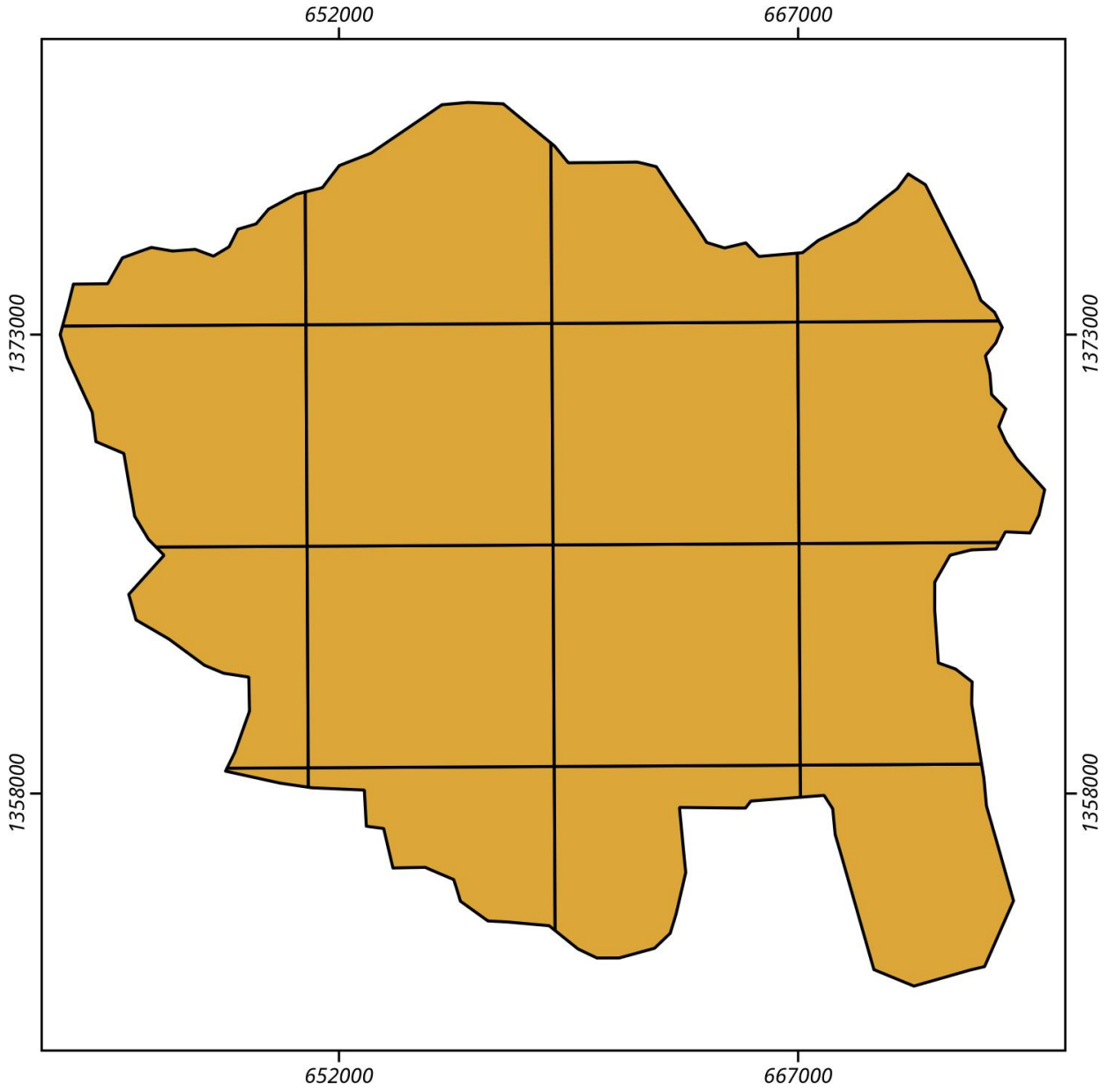
- Usually require exhaustive reference dataset which are not available for many SSA cities
- Our approach rely on EO-derived data and OSM
- Mapping land use at the street block level
  - Need of geometries of street block for using them in GIS → again usually difficult to obtain
  - Creation of street block geometries from OpenStreetMap



Projection: EPSG 32630
WGS 1984 / UTM zone 30N

0 5 10 km

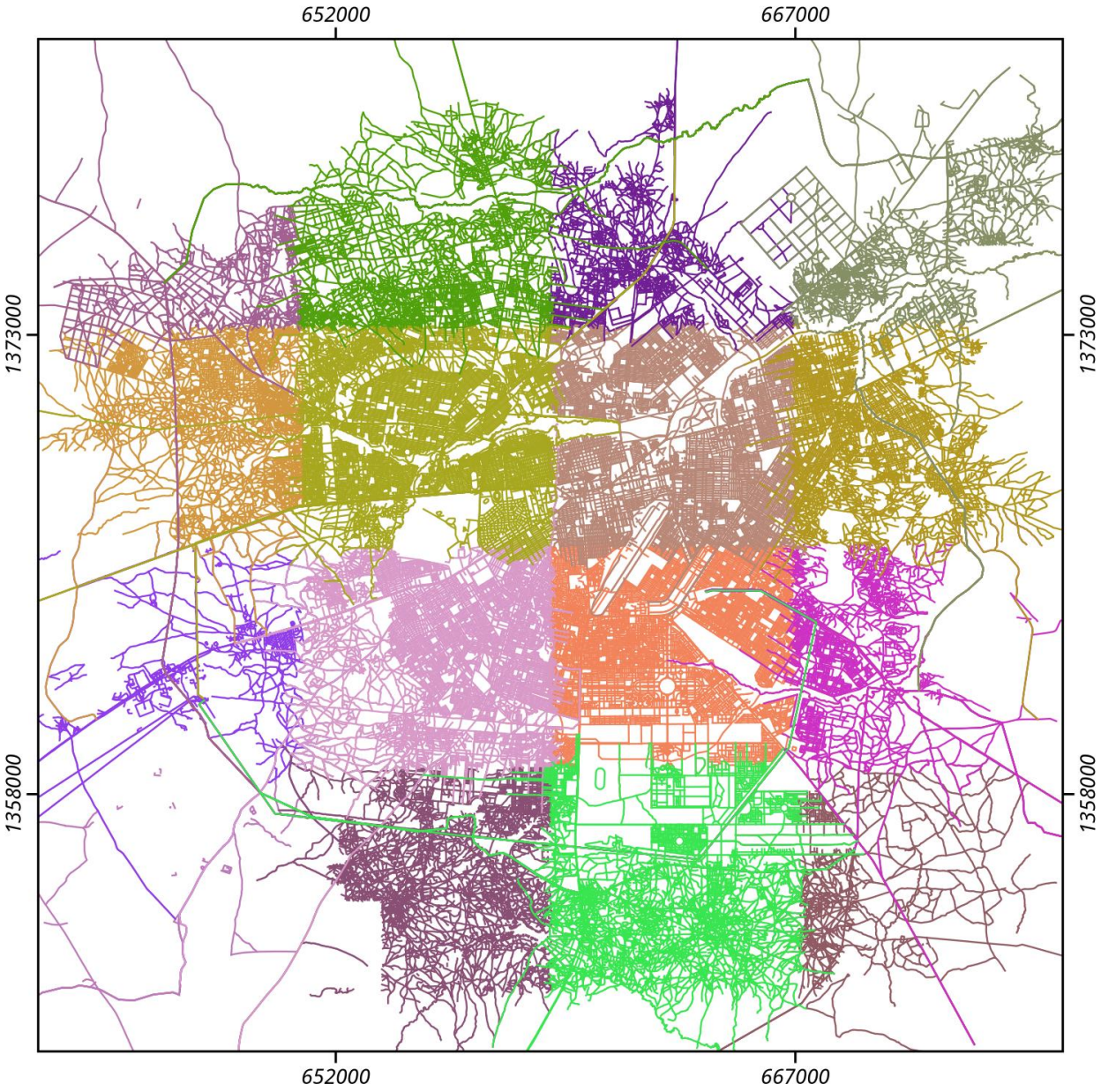
Author: Grippa Taïs



Projection: EPSG 32630
WGS 1984 / UTM zone 30N

0 5 10 km

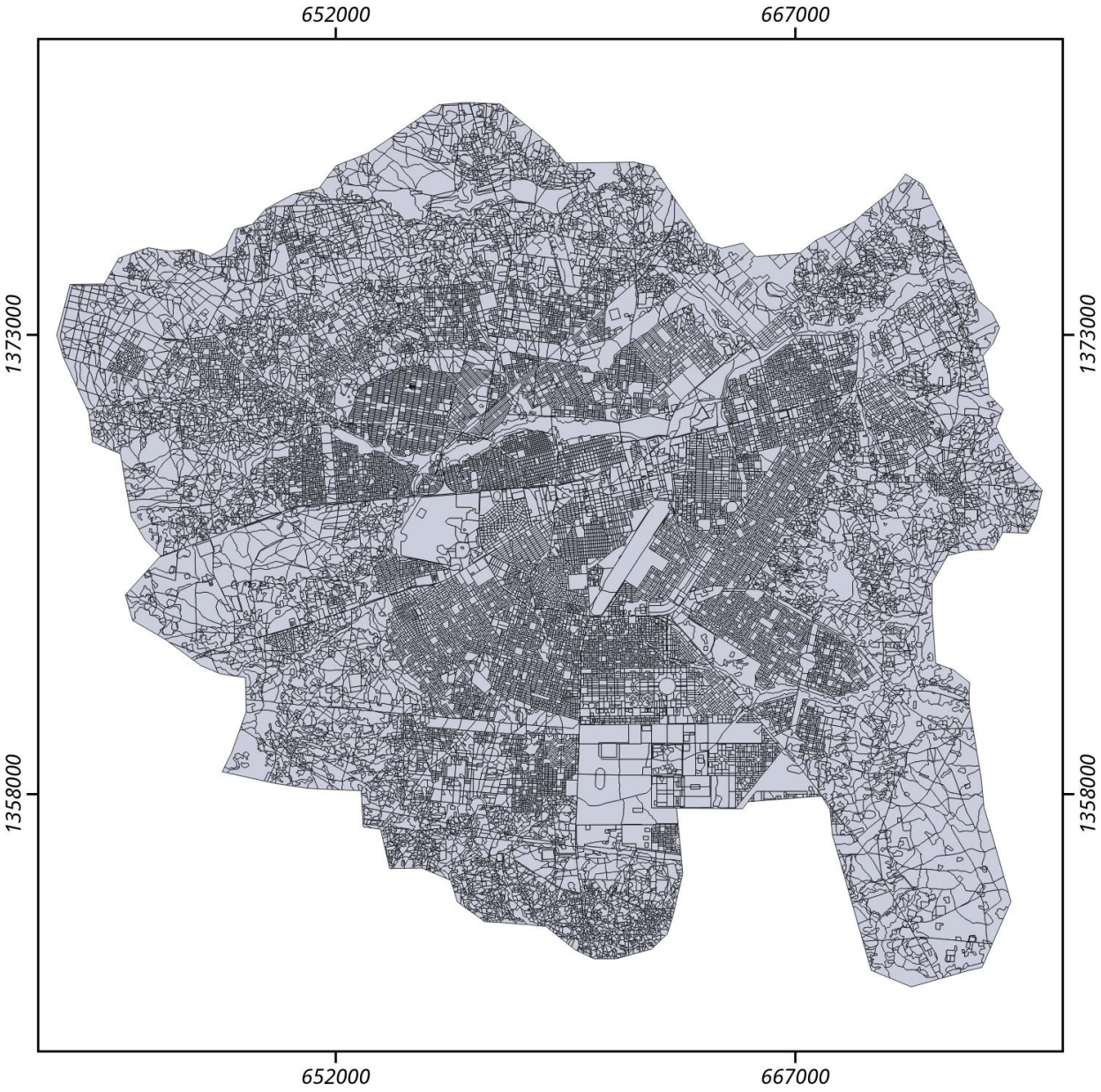
Author: Grippa Taïs



Projection: EPSG 32630
WGS 1984 / UTM zone 30N

0 5 10 km

Author: Grippa Taïs

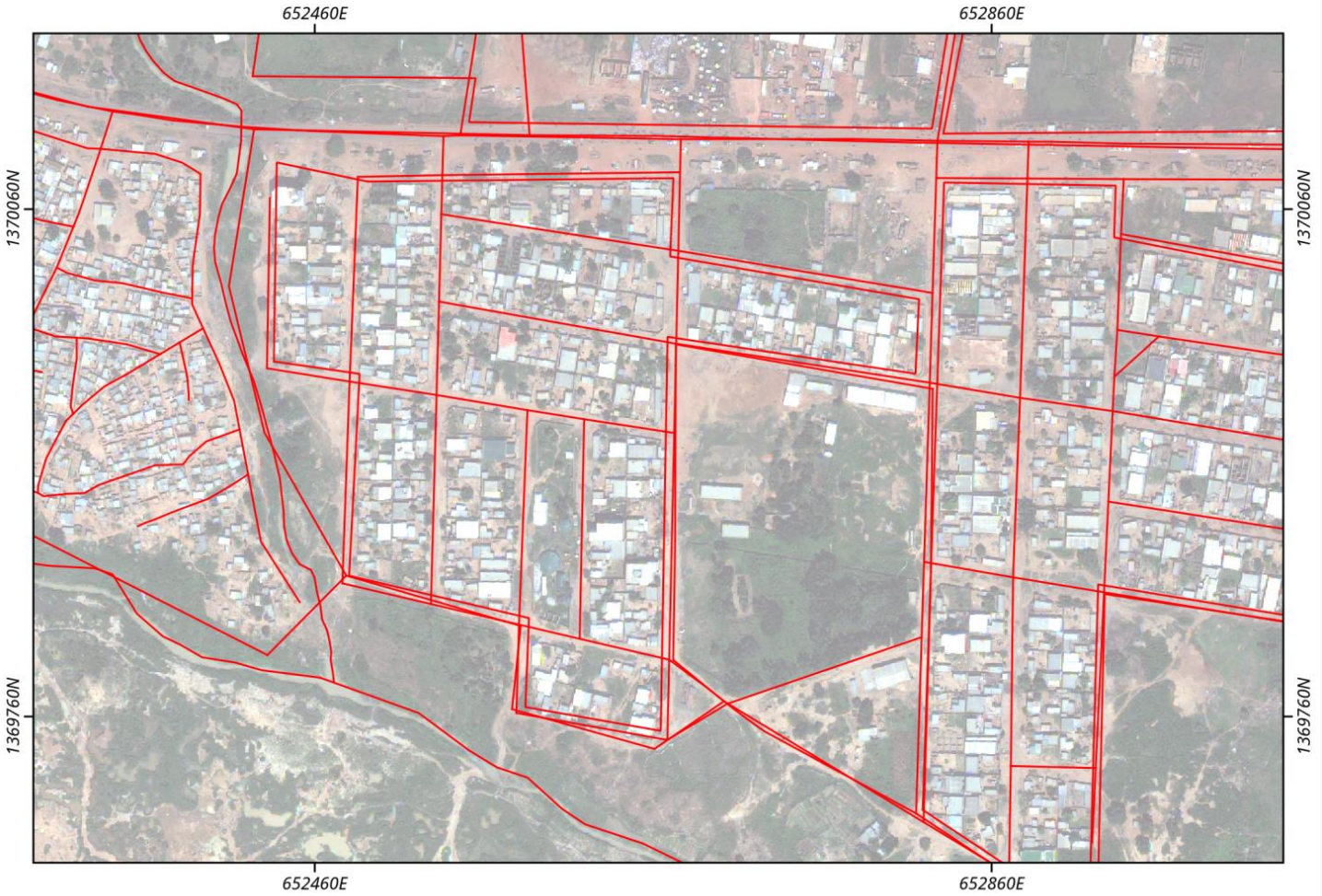


Projection: EPSG 32630
WGS 1984 / UTM zone 30N

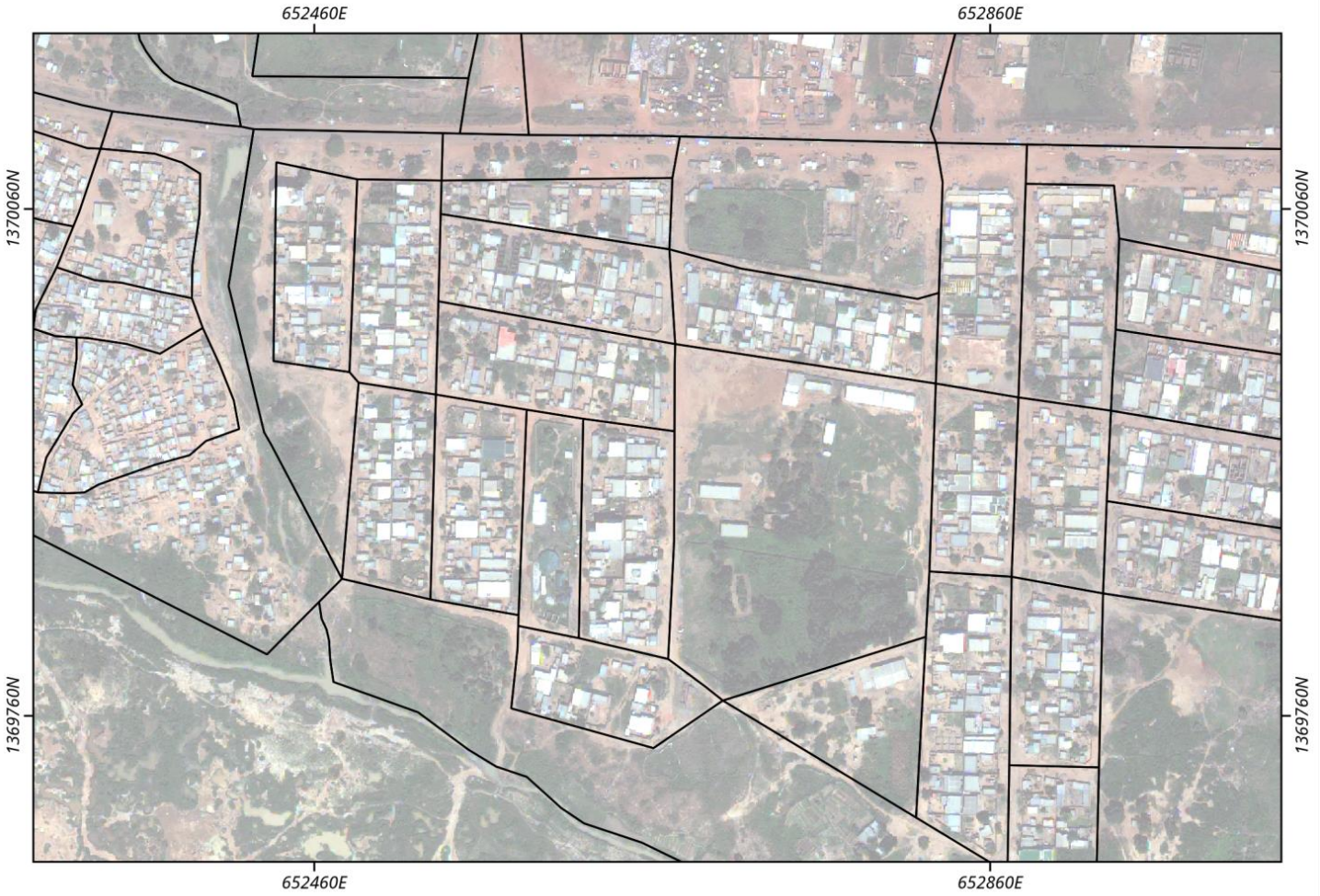
0 5 10 km

Author: Grippa Taïs

Land use mapping

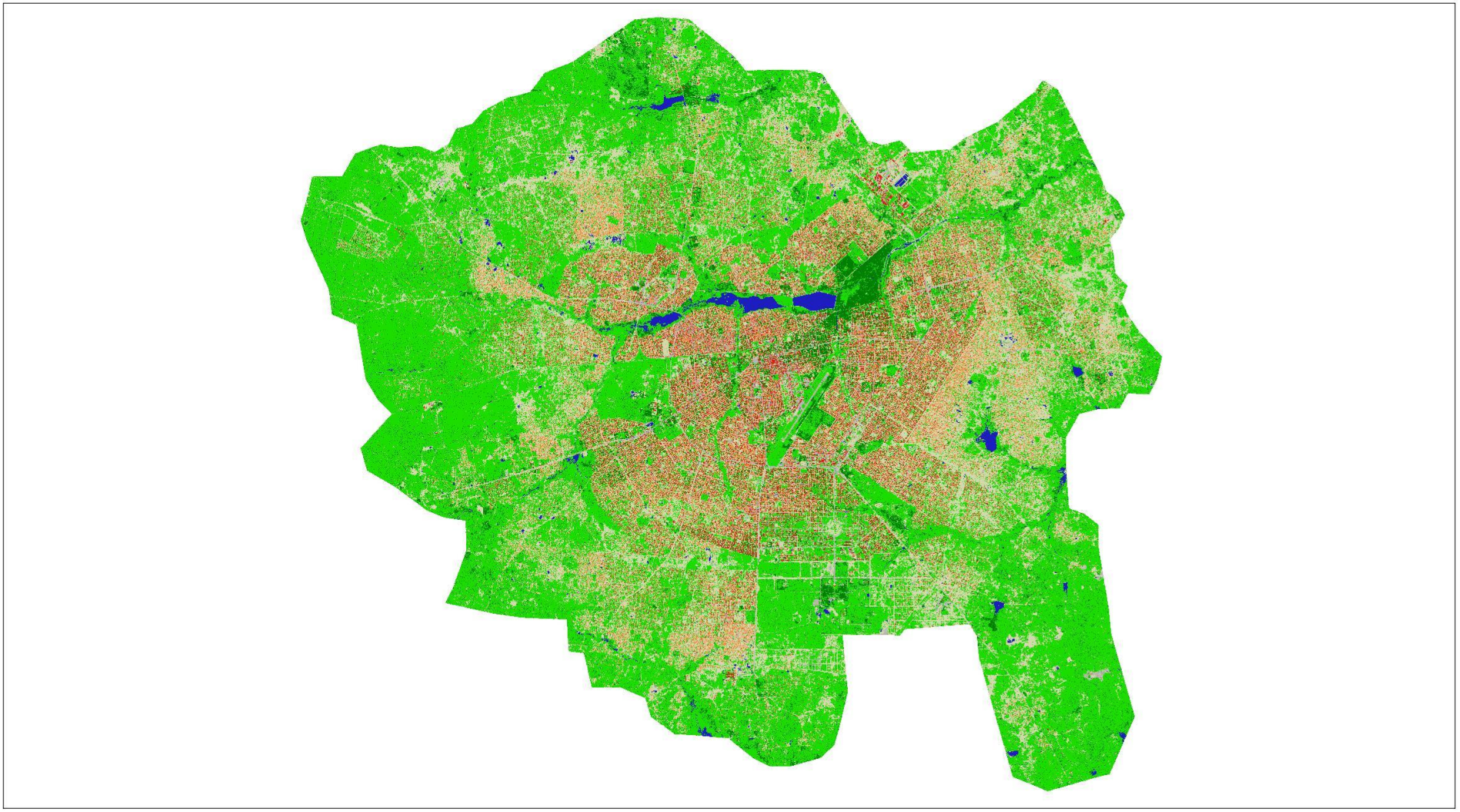


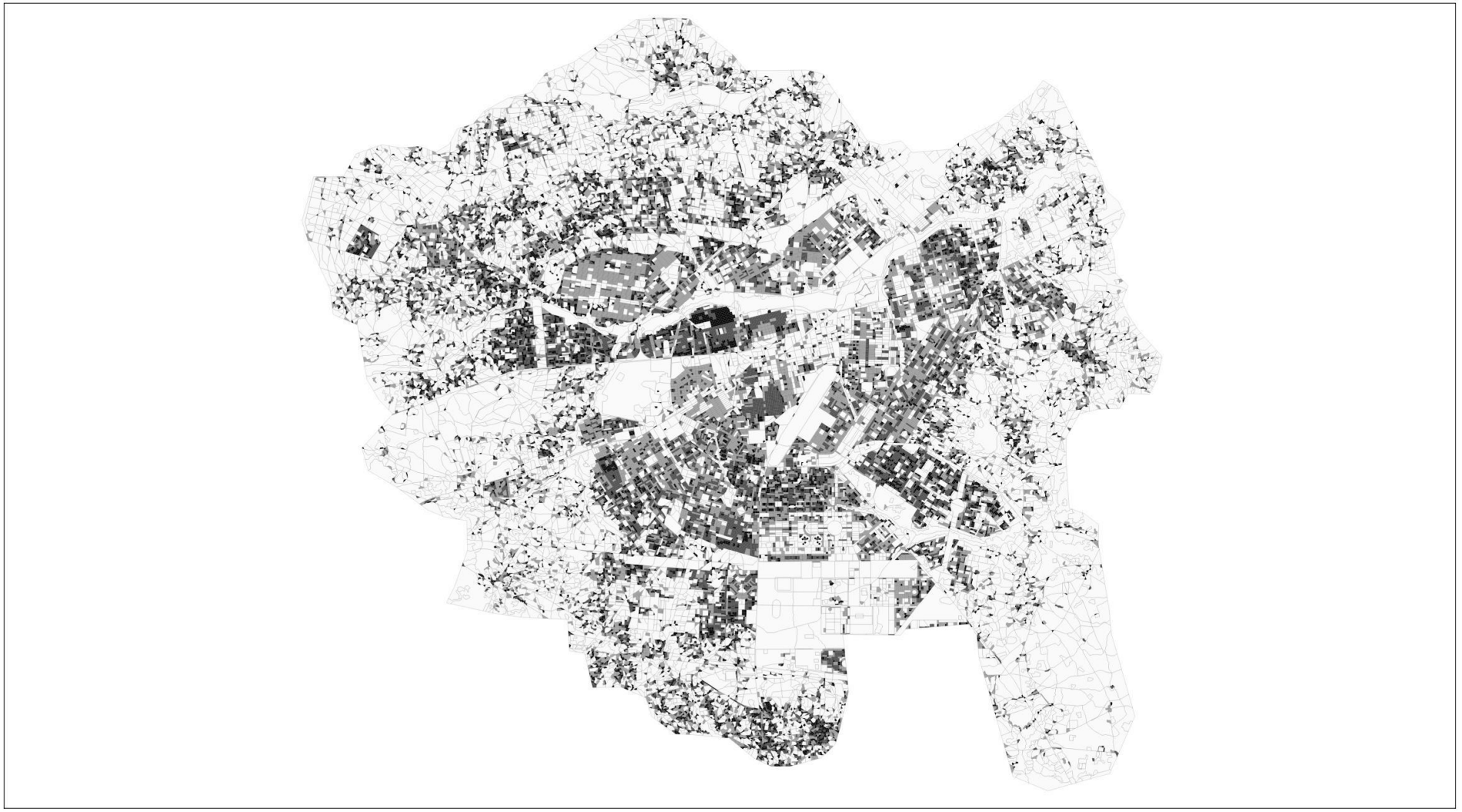
Land use mapping

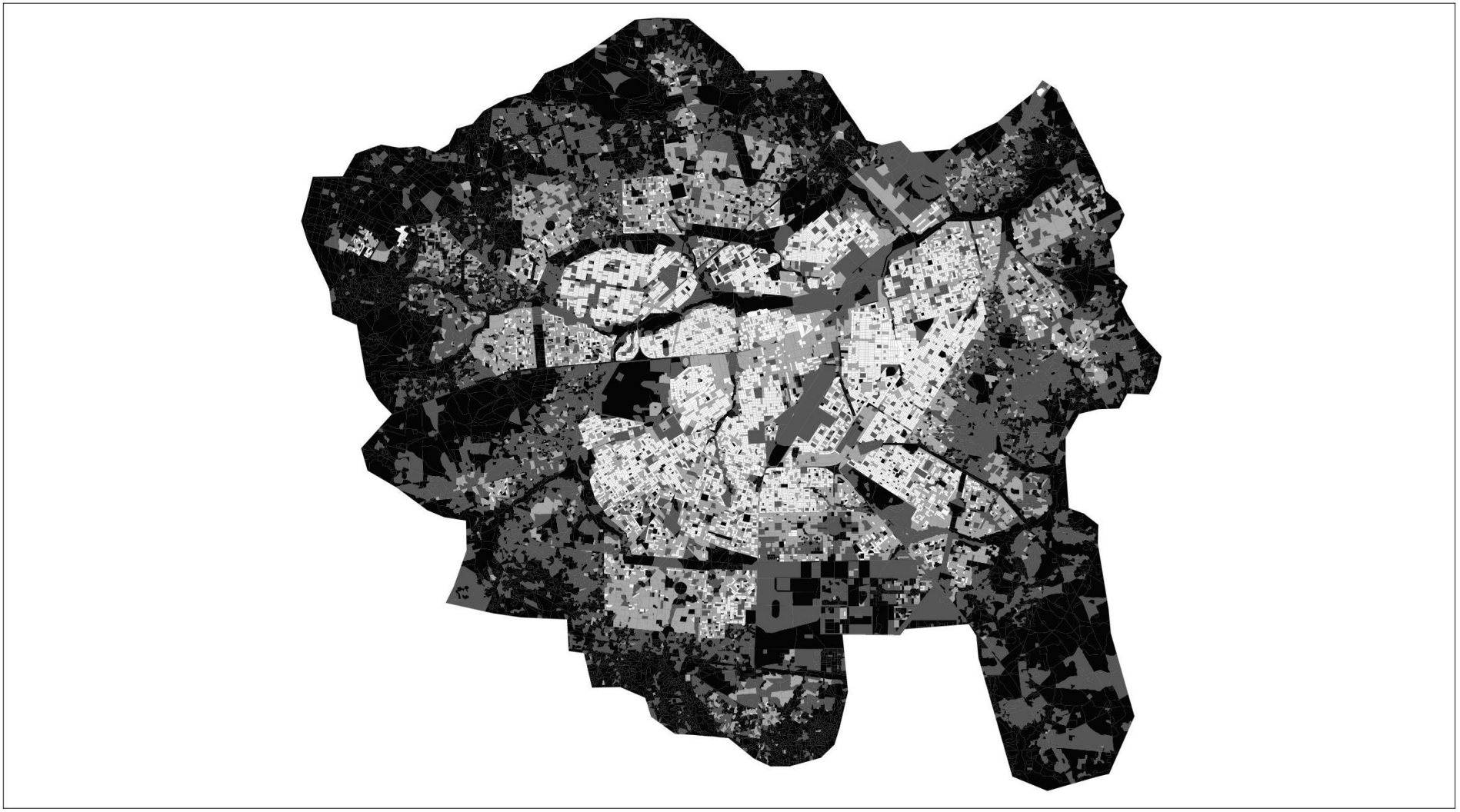


Land use mapping

- Characterization of street blocks for land use classification
  - Street block geometry (shape index, area)
  - RS-derived information (nDSM, NDVI)
  - LC-derived information (Landscape/Spatial metrics)


Land cover
0
3
6 km
HB
LB
SW
AS
BS
TR
LV
WB

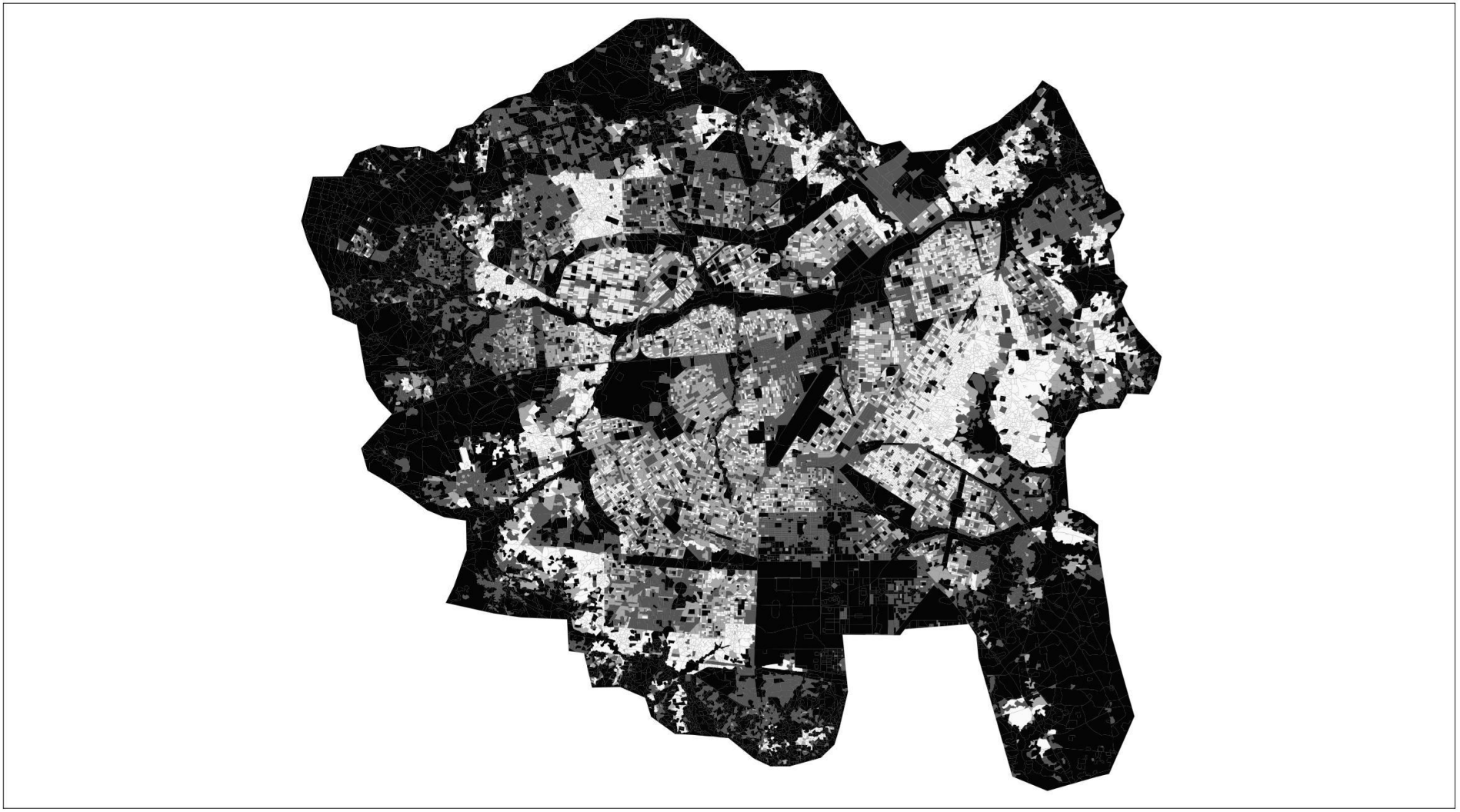

Street block area (ha)
0
3
6 km
< 2.37
2.37 - 3.68
3.68 - 6.29
> 6.29



Class High-elevated building - Patch density

0 3 6 km

0
0.00 - 0.78
0.78 - 2.74
> 2.74



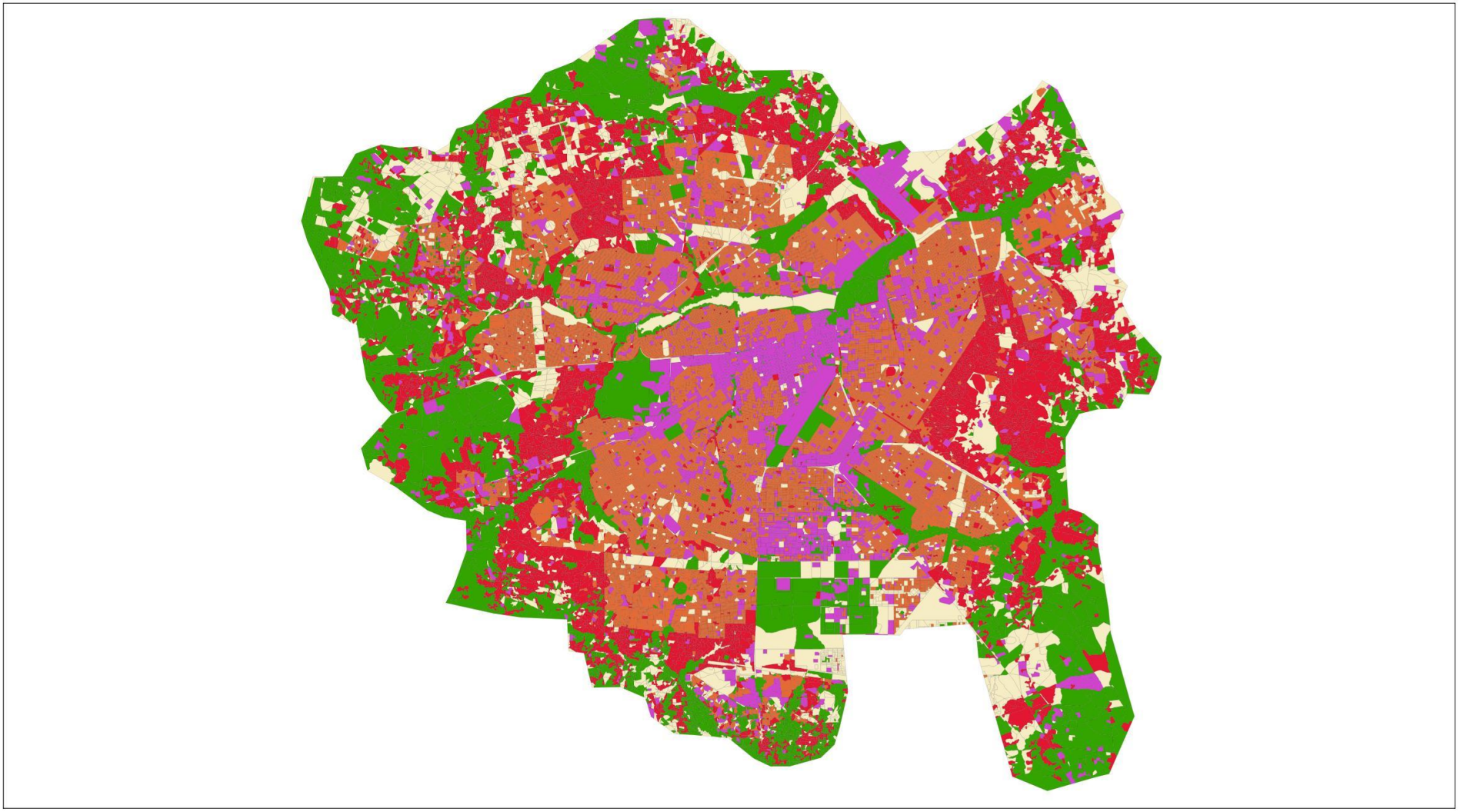
Class Low-elevated building - Patch density

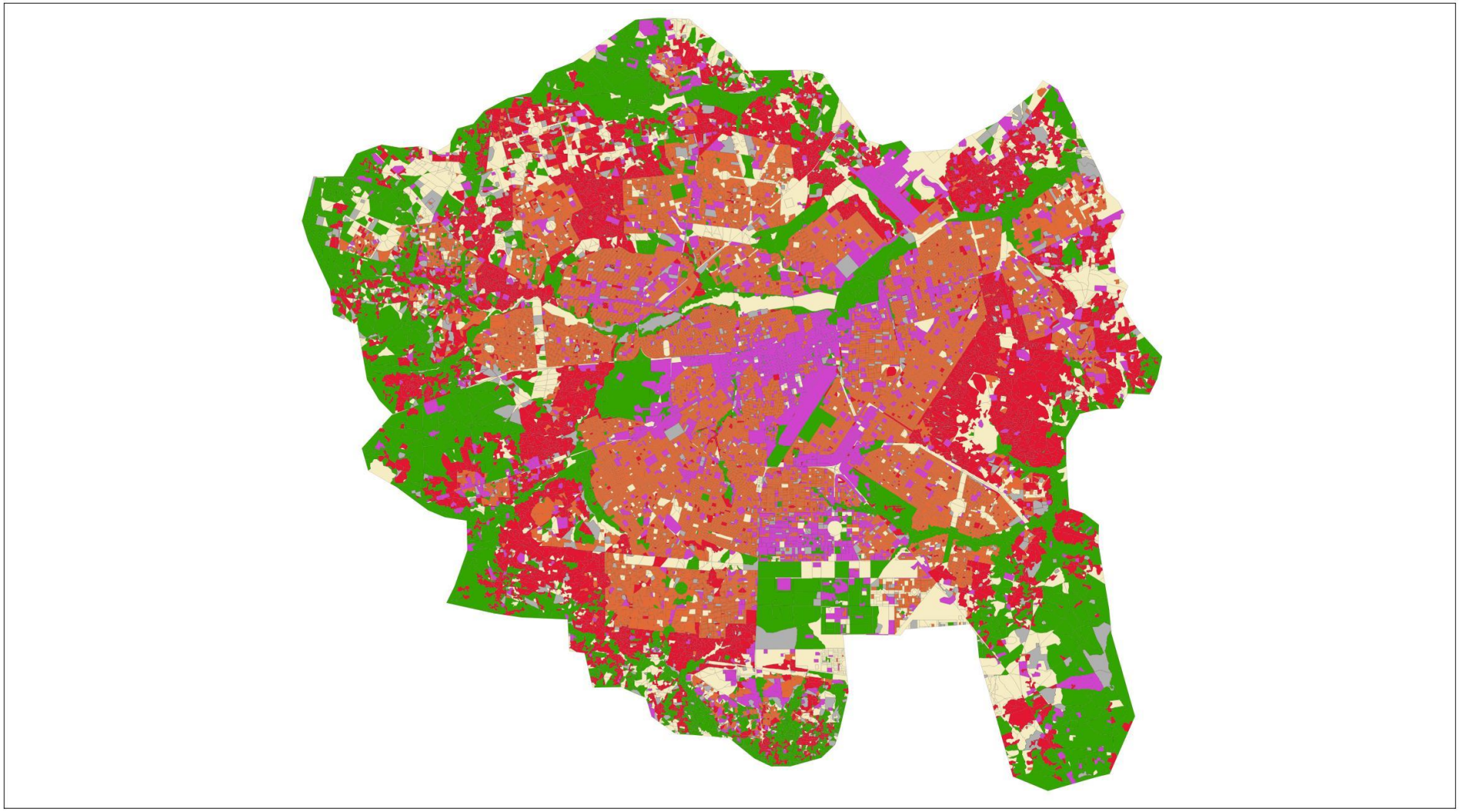
0 3 6 km

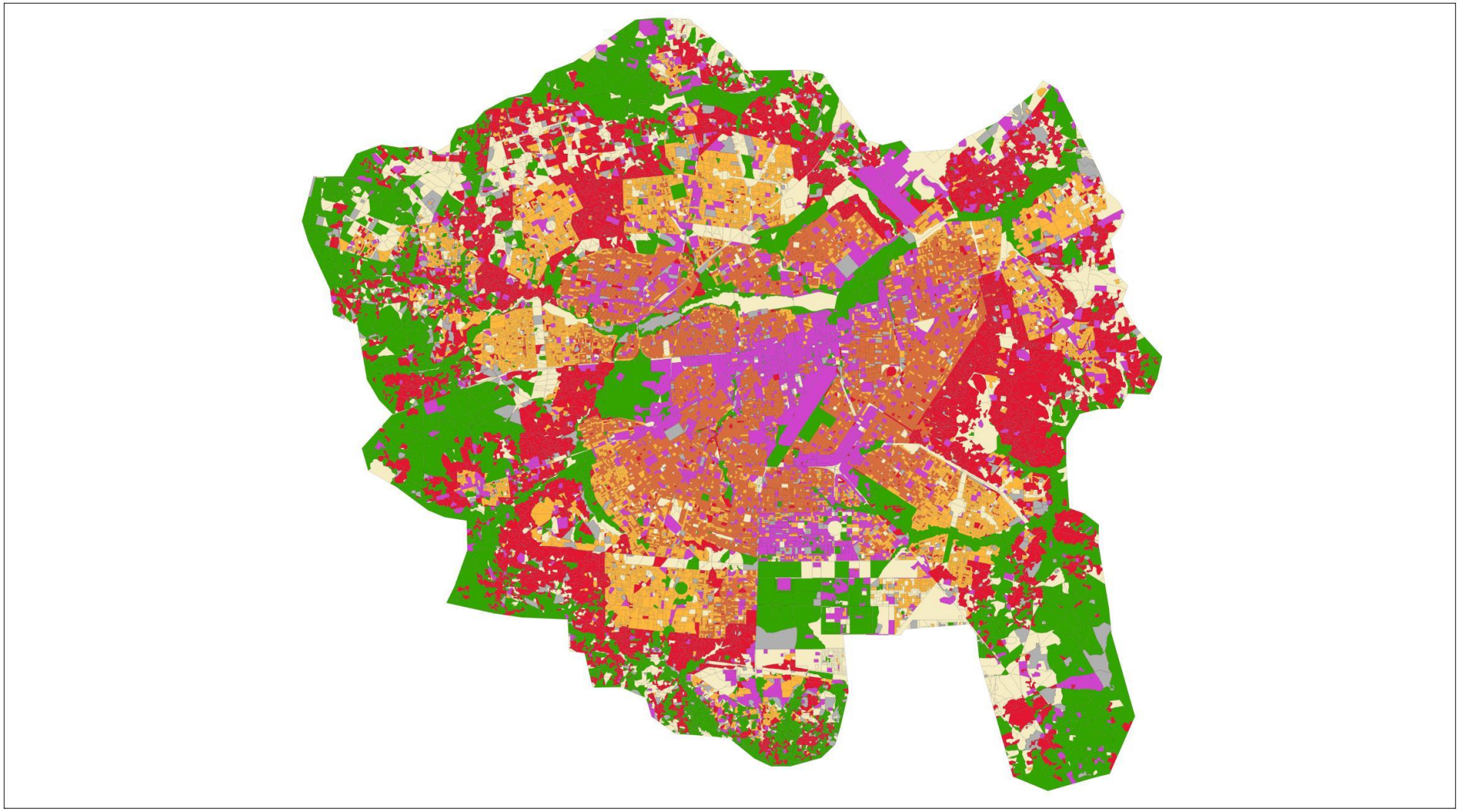
< 1.96
1.96 - 6.15
6.15 - 9.55
> 9.55

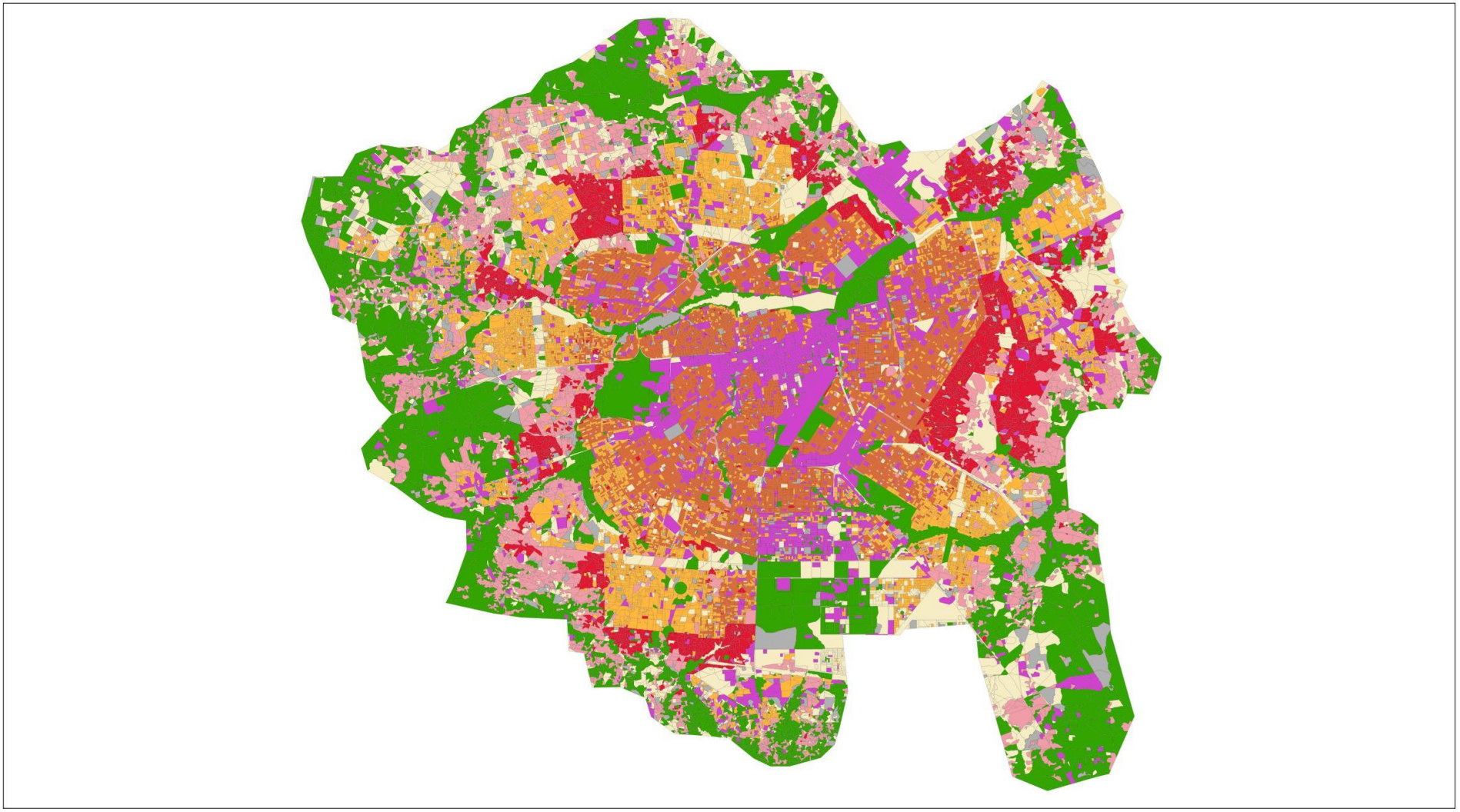
Land use mapping

- Supervised classification using machine learning algorithm
  - Random Forest for supervised classification
  - Feature selection and classification using RF
  - Incorporation of an uncertainty class
  - Thresholding on proportion of built-up pixels to get different classes of density


Land use - RF softmax
PLAN
UNPLAN
ACS
VEG
BARE
0
3
6 km


Land use - RF softmax + uncertainty
PLAN
UNPLAN
ACS
VEG
BARE
UNCERT
0
3
6 km


Land use - RF softmax + uncertainty + density 1
0
3
6 km
PLAN
PLAN LD
UNPLAN
ACS
VEG
BARE
UNCERT


Land use - RF softmax + uncertainty + density 2
0
3
6 km
PLAN
PLAN LD
UNPLAN
UNPLAN LD
ACS
VEG
BARE
UNCERT

Validation of products

- Land cover
  - Reaching about **90%** of overall accuracy
- Land use
  - Reaching about **80%** of overall accuracy
- → Depending 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.

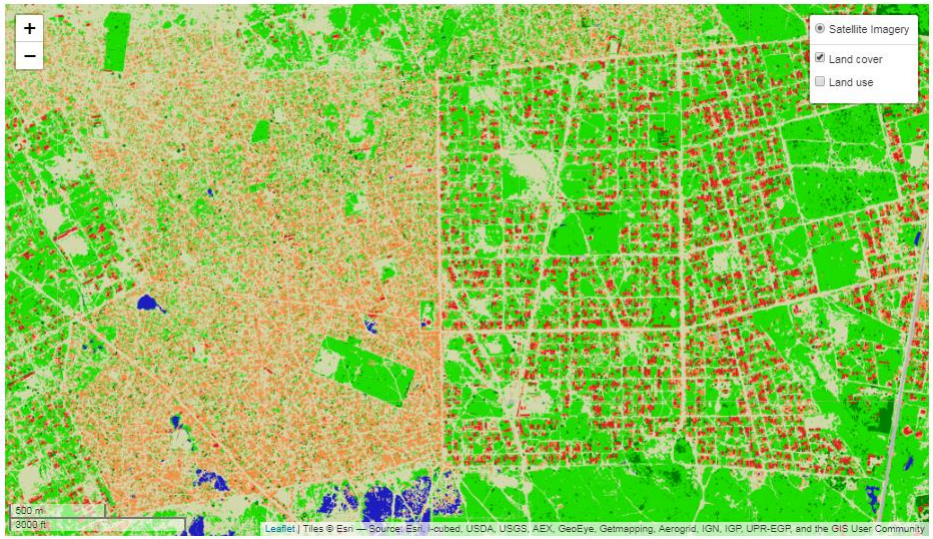
Transferability to other case studies

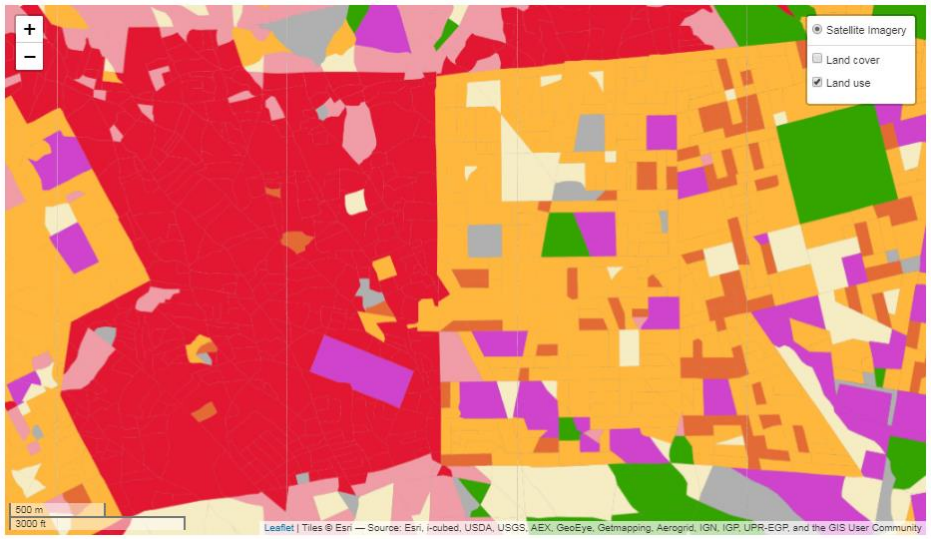
- MAUPP project
  - Ouagadougou, Burkina Faso
  - Dakar, Senegal
- REACT project
  - Kampala, Uganda
- SmartPop project
  - Liège, Belgium
- WALLOUS project
  - All Walloon region, Belgium (+16 000 km²)

Web-map

Mapping urban land use at street block level using OpenStreetMap, remote sensing data and spatial metrics

Published in ISPRS International Journal of Geo-Information





Land cover

- High buildings
- Medium buildings
- Low vegetation
- Trees
- Bare soils
- Asphalt surfaces
- Water bodies
- Swimming pools

Land use

- Planned residential
- Planned residential (low density)
- Bare soils
- Non-residential
- Unplanned residential
- Unplanned residential (low density)
- Vegetation
- Uncertain

Computer code available

LC OBIA

- Initial processing chain => HERE
- Local approach implementation => HERE
- Rule-based OBIA post-classification => HERE

LU

- Street blocks creation from OSM => HERE
- Spatial metrics as LU classification features => HERE

Hardware requirement

Large-scale cities + VHR = intensive processing

Ouagadougou example

- 615 km²
- +200 Gb data in total
- +15 10^6 segments
- +50 Gb tabular file (csv)
- Segmentation: ±10 days using 17 cores
- Segment stats and classification: ±2 days
- Post-classification: ±1,5 days
- Land use: ±2 days

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QUESTIONS ?