

Addis Abeba, 1st November 2014

PhD thesis:

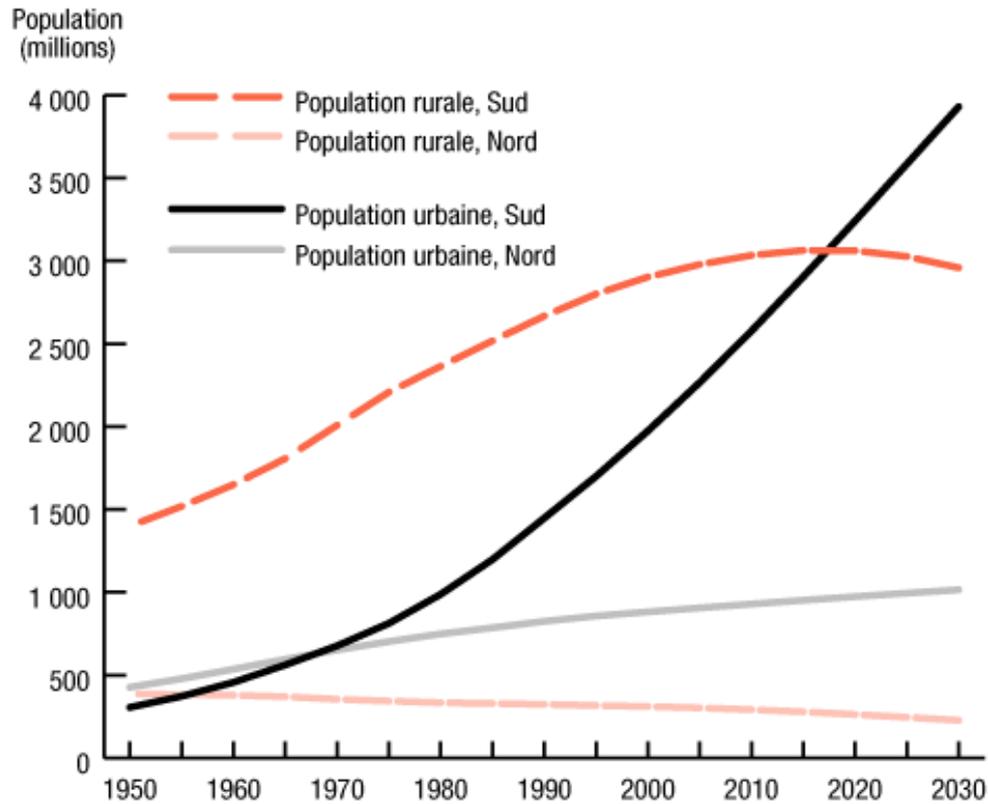
The urbanization process through
urban ecology:
which definitions
&
which resilience among ecosystems?

André M.



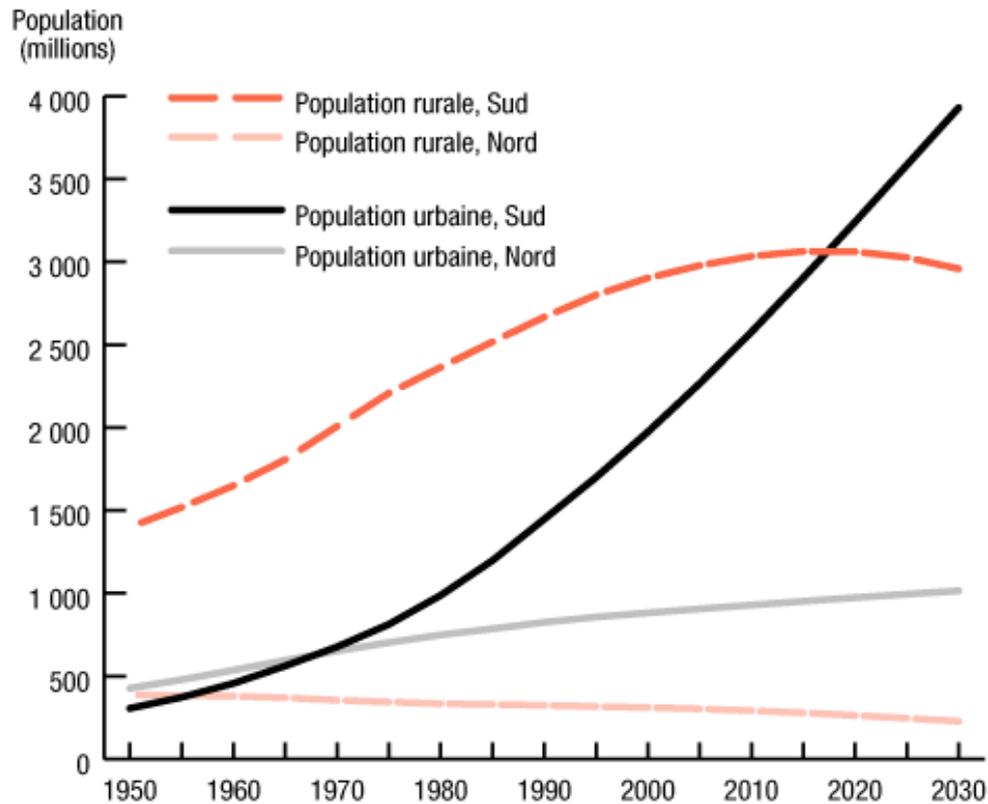
Introduction: a growing urban population

2



ONU, 2004

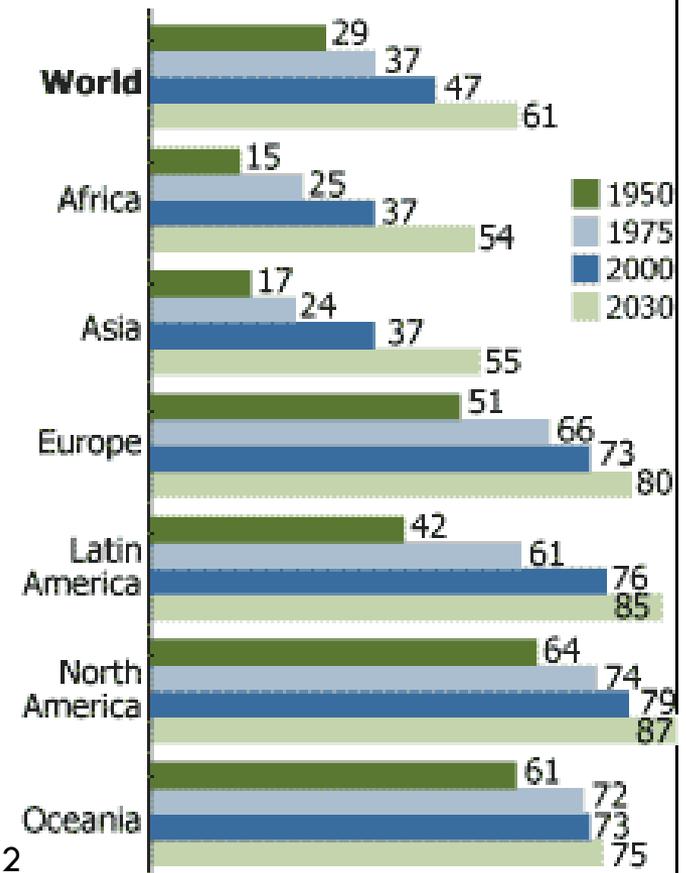
Introduction: a growing urban population



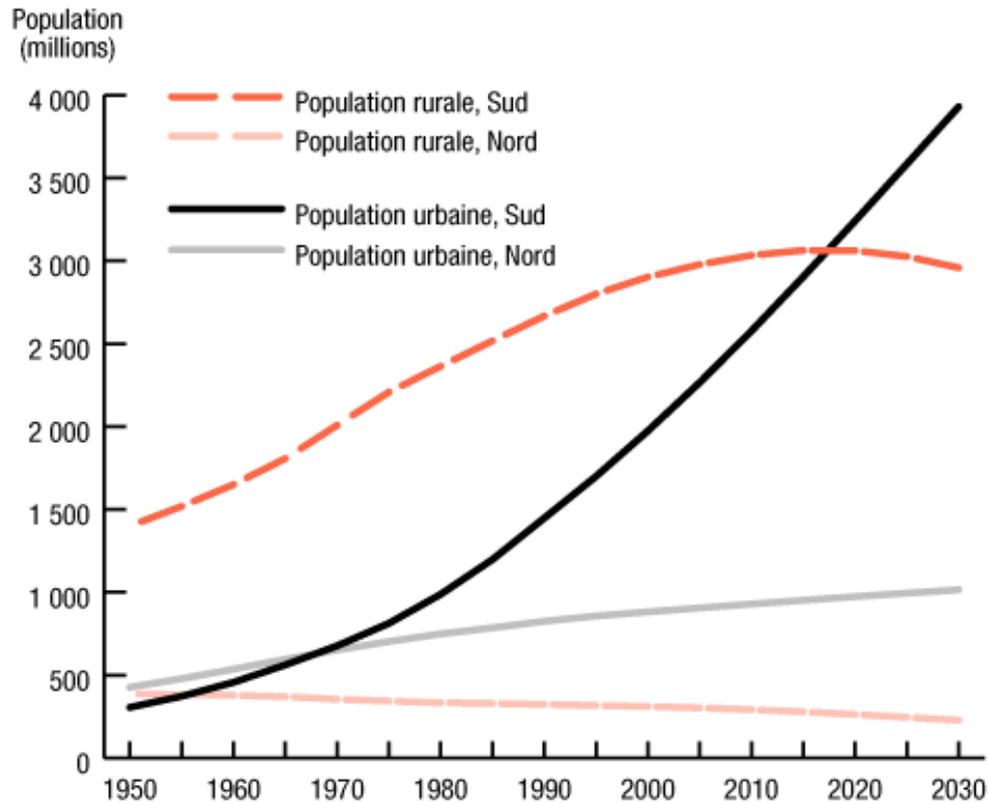
ONU, 2004

Adapted from UN, 2012

Percent urban



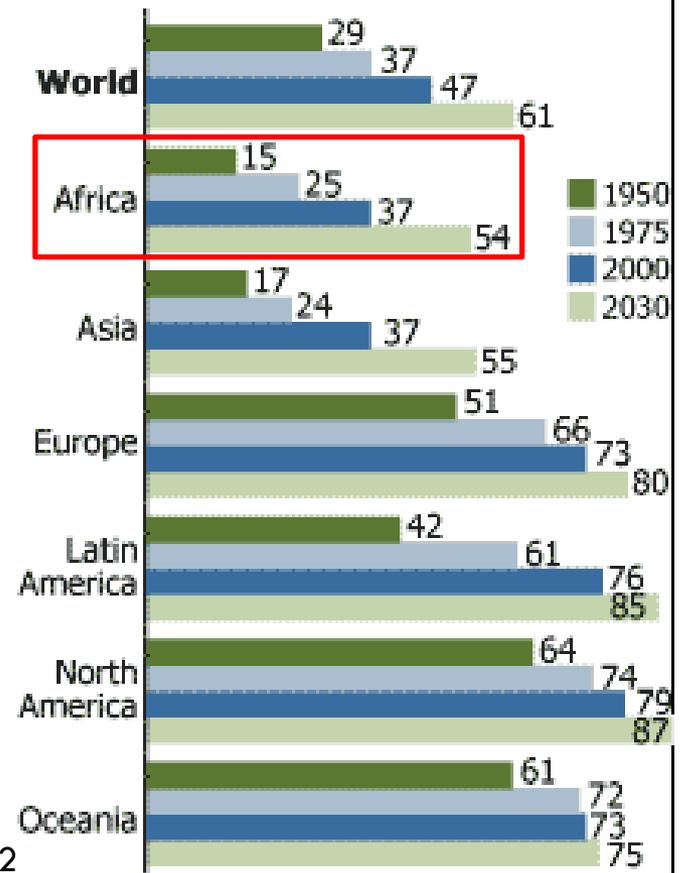
Introduction: a growing urban population



ONU, 2004

Adapted from UN, 2012

Percent urban



1/5

Objectives

Objectives

6

1. Delimit the zones included in the urban-rural gradient

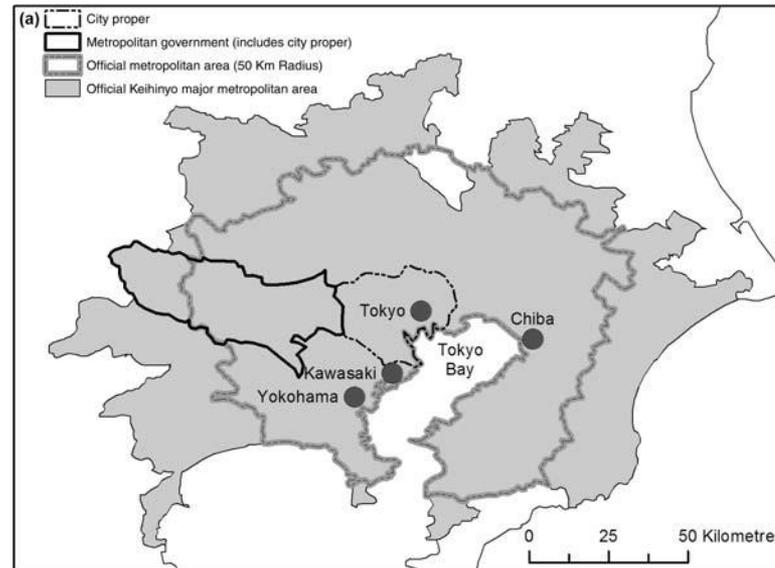
Objectives

7

1. Delimit the zones included in the urban-rural gradient
2. Study of the landscape ecological consequences of the urbanization and periurbanization processes in sub-saharan Africa

Objectives

8



Forstall et al, 2008

| *Official UA or MA definition [WUP]: Definition used by UN | Type of definition (see Table 2) | Population 2000 | Area (km ²) 2000 | Population per km ² 2000 | Annual average | |
|---|--|--------------------|------------------------------------|---|----------------------|-------------------|
| | | | | | Population change | Percent change |
| Tokyo (2000 and 1995 censuses) | | | | | | |
| City proper | I | 8,134,688 | 621 | 13099.3 | 33,000 | 0.41 |
| Administrative area | II | 12,064,101 | 2,187 | 5516.3 | 58,000 | 0.49 |
| Urbanised area* | III | 28,271,210 | 3,084 | 9167.1 | 169,000 | 0.61 |
| UA (administrative boundaries) | IV | 30,402,132 | 6,657 | 4566.9 | 165,000 | 0.55 |
| Metropolitan area (1)* [WUP] | V | 34,493,466 | 13,504 | 2554.3 | 179,000 | 0.53 |
| Metropolitan area (2)* | V | 30,724,311 | 7,628 | 4027.8 | 170,000 | 0.56 |
| Consistently defined metropolitan area | CDMA | 31,865,900 | 8,014 | 3976.3 | 175,000 | 0.56 |

Objectives

9

1. Delimit the zones included in the urban-rural gradient

Objectives

10

1. Delimit the zones included in the urban-rural gradient

Cities: which exact extent?

Objectives

11

1. Delimit the zones included in the urban-rural gradient

Cities: which exact extent?

Grow: which surface?

Objectives

12

1. Delimit the zones included in the urban-rural gradient
 - ▣ Review
 - ▣ Segmentation using landscape indexes
 - ▣ Methodology of classification for satellite images
 - ▣ Application to the study zone (1 dozen of cities in sub-saharan Africa)
 - ▣ Typology based on the (sub)urbanization dynamic

Objectives

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2. Study of the landscape ecological consequences of the urbanization and periurbanization processes in sub-saharan Africa

Urbanization: To the detriment of which landscape class/ecosystems?

Objectives

14

2. Study of the landscape ecological consequences of the urbanization and periurbanization processes in sub-saharan Africa

SENSITIVE ECOSYSTEMS TO PRESERVE?

Objectives

15

2. Study of the landscape ecological consequences of the urbanization and periurbanization processes in sub-saharan Africa

SENSITIVE ECOSYSTEMS TO

integrate as green spaces?

Objectives

16

2. Study of the landscape ecological consequences of the urbanization and periurbanization processes in sub-saharan Africa

ECOSYSTEMS

Unadapted for urban development?

Plan of the objectives

17

- 1. Delimit the zones included in the urban-rural gradient
 - ▣ Review
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Plan of the objectives

18

○1. Delimit the zones included in the urban-rural gradient

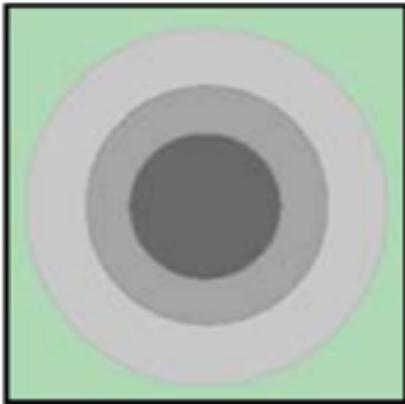
- Review
 - What are the different configurations of cities?
 - Which appellations are synonyms?
 - Which characteristics differentiate the different zones?
 - Which characteristics are the most relevant for the second part of the study?
- Methodology of classification
- Segmentation using land use/cover data
- Application to the study area (sub-saharan Africa)
- Typology based on the results

○2. Study of the landscape ecological consequences of the urbanization and periurbanization processes in sub-saharan Africa

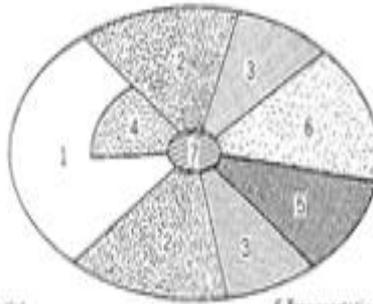
O1. Review

19

- What are the different configurations of cities?

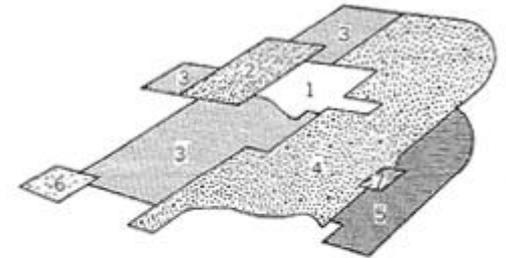


Concentric model
(Continuous & decreasing density)



- 1 High-rent residential
- 2 Intermediate-rent residential
- 3 Low-rent residential
- 4 Education and recreation
- 5 Transportation
- 6 Industrial
- 7 Core

Sectoral model



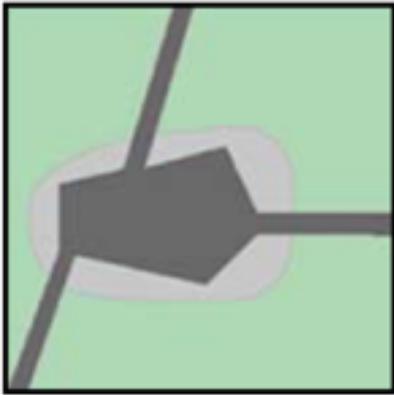
- 1 Central business district
- 2 Wholesale, light manufacturing
- 3 Low-rent residential
- 4 Medium-class residential
- 5 High-class residential
- 6 Heavy manufacturing
- 7 Outlying business district

Multicore model

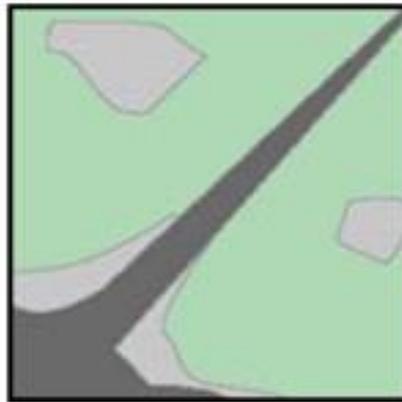
O1. Review

20

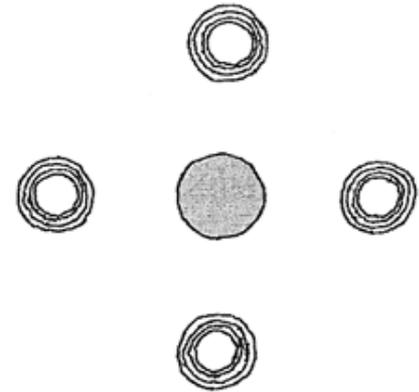
- What are the different configurations of cities?



Ribbon model



Leapfrog model



Satellite towns model

O1. Review

21

- Which appellations are synonyms?
 - ▣ Urban zone = core = central city = city centre
 - ▣ « Zone de banlieue » = dwelling quarters =
urban crown
 - ▣ Suburban zone = urban fringe
 - ▣ Rural zone

O1. Review

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- Which characteristics are the most relevant for the second part of the study?

O1. Review

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- Which characteristics differentiate the different zones?

| Caractéristique | Type de caractéristique | Urbain | Banlieue | Péri-sub-urbain | Exurbain | Etagement urbain | Rural | lfg | lfr |
|---|-------------------------|--------|----------|-----------------|----------|------------------|-------|------------|-------------|
| Position dans un gradient s'éloignant du centre-ville | Morphologique | 3% | 11% | 8% | 33% | 3% | 26% | 84% | 100% |
| Composition du paysage | Morphologique | 18% | 11% | 12% | 11% | 6% | 15% | 73% | 87% |
| Densité de population | Démographie | 13% | 11% | 4% | 7% | 9% | 15% | 59% | 70% |
| Densité de constructions | Morphologique | 7% | | 4% | 7% | 10% | 11% | 39% | 46% |
| Organisation de l'espace: dispersion de l'habitat | Morphologique | 6% | 17% | 4% | | 11% | | 38% | 45% |
| Nombre de personnes | Démographie | 9% | | | | | 15% | 24% | 29% |
| Distance à l'agglomération | Morphologique | | | 4% | 7% | 3% | | 14% | 17% |
| Navette vers l'agglomération | Fonctionnel/mobilité | | | 4% | 7% | | | 11% | 13% |
| Organisation de l'espace: autres | Morphologique | | | | | 9% | | 9% | 11% |
| Landscape metrics | Morphologique | | | | | 8% | | 8% | 10% |
| Mode de déplacement | Fonctionnel/mobilité | | | | | 7% | | 7% | 8% |
| Vitesse de changement | Dynamique | | | 3% | | 3% | | 6% | 7% |

O1. Review

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- Which characteristics differentiate the different zones?

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|---|-------------------------|--------|----------|-----------------|----------|------------------|-------|------------|-------------|
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O1. Review

25

- Which characteristics differentiate the different zones?

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| Mode de déplacement | Fonctionnel/mobilité | | | | | 7% | | 7% | 8% |

O1. Review

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| Caractéristique | Quantitatif | Caractère intégratif | Consensus global | Caractère discriminant | Facilité d'application sur le terrain |
|---|-------------|----------------------|------------------|------------------------|---------------------------------------|
| Position dans un gradient s'éloignant du centre-ville | | | x | x | x |
| Composition du paysage | x | | x | x | x |
| Densité de population | x | | x | | |
| Densité de constructions | x | | | | |
| Organisation de l'espace: dispersion de l'habitat | x | | | x | x |
| Nombre de personnes | x | | | | |
| Distance à l'agglomération | x | | | | |
| Navette vers l'agglomération | x | | | x | |
| Organisation de l'espace: autres | x | | | x | x |
| Landscape metrics | x | | | | |
| Mode de déplacement | x | | | x | x |
| Vitesse de changement | x | | | | |
| Croissance de population | x | | | | |
| Maisons unifamiliales | | | | x | |
| Déchets | x | x | | | |
| Énergie | x | x | | | |

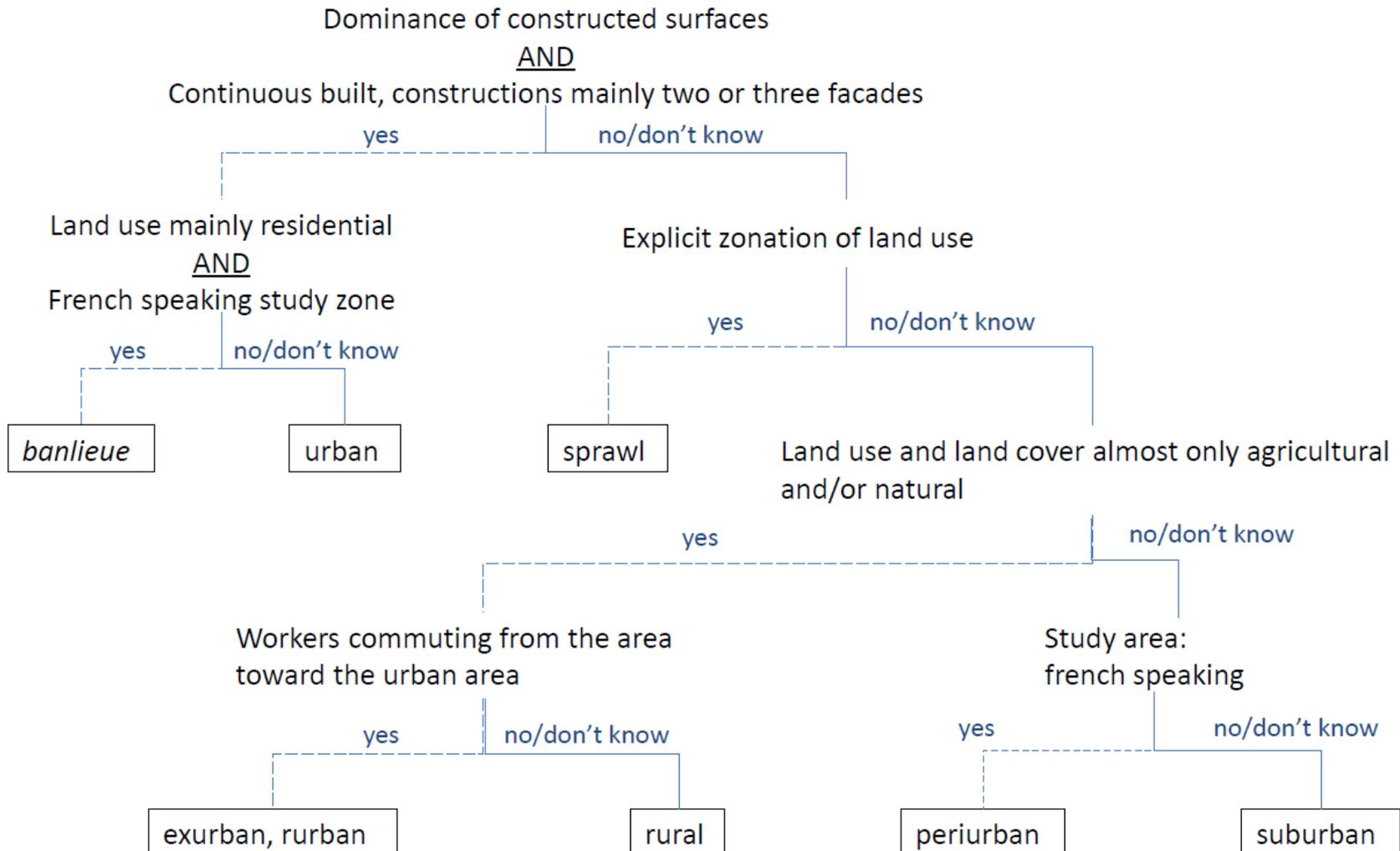
O1. Review

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- New definitions

O1. Review

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Plan of the objectives

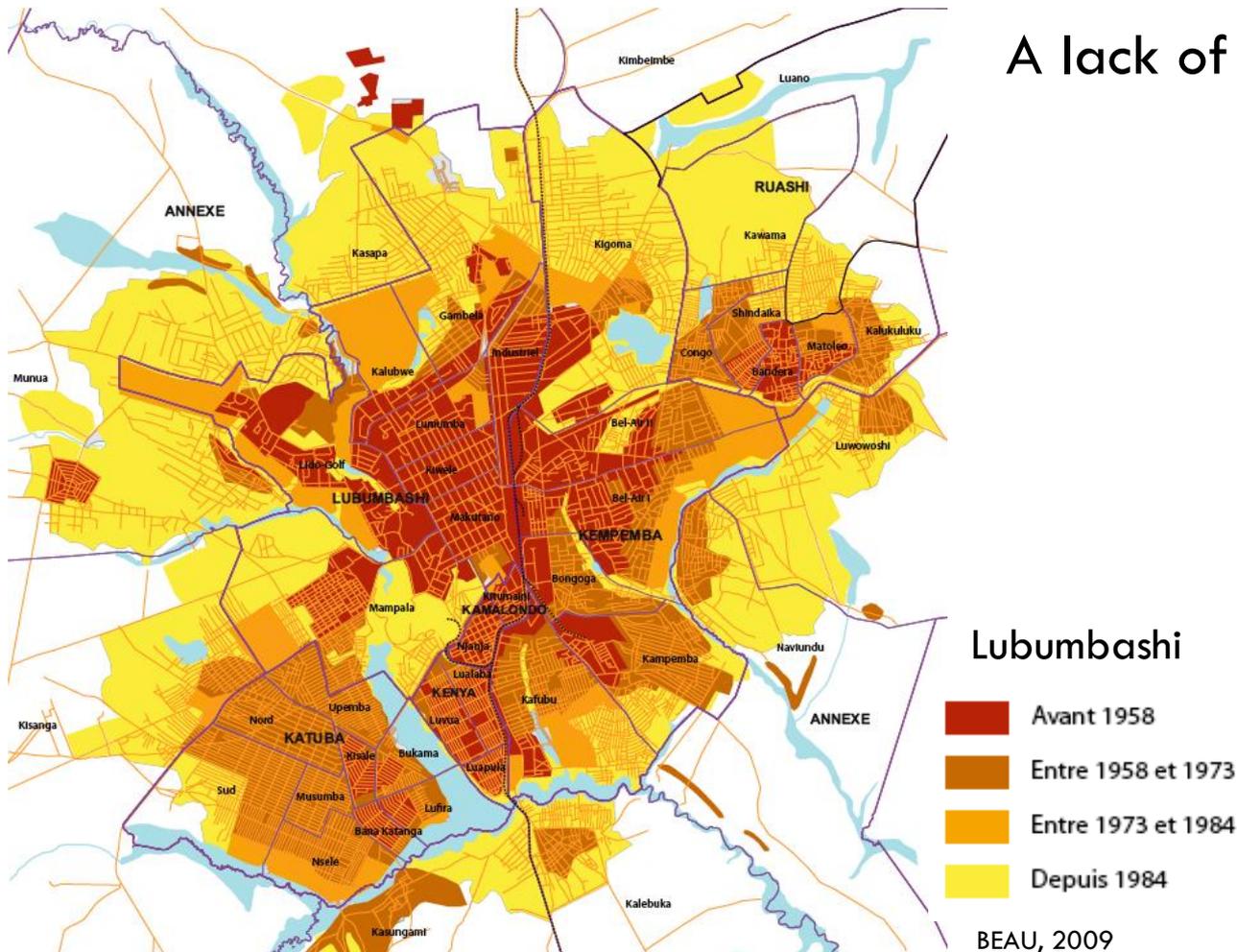
29

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O1. Methodology of classification

30

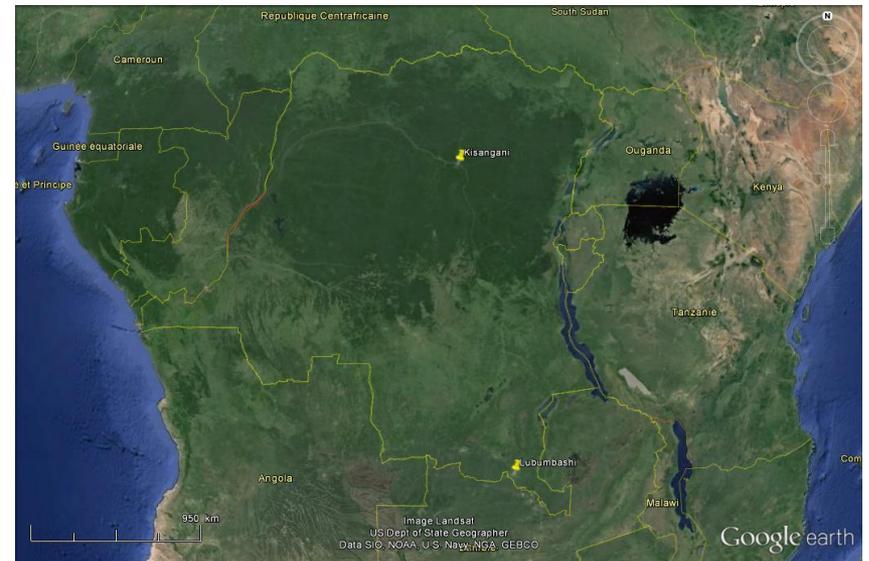
A lack of datas and of maps



O1. Methodology of classification

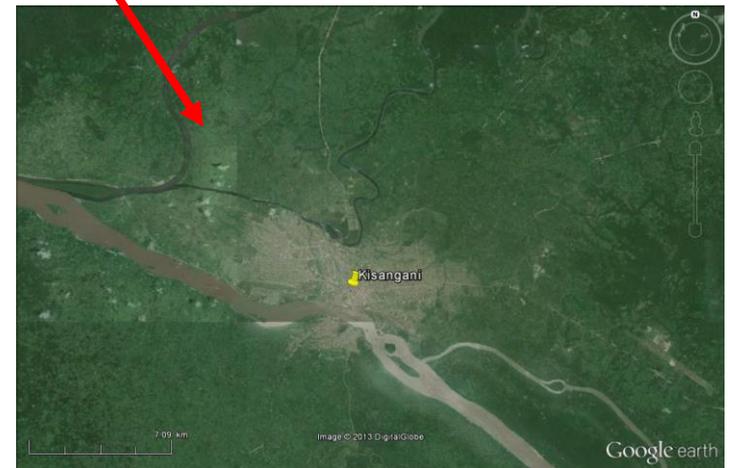
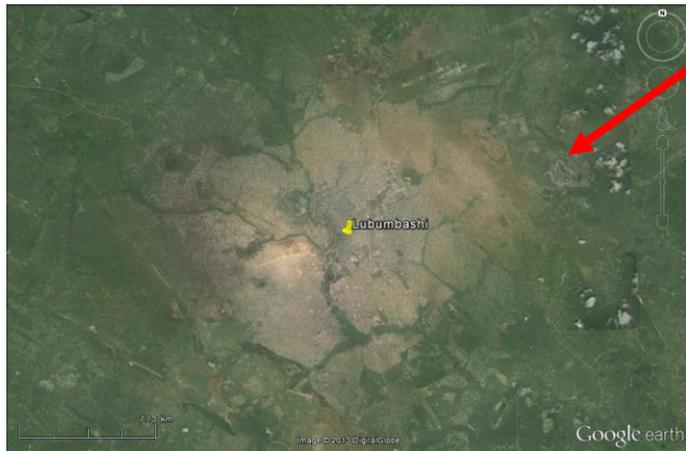
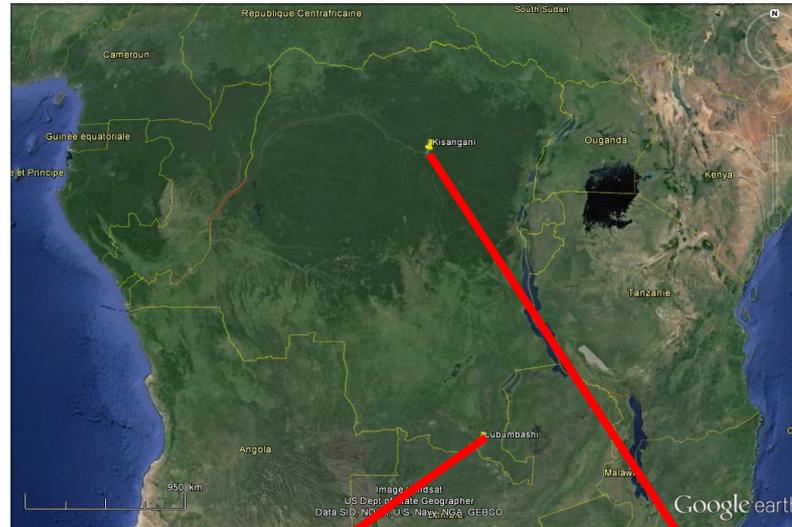
31

□ localisation of the two study cases



O1. Methodology of classification

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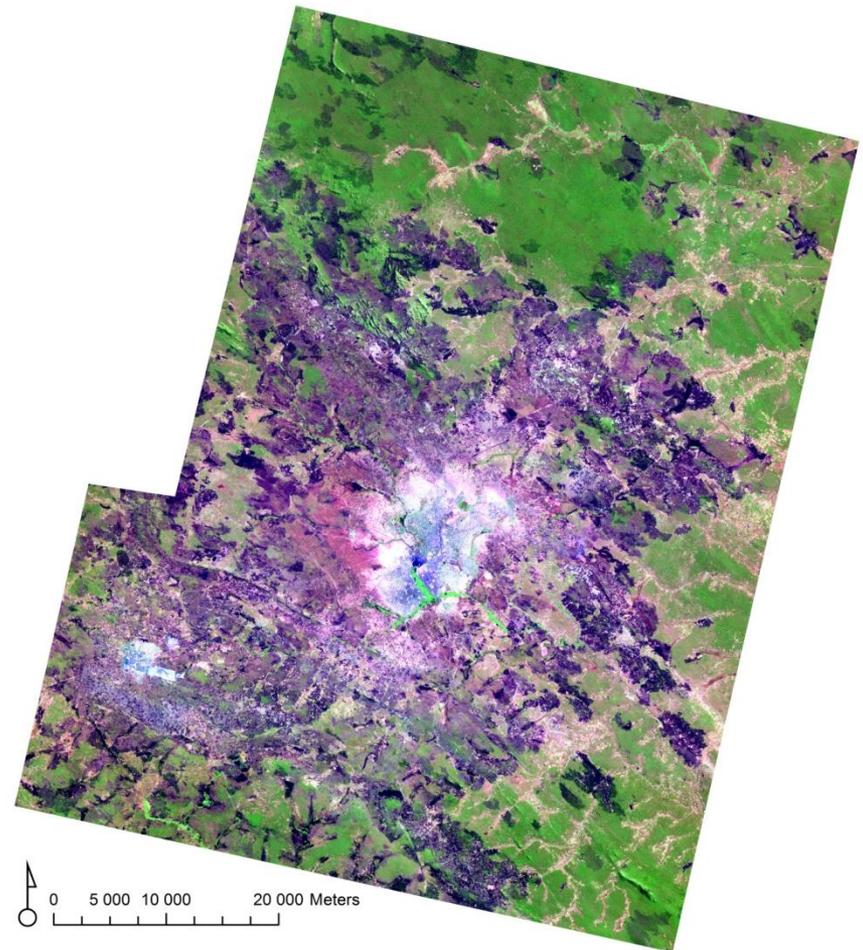
O1. Methodology of classification

33

Material:

- SPOT 5 images
- Two years:
 - 2002 and 2008 (2009) for Lubumbashi
 - 2002 and 2010 for Kisangani

Study zone of Lubumbashi, SPOT Image, July 17, 2002

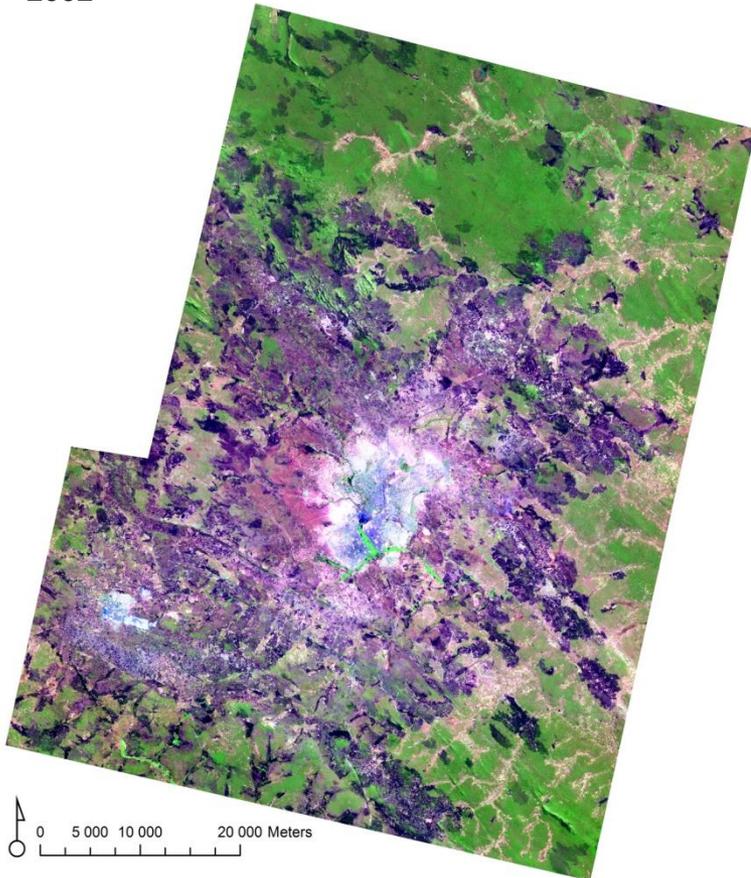


O1. Methodology of classification

34

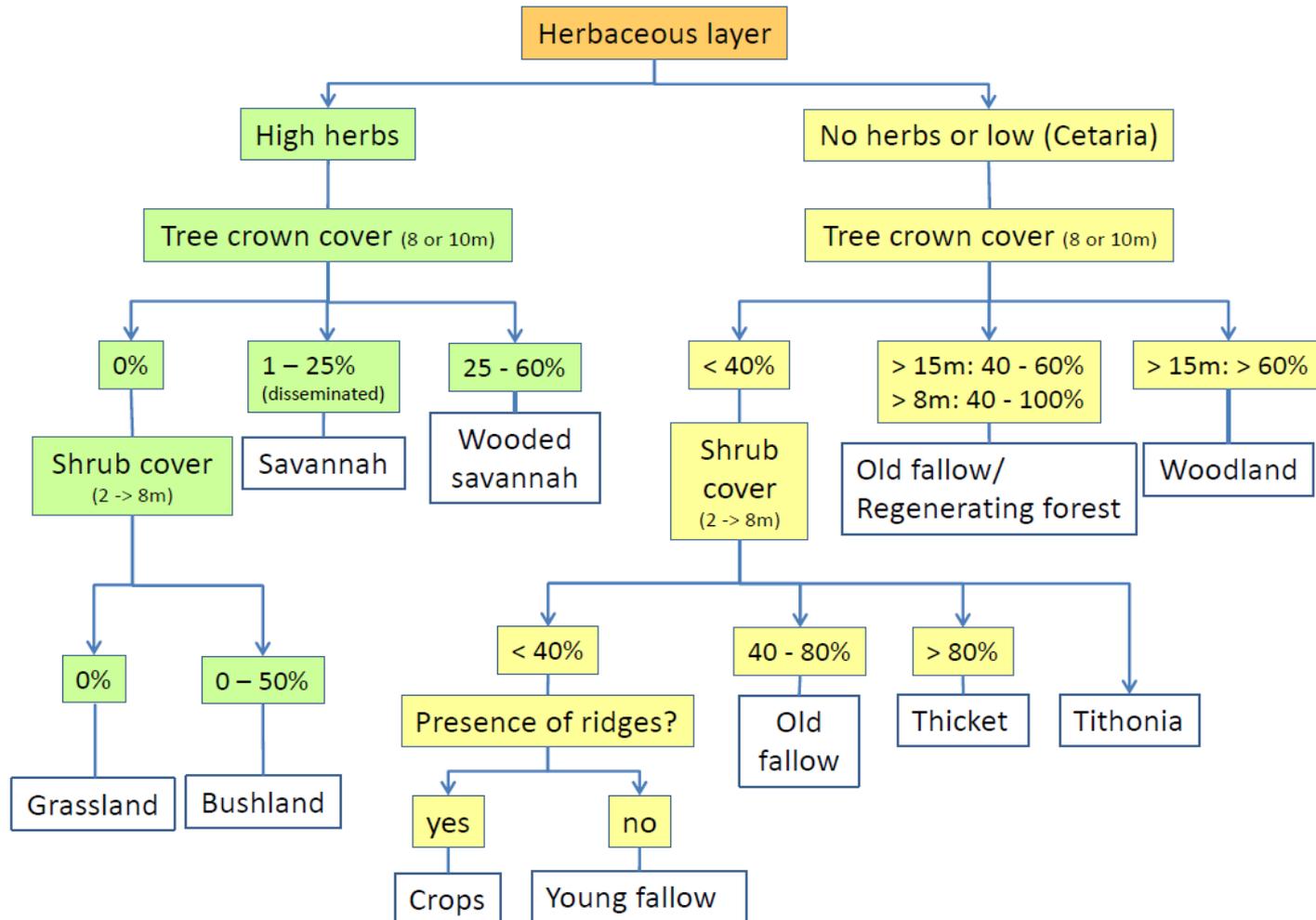
Method: oriented-object classification

Study zone of Lubumbashi, SPOT Image, July 17, 2002



O1. Methodology of classification

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O1. Methodology of classification

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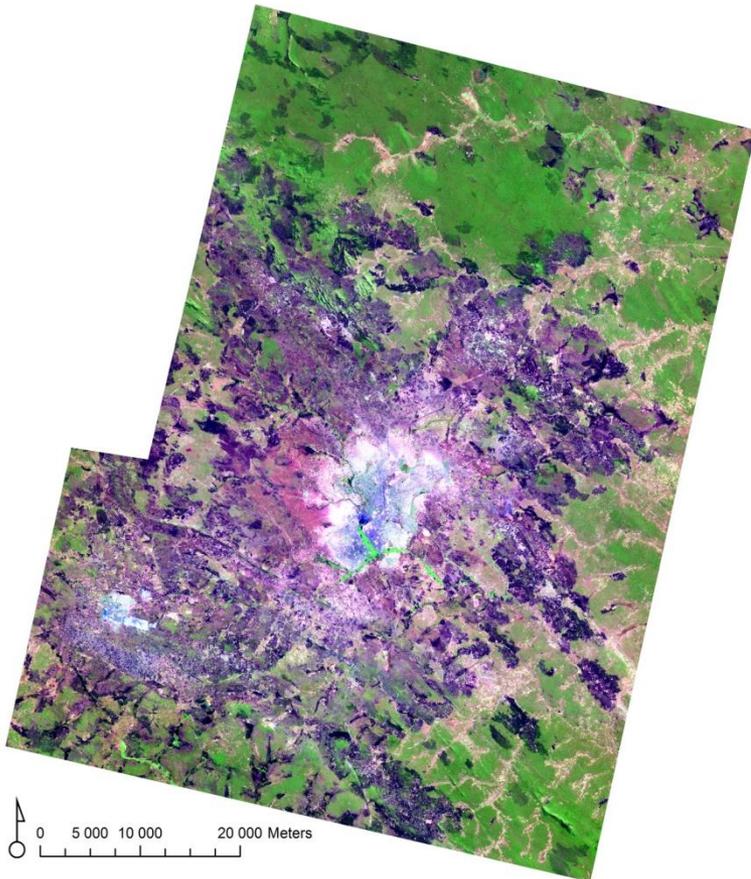


01. Methodology of classification

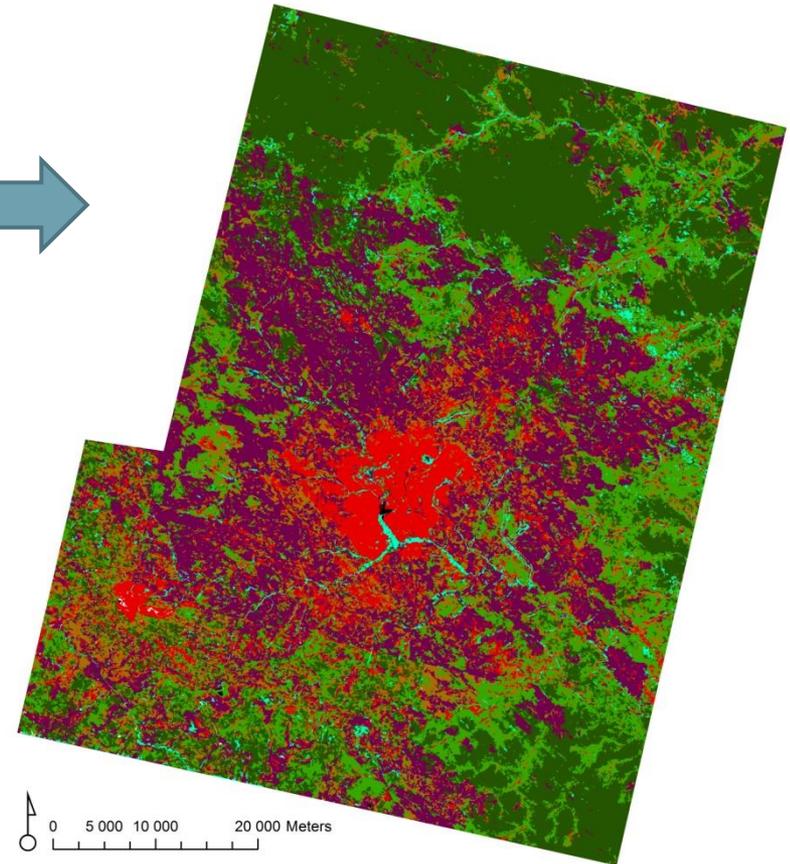
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2. Oriented-object classification

Study zone of Lubumbashi, SPOT Image, July 17, 2002



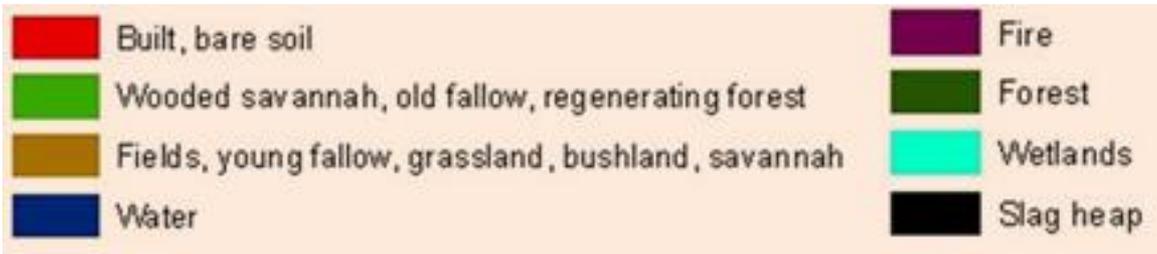
Classification, 2002



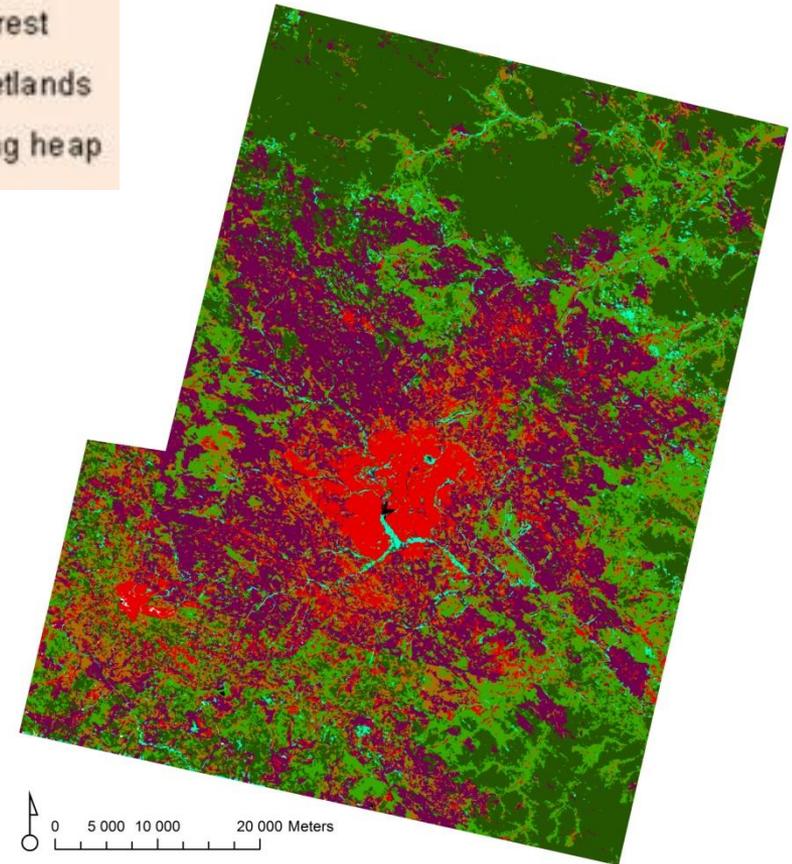
01. Methodology of classification

38

2. Oriented-object classification



Classification, 2002



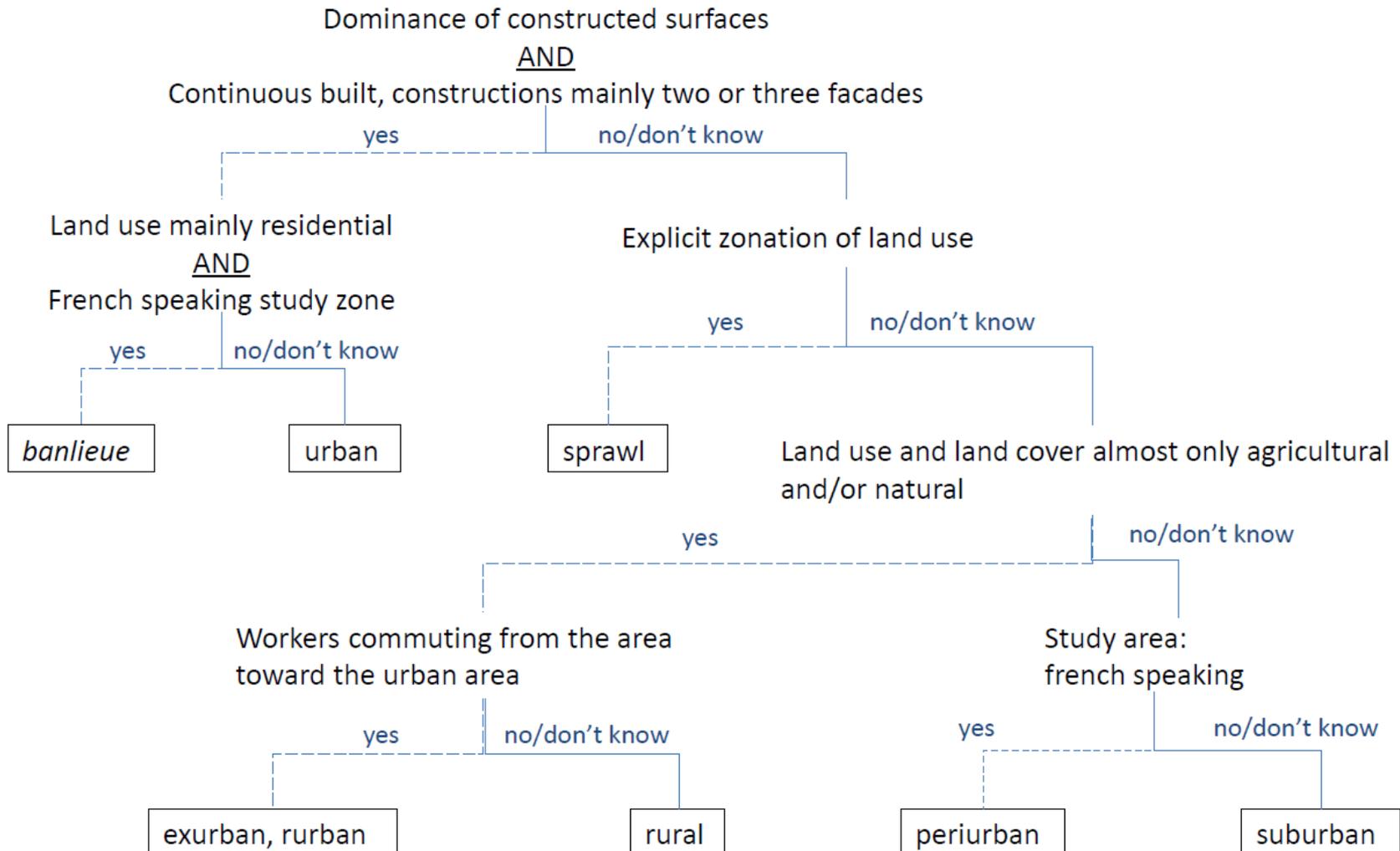
Plan of the objectives

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01. Segmentation using landscape indexes

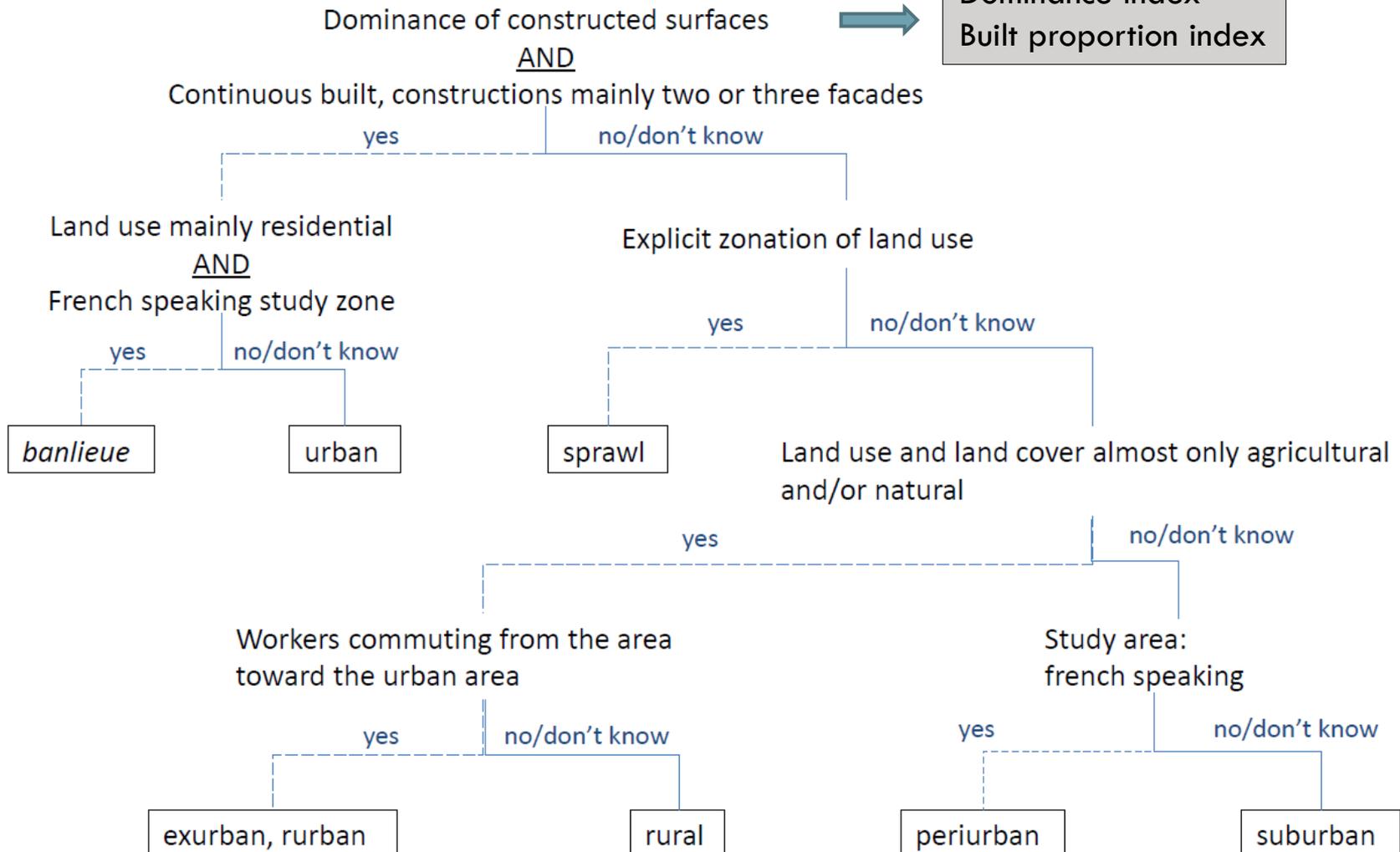
40



01. Segmentation using landscape indexes

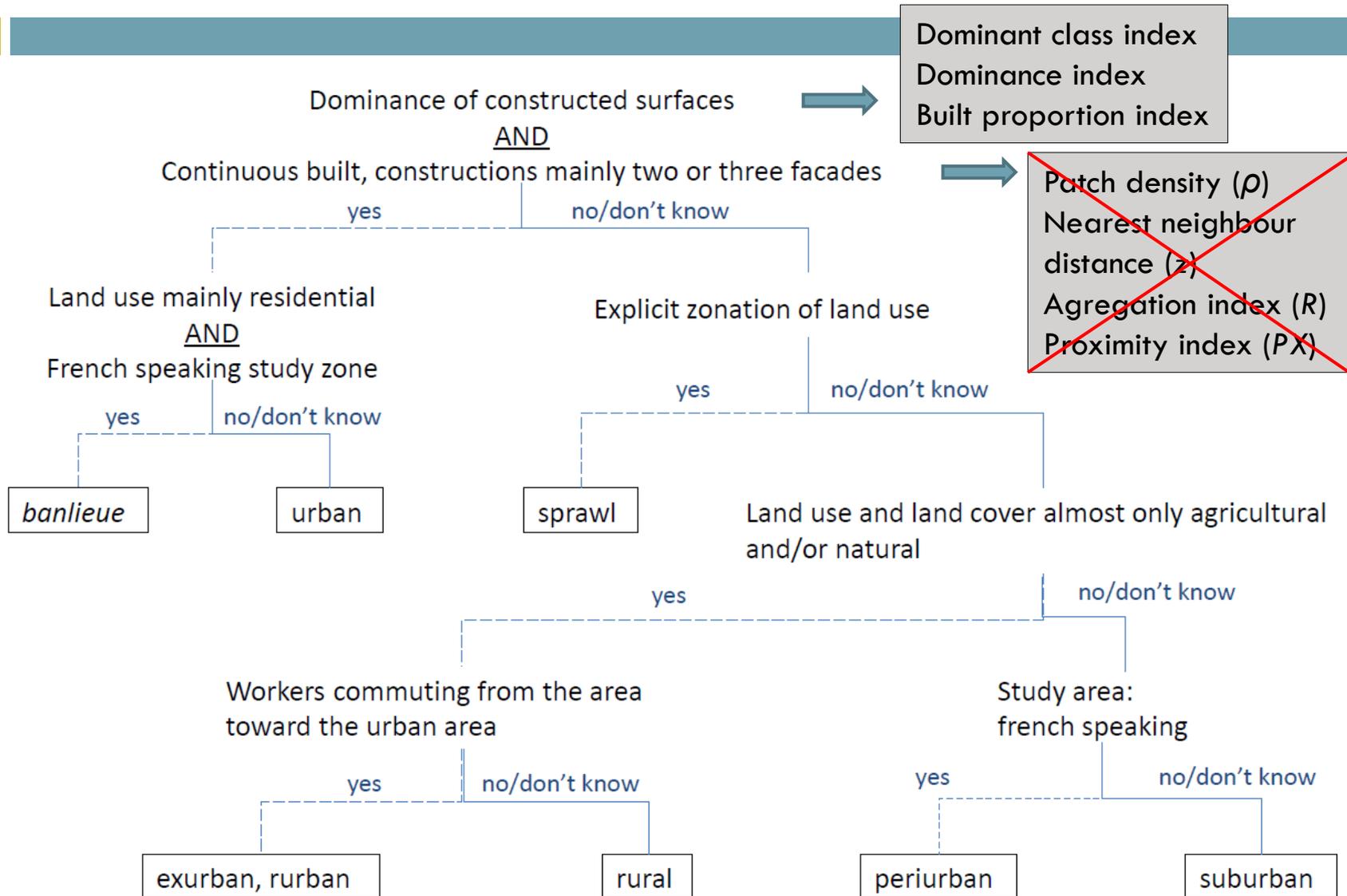
41

Dominant class index
Dominance index
Built proportion index



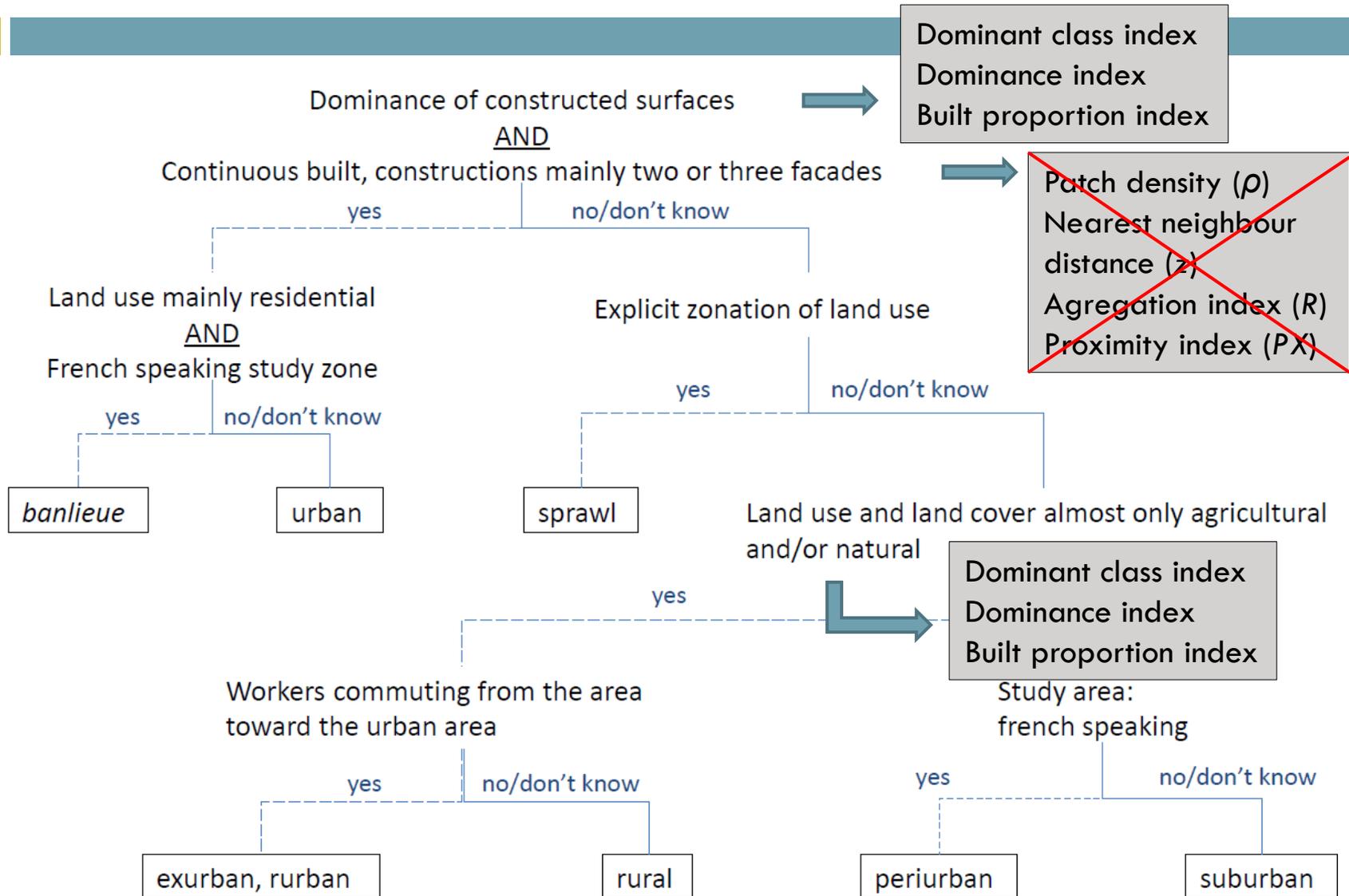
01. Segmentation using landscape indexes

42



01. Segmentation using landscape indexes

43

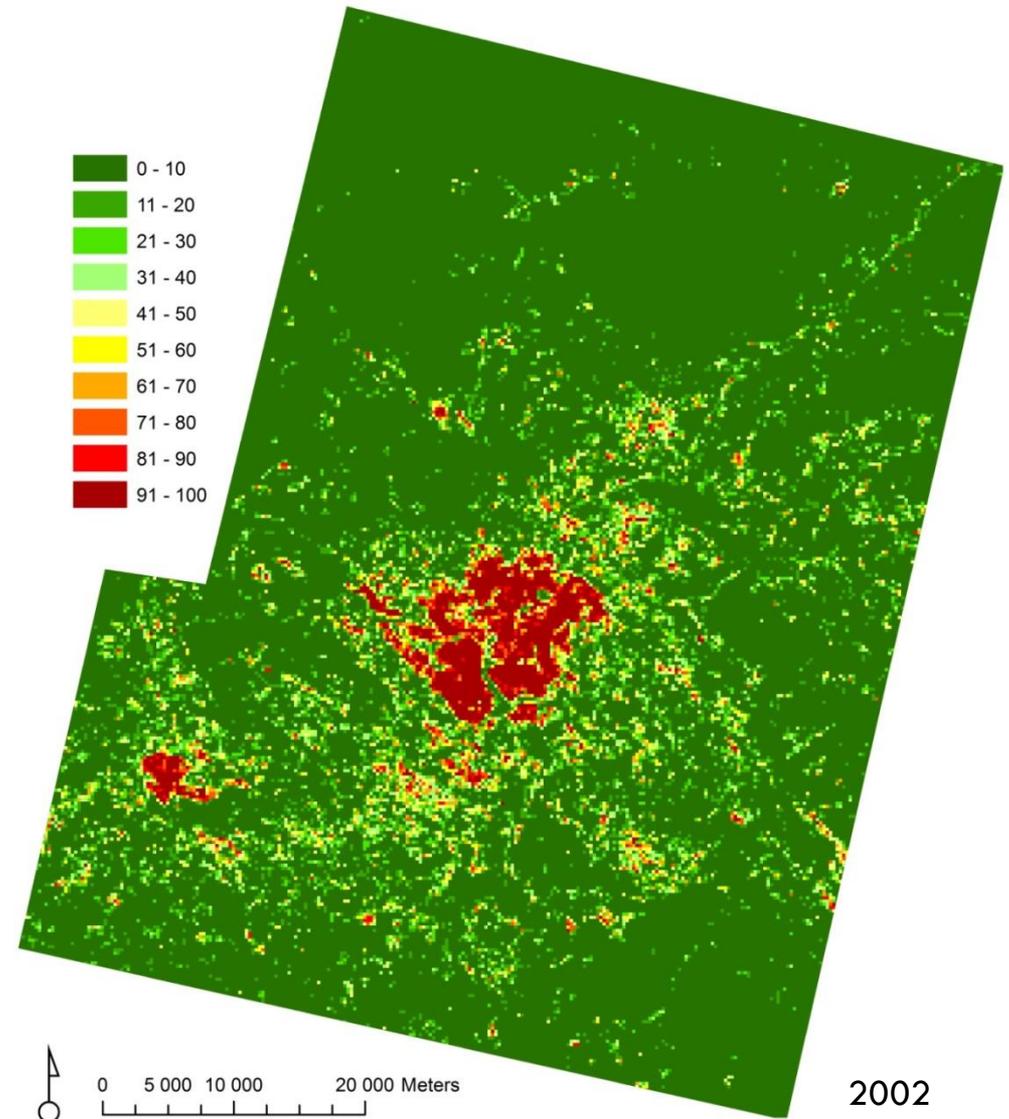


01. Segmentation using landscape indexes

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3. Landscape metric calculation:

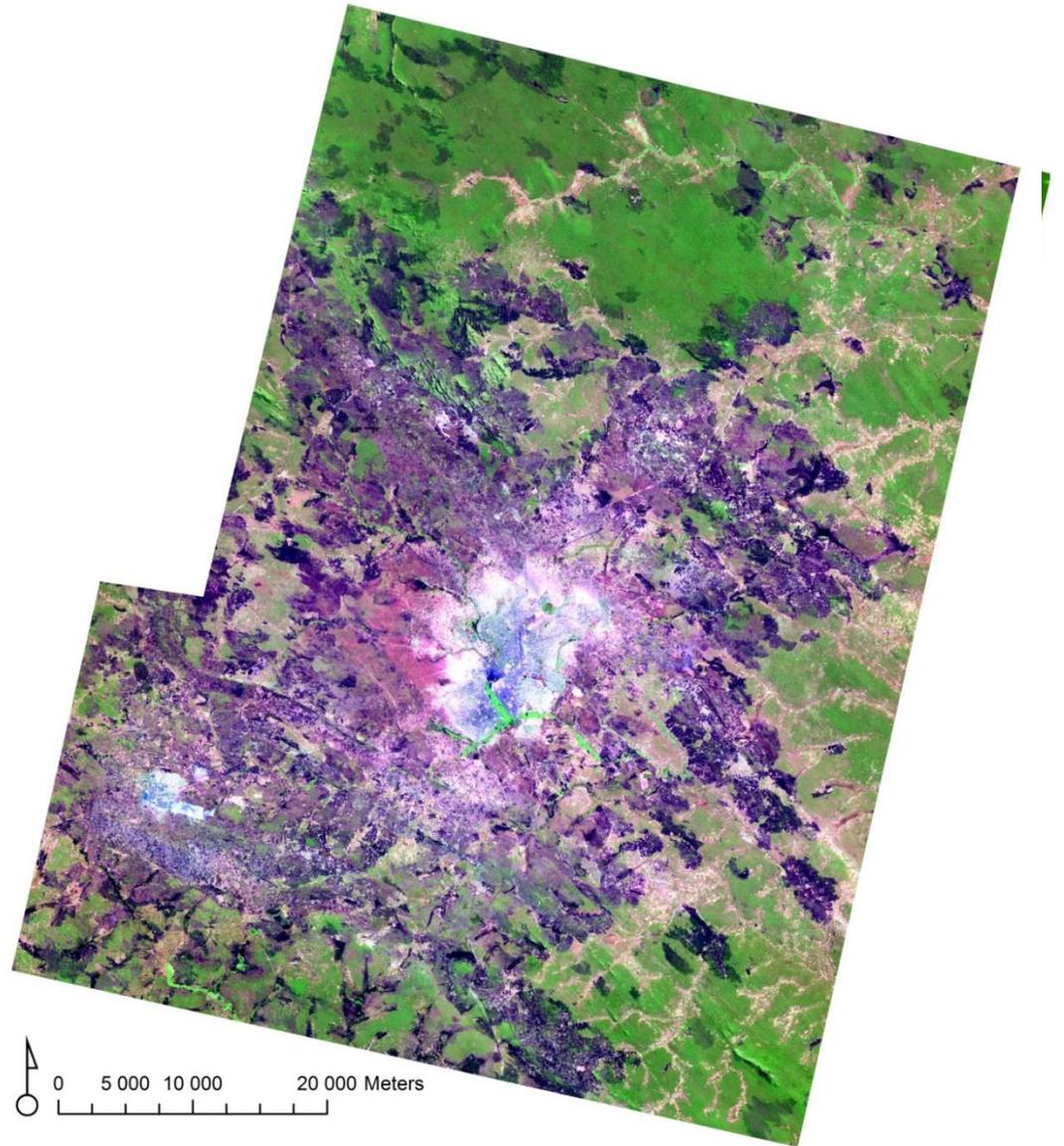
Built area proportion (%)



01. Segmentation using landscape indexes

45

4. Field work reference points for each areas

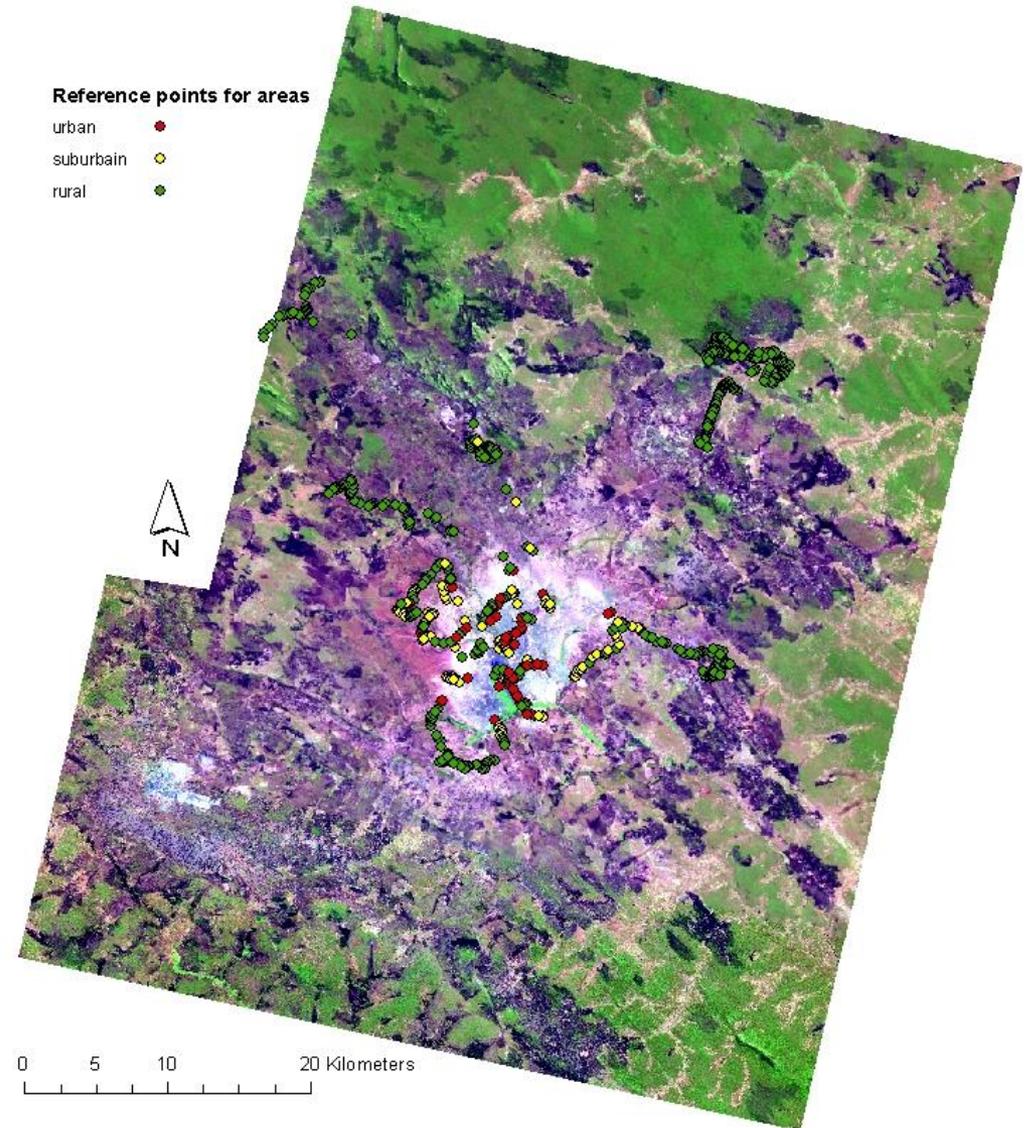


Study zone of Lubumbashi, SPOT Image,
July 17, 2002

O1. Segmentation using landscape indexes

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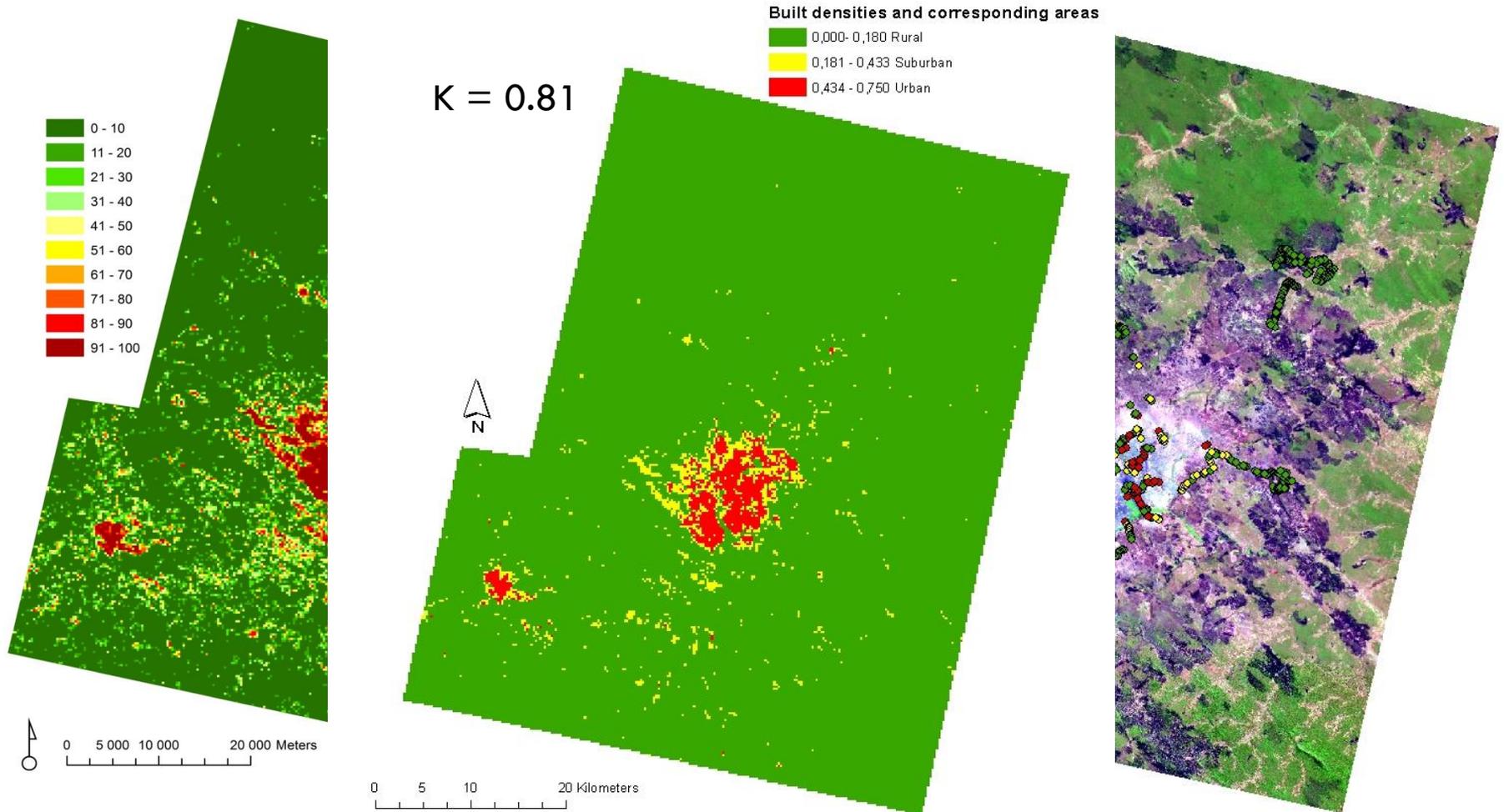
4. Field work reference points for each areas



01. Segmentation using landscape indexes

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5. Recursive segmentation



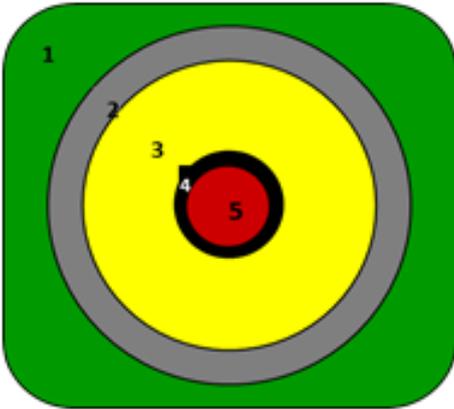
Plan of the objectives

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O1. Typology

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5 zones



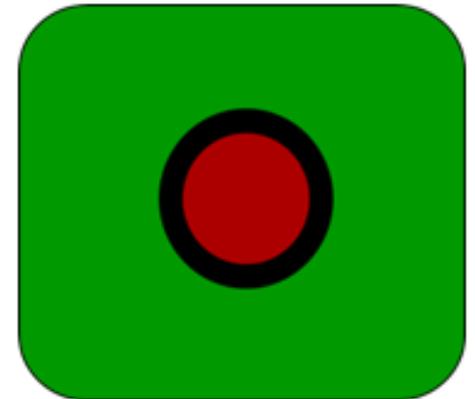
No dynamic suburban zone



No dynamic urban zone



No non-dynamic suburban zone



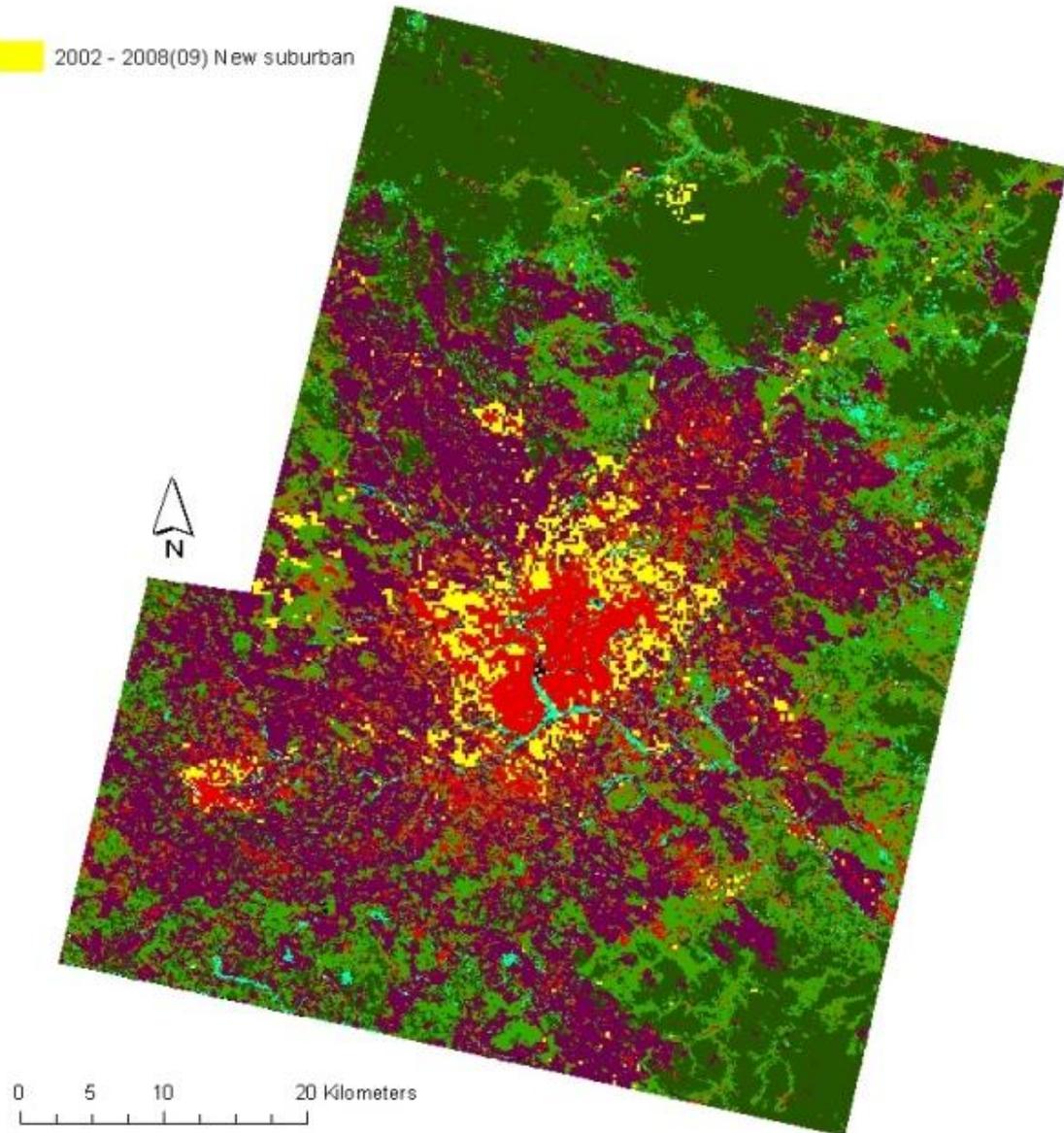
No suburban zone

O1. Typology

50

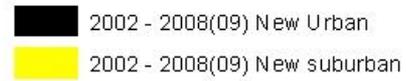
2002 - 2008(09) New suburban

Lubumbashi

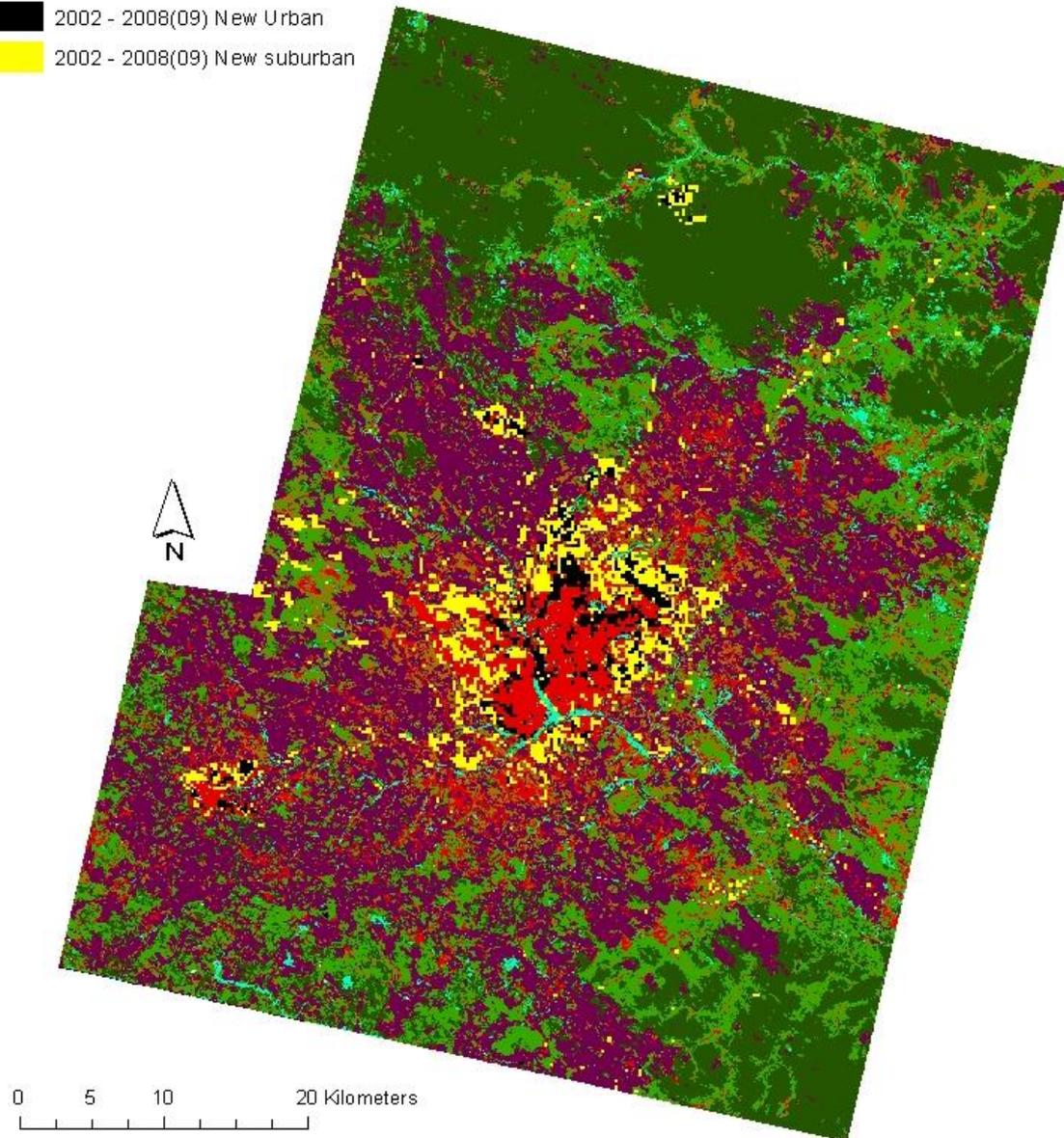


O1. Typology

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Lubumbashi

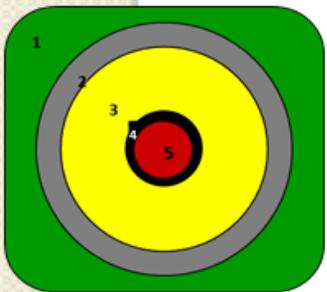


O1. Typology

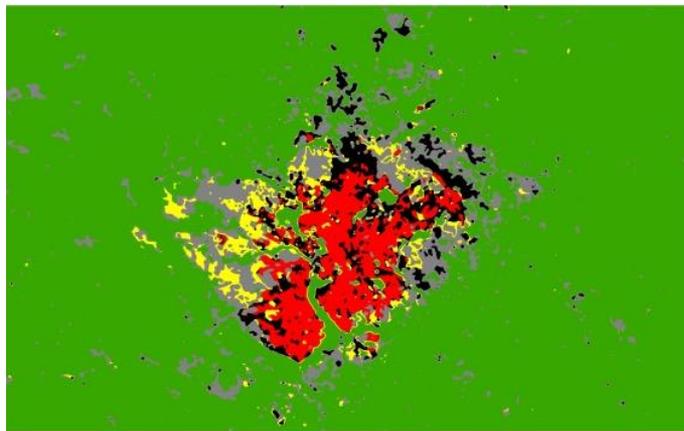
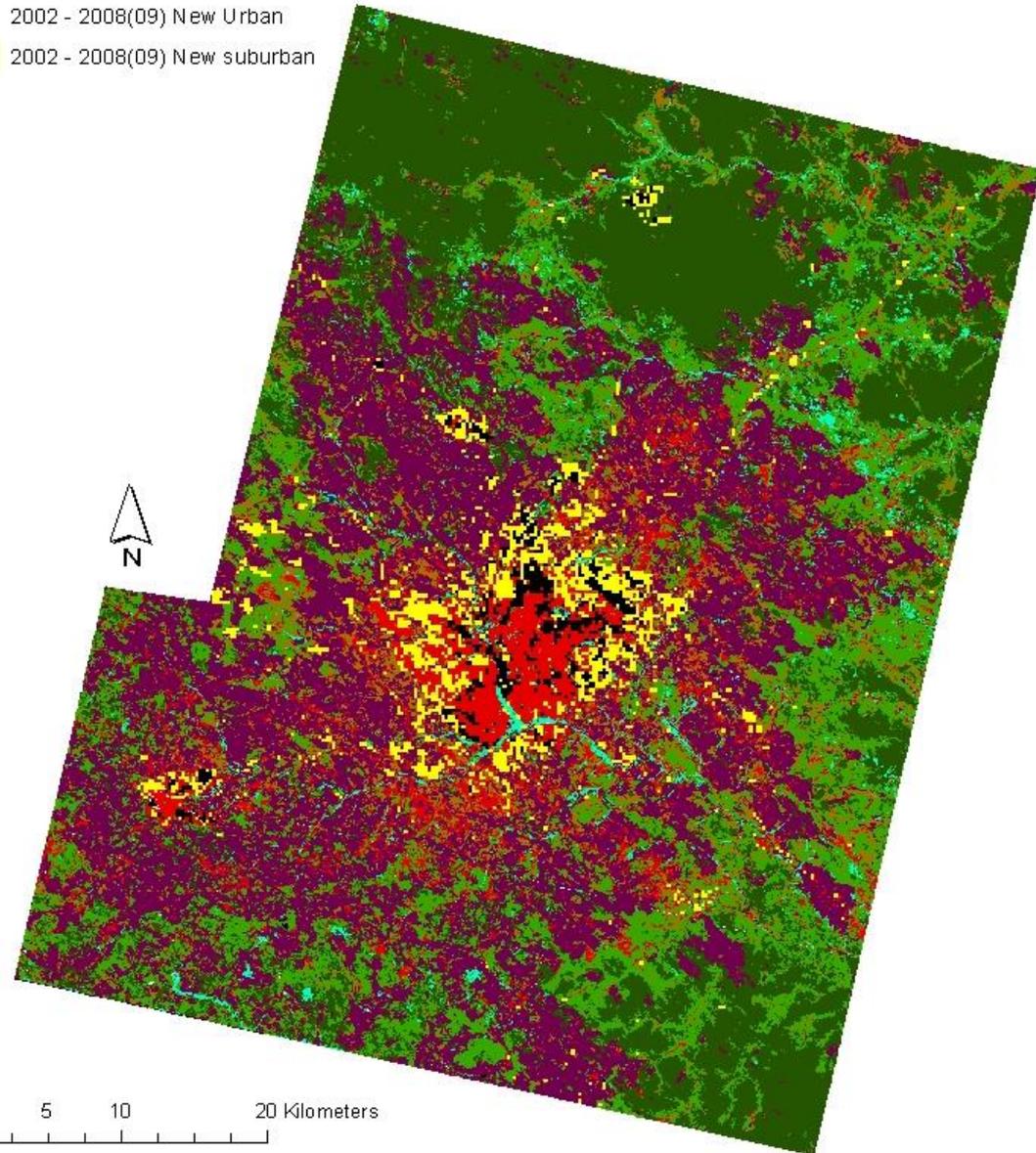
52

- 2002 - 2008(09) New Urban
- 2002 - 2008(09) New suburban

Lubumbashi



5 zones



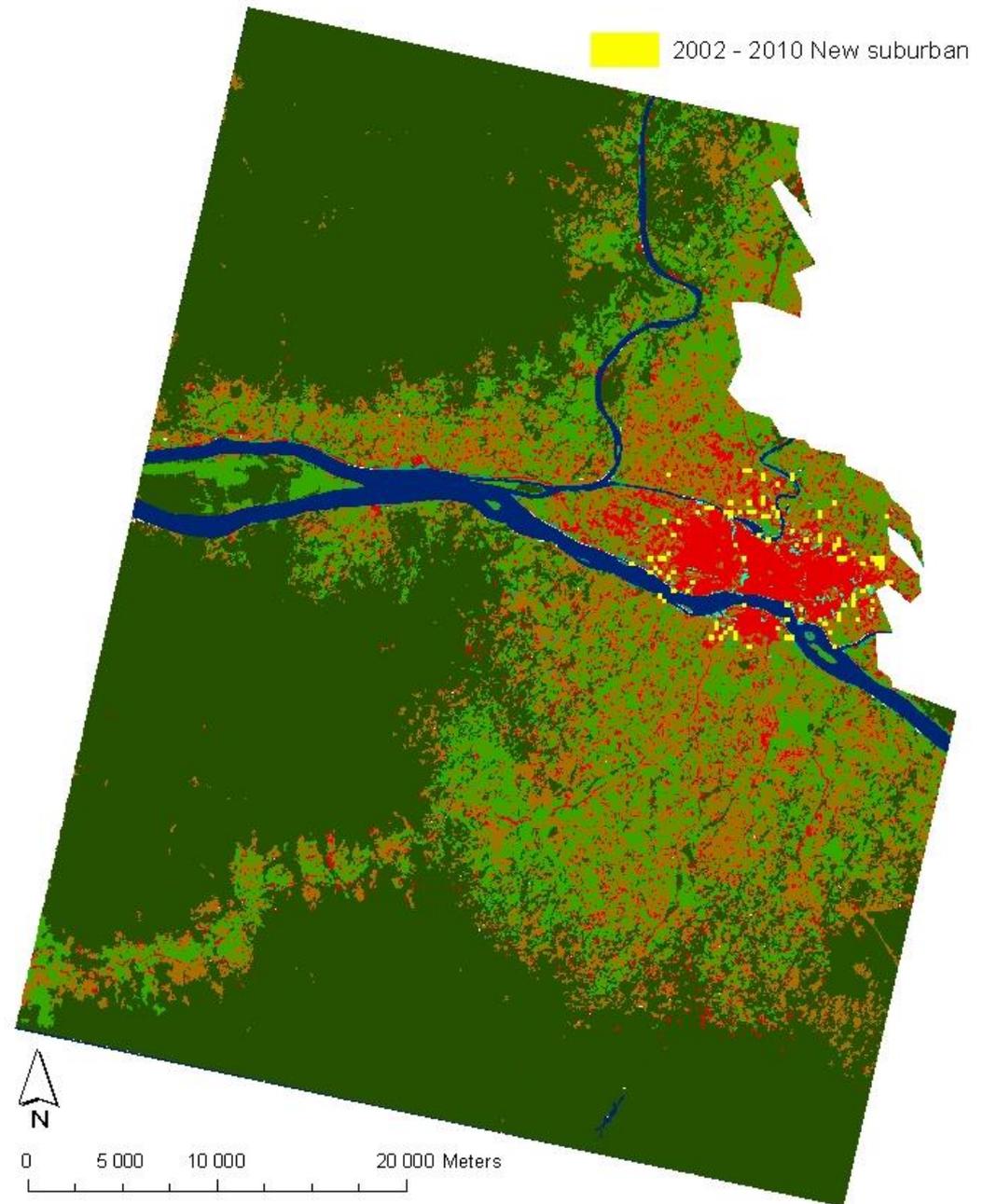
Lubumbashi, 2008 & 2009, Built density index and zones

- 0.00 - 23.07 Rural
- 23.07 - 48.03 Suburban
- 48.03 - 75.00 Urban
- 2002-2008(9) New urban
- 2002-2008(9) New suburban

O1. Typology

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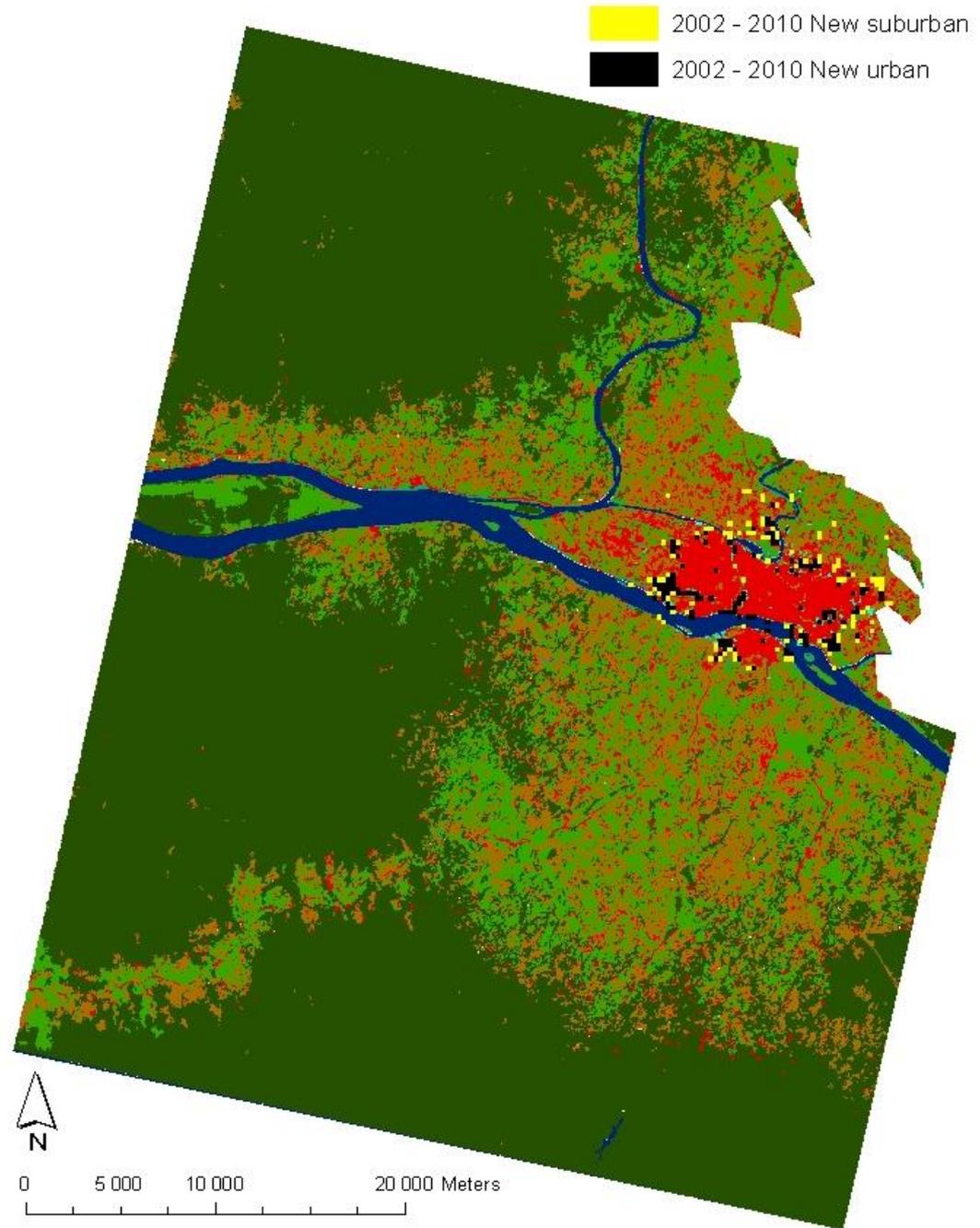
Kisangani



01. Typology

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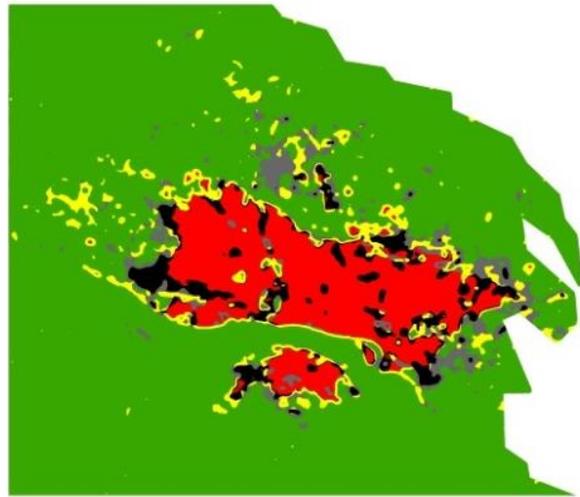
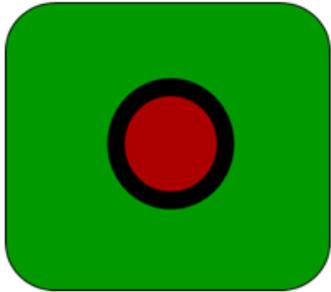
Kisangani



O1. Typology

55

Kisangani

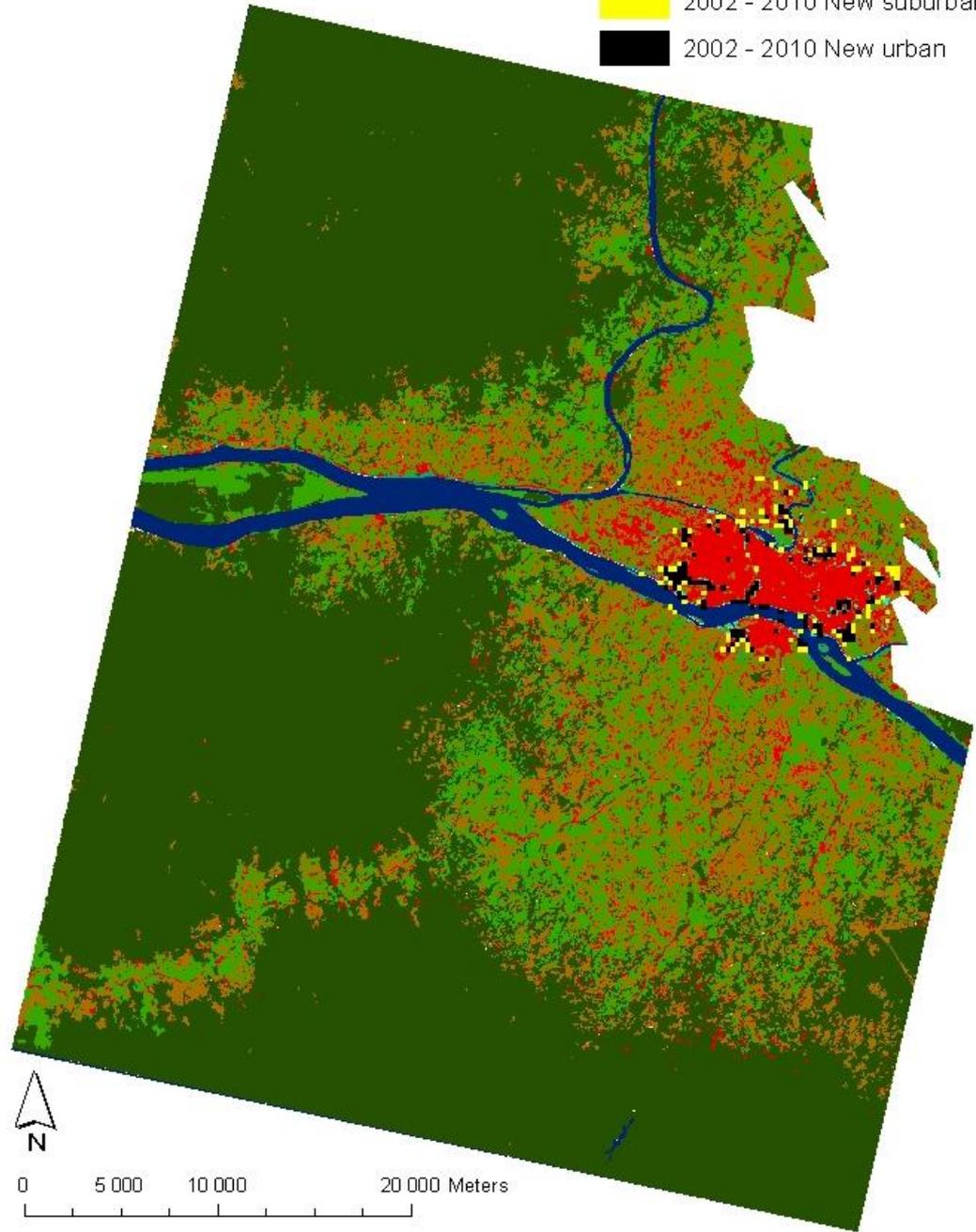


2002-2010 New urban
2002-2010 New suburban
Kisangani, 2002 Built density index and zones
0.00 - 21.65 Rural
21.65 - 57.25 Suburban
57.25 - 75.00 Urban

0 1.25 2.5 5 Kilometers



2002 - 2010 New suburban
2002 - 2010 New urban



0 5 000 10 000 20 000 Meters

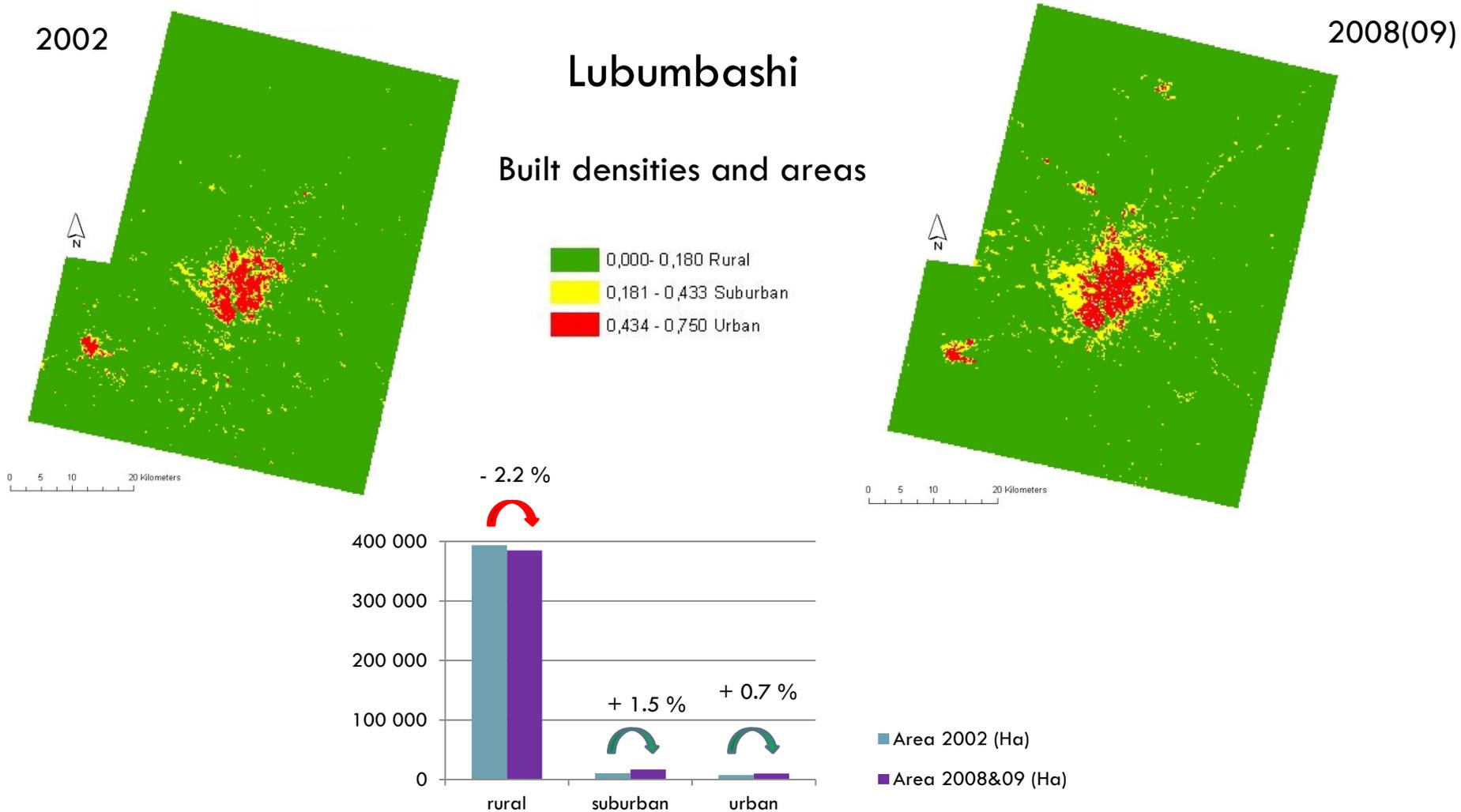
Plan of the objectives

56

- 1. Delimit the zones included in the urban-rural gradient
 - ▣ Review
 - ▣ Methodology of classification for satellite images
 - ▣ Segmentation using landscape indexes
 - ▣ Application to the study zone (1 dozen of cities in sub-saharan Africa)
 - ▣ Typology based on the (sub)urbanization dynamic
- 2. Study of the landscape ecological consequences of the urbanization and periurbanization processes in sub-saharan Africa

O2. Landscape ecological consequences

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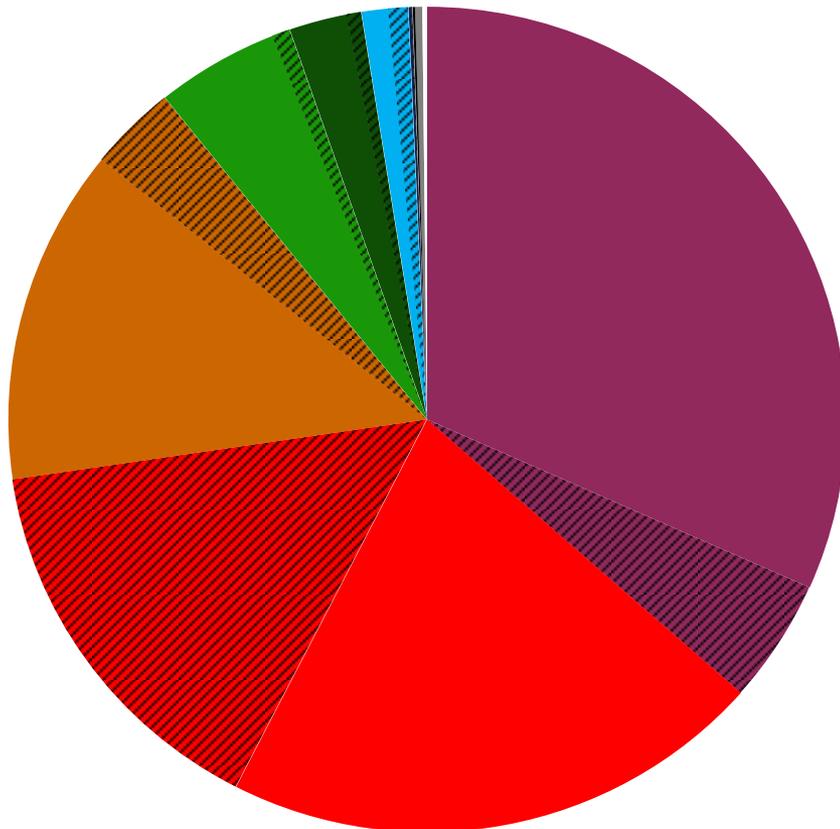


O2. Landscape ecological consequences

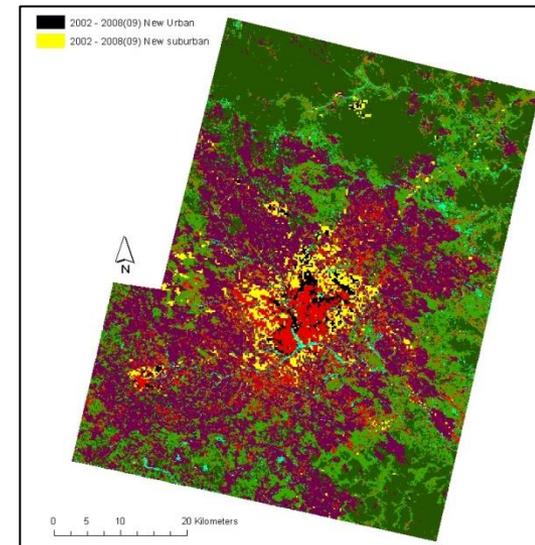
58

Lubumbashi

Percentage of the occupied area (%)



- suburban Burned areas
- urban Burned areas
- suburban Built and bare soil
- urban Built and bare soil
- suburban Fields, young fallow, grassland, bushland, savannah
- urban Fields, young fallow, grassland, bushland, savannah
- suburban Wooded savannah, old fallow, regenerating forest
- urban Wooded savannah, old fallow, regenerating forest
- suburban Forest
- urban Forest
- suburban Wetlands
- urban Wetlands
- suburban Water
- urban Water
- suburban Slag heap
- urban Slag heap
- suburban unclassified
- urban unclassified



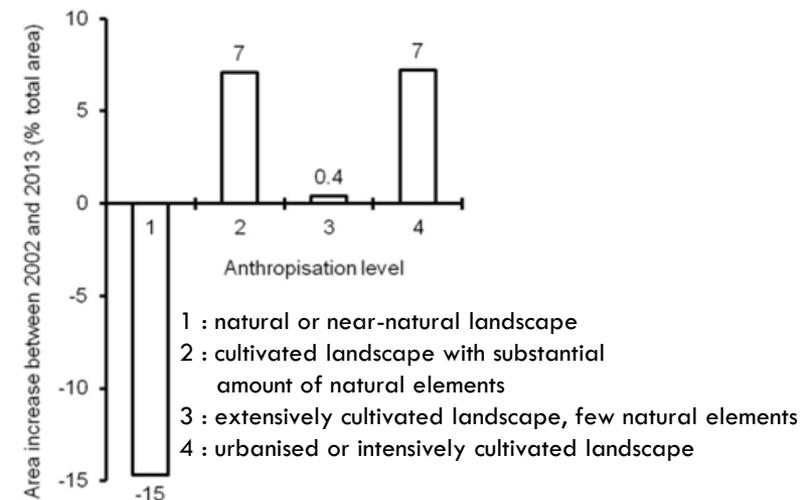
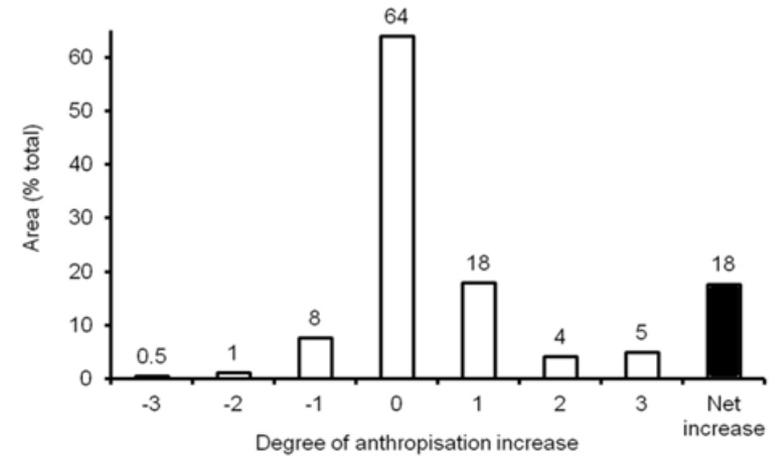
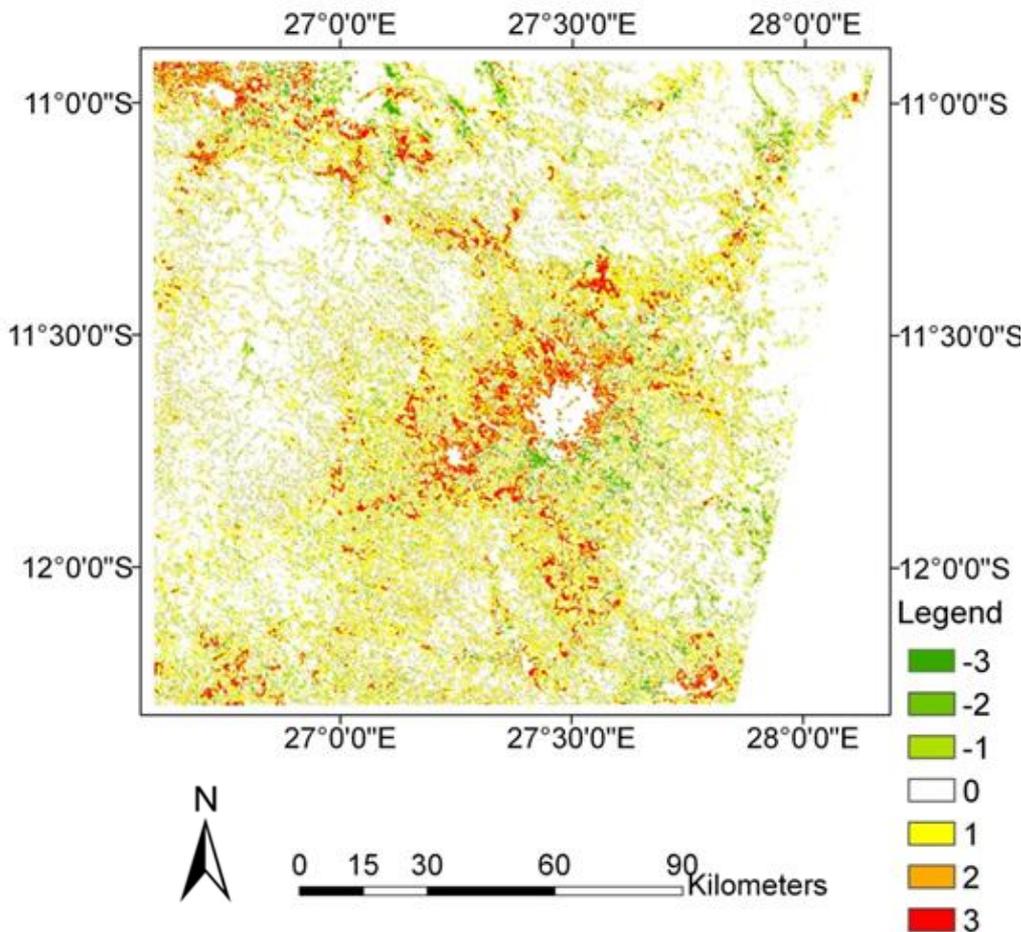
O2. Landscape ecological consequences

59

| Hemeroby level | Description | | | Ecosystems (land use / land cover) in the area of Lubumbashi | Matching image classes | |
|-------------------------------------|--|---|---|--|-------------------------|---|
| | Type of anthropogenic influence | Ecosystem patterns and processes | Examples of land use types found in Austria | | Matching hemeroby class | Class composition |
| 1. Natural | No or only minimal anthropogenic influence (e.g. global pollution) | | Bare rock, sparsely vegetated areas, glaciers and perpetual snow, inland marshes, peatbogs, natural forests | <i>Muhulu</i> , Wetlands, <i>Dembo</i> , Copper hills | 1 | Wetlands, <i>Dembo</i> |
| 2. Near-natural | Anthropogenic influences | Structure and type of ecosystem is basically the same as naturally expected at the side but some characteristics (e.g. plant species composition) are altered | Natural grasslands (above timberline), moors and heathland, water bodies, sustainably managed forests | <i>Miombo</i> , Water | 2 | <i>Miombo</i> , Streams |
| 3. Semi-natural | Anthropogenic activities | The naturally occurring ecosystem is no longer present but has been transformed into a new ecosystem type because of anthropic activity | Alpine meadows substituting forest pastures, fallow land | Regenerating forest, Wooded savannah, Old fallow | 3 | Wooded savannah and old fallow |
| 4. Altered | Regularly disturbing anthropogenic activities (e.g. drainage, regular passing over, intense fertilisation) | Changed ecosystem type, edaphon regularly disturbed | Vineyard, intensively used grasslands, plantation of energy forests | Young fallow, Savannah, Bushland, Grassland, Pastures | 4 | Savannah and bushland |
| | | | | | 4.5 | Savannah / crops mosaic |
| 5. Cultural | Intense and regular impacts | Destruction of the natural occurring edaphon. Natural occurring floristic elements are reduced to a minimum (< 25% coverage) | Arable land, green urban areas, sport and leisure facilities | Anthropised wetlands, Crops, Reservoirs, Anthropised <i>Dembos</i> | 5 | Anthropised wetlands; Crops, pastures, grassland and young fallow; Recurrent burned areas; Reservoirs |
| 6. Artificial with natural elements | Intensive and irreversible changes of terrain and landscape structure; soil sealing up to 30% | Natural elements only in the form of secondary biotopes | Rural settlements, mineral extraction sites, dump sites, airports | Discontinuous built, Bare soil | 6 | Discontinuous built, Bare soil |
| 7. Artificial | soil sealing over 30% | Artificial systems or structures | Continuous urban fabric, industrial or commercial units, road and rail networks | Continuous built, Slag heap | 7 | Continuous built, Slag heap |

O2. Landscape ecological consequences

Lubumbashi



O2. Landscape ecological consequences

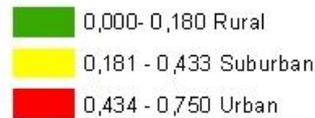
61

2002

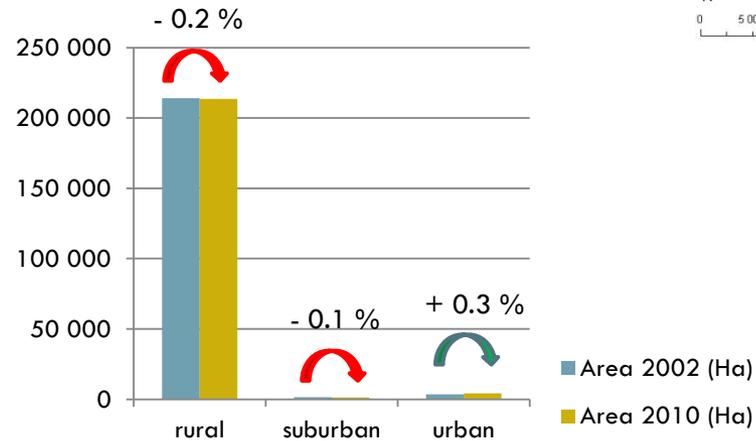
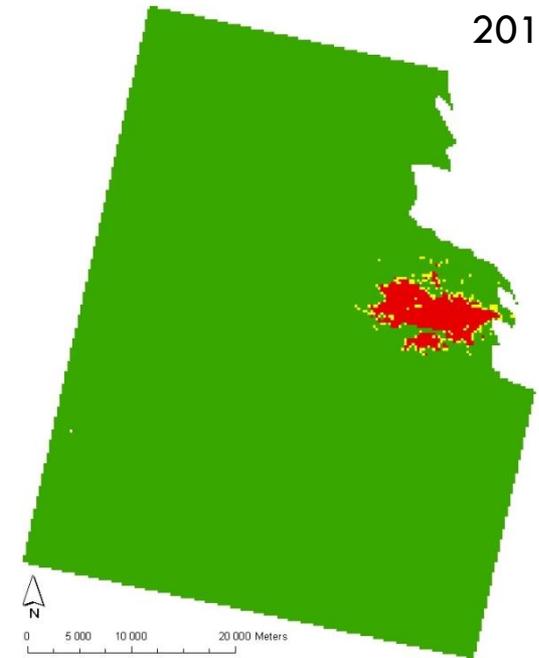


Kisangani

Built densities and areas



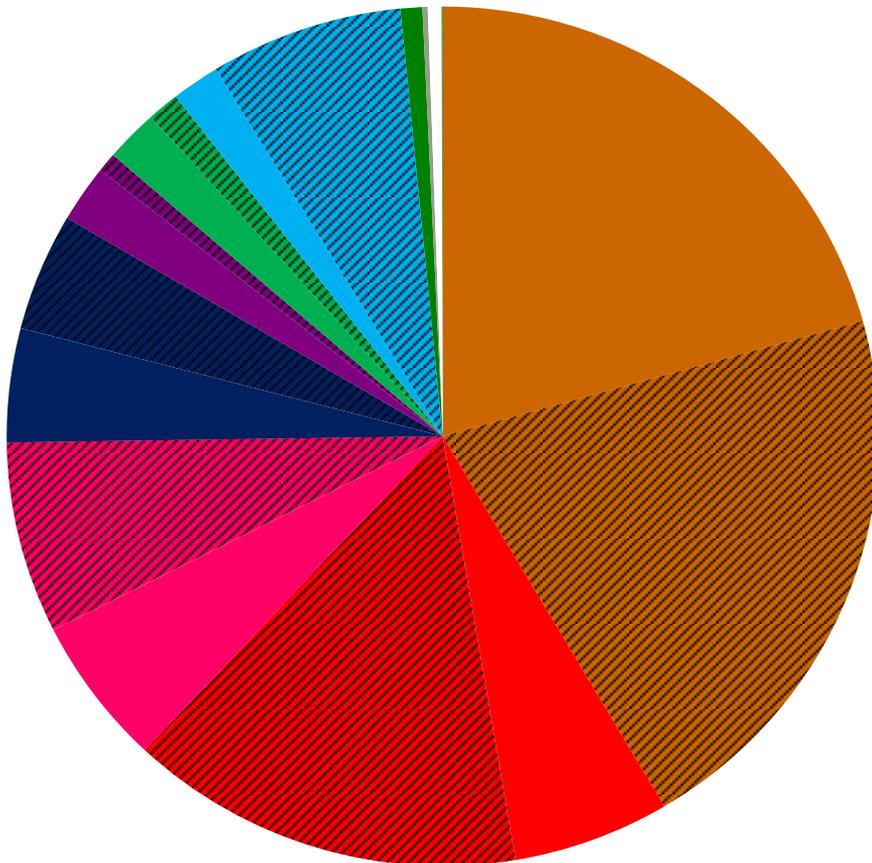
2010



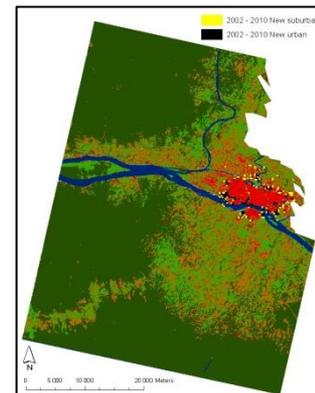
O2. Landscape ecological consequences

Kisangani

Percentage of the occupied area (%)



- suburban Fields, young fallow and bamboos
- ▨ urban Fields, young fallow and bamboos
- suburban Continuous built
- ▨ urban Continuous built
- suburban Discontinuous built
- ▨ urban Discontinuous built
- suburban Water
- ▨ urban Water
- suburban Burned areas and bare soil
- ▨ urban Burned areas and bare soil
- suburban Old fallow and secondary forest
- ▨ urban Old fallow and secondary forest
- suburban Ponds and wetlands
- ▨ urban Ponds and wetlands
- suburban Floating vegetation
- ▨ urban Floating vegetation
- suburban Unclassified
- ▨ urban Unclassified
- suburban Primary forest
- ▨ urban Primary forest

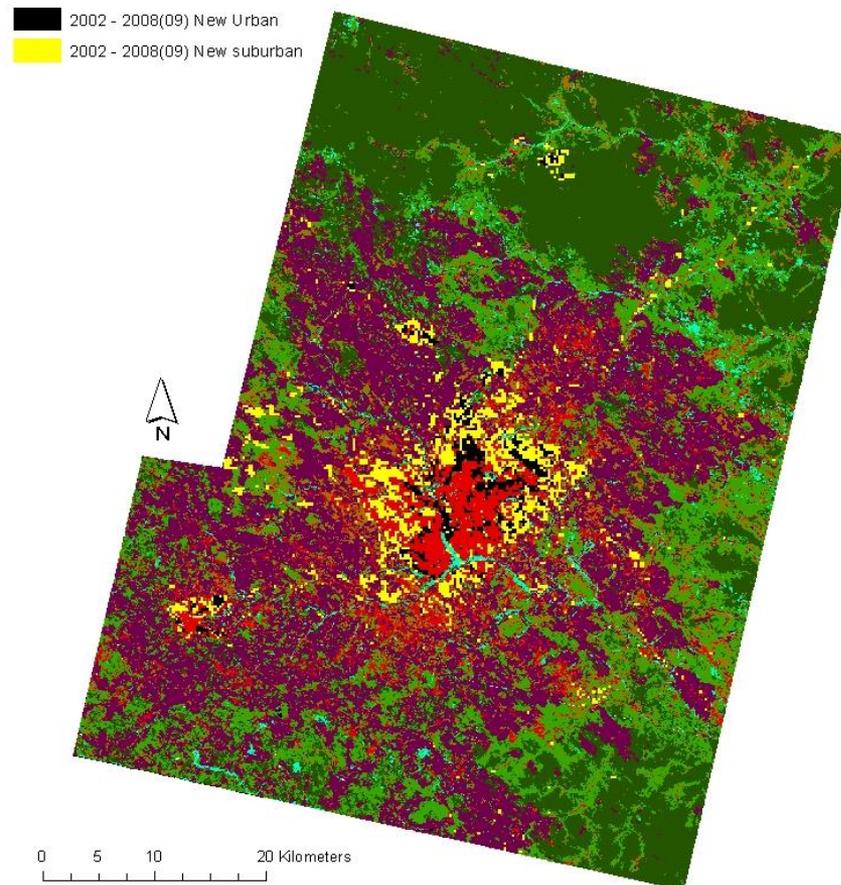


5/5 Discussion and perspectives

Discussion

64

- Secondary effect? -> Rural anthropized areas



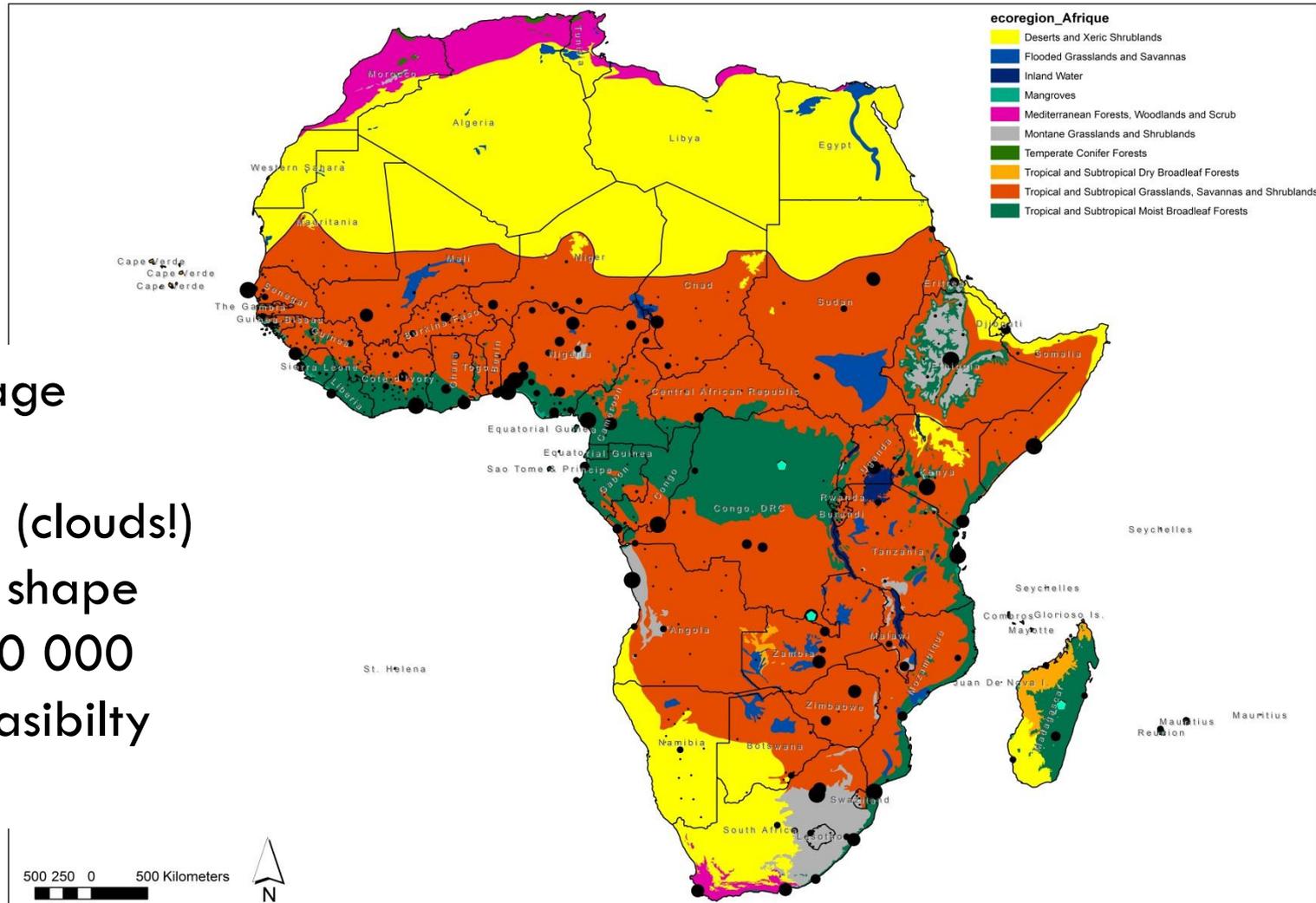
Discussion

65

- Secondary effect? -> Rural anthropized areas
- Time interval different for the two cities
- Depends on the spatial resolution of the images and on the accuracy of the classification

Perspectives

66



- Satellite image (LANDSAT) disponibility (clouds!)
- « Circular » shape
- Inhab. > 100 000
- Technical feasibilty
- Biome

5/5

Conclusions

Plan of the objectives

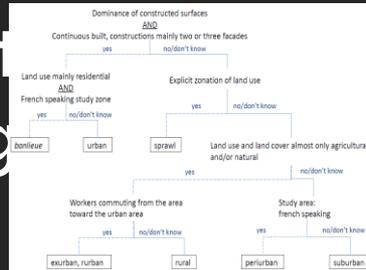
68

- 1. Delimit the zones included in the urban-rural gradient
 - ▣ Review
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Plan of the objectives

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01. Delimitation of the study zone included in the urban-rural gradient



Review

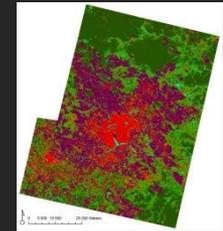
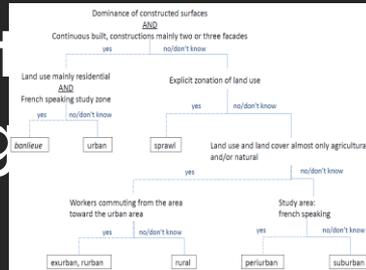
- Methodology of classification for satellite images
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- Typology based on the (sub)urbanization dynamic

02. Study of the landscape ecological consequences of the urbanization and periurbanization processes in sub-saharan Africa

Plan of the objectives

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01. Delimitation of the study zone included in the urban-rural gradient



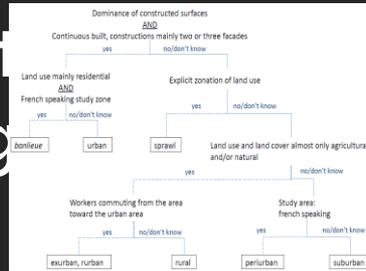
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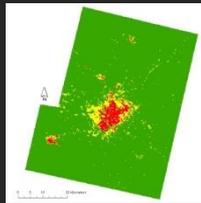
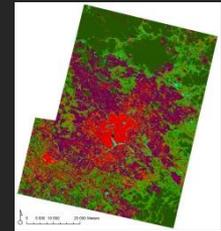
Plan of the objectives

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01. Delimitation of the urban-rural gradient



included in the urban-



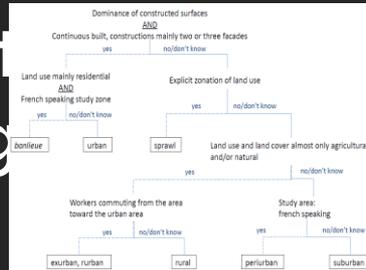
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Plan of the objectives

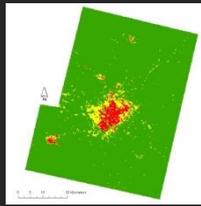
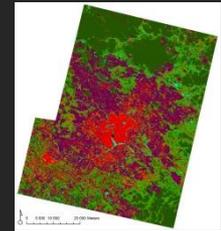
72

01. Delimitation of the urban-rural gradient

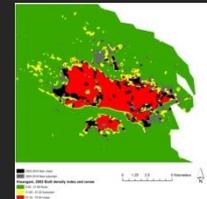


Review

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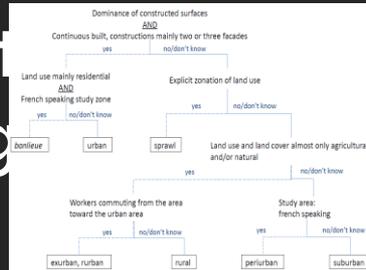
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Plan of the objectives

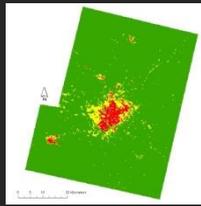
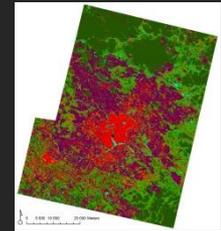
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01. Delimitation of the urban-rural gradient

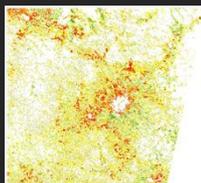
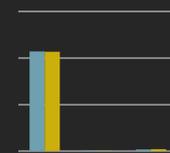
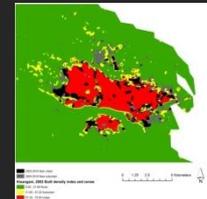


included in the urban-rural gradient

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- Typology based on the (sub)urbanization dynamic



02. Study of the landscape ecological consequences of the urbanization and periurbanization processes in sub-saharan Africa



THANKS FOR YOUR ATTENTION!

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