Classification des tissus urbains à partir de données vectorielles – application à Strasbourg

Classification of urban fabrics from vector database – exemple on Strasbourg

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The GEOpenSim Project

- funded by the French National Research Agency
  - The aim is to build an OpenSource GIS platform to analyze the evolution of urbanization and to simulate it on specific areas.

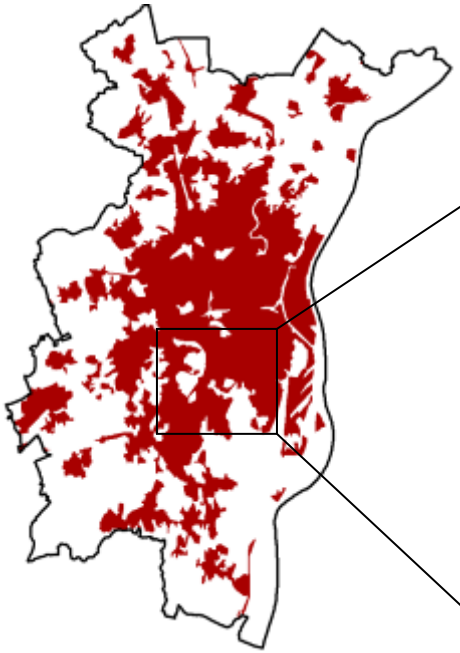
- 5 Modules
  - to build spatio-temporal databases
  - **for spatial analysis and data enrichment**
  - for the simulation
  - to build evolution rules
  - for evaluation

Context

- Scales of analysis of urban area

Urban area of Strasbourg

Urban patch
1:100,000 – 1:50,000



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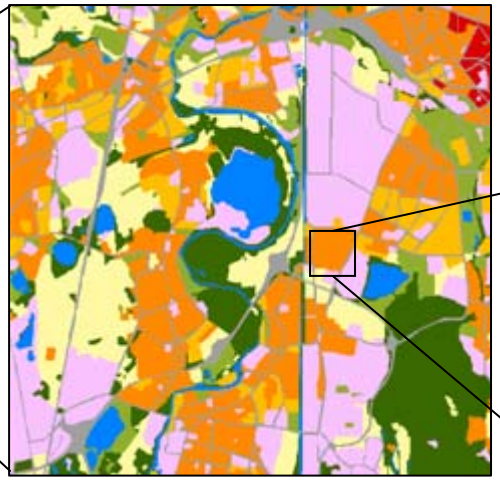
Urban fabric
1:25,000 – 1:10,000



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Urban object
1:5,000 – 1:2,000

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⇒ Needs on information at different scales

⇒ Needs of information on urban dynamics

Context

- Objectives
  - Using available vector database
  - Create database on urban fabric
  - Extract knowledge on urban pattern

  => Characterize spatial evolution of urban fabric

  => Simulate their dynamic (evolution rules)

- Questions
  - **Which** knowledge?
  - **How** to extract knowledge?

  => Problem of data mining

Objectives

- Classification and knowledge extraction

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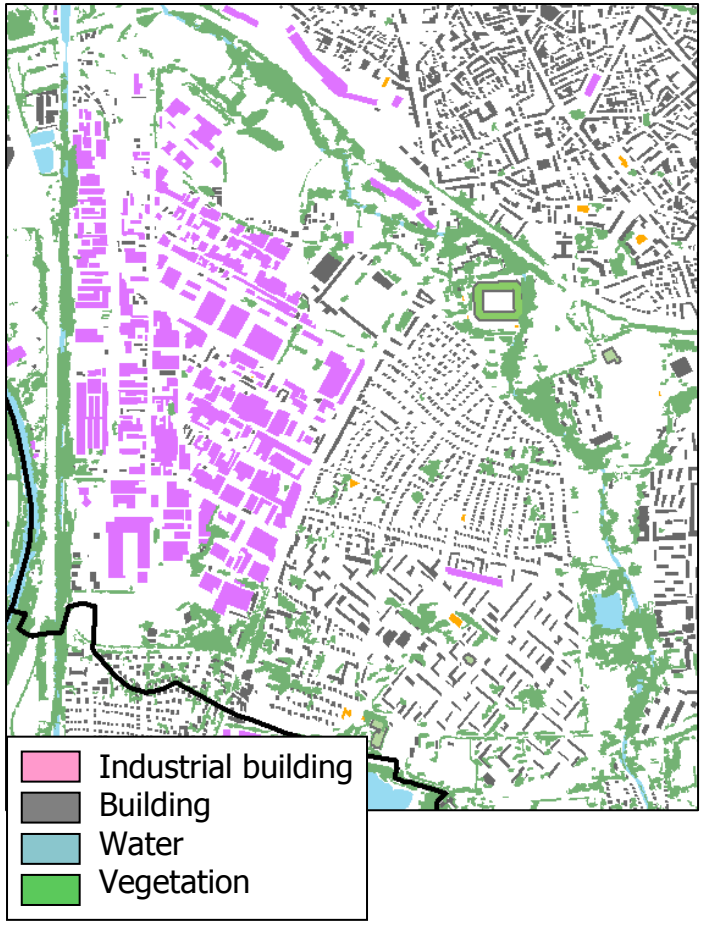

?

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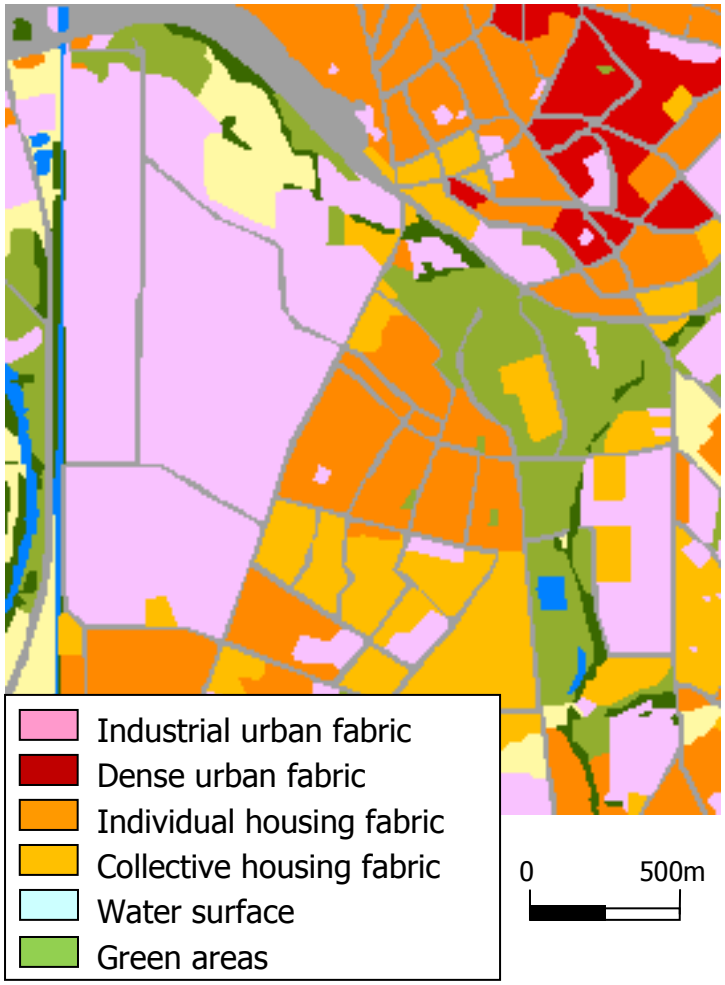

Extract of the urban area of Strasbourg

Method

- Methodology in 5 steps :

  - Step 1 : Typology of urban fabric
  - Step 2 : Building of urban blocks based on vector data
  - Step 3 : Measures on urban object and blocks
  - Step 4 : Classification of urban blocks / validation
  - Step 5 : Application on historic vector database

  => Knowledge extraction on urban pattern

  => Knowledge extraction on evolution

  => rules for simulation

Step 1 – Urban fabric

- Typology in 9 classes based on their morphology

(1) Dense urban fabric

(2) Individual housing

(3) Collective housing

(4) Mixed housing fabric

(individual and collective)

(5) Industrial urban fabric

(6) Mixed urban zone (activities and housing)

(7) Low density of specialised area

+ (8) rail/road network
+ (9) hydrology network

Step 2 – Block level

- Building urban blocks

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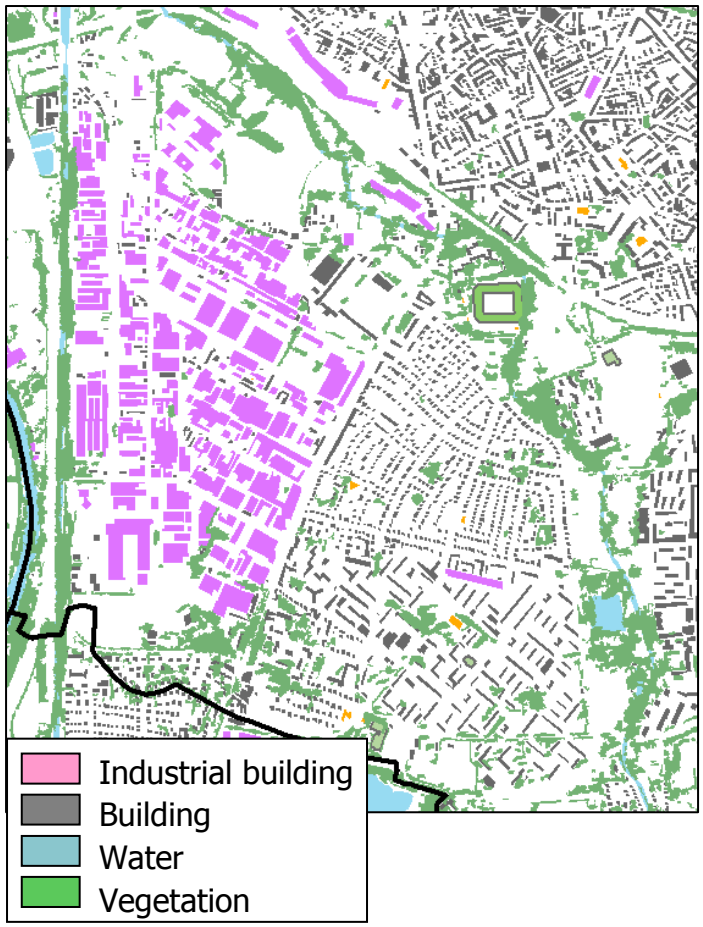

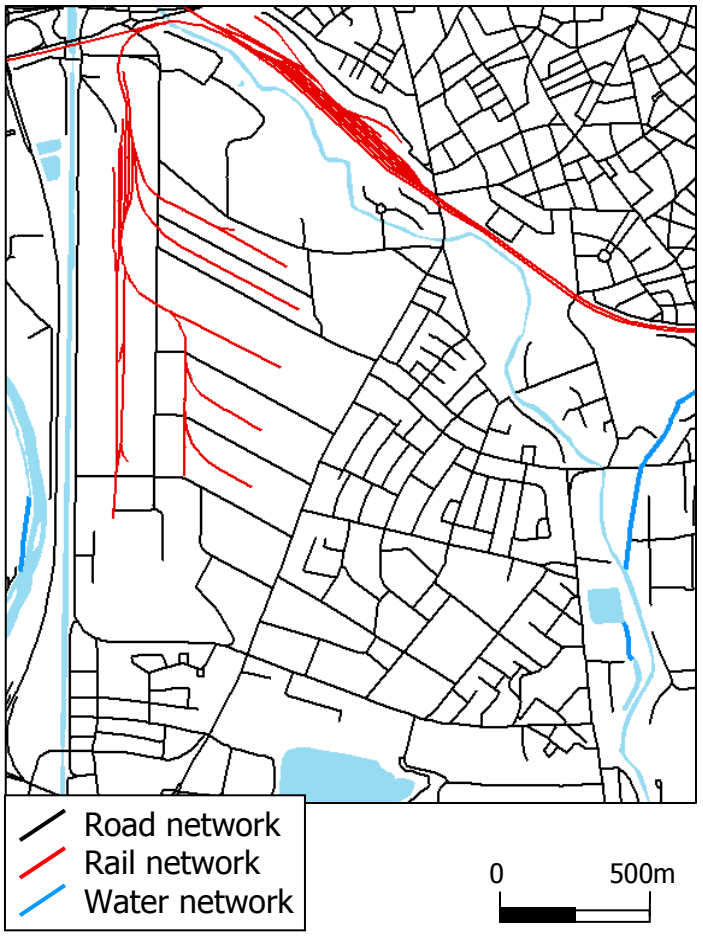

Step 2 – Block level

- Building urban blocks

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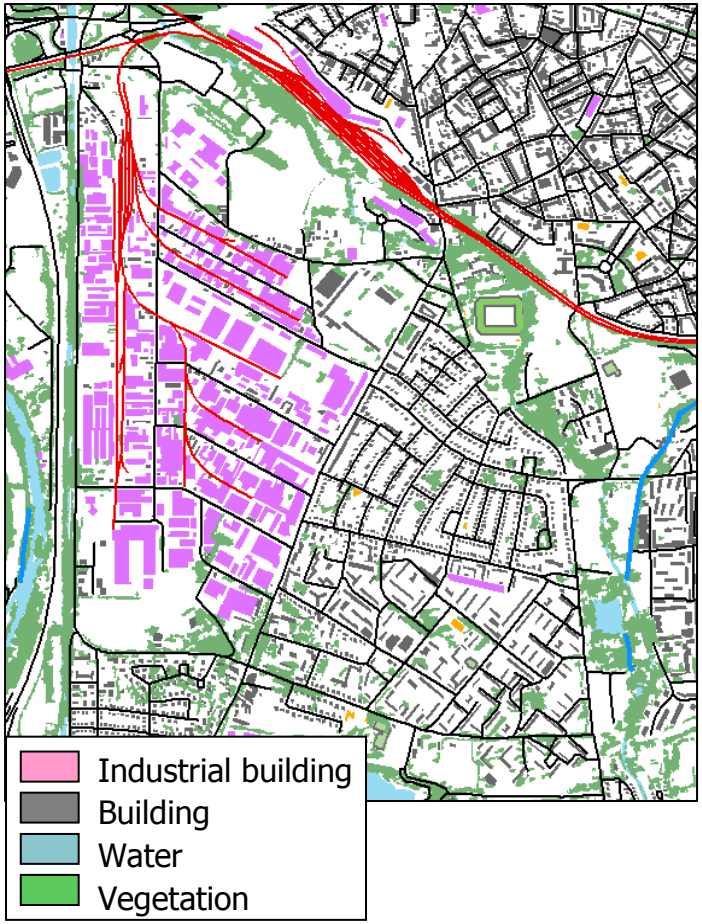

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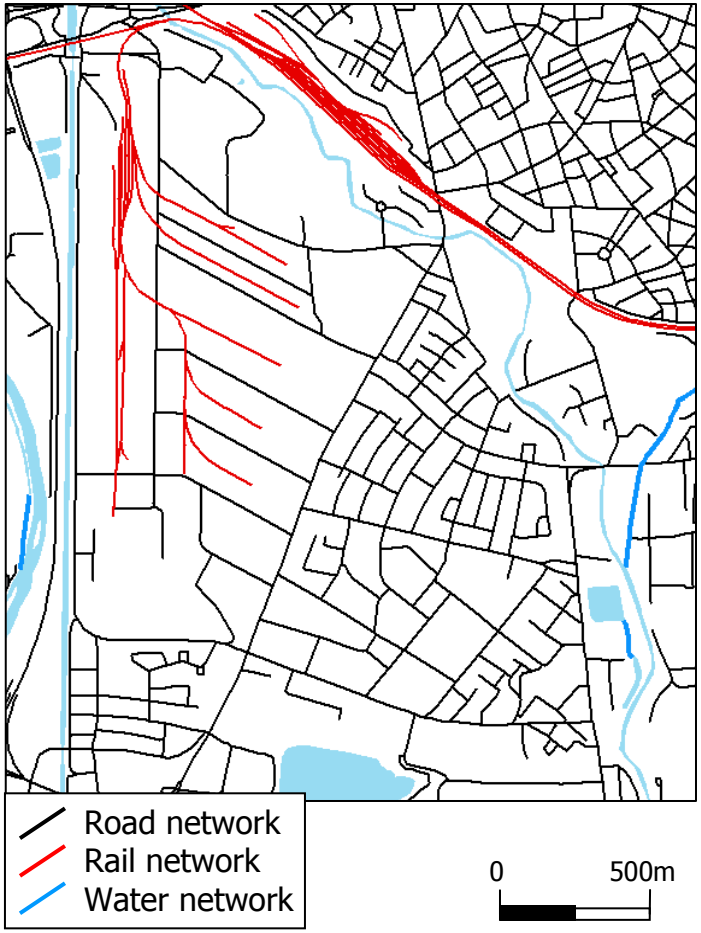
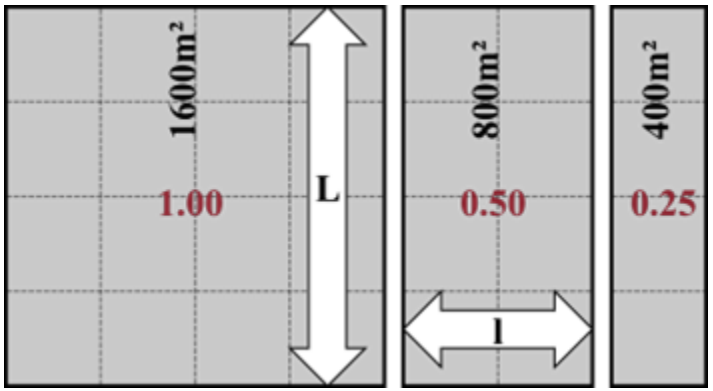
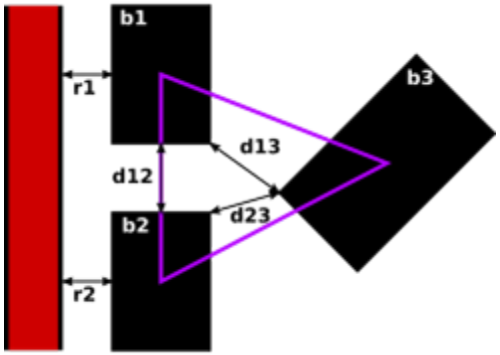


Step 3 - Measures

- At the level of building:



Measures of area, length (L), width (l) and elongation (l/L), convexity …



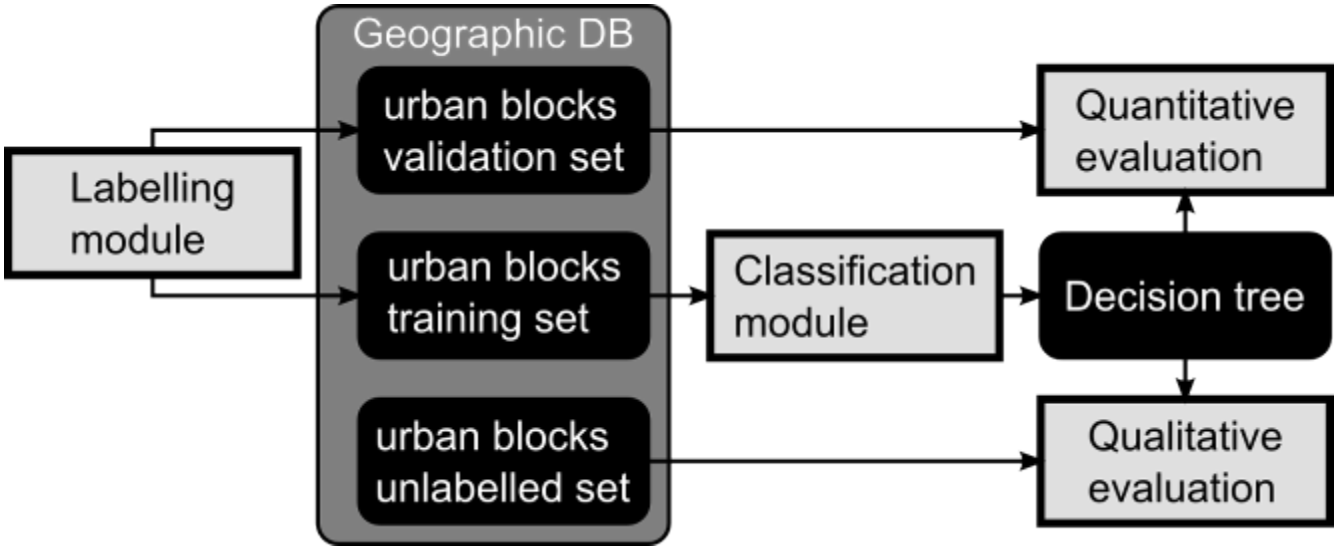
Distances between buildings and between buildings and roads

- At the level of block:

  - Number of buildings
  - Built area
  - Density

Step 4 - Classification

❑ Supervised classification scheme



❑ Protocol of test

- **Two objectives:**
  1) Identify the best sampling method to classify the whole urban area
  2) Apply the best model to classify historic vector database

Step 4 - Classification

- Test on sampling methods

  to classify a whole urban area

  - **Test 1**
    - ✓ size of training set = 5 %
    - ✓ samples chosen on the whole area
    - ✓ min of 30 samples per class

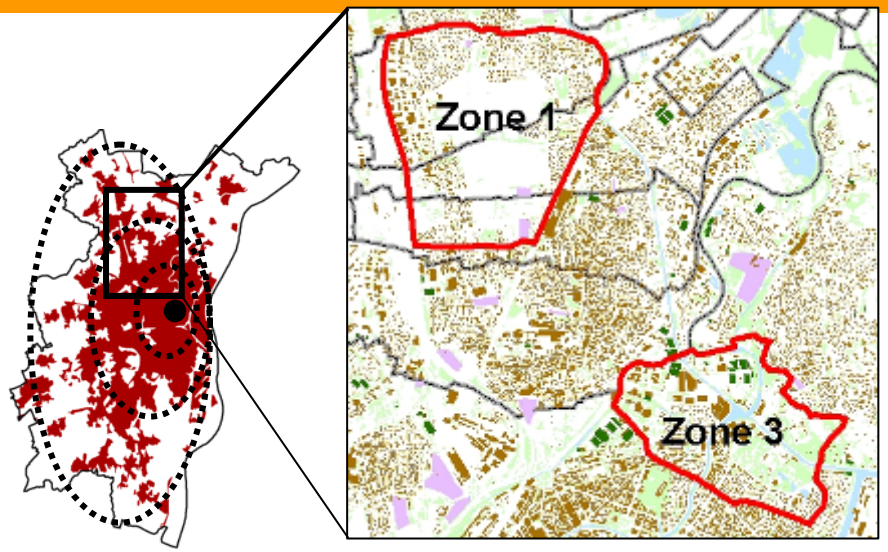
  - **Test 2**
    - ✓ size of training set = 5 %
    - ✓ samples chosen on selected zone (zone 1 et zone 3)
    - ✓ Block labelled = 60% of each zone

Results

- Zones of interest

Zone 3 : first ring
Zone 1 : second ring

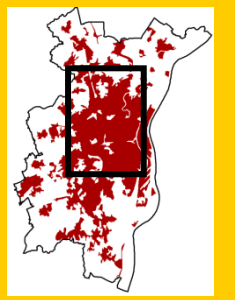
- Diversity of urban fabric
- Evolution

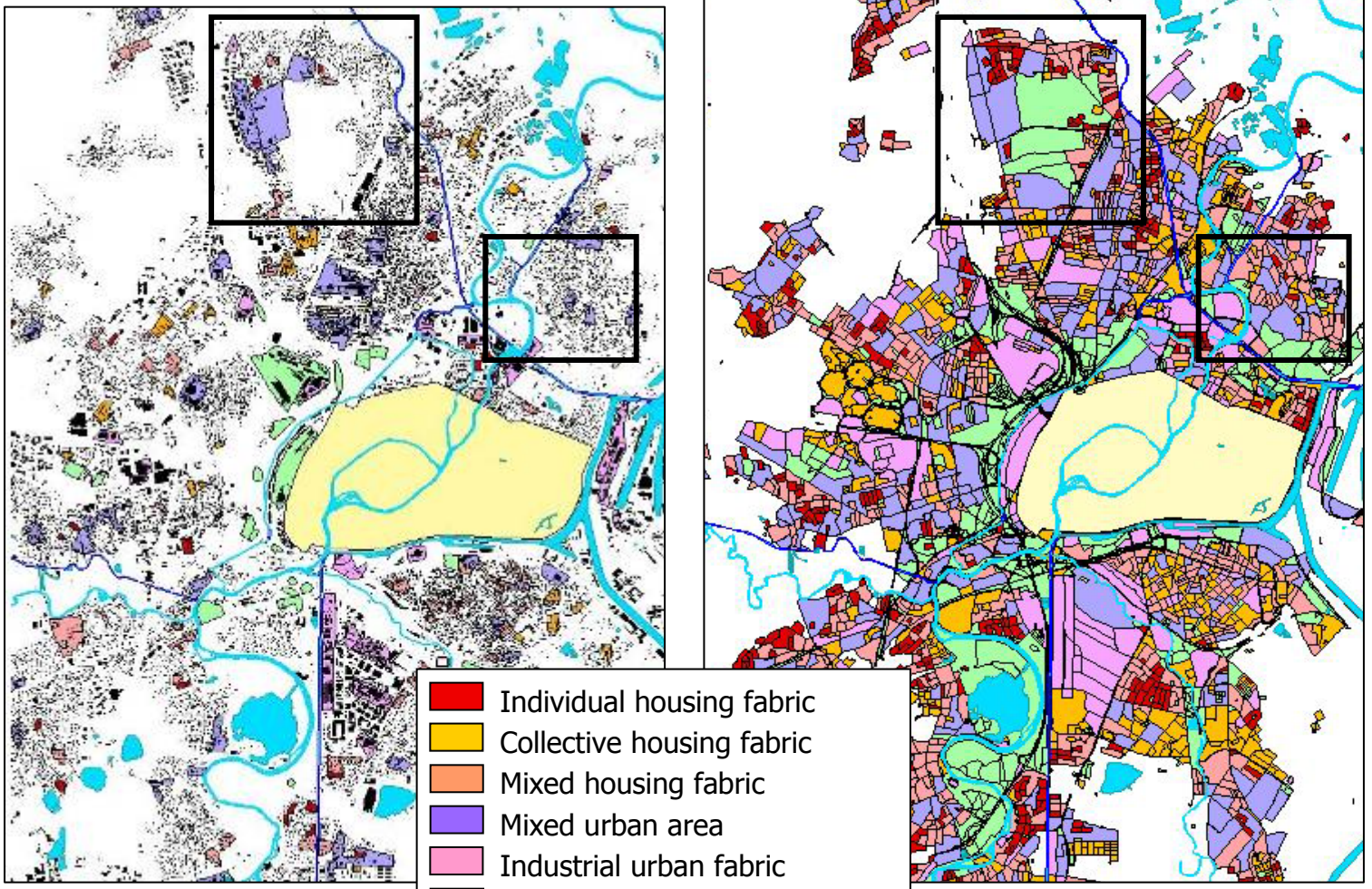


2002	***Test 1***	***Test 2***		
		Test 2a	***Test 2b***	***Test 2c***
Classes	***Urban area***	***Zone 1***	***Zone 3***	***Zone 1 et 3***
Individual houses	40	56	22	78
Housing blocks	39	21	21	42
Mixed housing	71	15	16	31
Midex area	60	14	7	21
High density of specialised areas	30	4	23	27
Low density of specialised areas	34	11	25	36
*Total number of blocks**	*5940*	133	201	354
Overall accuracy (%)	***78%***	**71%**	**63%**	**77%**

Results

- Classification



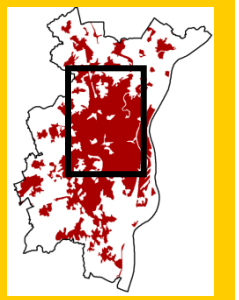


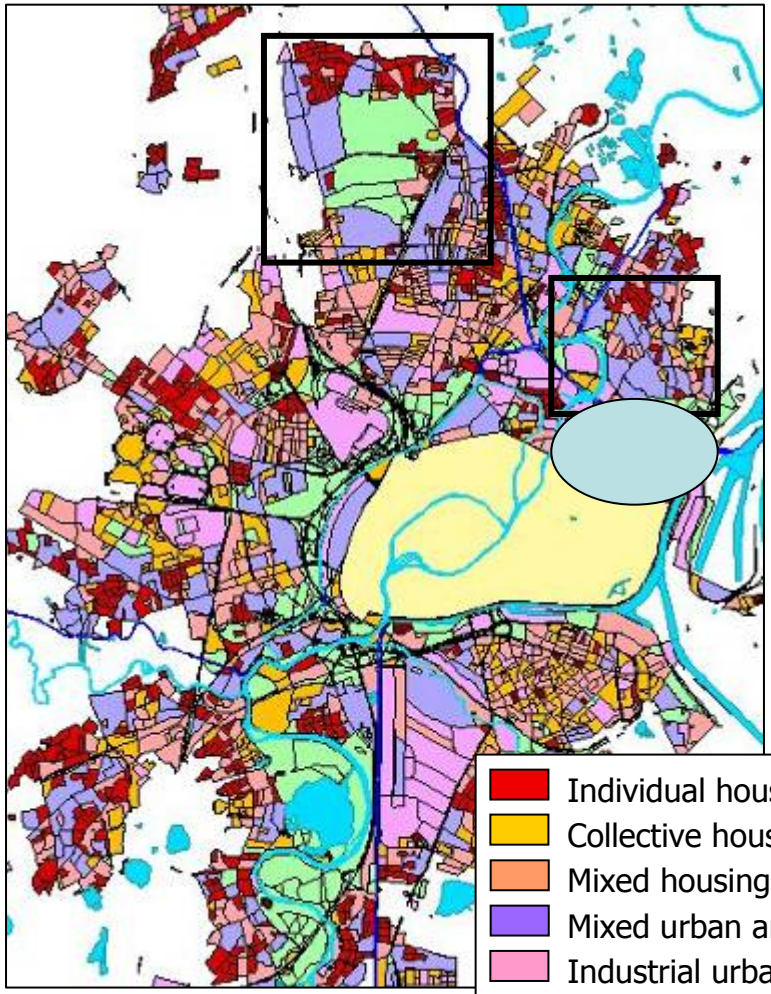
Training data set

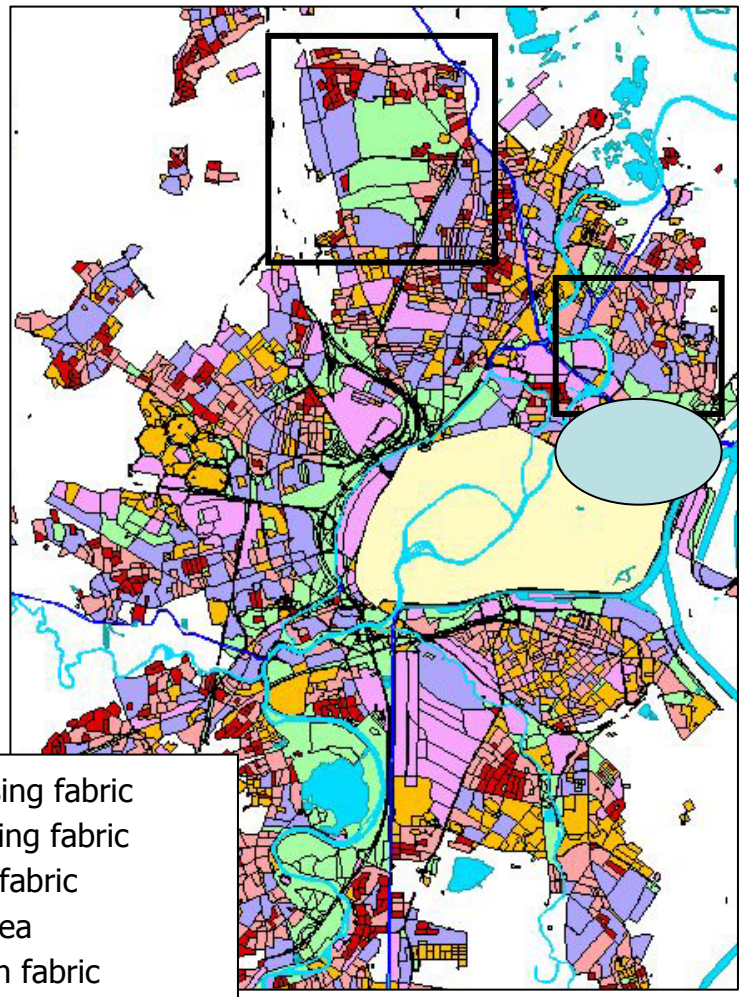
Classification test 1

Results

❑ Classification







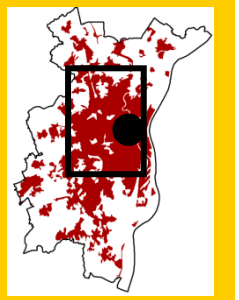
Individual housing fabric
Collective housing fabric
Mixed housing fabric
Mixed urban area
Industrial urban fabric
Low density of specialised area

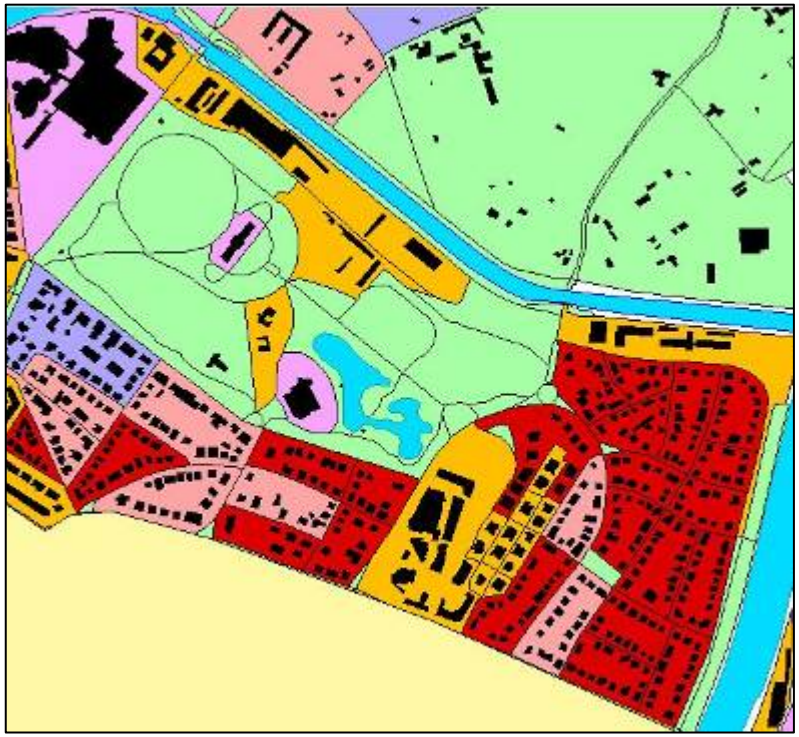
Classification test2c

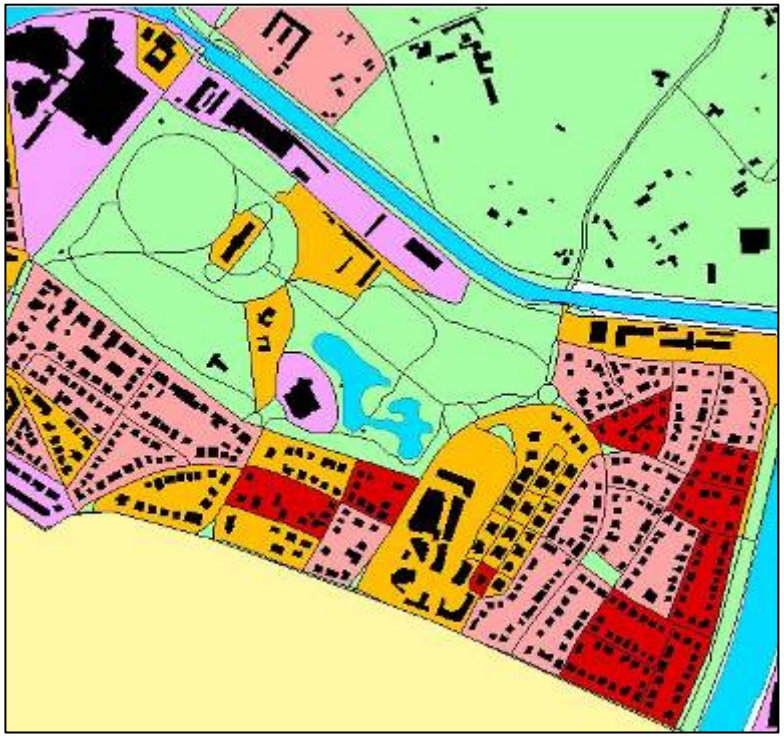
Classification test 1

Results

❑ Classification







Classification test2c

Classification test 1

- Individual housing fabric
- Collective housing fabric
- Mixed housing fabric
- Mixed urban area
- Industrial urban fabric
- Low density of specialised area

Results

- Knowledge extraction on **urban patterns**

  by decision tree algorithm (TILDE) => rules

8 relevant rules based on :

- density
- number of building
- area of building
- area of built surfaces

=> Definition of tresholds useful for simulation (population process)

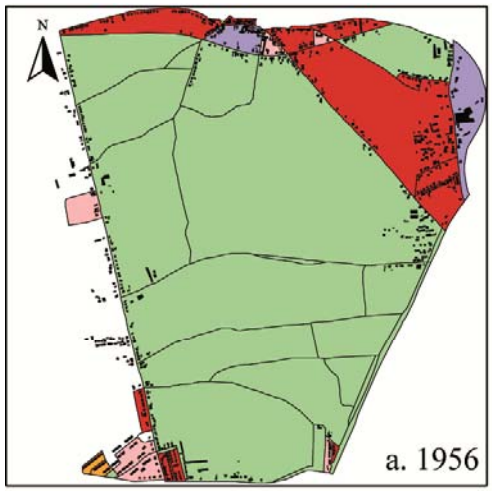
T1 : emp_pas_b si densite < 0.05

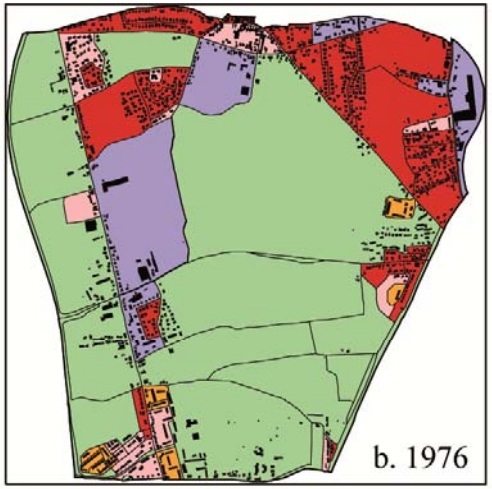
T3 : h_indiv si densite > 0.05 et |airebat<105| ≤ 3 et |airebat<185| > 1 et maxairebat < 1710 et densite < 0.23 et moyairebat < 20

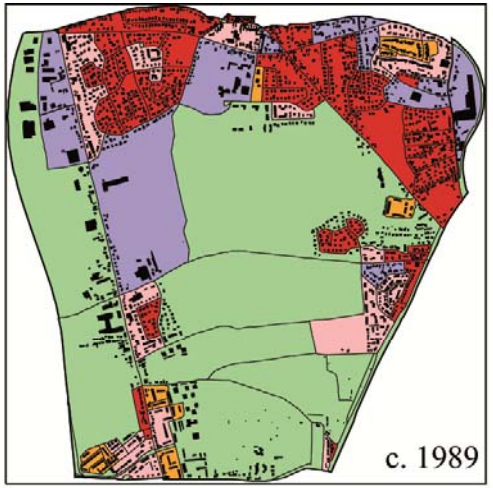
T7 : h_coll si densite > 0.05 et |airebat<105| ≤ 3 et |airebat<185| ≤ 1 et moyaire < 1200

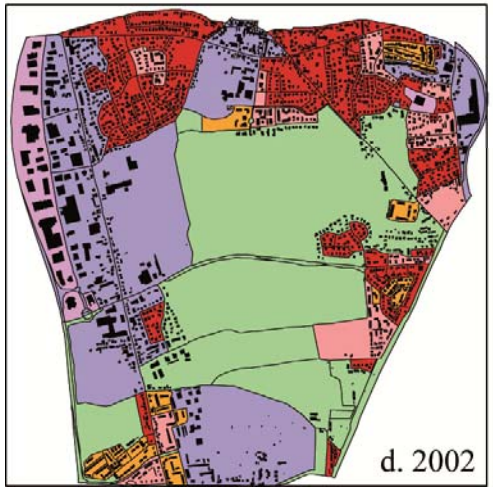
Step 5 – evolution

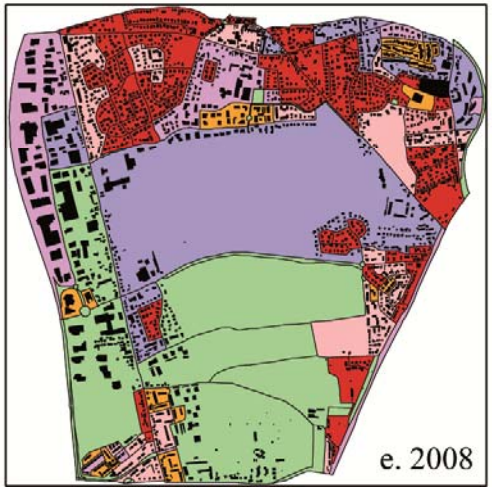
- Classification on historic database (model 2c)











0 400 m

Low density of specialised areas
High density of specialised areas
Urban fabric with housing blocks
Urban fabric with individual houses
Mixed urban fabric
Mixed urban areas
Limits of urban blocks
Buildings

Step 5 - results

- Overall accuracy (%) – *without new traning data*

Test 2c	Zone 1	Zone 2	Zone 3	Zone 4
2008	89	65	79	65
2002	/	63	/	58
1989	83	62	79	60
1976	84	71	76	56
1966	NA	NA	80	57
1956	79	93	83	53

- Knowledge extraction on **evolution**:
  - (1) Global => split of blocks, % of evolution by class
  - (2) Local => transition by period

Necessity to apply on large database !

Conclusions and perspectives

- Generic methodology to help end-users to classify urban area based on urban blocks (with vector data)
- Relevant to extract knowledge on urban pattern and evolution (threshold and transition)

BUT

- Application on other urban area and on large historic database
- Necessity to add other measures (spatial relations, vegetation pattern, …)
- Relevance of the level block building by network data ?

AND

- Possibility to use this knowledge in image analysis to improve classification method (OBIA)