H2GIS a spatial database to feed urban climate issues

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Introduction

- Geographic methods, geographical data and tools → a key feature to study the impact of cities on the urban climate.

- Research focused on mapping urban cities using demographic, administrative, remote sensing data.

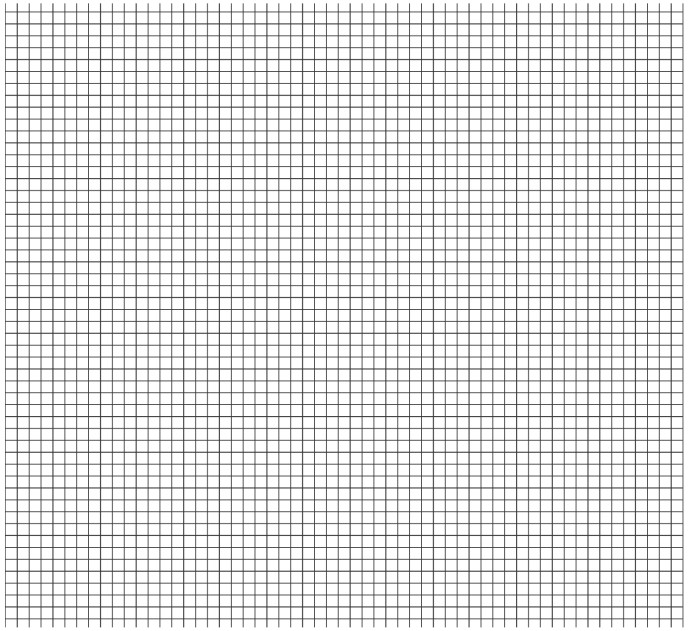
- Number of image processing techniques are applied to improve the description of urban land uses.

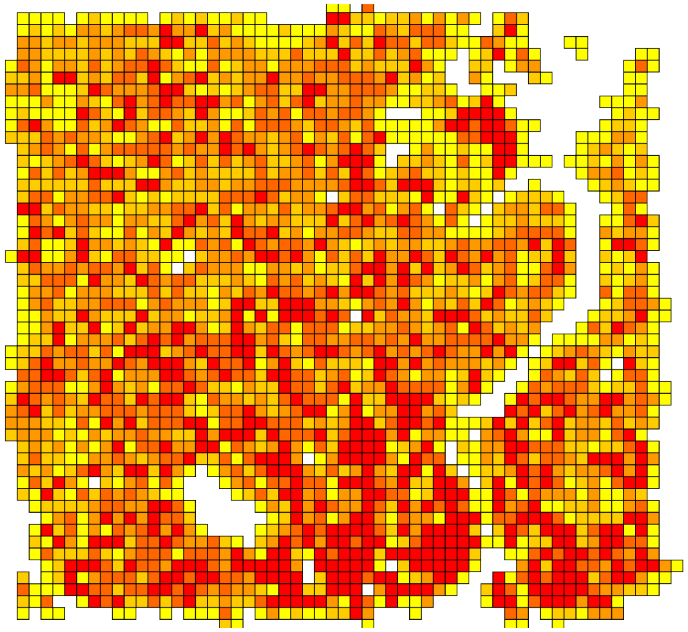
- Thanks to Spatial Analysis (SP), geostatistical fields that offer methods to explore on the inner of cities.

- SP is commonly used to compute indices, aggregate data at differents scales, detect patterns...

Buildings

Grid





Density of buildings

Indicators

Plenty of indices concerning form and structure have been proposed by the scientific community.

Average orientation of sides

Facade density

Betweenness centrality

Densities

Average building height

Closeness centrality

Strip Development Index

Open Space Index

Sky view factor

Shape Index

Aspect ratio

Minimum Convex Polygon (MCP)

Building elongation

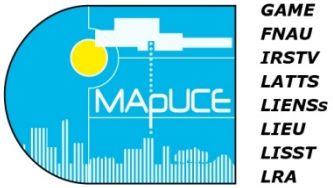
Discontinuous Development Index

Planning Consistency Index

Sinuosity Index

Many tools (GIS, libraries, …) avalaible … but many definitions, languages and implementations for the same indicator.

Our vision



Need of a standardized geoprocessing framework dedicated to urban indicators.

In the context of the ANR MAPUCE research project.

→ our task is to built a set of indicators at French scale, using a national vector database called BD Topo, made by IGN (French Geographic National Institute).

→ these indicators will be used to classify the cities (a LCZ like classification) and to populate the TEB model from Météo France.

See *« Masson et al, Urban Climate, Human behavior & Energy consumption: from LCZ mapping to simulation and urban planning »*.

Standardized urban indicators issues

"*The scientific method and the credibility of science rely on full transparency and explicit references to both methods and data*."

(Parsons, M. A., Duerr, R., & Minster, J.-B. (2010). Data citation and peer review. Eos, Transactions, American Geophysical Union, 91 (34), 297-298. Retrieved April 21, 2012, from http://dx.doi.org/10.1029/2010EO340001)

5 Reasons :

- Transparency
- Verifiability
- Cross-disciplinary studies (same langage)
- Re-use
- Compatibility

… and open knowledge

A 3 steps method

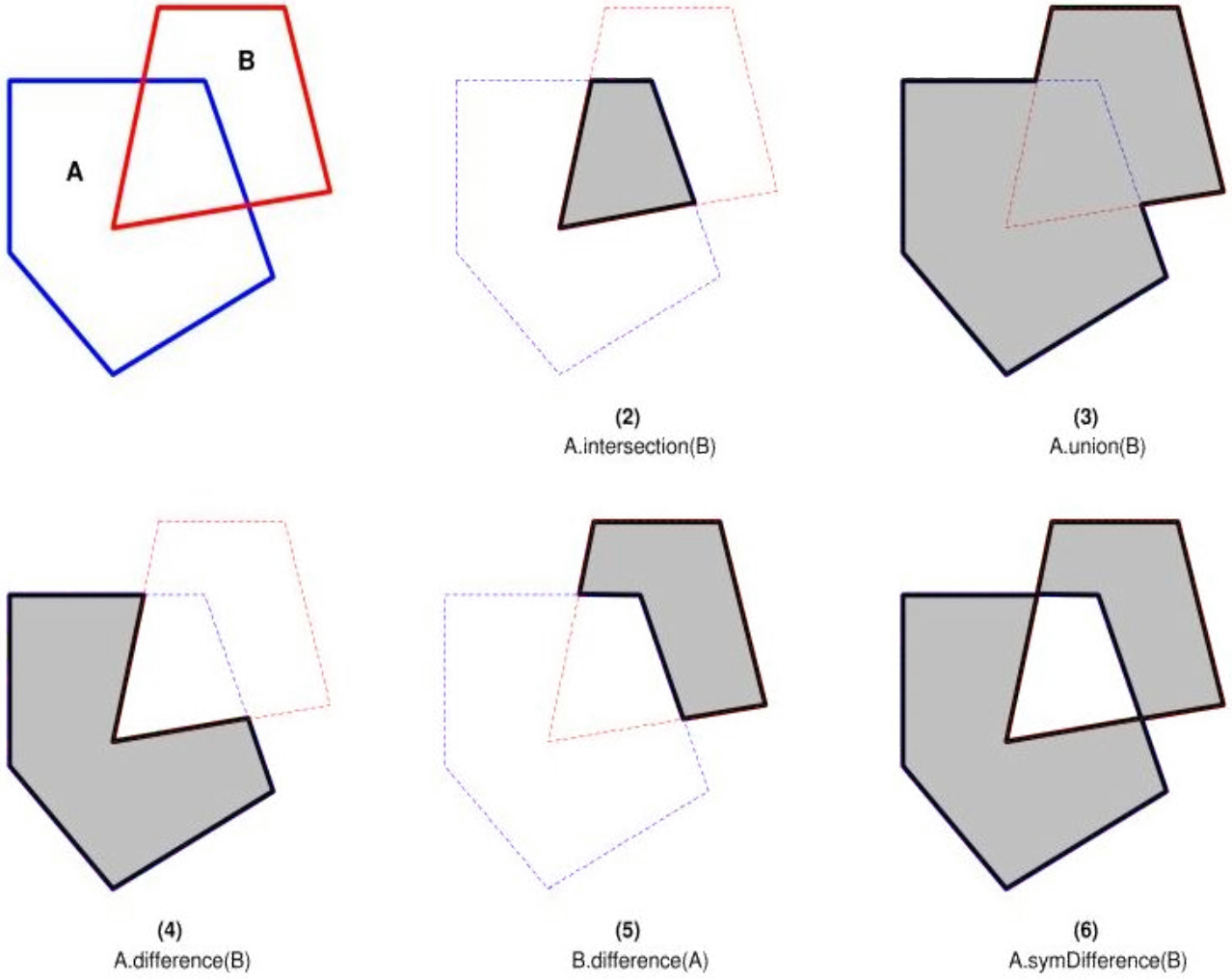
1- Choice of a standardized language

→ Spatial Structured Query Langage (SQL)

2- List of indicators (input, output and algorithm)

3- Translation into SQL scripts

Step 1 : The Spatial SQL standard

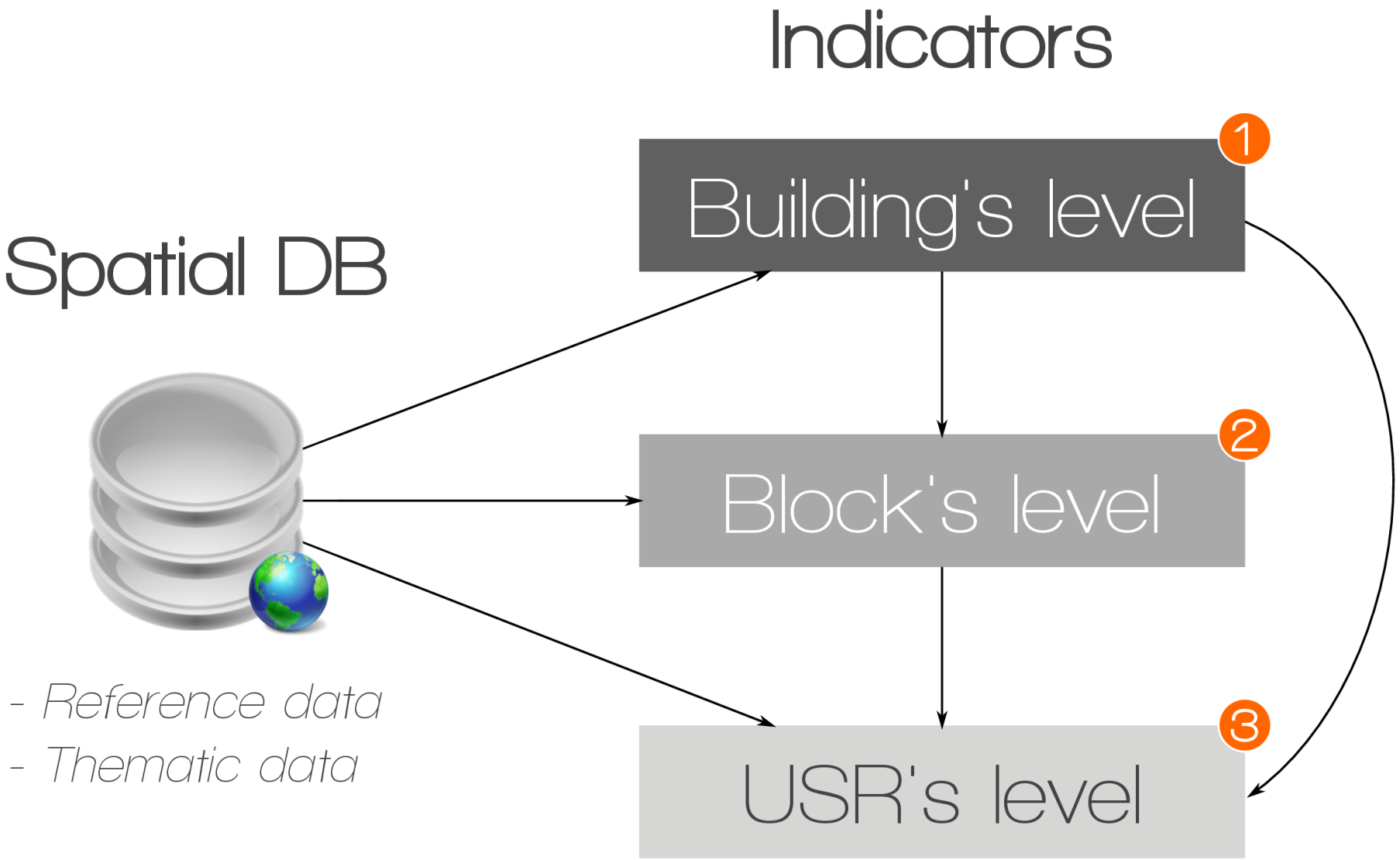


→ Supported by Open Geospatial Consortium (OGC)

→ A set of geometric predicates and operators

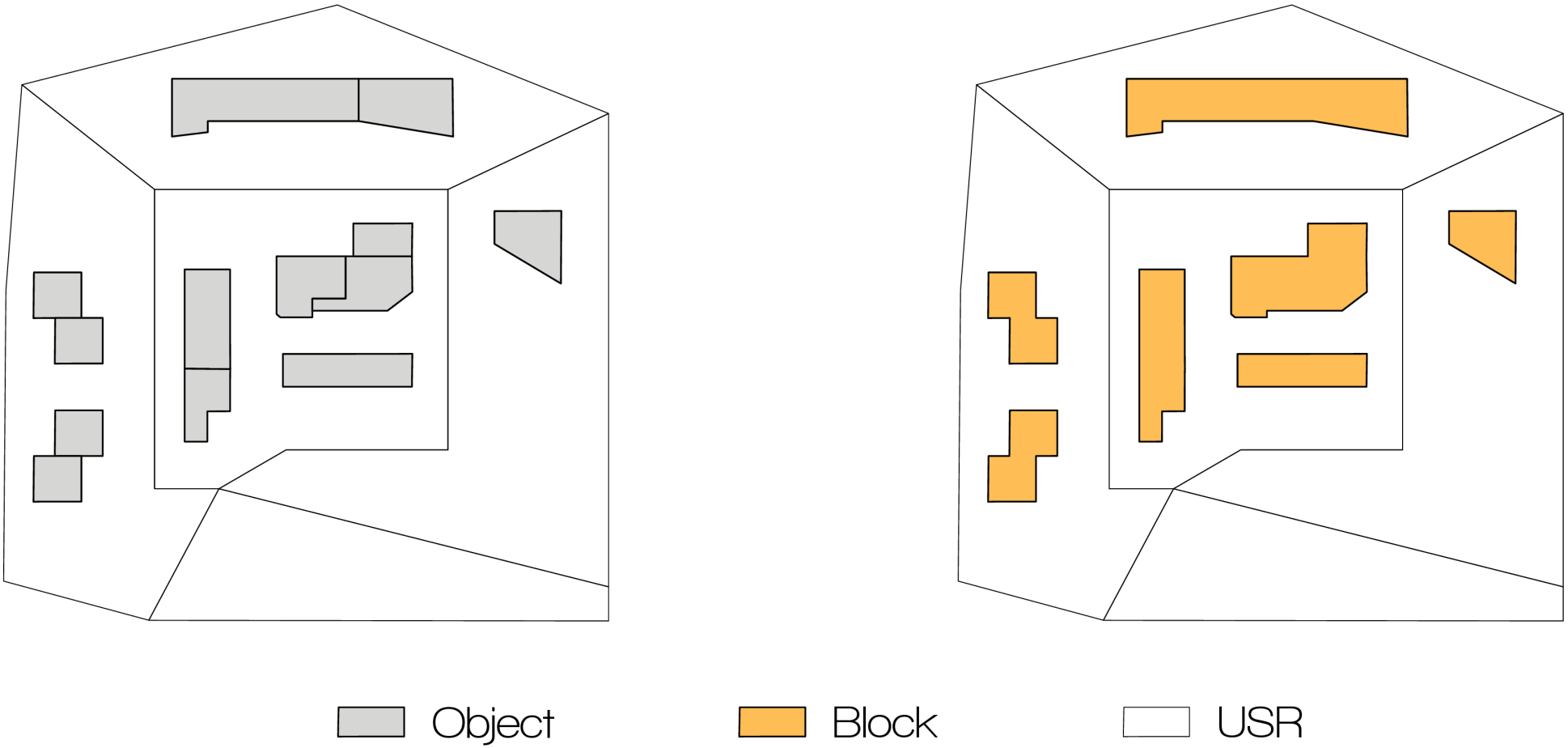
Step 2 : List of indicators

3 levels of spatial unit



Step 2 : List of indicators

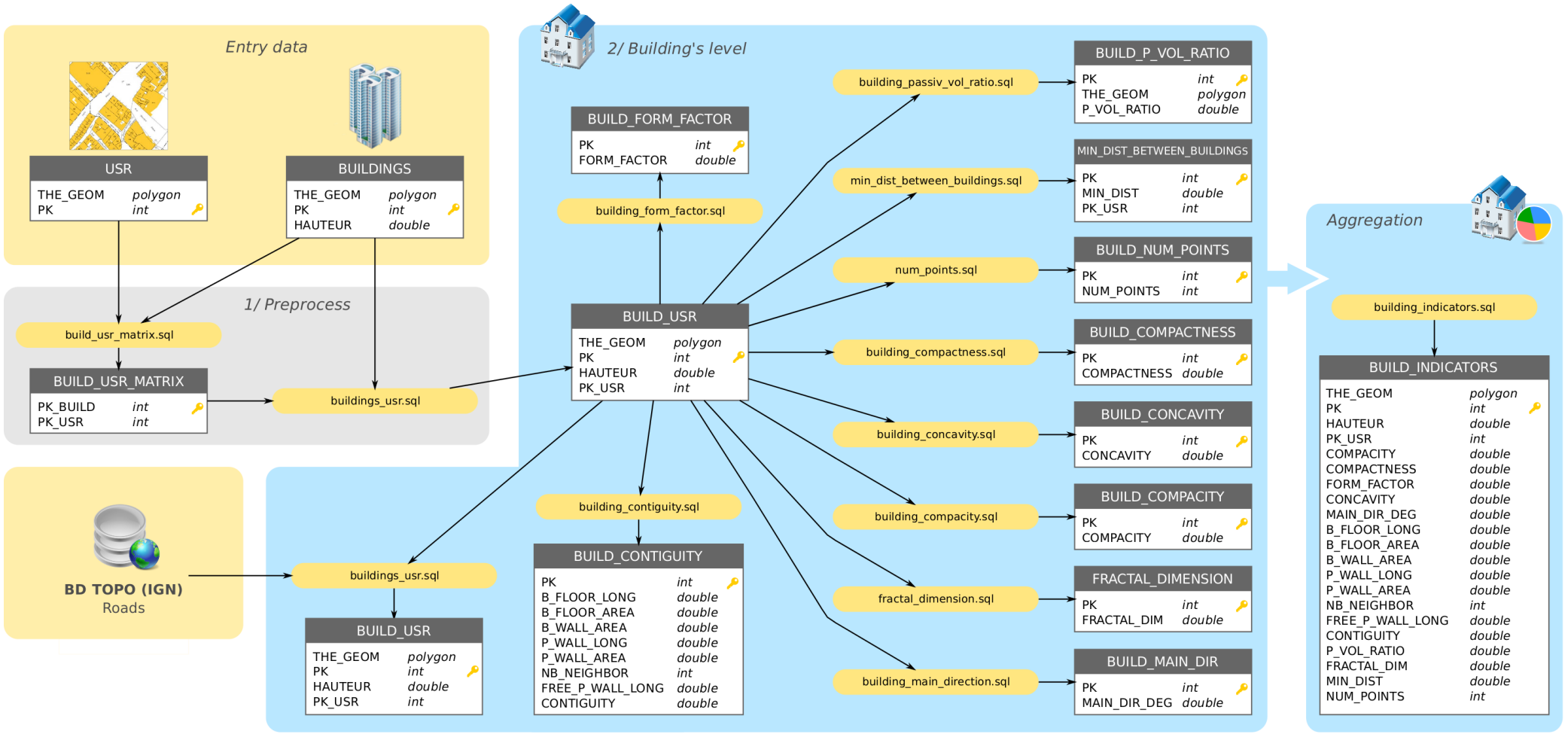
3 levels of spatial unit



Object : here the building,
Block : aggregation of contigous buildings,
Islet = USR (Unité Spatiale de Référence – Reference Spatial Unit)

Step 2 : List of indicators

A part of the building's indicators schema



Number of indicators : Building (29) / Block (9) / Islet (28)

e.g Compactness ratio, Contiguity, Form factor, Number of neighbor, ...

Step 3 : Translation into SQL scripts

An example with the form factor indicator

$$FF_{build} = \frac{S_{build}}{L^2_{build}}$$

Where

- S_{build} is the building's area
- L_{build} is the building's length (perimeter)

SQL script

```
DROP TABLE IF EXISTS BUILD_FORM_FACTOR ;
CREATE TABLE BUILD_FORM_FACTOR (PK integer primary key,
    FORM_FACTOR double)
  AS SELECT PK , ST_AREA(THE_GEOM) / POWER(ST_LENGTH(
      THE_GEOM),2) AS FORM_FACTOR
FROM BATI;
```

The implementation

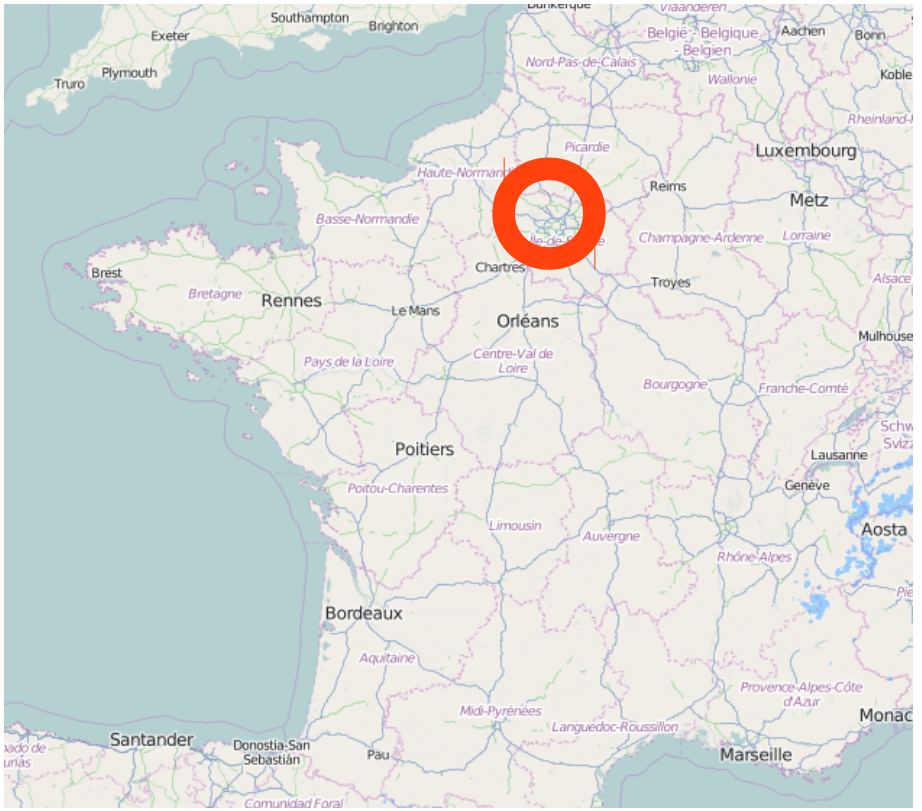
- A spatial extension of H2 Database
- http://www.h2gis.org
- Open-source (GPL 3)
- 100% in Java
- Based on the JTS Topology Suite
- Cross-platform & no installation
- Implements all SFS functions and additional spatial functions
- Lightweight (8mo)

- A robust and powerful DBMS
- http://www.h2database.com
- Open-source … like PostGreSQL
- 100% Java
- Cross-platform & no installation
- Fully SQL compliant
- Complete documentation
- Connects to a wide range of other DBMSes

Paris area in action

Process the area of Paris

→ 2 departments (75 + 92)



Number of ...

... buildings : 301 517

... blocks : 110 622

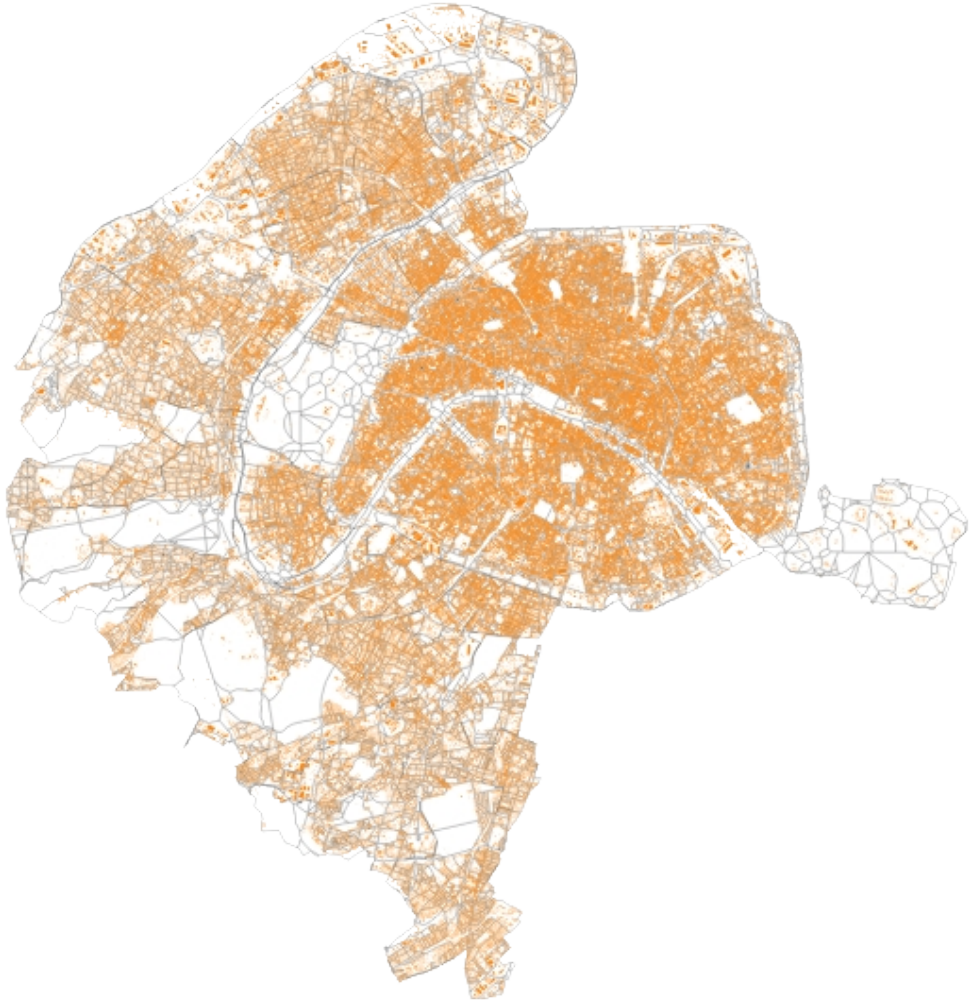
... islets : 11 281

Time processing : 2000s

… with a laptop i5-3337U CPU @ 1.80GHz × 4 / 16Go RAM (4Go dedicated) / SSD hard drive

Paris area in action

Islet ...



… and Buildings

301 517 buildings / 110 622 blocks / 11 281 islet

Paris area in action

Zoom on buildings

Zoom on blocks

301 517 buildings / 110 622 blocks / 11 281 islet

Paris area in action

Preview	Label
	[0.0; 0.5[
	[0.5; 1[
	[1; 1,5[
	[1,5; 2[
	[2; +∞[

Building's minimum distance

Preview	Label
	0
	1
	2
	3
	4
	⩾ 5

Building's number of neighbors

Conclusion

A standardized list of indicators available through the Spatial SQL language.

→ open and for free

→ merged in a single place

A full-scale application

→ at the end, more than 50 million of buildings

Outlook

- Build a bridge between our database and WUDAPT

- Publish our indicators through a web platform (using Web Processing Service (WPS))

- Apply with other vector db (e.g Open Street Map)

Thanks for your attention
-
Questions ?

To use H2GIS : http://h2gis.org/

Join the « Open Source Geospatial Research & Education Symposium » Community : http://www.ogrs-community.org/

Acknowledgement

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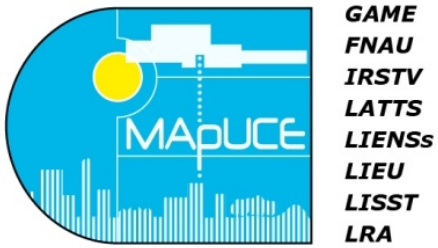

See more : http://www.agence-nationale-recherche.fr/?Project=ANR-13-VBDU-0004