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Urban noise maps in a GIS

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IFSTTAR

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- Description of the method
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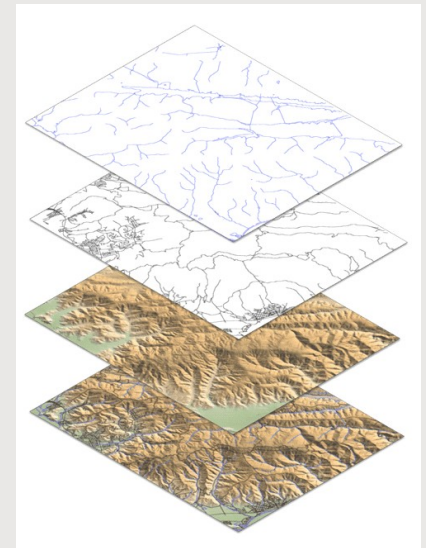
Introduction

- Strategic Noise mapping in the EU [2002/49/EC]
- EU action plans for decreasing noise exposure
- Main action by optimising “Urban mobility plans”
 - Testing several scenarios using “standard approaches”:
 - Complex process
 - Time consuming
 - **Need for a simplified approach:**
 - Propose a “2D simple approach” of the French standard method NMPB 08, with low computation time (~a day)
 - Include the method in a open source GIS software: OrbisGIS

Introduction

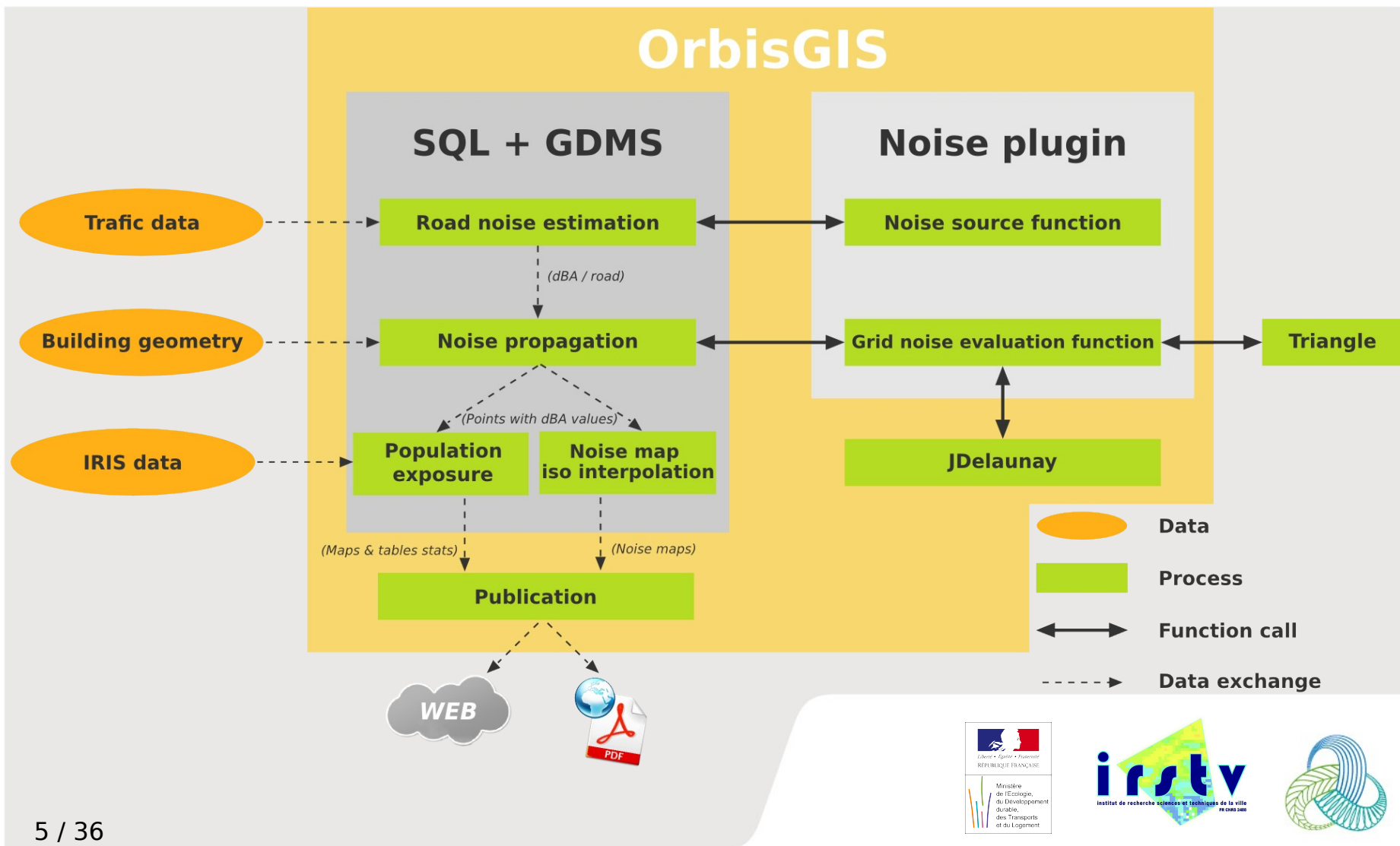
Why a GIS ?

1. Integrates methods and tools for capturing, managing, analyzing, and displaying all forms of spatially referenced data.
2. Concept and methods to aggregate and disaggregate data.
3. Able to process huge data.
4. Languages to process data.
5. Connected with the earth system.



Description of the method

General procedure



Description of the method

Noise emission from traffic data

Using data like :

- Average vehicle speed
- Light vehicle/hour
- Heavy vehicle/hour
- Tram vehicle/hour
- Speed limitation
- Road category ex: “Highway 2x2”
- Reference spectrum for each vehicle category

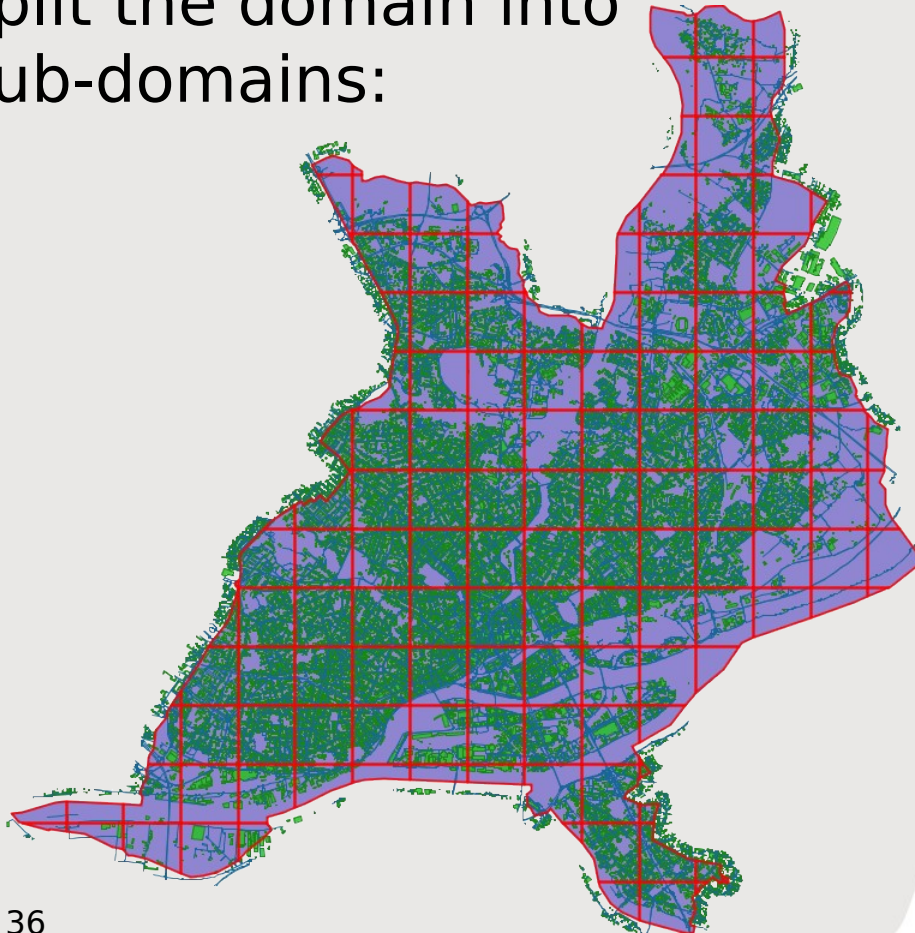
Computation of the frequency distribution of the sound pressure level in 1/3 octave bands from 100 to 5000 Hz



Description of the method

Propagation: domain calculation and meshing

- Parallel computing, split the domain into sub-domains:



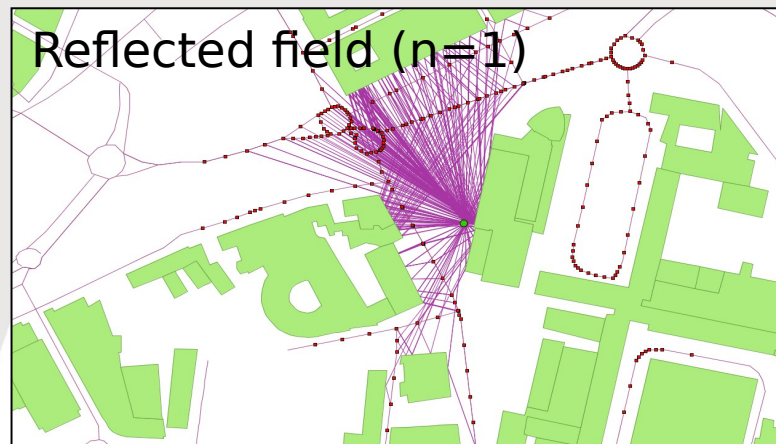
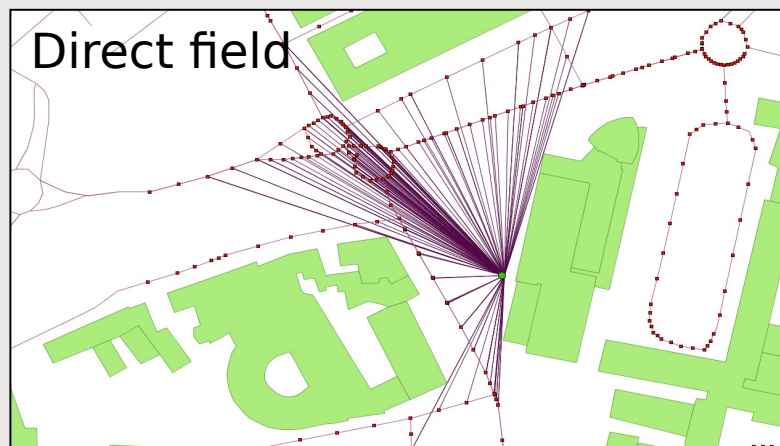
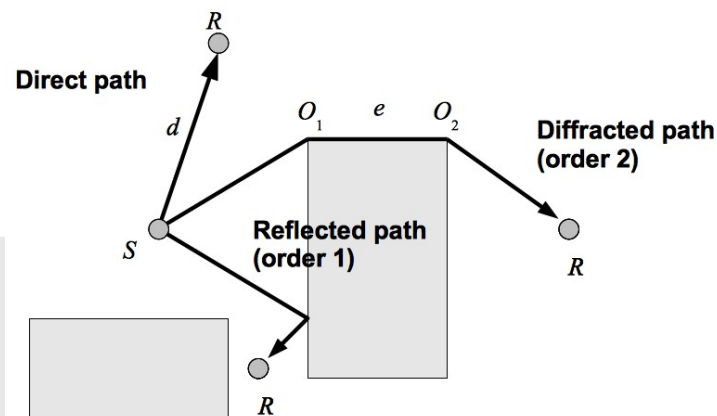
- For noise mapping, quality constrained Delaunay triangulation of a sub-domain:



Description of the method

Sound propagation paths

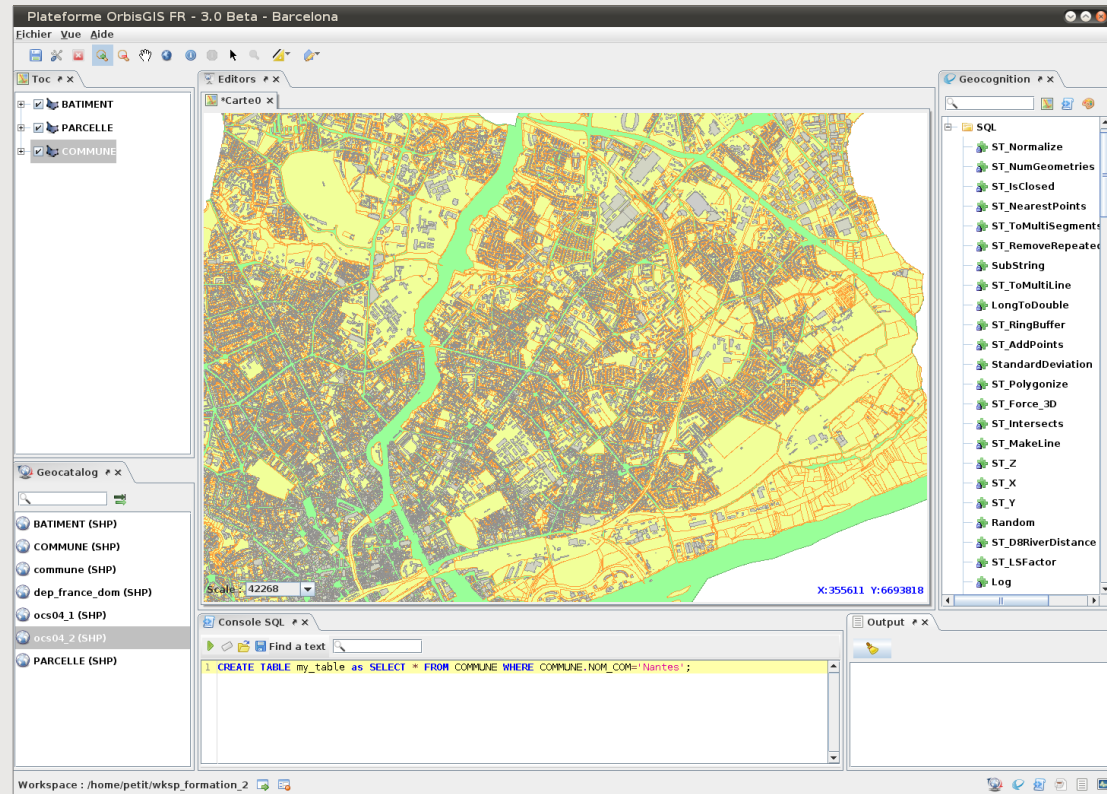
- For a given receiver:
research of all propagation paths: direct, reflected (order n), diffracted (order m)
- Calculation of sound level for each path



Implementation within OrbisGIS

What is OrbisGIS : a GIS?

- An open source GIS (GPL 3),
- Cross platform developed in JAVA,
- Based on standards,
- Documented,
- Tested.



Implementation within OrbisGIS

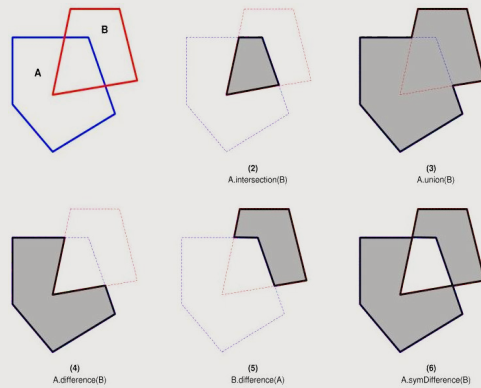
What is OrbisGIS : a common language ?

- GeoAlgebra, Takeyama and Couclelis (1997) an extension of map algebra that allows for flexible definitions of neighborhoods,
- MapScript language, Pullar (2001), “that allows control structures and dynamical models to be incorporated into map algebra”,
- Mennis et al, 2005, propose an extension of map algebra for spatio-temporal data handling.
- Camara et al, 2005 propose to apply of topological predicates to coverages.



Implementation within OrbisGIS

What is OrbisGIS ?



```
Console SQL ✕  
Find a text   
1 select ST_buffer(the_geom, 20) from roads.
```

References : <http://www.vividsolutions.com/jts/>

before...

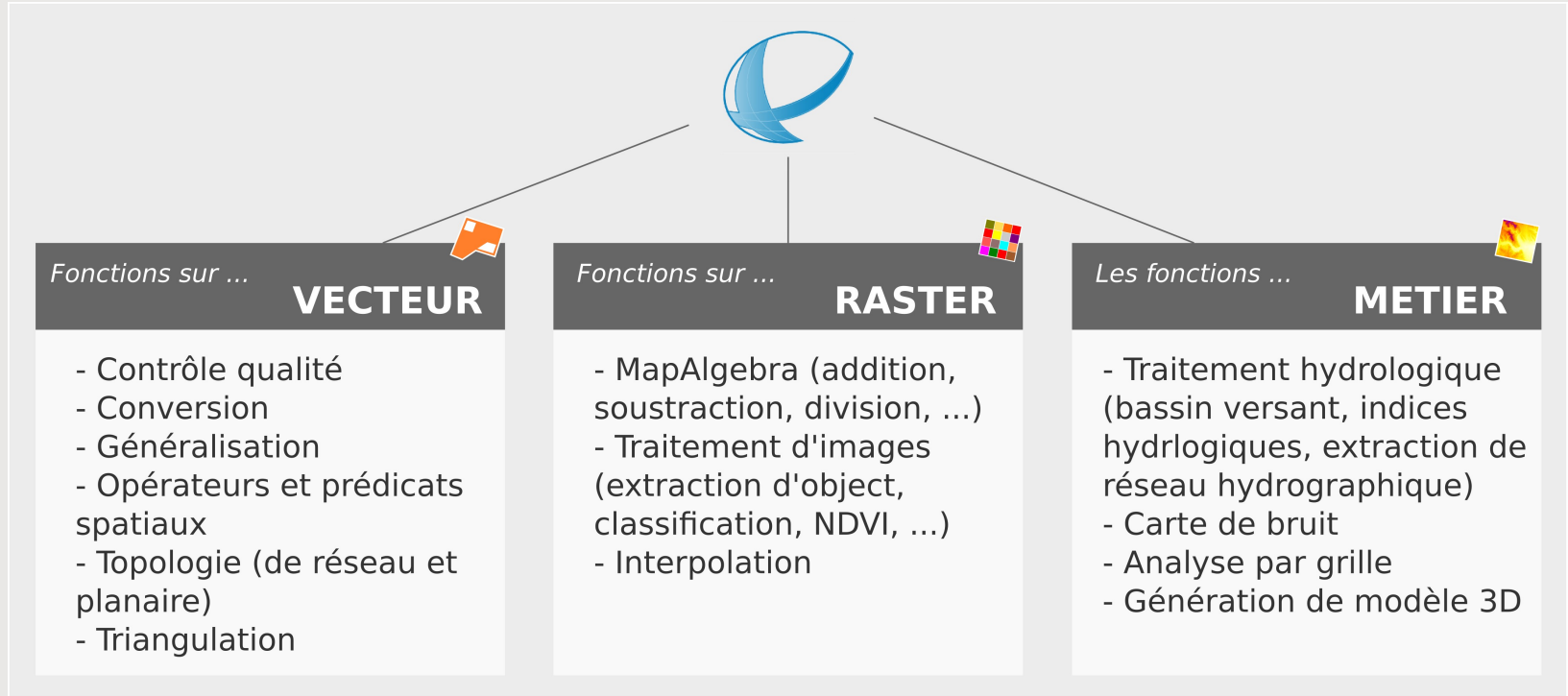


... after



Implementation within OrbisGIS

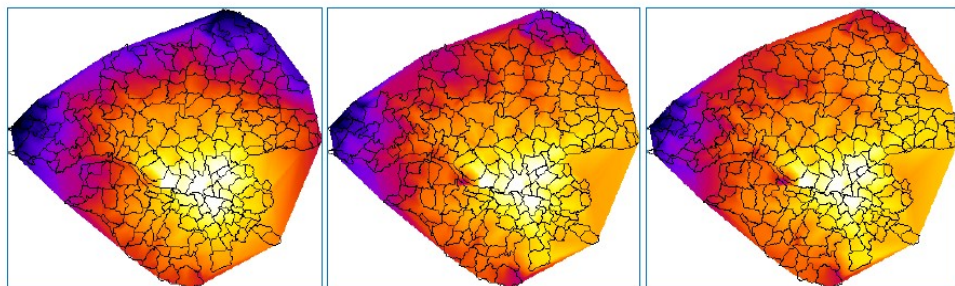
What is OrbisGIS ?



> 150 fonctions

Implementation within OrbisGIS

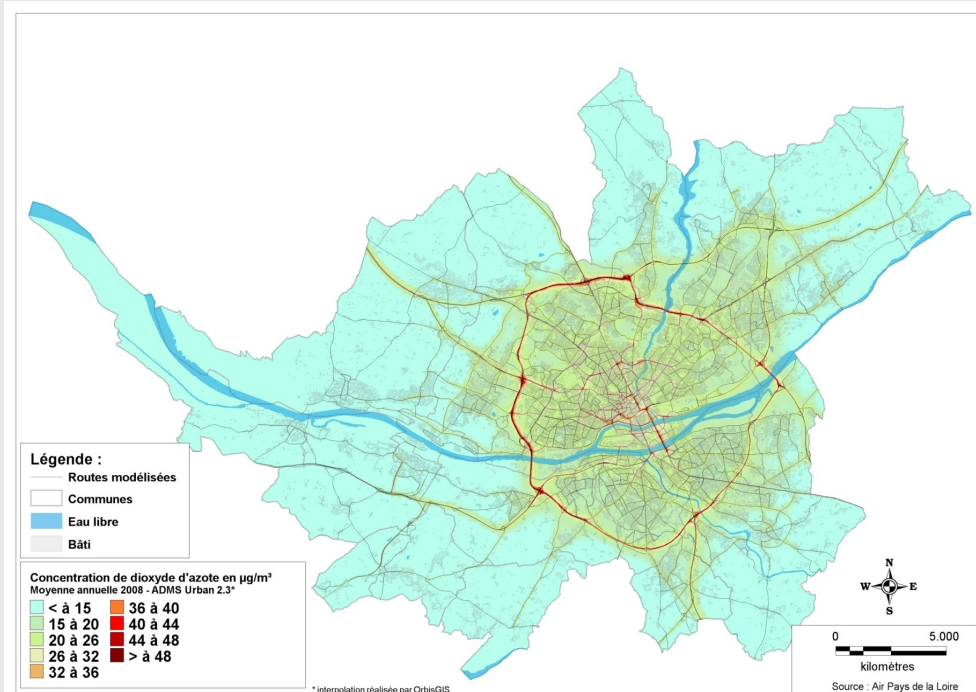
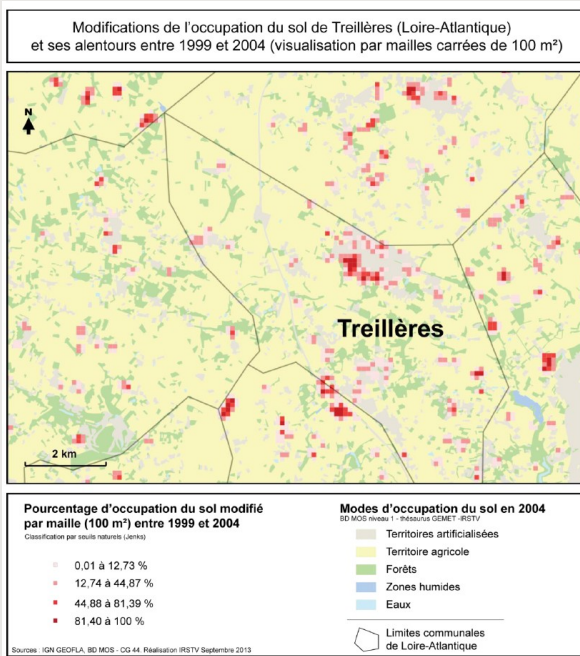
What is OrbisGIS : a framework for research and education applications?



Δ longueur réelle (1) Δ trajet en heure creuse (2) Δ trajet en heure de pointe (3)

E Bocher and P Rohel, 2012

T Schmidt 2011



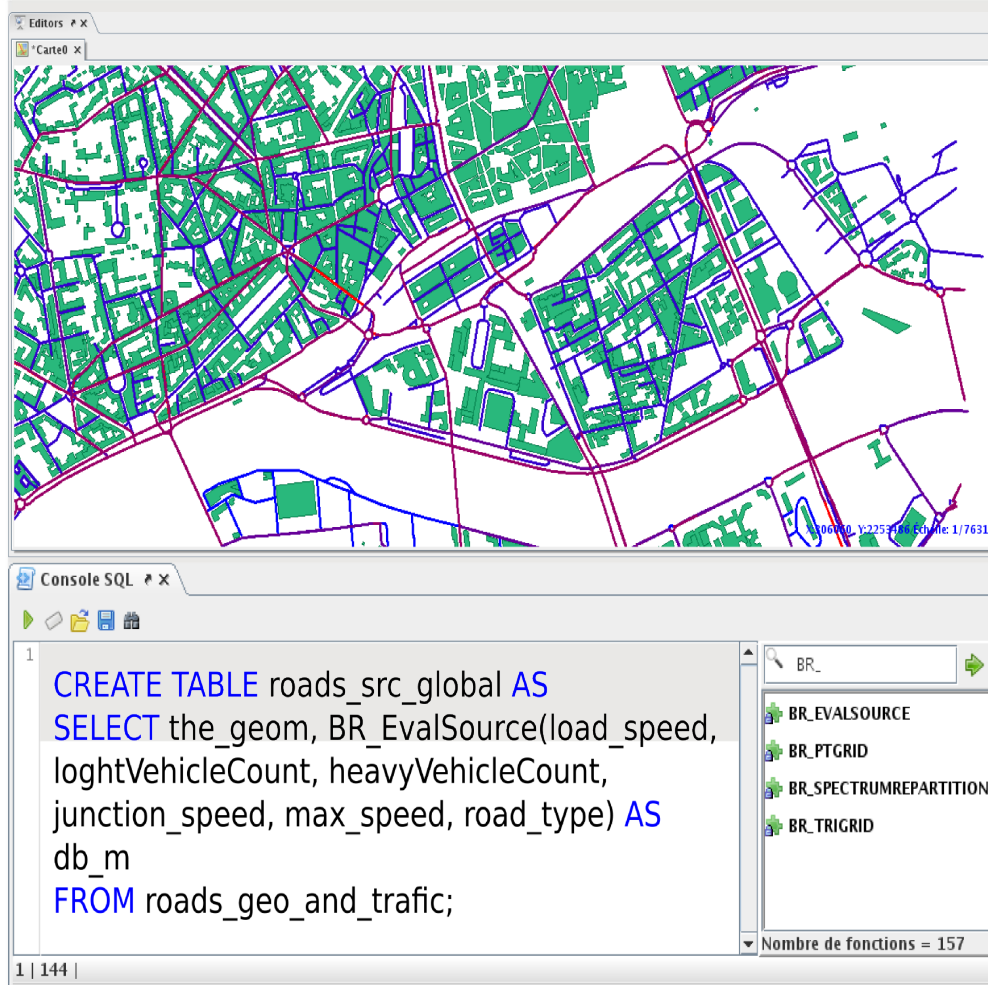
Implementation within OrbisGIS

What is OrbisGIS : a distributed system?



Implementation within OrbisGIS

Noise Map Plugin



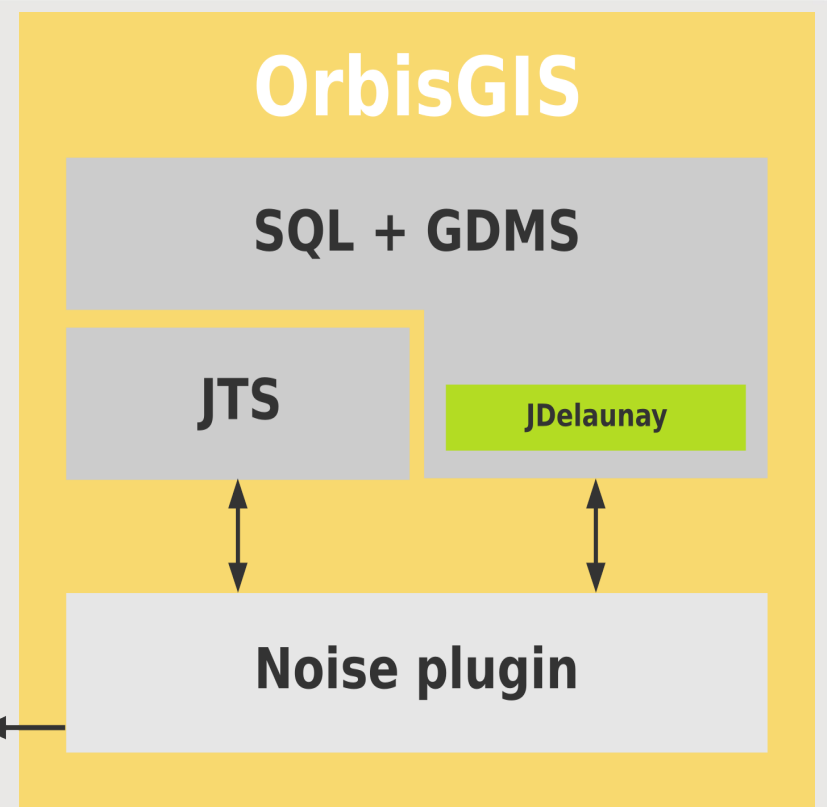
The screenshot shows the OrbisGIS interface. The top window displays a map with a network of roads and green areas. The bottom window is the SQL console, showing the following SQL code:

```
1 CREATE TABLE roads_src_global AS  
2 SELECT the_geom, BR_EvalSource(load_speed,  
3 loghtVehicleCount, heavyVehicleCount,  
4 junction_speed, max_speed, road_type) AS  
5 db_m  
6 FROM roads_geo_and_traffic;
```

On the right side of the SQL console, a dropdown menu is open, showing the following options:

- BR_EVALSOURCE
- BR_PTGRID
- BR_SPECTRUMREPARTITION
- BR_TRIGRID

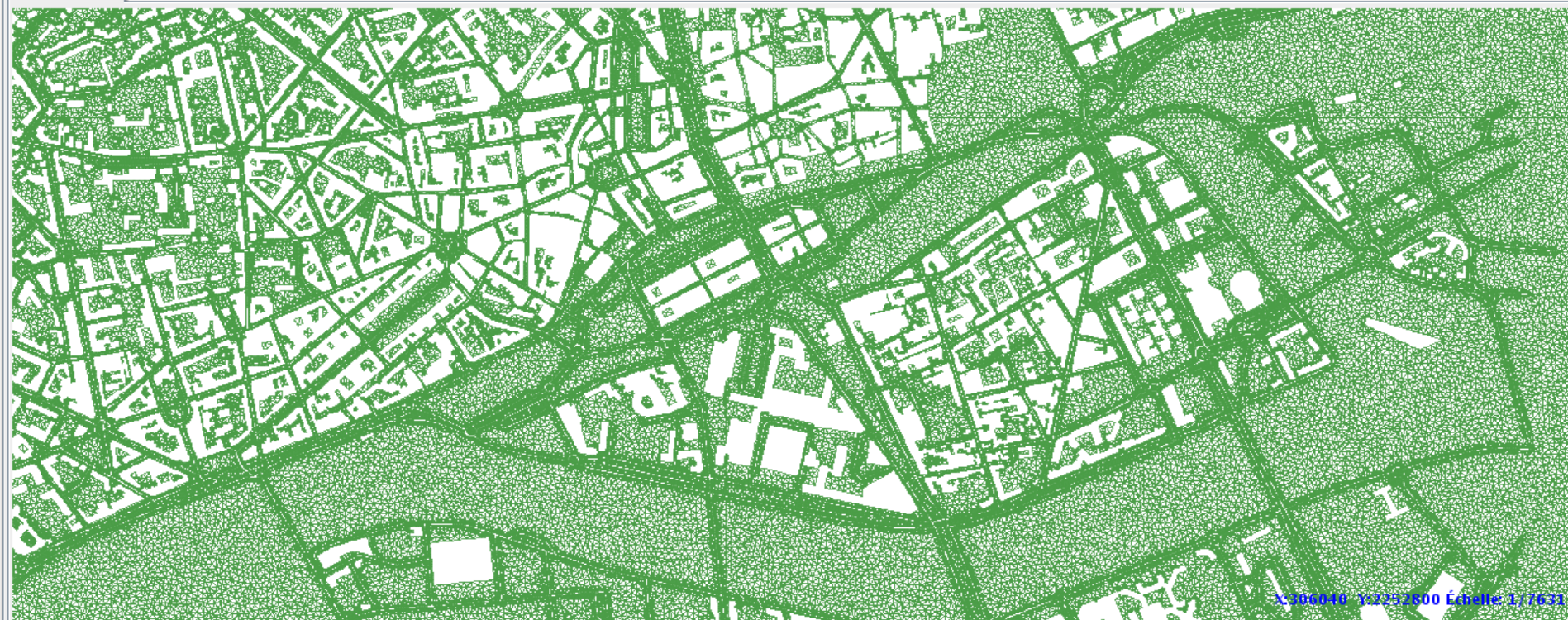
Below the dropdown, it indicates "Nombre de fonctions = 157".





Editors

*Carte0



X:300040 Y:3292800 Échelle: 1/7633

Console SQL



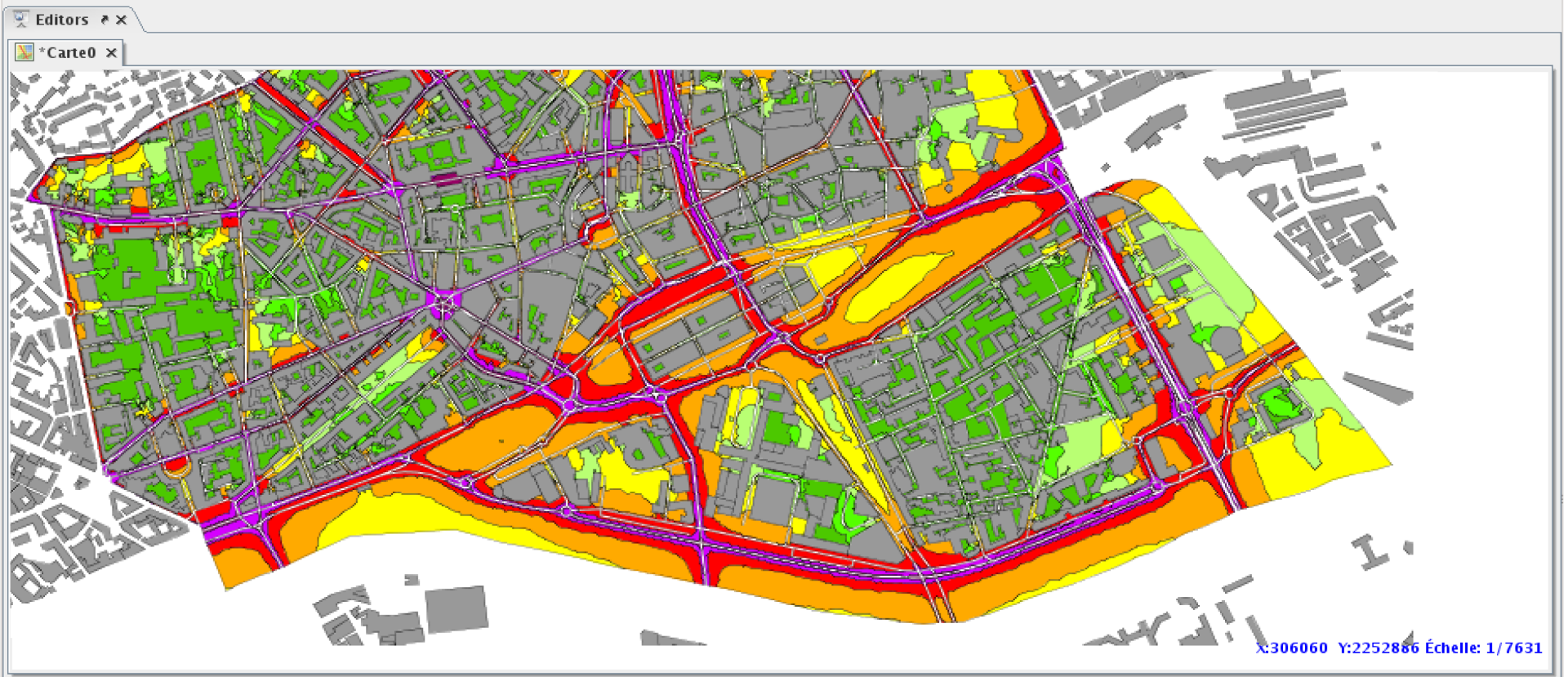
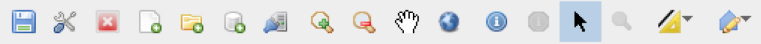
```
1 create table tri_tv1 as SELECT * from BR_TriGrid(buildings,roads_src,'db_m',750,50,0,1.5,2.8,75,2,1,0.23);
```

BR_

- BR_EVALSOURCE
- BR_PTGRID
- BR_SPECTRUMREPARTITION
- BR_TRIGRID

Nombre de fonctions = 157

1 | 106 |



Console SQL

```
1 create table tricontouring_noise_map AS SELECT * from ST_TriangleContouring(tri_lv1,'the_geom','db_v1','db_v2','db_v3');
```

ringn

ST_TRIANGLECONTOURINGNOISEMAP

Nombre de fonctions = 157

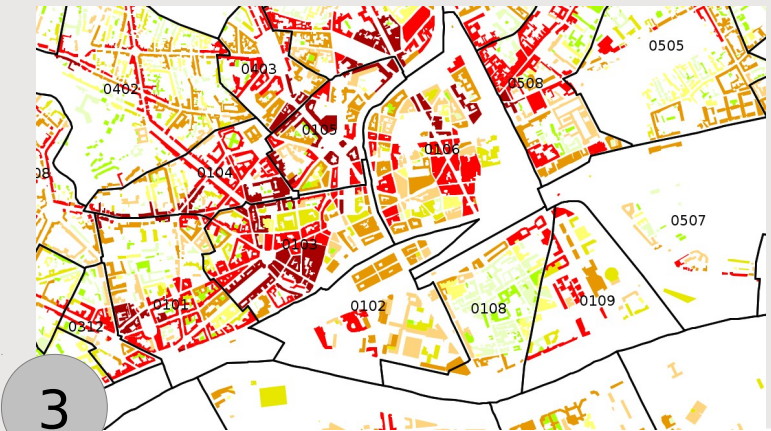
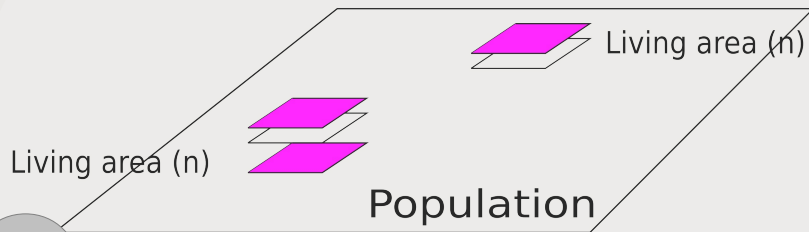
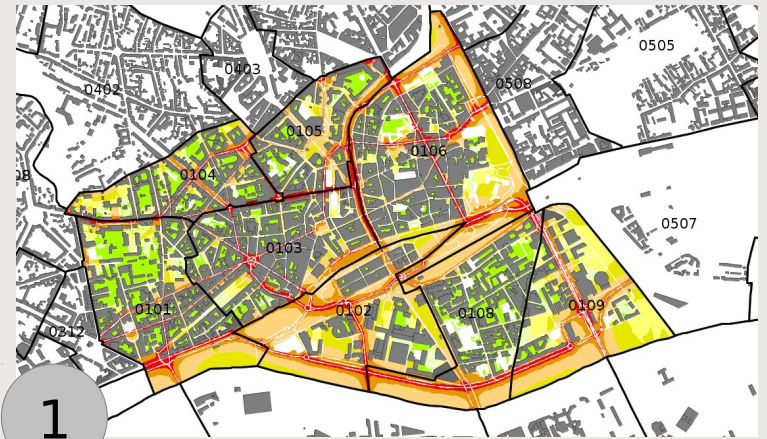
Application

Study of Nantes urban mobility plans scenarios

- Methodology:
 - Calculation of the maximum sound level on frontage: IGN topographic data (1)
 - Calculation of urban population data by building: statistical data bank from INSEE IRIS units (2)
 - Calculation of the noise exposure (related to the population) for each building (3)

Application

Study of Nantes urban mobility plans scenarios



Application

Study of Nantes urban mobility plans scenarios

■ Results:

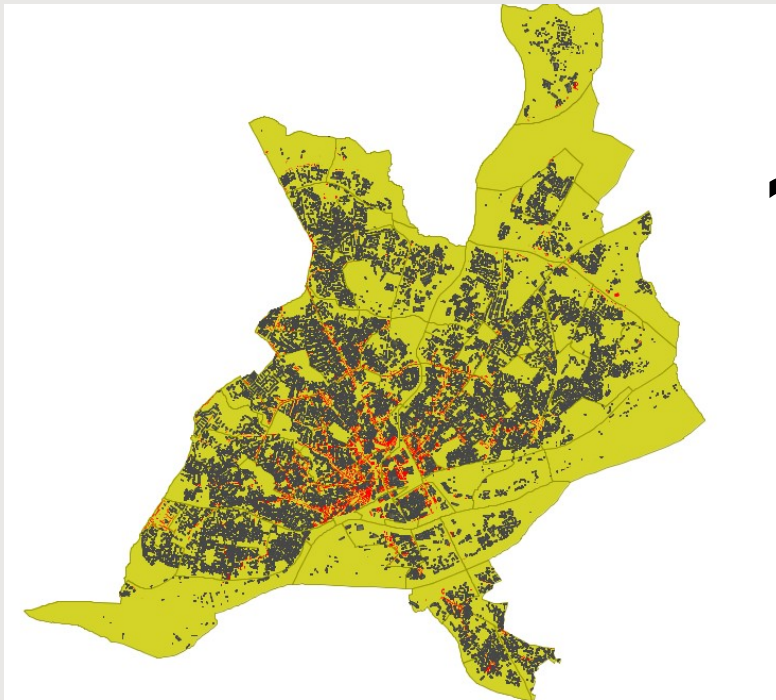
LDEN	2008 base year		Scenario 1		Scenario 2		Scenario 3	
Population	Number	%	Number	%	Number	%	Number	%
< 50 dB	67 180	23.9	69 628	24.8	66 929	23.8	68 996	24.6
50-55 dB	29 071	10.3	28 764	10.2	27 986	10	27 458	9.8
55-60 dB	33 347	11.9	34 636	12.3	33 070	11.8	33 329	11.9
60-65 dB	54 093	19.3	57 052	20.3	51 512	18.3	54 405	19.4
65-70 dB	53 505	19	50 807	18.1	55 640	19.8	53 280	19
65-75 dB	36 243	12.9	33 254	11.8	38 092	13.5	36 017	12.9
>75 dB	7 478	2.6	6 776	2.4	7 688	2.7	7 431	2.6

Nantes population : 280 920 (INSEE 2008)

Application

Study of Nantes urban mobility plans scenarios

- Results : Map of limit values exceeded (>68 dB)



Base year : 64600 hab

?

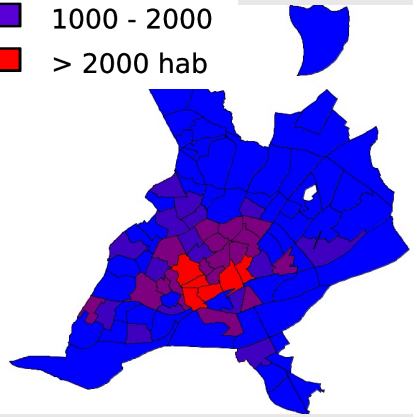
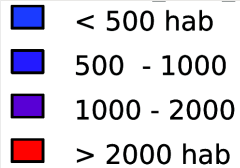


Scenario 3: 64167 hab

Application

Study of Nantes urban mobility plans scenarios

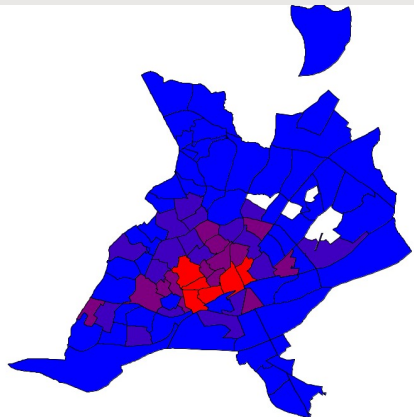
- Results: Map of limit values exceeded by population and reported to the IRIS units (>68 dB)



Base year

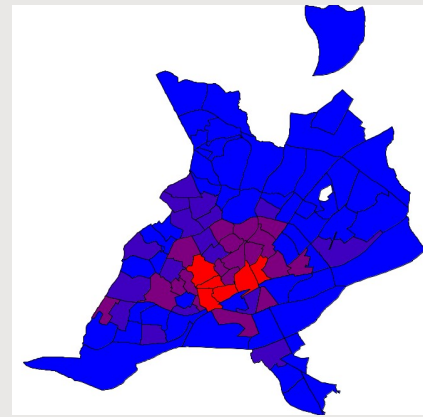
64600

Total population



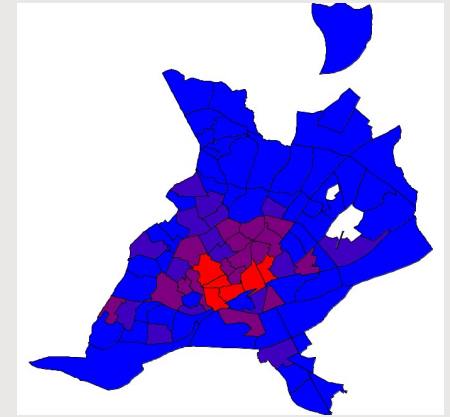
Scenario 1

59396



Scenario 2

67574



Scenario 3

64167

Exercices

- Discovering the OrbisGIS platform,
- How to create a noise map,
- How to investigate the noise map,
- How to compute local sound pressures.



Discovering OrbisGIS

- Download sample data
<http://www.orbisgis.org/download/>

The screenshot displays the OrbisGIS version 4.0 La Rochelle FR interface. The main window is titled "landcover2000 - 1/1 235". The interface includes a "Toc" (Table of Contents) on the left, a "GeoCatalogue" at the bottom left, and a "Map Editor 'MaCarte' [Modifié]" in the center. The data table in the top right shows the following information:

	the_geom	type	runoff_win	runoff_sum	gid
1	MULTIPOLYGON (((184856.7031...	grassland	0,05	0,05	1
2	MULTIPOLYGON (((185098.6718...	forest	0,05	0,05	2
3	MULTIPOLYGON (((184661.6406...	grassland	0,05	0,05	3
4	MULTIPOLYGON (((185231.3593...	humid zone	0,05	0,05	4
5	MULTIPOLYGON (((185248.7187...	humid zone	0,05	0,05	5
6	MULTIPOLYGON (((185250.9687...	cereals	0,2	0,2	6
7	MULTIPOLYGON (((185440.0156...	cereals	0,2	0,2	7

The map editor shows a map of a region with a network of blue lines (roads) and green areas (land cover). The status bar at the bottom right indicates coordinates X:183957.747 Y:2429517.65, Projection: Unknown CRS, and Échelle: 1:44 851.

Discovering OrbisGIS



- Data Definition Language
 - create tables : CREATE TABLE
 - modify tables: ALTER TABLE
 - remove tables: DROP TABLE



- Data manipulation language
 - update records : UPDATE
 - insertion of records (lines) : INSERT
 - remove lines: DELETE



- Query Language
 - SELECT FROM WHERE



Discovering OrbisGIS

- Select all features where the type is grassland

```
SELECT * FROM landcover2000 WHERE type='grassland';
```

Discovering OrbisGIS

- Select all features where the area is greater than 2 ha ?

```
SELECT * FROM landcover2000 WHERE  
ST_AREA(the_geom)>20000;
```


Discovering OrbisGIS

- Sum all areas according the landcover type ?

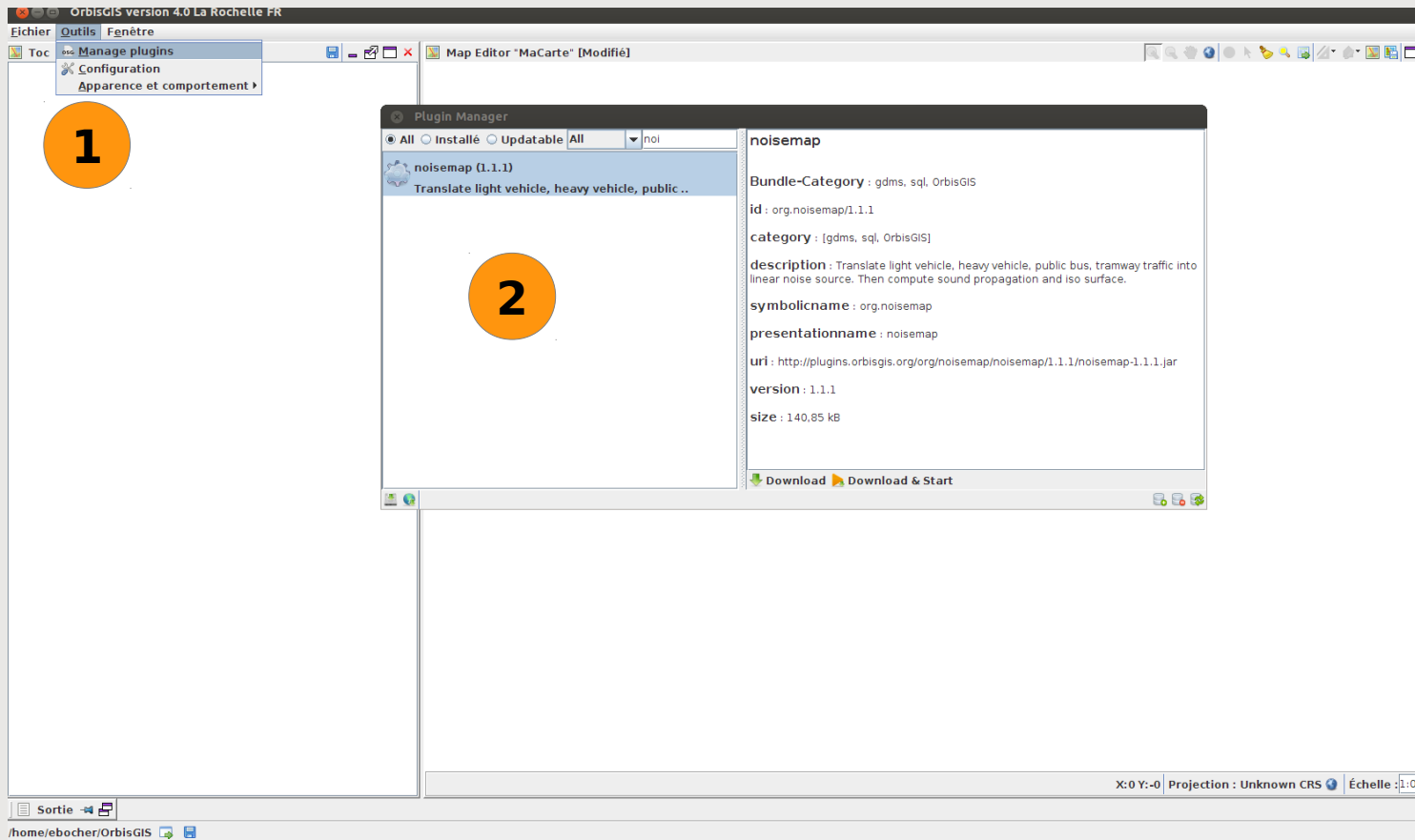
```
SELECT SUM(ST_Area(the_geom)) as total  
FROM landcover2000  
GROUP BY type;
```

Discovering OrbisGIS

- Compute the total length of hedgerows that are contained in a sub-watershed ?

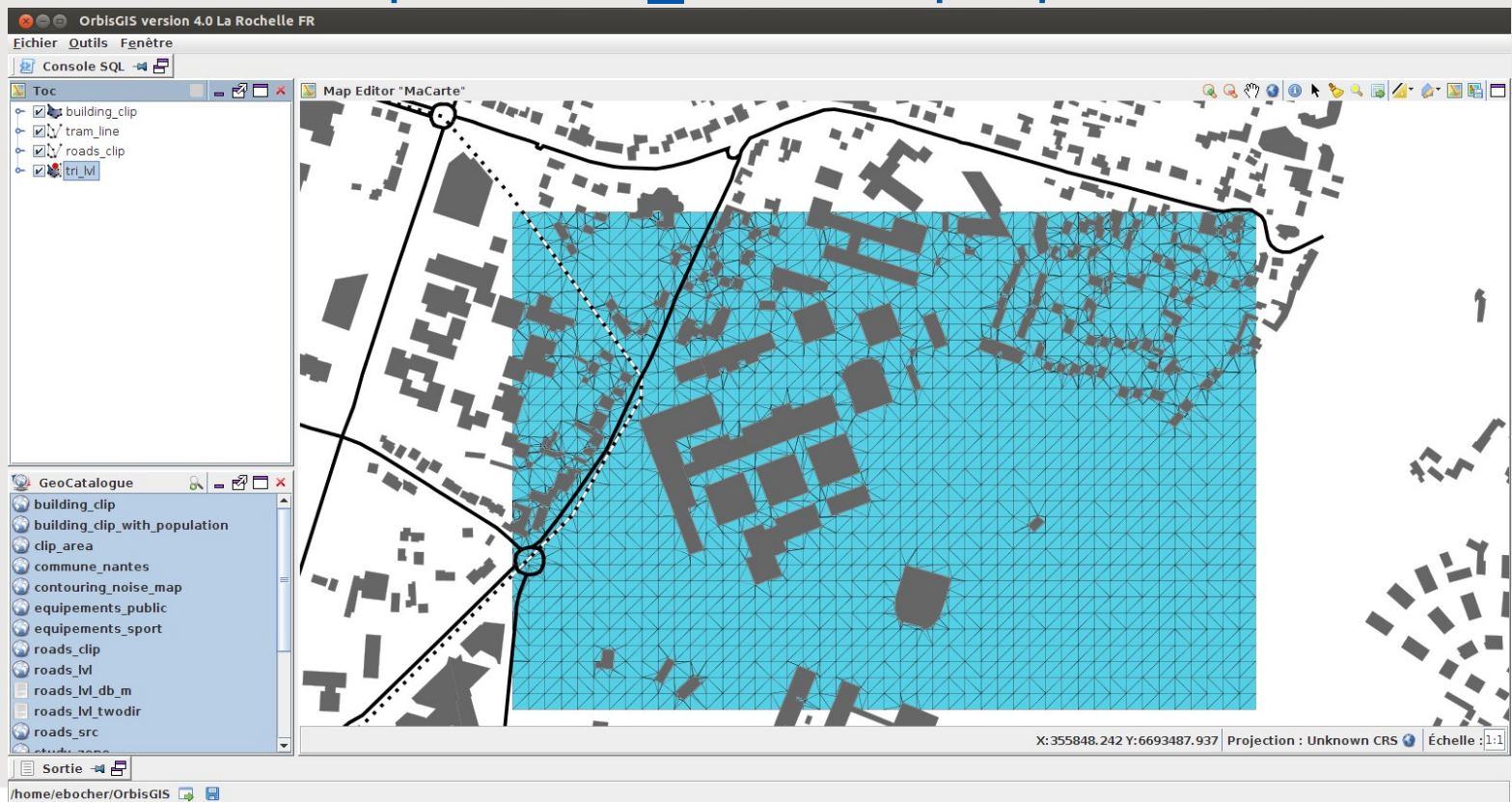
```
SELECT SUM(ST_LENGTH(a.the_geom)) as total,  
        b.gid  
FROM hedgerow As a, subwatershed As b  
WHERE ST_Contains(a.the_geom, b.the_geom);
```

Noise map plugin (install)



How to create a noise map

- Check that the two layers roads_clip and building_clip are loaded in the GeoCatalog
- Open the SQL script “create_noisemap.sql”



How to investigate the noise map

- Create a contouring map,
- Load the population data and build statistics.

Compute the number of inhabitants by iso-surfaces.



How to compute local sound pressures

- Open the SQL script “create_localsoundpressures.sql”



Conclusion

- New alternative to classical tools in order to produce noise maps using only Open Source software,
- Reduce manipulation time and computation time

Prospects

- From 2D to 2D^{1/2}: vertical diffraction and topography
- More documentation and tutorials
- Information to French collectivities



Thank you for your attention

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Judicaël Picaut (Ifsttar):

Judicael.Picaut@ifsttar.fr

More information about OrbisGIS:

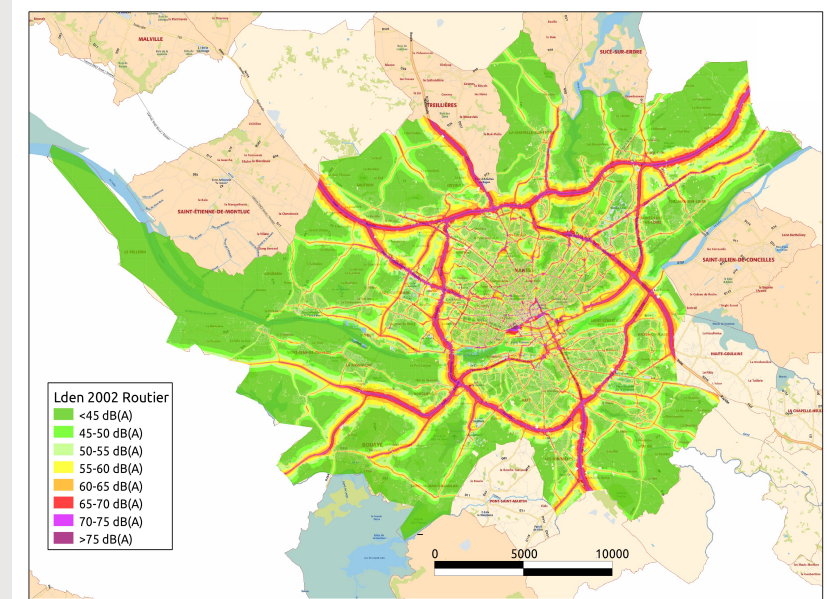
<http://www.orbisgis.org>

Sources:

<http://github.com/irstv/noisemap>

Acknowledgements:

Authors wish to thank the French National Research Agency for providing financial support (Project ANR-08-VILL-005)





<http://www.orbisgis.org>



CartoPOLIS

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<http://www.cartopolis.org>

