



Web mapping solutions for the development of Emission Inventory Models

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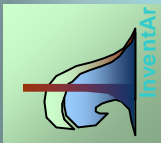
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EPA's 17th Annual International Emission Inventory Conference
Portland, Oregon, USA

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Overview

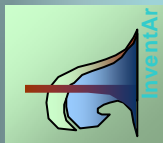
- Case Study overview: Air Quality in Lisbon
- Objectives of the Project
- SIMULAIR description
 - Principles
 - Interface
 - Implementation details
- Conclusions



Case Study:

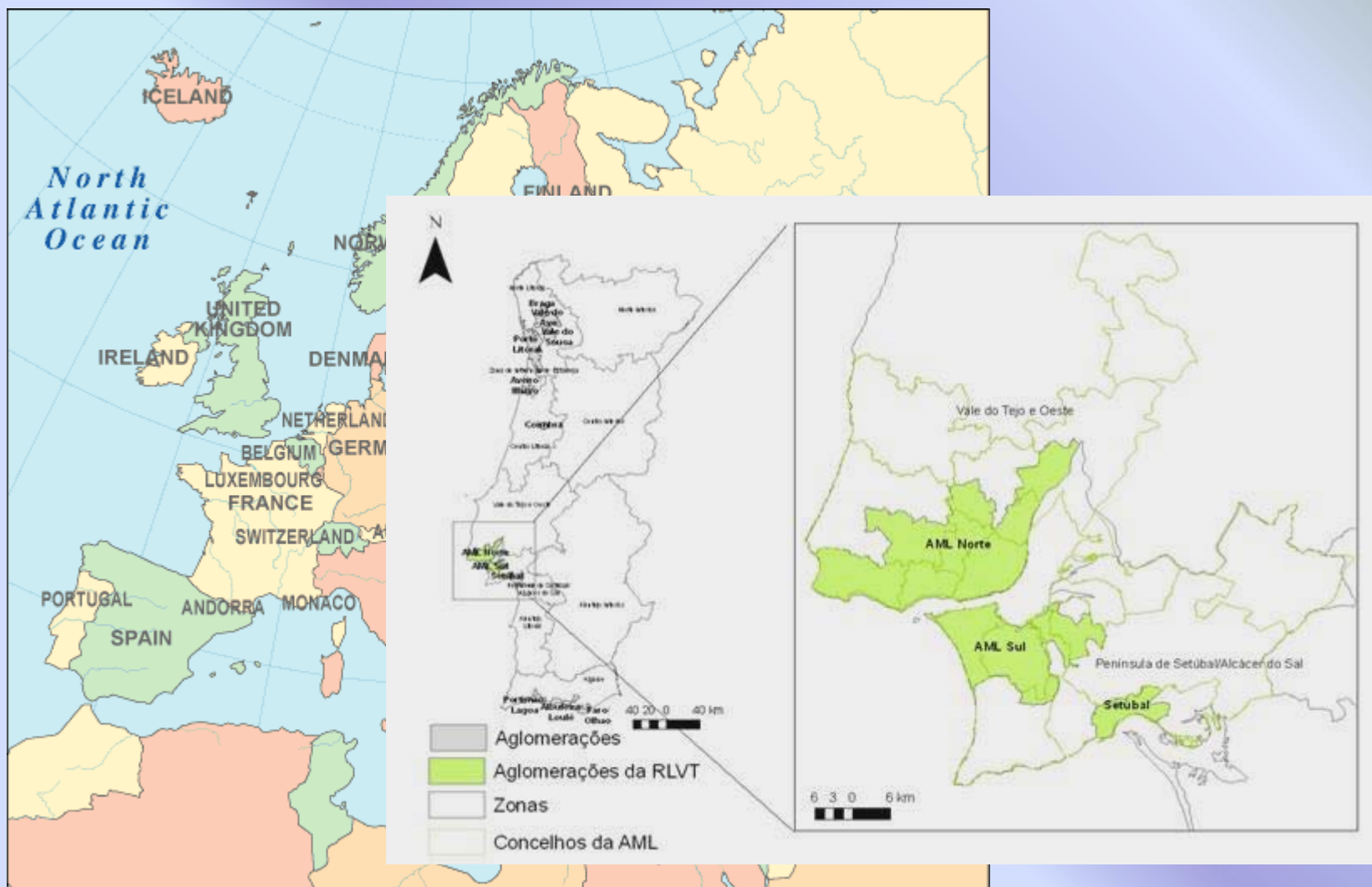
Air Emission Inventory of the Region of Lisbon and Tagus Valley

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Zones and Agglomerations for Air Quality Management





Air Quality Management in Lisbon

Air Quality Authority

Commission for Coordination and Regional Development of
Lisbon and Tagus Valley (CCDR-LVT)

Tools

1. Monitoring survey system

- Stationary stations
- Extensive monitoring: period campaigns using Passive sampling (Diffusion tubes and portable PM samplers)

2. Inventory of Emissions of Air Pollutants

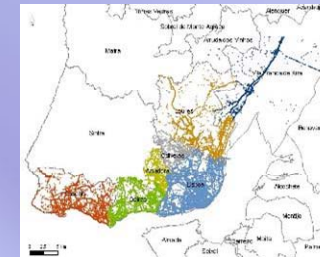
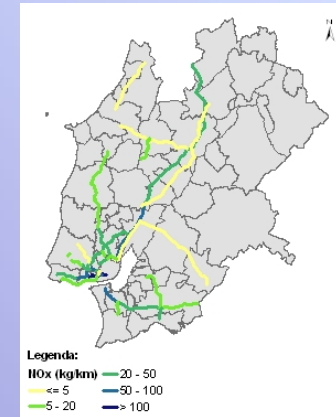
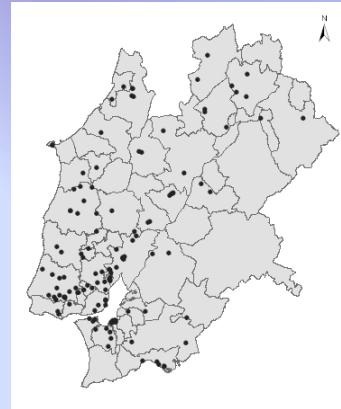
3. Policies and Measures

- Plans and Programs (June, 2005, updating now)

4. Modelling tools

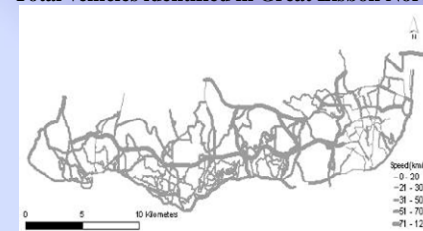
- Regional level (TAPM from CSIRO)
- National/European level (Chimere, CAMx, REM-3 under CAFE program)

Emission Inventory Overview of Methodology



Identification of moving vehicles from aerial photography

Total vehicles identified in Great Lisbon North



Average velocity determination using GPS

Classes of average velocities in main roads (km/hr)

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Plans and Programs

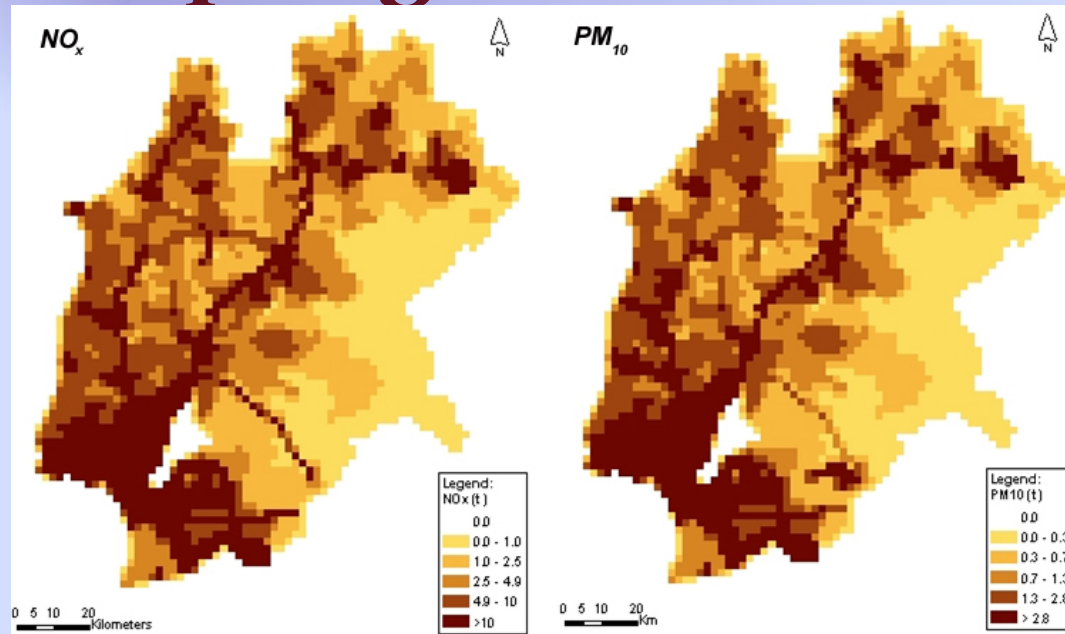
Directive 1999/30/CE of the European Union (UE)

Reduction Measure		Total PM10 reduction (t/yr)	Cost-Benefit	Relative ranking
M20a	Increase of the number of BUS corridors	2	5	1
M19	Implementation of differentiated payment schemes according to the occupation of vehicles on existing toll roads	8	1	2
M16	Implementation of Lanes of High Occupancy on Lisbon major roadways	7	3	3
M13a	Incentive to retrofiting of buses	4	8	4
M9	Parking regulations enforcement increase	3	10	5
M8	Introduction of alternate license plates	12	1	6
M6a	Retrofit plan for Buses	6	9	7
M18a	Retrofit plan for taxis	11	4	8
M17a	Taxi fleet renewal	5	12	9
M14a	Buses renewal	1	15	10
M7	Installation of particle filters systems in buses	13	7	11
M10	Introduction of a Low Emission Zones in the city of Lisbon	14	6	12
M11a	Conversion of TCR vehicles to LPG	9	13	13
M11a	Conversion of TCR vehicles to LNG	10	14	14
M15a	Retrofit of vehicles for solid waste collection	15	11	15
M12	Circulation tax in downtown areas	16	1	16



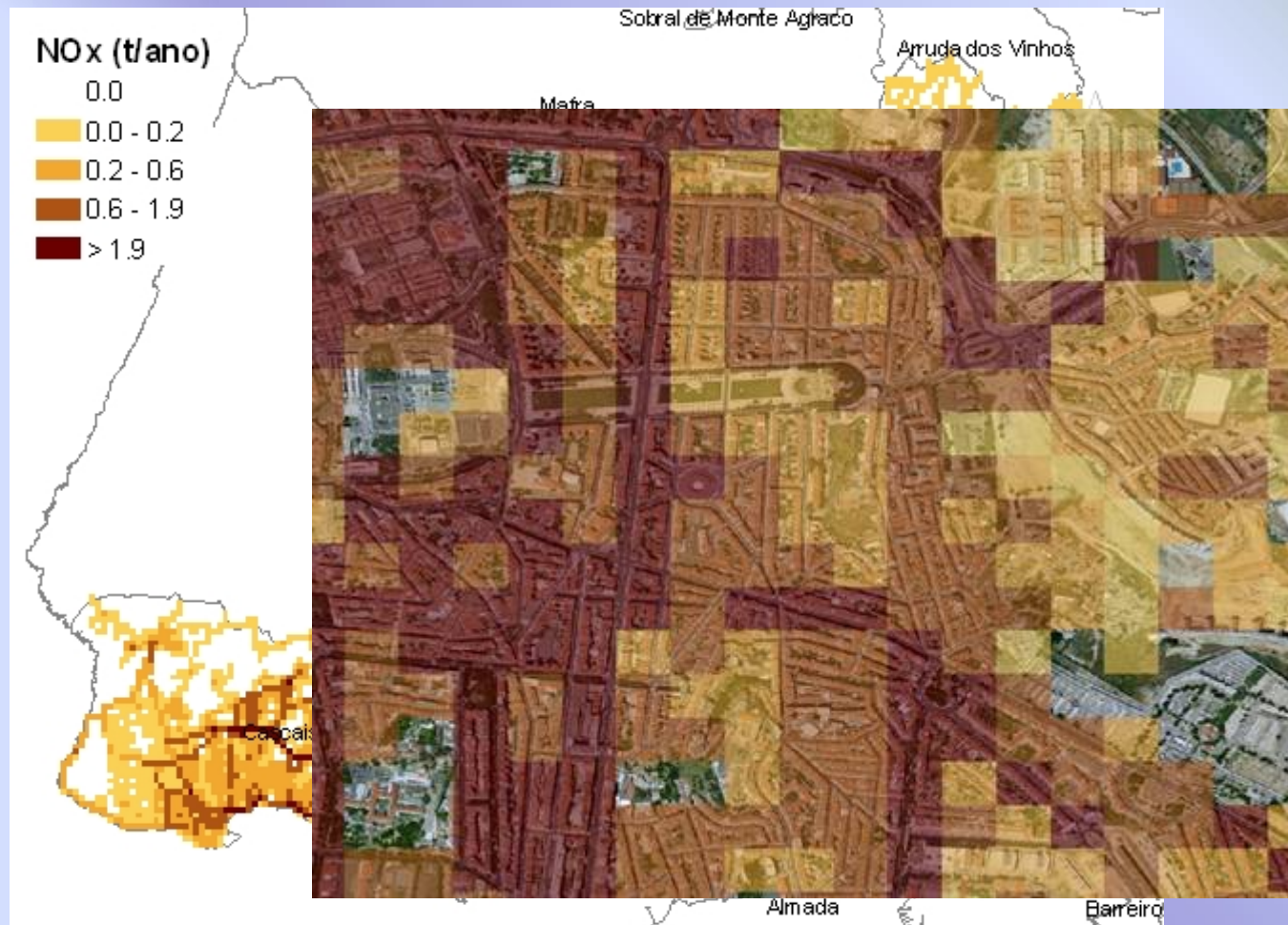
TAPM

Input grid to model



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Level of Detail of Model Results

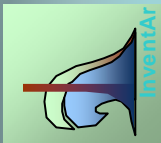




Inventory Model

Principles and Objectives of the System

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Principles of System Development

- The inventory should not be an end in itself
 - Should be a steward to models and policy developers
- Importance of the spatial placement of measures
 - Policy experts want to act on real objects
 - Need of a GIS system, but simplified
- An image of the Inventory
 - Simplification of the information provided to policy developers
 - Only an image of the inventory is sufficient
 - Focus on key variables (policy team's view)
- A pathway facilitating team communication and joint work
 - Should integrate/facilitate work of teams in different places

Enhancement of Team Work

263	3.5	0.45	0.6
23	4	-0.13	4.54
3	32	34.8	34.2
23	2.2	-0.15	34



Emission Inventory

$$\frac{\partial \eta}{\partial t} + \frac{\partial(\eta u)}{\partial x} + \frac{\partial(\eta v)}{\partial y} = 0$$

$$\frac{\partial(\eta u)}{\partial t} + \frac{\partial}{\partial x} \left(\eta u^2 + \frac{1}{2} g \eta^2 \right) + \frac{\partial(\eta u v)}{\partial y} = 0$$

$$\frac{\partial(\eta v)}{\partial t} + \frac{\partial(\eta u v)}{\partial x} + \frac{\partial}{\partial y} \left(\eta v^2 + \frac{1}{2} g \eta^2 \right) = 0.$$



Air Quality Model



Policy Development

3 – List of Measures
4 – Inventory Scenario

1 – Request of Measures
2 – List of Measures

5 – Request Simulation
6 – Model Results using Scenario



Air Quality Authority

Enhancement of Team Work

263	3.5	0.45	0.6
23	4	-0.13	4.54
3	32	34.8	34.2
23	2.2	-0.15	34



Emission Inventory

1- Inventory Simplification

Inventory Image

4- Export Scenario

5- Model Results

3- List of Measures



Policy Development

2- Request of Measures



Air Quality Authority

$$\frac{\partial \eta}{\partial t} + \frac{\partial(\eta u)}{\partial x} + \frac{\partial(\eta v)}{\partial y} = 0$$

$$\frac{\partial(\eta u)}{\partial t} + \frac{\partial}{\partial x} \left(\eta u^2 + \frac{1}{2} \eta v^2 \right) + \frac{\partial(\eta u v)}{\partial y} = 0$$

$$\frac{\partial(\eta v)}{\partial t} + \frac{\partial(\eta u v)}{\partial x} + \frac{\partial}{\partial y} \left(\eta v^2 + \frac{1}{2} \eta u^2 \right) = 0$$

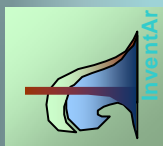


Air Quality Model



The system should be:

- Easy to use
- Fast to navigate
- No ambiguous commands
- Intuitive to Learn
- Attractive
- Focusing on spatial objects
- Handle single objects or groups
- Low cost (Open source)
- Work at distance





The mirror image from the inventory

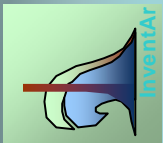
Source	Manipulable data	Notes
Point Sources	ID, Name and Activity code (EAC code)	The number of Large Point Source data is larger than the large point sources used as input to TAPM. Every individual unit may include more than one stack. The relation between flow variables in the stack is automatically updated by the system.
	Coordinates	
	Stack parameters: H, D, V, VF, T	
	Activity Data	
	Emission Factors	
Line sources	Emissions	Each road is made of several sub-link segments, according to changes in flow, velocity or traffic composition. User may change the fleet in absolute terms or per cent, SIMULAIR checking for 100 per cent. EF for each individual vehicle type is automatically estimated from velocity and average vehicle fleet. Velocity may vary according to vehicle type
	ID, road name and sub-link ID	
	Coordinates	
	Total Vehicle flow	
	Composition of fleet: Heavy Vehicles, Passenger Cars, Light Duty Vehicles, 2 wheelers	
	Velocity	
Area sources	EF per pollutant and vehicle type	Area boundaries are administrative boundaries and cannot be changed by the user.
	ID, Name and Activity code (EAC code)	
	Activity Data	
	Emission Factors	
	Emissions	



SIMULAIR

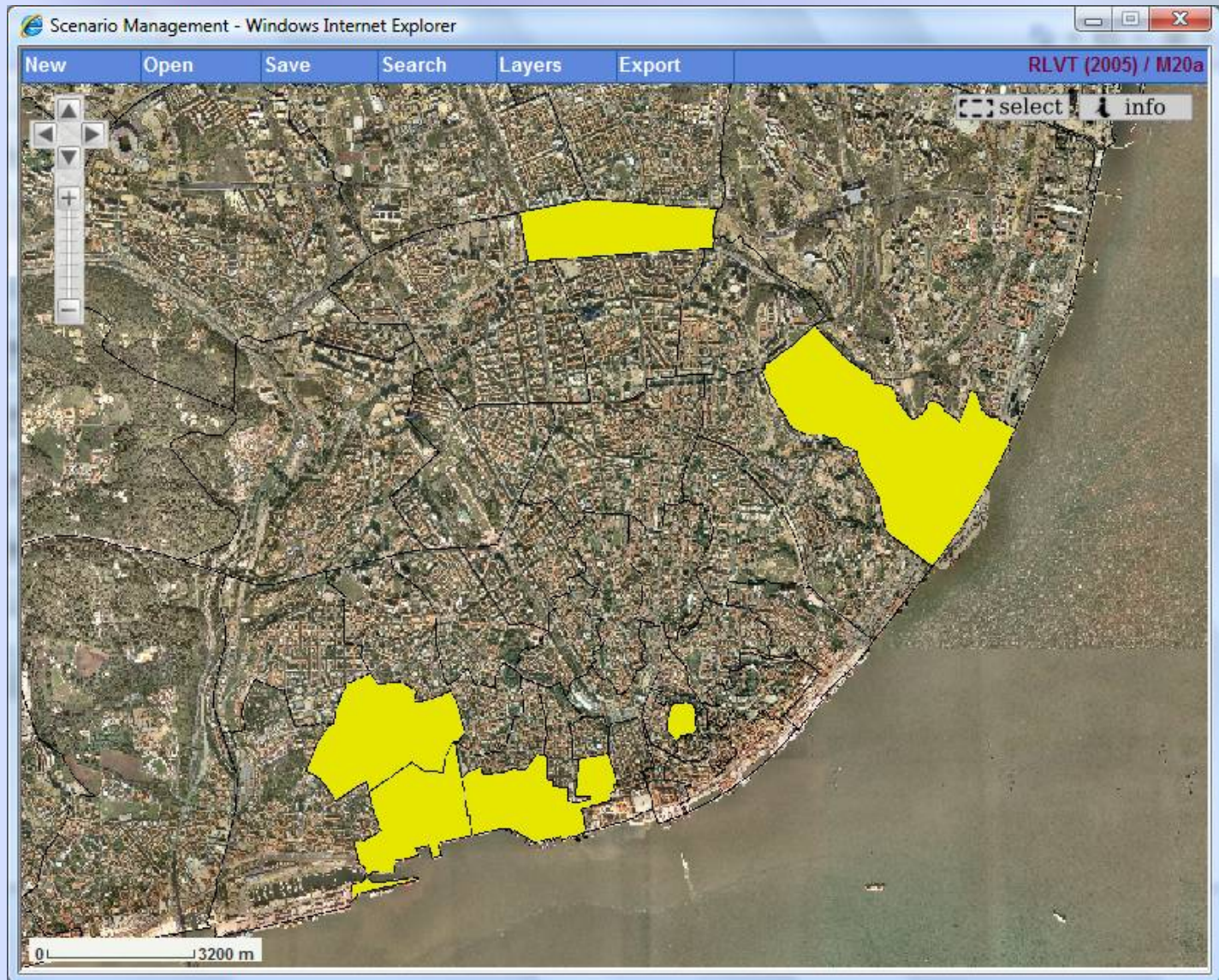
Development of the Interface

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Spatial Environment






Case Definition: Inventory x Scenario




SIMULAIR - Windows Internet Explorer

Inventory Management

Available Inventories

- Norte
- Centro
- [RLVT \(2005\)](#)
- Alentejo
- Algarve

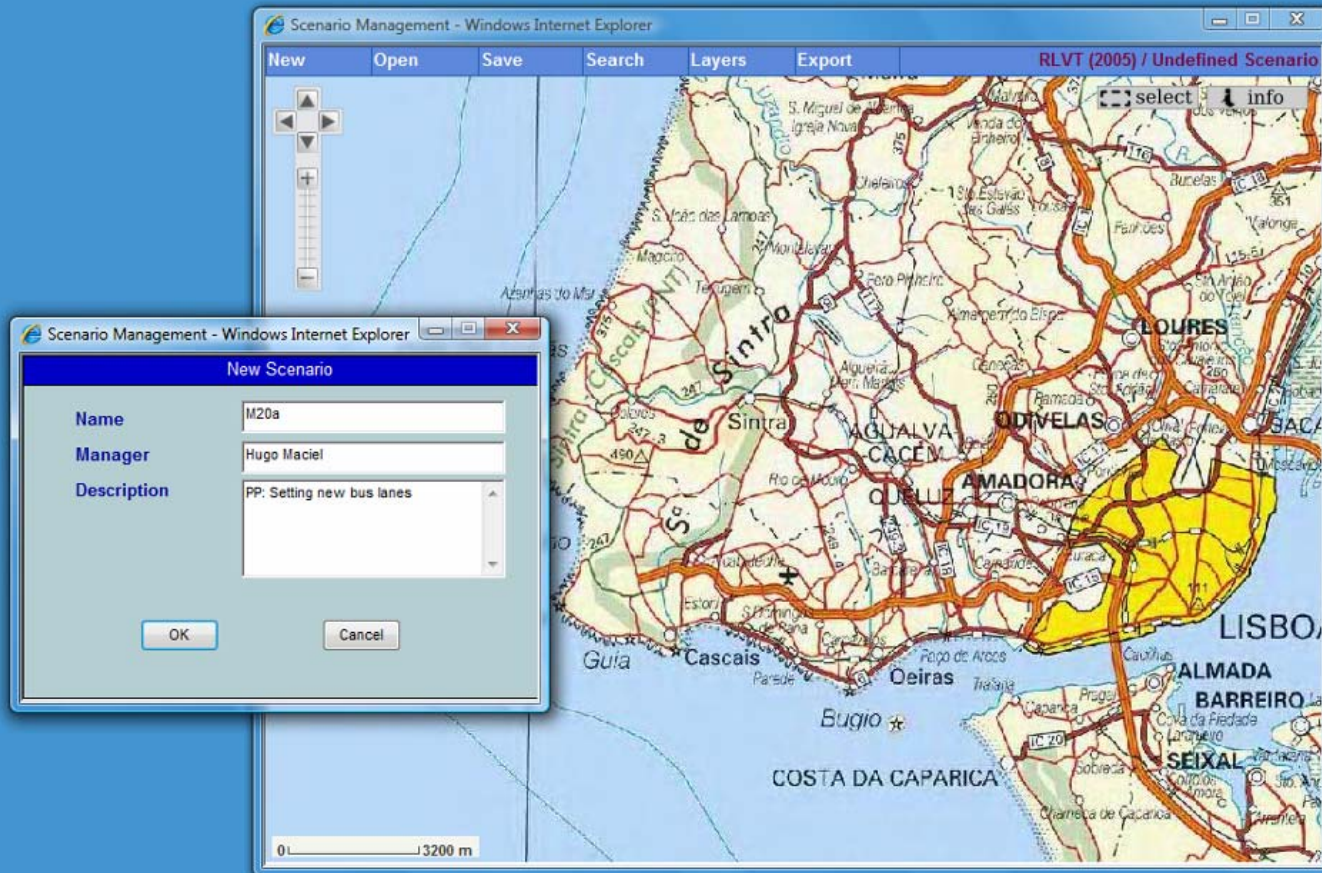


[About](#)



Case Definition: Inventory x Scenario



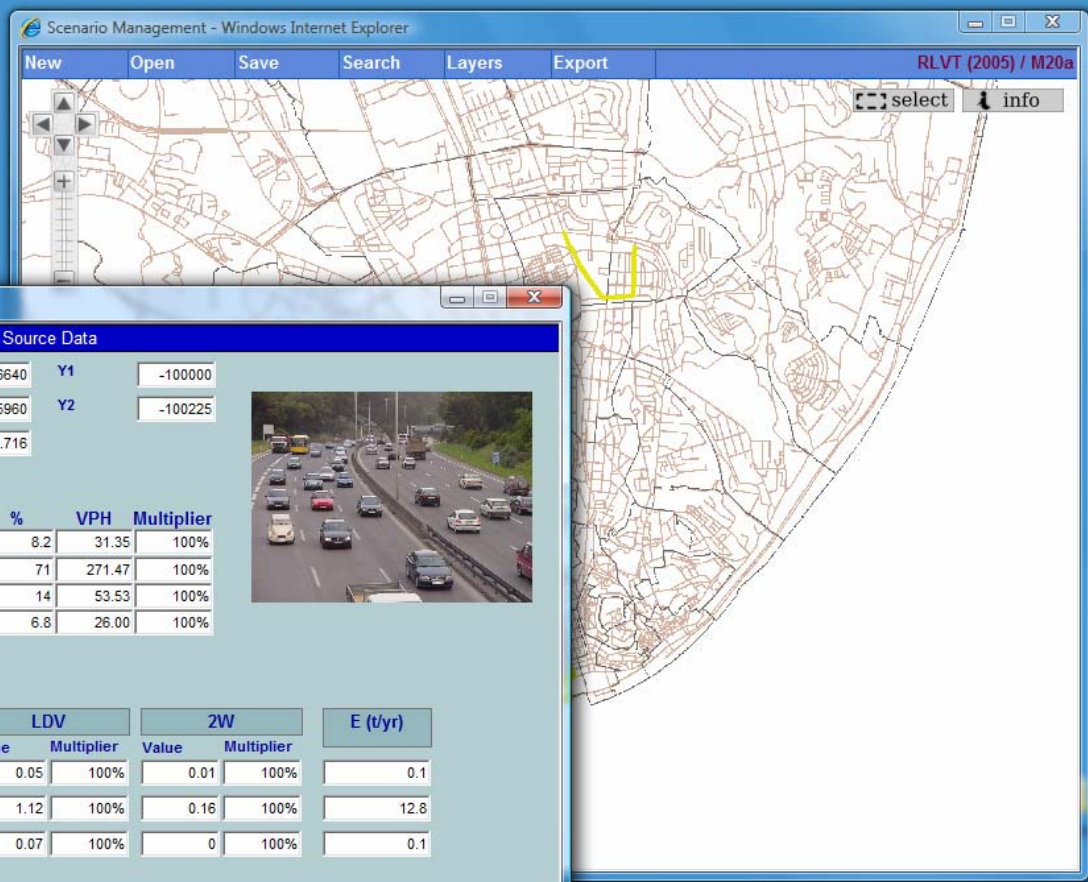
Case Definition: Inventory x Scenario

The screenshot displays the 'Scenario Management - Windows Internet Explorer' application. The main window shows a map of the Lisbon region, including areas like Sintra, Loures, Amadora, and Odivelas. A yellow shaded area is visible on the map. An 'Open Scenario' dialog box is open in the foreground, showing a table of scenarios.

Name	Manager	Created	Last Update
M4	L. Nogueira	11.04.2008	17.04.2008
M8	L. Nogueira	16.04.2008	17.04.2008
M10	C. Almeida	24.04.2008	28.04.2008
M11b	L. Nogueira	24.04.2008	29.04.2008
M20a	Hugo Maciel	13.05.2008	13.05.2008

Cancel


Multipliers



Info Tool - Windows Internet Explorer

Line Source Data

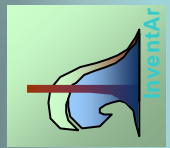
ID: 4016 X1: -86640 Y1: -100000
 Name: Av. Marechal Gomes da Costa X2: -85960 Y2: -100225
 Segment: 3 Length (km): 0.716



	Vel (km/h)	%	VPH	Multiplier
HV	24.5	8.2	31.35	100%
PC	24.5	71	271.47	100%
LDV	24.5	14	53.53	100%
2W	24.5	6.8	26.00	100%

EF (g/km)	HV Value	HV Multiplier	PC Value	PC Multiplier	LDV Value	LDV Multiplier	2W Value	2W Multiplier	E (t/yr)
SOx	0.19	100%	0.03	100%	0.05	100%	0.01	100%	0.1
NOx	5.35	100%	0.1	100%	1.12	100%	0.16	100%	12.8
PM10	0.18	100%	0	100%	0.07	100%	0	100%	0.1

OK Cancel



Multipliers

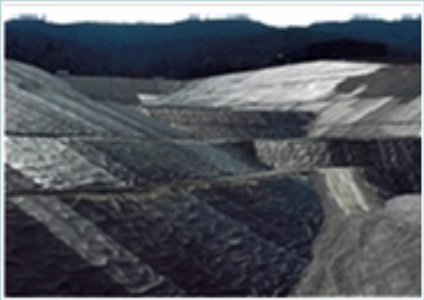
Info Tool - Windows Internet Explorer

Area Source Data

ID:

Name:

EAC:



AD				EF			E (t/yr)
	Value	Unit	Multiplier	Value	Unit	Multiplier	Value
SOx	<input type="text" value="45"/>	ha	<input type="text" value="100%"/>	<input type="text" value="0"/>	kg/ha	<input type="text" value="100%"/>	<input type="text" value="0"/>
NOx	<input type="text" value="45"/>	ha	<input type="text" value="100%"/>	<input type="text" value="0"/>	kg/ha	<input type="text" value="100%"/>	<input type="text" value="0"/>
PM10	<input type="text" value="45"/>	ha	<input type="text" value="100%"/>	<input type="text" value="12"/>	kg/ha	<input type="text" value="100%"/>	<input type="text" value="0.54"/>

Working with groups

The screenshot displays a Windows desktop environment with two overlapping Internet Explorer windows. The background window, titled 'Scenario Management - Windows Internet Explorer', shows a map of a region with several yellow and orange dots representing point sources. The foreground window, titled 'Info Tool - Windows Internet Explorer', is a 'Point Source Data' dialog box. It contains a grid of input fields for various parameters and a small image of an industrial facility.

Point Source Data

ID	23	H (m)	30		
Name	confidential	D (cm)	80		
EAC	15960	Qv (Nm3/h)	6000		
X	-150 250	V (m/s)	7.1		
Y	-255 500	T (°C)	280		

AD

	Value	Unit	Multiplier
SOx	139 525	t Beer	100%
NOx	139 525	t Beer	100%
PM10	139 525	t Beer	100%

EF

	Value	Unit	Multiplier
	0.27	kg / t Beer	100%
	0.28	kg / t Beer	100%
	0.05	kg / t Beer	100%

E (t/yr)

Value
37.67
39.07
6.98

OK Cancel

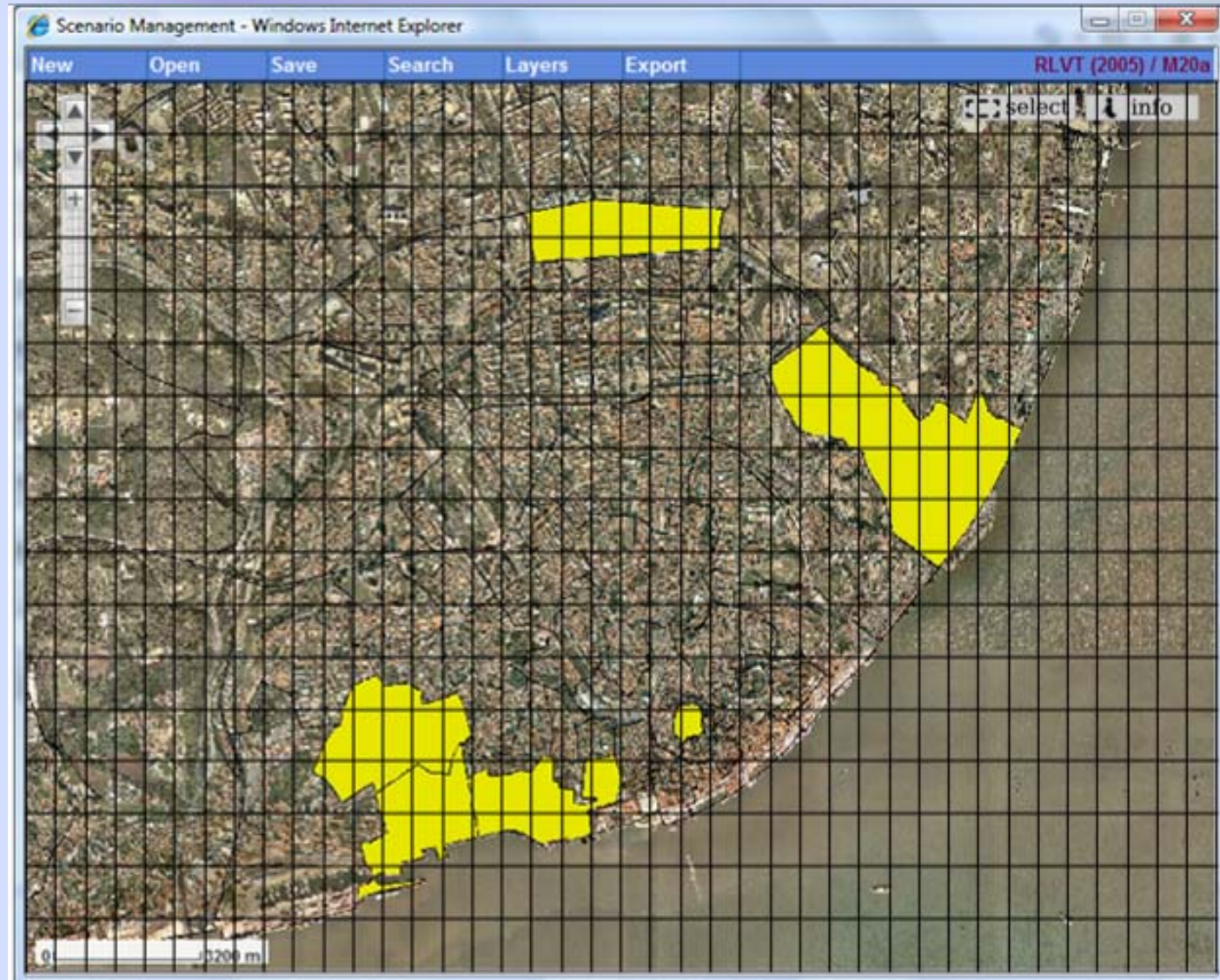
Working with groups

The screenshot displays a web-based interface for Scenario Management. The main window, titled "Scenario Management - Windows Internet Explorer", shows a map of a region with several yellow dots representing point sources. A dialog box titled "Info Tool - Windows Inter..." is open, displaying "Point Source Data" for "Sum E (t/yr)". The dialog box contains a table with the following data:

	Value	Multiplier
SOx	244.87	100%
NOx	253.94	100%
PM10	45.35	100%

The dialog box also includes "OK" and "Cancel" buttons. The background map shows a scale bar for 3200 m and a "Reciclagem" icon on the desktop.

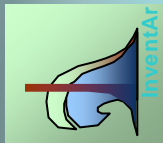
Export to model





SIMULAIR

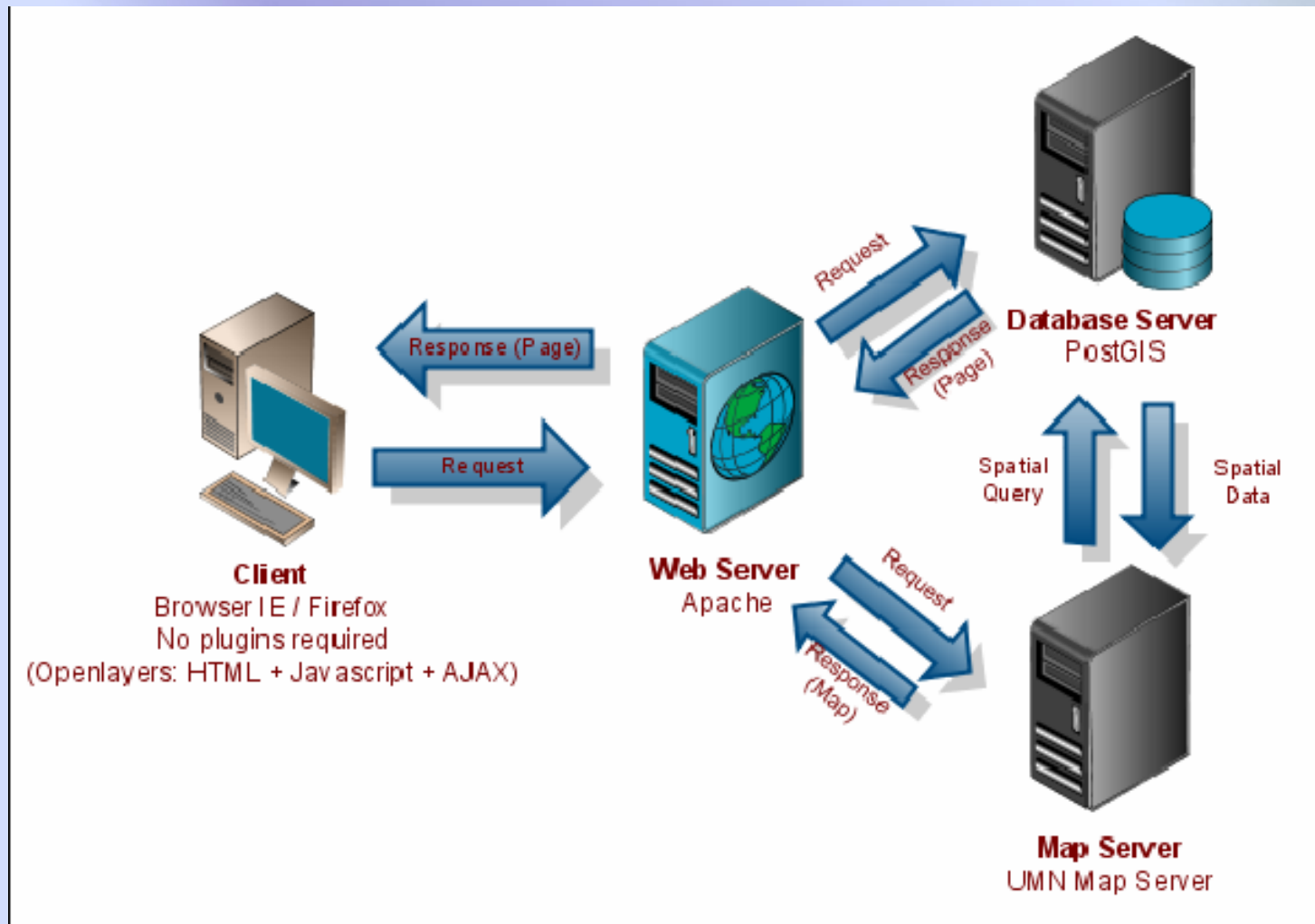
Implementation



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System Architecture



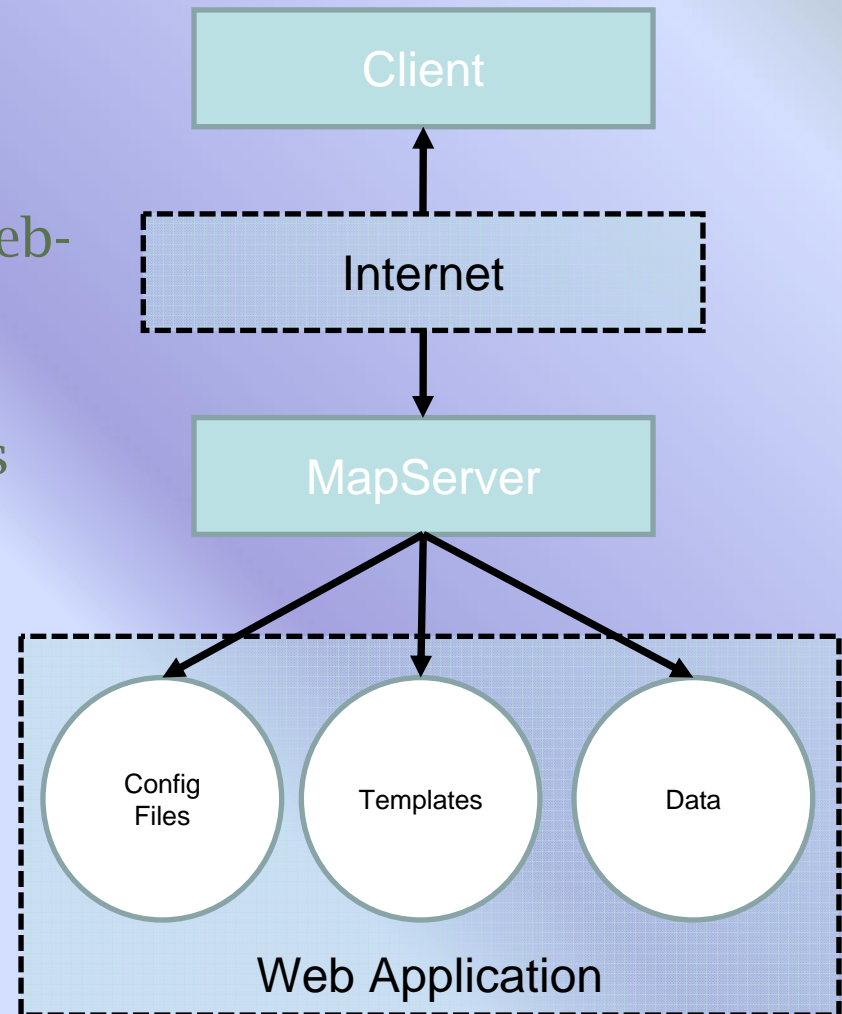


Technological Implementation Details (short summary)

Map Server

- Server-Based
- Development System for Web-Based Mapping
- Open Source
- Supports OGC Web Services Specifications

- Fast
- Extremely Configurable
- Easy-To-Use

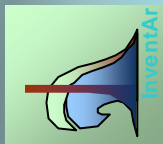




Technological Implementation Details

Open Layers

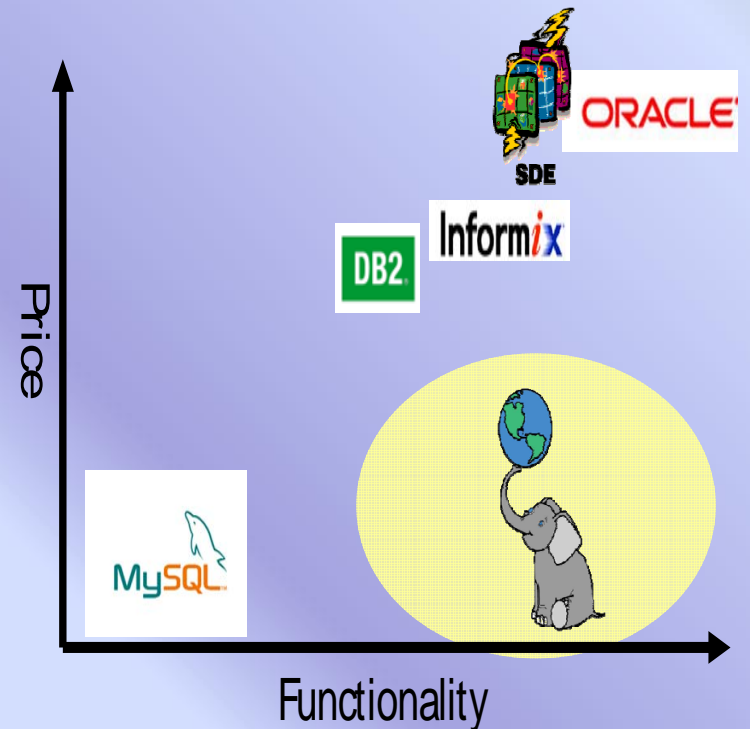
- Pure client-side JavaScript
- Library for web mapping applications
- Supports open standards
- Rapidly construct applications using layers from different providers of geo-referenced data
- AJAX toolkit
 - Asynchronous
 - Updates page components independently



Technological Implementation Details

Post GIS

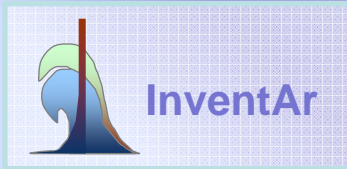
- Open source geospatial extension for PostgreSQL
- PostgreSQL - open source relational database management system (RDBMS)
- Robust and scalable solution to a ever-increasing dataset size.





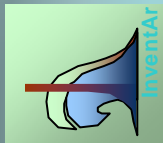
Conclusions

- There were Needs
 - for a tool to facilitate communication of the teams involved in air quality management
 - and to speed work: fast verification of outcomes of proposed measures
- Answer: SIMULAIR
 - SIMULAIR, developed for a pilot region, promotes these objectives
 - SIMULAIR is open source, general, simple, flexible, easy to learn and WWW



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Thank you

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