Air Quality and Urban Planning

Carlos Borrego
CESAM & Department of Environment and Planning,
University of Aveiro, Aveiro, Portugal

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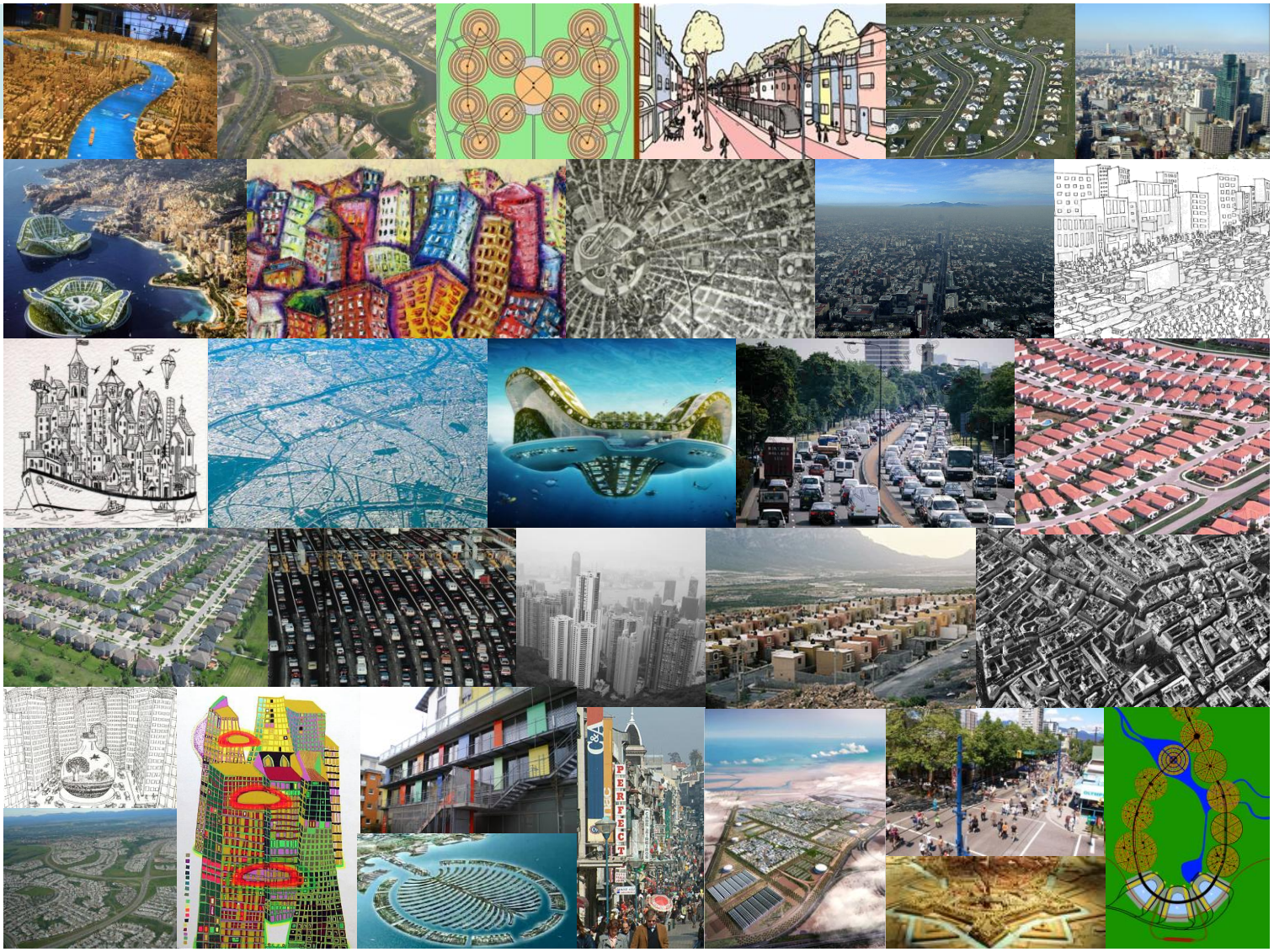

Since always the human being has imagined cities, and planners have devoted their attention, imagination and effort towards the creation of cities that better serve us in economic, social and environmental terms – the sustainable city.

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In Europe around 80% of the population lives in urban areas.

It’s expected that by 2030, around 60% of the world population will live in cities.

In the last years, emissions from motorized vehicles and large point sources have been reduced…

… however, urban areas continue to show increasing signs of environmental stress…

… thus, around 25% of the world population is exposed to excessive concentrations of gaseous and particulate pollutants.

Technology options alone are unlikely to provide the solution…

… what about urban patterns?

Could they influence air quality? What's the more suitable urban form?

Urban structure – actual trend

Urban structure – actual trend

Mexico city

"The sky over Mexico city is still blue, although many have never seen it"

Low-cost habitation complex, over 10 000 houses.

Framework

80% of the European citizens live in cities and towns, many of them characterised by intense road traffic and air pollution

EEA (2007) *Europe's environment – The fourth assessment*.

The official statistics and reports show that the trends on urban sprawl and road transportation have significant effects on human health. Nearly 100.000 deaths occur, each year, in the largest European cities as a consequence of air pollution

WHO (2004) *Health Aspects of Air Pollution Results from the WHO Project "Systematic Review of Health Aspects of Air Pollution in Europe"*.

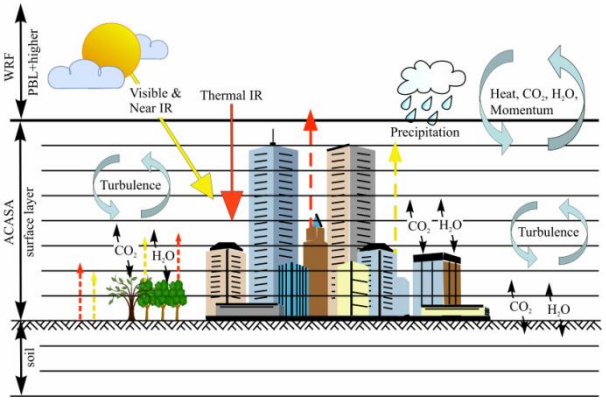
Several studies recognise the importance of urban planning for the improvement of the interactions between different land uses and economic activities, and also towards a more sustainable urban metabolism

Borrego *et al*. (2009) The importance of urban planning on air quality and human health (Chapter 2). *Urban Planning in the 21st Century*, eds. D.S. Graber & K.A. Birmingham, Nova Science Publishers Inc.

BRIDGE study cases description

Selected to improve urban planning:

- air quality
- increase free and green spaces
- urban mobility
- energy efficiency of public and private buildings
- decrease waste production
- management of the quantity and quality of water
- raise awareness on environmental responsibility
- definition of land use plans



- The **baseline situation** is the study cases current situation

- **Planning alternatives** are scenarios based on modifications in the urban structure both at the structural level (new building configurations), the introduction of new road configurations and new traffic patterns.

Focusing on air quality assesment

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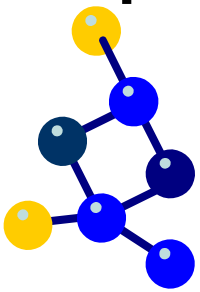
Urban structure vs air quality

emissions

Urban structure

Dispersion and transport

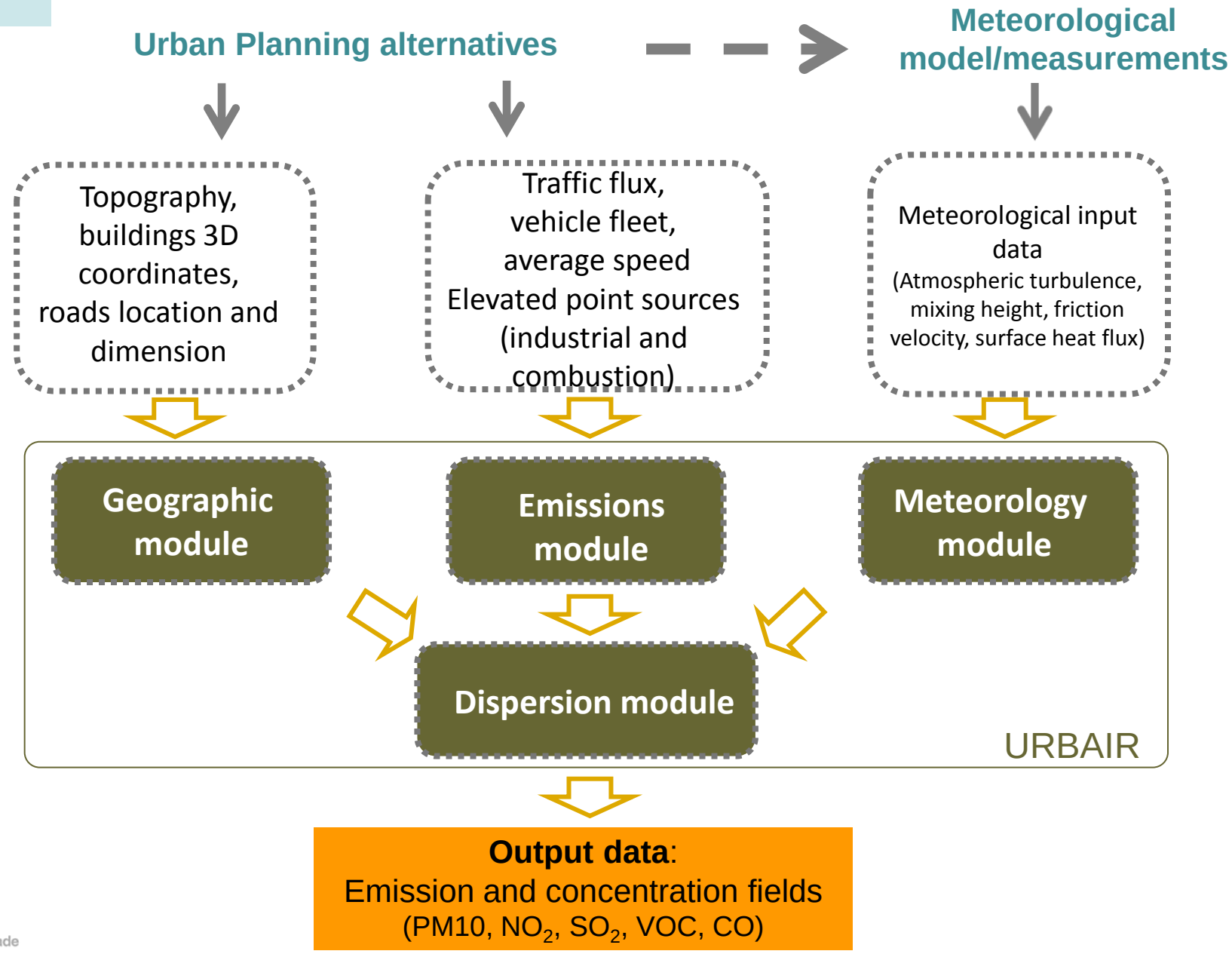


Chemical reactions

Air quality

exposure

Modelling approach



URBAIR system description

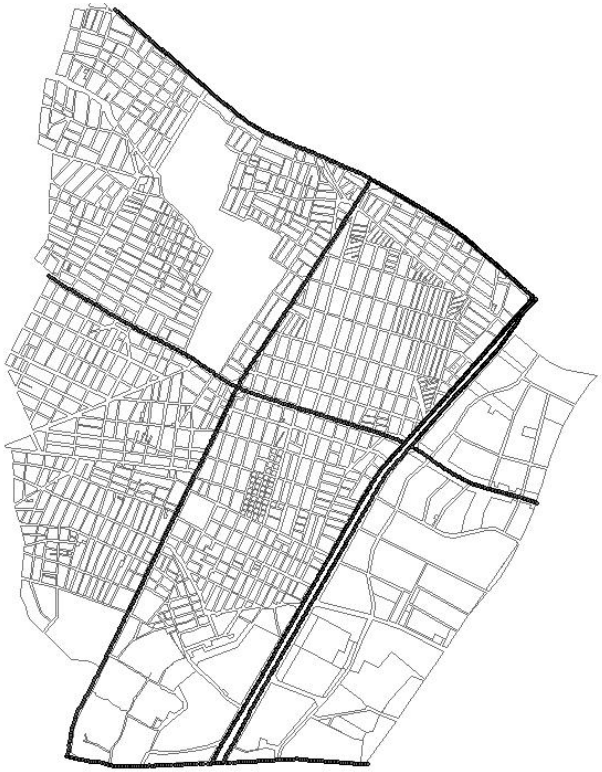
Urban scale modelling

URBAIR second generation Gaussian atmospheric dispersion model

- **on-line** model capable to provide almost real time results to support planning decision at urban level
- developed to be integrated in a GIS platform using ArcGIS maps
- integrates the pre-processing of urban morphology, meteorological data and traffic emissions in a single tool
- Two versions available:
  - 32 bits
  - 64 bits (allows using a higher number of roads)

Study case description – Athens example

Intervention area: Eleonas industrial area (650 ha), in the municipality of Egaleo (western Athens)



Baseline

URBAIR computational domain: 4000×4000 m^2
Spatial resolution: 100×100 m^2

PA1: Apply cool materials

on all buildings and on roads

PA2: Urban fabric

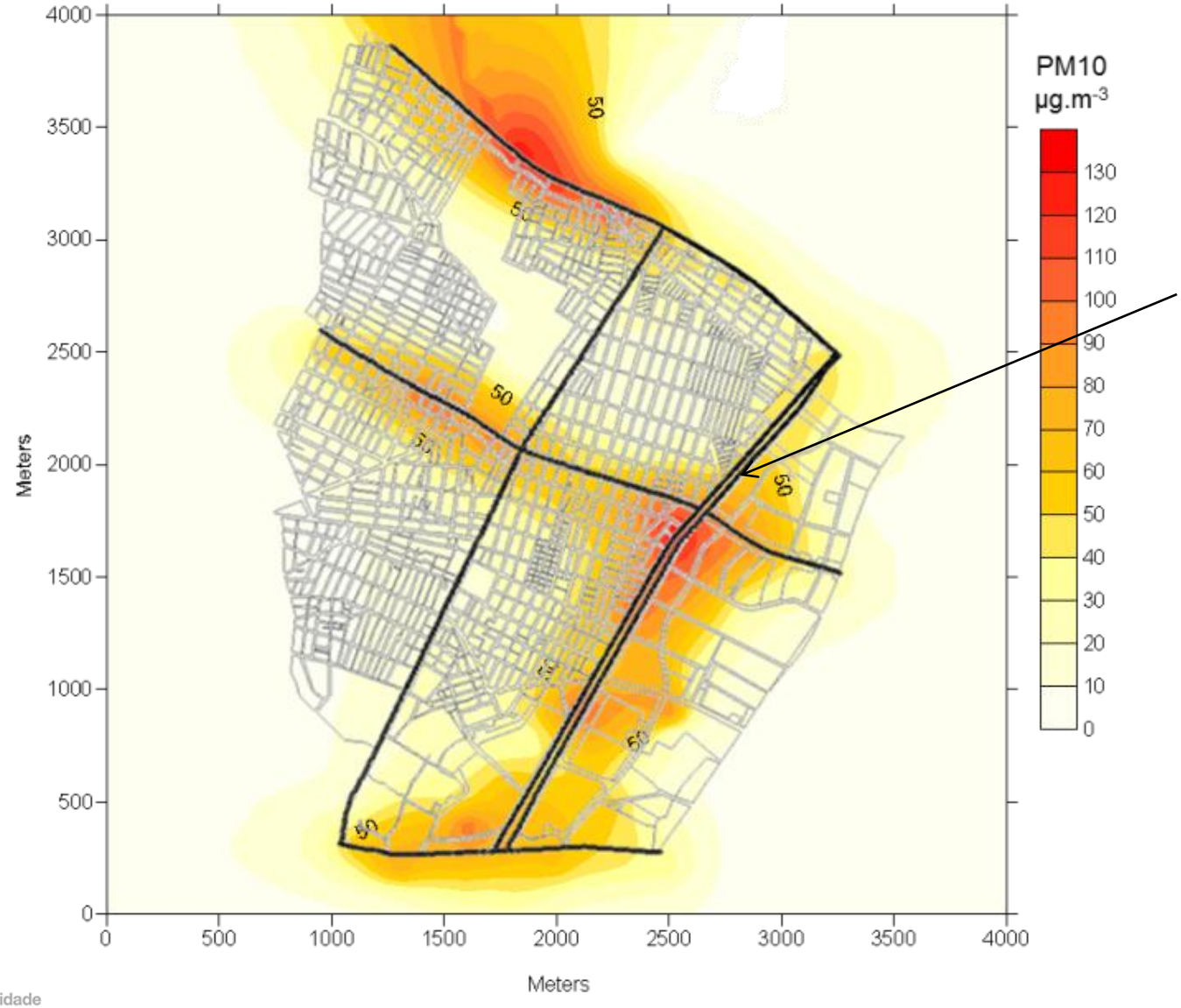
Increase in the number of buildings

Traffic flows are considered to be the same as nearby roads in the Egaleo area

PA3: Green area

Reduction of 90% on traffic flows compared to planning alternative 2

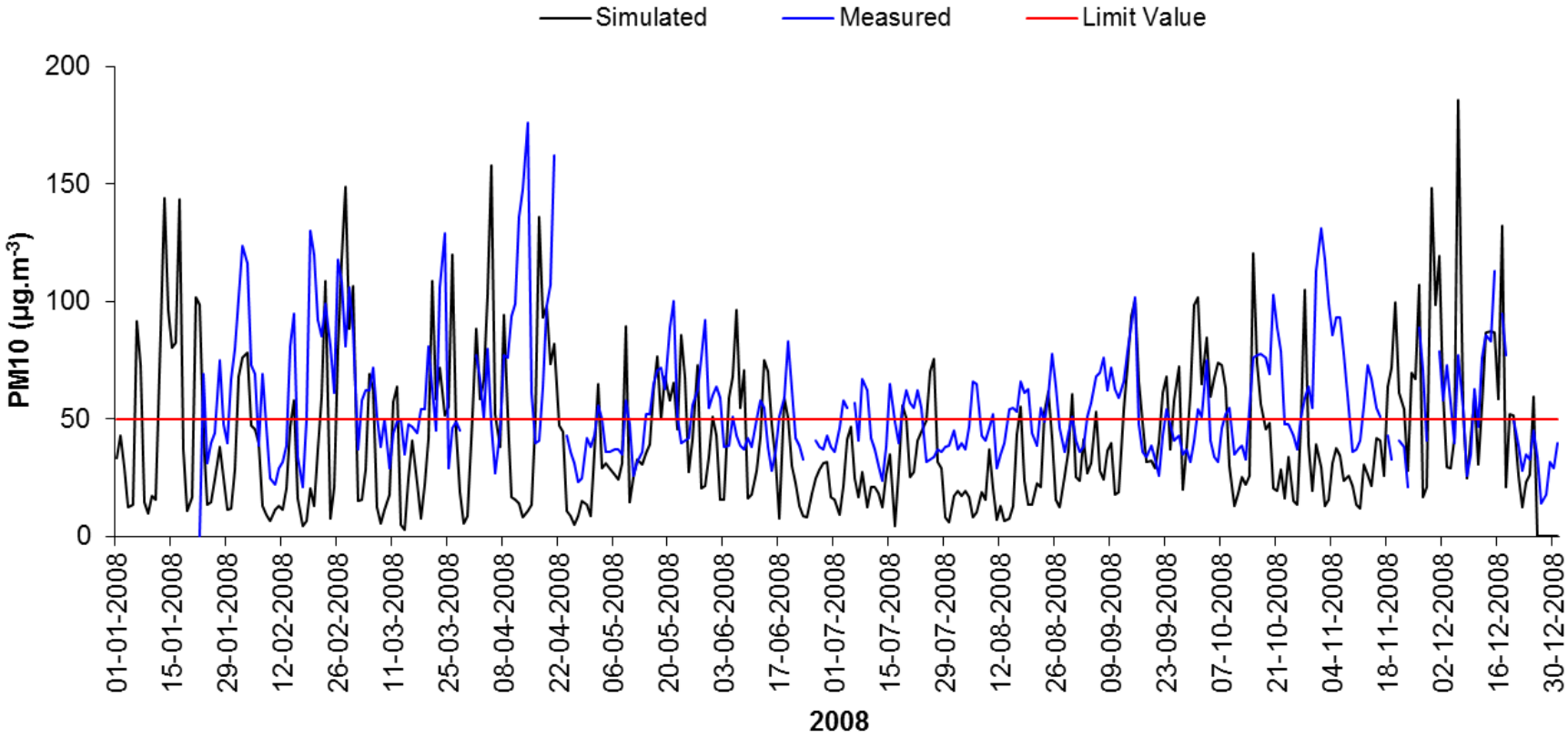
Air Quality measurements - Athens



Aristotelous Air Quality Station

Air Quality comparison - Athens

Comparison of measured and simulated [PM10] in Aritotelous AQ, 2008



Underestimation tendency

- Background concentrations and local emission point sources were not considered
- Road traffic emissions based on vehicles counting and average speed (no emissions during traffic jams, relevant during the peak hours)
- Only exhaust emissions were considered

Several exceedances of 50 µg.m^{-3}

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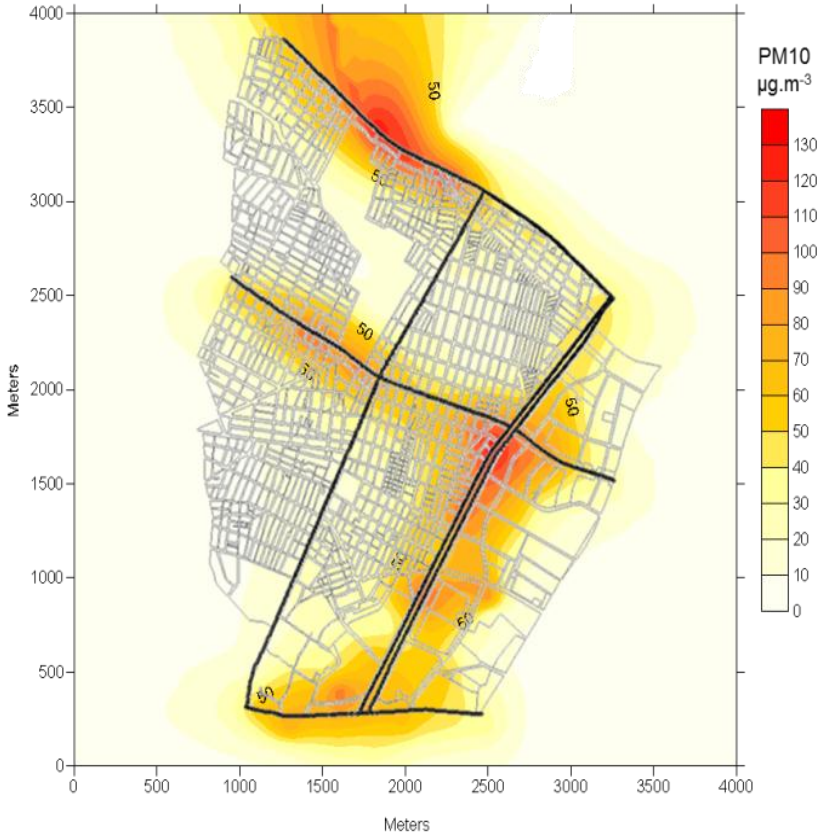
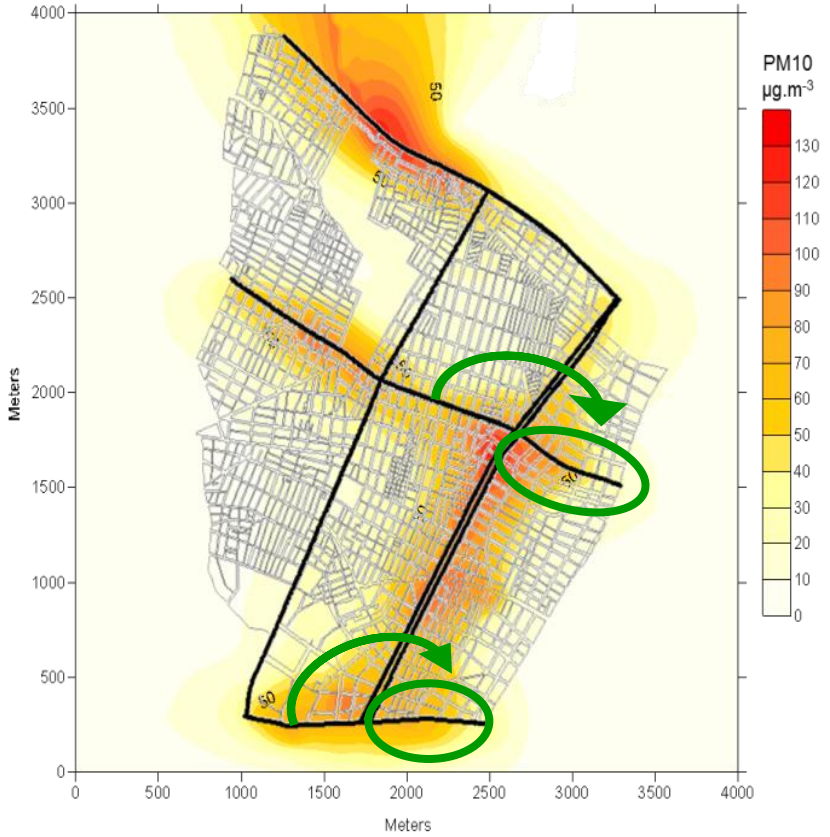
Air Quality results - Athens

24 hour average [PM10] fields in Athens domain, 22nd Sep 2008



Baseline

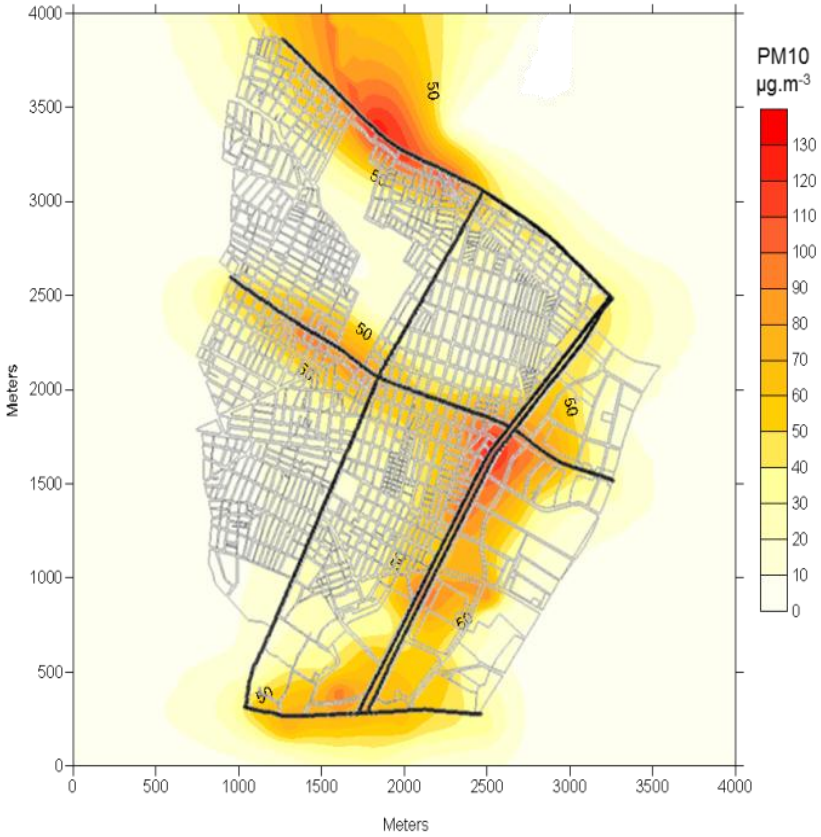


Planning alternative 2

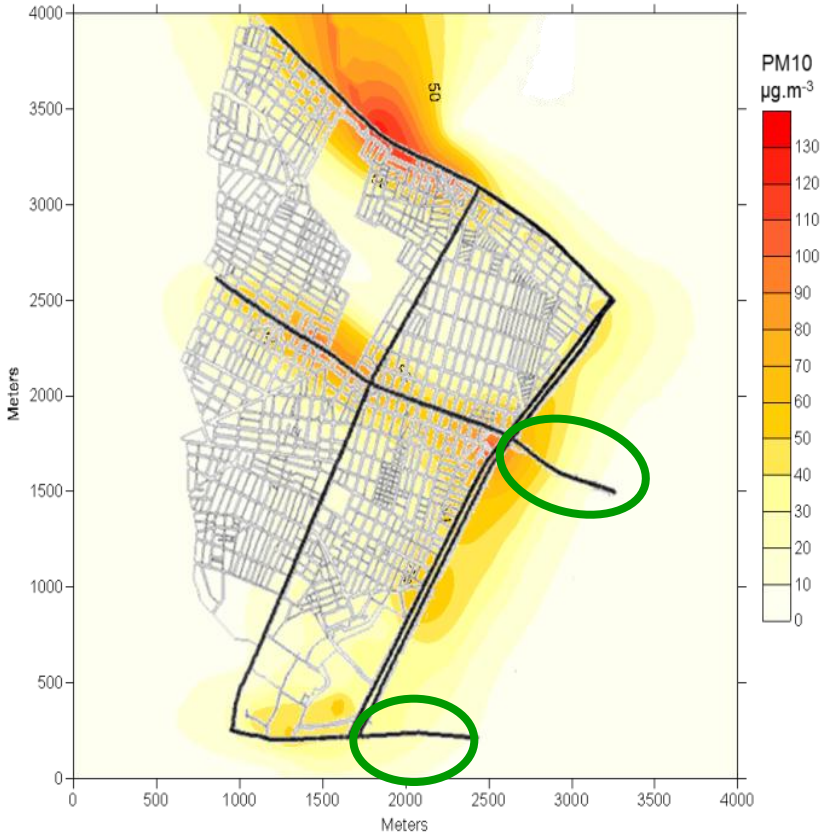
PA2 Urban fabric
Increase of number of buildings
Traffic flow = nearby roads
Concentrations 130 µg.m^{-3}

Air Quality results - Athens

24 hour average [PM10] fields in Athens domain, 22nd Sep 2008



Baseline



Planning alternative 3

PA3 Conversion of intervention zone into a green area
Reduction of 90% in traffic (related to nearby roads)
Strong reduction in concentrations

Results

Maximum simulated concentrations of PM10, CO, NO_2 and SO_2 for Athens in 2008

Study case	Baseline	Planning alternative		
		1	2	3
PM10 ($\mu g.m^{-3}$)				
Athens	248	-	**253**	**222**
CO ($\mu g.m^{-3}$)				
Athens	5045	-	5526	4995
NO_2 ($\mu g.m^{-3}$)				
Athens	382	-	388	370
SO_2 ($\mu g.m^{-3}$)				
Athens	236	-	240	228

→ Pollutant levels increase in PA2 and decrease in PA3

Discussion

Number of exceedances, according to Directive 1999/30/EC, to PM10, CO, NO_2 and SO_2 in Athens 2008

- Athens baseline and planning alternative concentrations are over allowed number of exceedances to PM10.
- Athens have exceedances for NO_2 hourly average concentration, but still in compliance with the Directive.

Final comments

URBAIR applications allowed a comparative analysis between current situations and predefined planning alternatives in terms of the number of exceedances to air quality thresholds.

Comparison of simulated concentrations with measured data → URBAIR presents some underestimation tendency:

- Average hourly traffic fluxes were calculated from annual values, except for Athens study case.
- Contribution of natural events, which can be relevant in some air pollution episodes, was not considered.

Despite the small scale of considered planning alternatives in terms of project dimension and the area of intervention, the results provide important information to urban planners and policy makers to choose the best planning solution according to quality of life standards pursuit by local authorities.

Thank you for your attention!

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