

LIFE Index-Air: A Decision Support Tool to Reduce the Exposure to Air Pollutants and Improve the Health of Citizens Living in European Cities

LIFE Index-Air @ INTERREG MED project REMEDIO
International Conference:
“HORIZONTAL CONDOMINIUM AS
A LIVING LAB FOR URBAN RENEWALS”



Motivation

EU urban population exposed to harmful levels of air pollution in 2013-2015



Air Quality in Europe – 2017 Report
EEA Report | No 13/2017

Round 90 % of Europeans living in cities are exposed to levels of air pollutants deemed damaging to health by the World Health Organization's more stringent guidelines.

Motivation

Assessment of human exposure to particles

Measuring outdoor levels of particles at **fixed** ambient air quality **monitoring sites** has been the **traditional** way of **evaluating** urban air quality

This fixed monitoring stations are **supposed to assess** the exposure of all the population to particles



However, this approach **fails** to account for **all components** of exposure

1st There is a huge **heterogeneity** in the **concentrations** of pollutants within the city

2nd People spend more than **90% of the time** **indoors**

3rd There is a huge **heterogeneity** in **time** activity patterns of the population

[illegible]

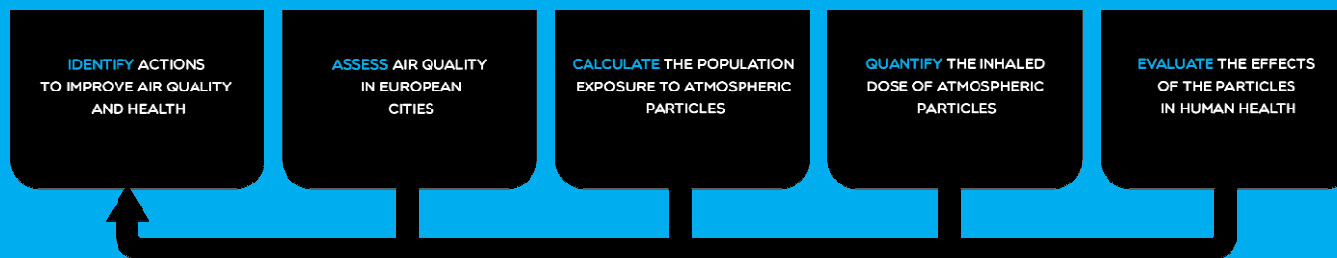
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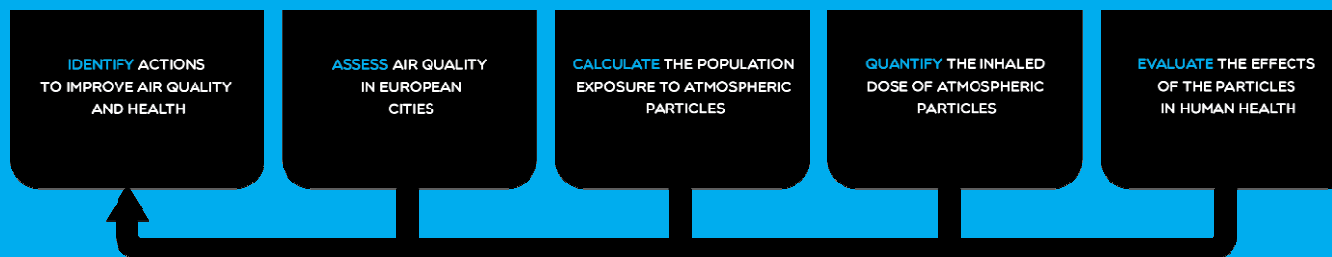
1st There is a huge **heterogeneity** in the **concentrations** of pollutants within the city

2nd People spend more than **90% of the time indoors**

3rd There is a huge **heterogeneity** in **time** activity patterns of the population

This brings the considerable importance of assessing the **personal integrated exposure** to particles as it is the key determinant of the **dose received by an individual** and to study the **sources associates with this exposure**.





**IMPLEMENTATION OF THE TOOL IN 5 EUROPEAN CITIES
LISBON, OPORTO, ATHENS, KUOPIO AND TREVISO**



IDENTIFY ACTIONS
TO IMPROVE AIR QUALITY
AND HEALTH

ASSESS AIR QUALITY
IN EUROPEAN
CITIES

CALCULATE THE POPULATION
EXPOSURE TO ATMOSPHERIC
PARTICLES

QUANTIFY THE INHALED
DOSE OF ATMOSPHERIC
PARTICLES

EVALUATE THE EFFECTS
OF THE PARTICLES
IN HUMAN HEALTH

IMPLEMENTATION OF THE TOOL IN 5 EUROPEAN CITIES
LISBON, OPORTO, ATHENS, KUOPIO AND TREVISO

DEVELOPMENT OF GUIDELINES FOR ACTION PLANS FORMULATION



SOURCES

AIR QUALITY
MODULE

EXPOSURE
MODULE

DOSIMETRY
MODULE

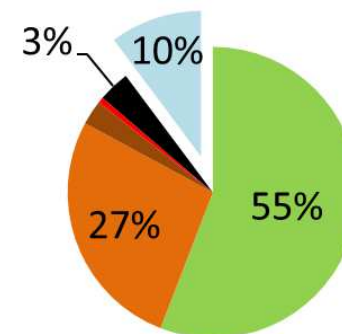
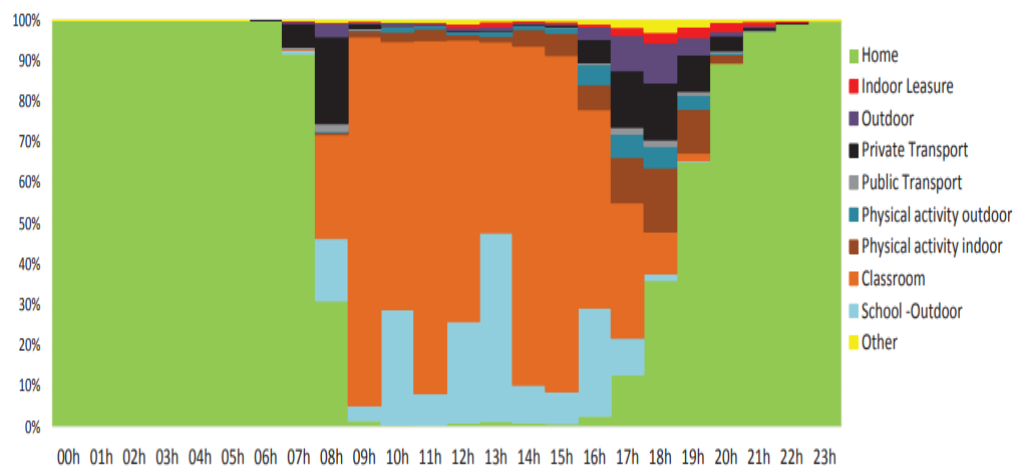
BURDEN DISEASE
MODULE

Time Activity Pattern



26 schools
4000 students and teachers
6000 questionnaires

TIME ACTIVITY PATTERN DURING WEEKDAYS



SOURCES

AIR QUALITY
MODULE

EXPOSURE
MODULE

DOSIMETRY
MODULE

BURDEN DISEASE
MODULE



40 Homes



5 Schools



4 transport modes



Outdoor

Objective:

- Model Validation
- Indoor / Outdoor Ratio
- Source Apportionment

PM_{2.5} + PM₁₀ + Elements (As + Cd + Ni + Pb) + PAHs (BaP) + EC/OC

SOURCES

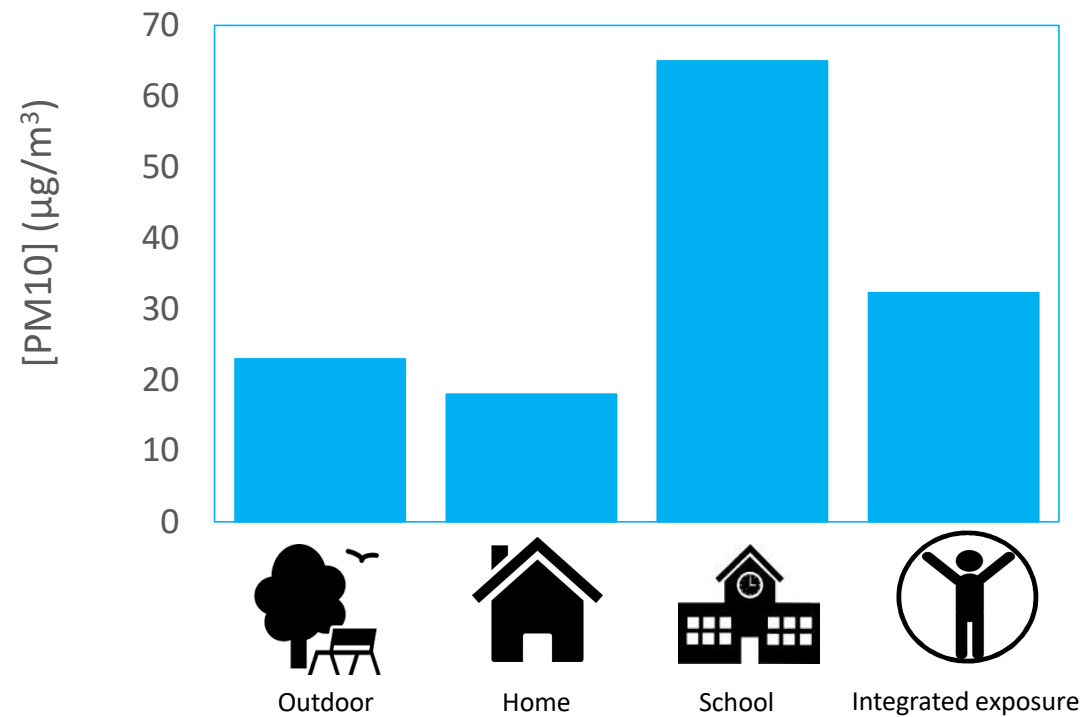
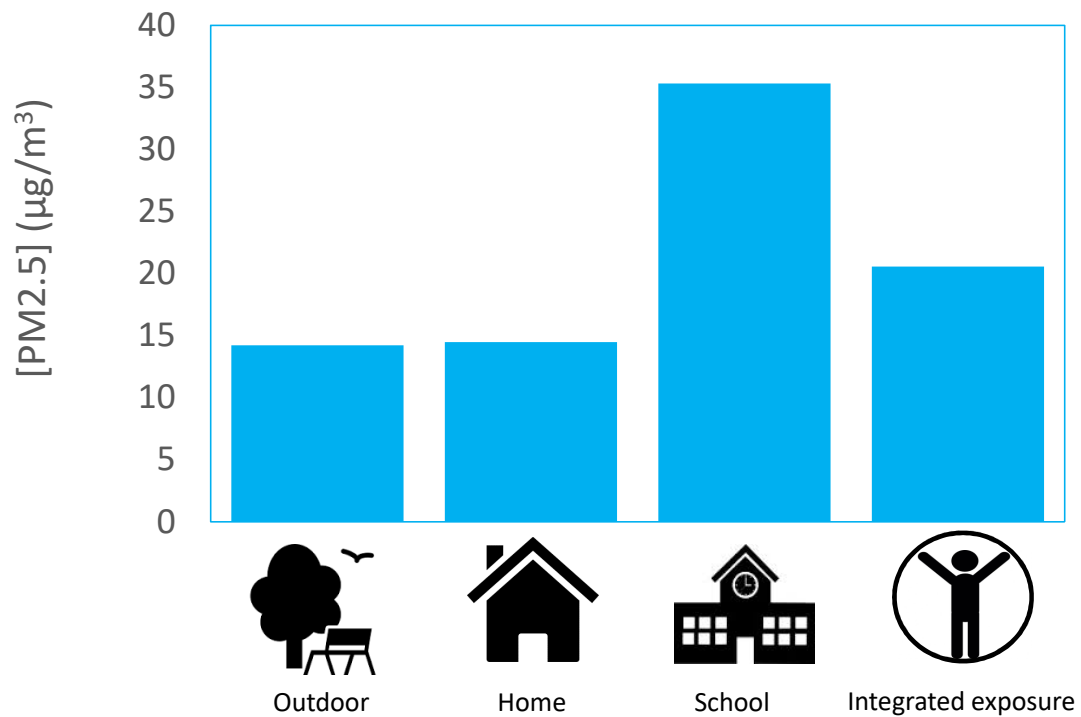
AIR QUALITY
MODULE

EXPOSURE
MODULE

DOSIMETRY
MODULE

BURDEN DISEASE
MODULE

PM mass concentration



SOURCES

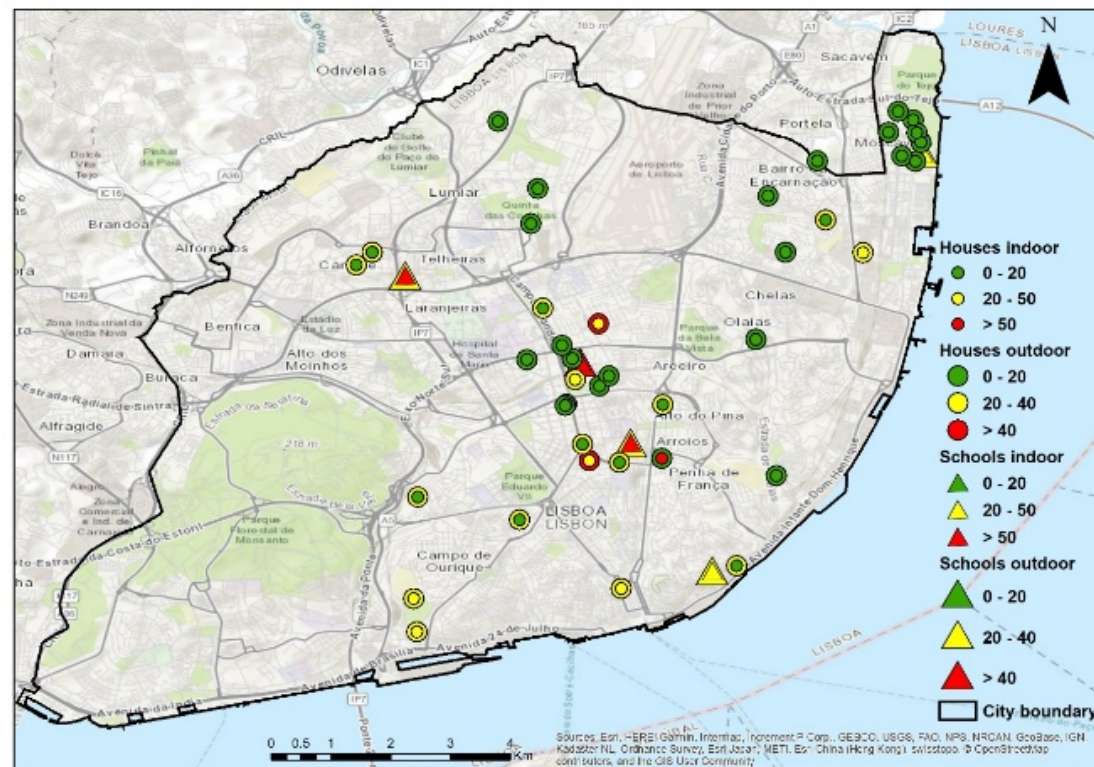
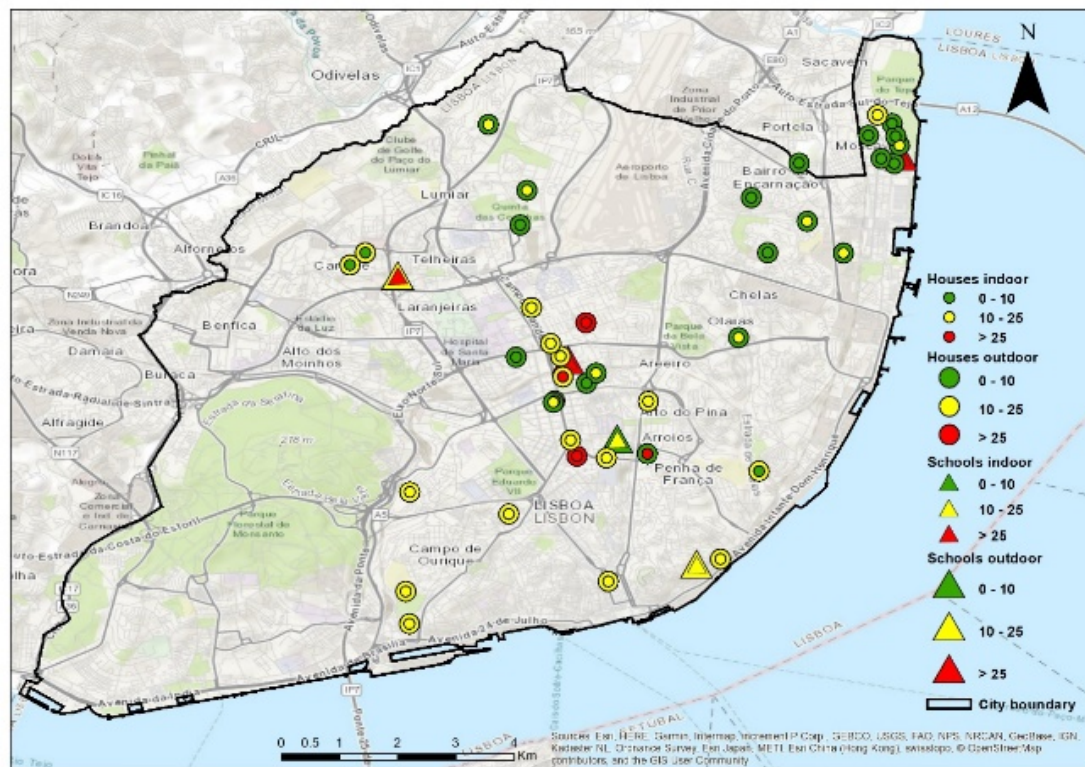
**AIR QUALITY
MODULE**

**EXPOSURE
MODULE**

**DOSIMETRY
MODULE**

**BURDEN DISEASE
MODULE**

PM mass concentration



PM2.5 and PM10 results in indoor and outdoor environments

SOURCES

AIR QUALITY
MODULE

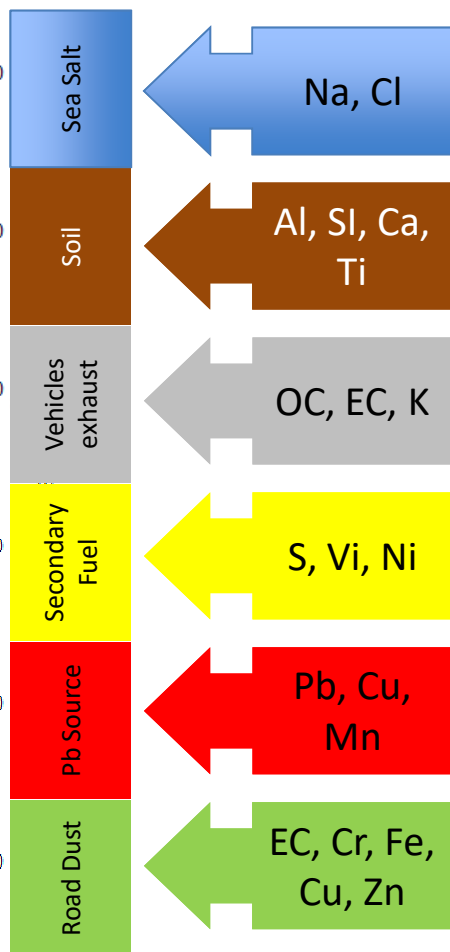
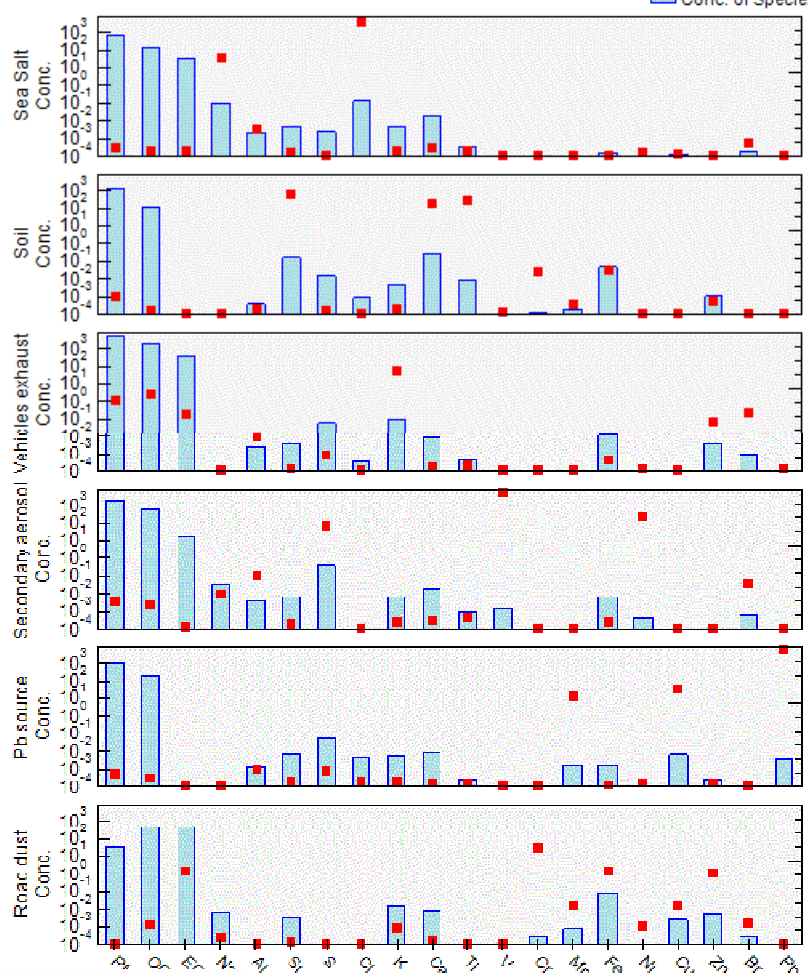
EXPOSURE
MODULE

DOSIMETRY
MODULE

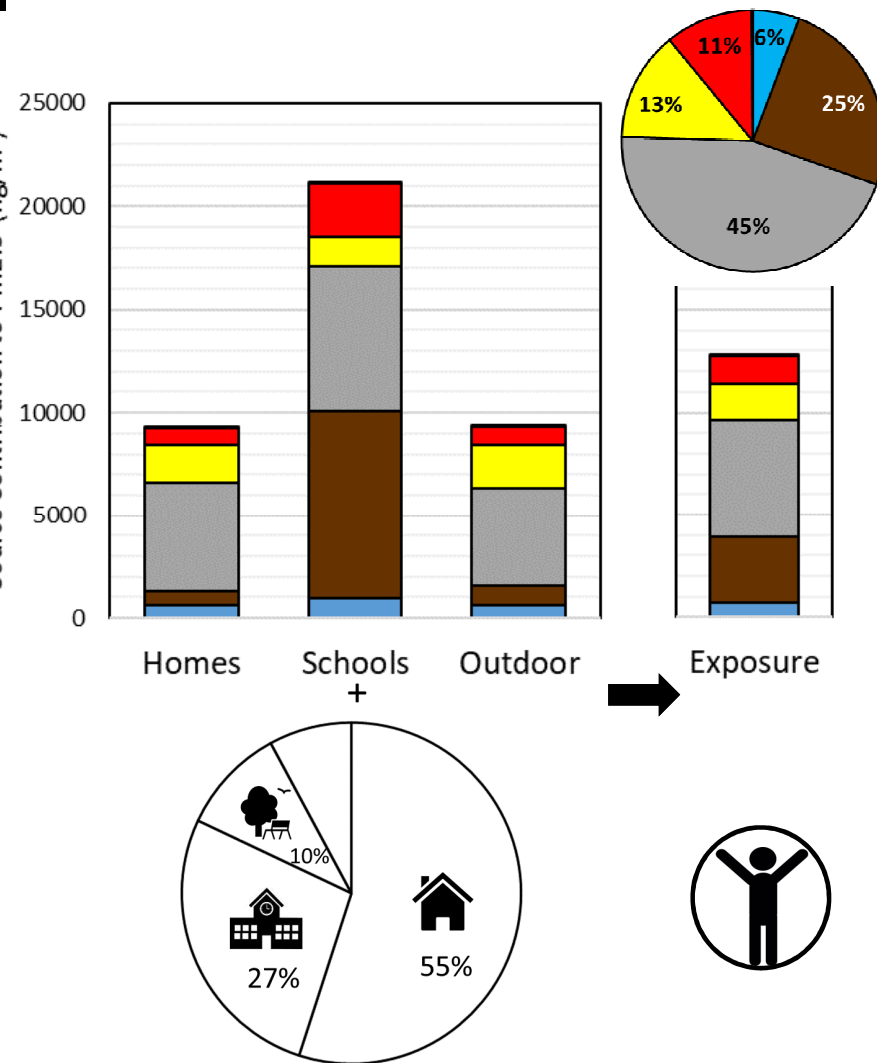
BURDEN DISEASE
MODULE

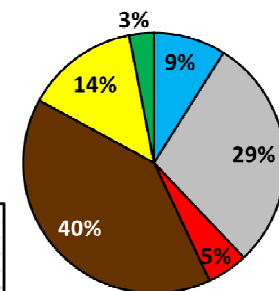
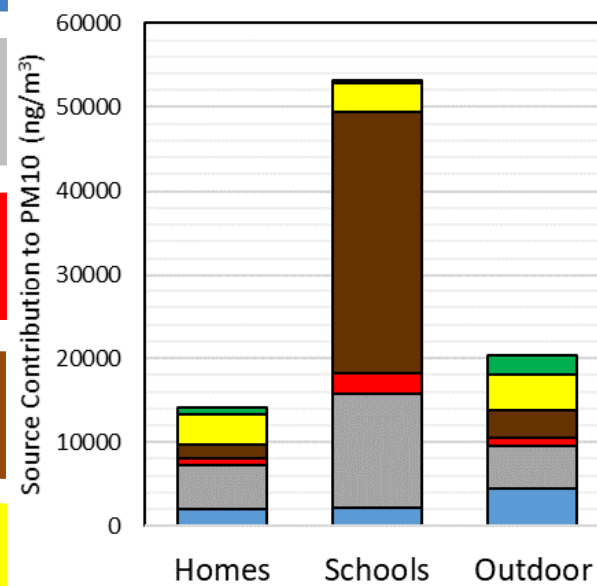
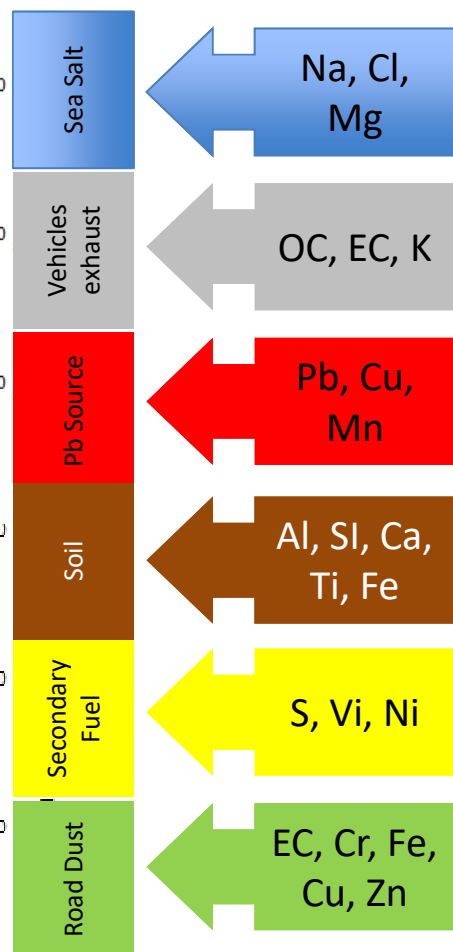
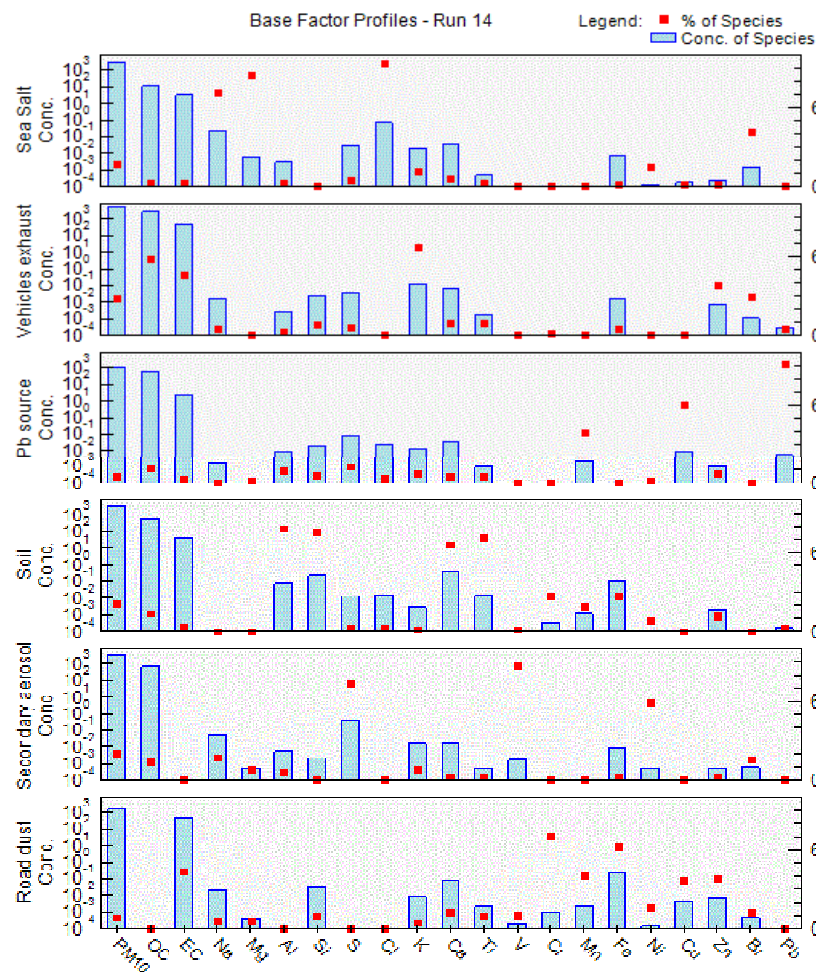
Base Factor Profiles - Run 2

Legend: ■ % of Species
■ Conc. of Species



Source Contribution to PM_{2.5} (ng/m³)





SOURCES

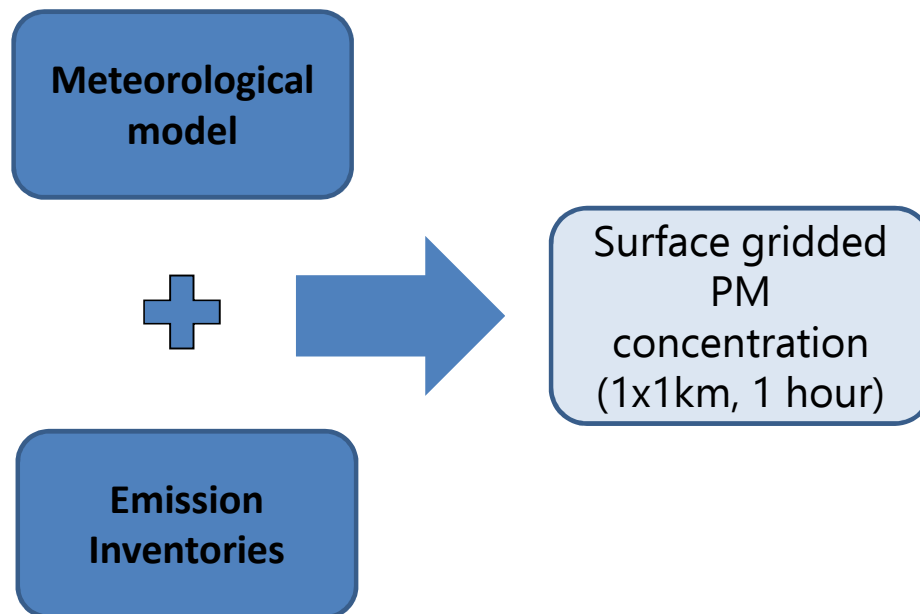
AIR QUALITY
MODULE

EXPOSURE
MODULE

DOSIMETRY
MODULE

BURDEN DISEASE
MODULE

Assessment of the emissions



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Home

Data Analysis

About ▾

Con

City: 1. Lisboa ▾

Year: 2015 ▾

Emissions

Ambient concentrations

Exceedances

Population groups maps

Pollutant: SO2 ▾

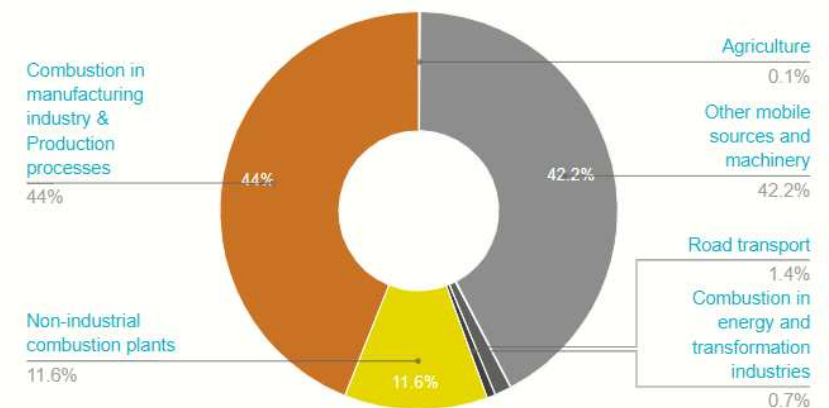
Source: Non-industr

12356300.729

Non-industrial combustion plants

Min value (Gg/year)	Max value (Gg/year)
0.0000000	0.0022822

SO2 per source in Gg/year



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SOURCES

**AIR QUALITY
MODULE**

**EXPOSURE
MODULE**

**DOSIMETRY
MODULE**

**BURDEN DISEASE
MODULE**

Assessment of the emissions

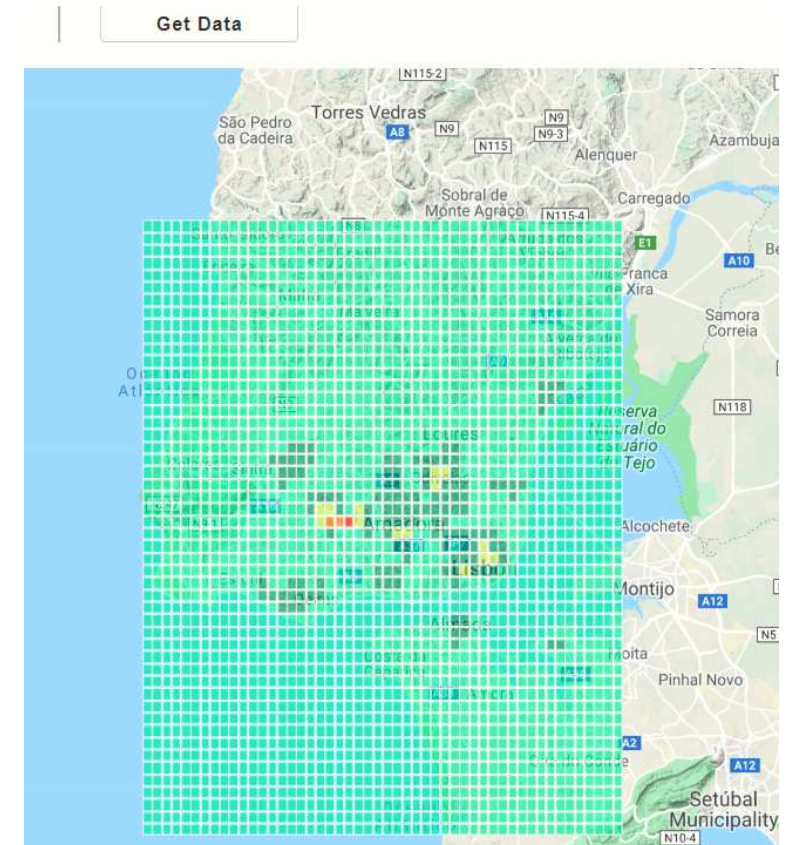
**Meteorological
model**



**Emission
Inventories**

**Surface gridded
PM
concentration
(1x1km, 1 hour)**

Emissions



SOURCES

AIR QUALITY
MODULE

EXPOSURE
MODULE

DOSIMETRY
MODULE

BURDEN DISEASE
MODULE

Assessment of the concentrations

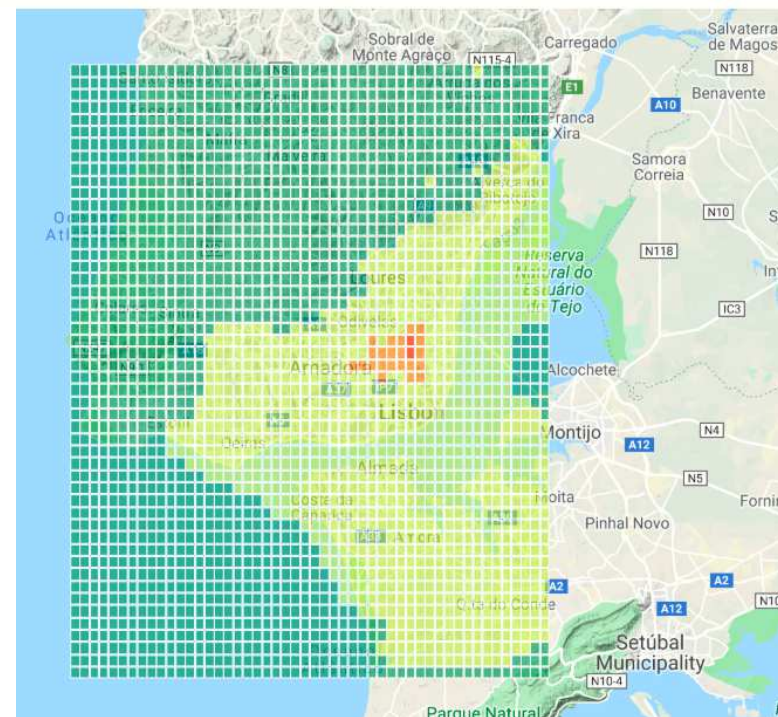
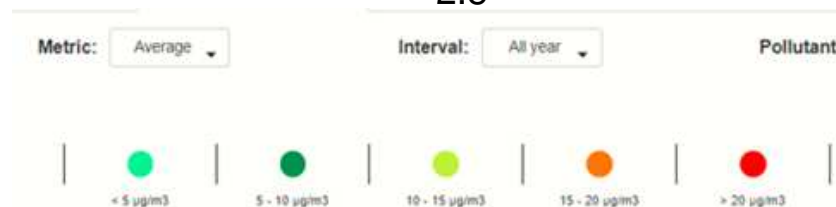
Meteorological
model



Emission
Inventories

Surface gridded
PM
concentration
(1x1km, 1 hour)

PM_{2.5}



SOURCES

AIR QUALITY
MODULE

EXPOSURE
MODULE

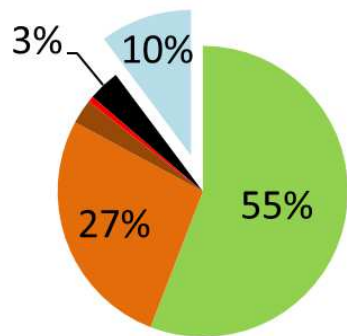
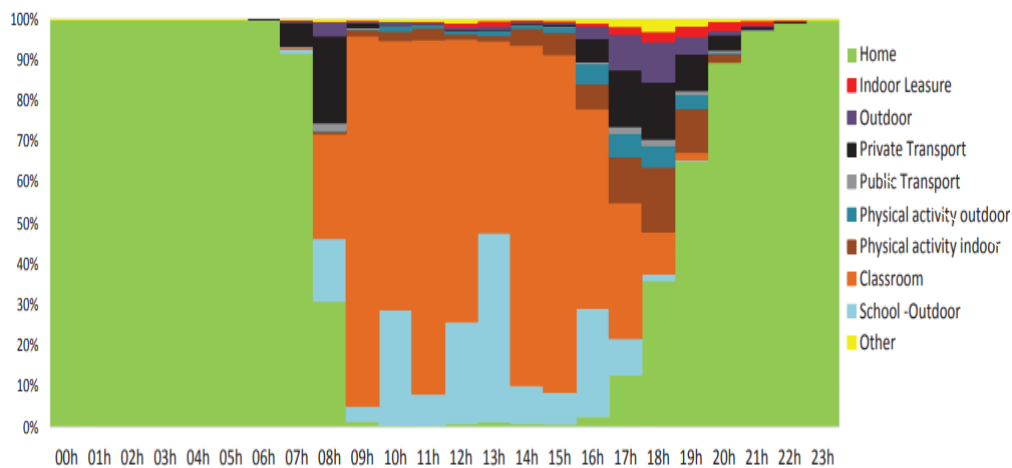
DOSIMETRY
MODULE

BURDEN DISEASE
MODULE

Assessment of population exposure

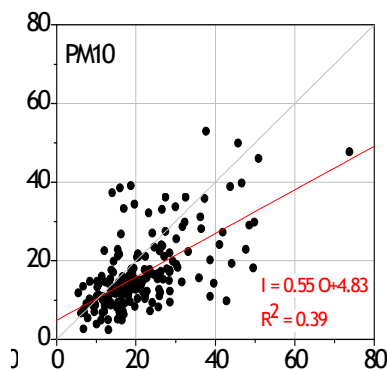
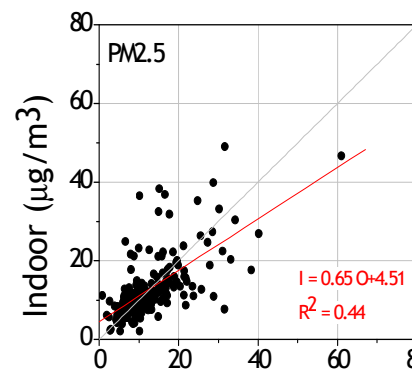
Time-Activity
Data

TIME ACTIVITY PATTERN DURING WEEKDAYS



I/O ratios

Homes



Outdoor ($\mu\text{g}/\text{m}^3$)

SOURCES

AIR QUALITY
MODULE

EXPOSURE
MODULE

DOSIMETRY
MODULE

BURDEN DISEASE
MODULE

Assessment of population exposure

Surface gridded PM
concentration
(1x1km, 1 hour)

Time-Activity
Data

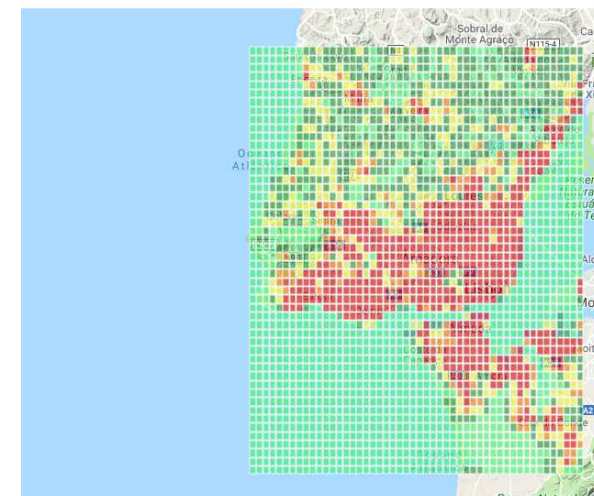
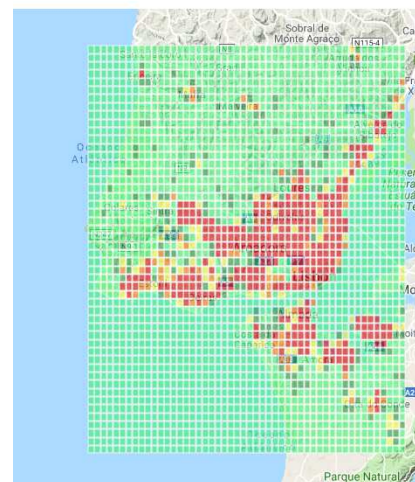
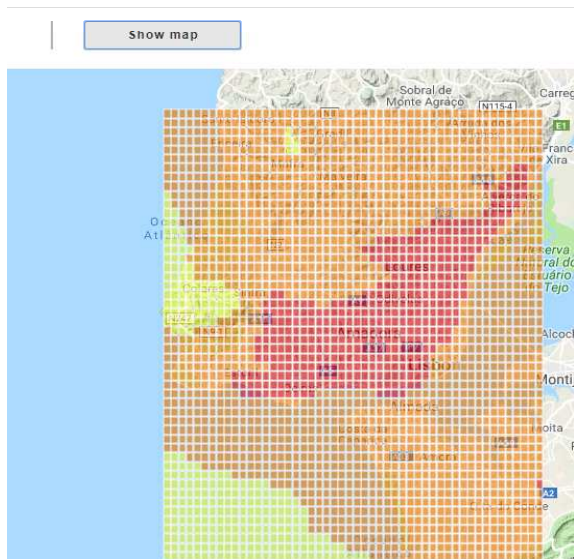


I/O ratios

Surface Gridded
Population



Surface gridded
Population
Exposure
(1x1km, 1 hour)



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SOURCES

AIR QUALITY
MODULE

EXPOSURE
MODULE

DOSIMETRY
MODULE

BURDEN DISEASE
MODULE

Assessment of respiratory deposition and internal doses

The internal dose of airborne particles and particle-bound metals were estimated

→ The ExDoM2 is a model calculates the dose and retention of particulate matter mass in the human respiratory tract (ICRP, 2012). The respiratory tract is treated as two regions: the Extrathoracic regions (ET) and the Thoracic regions (TH).

The screenshot shows the ExDoM2 Model software interface. It includes input fields for Gender & Age (Male Adult), Breathing Type (Nose), Exposure duration (0 Days, 8 Hours), Total Concentration in the Input File (e.g. PM10, ...), Particle density (1.5 g/cm³), and Shape Factor (1 for spherical particles). It also features a 'Particles' section with 'PM' and 'PM Bound-Metal' options, a 'Size Distribution' section with a histogram, and an 'Input File' section with 'Attach an Input File (.xls)' and 'Create a new Input File (.xls)' options. A 'start' button is visible at the bottom right.

The extrathoracic regions are

- ☐ ET1 (anterior nasal passage) and ET2 (posterior nasal passages, pharynx and larynx) regions.

The thoracic region (the lungs) is divided into

- ☐ the BB (trachea and bronchi),
- ☐ bb (bronchiolar) and
- ☐ Al (alveolar).

The Physiologically-Based Pharmacokinetic (PBPK) model simulates absorption, distribution, metabolism and excretion of chemicals that enter the body

SOURCES

AIR QUALITY
MODULE

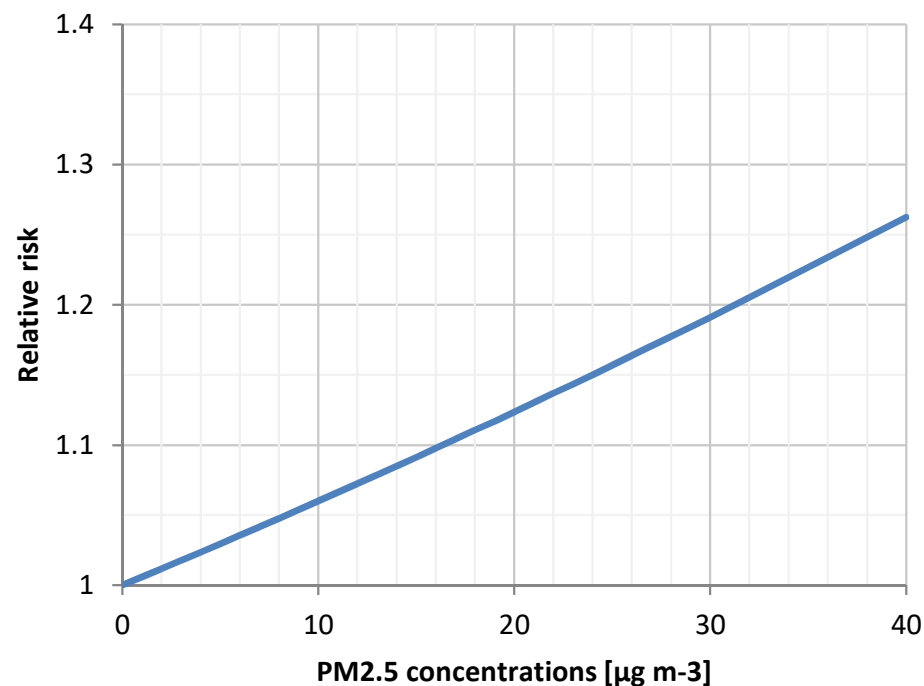
EXPOSURE
MODULE

DOSIMETRY
MODULE

BURDEN DISEASE
MODULE

Assessment of the Environmental Burden of Disease

1. Identification of health endpoints.
Determination of C-R functions (shape, parameters)
2. Background burden of disease
Geographical scales (national - municipality)
3. Population attributable fractions (PAF)
4. Quantification of the attributable burden
Number of deaths, sick days
visualization, comparisons, reduction potential



C-R functions for natural mortality from HRAPIE recommendations (Heroux et al. 2015).

SOURCES

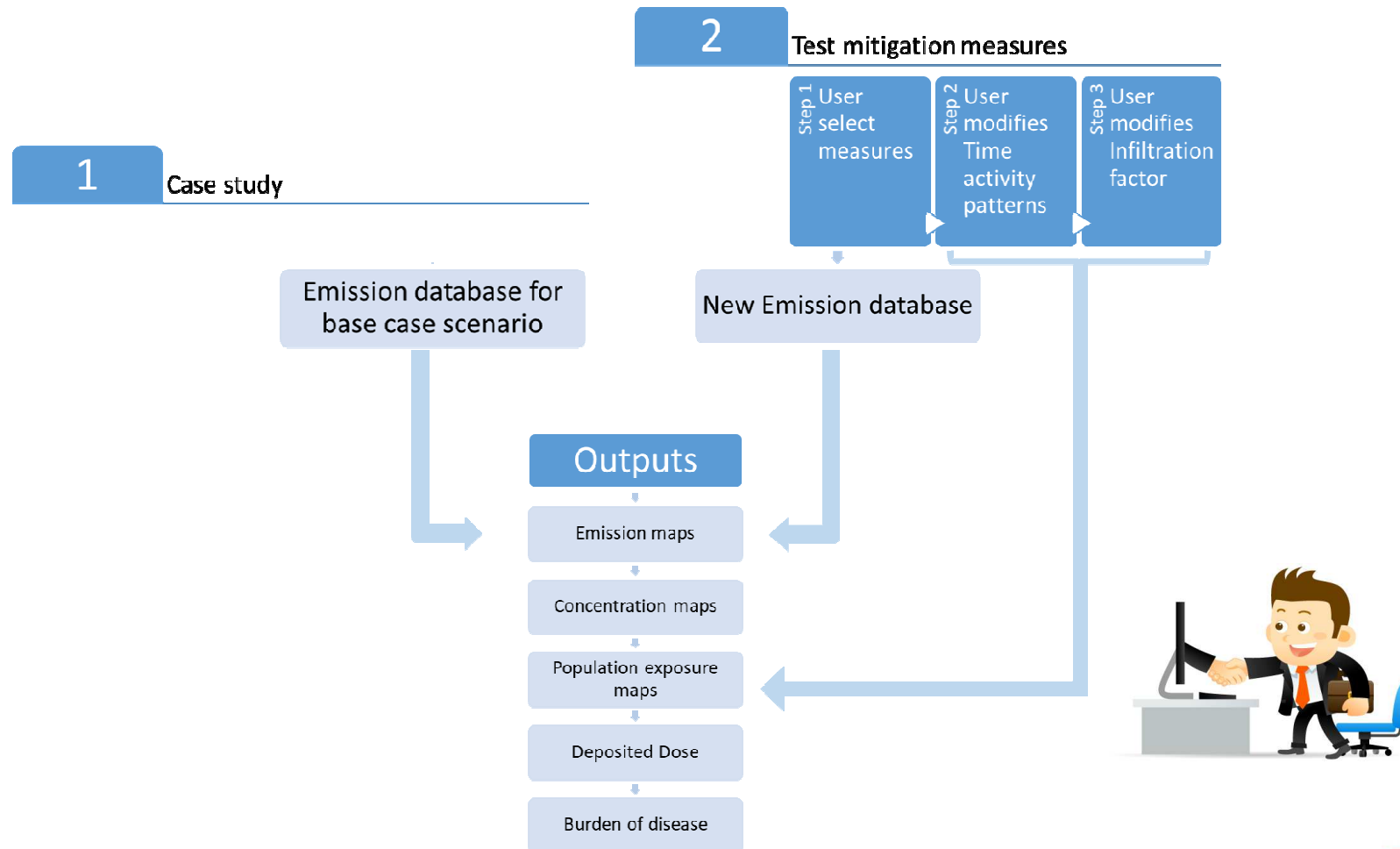
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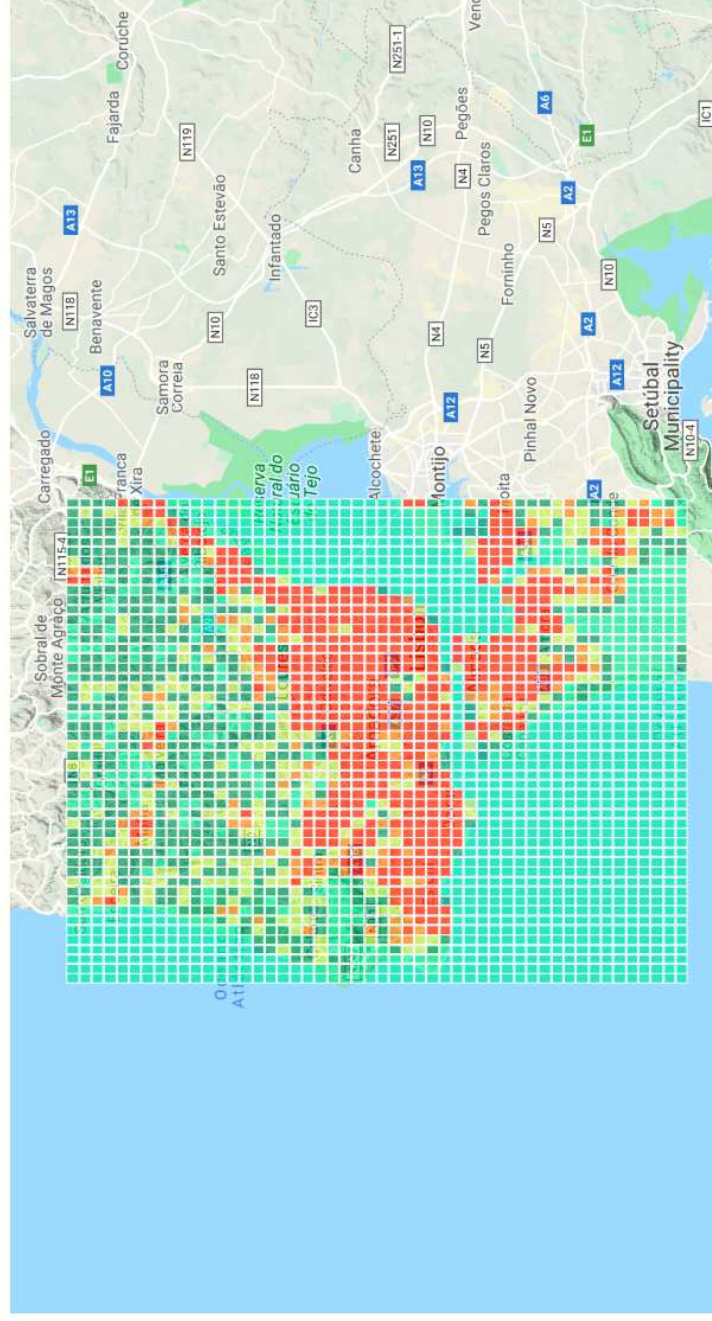
EXPOSURE
MODULE

DOSIMETRY
MODULE

BURDEN DISEASE
MODULE

MODULES COUPLING: Development of a versatile and long-term, decision-making tool





Conclusions

- LIFE Index-Air Tool is an user-friendly and interactive software;
- The tool addresses non-scientific audiences:
 - It was developed to assist the authorities in the definition of actions plans to improve air quality;
 - But it also has a huge awareness potential.
- After the validation of the tool in Lisbon, it will be implemented in Treviso and guidelines for action plans formulation will be delivered to the city;
- LIFE Index-Air and Remedio tools are complementary and together can contribute for the improvement of the air quality of the European cities and wellbeing of the population.

LIFE Index-Air: helping citizens to get involved



LISBON ENGAGEMENT IN NUMBERS

NUMBER OF SCHOOLS 26

TOTAL NUMBER OF TEACHERS 165

NUMBER OF AWARENESS SESSIONS 60

STREET EVENT DAYS 5

TOTAL NUMBER OF STUDENTS 3796

LIFE INDEX AIR

IMPROVING OUR LIFE

PROJECT FUNDED BY EUROPEAN UNION

Thank you!
smarta@ctn.tecnico.ulisboa.pt



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