HARMO 15, Madrid, May 2013

15th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes

CHILDREN EXPOSURE TO TRAFFIC-RELATED POLLUTION: ASSESSMENT OF A TYPICAL SCHOOLDAY

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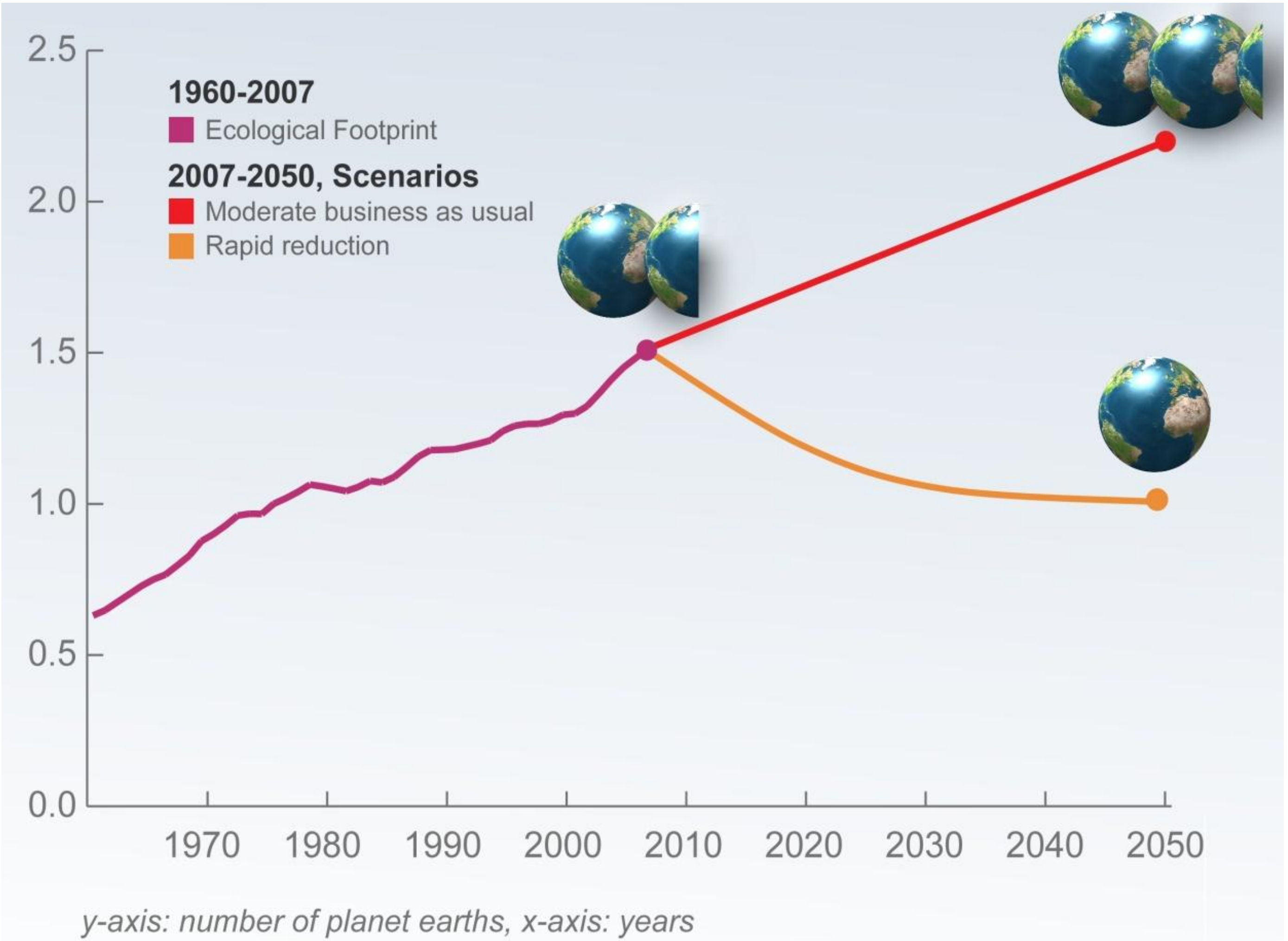
sustainability?



world population

world population (% living in cities)

- **In 1900: < 2 billions (14%)**
- **In 2011: > 7 billions (50%)**

  Europe: 75%

- **In 2030: ≈ 9 billions (60%)**


One of the major challenges and threats to urban sustainability and welfare is air pollution

human health

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.

Worldwide: ± 1500 million people (25% of world population) are exposed to excessive concentrations of gaseous and particulate pollutants.

(World Health Organization)

In Europe: loss of 200 million working days per year due to diseases related to air pollution.

(European Environment Agency)

traffic related air pollution

Large quantities of air pollutants that have a negative impact in human health: carbon monoxide, hydrocarbons, nitrogen oxides, particulate matter, benzene, formaldehyde, acetaldehyde, and contribute to the formation of ozone and secondary aerosols.

Non-combustion emissions : road dust and tire and break wear contain chemical compounds that may pose risk to human health.

Difficulty in quantifying them taking all into account, it is common to use traffic-pollutant surrogates such as CO, NO_2 or benzene, in exposure studies.

linking human activity with human health

traffic dynamics

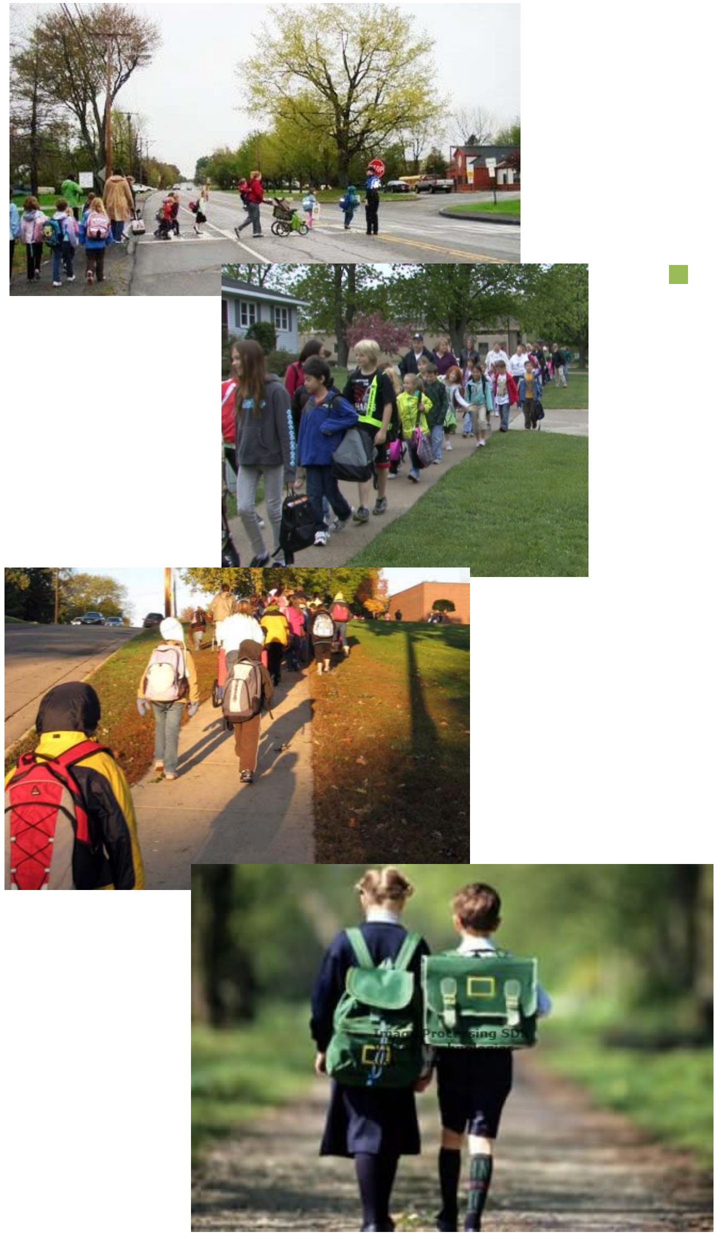
emissions

transport and dispersion

air quality (outdoors / indoor)

human exposure

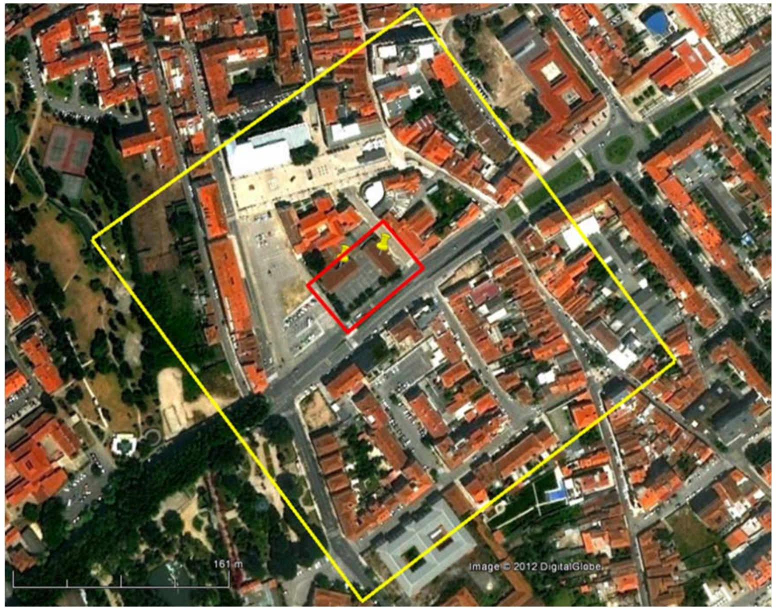
human health



Objectives

- to understand how **different walking routes** can potentially affect human **exposure levels**
    - to understand how **different locations in a building** can potentially affect human **exposure levels**

Case study

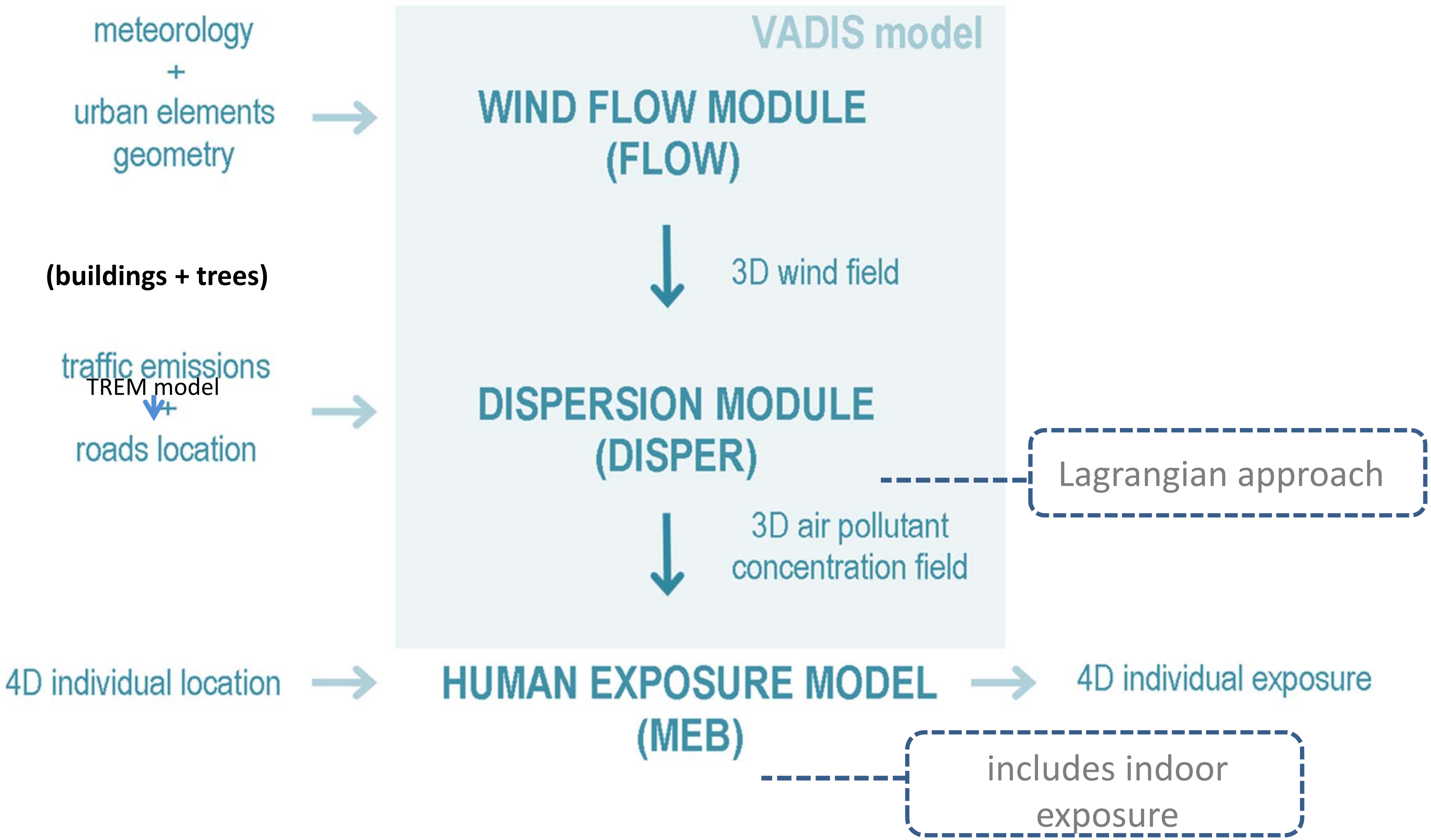


Satellite image (Google Earth) of the study area (the simulation domain is defined in the yellow rectangle, and the school is located within the red line).

- Aveiro (Northwest Portugal)
- area of 550 x 550 m2
- Elementary school
- Residential area crossed by one of the main avenues of the town

- Pathways of 4 students from 2 classrooms
- Simulation CO concentrations indoors and outdoors (quality assessed with measurements)

numerical modelling approach
- estimation of individual human exposure in a city -



numerical model
- human exposure -

input data:

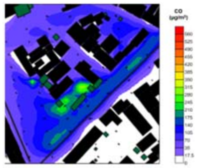
temporal variation of the spatial distribution of concentrations at an average inhalation height

temporal variation of the individual location

$$\exp_{ij} = C_j \times t_{ij}$$

C – concentration

t – time

outdoors  **VADIS results**

GPS tracking 

indoors $E_i(t) = Q_{0,i} \times f \times C(t)$

E - pollutant infiltration flow rate,

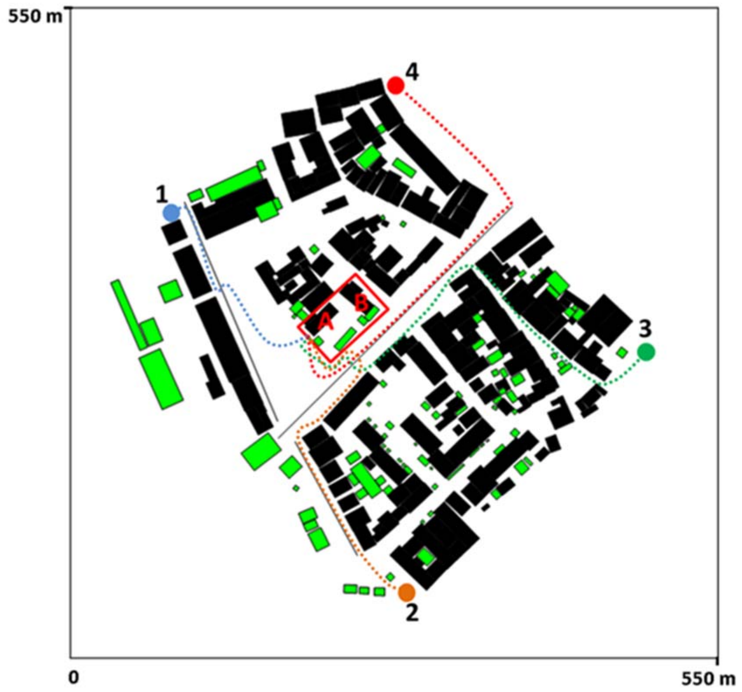
F - penetration factor

Q - ventilation

the model **tracks the time evolution of the personal exposure** by matching, in each time-step, the georeferenced position of the individual with the concentration in that spot

output data: instant and mean exposure values

walking routes

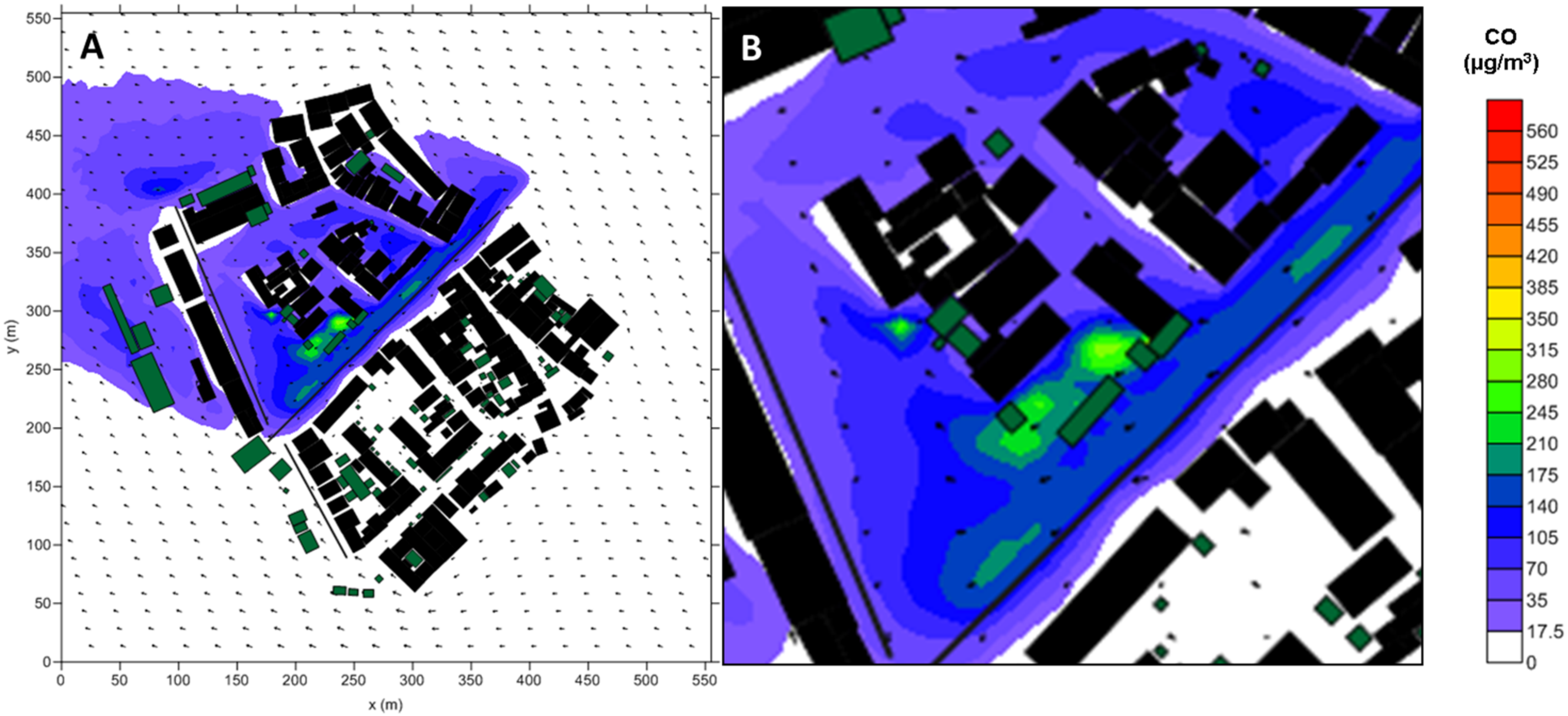


Selection of **4 alternative walking pathways** to the school and **2 classrooms**

Children 1 and 2: room A
Children 3 and 4: room B

The **time profile** of each route was monitored using a **GPS**

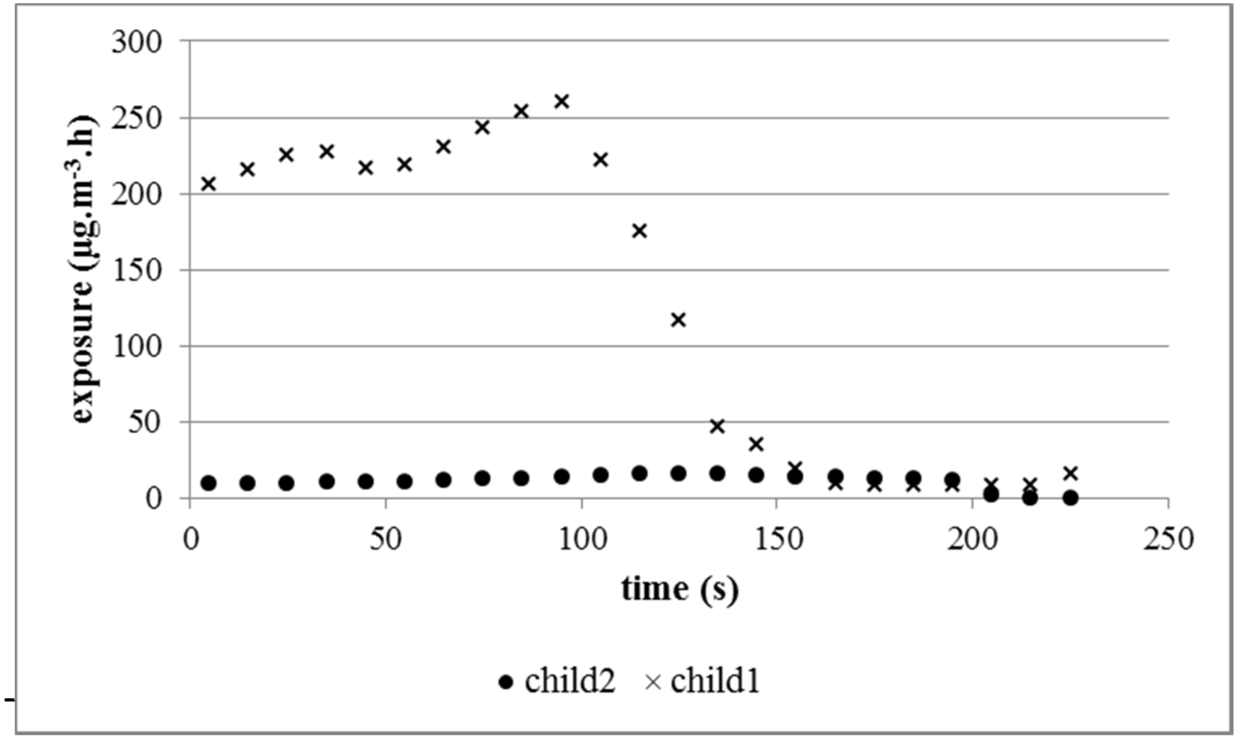
modelling results: CO concentration



1.5 m high horizontal CO concentration field for the period between 8 and 9 a.m.

Results show a good agreement with the measured CO concentrations.
The model slightly underestimates CO concentration (BIAS – 10 µg.m^{-3})
(after a background value was added)

exposure results: CO exposure (ug.m-3.h)



Morning walk to school (air quality 8h- 9h): exposure varies significantly between children and along the way

modelling results: CO exposure (ug.m-3.h)

Exposure during schoolday (includes time spent at classroom, yard and canteen).

		9h	10h	11h	12h	13h	14h	15h	16h
Room A	**1**	224	208	92	163	568	90	90	182
	2	218	208	92	163	568	90	90	180
Room B	**3**	203	157	91	66	568	90	101	184
	4	200	157	91	66	568	90	101	189
	AQS	190	163	127	142	169	134	108	92

Values vary between children. Values quite different from exposure calculated from data from the air quality station.

final remarks

CO exposure varies significantly in the different routes, which means that even in a small domain, **a significant error can occur if a mean air quality value is used as a proxy for the exposure of the individuals** that use that space

indoor spaces in the same building may have quite different concentration of pollutants, and consequently, exposure values

CO **exposure indoors is sometimes higher** than CO exposure outdoors (although there were no indoor sources)

exposure studies could be very helpful when planning buildings such as **schools or hospitals**

final remarks

near future will probably bring **intelligent routing techniques** as a way to promote lower exposure of urban citizens to air pollutants in typical daily travels

the enhanced understanding of the symbiosis between **urban planning, air quality** and **human exposure**, is a needed step towards

healthier and sustainable cities