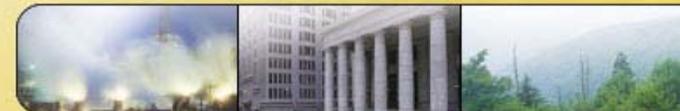


Comparing the impact of a road tunnel versus a road viaduct by means of an integrated exposure assessment

Clemens Mensink, Guido Cosemans, Inge Liekens,
Rudi Torfs and Jean Vankerkom.

VITO

Centre for Integrated Environmental Studies
Mol, Belgium



Outline

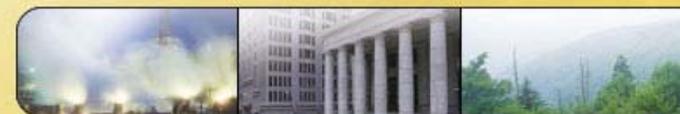
- Introduction
- Methodology
 - Emission calculations
 - Air quality modelling
 - Exposure calculations
- Results and discussion
- Conclusions



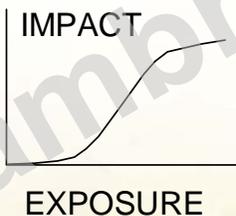
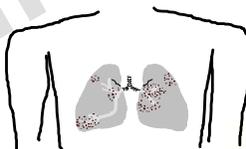
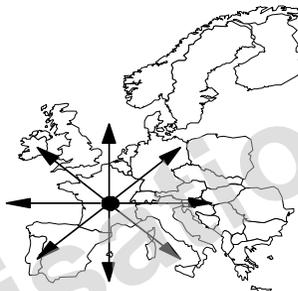
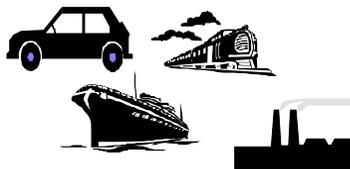
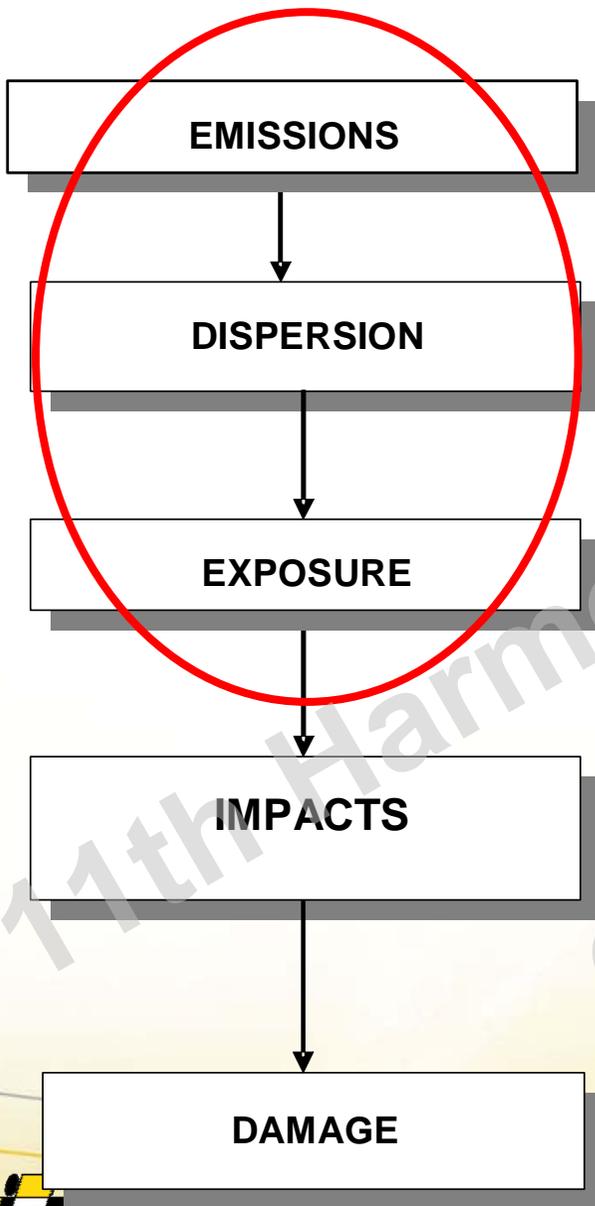


Outline

- Introduction
- **Methodology**
 - Emission calculations
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Steps



Models and data

Emission models/inventories

Dispersion models

local, regional, chemical reactions

Exposure assessment

GIS based information on receptors at risk

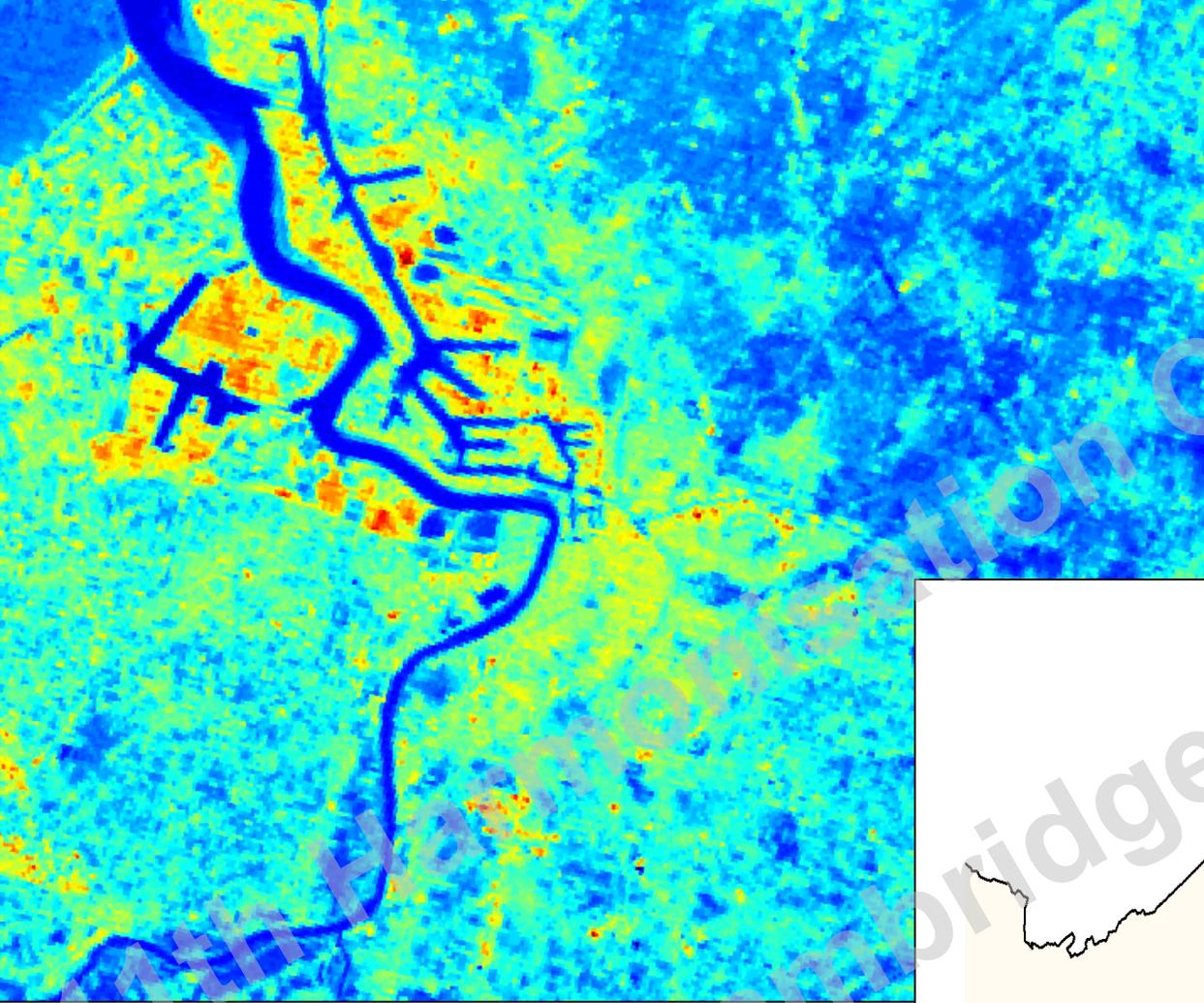
Exposure-Response relationships

public health
agriculture
materials
ecosystems

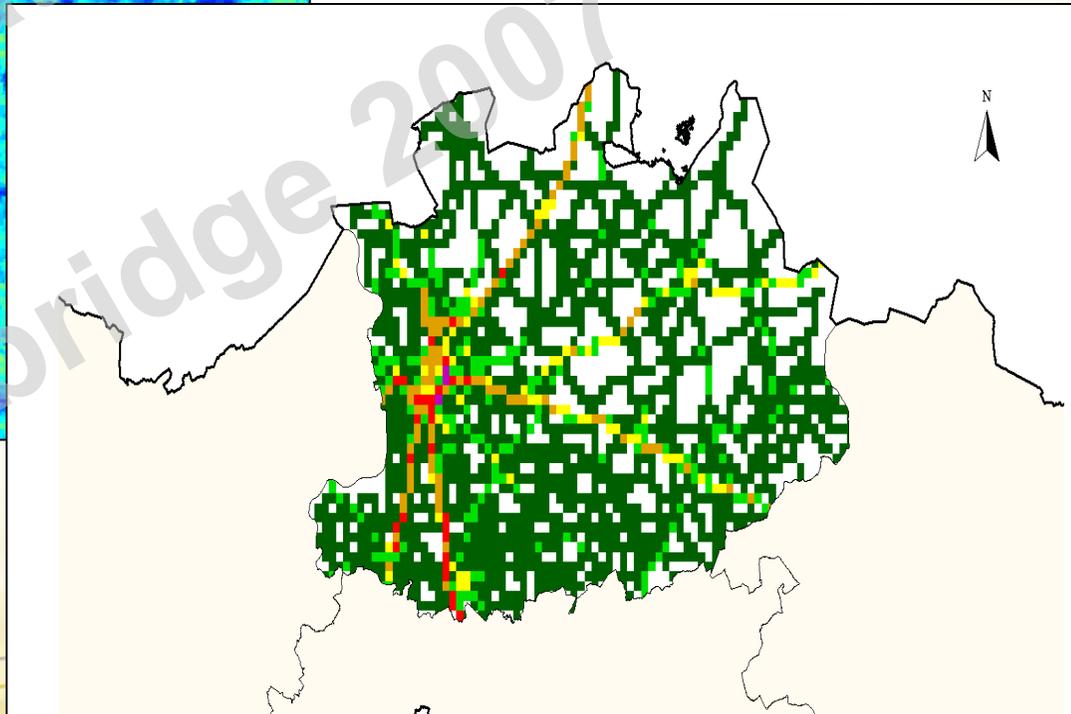
Critical loads

Market prices, CVM- studies, Transport Method studies, Shadow prices based on implicit values of policy makers .

Emission calculations



Landsat T_s (12 August 1995)



Emissies 1 - 10 10 - 20 20 - 30 30 - 60 60 - 90 90 - 139 (ton)

Dispersion calculations

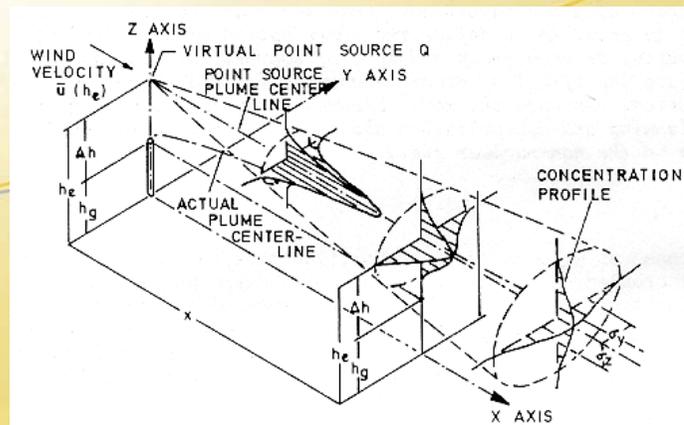
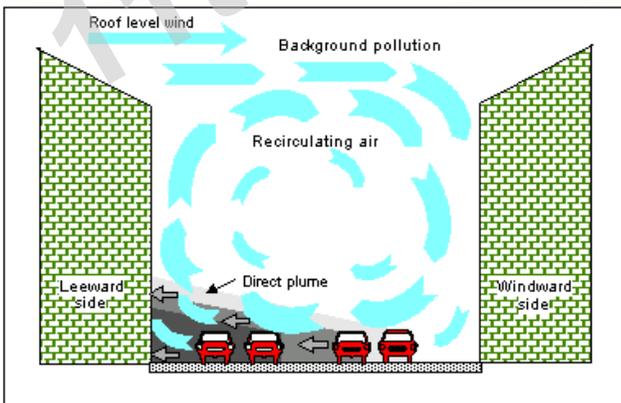
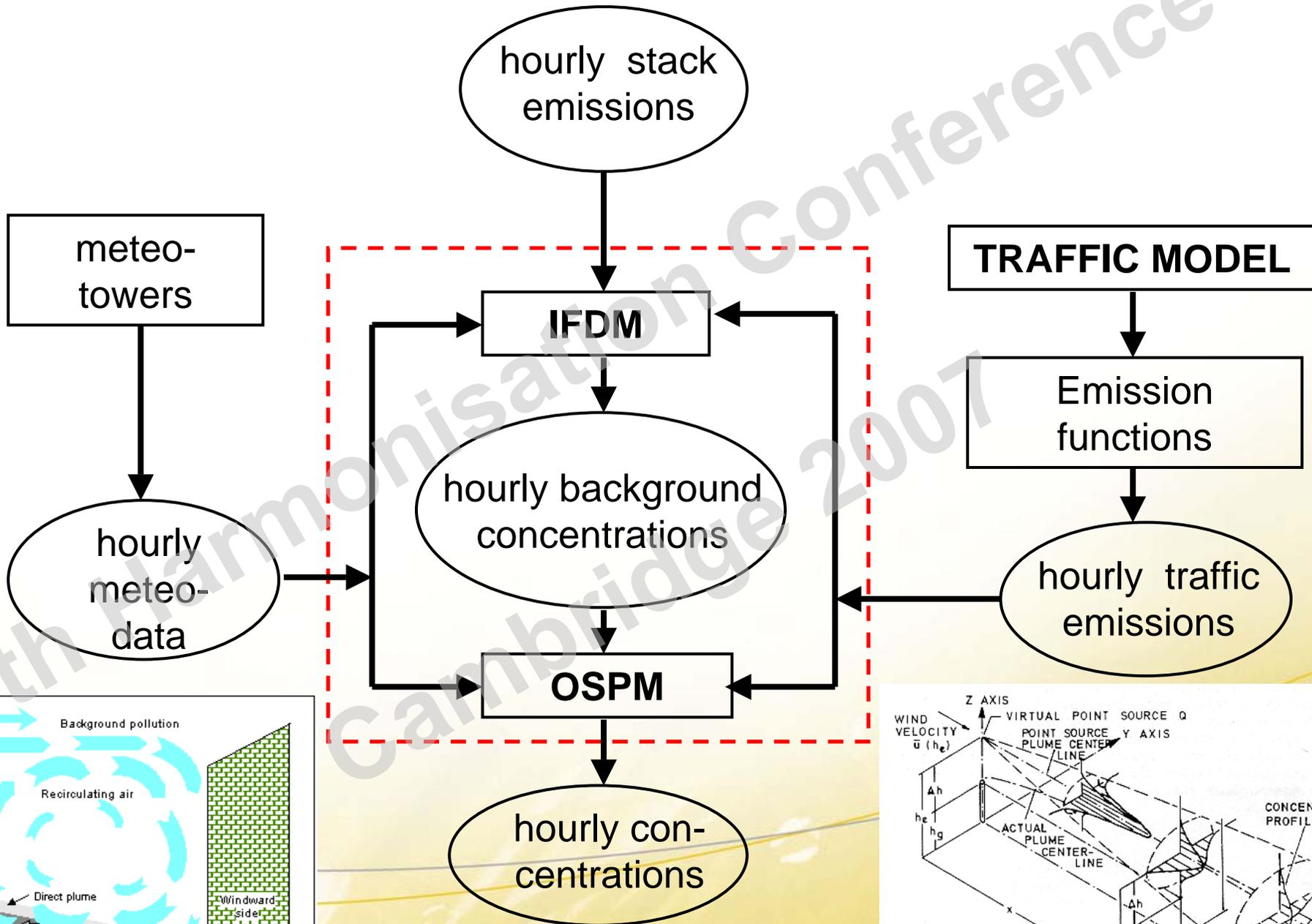
- For every hour calculate:

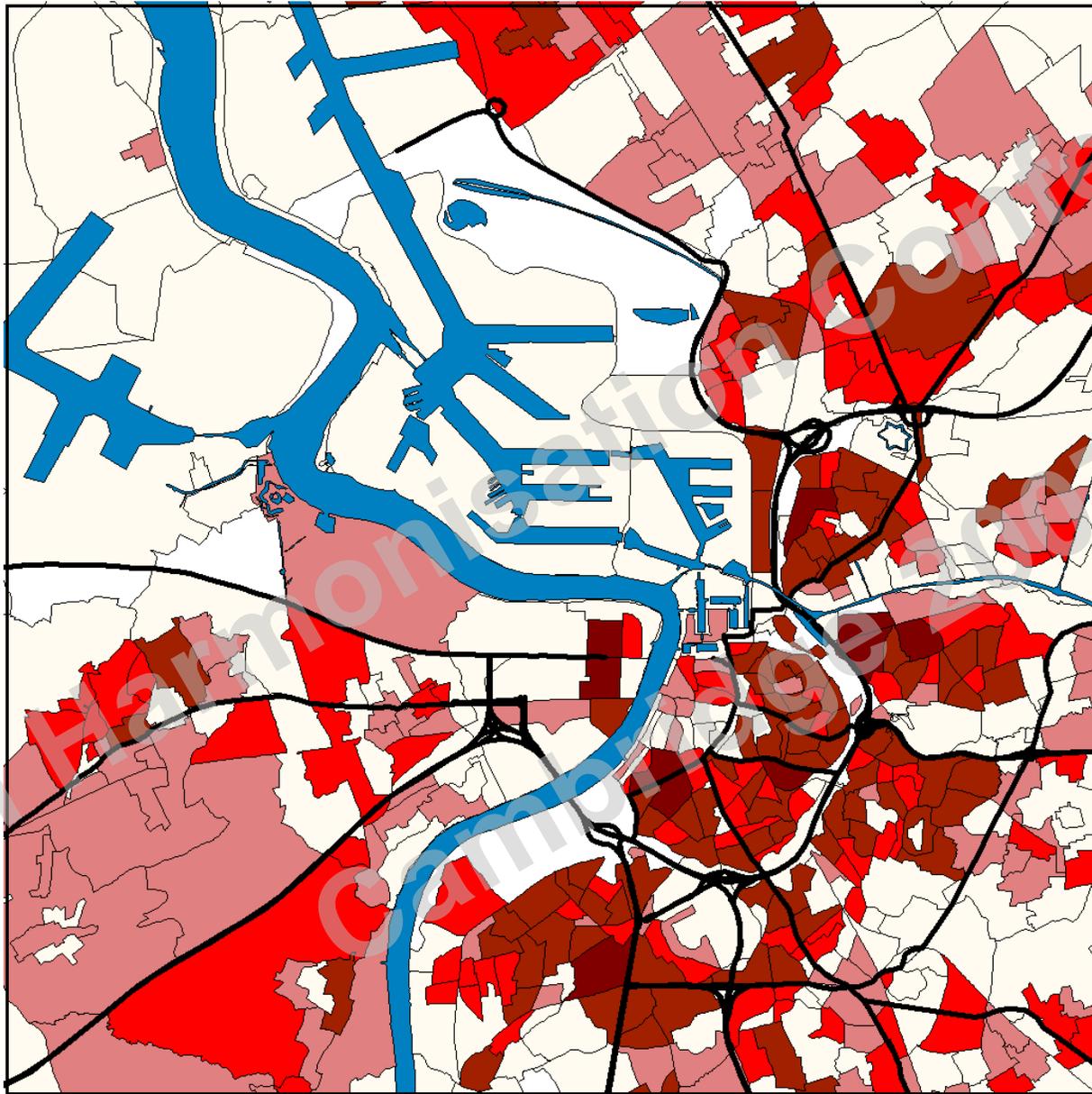
$$C = C_{\text{street}} + C_{\text{background}}$$

From a street
canyon model
(OSPM)

From a
Gaussian plume
model (IFDM)







 Schelde
 Highways

Population density /
statistical sector

	1 - 500
	500 - 1000
	1000 - 2000
	2000 - 4000
	4000 - 6385



Exposure to PM

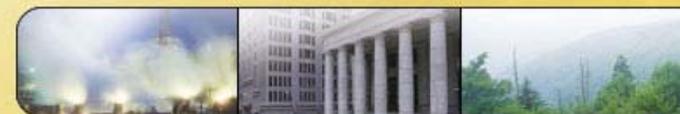
	Attributable cases	DALY	External costs (1 000 Eur)
Acute cardiorespiratory mortality	750 (375 – 1 100)	131 (66 – 195)	31 000 (15 600 – 46 000)
Resp. hospital admissions	1 400 (900 - 1 900)	34 (22 – 46)	6 000 (4 000 – 8 250)
Cardiovascular hospital admissions	1 700 (1 150 –2 300)	46 (31 – 61)	28 500 (19 000 – 38 000)
Bronchodilator use	1 900 (1 250 – 2 500)	2 (1,4 – 2,8)	75 (50 – 100)
Prevalence of cough	1 100 (550 – 1 300)	1 (0,5 – 1,3)	48 (24 – 60)
Lower resp. symptoms	350 (250 – 600)	3 (2 – 5)	2 ,8 (1,9 – 4,7)
Resp. hospital admissions for COPD ^a	160 (50 – 280)	37 (11 – 63)	700 (200 – 1 200)

Source: MIRA, 2001



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Results

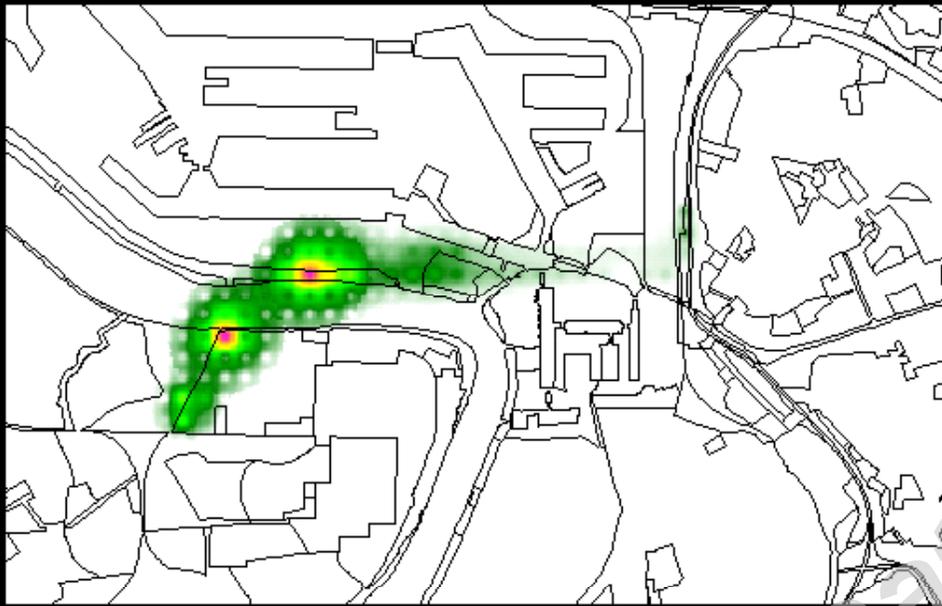
- What's the difference in exposure between a road tunnel and a road viaduct ?
- What's the impact in 2015 ?
 - Current situation (2003)
 - Autonomous scenario (2015)
 - Oosterweel scenario (2015)



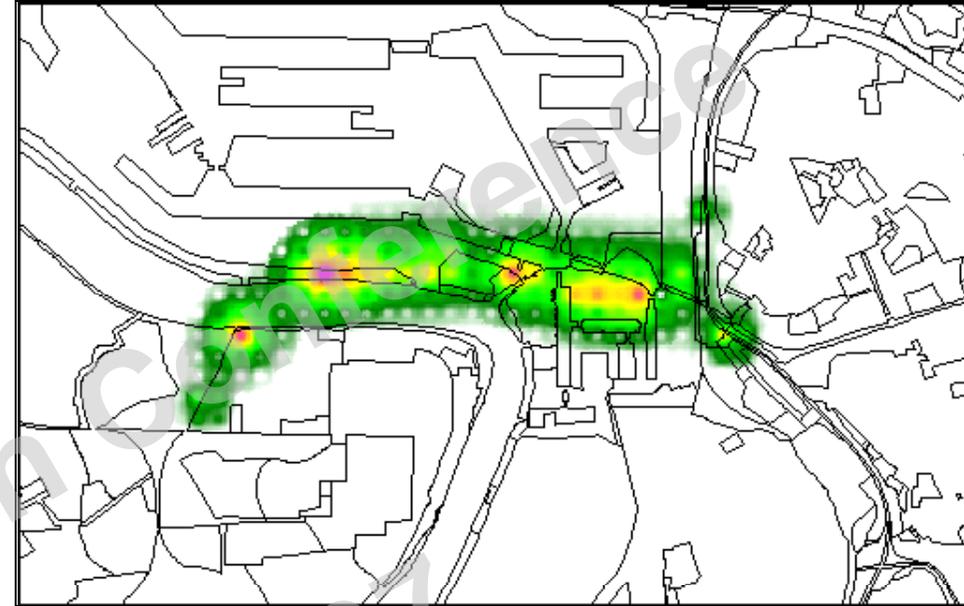
Traffic Emissions

Scenario	NO _x (tons/year)	PM ₁₀ (tons/year)
Viaduct scenario	201,2	8,15
Tunnel scenario	197,7	8,0
Ring road neighbourhood	709	31
Traffic in Flanders	87488	4384



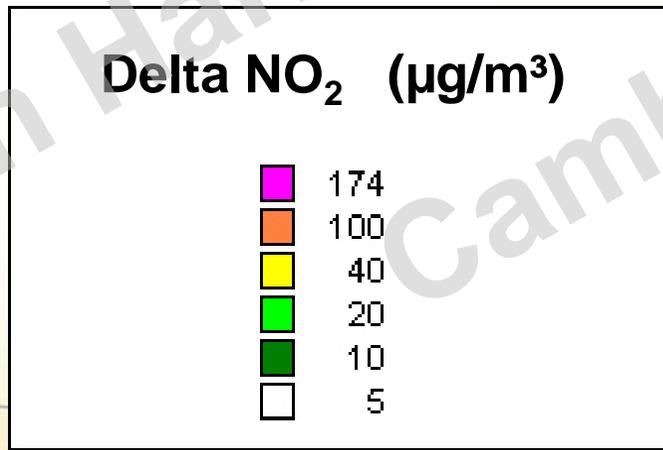
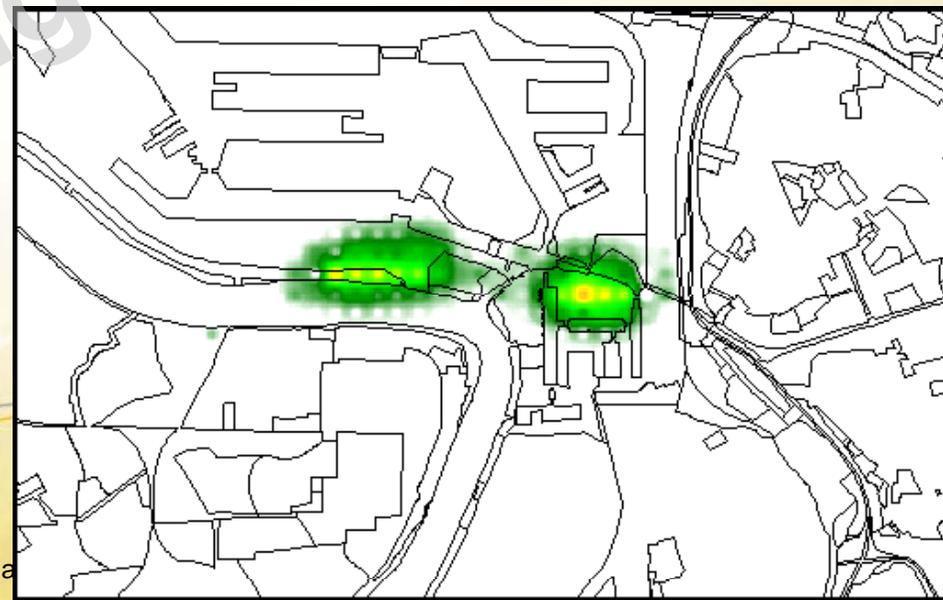


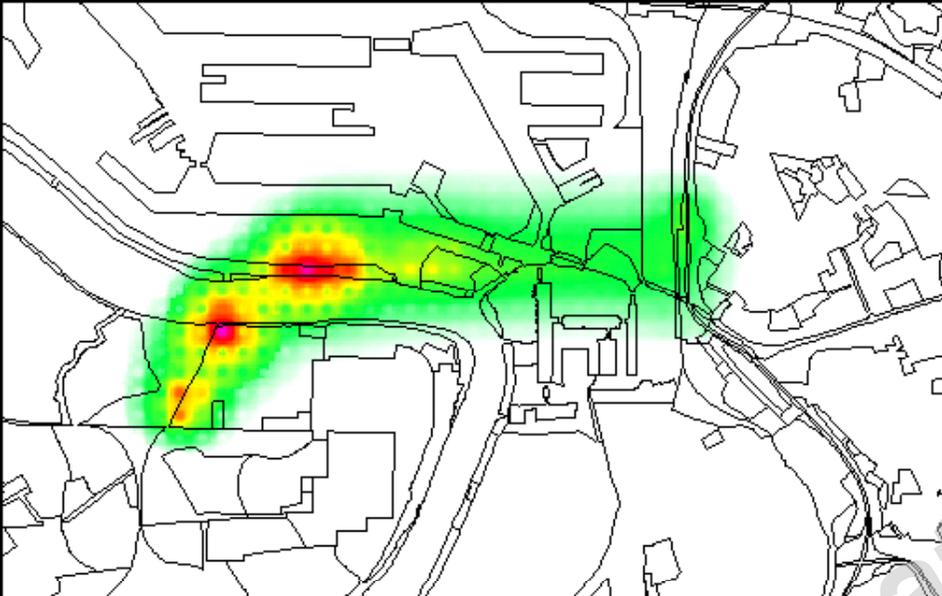
Viaduct 



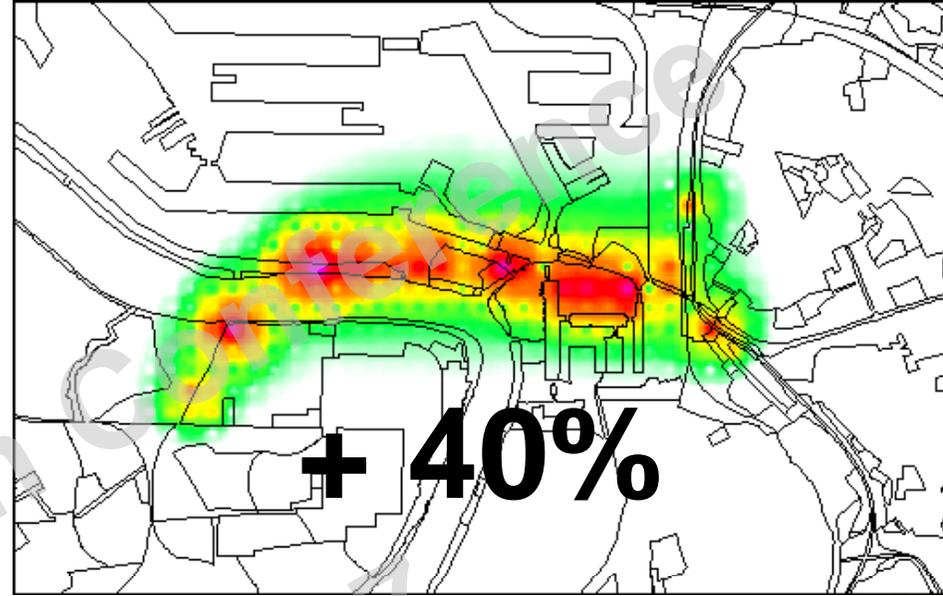
Tunnel, exhaust height = 5 m. 

Tunnel, exhaust height = 30 m. 



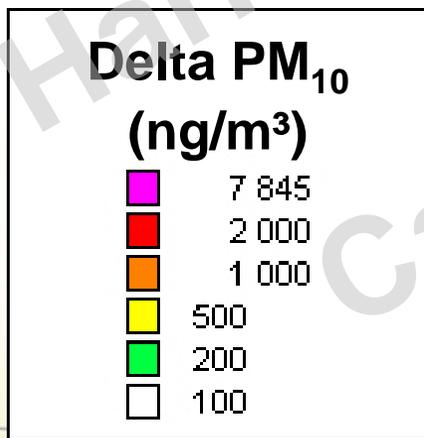
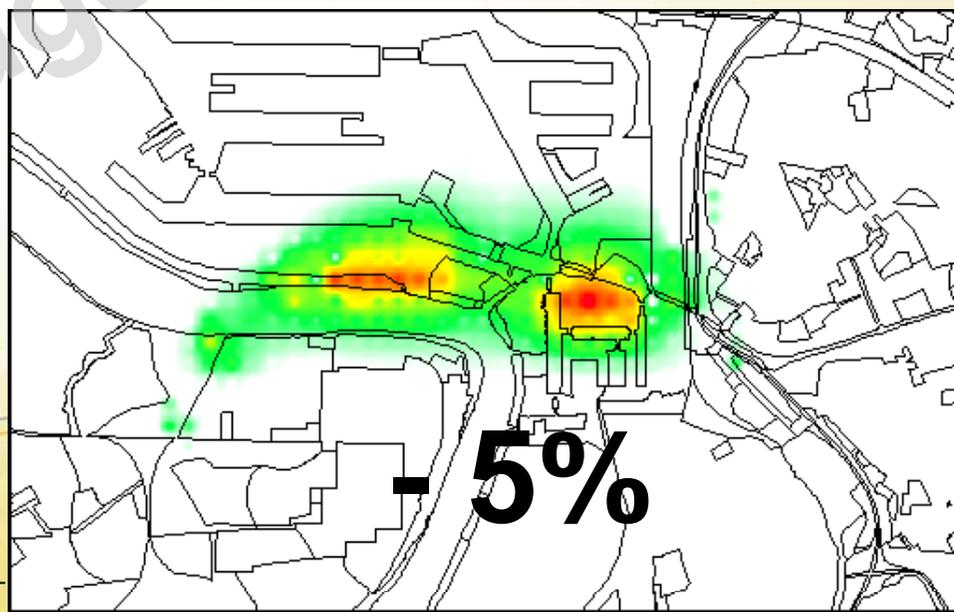


Viaduct 



Tunnel, exhaust height = 5 m. 

Tunnel, exhaust height = 30 m. 



Results

- What's the difference in exposure between a road tunnel and a road viaduct ?
- What's the impact in 2015 ?
 - Current situation (2003)
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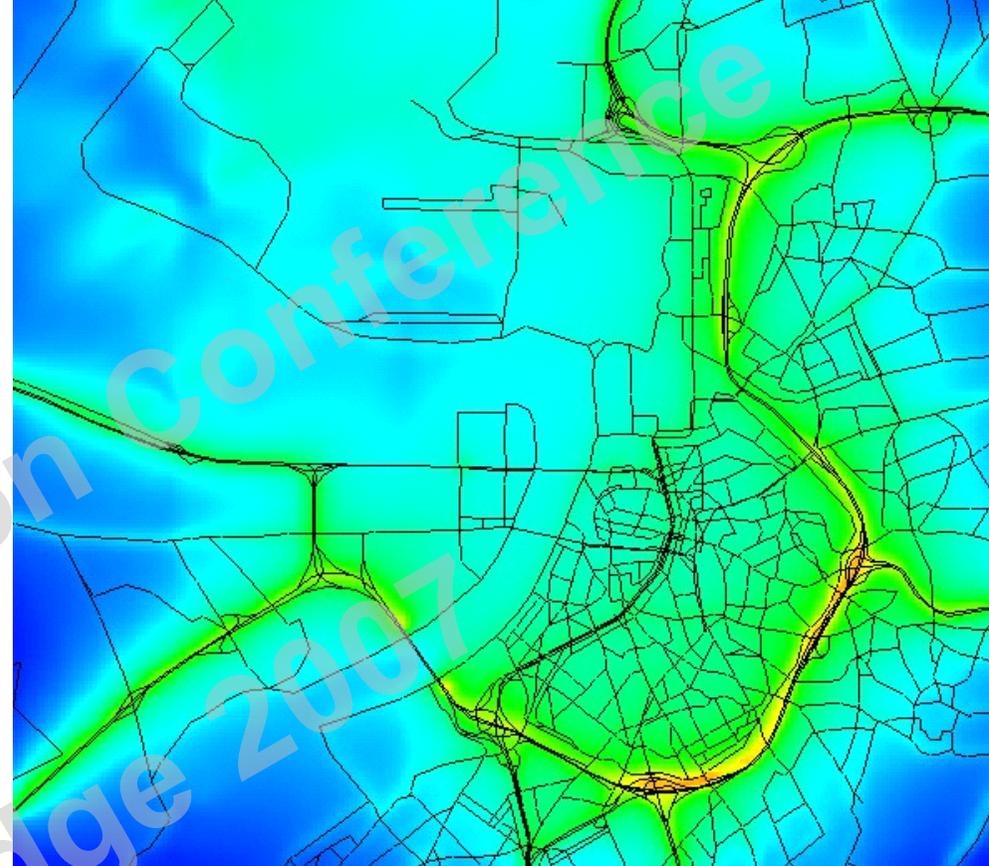
Model validation

	PM10 measured $\mu\text{g}/\text{m}^3$	PM10 computed $\mu\text{g}/\text{m}^3$	NO2 measured $\mu\text{g}/\text{m}^3$	NO2 computed $\mu\text{g}/\text{m}^3$
Annual average	39	39	50	48
P50	34	34	48	46
P70	47	43	60	54
P80	56	50	68	60
P90	71	64	81	70
P95	86	78	94	81
P98	103	86	109	95
P99	118	99	126	105
MAX	251	115	230	168

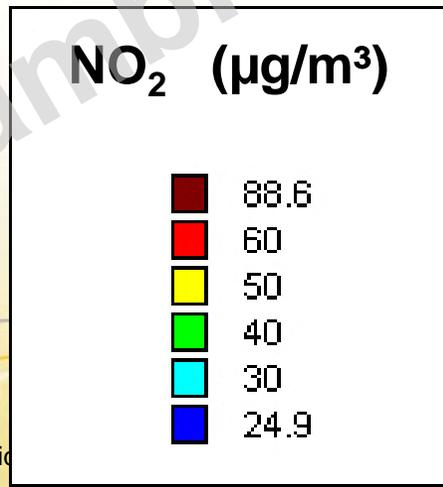




Situation 2003

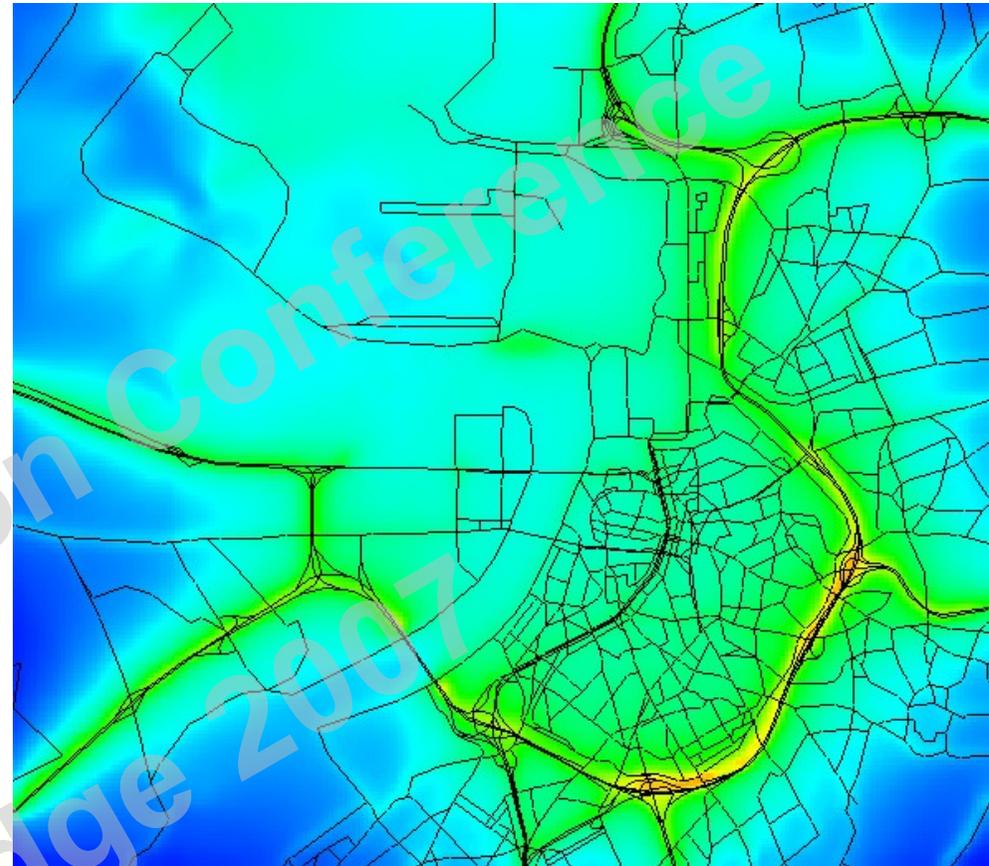


Autonomous 2015

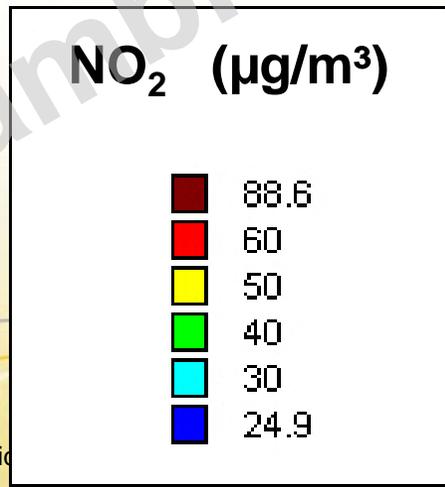




Situation 2003



Oosterweel 2015



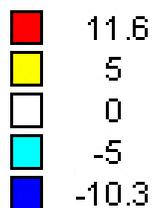


Absolute difference

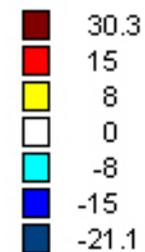


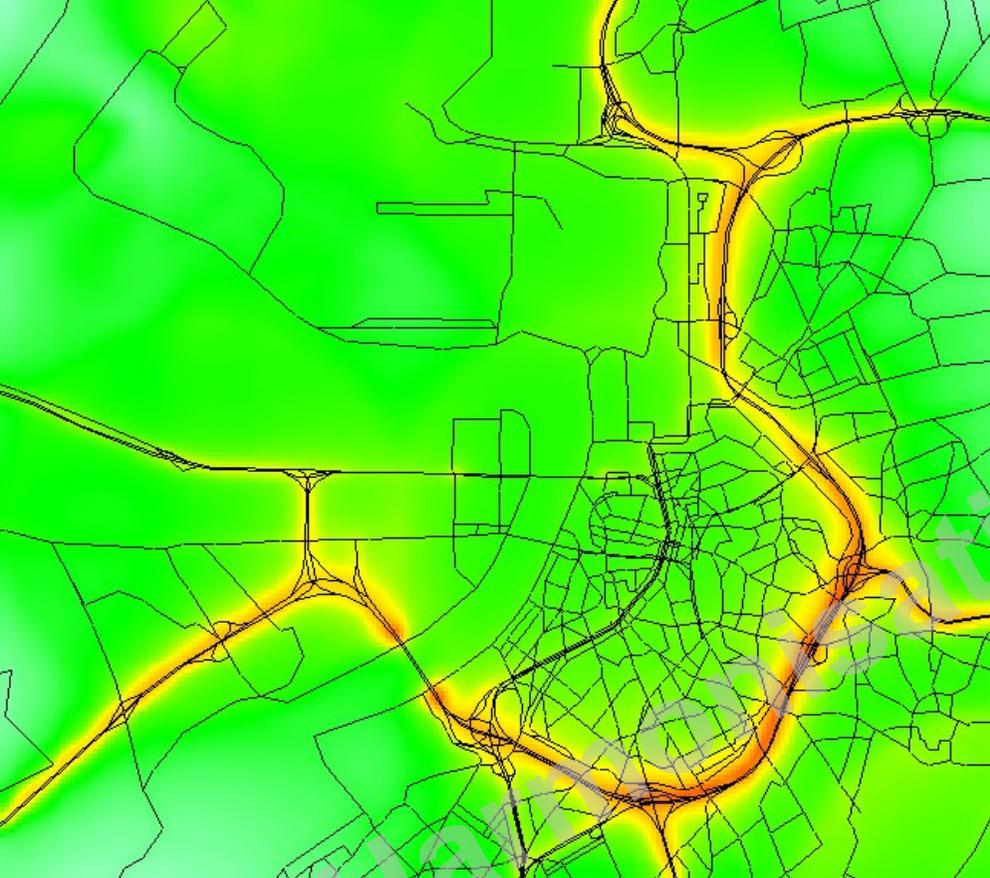
Relative difference

NO₂ (µg/m³)

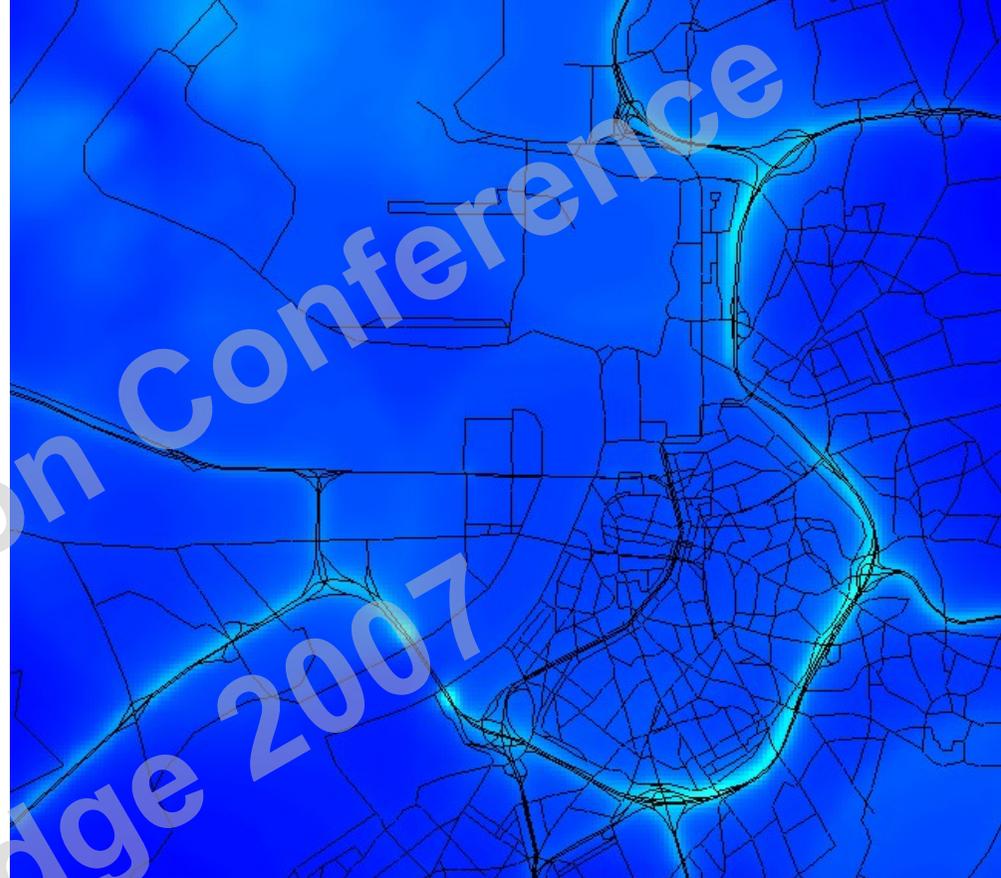


Change (%)

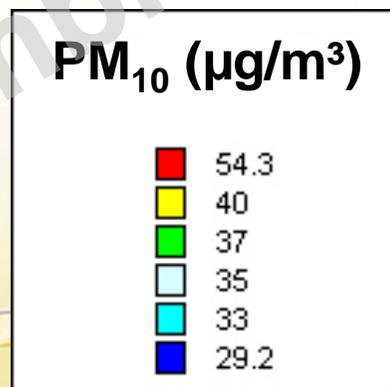


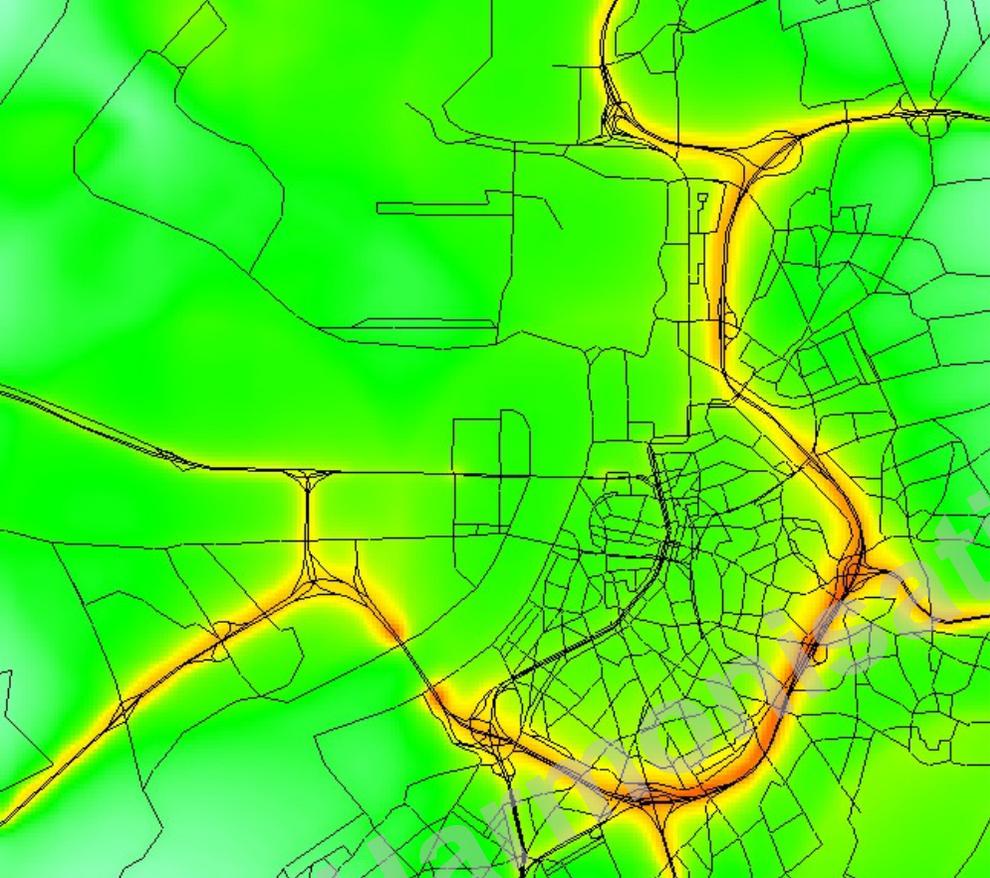


Situation 2003

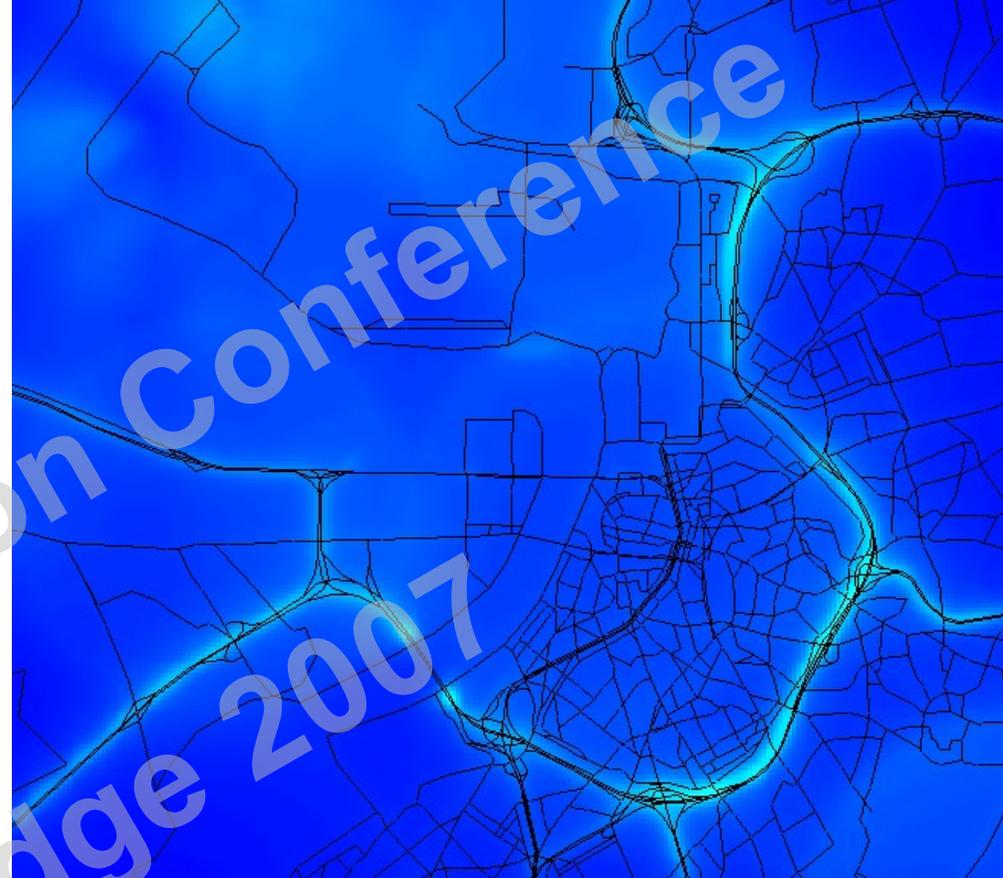


Autonomous 2015

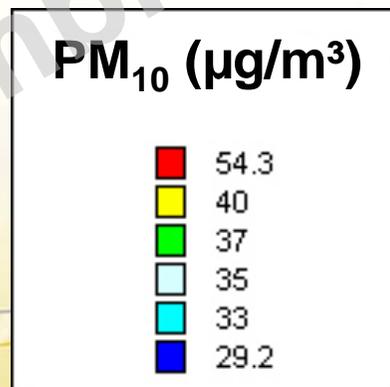




Situation 2003

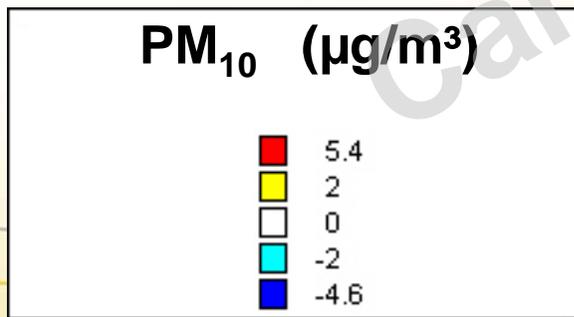


Oosterweel 2015

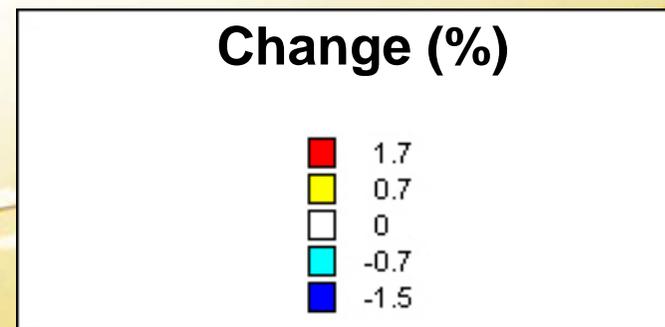


**Changes in exposure
are negligible: <0,1%**

Absolute difference



Relative difference



Assumptions and caveats

- Emissions 2015 based on assumptions for fleet scenario and emission factors in 2015
- Population is assumed to remain unchanged in 2015
- Static approach for exposure: activity based modelling is needed in the future



Conclusions

- Compared to the impact of a viaduct, a tunnel with an exhaust height of 5 m. shows an *increase* in total exposure of 40%, whereas a tunnel with an exhaust height of 30 m. shows a *decrease* of 5%
- However, these differences are not very significant in absolute terms, because of the high background concentrations for PM₁₀ and low population density
- Exposure will decrease considerably in 2015 due to an expected sharp decrease in traffic emission factors, especially for PM₁₀



Thank you!

