Health costs of air pollution in European cities and the linkage with transport

CE Delft

Committed to the Environment

Introduction

Air Pollution is a place where Economics and Health sciences can meet

- Air pollution is the **4th highest cause of death** among all health risks, exceeded only by high blood pressure, diet and smoking (WHO, 2018)
- Air pollution in economics is a **traditional external effect**: an individual cannot choose their level of pollution.
- The imperative from economics is since Pigou (1926): internalize the external effect by making **the polluter pay for the damage**.

- Since 1930s: what is the damage? (trail smelter case)
- Social costs = costs of tangible (medical costs, loss of working days) and intangible (reduced life expectancy) costs.
- WHO (2013) quantifies impacts from air pollution on numerous endpoints.

Present study

- *2018: study estimating social costs of diesel emissions at **country level***

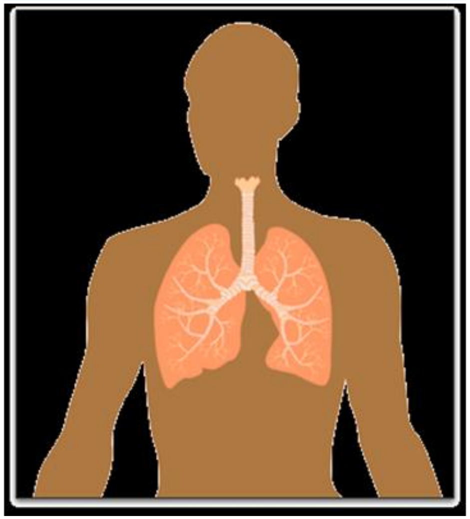
- 2020 study: To estimate at the **city level** the social costs of air pollution and investigate the role of transport in these emissions

- *Future 2021 study: To investigate effective transport policies at the city level to reduce the social costs of air pollution*

Methods

Step 1: Determine the air quality in a city

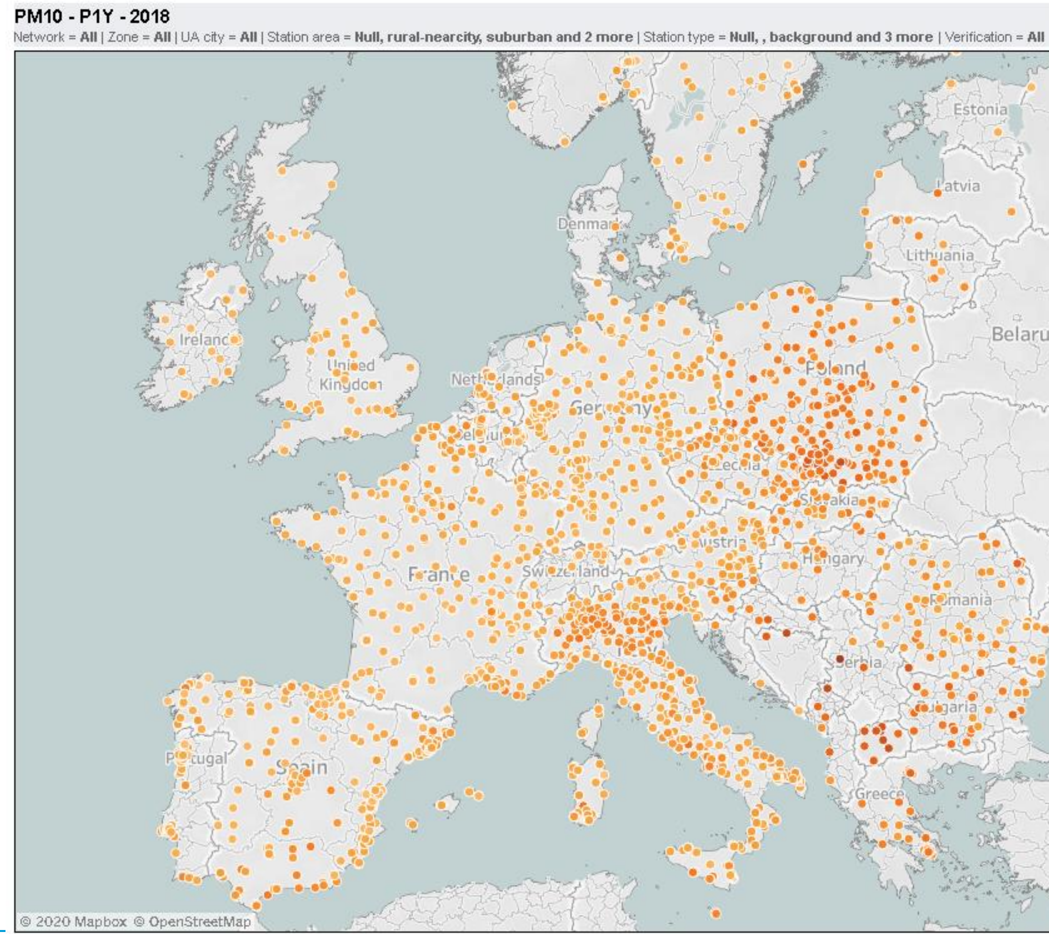
Step 2:
Quantify the impacts



Step 3:
Value these impacts

Step 1: Pollutants: concentration levels

- Levels of reported air quality
- Eurostat: Urban Audit data combined with monitoring stations (EEA)
- Total cities: 432
- Year 2018



Step 2: Calculation of impacts

- Mortality endpoints: RRs from WHO (chronic and acute) for PM2.5, NO2, O3 *with city specific age cohorts and country specific incidence rates*
- Morbidity endpoints: Using Impact Tables with concentration response functions (CRFs) *with city specific age cohorts and EU incidence rates*

Endpoint	Substance	Age groups	RR or CRF	Value^	Source
Life years lost (chronic)	$PM_{2.5}$	Adults 30+	RR	6.20E-03	WHO (2013)
Life years lost (acute)	$PM_{2.5}$	Adults 30+	RR	1.23E-03	WHO (2013)
netto Restricted activity days	$PM_{2.5}$	All	CRF	9.59E-03	NEEDS (2008)*
Work loss days	$PM_{2.5}$	Labour Force	CRF	2.07E-02	NEEDS (2008)*
Minor restricted activity days	$PM_{2.5}$	Adults_18_to_64	CRF	5.77E-02	NEEDS (2008)*
Increased mortality risk (infants)	PM_{10}	All	CRF	4.00E-03	NEEDS (2008)*
New cases of chronic bronchitis	PM_{10}	Adults18 and Above	CRF	4.51E-05	CE Delft (2019)*
Respiratory hospital admissions	PM_{10}	All	CRF	7.03E-06	NEEDS (2008)*
Cardiac hospital admissions	PM_{10}	All	CRF	4.34E-06	NEEDS (2008)*
Medication use	PM_{10}	Children_5_to_14	CRF	4.76E-03	CE Delft (2019)*
Increased mortality risk	SOMO35	All	RR	2.90E-04	WHO (2013)
CVD/resp. hospital admissions	SOMO35	Elderly_65+	CRF	3.43E-05	CE Delft (2019)*
MRAD	SOMO35	Adults_18_to_64	CRF	1.15E-02	NEEDS (2008)*
Life years lost	NO_2	Adults 30+	RR	7.60E-04	CE Delft (2020)*
Bronchitis in asthmatich children	NO_2	Children_5_to_14	CRF	5.25E-03	CE Delft (2019)*
Hospital admissions	NO_2	All	CRF	1.11E-05	CE Delft (2019)*

Step 3: Valuation

- Taken from DG Move study (CE Delft, 2019) which bases this on literature review (peer reviewed)
- Average value of EU28
- City specific value can be obtained by using the income elasticity (in PPP) of 0.8 as recommended by OECD.

Core Endpoints	Pollutant	Unit	Valuation per unit
Increased mortality risks (YOLL)*	$PM_{2.5}$, SOMO35, NO_2	YOLL*	70,000
netto Restricted activity days (netRADs)	$PM_{2.5}$	Days	157
Work loss days (WLD)	$PM_{2.5}$	Days	94
Minor restricted activity days (MRAD)	$PM_{2.5}$, SOMO35	Days	52
Increased mortality risk (infants)	PM_{10}	Cases	3,600,000^
New cases of chronic bronchitis	PM_{10}	Cases	240,000^
hospital admissions (CVD, respiratory)	PM_{10}, SOMO35, NO_2	Cases	2,850^
medication use/bronchodilator use	PM_{10}, NO_2	Cases	2

Results: Total damage costs in 2018

#	Country	City	Total damage costs (mln€)
1	United Kingdom	London (greater city)	€ 11,381
2	Romania	Bucuresti	€ 6,345
3	Germany	Berlin	€ 5,237
4	Poland	Warszawa	€ 4,223
5	Italy	Roma	€ 4,144
6	Poland	Metropolia Silesia	€ 3,596
7	France	Paris	€ 3,505
8	Italy	Milano	€ 3,499
9	Spain	Madrid	€ 3,383
10	Hungary	Budapest	€ 3,272
11	Germany	Hamburg	€ 2,936
12	Germany	München	€ 2,878
13	Bulgaria	Sofia	€ 2,575
14	Austria	Wien	€ 2,567
15	United Kingdom	Greater Manchester	€ 2,409
16	Czech Republic	Praha	€ 2,253
17	Spain	Barcelona	€ 2,020
18	Italy	Torino	€ 1,815
19	United Kingdom	West Midlands urban area	€ 1,807
20	Germany	Köln	€ 1,787
21	Belgium	Bruxelles / Brussel	€ 1,586
22	Poland	Kraków	€ 1,490
23	Germany	Frankfurt am Main	€ 1,345
24	Croatia	Zagreb	€ 1,312
25	Poland	Wroclaw	€ 1,240

Total damage costs are influenced by in our calculations by:
- Air quality
- Population size
- Income level
- Age structure

Results: Damage costs per capita in 2018

Top 10 highest damage cost per capita				Top 10 lowest damage cost per capita			
	Country	City	Damage cost per capita		Country	City	Damage cost per capita
1	RO	Bucuresti	€ 3,004	1	ES	Santa Cruz de Tenerife	€ 382
2	IT	Milano	€ 2,843	2	EE	Narva	€ 405
3	IT	Padova	€ 2,455	3	FI	Kuopio	€ 428
4	PL	Warszawa	€ 2,433	4	ES	Arrecife	€ 448
5	SK	Bratislava	€ 2,168	5	FR	Pau	€ 467
6	IT	Venezia	€ 2,106	6	FR	Perpignan	€ 474
7	IT	Brescia	€ 2,106	7	EE	Tartu	€ 481
8	BG	Sofia	€ 2,084	8	FR	Brest	€ 501
9	IT	Torino	€ 2,076	9	CH	Genève	€ 510
10	DE	München	€ 1,984	10	FI	Tampere/ Tammerfors	€ 514

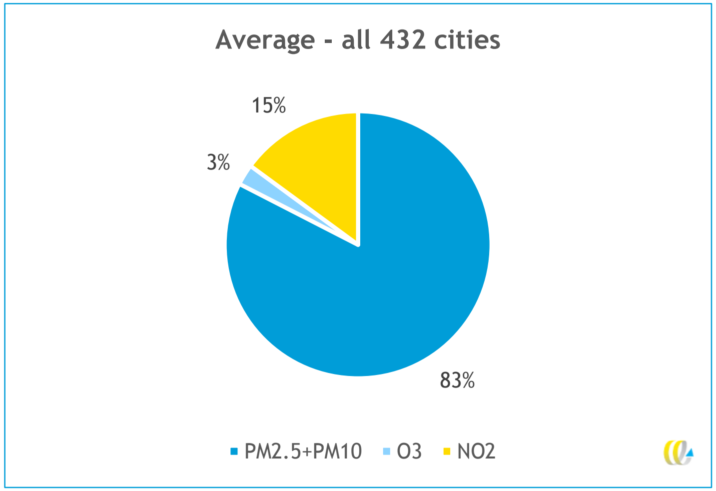
Costs per capita are influenced in our calculations by:
Air quality
Income level
Age structure

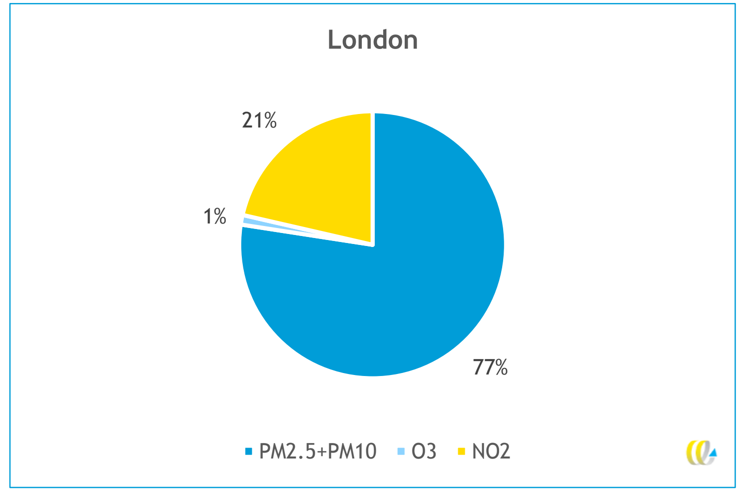
Results: Damage costs per unit income

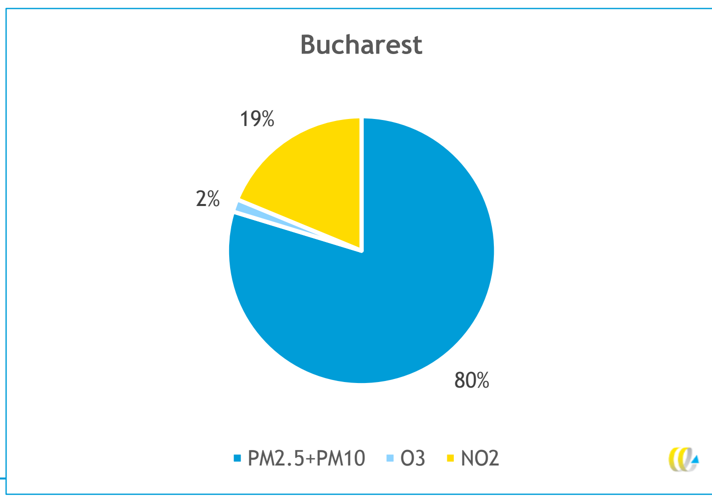
Top 10 highest				Top 10 lowest			
	Country	City	Share of damage costs in GDP		Country	City	Share of damage costs in GDP
1	BG	Ruse	9.9%	1	FI	Kuopio	1.3%
2	RO	Iasi	9.4%	2	IE	Dublin	1.4%
3	PL	Metropolia Silesia	8.6%	3	IE	Cork	1.5%
4	BG	Shumen	8.6%	4	SE	Stockholm	1.5%
5	PL	Bielsko-Biala	8.6%	5	NO	Bergen	1.5%
6	BG	Plovdiv	8.6%	6	FI	Oulu	1.6%
7	PL	Rybnik	8.5%	7	ES	Arrecife	1.7%
8	BG	Burgas	8.2%	8	FR	Pau	1.7%
9	PL	Kraków	8.1%	9	ES	Santa Cruz de Tenerife	1.7%
10	RO	Brasov	8.1%	10	EE	Tallinn	1.8%

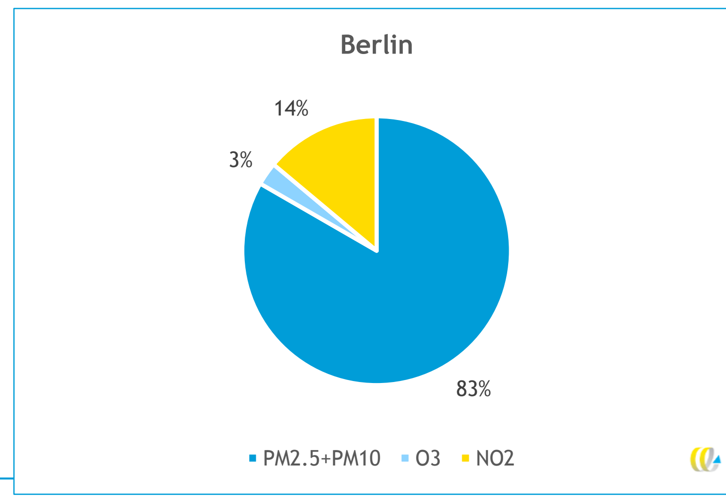
Costs per unit of GDP are influenced in our calculations by:
Air quality
Age structure
Income level

Task 1 Results: Contribution to air pollution









Task 2: Impacts of modes of transport

- Relate the ambient air quality to indicators of transport through regression analysis;
- Indicators of transport in the Urban Audit (only for 79 cities!).

Share of journeys to work by car -%
Share of journeys to work by public transport (rail, metro, bus, tram) -%
Share of journeys to work by motor cycle -%
Share of journeys to work by bicycle -%
Share of journeys to work by foot -%
Share of journeys to work by car or motor cycle -%
Average time of journey to work - minutes
Average length of journey to work by private car - km
People commuting into the city
People commuting out of the city
Length of bicycle network (dedicated cycle paths and lanes) - km
Cost of a combined monthly ticket (all modes of public transport) for 5-10 km in the central zone - EUR
Cost of a taxi ride of 5 km to the centre at day time - EUR
Number of private cars registered
Number of deaths in road accidents
Number of registered cars per 1000 population

Task 2 Results

- Finding that transport related variables plus household heating influence around 30% of city's air quality is confirmed by the literature and by experts.
- Overall the model points that car possession is an import explanatory variable in the model. If car possession in a city could be halved, city's air quality tend to improve by 24-25%.
- Halving the journey time to work could improve air quality by 15-27%
- There are many other variables that have not been quantified in our research because no indicators are available at the level of an individual city.

Conclusions

- Air quality in cities is an important determinant of public health in those cities
- We quantify that every citizen in Europe loses annually €1,276 in welfare due to poor air quality
- This figure differs considerably between over €3000/year in Bucharest with various bigger cities scoring below the €1000/year (e.g. Talinn, €584)
- Per unit of GDP, a European citizen looses on average 3.9% of their income on welfare losses due to air pollution. In Central and Eastern European cities this figure can be as high as nearly 10%.
- Our regression analysis suggest that transport policies matter for air quality in cities and may be key in reducing the social costs of air pollution.

THANK YOU FOR YOUR ATTENTION!

CE Delft

- Independent environmental policy research institute (1978)
- 70 employees
- Multidisciplinair research (economists, engineers, LCA)
- Non-profit
- Economic Dept: 9 people, mostly PhD.

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