Assessment of health impacts and costs attributable to air pollution

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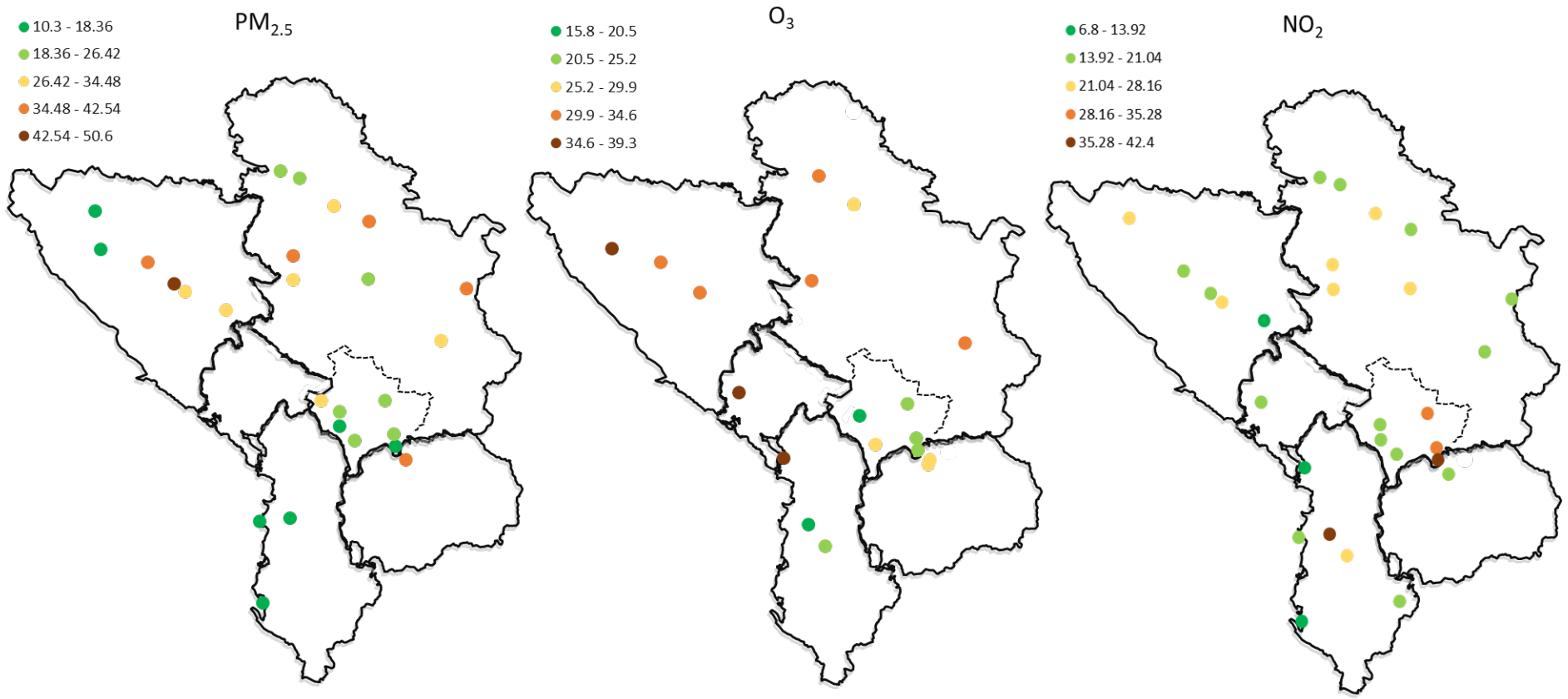
Outline

- Estimation health impacts and costs is 30 Western Balkans' cities
- Econometric model to estimate VSL and VOLY
- Report on Environment and Climate in the Western Balkans
- Report on Environment and Climate in Ukraine

Levels of pollutants in 30 Western Balkans' cities (2019)



- The analysis includes local networks in addition to those reported to EEA.
- Only urban background stations with **> 75%** data capture
- The health impact of air pollution was assessed in **30** cities with population ranging from 6,000 to 600,000 inhabitants.
- The population captured in this study represents **37%** of the region urban population.

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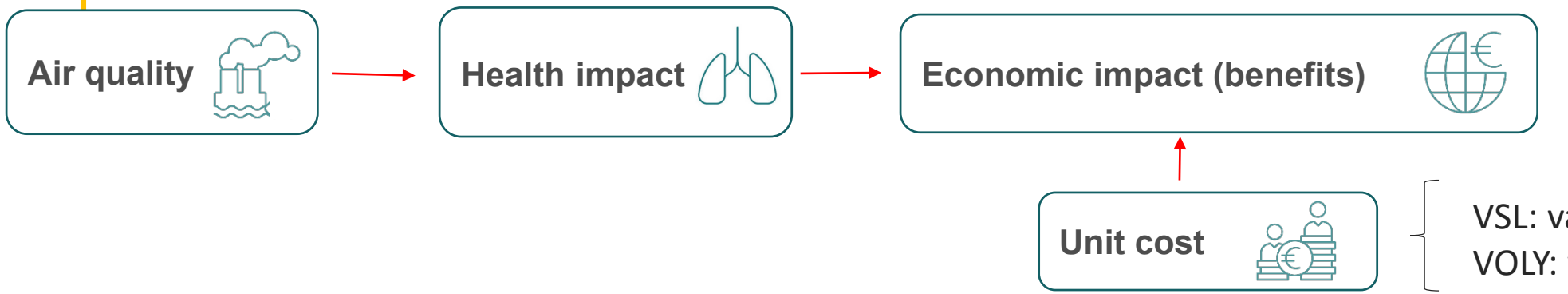
Parameters of the concentration response functions (CRF) used in this study.

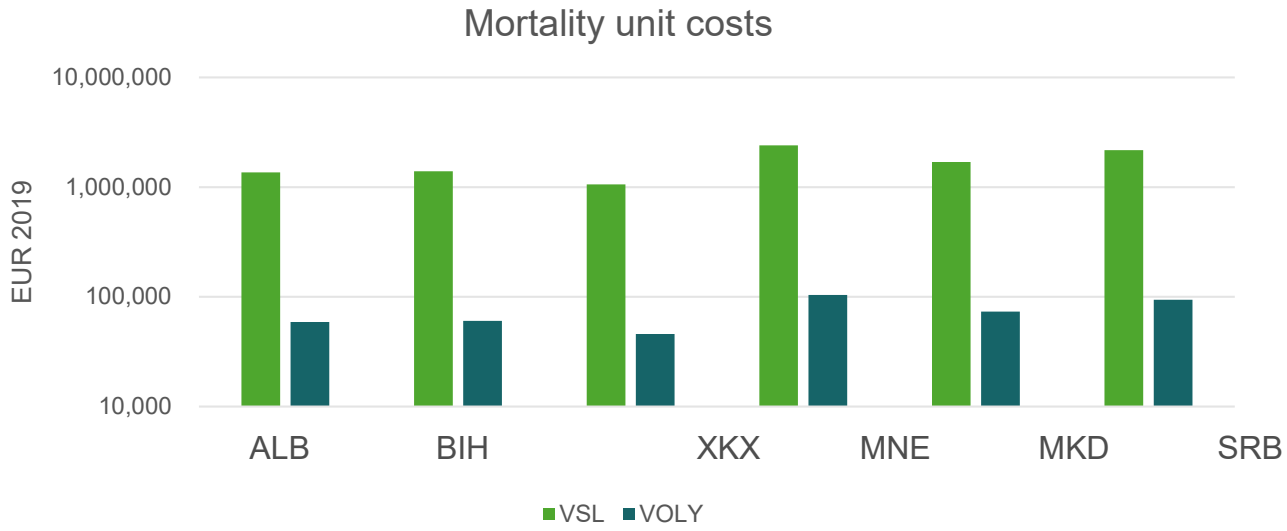
Pollutant	Metric	Type	Health outcome	CRF central	CRF low	CRF high	cut-off	Interval (µg/m^3)	Source
$PM_{2.5}$	annual mean	mortality	Mortality, all-cause (natural)	1.08	1.06	1.09	5	10	Chen and Hoek, 2020
O_3	SOMO35	mortality	Mortality, respiratory diseases	1.02	0.99	1.05	0	10	Huangfu and Atkinson, 2020
O_3	SOMO35	mortality	Mortality, all (natural) causes	1.01	1	1.02	0	10	Huangfu and Atkinson, 2020
NO_2	annual mean	mortality	Mortality, all-cause (natural)	1.02	1.01	1.04	10	10	Huangfu and Atkinson, 2020

Health cost (=benefit) estimation



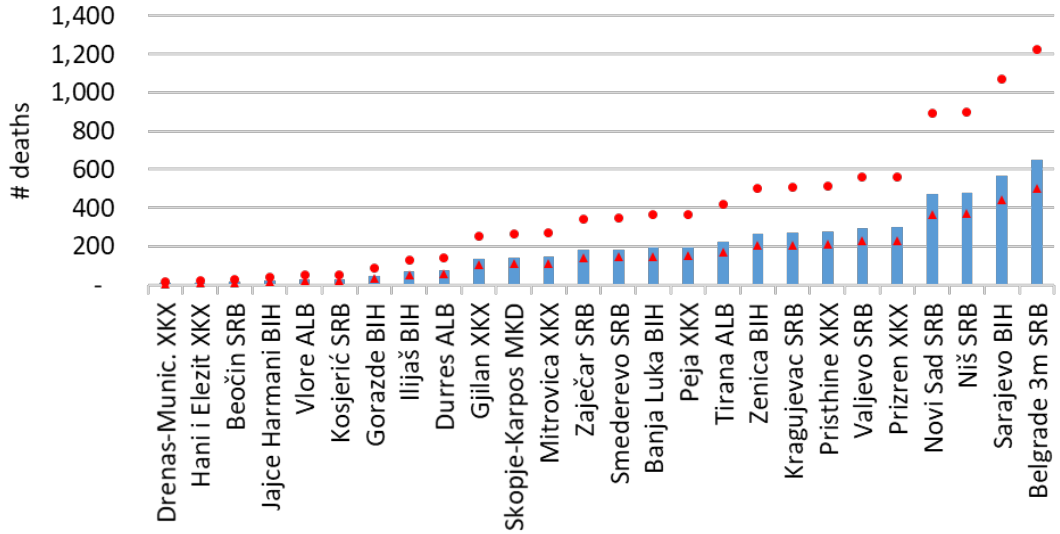
Unit cost

VSL estimated by
Willingness to Pay method (OECD, 2012)
Derived by value transfer based on GDP per capita
VOLY was derived from VSL

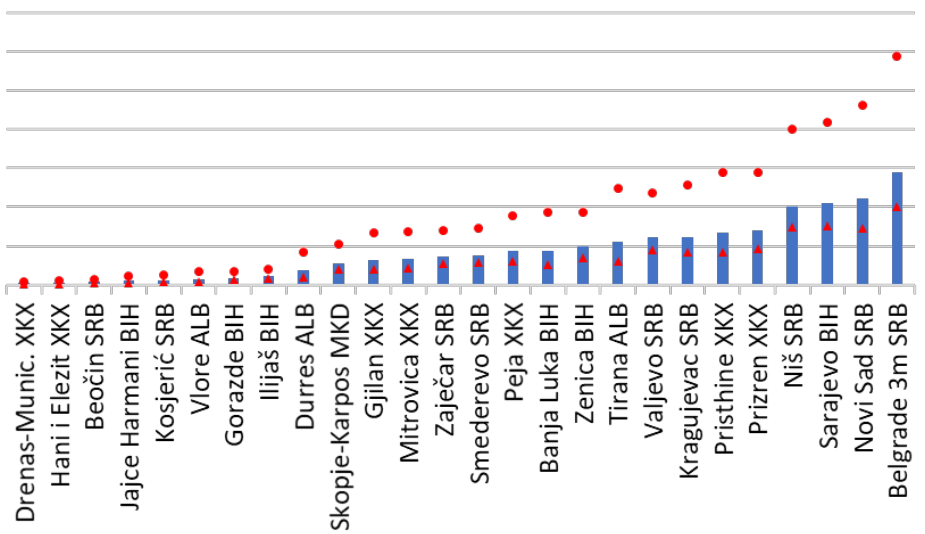


Mortality attributable to air pollution in WB cities (2019)

$PM_{2.5}$, Mortality all causes, CRF

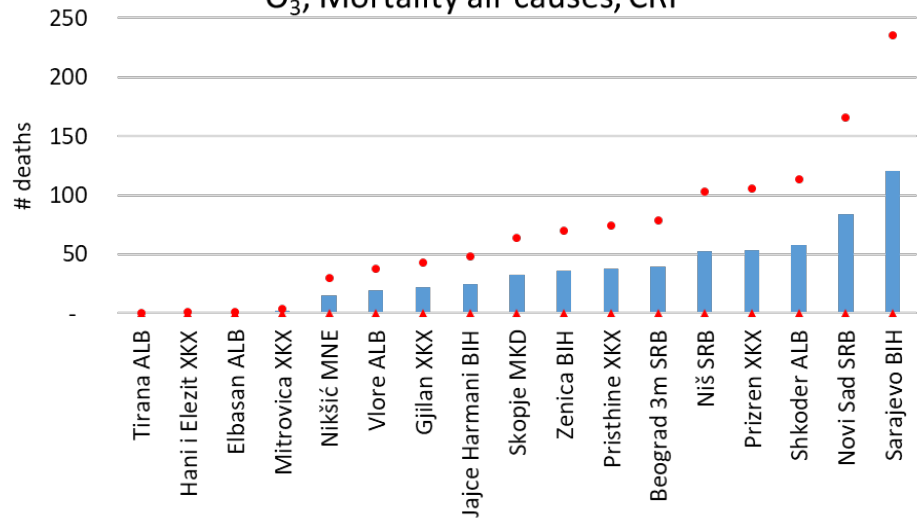


$PM_{2.5}$, Mortality six causes, IER

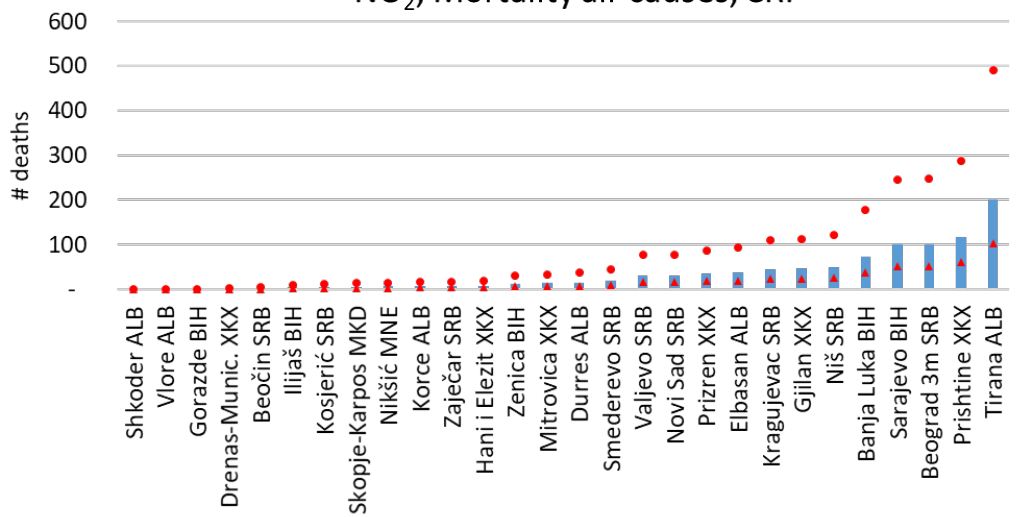


PREMATURE MORTALITY ATTRIBUTABLE TO:
$PM_{2.5}$: 4,600 – 5,300
OZONE: 600
NO_2: 970

O_3, Mortality all-causes, CRF



NO_2, Mortality all-causes, CRF



YEARS OF LIFE LOST ATTRIBUTABLE TO:
$PM_{2.5}$: 75,100 - 86,000
OZONE: 9,700
NO_2: 15,500

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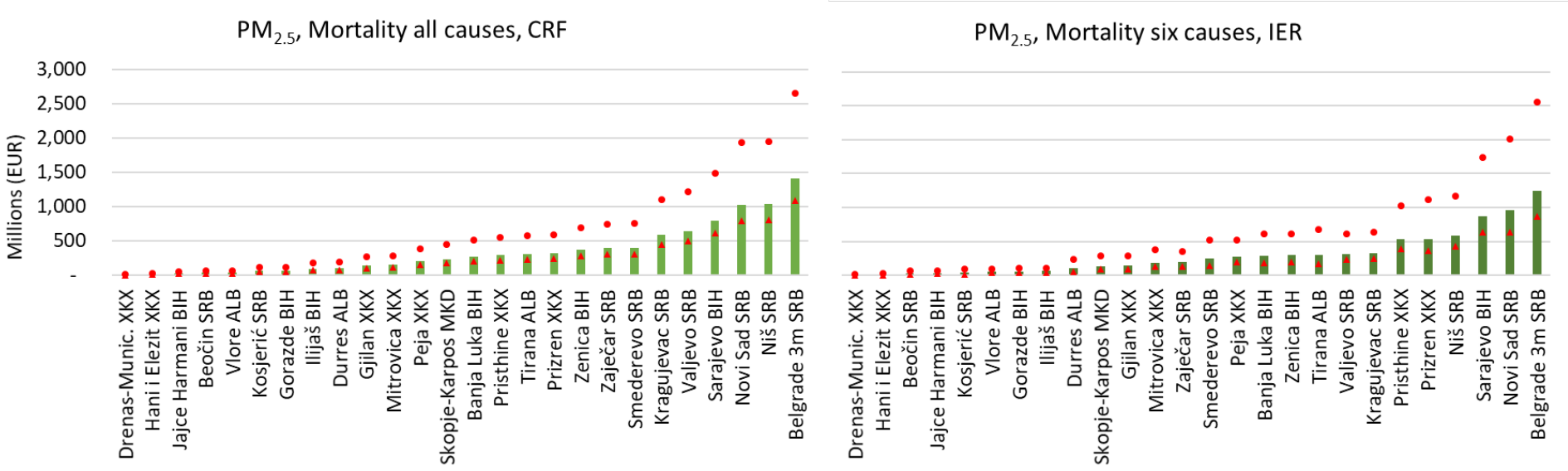
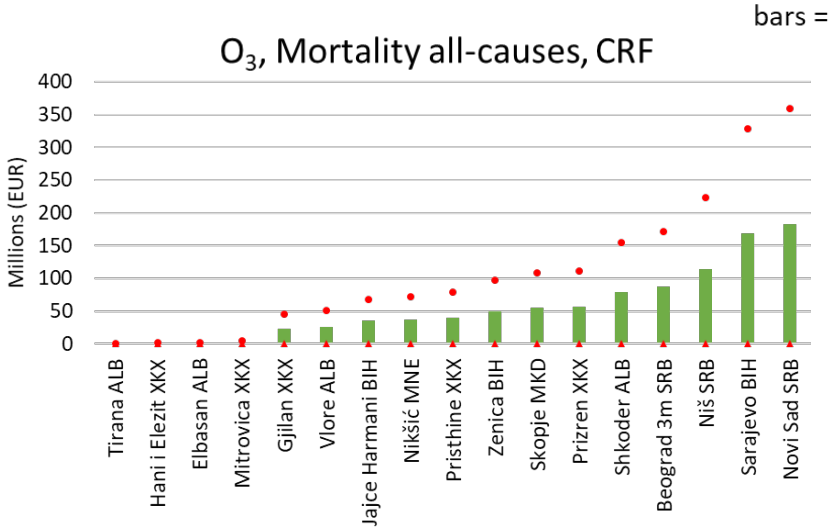
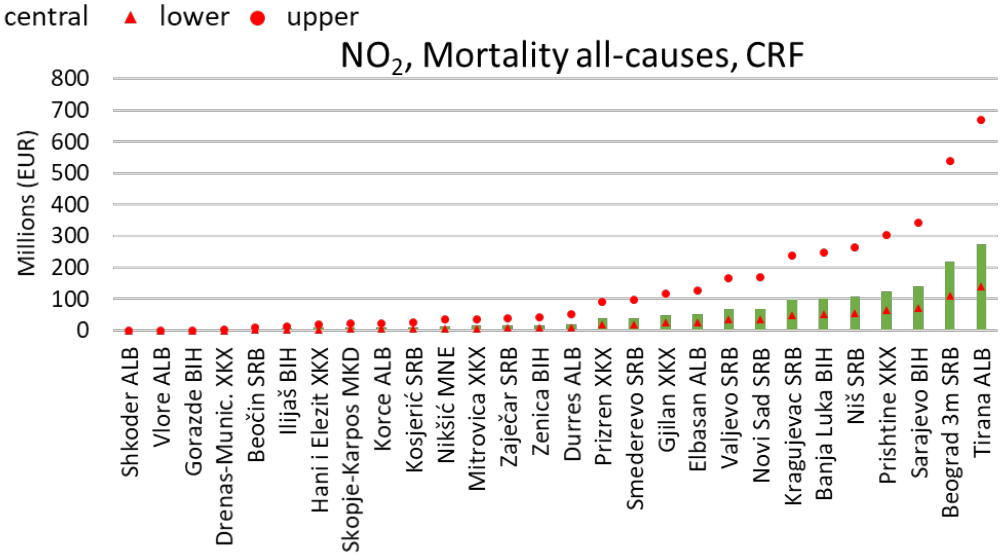
Costs (benefits) attributable to air pollution in WB cities (2019)







Cost of Mortality Attributable to:

$PM_{2.5}$
€ 7.8 - 9.0 BN
Urban areas: 26

O_3
€ 1.0 BN
Urban areas: 17

NO_2
€ 1.5 BN
Urban areas: 28

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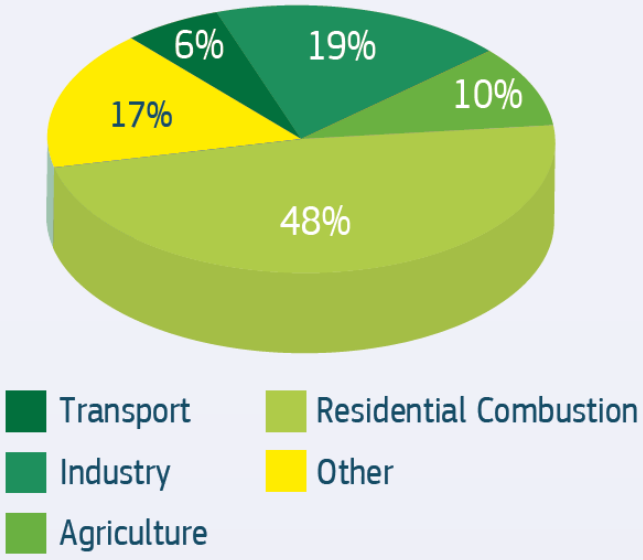
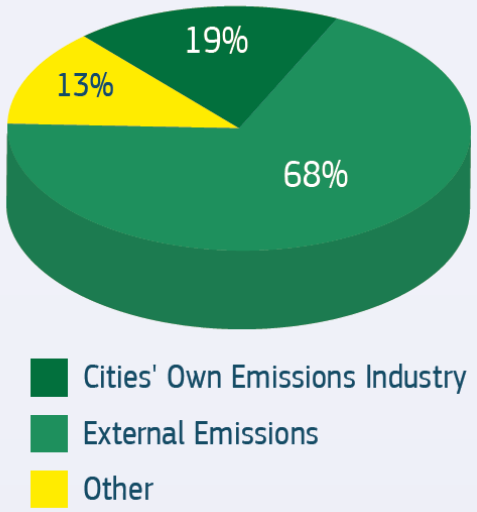
Allocation of benefits to $PM_{2.5}$ sources

Sources of urban $PM_{2.5}$

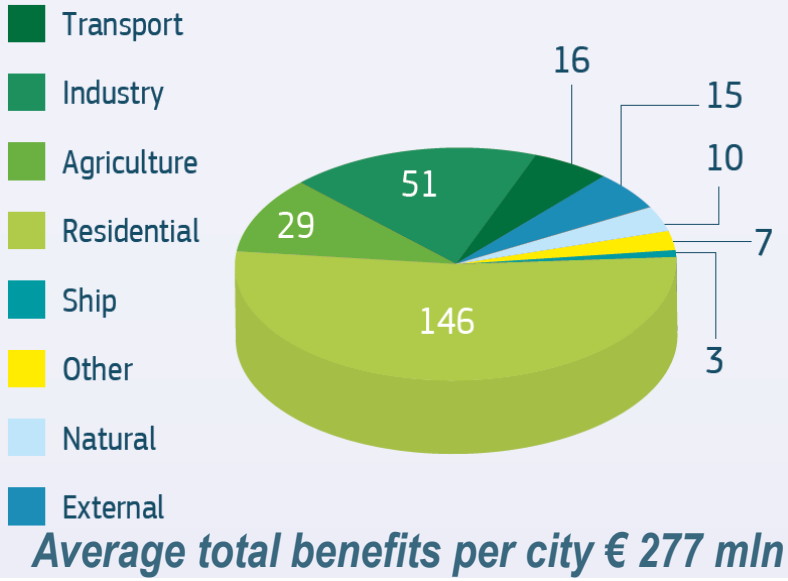


Distribution of $PM_{2.5}$ Contributions



Benefits attributed to $PM_{2.5}$ Sources

(Avg. 17 cities, € mln)



Average total benefits per city € 277 mln

The source identification presented in this slide is an update based on SHERPA by S. Zauli and E. Pisoni, 2024 pers. comm.

Contents lists available at ScienceDirect

Environment International

journal homepage: www.elsevier.com/locate/envint

Full length article

Assessment of health impacts and costs attributable to air pollution in urban areas using two different approaches. A case study in the Western Balkans

Claudio A. Belis [a,*], Vlatka Matkovic [b,f], Marta Ballocci [a,g,h], Marija Jevtic [c,i], Giovanni Millo [d], Elida Mata [e], Rita Van Dingenen [a]

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European Commission

Econometric model derived from meta-analysis to estimate VSL and VOLY associated to air pollution at a global level

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Objectives

- To estimate the costs related to **air pollution** effects on **health** through a **meta-analysis**
- To create an **extensive** and **updated dataset** made up of **VSL** and **VOLY estimates** as input for the meta-analysis
- To develop **econometric models** to be applied in the EU Enlargement region and **globally**

Why?

- Most countries have insufficient and unreliable VSL and VOLY estimates
- Lack of country-specific data
- Lack of common methodology among different studies

How?

- Selection of **high quality data** as **input** for meta-analysis
  - Literature review of peer-reviewed and technical reports publications
  - Only air pollution-related VSL/VOLY estimates selected

Meta-analysis (MA)

- VSL/VOLY estimates are transferred from the available literature to a policy context where **VSL/VOLY estimates are missing** (OECD, 2012)
- MA is used to **improve accuracy** of benefit transfer models
- It includes **different policy-relevant factors** potentially affecting VSL/VOLY values
- There is no one single, most appropriate or correct meta-model to use (OECD, 2016)
- Example used by OECD (2012), Mortality Risk Valuation in Environment, Health and Transport Policies:

  - Ordinary Least Square estimation $$lnvsl_{si} = \beta_0 + \beta_1 lngdp_{si} + \Sigma_k B_k X_{si}(k) + \varepsilon_{si}$$

- Lnvslsi: natural logarithm of VSL
- Lngdpsi: natural logarithm of GDP/capita
- Xsi : vector of other explanatory variables

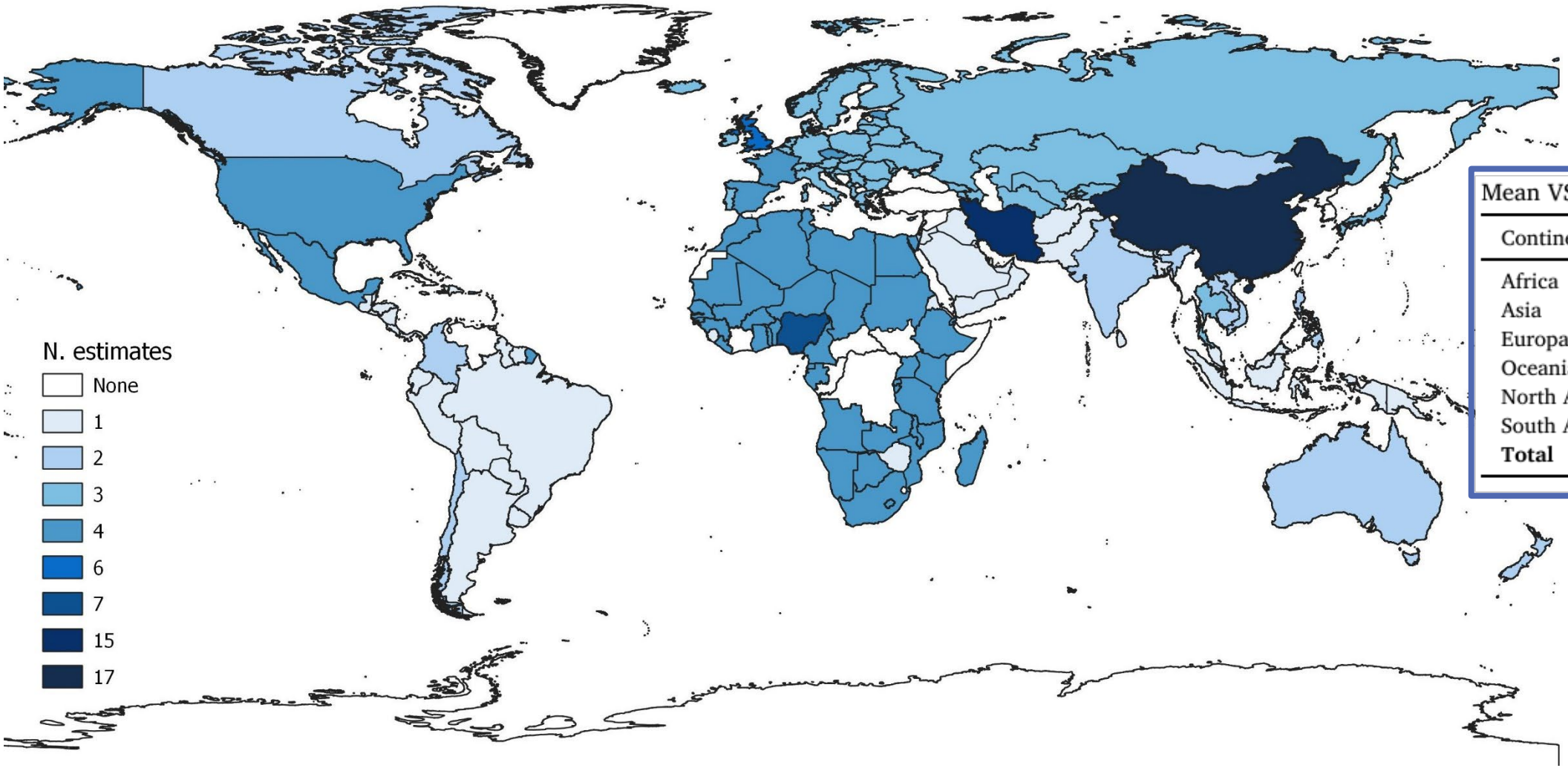
i: single estimate
s: group (categorical variable)

Database composition

	Assessed publications	Publications included in the final database	Number of VSL/VOLY values estimated
Peer-reviewed papers	621	23	51
Technical reports	24	11	443
Total	**645**	**34**	**494**

Estimates in common currency (I$) and inflation-adjustments

Geographic coverage



Mean VSL (in 2019 PPP I$) values

Continent	Mean VSL (I$)
Africa	737,670
Asia	1,552,518
Europa	3,489,625
Oceania	2,168,234
North America	2,362,474
South America	1,775,335
Total	**186**

Initial explanatory variables

Preliminary tests

1. Linearity relationship → Pearson
2. Homoscedasticity → residuals
3. Multicollinearity → VIF
4. Autocorrelation → Durbin Watson *
5. Normality → Kolmogorov Smirnov
6. Outliers ≤ 5% → robust regression

Variables	Category
GDP per capita PPP	economic
Consumer Price Index	economic
Gross National Income per capita	economic
Unemployment rate	economic
People living below the poverty line	economic
GINI index	economic
Income	economic
Population	demographic
Population density	demographic
Urban population	demographic
Number of megalopolis	demographic
Mean years of schooling	education
Life expectancy	health
Number of doctors per capita	health
Health expenditurre	health
Health expenditurre	health
Human Development Index	
PM2.5 concentrations	environment
O3 concentrations	environment
NOx concentrations	environment

Final explanatory variables

Final model

- The meta-analysis was conducted using a robust meta-regression technique with a backward selection process
- Multiple linear regression final model:

$$VSL_{ij} = \alpha + \beta_1 GDP_{ij} + \beta_2 GINI_{ij} + \beta_3 \log(pop_{ij}) + \beta_4 doctors_{ij} + \beta_5 GDP_{ij}\ \ income_{ij} + \varepsilon_{ij}$$

  - Dependent variable (VSL_{ij}) = mean Value of Statistical Life expressed in 2019 PPP International Dollars (I$).
  - *i* = number of studies
  - *j* = observation level, total number of observations ~ 500

- GDP coefficient higher in LMIC
- Sensitivity analysis using JRC SIMLAB tools
- Contribution to uncertainty: GDP, income, n. of doctors
- Mixed model to check autocorrelation (within study, between studies)
- Confirmed the results of the robust regression

	coefficient	standard error	significance
(Intercept)	361,099	231,846	
GDP	101	7	***
GINI	702,603	292,758	*
pop	-37,633	10,871	***
doctors	8,146	1,882	***
GDP:income(UM-H)	-18	7	**
Multiple R^2	0.95		
Adjusted R^2	0.95		
Robust res. Std. err	324,300		

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Research article

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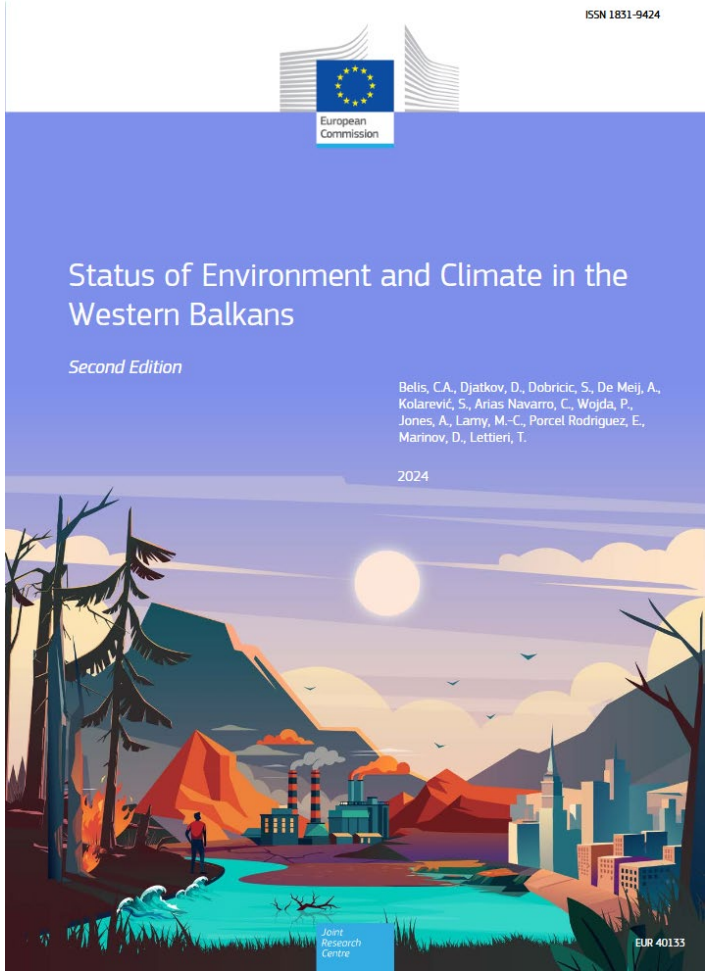
Upcoming paper:
Ciarlantini S., Frontuto V., Pezzoli A., Gavros A. , Belis C. A. ,
Economic valuation of health impacts attributable to air pollution at country level worldwide (in preparation)

European Commission

Report on Environment and Climate in the Western Balkans (second edition)

Topics:

- **Alignment** with EU *acquis* and implementation
- **Air pollution**: emissions, trends, impacts on health
- **GHG** emissions
- Impacts of **climate change** on: precipitations, droughts, heat waves, forest fires, surface and ground water bodies
- **Soil** health, contaminated sites, monitoring data and gaps
- **Water** Framework Directive, urban wastewater treatment, chemical and faecal contaminants, antimicrobial resistance



Citation: European Commission: Joint Research Centre, Belis, C.A., Djatkov, D., Dobricic, S., De Meij, A., Kolarević, S., Arias Navarro, C., Wojda, P., Jones, A., Lamy, M.-C., Porcel Rodriguez, E., Marinov, D. and Lettieri, T., Status of Environment and Climate in the Western Balkans, Publications Office of the European Union, Luxembourg, 2024, https://data.europa.eu/doi/10.2760/1865356, JRC140061.

https://publications.jrc.ec.europa.eu/repository/handle/JRC140061

European Commission

Report on Environment and Climate in Ukraine

Assessing the impacts of war and its implications for reconstruction

ISSN 1831-9424

Topics:

- Status of **air quality** and **emissions** of air pollutants
- **GHG** emissions and climate mitigation and adaptation
- **Forest** environment and climate
- **Soil** characteristics and degradation
- **Marine** environment
- **Impact of war on Environment**
- **Ukraine Plan** as an opportunity for Environmental and Climate progress

Citation: European Commission: Joint Research Centre, Belis, C. A., Djatkov, D., Dobricic, S., De Meij, A., Kolarević, s., Arias Navarro, C., Wojda, p., Jones, A., Lamy, M.-C., Porcel Rodriguez, E., Marinov, D. and Lettieri, T., Status of Environment and Climate in the Western Balkans, Publications Office of the European Union, Luxembourg, 2024, https://data.europa.eu/doi/10.2760/1865356, JRC140061.

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Thank you!

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