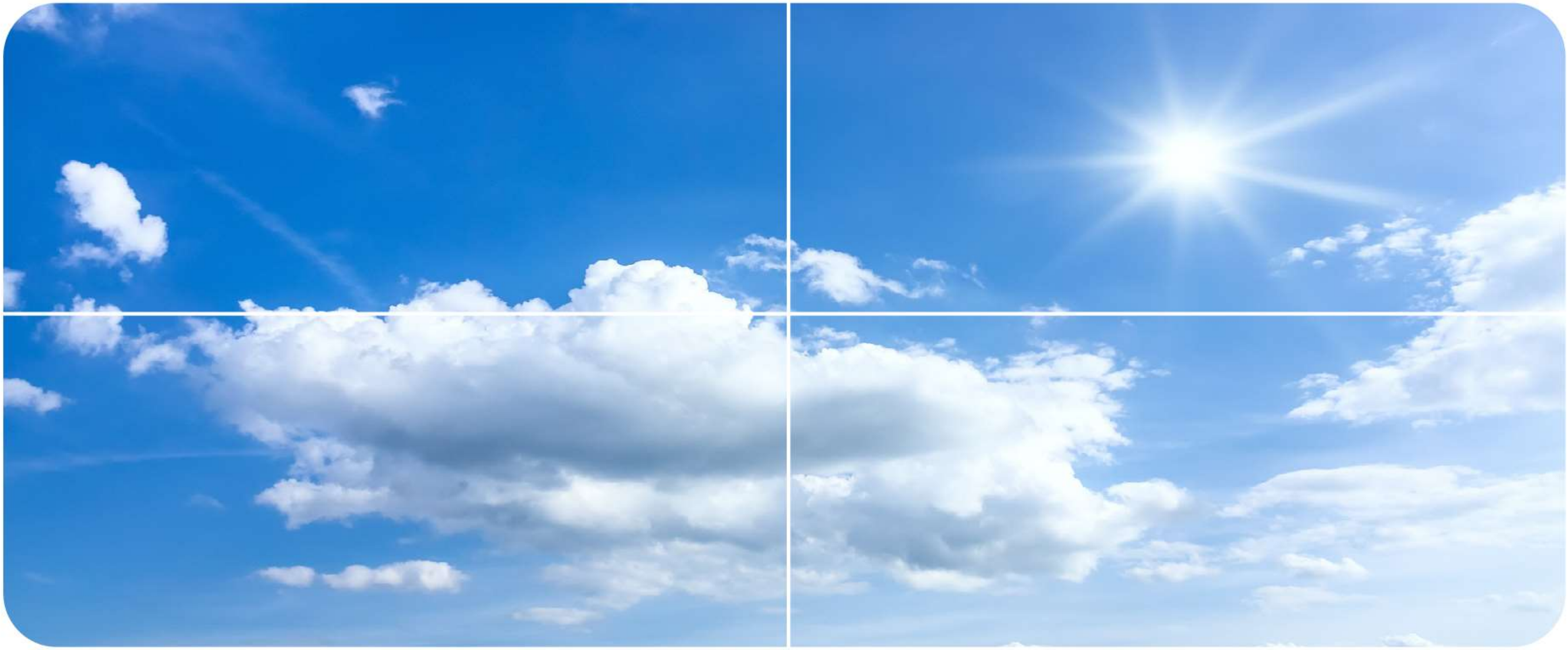

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Health impact and cost-benefit assessment

Approach and results for Serbia

Simone Schucht, INERIS

20/08/21

Outline of the Presentation

01 Health Impact Assessment (HIA) approach

02 Scenario input data

03 HIA results

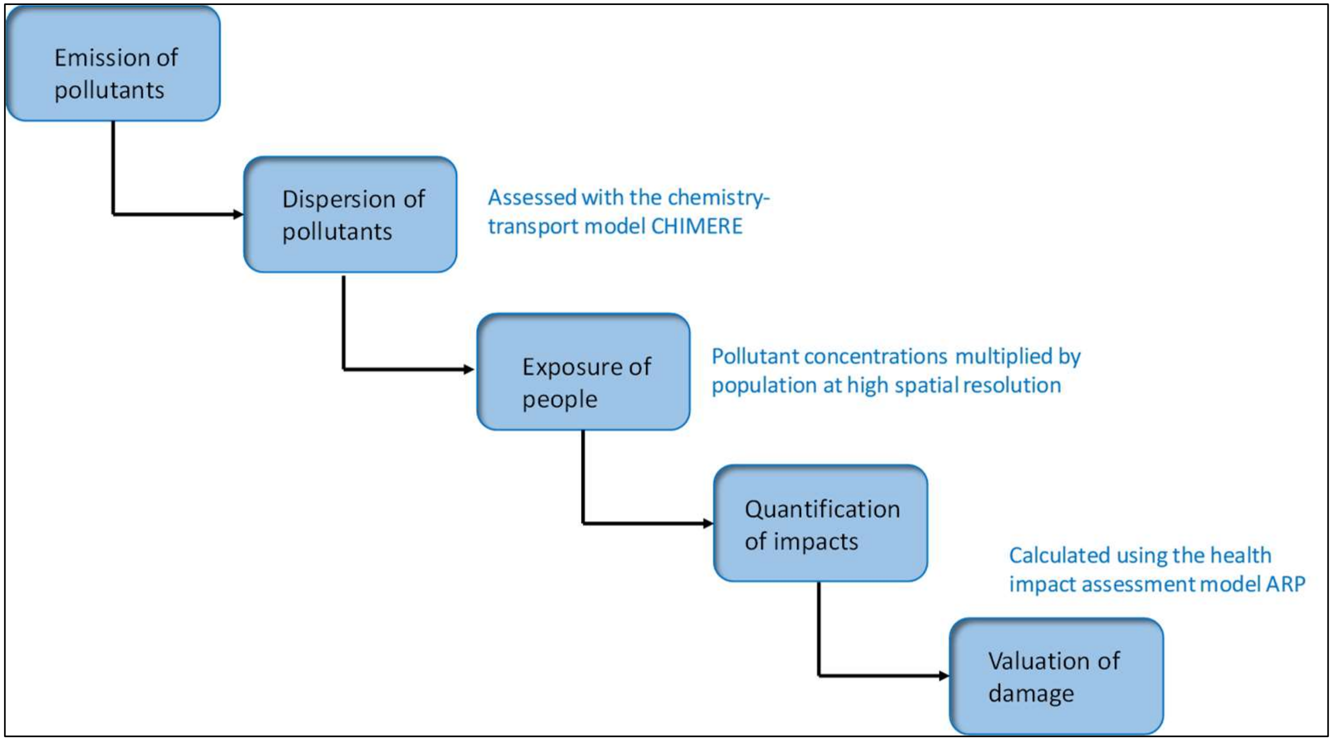
04 Cost-benefit analysis

01

Health Impact Assessment (HIA) approach

The study applies the Impact Pathway Approach (IPA)

The logical progression from the emissions estimate through exposure to the quantification of impact and finally monetisation



The HIA model Alpha-RiskPoll (ARP) is used

ARP quantifies annual health effects from $PM_{2.5}$, O_3 and NO_2 based on

- **Exposure-response functions recommended by WHO/Europe**
- **Monetary unit values used in studies for DG ENV and EEA (adapted to Serbian income)**
- **Population data (UN WPP) and mortality data (Eurostat)**

WHO/Europe (2013), Holland (2014), Schucht et al. (2015), Amann et al. (2020), Schucht et al. (2020), OECD (2012)

End point	Impact	Pollutant	Valuation for EU28 ($€_{2005}$)
Acute Mortality (All ages) median VOLY	Premature deaths	O3	79 500
Respiratory hospital admissions (>64)	Cases		4 000
Cardiovascular hospital admissions (>64)	Cases		5 000
Minor Restricted Activity Days (MRADs all ages)	Days		40
Chronic Mortality (All ages) LYL median VOLY	Life years lost	PM2.5	79 500
Chronic Mortality (30yr +) deaths mean VSL	Premature deaths		3 060 000
Infant Mortality (0-1yr) mean VSL	Premature deaths		4 590 000
Chronic Bronchitis (27yr +)	Cases		53 600
Bronchitis in children aged 6 to 12	Added cases		301
Respiratory Hospital Admissions (All ages)	Cases		4 000
Cardiac Hospital Admissions All ages)	Cases		5 000
Restricted Activity Days (all ages)	Days		110
Asthma symptom days (children 5-19yr)	Days		42
Lost working days (15-64 years)	Days		130
Bronchitis in children aged 5 to 14	Added cases	NO2	301
Respiratory Hospital Admissions (All ages)	Cases		4 000
Chronic Mortality (All ages) LYL median VOLY	Life years lost		79 500
Chronic Mortality (30yr +) deaths mean VSL	Premature deaths		3 060 000

Two alternative approaches to quantifying and valuing mortality:

- Premature deaths valued by the value of a statistical life (VSL)

  => estimate of damage costs based on willingness to pay for a reduction in the risk of dying from adverse health conditions

- Life years lost valued by the value of a life year (VOLY)

  => estimate of damage costs based upon the loss of life expectancy, takes into account the age at which death occurs

Monetary damage is aggregated over all health end points, selecting either VOLY or VSL

The conversion from €$_{2005}$ to €$_{2019}$ and the necessary adaptation to the Serbian economic context follow standard procedures

Standard procedure for benefits transfer as recommended by OECD (2012), oecdpublichealthexplorer.org and World Bank (2016) for values based on willingness to pay (WTP) studies

$$Value_{Serbia,2019} = Value_{EU28,2005} \times \left(\frac{Y_{Serbia,2019}}{Y_{EU28,2019}}\right)^{\beta} \times (1 + \%\Delta P + \%\Delta Y)^{\beta}$$

Value: monetary unit value of the respective health indicator; Y: GDP; ΔP: increase in consumer prices; ΔY: change in real GDP/capita growth; β: income elasticity of the willingness to pay

Adjustment factors	Result	Source
Initial values in ARP are for the European Union in €$_{2005}$		Various
EU28 inflation 2005-2019: 1.2758	Value for EU28 €$_{2019}$	Eurostat, HICP
EU28 real income growth 2005-2019: 0.167		World Bank, constant GDP per capita
Marginal utility of consumption Elasticity (high income): 0.8		OECD, World Bank
EU28, current GDP/cap at 2019 PPP: 46,443	Value for Serbia €$_{2019}$ at PPP prices	World bank, current GDP per capita, PPP
Serbia, current GDP/cap at 2019 PPP: 18,930		
Income elasticity (medium income): 1.2		OECD, World Bank

Adjustment here: first time, then space

This correction is applied to all health end points based on, or including at least as part, WTP estimates

Unit values only based on market prices are only adjusted for inflation (this is the case for work loss days)

Resulting values adjusted for time (year of price base) and space (EU to Serbia)

End point	Impact	Pollutant	Valuation for EU28 (€2005)	Valuation for EU28 (€2019)	Valuation for Serbia (€2019)
Acute Mortality (All ages) median VOLY	Premature deaths	O3	79 500	106 620	36 318
Respiratory hospital admissions (>64)	Cases		4 000	5 365	1 827
Cardiovascular hospital admissions (>64)	Cases		5 000	6 706	2 284
Minor Restricted Activity Days (MRADs all ages)	Days		40	54	18
Chronic Mortality (All ages) LYL median VOLY	Life years lost	PM2.5	79 500	106 620	36 318
Chronic Mortality (30yr +) deaths mean VSL	Premature deaths		3 060 000	4 103 883	1 397 885
Infant Mortality (0-1yr) mean VSL	Premature deaths		4 590 000	6 155 825	2 096 827
Chronic Bronchitis (27yr +)	Cases		53 600	71 885	24 486
Bronchitis in children aged 6 to 12	Added cases		301	404	138
Respiratory Hospital Admissions (All ages)	Cases		4 000	5 365	1 827
Cardiac Hospital Admissions All ages)	Cases		5 000	6 706	2 284
Restricted Activity Days (all ages)	Days		110	148	50
Asthma symptom days (children 5-19yr)	Days		42	56	19
Lost working days (15-64 years)	Days		130	166	166
Bronchitis in children aged 5 to 14	Added cases	NO2	301	404	138
Respiratory Hospital Admissions (All ages)	Cases		4 000	5 365	1 827
Chronic Mortality (All ages) LYL median VOLY	Life years lost		79 500	106 620	36 318
Chronic Mortality (30yr +) deaths mean VSL	Premature deaths		3 060 000	4 103 883	1 397 885

The ARP approach is consistent with assessments by EEA

Assessment of consistency for calculating chronic mortality from $PM_{2.5}$ which dominates monetary results

- **Health costs from $PM_{2.5}$ in overall health costs ≈ 93%**
- **Health costs for premature deaths in overall $PM_{2.5}$ health costs ≈ 95%**

HIA studies for Serbia				**Results in ARP**	**Differences in approaches?**
EEA Air quality report 12/2018, European Environment Agency	Input data	Year	2015	Same as in EEA	Fully consistent for $PM_{2.5}$ mortality (1 - 3 % difference in results); ARP uses more recent exposure-response functions for chronic mortality from NO_2
		Annual mean concentration	23.3 μg/m^3		
	Results	Premature deaths	13 000	13 128	
		Years of life lost	127 800	123 566	
Serbia HEI Air Pollutants Factsheet 2020, Health Effects Institute	Input data	Year	2019	Same as in HEI	HEI approach as in Global Burden of Disease studies, calculating cause-specific mortality based on integrated exposure-response functions; ARP uses the approaches recommended by WHO for Europe, applying all-cause mortality estimates for European studies (31% difference in results)
		Annual mean concentration	25 μg/m^3		
	Results	Premature deaths	10 500	13 800	
WHO 2019	Input data	Year	2015		WHO uses AirQ+ Software; Exposure response functions from WHO as in ARP but calculation of mortality specific to selected causes
		Annual mean concentration	City specific data	(*)	
	Results	Premature deaths	City specific		
(*) Replication of calculation in ARP would require city specific population and mortality data.					

02

Scenario input data

Annual mean population weighted concentrations differ between studies

Results from CHIMERE based on emission scenarios produced in this project

- **Annual mean exposure of the population expressed as concentration (µg/m^3) except for ozone for which the SOMO35 indicator is used (expressed in ppb.days)**
- **In this study, we only quantify health impacts & damage in Serbia (transboundary effects are neglected** => underestimate of damage and benefits**)**

Scenario	**REF**	**WEM**	**WAM A**	**WAMB**	**WAMC**
Year	**2015**	**2030**	**2030**	**2030**	**2030**
$PM_{2.5}$ (µg/m^3)	17.4	13.9	12.5	10.8	10.2
SOMO35 (ppb.days)	3 036	2 559	2 512	2 469	2 466
NO_2 (µg/m^3)	9.1	6.5	5.9	5.3	5.2
Population in 2015: 7,108,454					

Note: the table shows population weighted concentrations averaged over the country, implying that concentrations measured in specific locations will be different (higher or lower)

Comparison to EEA (2018) and HEI (2020) studies

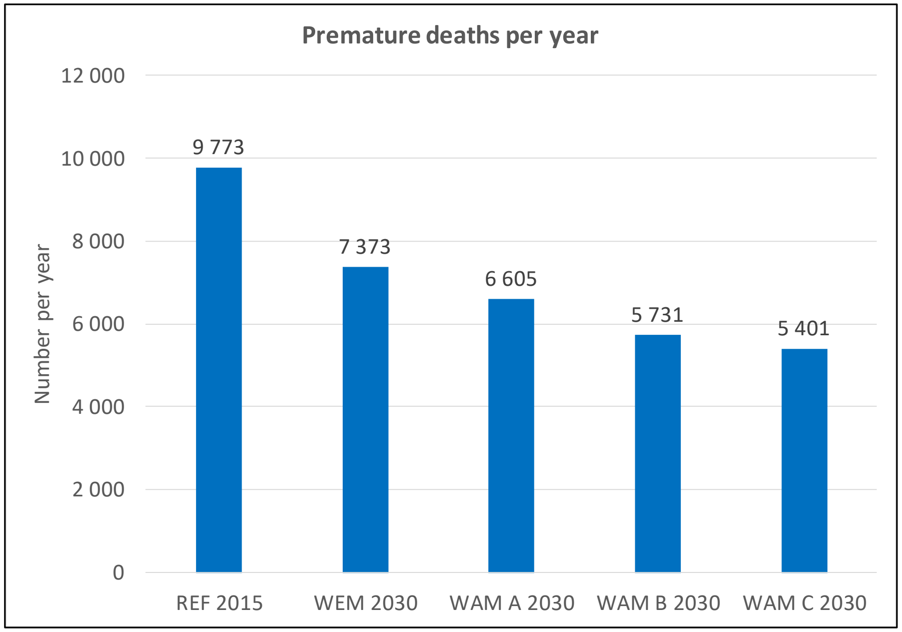
- Distinctly lower $PM_{2.5}$ concentrations than in the EEA and HEI studies
- CHIMERE results show overall good performance relative to the data from monitoring stations

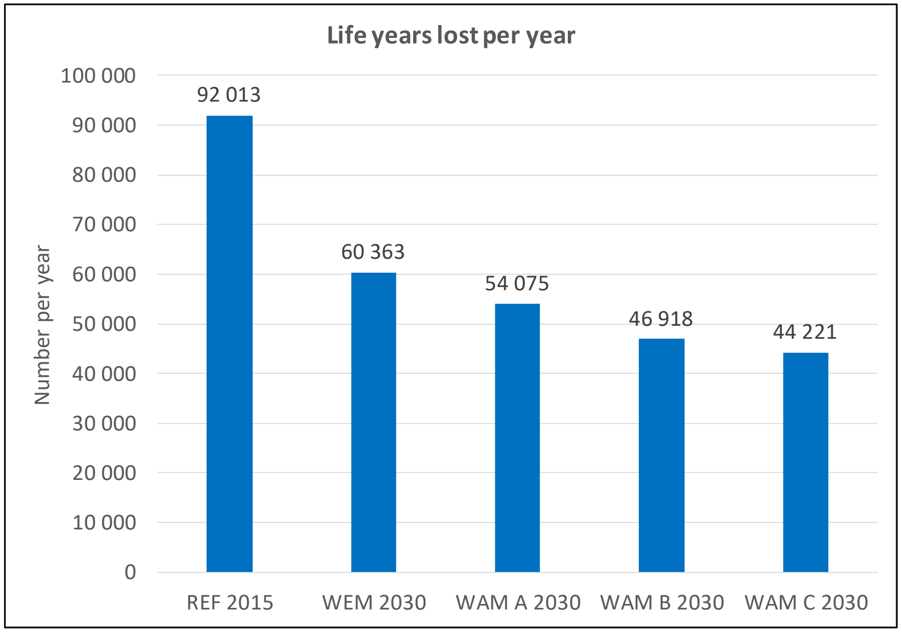
03

HIA results

In 2030 additional measures yield reductions in premature mortality from $PM_{2.5}$

Each additional scenario yields health benefits (= avoided health impacts)



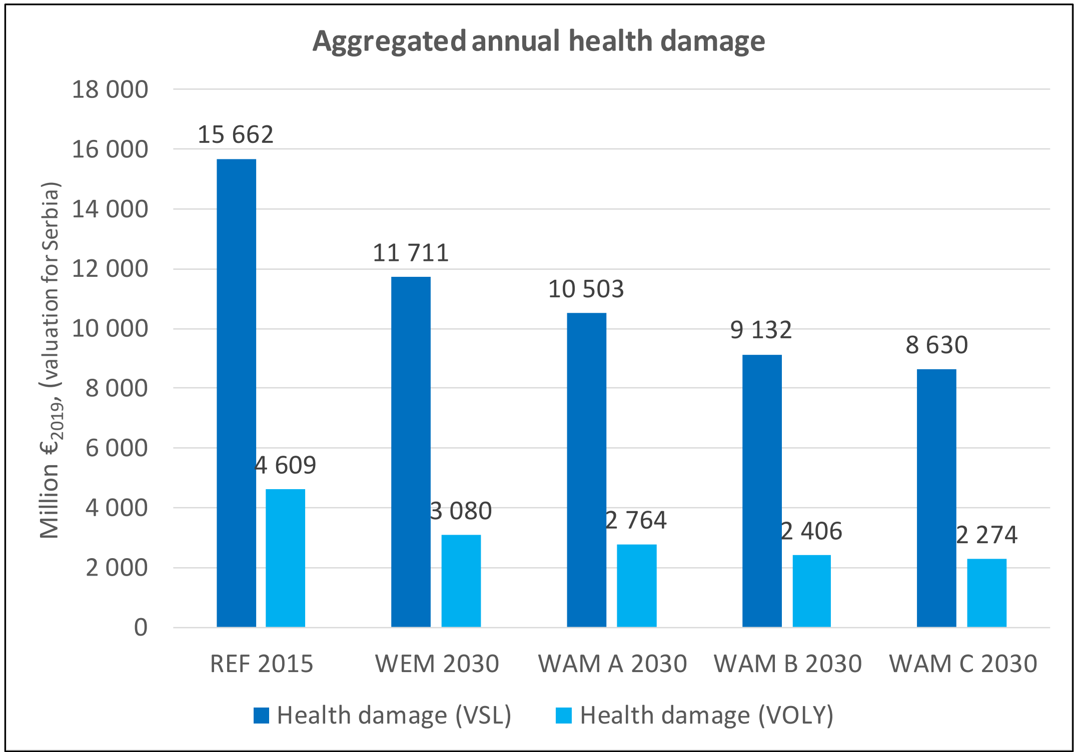


Avoided health damage (= benefits) per year relative to the previous scenario				
Scenario/Health endpoint	WEM 2030 rel. to REF 2015	WAM A 2030 rel. to WEM 2030	WAM B 2030 rel. to WAM A 2030	WAM C 2030 rel. to WAM B 2030
Premature deaths	2 400	768	874	329
Life years lost	31 649	6 289	7 157	2 697

Avoided health damage (= benefits) per year relative to WEM			
Scenario/Health endpoint	WAM A 2030 rel. to WEM 2030	WAM B 2030 rel. to WEM 2030	WAM C 2030 rel. to WEM 2030
Premature deaths	768	1 642	1 972
Life years lost	6 289	13 446	16 142

Additional reduction measures strongly decrease health costs from $PM_{2.5}$, O_3 and NO_2

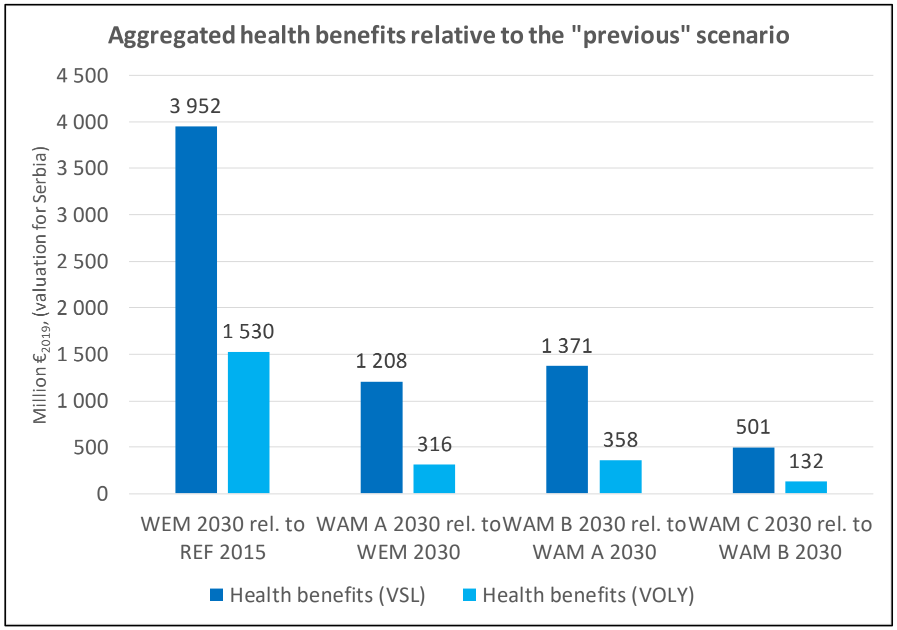
The decrease in aggregate damage between scenarios follows the same trend

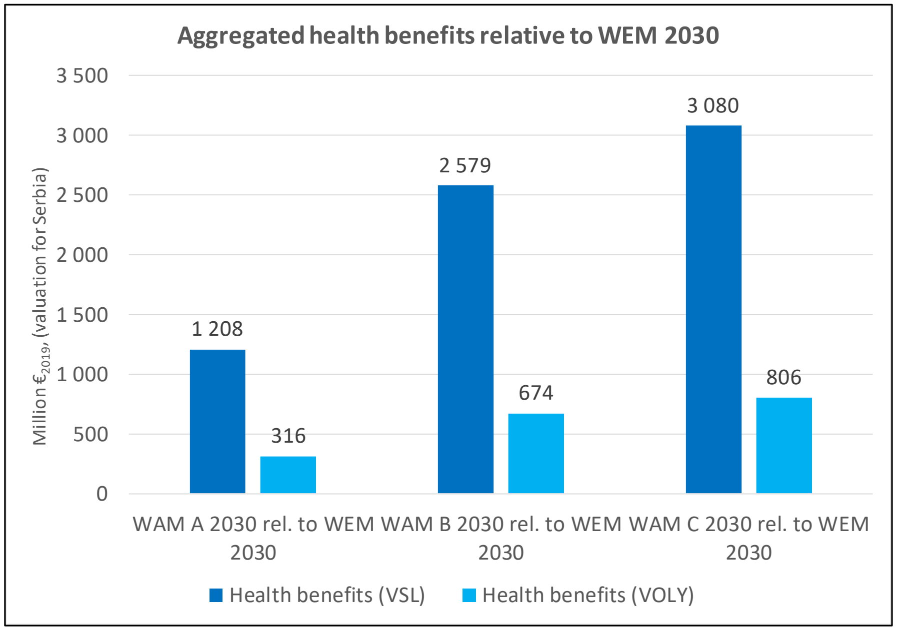


Scenario/Health endpoint	WEM 2030 rel. to REF 2015	WAM A 2030 rel. to WEM 2030	WAM B 2030 rel. to WAM A 2030	WAM C 2030 rel. to WAM B 2030
Health damage (VSL)	-25%	-10%	-13%	-5%
Health damage (VOLY)	-33%	-10%	-13%	-5%

Additional reduction measures might save up to 3 billion € health costs per year in 2030

Avoided health damage (= benefits) presented relative to the “previous” scenario (left) and relative to WEM 2030 (right)





04

Cost-benefit analysis

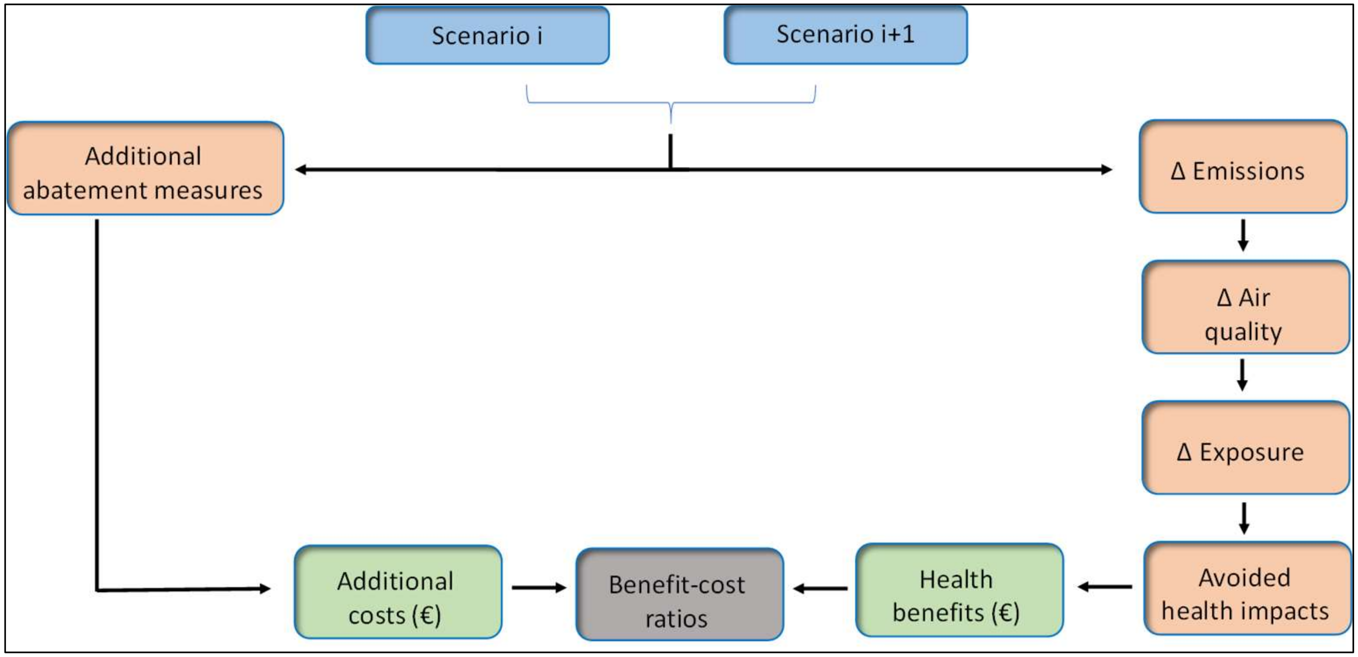
Additional costs and benefits in 2030 are compared in CBA

All values are annualised, and calculated with respect to the target year (2030)

Mitigation cost data were provided by CITEPA: Values are adapted for inflation (producer price index) but not for income

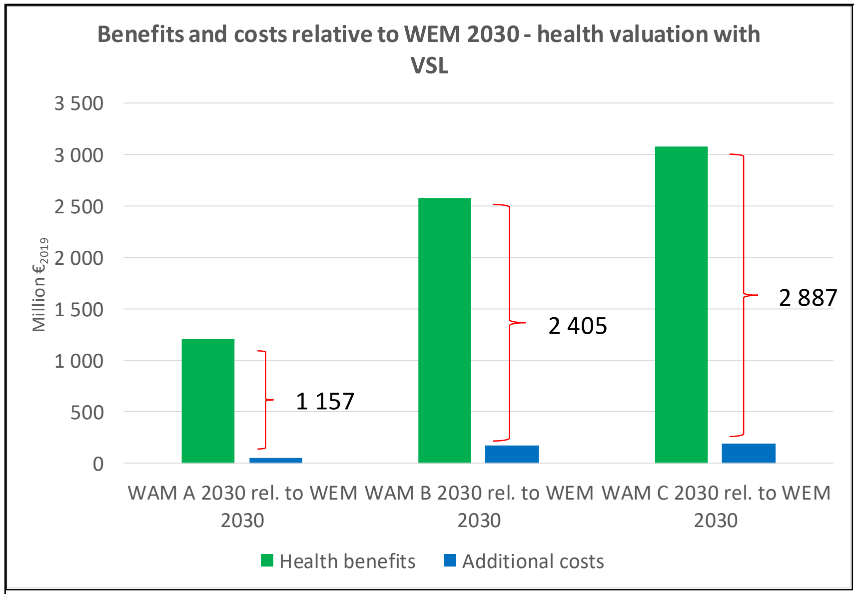
Benefit data were provided by INERIS: Monetary unit values account for inflation for market-based values (consumer price index); for WTP based values they also account for income changes, for income differentials between EU28 and Serbia and for income elasticities

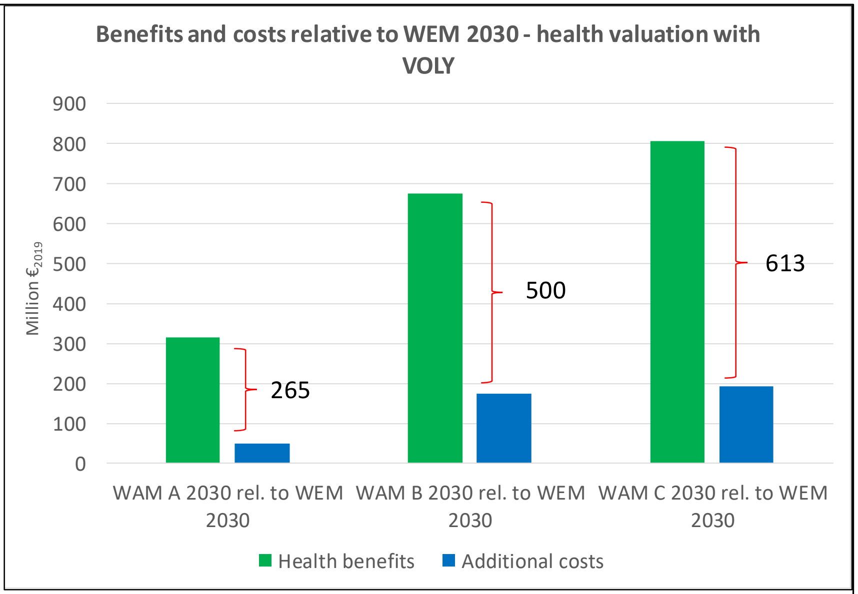
We analyse relative results: changes between the baseline WEM and the three WAM mitigation scenarios (WAM A, B & C), respectively



Annual net benefits in 2030 increase with increasing scenario ambition

Net benefits = avoided health costs (health benefits) minus additional investment & operating and maintenance costs of mitigation scenarios relative to WEM, in 2030



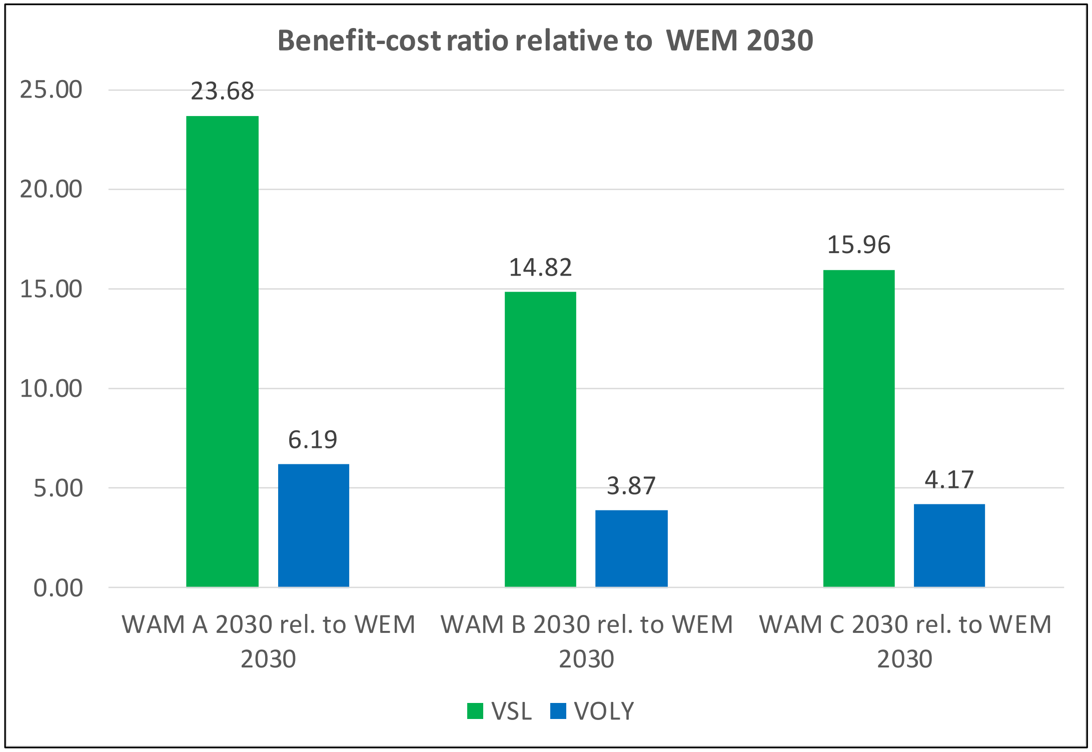


M€/year (VSL)	WAM A 2030 rel. to WEM 2030	WAM B 2030 rel. to WEM 2030	WAM C 2030 rel. to WEM 2030
Health benefits	1 208	2 579	3 080
Additional costs	51	174	193
Net benefit	1 157	2 405	2 887

M€/year (VOLY)	WAM A 2030 rel. to WEM 2030	WAM B 2030 rel. to WEM 2030	WAM C 2030 rel. to WEM 2030
Health benefits	316	674	806
Additional costs	51	174	193
Net benefit	265	500	613

The benefit-cost ratio is slightly advantageous for WAM A

Benefit-cost ratio = annual benefits/annual costs of mitigation scenarios relative to WEM 2030



Conclusions from the cost-benefit analysis:

- In 2030, WAM C yields the highest net benefit relative to WEM, followed by WAM B and WAM A
- In 2030, WAM A yields the highest benefit-cost ratio relative to WEM, followed by WAM C and WAM B
- The absolute level of net benefits / cost-benefit ratios varies between the valuation of mortality with VSL versus VOLY

Implications for the multi-criteria analysis (MCA)?

- Assess the sensitivity of the MCA results to the alternative mortality and/or cost-benefit indicators

05

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Questions and assistance

Simone Schucht
Environmental economist/research engineer at INERIS
EAS3 Senior non-key expert
EU for better Environment
+33 (0)3 44 55 65 14
Simone.Schucht@ineris.fr

Thank you for your attention!