Benefits assessment following the completion of the HRAPIE 2, EMAPEC and VALESOR projects

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WHO-led studies

- HRAPIE2
  - *Health Response to Air Pollutants in Europe edition 2*
  - Published December 2025
  - Focused on mortality for $PM_{2.5}$, NO_2, O_3
  - Includes adjusted functions for $PM_{2.5}$ and NO_2 permitting direct additivity
  - Report also provides updated EMAPEC functions for morbidity

- EMAPEC
  - *Estimating the Morbidity from Air Pollution and its Economic Consequences*
  - Publication pending, will include France, Italy, UK case studies

EU (and UK) funded work under HORIZON

- VALESOR
  - Published February 2026
  - Quantification and valuation of air pollution and hazardous chemical impacts on health.
  - Assessed health impact and valuation literature to develop recommendations for quantification.
  - Original valuation studies, also factored in healthcare and productivity costs alongside utility losses.
  - Developed innovative online tools.

VALESOR is part of the METEOR cluster together with four other projects that received funding from the call HORIZON-HLTH-2022-ENVHLTH-04-01:

- UBDPOLICY (1010)94639)External link, opens in new window.
- MARCHES (101095430)External link, opens in new window.
- BEST-COST (101095408)External link, opens in new window.
- MISTRAL (101095119)

HRAPIE2: Mortality options from HRAPIE2

- $PM_{2.5}$, NO_2, O_3
- Short- and long-term exposure
- Adjustment in 2-pollutant models
- All-natural cause and cause-specific mortality

- Potential for systematic underestimation and double counting

$PM_{2.5}$ and NO_2 mortality – the detail

- $PM_{2.5}$
  - All-natural-cause, RR = 1.095/10 $\mu g.m^{-3}$ (A) annual mean (long-term exposure)
    - HRAPIE2 cites RR=1.10, but rounds the original estimate
  - For GP, suggest cause-specific functions and short-term function excluded (double counting)
  - PM_{10} functions excluded (double counting)
- NO_2
  - All-natural-cause, RR = 1.05/10 $\mu g.m^{-3}$ (A) annual mean (long-term exposure)
  - Cause-specific functions and short-term function excluded (double counting)
- Adjusted functions allowing summation, both all-natural-cause
  - Noting that Chen et al is a biased sample, as it only included 2-pollutant studies
  - $PM_{2.5}$ RR = 1.0617/10 $\mu g.m^{-3}$ annual mean (long-term exposure)
  - NO_2 RR = 1.0374/10 $\mu g.m^{-3}$ annual mean (long-term exposure)
  - Over what range of pollution climates ($PM_{2.5}/NO_2$ ratios) is the adjustment valid?

O_3 mortality – the detail

- O_3
  - HRAPIE2: All-natural-cause, RR = 1.0018/10 μg.m^{-3} (A) annual mean (short-term exposure > 60 μg.m^{-3}) directly generates ‘deaths’, assumed 1 year loss of life expectancy per death
  - HRAPIE2: Respiratory, RR = 1.05/10 μg.m^{-3} (B+) annual mean (long-term exposure > 60 μg.m^{-3}) but does not reflect European results
  - Proposal for Gothenburg Protocol:
    - Use HRAPIE2 short-term function for core analysis
    - Use long-term function in sensitivity analysis

Mortality - approach

- Generate main estimates for
  - All-natural-cause $PM_{2.5}$ (as lower bound)
  - All-natural-cause NO_2 (as upper hound when added to $PM_{2.5}$)
  - $PM_{2.5}$ + NO_2 using adjusted functions (as best estimate?)
  - Add short-term O_3

- Use of cause-specific functions
  - Provide interesting background data
  - When aggregated, don’t provide total impact as they do not account for all effects so consider as secondary to all-natural-cause functions
- Use of functions for other time periods
  - Provide interesting background data

Morbidity

- HRAPIE2:
  - $PM_{2.5}$:
    - Core (A): COPD, stroke, AMI, lung cancer, child asthma, hypertension, CHAs
    - Sensitivity (B+): Diabetes, dementia, autism spectrum disorder, school loss days
    - *Not in HRAPIE2 but in some earlier analysis: Infant mortality, child bronchitis, RHAs, restricted activity days, lost working days*
  - NO_2:
    - Core (A): Asthma in adults, ALRI in children, RHAs
    - Sensitivity (B+): None
    - *Not in HRAPIE2 but in some earlier analysis: child (acute) bronchitis*
  - O_3:
    - Core (A): None
    - Sensitivity (B+): RHAs
    - *Not in HRAPIE2 but in some earlier analysis: CHAs, mRADs*

Why has the list of morbidity impacts changed?

- Evidence on health impacts has strengthened
- Since analysis of the ‘Multi-pollutant, Multi-effect Protocol’ shift away from short- to long-term exposure/effects
- Recent research has been more interested in the effects of long-term exposure and long-term health conditions than previously
- Evidence for short-term exposure effects remains
- Some risk of double counting effects, e.g.
  - New incidence of asthma, COPD and RHAs
  - New incidence of heart disease and CHAs
- From a CBA perspective the short-term effects tend to be much less important than the long-term

Is the list of air-pollution morbidity impacts complete? (No!)

> BMJ Open. 2024 Feb 29;14(2):e081351. doi: 10.1136/bmjopen-2023-081351.

Air pollution and human health: a phenome-wide association study

Emilie Rune Hegelund [1], Amar J Mehta [2], Zorana J Andersen [2], Youn-Hee Lim [2], Steffen Loft [2], Bert Brunekreef [3], Gerard Hoek [3], Kees de Hoogh [4], Laust Hvas Mortensen [5]

Affiliations + expand

PMID: 38423777 PMCID: PMC10910582 DOI: 10.1136/bmjopen-2023-081351

- **Results:** Exposure to $PM_{2.5}$ and NO_2 both positively associated with onset of > 700 health conditions (ie, >80% of the registered health conditions). $PM_{2.5}$and NO_2 were associated strongest with chronic obstructive pulmonary disease, type 2 diabetes and ischaemic heart disease…

Static vs dynamic population

- Not a new issue – first discussed >20 years ago
- Problem is not scientific but linguistic

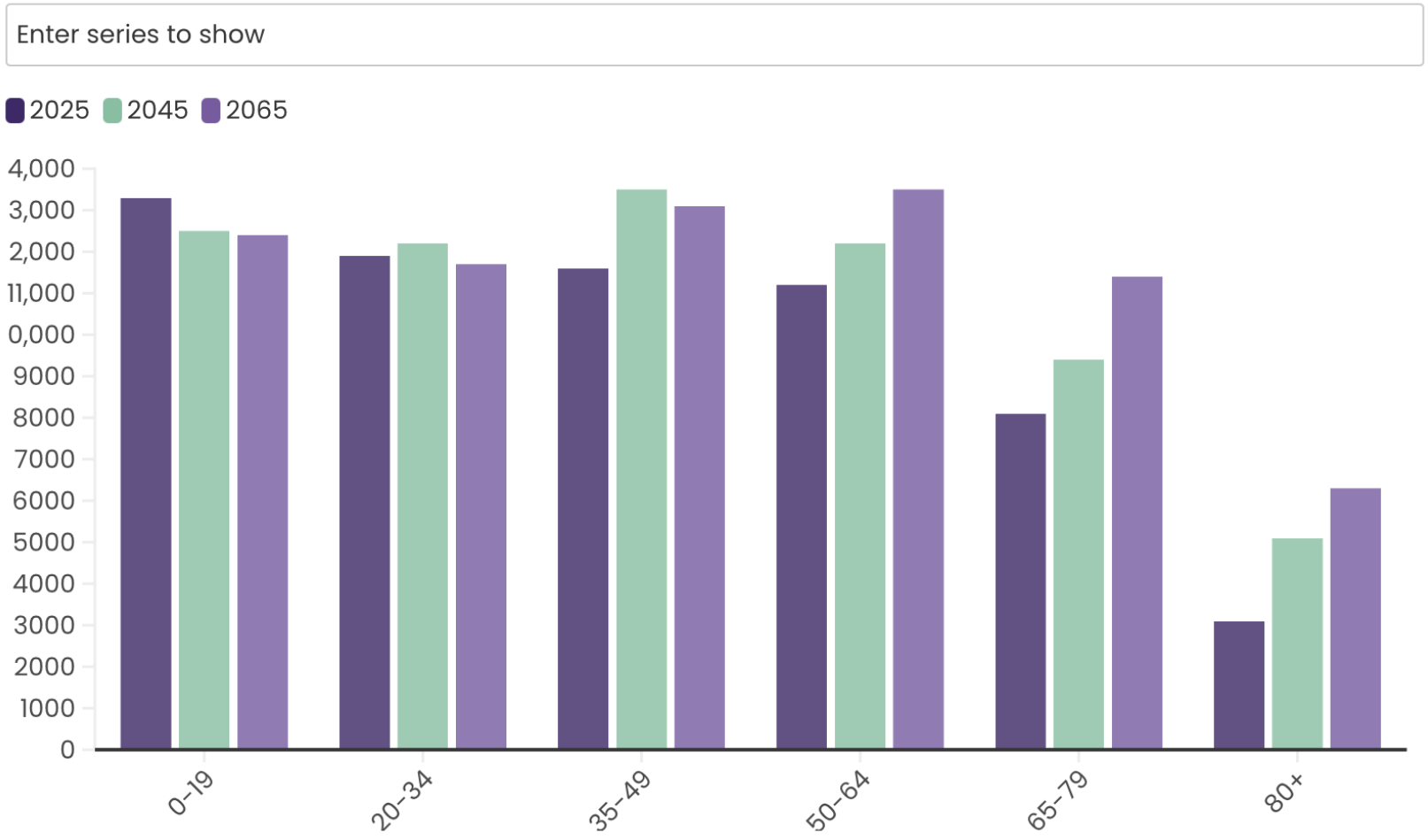
- Static population best for showing change in risk, e.g. change in mortality rate

- Dynamic population needed for consistent comparison of costs and benefits

- In terms of generating a net benefit for likely policy scenarios probably no difference between the two…
- …but will affect benefit-cost ratios

Static vs dynamic population (England)

2.03a Projected population (thousands), by age, England, 2025 to 2045 and 2065



Source: ONS: 2022-based national population projections

- Change in population >65 years from 2025
  - 30% by 2045
  - 58% by 2065

Centre for Ageing Better

New valuation studies

- VALESOR study
  - Review of available data and new valuation studies
  - Disaggregates to health care costs, productivity losses, utility losses
    - Alternative route to productivity assessment (not via WLDs) – would that work for JRC? Also, role of Dechezleprêtre study?)
- OECD mortality valuation
  - Greater consistency between Europe and US, and between revealed and stated preference studies
  - Increase in recommended VSL (will feed through to VOLY) from €4.3 vs €5.3 million (did not include new VALESOR-survey estimate which was €4.6 million) – all figures in €2022

New morbidity valuation data

- VALESOR estimates, being checked (EU averages, not UNECE)

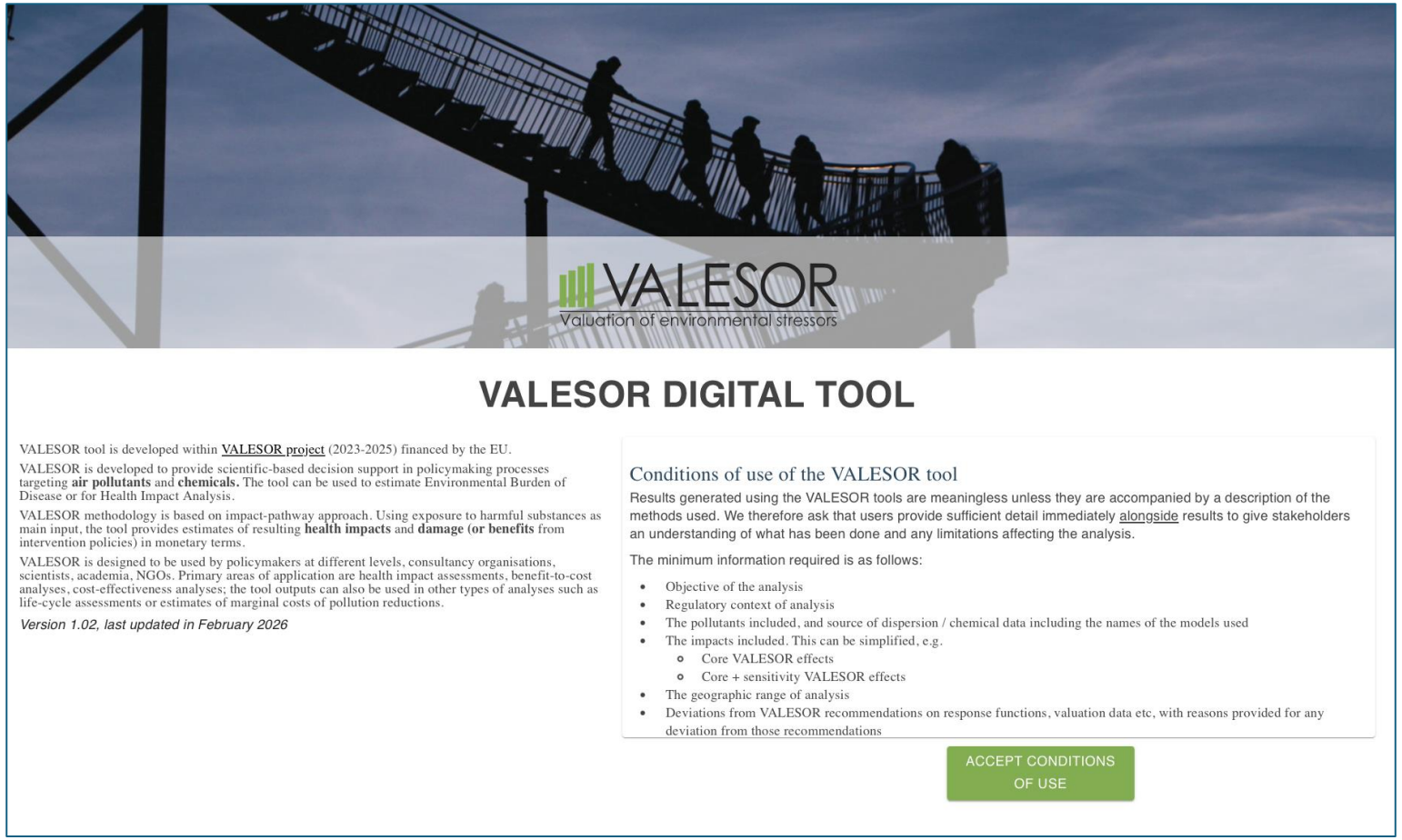
VALESOR estimates of health costs per case				
	Healthcare	Productivity	Utility	Total
ALRI	190	100	50	340
Asthma - adult	3,490	12,650	59,080	75,220
Asthma - child	4,890	12,650	164,750	182,290
ASD	760,080	1,574,870		2,334,950
COPD	11,440	7,030	42,030	60,500
Dementia	152,480	21,090	439,760	613,330
Diabetes	10,800	11,250	43,150	65,200
Hypertension	5,370	1,160		6,530
IHD events	6,230	1,340	113,170	120,740
Lung cancer	21,600	77,330	682,850	781,780
Stroke	139,780	9,140	474,750	623,670

Equity from a health perspective

- Socially deprived groups have …
  - Lower economic activity levels
  - Less access to low pollution technologies

  - Higher mortality rates
  - Higher morbidity rates
  - And hence a greater susceptibility to air pollutant impacts

The VALESOR online tool



Using the VALESOR online tool

- Default data align with HRAPIE2/EMAPEC conclusions and VALESOR recommended valuations
- Requires population-weighted concentration data as input
- All other data are provided, covering full European UN/ECE region (all UN/ECE states except Canda, Israel, US)
- Generates health impacts and associated values
- All variables adjustable by users
- Tested in case studies across EU, Balkans, UK
- Training materials provided on the VALESOR website