



WORKING FOR A HEALTHY FUTURE

# Health Impact Assessment from CAFE to HEIMTSA and beyond...

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for some of the slides included here**

# Health Impact Assessment (HIA)

A combination of procedures, methods and tools by which a policy, programme or project may be judged

- as to its potential effects on the health of a population, and
- the distribution of those effects within the population.

WHO/ECHP, 1999, Gothenburg Consensus Paper

- One way of distilling/organising scientific evidence to inform policy development.
- May also help distil/organise community perceptions
- About predicting the health effects of planned policies, not evaluation of policies already in place

Simple but not easy to do

# CAFE: Clean Air for Europe

- Extensive work programme managed by DG Environment
- Strongly based in evidence, including detailed reviews for CAFE by expert groups convened by the World Health Organisation (WHO).
  - WHO reviews were mostly qualitative, not quantitative
- DG Environment commissioned also a HIA and cost-benefit-analysis of the main proposed policies – CAFE CBA
  - Led by AEA Technology with IOM, Metroeconomica and EMRC

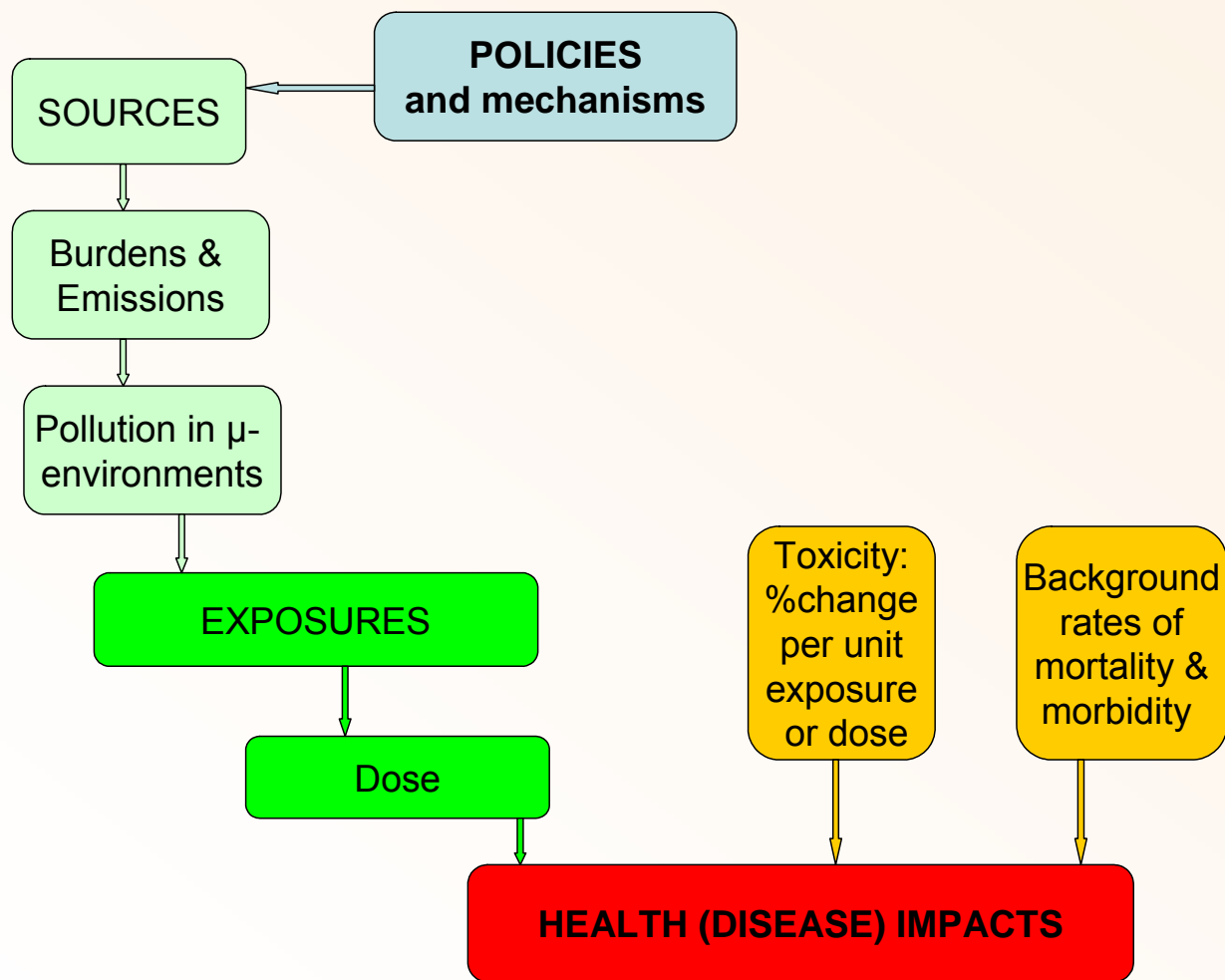
# EU Projects - INTARESE and HEIMTSA

- Two major, linked, EC-funded Integrated Projects – draw on other FP6 projects, e.g. METHODEX, ESPREME, HEARTS, NEEDS....
- INTARESE: Integrated Assessment of Health Risks of Environmental Stressors in Europe
  - Led by David Briggs at Imperial College, London; 5yr from Nov 2005
  - Focus on method development and applications using case studies
- HEIMTSA: Health and Environment Integrated Methodology and Toolbox for Scenario Assessment
  - Led by us at IOM; 4yr from Feb 2007
  - Focus on real-life policy scenarios across Europe
  - transport, energy, agriculture, industry, households and waste treatment and disposal
- Both with a focus on (i) using best up-to-date evidence; (ii) quantifying and representing uncertainty; (iii) tackling mixtures

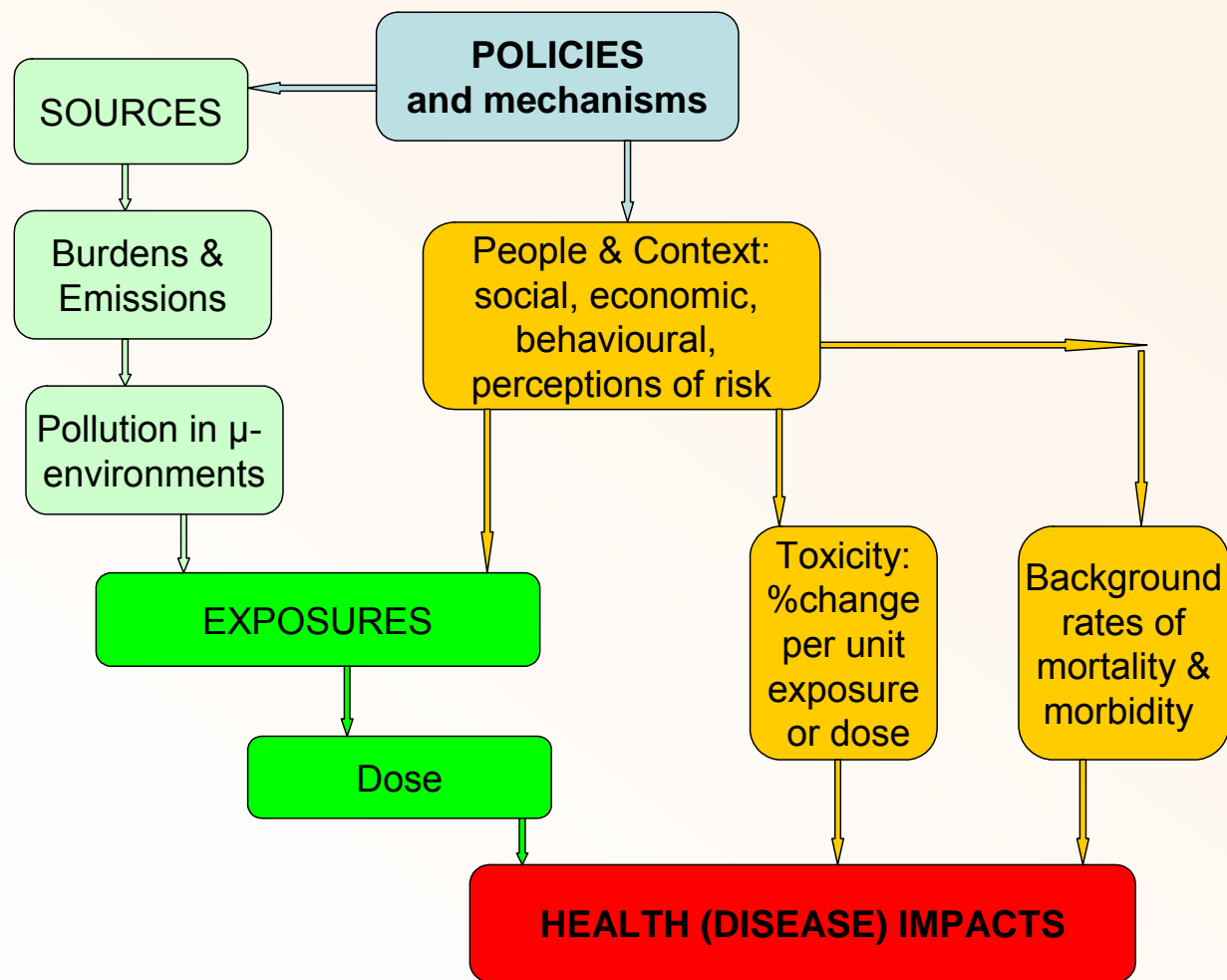
# IEHIA Methodological Framework: The 'full chain' ('impact pathway') approach

- The full chain or impact pathway approach 'tracks' environmental pollution works through the stages from:
  - i. (changes in) policy; to
  - ii. (changes in) burdens, and emissions, to air, soil and water; to
  - iii. (changes in) pollutant concentrations in micro-environments; to
  - iv. (changes in) exposures of individuals and populations (by inhalation, dermal and/or ingestion routes); to
  - v. (changes in) internal dose at target organs in the body; to
  - vi. (changes in) risks of health effects; to
  - vii. (changes in) health impacts (overall and in sub-populations); to
  - viii. (changes in) monetary value of health effects

# Full chain approach



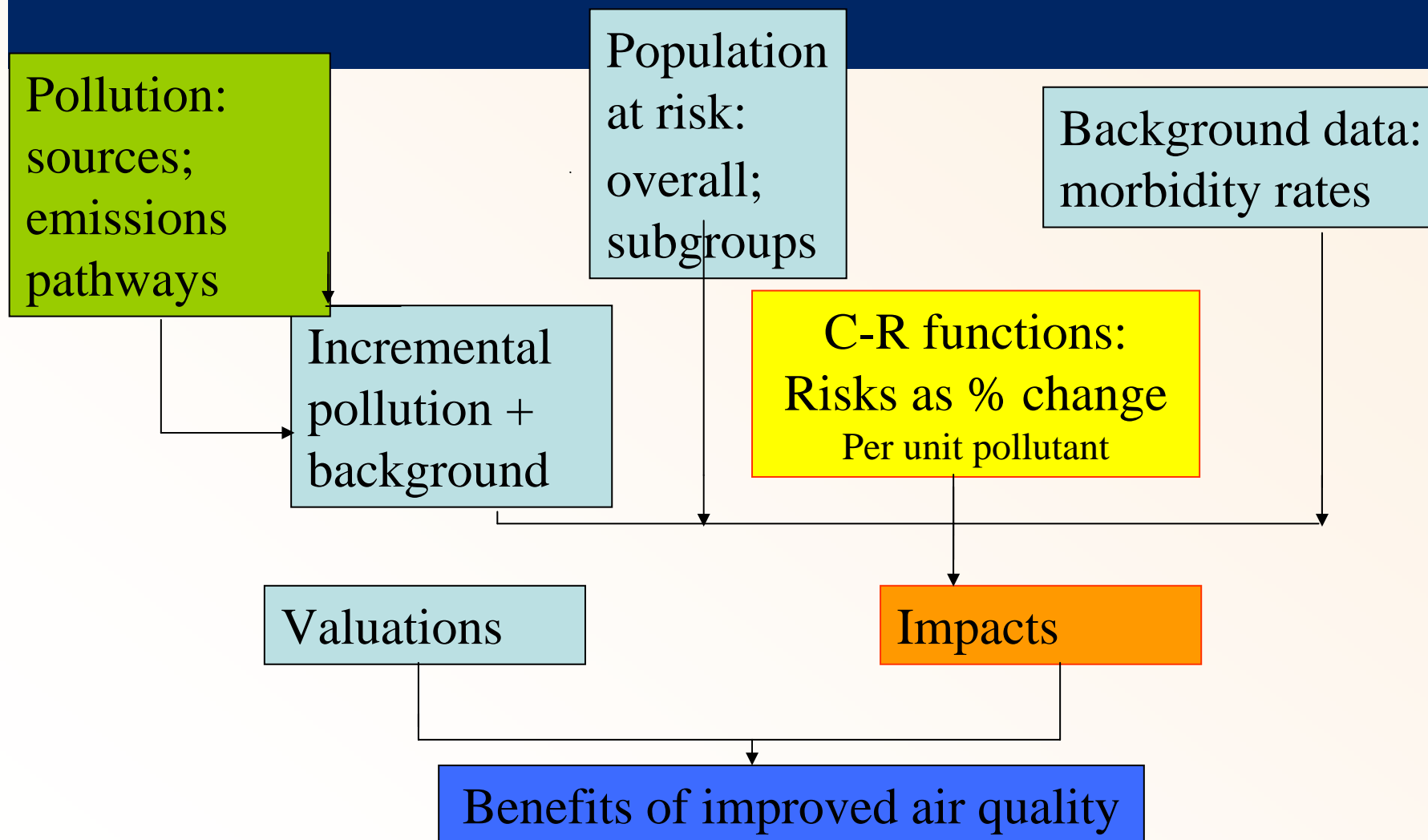
# Full chain with social determinants



# Why HIA of air pollution is well developed

- Strong research base (a lot of evidence, a strong research community)
- Important public health effects, so there is impetus to know how big they are
  - In terms of life years across whole population, estimated greater effect than passive smoking or road traffic accidents
- Relatively simple causal pathway (if you accept causality)
  - Emissions to air, exposure by inhalation
  - Main studies relate health (mortality, morbidity) to background concentrations of air pollutants – not to personal exposure or dose
  - Gives rise to a simplified HIA model for outdoor air pollution

# Components of model for air pollution HIA



# Air pollution mixture and health – which pollutants?

- PM (which is itself a mixture)
- Gases – SO<sub>2</sub>, NO<sub>2</sub>, O<sub>3</sub>, CO
- Other stuff, usually not measured routinely
- Causality of the mixture or of the pollutant?
  
- Health effects principally linked with PM and O<sub>3</sub>; CAFE (and other major HIAs) quantify relationships of health with PM and O<sub>3</sub>
  - SO<sub>2</sub>, NO<sub>2</sub> are precursors of ambient PM
  - NO<sub>2</sub> is a precursor of ozone
  - SO<sub>2</sub> and sulphates – markers of industrial pollution
  - NO<sub>2</sub>, CO, PM number, nitrates – markers of traffic
- Treat PM and O<sub>3</sub> effects as additive (Interactions?)
- WHO: On current evidence, quantify all PM<sub>2.5</sub> as equally harmful

# Health Effects quantified in CAFE CBA

- Chronic (long-term) exposure to particulate matter (PM):
  - Mortality (PM) – the dominant effect
  - Development of bronchitis (PM)
- Acute (short-term) exposure to PM and to O3
  - Mortality (O3) – mortality and PM already included
  - Hospital admissions
    - Respiratory (PM, O3); Cardiovascular (PM)
  - Days of Restricted Activity; Days off Work (PM, O3)
  - Days with symptoms and/or using medication (PM, O3)
    - In people with chronic lung disease (asthma, COPD)
    - In the general population
- No threshold for PM from human activity; cut-point of 35ppb for O3
- Full methodology report (Hurley et al., 2005) on the Web

# What to quantify? – Use of evidence in HIA

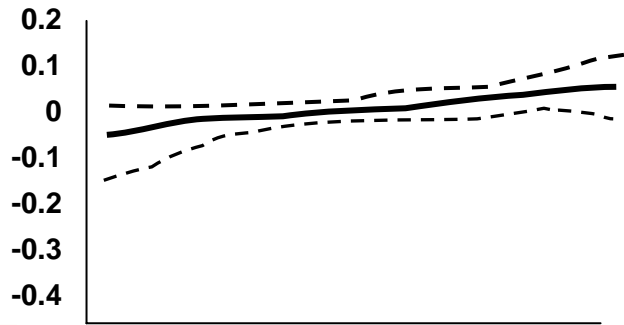
- Definition of HIA implies a different viewpoint on evidence compared with basic scientific papers
  - Usual scientific ‘proof beyond reasonable doubt’, using e.g. standard 5% statistical significance levels, is too conservative for HIA - too many things that might be caused by air pollution are left unquantified
  - A better criterion for HIA is ‘balance of probabilities’ or ‘more likely than not’. [‘Can we make a better estimate than zero?].
  - This implies making quantitative judgements (and assessments of their uncertainty) before the evidence is compelling or there is consensus about it. [We used some functions that were not statistically significant].
  - This seems to be a version of the precautionary principle...
- Winning this position is not easy in policy applications – okay in CAFE

# Stakeholder involvement in CAFE HIA/ CBA – Is an open process procedurally just?

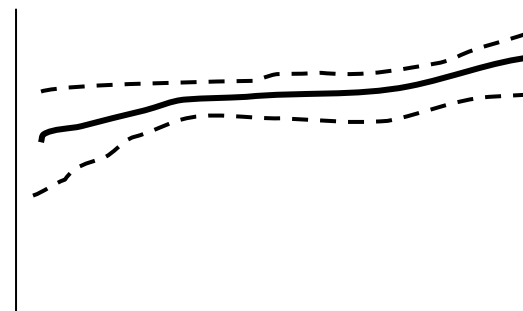
- Overseen by CAFE Steering Group: 50-100 people
- Several specific stakeholder consultation days
- Comments on draft methodology – differences on methods discussed before we had results (and then again afterwards...)
- Who commented?
  - Strong industry involvement; detailed comments; we published our response (32 pages long...)
  - Comments from other DGs, especially DG Enterprise
  - NGOs very interested but less well resourced
    - Took a very strong interest in results, not in methods
    - Got unpaid help from individual researchers
  - Most member states did not comment on methods (UK did)
- Formal external review of draft methods: high-level US HIA / CBA team

# PM<sub>2.5</sub> (µg.m<sup>-3</sup>) and mortality: Pope et al (2002)

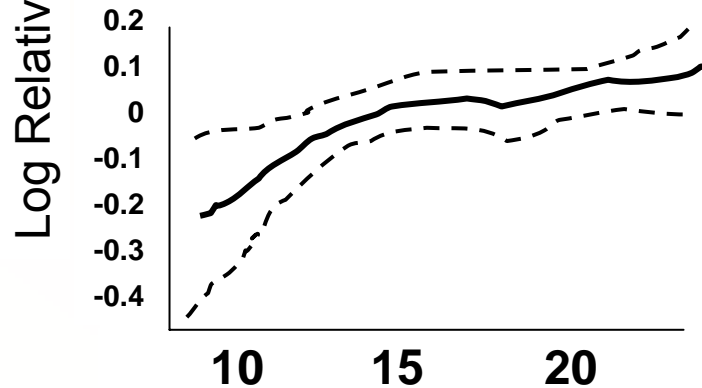
**A] All cause mortality**



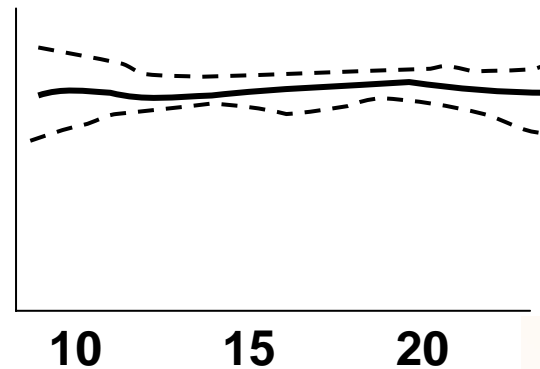
**B] Cardiopulmonary mortality**



**C] Lung cancer mortality**



**D] All other cause mortality**



Relative Risk and CIs of mortality 1982-1998 and annual average ambient particles (PM<sub>2.5</sub>) in 51 US metropolitan areas, based on a cohort of 319,000 adults aged 30+

6% change in mortality hazard per 10µg/m<sup>3</sup> PM<sub>2.5</sub>

# The NEEDS project

- The Methodology for CAFE was developed hand-in-hand with corresponding work for the NEEDS project **New Energy Externalities Developments for Sustainability** – another large IP under FP6, led by Andrea Ricci at ISIS in Italy.
- NEEDS also later looked at other issues, including transferability, within Europe especially

# Some key results from CAFE Cost-Benefit Analysis (CBA)

- CAFE included a full HIA and cost-benefit analysis (CBA) of policies – ‘baseline’ and new policies
- Baseline policies from Table 5, Watkiss et al. (2005) – [http://www.cafe-cba.org/assets/baseline\\_analysis\\_2000-2020\\_05-05.pdf](http://www.cafe-cba.org/assets/baseline_analysis_2000-2020_05-05.pdf)
  - Baseline 2000:
  - Baseline 2020: Assuming policies currently in place
- Costs and benefits from Commission summary staff paper
  - [http://europa.eu.int/comm/environment/air/cape/pdf/ia\\_report\\_en050921\\_final.pdf](http://europa.eu.int/comm/environment/air/cape/pdf/ia_report_en050921_final.pdf) (Commission staff paper, Table 33)

# PM<sub>2.5</sub>: estimated annual effects in EU25

End point	Units	Baseline 2000	Baseline 2020
Chronic effects on mortality (a)	Life years	3,620,000	2,470,000
Chronic effects on mortality (b)	Deaths	348,000	272,000
Infant mortality	Deaths	677	352
Chronic bronchitis (adults)	Cases	164,000	128,000
Resp. hospital admissions	Cases	62,000	42,300
Cardiac hospital admissions	Cases	38,300	26,100
Restricted activity days (adults)	Days	348,000,000	222,000,000
Resp medication use (children)	Days	4,220,000	1,990,000
Resp medication use (adults)	Days	27,700,000	20,900,000
Lower resp symptoms (children)	Days	193,000,000	88,900,000
Lower resp symptoms (adults)	Days	285,000,000	208,000,000

# Mortality, Morbidity and Valuation

- Mortality expressed as
  - (i) changes in life expectancy and (ii) 'attributable deaths';
  - CAFE CBA team strongly preferred (i); peer reviewers and Commission wanted (ii) also
- Monetary valuation and Mortality
  - Value of a life year (VOLY): €50k - €120k
  - Value of statistical life, of a prevented fatality (VSL/VPF): €1-2M.
- Morbidity
  - Mix of medical costs, lost productivity and willingness to pay (WTP)

# CAFE CBA: estimated costs and benefits

- Current levels of PM2.5 air pollution imply loss of life expectancy of about 8 months, on average across the EU-25
- Both costs and benefits increase as PM2.5 is reduced
- In monetary terms, benefits 5-20 times greater than costs for a 20% reduction in PM2.5
- There is a strong economic case for even stronger reductions i.e. Europe-wide, the estimated benefits of further reductions are 1-3 times greater than estimated costs

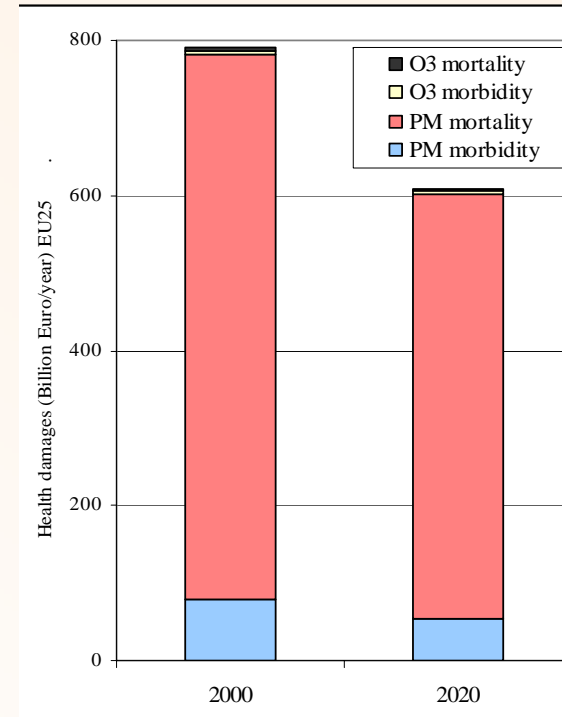
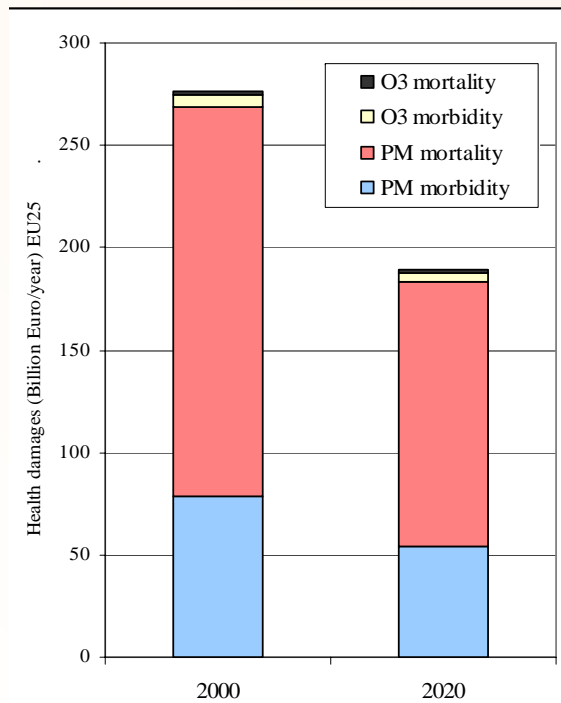
# Beyond CAFE / Research needs: Air pollution issues c/f ESCAPE

- Dominant effect of long-term exposure to PM on mortality in adults; need to
  - Confirm better EU-wide
  - Establish better the morbidity effects also – respiratory, CV, young people
  - Get more epidemiological evidence on relative toxicity of PM from different sources, i.e. *as it is experienced*
  - Effects of long-term exposure to O<sub>3</sub>, NO<sub>2</sub>, (SO<sub>2</sub>?),...
- ESCAPE – existing cohorts, new air pollution exposure estimation
- Need new cohorts also, to look e.g. at co-exposures?

# Beyond CAFE / Research needs: HIA methods c/f HEIMTSA, INTARESE etc. (1)

- Stay on top of developing evidence and of current interpretations of it
  - Developing evidence – e.g. US studies, ESCAPE...
  - Interpretations
    - COMEAP in UK
    - Expert Elicitation in the USA – generally higher estimates
  - WHO meeting March 2007 on different kinds of PM
- Simplify basic tools and methods
  - Focus only on mortality and long-term exposure to PM?
- Incorporate health inequalities – the distribution of effects

# Relative importance of PM-related mortality



- Health damages (billion Euro/year) in EU25
- (a) VOLY, median: 0-300bn; (b) VOSL, mean: 0-800bn

# Implications of quantifying only effects of long-term PM exposure on adult mortality

- Benefits would still far outweigh costs – the policy implications would not be very different, though the advantages of further reductions would seem more questionable
- Policy makers would have lost information about
  - The range of health endpoints affected (with symptoms) through days off work and visits to doctors to admissions to hospital
  - The distribution of effects – who is affected
  - The adverse health effects of ground-level ozone
- Quantification would have been based entirely on results from one (large) US study – issues of transferability to Europe would have been (even) higher than they were

# Inequalities in air pollution HIA, in CAFE

- CAFE paid some attention to distributional issues, e.g. by age, by country and health status; but not a main focus
- Differences in exposure to air pollution
  - The nature of the air pollution mixture
  - Background concentrations of individual pollutants (i.e. PM, O<sub>3</sub>, NO<sub>2</sub> etc.)
  - Personal exposures, for a given background concentration
- Differences in relative risks, per unit exposure ( $\mu\text{g}/\text{m}^3$ )
  - expressed as % change in risk of adverse health effect
- Differences in background rates of mortality or morbidity
  - the same % change implies a different absolute level of impact, if background rates differ
- (Differences in monetary valuation of health effects)

# Beyond CAFE / Research needs: HIA methods c/f HEIMTSA, INTARESE etc. (2)

- Explore new approaches
  - Track effects of policies on *the distribution of personal exposures*. Would help track effects on inequalities.
    - How well can this be done?
    - Can it be carried through to estimates of impacts?
    - Would need to 'convert' existing CR functions into functions based on personal exposures
  - Consider a mechanistic approach – c/f Denis Sarigiannis
- Issues like these being explored in HEIMTSA (and INTARESE?)
  - Not necessary for air pollution HIA *per se*
  - Excellent opportunity to test various approaches in one area where epidemiological HIA is well established in evidence.

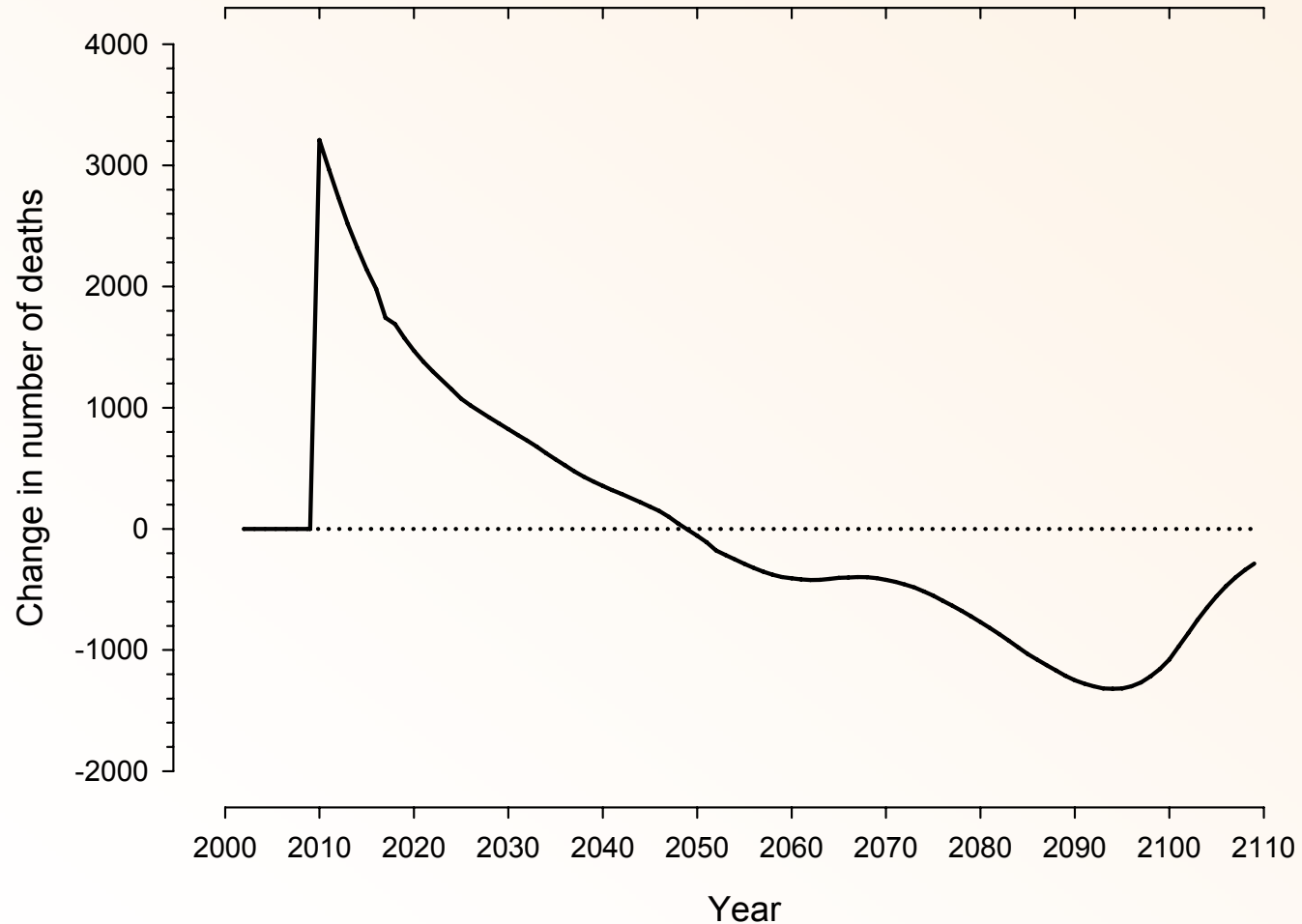
# Beyond CAFE / Research needs: HIA methods c/f HEIMTSA, INTARESE etc. (3)

- Background rates of morbidity
  - Europe-wide, weak coverage
  - In CAFE, sometimes
  - Do not need to be from air pollution studies
  - In CAFE, some of these
- Assessing and representing uncertainty
  - CAFE Vol 3 – Holland et al – Monte Carlo methods
- Expressing mortality impacts: “attributable deaths” or life expectancy?
  - Work led by Brian Miller at IOM (UK funding); (paper by Bert, BM, FH);
  - Also Ari Rabl, KTL, RIVM/MNP etc.
- EU projects such as NEEDS, HEIMTSA...

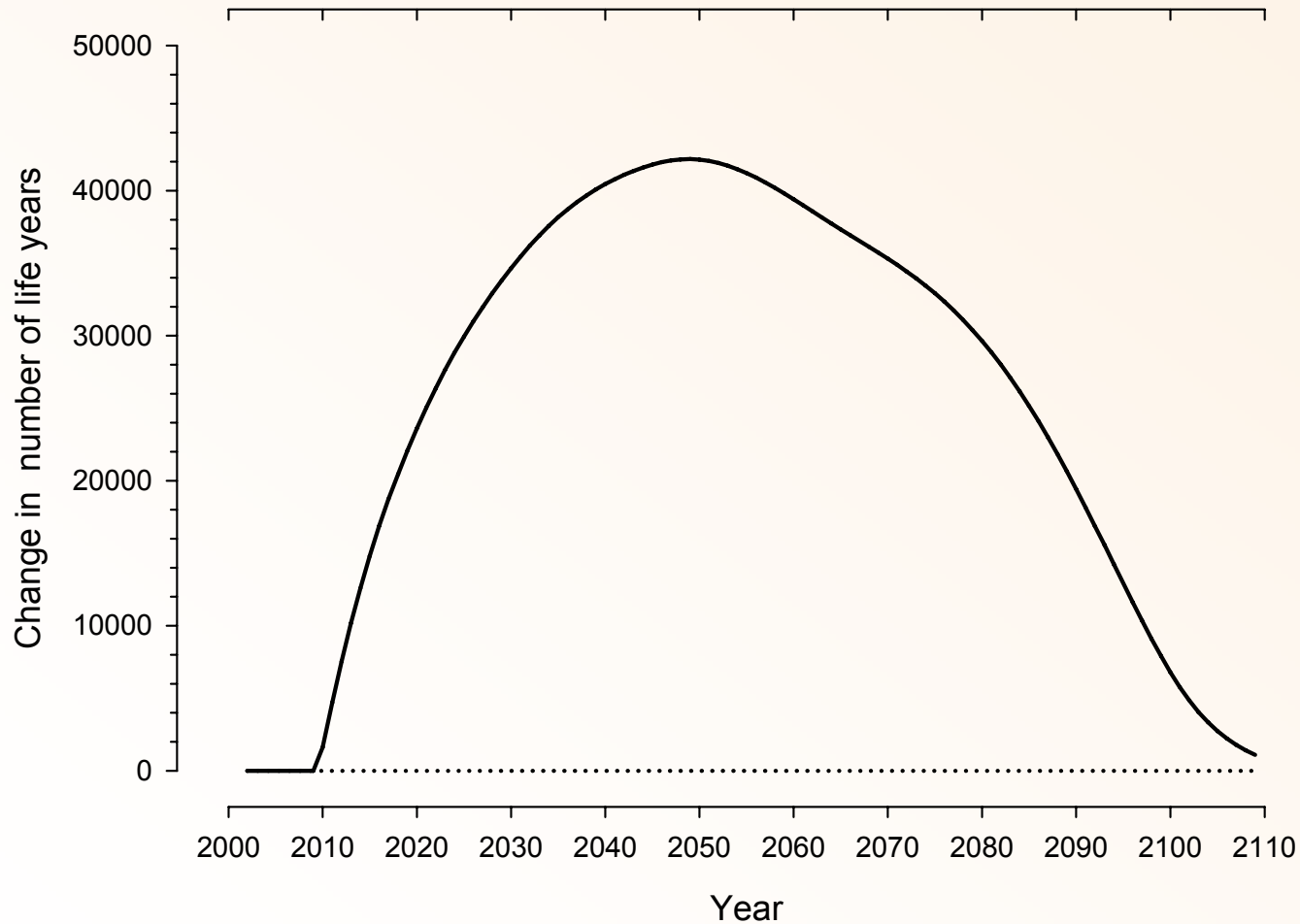
# “Annual attributable deaths” seems simple

- Reduce death rate by 6% for  $10\mu\text{g}/\text{m}^3$  reduction in annual average PM2.5
  - Take annual number of deaths in the population;
  - Reduce by 6% to give ‘annual lives saved’
- BUT: The number of ‘lives saved’ varies year by year
  - Everyone in the population dies eventually; there are no ‘extra’ or ‘saved’ deaths; There are deaths brought forward or postponed
  - Lower death rates (with lower air pollution) mean (eventually) a larger population at risk and more deaths per year
- We prefer changes in life expectancy / life years lived.. Always better under lower pollution

# Differences in annual numbers of deaths after reduction in mortality hazard rates, current pop<sup>n</sup>



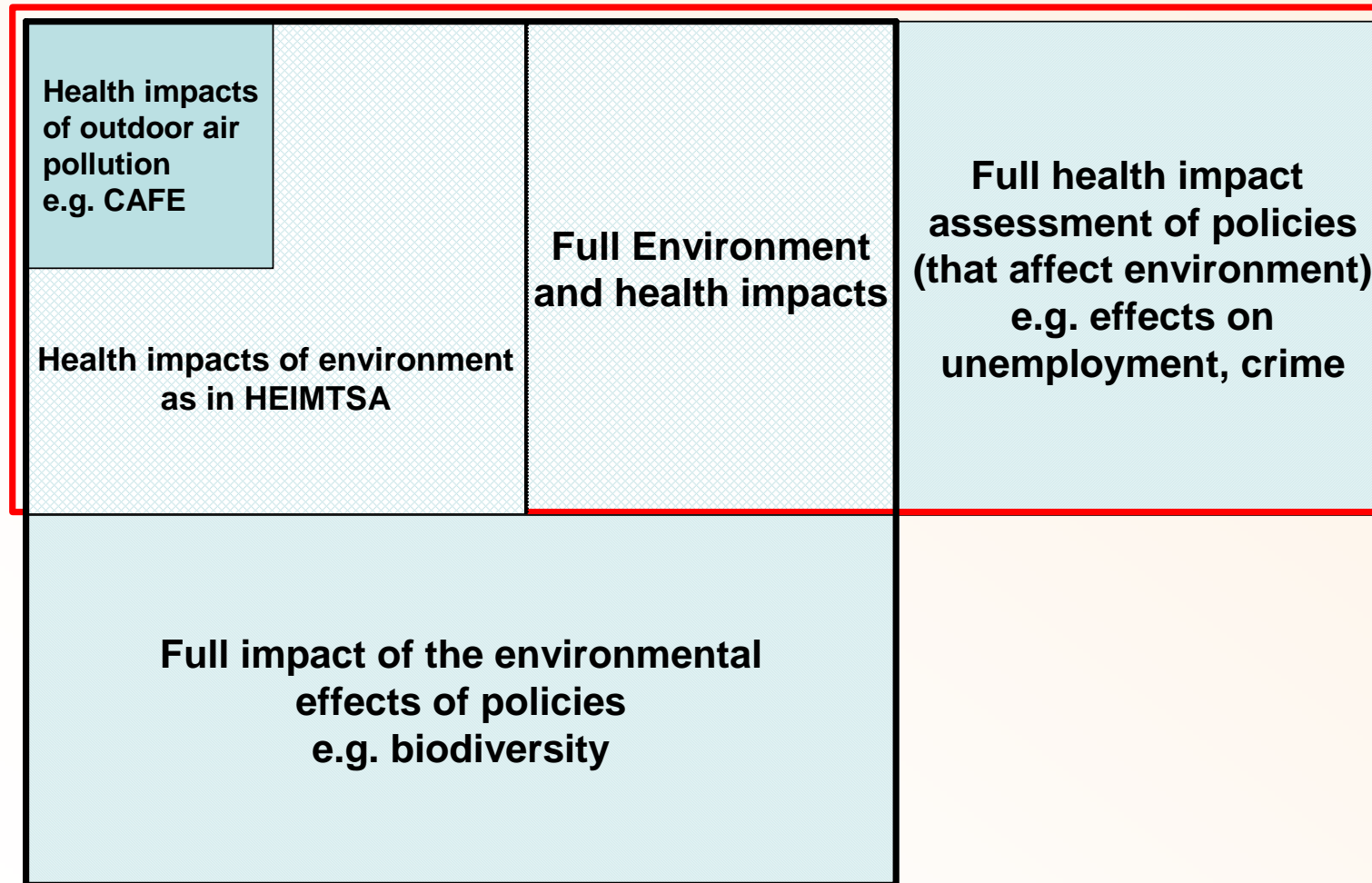
# Differences in annual life years after reduction in mortality hazard rates, current pop<sup>n</sup>



# Beyond CAFE/ Governance issues – How HIA fits into the wider policy process

- CAFE as a case study
- Role of HIA
  - To inform the policy/ decision-making process
  - Decisions ultimately are political (and so they should be?)
- Stakeholder / user involvement
  - ‘Procedural justice’ becomes more important
- Research needs in social science and politics

# What aspects of HIA / CBA?



# Conclusions

- CAFE was a benchmark in the EU's use of evidence to inform development of policy, including via HIA and CBA. Relative success depended on (i) underlying strength of evidence and data; and (ii) relatively well accepted HIA methods for air pollution – developed through the 90s by Bart Ostro, ExternE, APHEIS, Nino Kuenzli et al; + life table work (Brunekreef, Miller, Rabl...)
- There is an interest, at least in DG Research, in further developing HIA and CBA methods, for air pollution and other environmental pollutants
- Research needs are in (i) Environment and health – core studies; (ii) several aspects of HIA / CBA methods; (iii) How policy is developed and decisions are made (Governance)
- There is plenty to be done...and EU funding currently to do some of it – things could be much worse 😊