Health Implications: Quantification and Valuation for Use in Policy Making






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Presentation

- Background – health based AQ policy and the role of monitoring
- Examples health based AQ policy
  - CAFE
  - UK AQSR
- Key issues and potential research focus – key issues for monitoring
- (with a focus on the 'classical' combustion air emissions)

Health Based AQ Policy

- Target set to protect human health – Ambient AQ standards/limit values
- Targets set to minimise health impacts, e.g. Ambient AQ standard set for pollutant with no threshold, where not possible (or cost-effective) to achieve absolute protection
- National Emission ceilings
- Sector based (e.g. Euro standard or IPPC)
- Measure based, e.g. AQ-health targeted policy (e.g. Low Emission Zones)
- Economic instruments – environmental taxes and charges e.g. RUC

Role of Monitoring

- In the health evidence – providing the data for epidemiological studies
- Providing data for modelling (source concentration relationships)
- Providing measurement data on current air quality concentrations, i.e. scale of the problem and the baseline
- Providing data on progress towards achievement of air quality policy

A Changing Policy Background

- Historically AQ standards were set to protect health, with targets levels to protect all (irrespective of cost)
- Now policy target setting almost always includes an economic dimension
  - Achieve a set target cost-effectively (at least cost)
  - Set a target to achieve benefits whist avoiding dis-proportionate cost
  - Comparing costs and benefits (monetary terms) to set target, or justify policy
- Increasing we are moving from environmental equity to environmental efficiency
  - E.g. a policy can give better health benefits by providing a small benefit to many people than a large benefit to a few
  - E.g. a target might lead to disproportionately high costs which cannot be justified by the benefits achieved

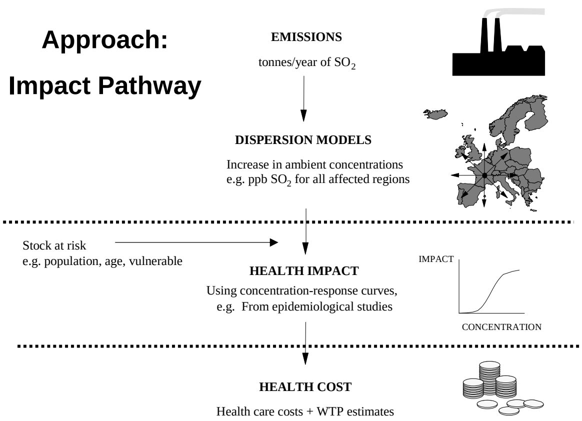
Cost-Effectiveness and Cost-Benefit Analysis

- Cost-effectiveness analysis compares the costs of alternative options for producing the same or similar outputs. It is a relative measure
- Cost-effectiveness used to assess the least-cost approach of reaching a given target (e.g. a threshold level), by picking most economically efficient options.
- Cost-benefit analysis is designed to show whether the total benefits of a project or policy exceed the costs. It is an absolute measure
- Quantifies costs and benefits in monetary terms, including non-market values. It shows whether a policy intervention is justified – are benefits greater than costs?
- (note CBA is the policy appraisal method of choice in the UK – Treasury green book)

Controversial?

- Many people object to adding an economic dimension to health based policy making, and especially valuing health and the environment…but
- Refusing to value health effects in appraisal often leads to being ignored (zero)
- We routinely value health in other aspects of policy (transport, NICE)
- Allows consideration against different priorities – broader view on where we should use limited resources
    - Is the resource spent reducing health impacts from air pollution sensible given other available options for improving public health
- Adored by Treasury ! optimises welfare – money counts!
- MANDATORY for all EC Directives (Impact Assessment) and UK policies (Regulatory Impact Assessment).
- A personal view……

Approach: Impact Pathway



Example 1. Clean Air for Europe

- CAFE assess ambition levels on future emissions, air quality and health and environmental objectives across Europe - year 2020
- Using results from CAFE, EC presented its Thematic Strategy on Air Pollution during September 2005 - for future European air quality policy
- Multi-pollutant, multi-effect scenarios. Independent advice on key areas, e.g. WHO
- Note only PM and O3 linked to health effects (but note PM includes secondary)
- Cost-effectiveness optimisation (RAINS) - integrated assessment model
    - Used to see how to achieve a given ambition level most cost-effectively (optimally).
- Cost-Benefit Analysis (CBA Model) – included full health impact assessment

CAFE Ambition Levels

- Recognised not possible to fully achieve environmental objectives (towards zero health and environmental effects from air pollution)
- Assess the maximum technical feasible reduction (MTFR), i.e. how far can reduce environmental and health damage due to air pollution irrespective of cost
- Investigate progressively more ambitious levels towards the MTFR (gap closure)

	CLE	*A*	*B*	*C*	*MTFR*
Years of life lost due to PM2.5 (EU-wide, million YOLLs)	137	110	104	101	96
Acidification (country-wise gap closure on cumulative excess deposition)	0%	55%	75%	85%	100%
Eutrophication (country-wise gap closure on cumulative excess deposition)	0%	55%	75%	85%	100%
Ozone (country-wise gap closure on SOMO35)	0%	60%	80%	90%	100%

CBA Results – marginal health benefits

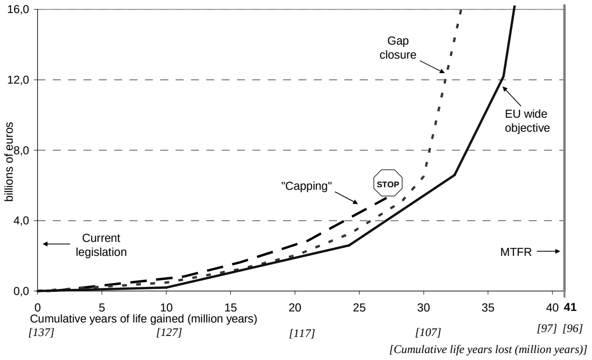
EndPointName		A	B	C	MTFR
Acute Mortality (All ages)	O_3	1,600	2,200	2,500	3,041
Respiratory Hospital Admissions (65yr +)	O_3	1,600	2,100	2,400	2,940
Minor Restricted Activity Days (MRADs 15-64yr)	O_3	3,224,500	4,295,700	4,938,400	5,930,767
Respiratory medication use (children 5-14yr)	O_3	964,900	1,281,000	1,473,000	1,761,305
Respiratory medication use (adults 20yr +)	O_3	623,500	830,800	954,700	1,146,367
Cough and LRS (children 0-14yr)	O_3	4,928,400	6,563,800	7,546,100	9,074,371
Chronic Mortality – YOLL	PM	492,500	600,800	654,600	744,600
Chronic Mortality – deaths	PM	53,800	65,700	71,600	81,400
Infant Mortality (0-1yr)	PM	70	80	90	100
Chronic Bronchitis (27yr +)	PM	25,500	31,100	33,900	38,500
Respiratory Hospital Admissions (All ages)	PM	8,500	10,300	11,200	12,800
Cardiac Hospital Admissions (All ages)	PM	5,200	6,400	6,900	7,900
Restricted Activity Days (15-64yr)	PM	44,402,100	54,104,400	58,934,300	67,013,700
Respiratory medication use (children 5-14yr)	PM	398,100	490,500	533,900	608,400
Respiratory medication use (adults 20yr +)	PM	4,166,600	5,076,500	5,530,900	6,288,200
Lower Respiratory Symptom (LRS) days (children 5-14yr)	PM	17,715,900	21,697,000	23,630,500	26,962,800
LRS among adults (15yr +) with chronic symptoms	PM	41,422,600	50,505,500	55,029,200	62,566,700

CBA Results – marginal monetary benefits

EndPointName		A	B	C	MTFR
Acute Mortality (VOLY median)*	O_3	83	110	127	152
Acute Mortality (VOLY mean*)	O_3	186	248	285	342
Respiratory Hospital Admissions (65yr +)	O_3	3	4	5	6
Minor Restricted Activity Days (MRADs 15-64yr)	O_3	124	165	190	228
Respiratory medication use (children 5-14yr)	O_3	1	1	1	2
Respiratory medication use (adults 20yr +)	O_3	1	1	1	1
Cough and LRS (children 0-14yr)	O_3	189	252	290	349
Chronic Mortality – VOLY – low (median)	PM	25,750	31,412	34,225	38,927
Chronic Mortality – VOLY – high (mean)	PM	57,798	70,508	76,822	87,377
Chronic Mortality – VSL – low (median)	PM	52,726	64,313	70,122	79,680
Chronic Mortality – VSL – high (mean)	PM	108,479	132,319	144,271	163,935
Infant Mortality (0-1yr) – low (median)	PM	100	121	132	150
Infant Mortality (0-1yr) – high *mean)	PM	199	242	264	300
Chronic Bronchitis (27yr +)	PM	4,786	5,827	6,348	7,219
Respiratory Hospital Admissions (All ages)	PM	17	21	23	26
Cardiac Hospital Admissions (All ages)	PM	10	13	14	16
Restricted Activity Days (RADs 15-64yr)	PM	3,703	4,512	4,915	5,589
Respiratory medication use (children 5-14yr)	PM	0	0	1	1
Respiratory medication use (adults 20yr +)	PM	4	5	5	6
LRS symptom days (children 5-14yr)	PM	681	834	908	1,036
LRS among adults (15yr +) with chronic symptoms	PM	1,591	1,940	2,114	2,404

Thematic Strategy (1)

- Move from PM_{10} to $PM_{2.5}$ - health based
- Health became priority effect (compared to previous NEC, Gothenburg, etc)
- Setting of high capping limit value as a 'safety valve', rather than aiming for a consistent low level to be achieved everywhere to a European wide optimisation – more cost-effective
- Also introduced exposure reduction targets
  - Both reflect an economic dimension
- Change to exposure reduction targets very important for monitoring – used to set baselines – increases importance of monitoring in the overall framework



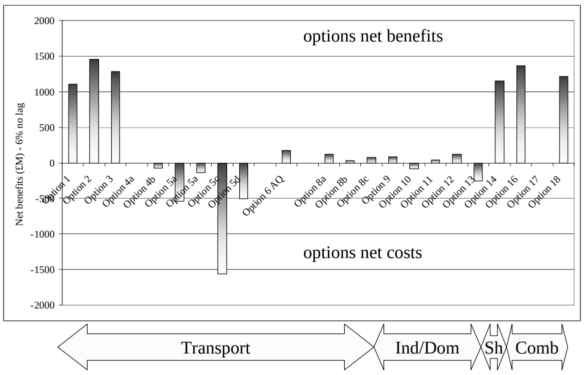
Thematic Strategy (2)

- Thematic Strategy proposed an ambition level of B for health, but A for other environmental constraints
- B level supported by the CBA
- (but also importantly sharp rise in cost curve after B ambition level)
- B Ambition level linked through to a $PM_{2.5}$ population exposure reduction target
- Progressing through Council and Parliament
- Different groups initially sceptical of HIA and valuation (both NGO and industry) but used analysis to support their arguments opportunistically

Example 2 - UK Air Quality Strategy Review

- Review of Air Quality Strategy - Focus on 2020 target year
- Health analysis based on advice from COMEAP
- Impacts through to health valuation (advice from Inter-Departmental Group on Costs and Benefits)
- Similarly focus on PM and O3
- Note whilst analysis similiar to CAFE (PM) – implementation slightly different
- Assessed set of individual measures and their costs and benefits
- Looking to draw together most promising options into the strategy
- Towards an exposure reduction target (level of ambition determined by options)

Net Benefits – high benefits (6% RR: no lag)



What is really important?

- While some differences between CAFE and UK approach – they are actually very consistent on issues that matter
- Health dominates the economic benefits

  …..and within health – PM dominates (note PM includes primary & secondary)

  ……and within PM – chronic mortality dominates
- Key issue driving policy is the assumed risk rate for YOLL in chronic mortality
- Location….also important – impacts primarily in urban areas because of population weighted effect – more so for primary PM emissions as a source
- Also when the impacts occur (whether to discount), and valuation estimate

What else matters?

Speciation and causality

- We still do not know what drives the health impacts.
- This is extremely important for policy appraisal, because different options have different Primary PM vs. NOx or SO2
- And different relative proportion with respect to mass, number, size
- New information here would affect policy and monitoring requirements

Given current evidence, less importance to NO_2, SO_2, CO as gases (and implicitly less need for monitoring)

BUT still need to keep these in the mix, in case the evidence shifts

What else might matter?

Chronic effects

- More evidence on chronic effects from PM for morbidity
- Chronic health impacts from ozone
- Effects of NO_2 in longer term effects, or as linked to other health

Secondary organic particles

- Not included in the models – important as would give greater importance to VOC emissions alongside ozone effects

Climate Change

Conclusions

- Policy landscape is changing – towards economic efficiency
- Health is now dictating European and UK ambient AQ policy
- Cost-effectiveness and cost-benefit analysis key tools to aid decision process – as an input
- In order to justify continued improvements in air quality, benefits will need to exceed costs
- Air quality monitoring continue to be key – and likely to have even more important role as exposure target based approach comes in
- Policy dominated by PM2.5 – followed by O3
- Policy appraisal driven by chronic long-term effects – risk rate determines what can be justified (not also requirement for monitoring programmes for underlying health)
- PM dis-aggregation could change policy response (options) – and could be extremely important if health evidence starts to move more strongly towards speciation/size/etc – change monitoring
- Current evidence suggests less importance for gases (NO_2, SO_2) but while the mechanisms remain unknown, important they are monitored

AQSR Health Analysis

1. Particulate matter and chronic mortality (Years of Life Lost)
   - 6% risk rate based on Pope ** - life tables used to assess change in risk rate
   - With zero and 40 year lag between exposure and effect
   - Equal causality to primary (PM) and secondary particulates (NOx and SO_2 and NH3)
   - Discounting of health effects in the future
   - Works with marginal PM10 as metric
2. PM and morbidity
   - Only respiratory and cardiac hospital admissions
3. Ozone and acute mortality
   - 0.6% increase in daily mortality per 10 µg/m3 O3 – assume 2 – 6 months of life lost
   - Quantified at concentrations greater than 0 ppb, 35ppb and 50 ppb
   - Plus respiratory hospital admissions

HIA in CAFE CBA

- CAFE CBA undertakes full HIA

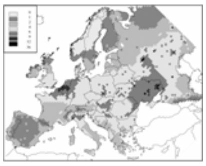
1. Particulate matter
   - Range of acute and chronic health effects
   - Equal causality assigned to primary and secondary particulates
   - Chronic mortality as for cost-effectiveness (but also variation expressing as premature deaths for valuation) – acute mortality not quantified separately
   - Works with $PM_{2.5}$ as metric – issue on conversion from primary studies
   - Core set of health impact functions, but also number of other functions quantified as sensitivity
2. Ozone
   - Acute mortality plus range of acute morbidity effects
   - Each 'death brought forward' involves a loss of life of 12 months

CAFE Key Health Issues

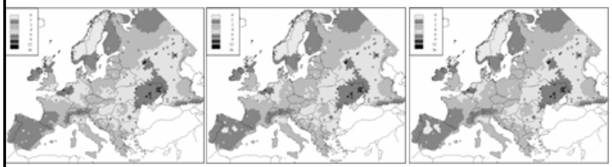
- Rains worked with two key health impacts

1. Particulate matter and chronic mortality (Years of Life Lost)
   - 6% risk rate based on Pope - life tables used to assess change in risk rate
   - Assumed no lag between exposure and effect
   - Equal causality to primary (PM) and secondary particulates (NOx and SO_2 and NH3)
   - No discounting of health effects in the future
   - Works with PM2.5 as metric
   - Analysed for different meteorological years
2. Ozone and acute mortality
   - 0.3% increase in daily mortality per 10 µg/m3 O3
   - concentrations greater than 35ppb (maximum 8-hr mean).

Years of Life Lost From PM2.5



Baseline 2020



A B C

suggest the statistical life expectancy of a European shortened by 8.1 months as a consequence of the exposure to anthropogenic PM2.5

EU25 Results – Marginal Benefit/Costs

	from CLE to A	from A to B	from B to C	from C to MTFR
EU incremental annualised benefits (health and crops)				
Total with Mortality – VOLY – low (median)	38	8.3	4.1	6.9
Total with Mortality – VSL – high (mean)	120	27	13	22
EU-25 annualised costs in Billion€/year - incremental changes to each scenario				
Total	5.9	4.8	4.2	25
NET incremental benefits				
Total with Mortality – VOLY – low (median)	32	3.5	-0.03	-18
Total with Mortality – VSL – high (mean)	115	22	9.1	-3.0
Benefit to cost ratio				
Total with Mortality – VOLY – low (median)	6.3	1.7	0.98	0.3
Total with Mortality – VSL – high (mean)	20	5.6	3.2	0.9

Uncertainty and Sensitivity