Valuation

Economic valuation of damage

Methodology and key issues

Within EC4MACS, the ALPHA2 methodology is employed to estimate the economic value of damage caused by air pollution. (Box 25). Key issues related to the valuation are listed in Box 26.

Box 25: The EC4MACS benefits assessment methodology

- The EC4MACS benefits assessment module quantifies the health and environmental benefits of emission control strategies in monetary terms. It is based on the EXTERNE methodology and maintained by a consortium including AEAT and MetroEconomica (UK). It follows a logical progression through the following stages:
  - Quantification of emissions (in CAFE, covered by the RAINS model);
  - Description of pollutant dispersion across Europe (in CAFE, covered by the RAINS and EMEP models)
  - Quantification of exposure of people, environment and buildings that are affected by air pollution
  - Quantification of the impacts of air pollution
  - Valuation of the impacts

Box 26: Key issues for the valuation of benefits

- Valuation is performed on estimates of impact from the perspective of 'willingness to pay' (WTP), which underpins any economic transaction: without a willingness to pay the price requested for a good there will be no sale. The following key issues are highlighted:
  - Approach to valuation of mortality: There are two approaches to valuing mortality. The traditional method applies the 'value of a statistical life' (VSL) to an estimate of the number of deaths linked to a particular cause. The second method applies the 'value of a life year' (VOLY) to the estimated change in life expectancy aggregated across the population. EC4MACS applies the second approach.
  - Mortality valuation estimates: Under the EC4MACS project review has been undertaken of VOLY and VSL research since the earlier work on the CAFE Programme was completed. A particular development concerns the finalisation of the EC-funded NEEDS project (Desaigues et al, 2006) in which a best estimate for the VOLY of €40,000 was generated. However, it has been concluded that further scrutiny of the NEEDS data is necessary before they are factored into the 'core analysis', bearing in mind the need for consistency in analysis carried out across the European Commission more generally in this area. On this basis the figures agreed under the earlier CAFE work (€52,000 median/€120,000 mean for VOLY and €0.98 million median/€2 million mean for VSL in year 2000 prices) are applied here, though only the extremes are reported. The €40,000 VOLY estimate from the Desaigues et al study is also applied for sensitivity analysis. It is notable that all estimates for mortality valuation used here are considerably lower than those applied in similar work in the USA.

Box 27: Key issues for the valuation of benefits (continued)

- Differences in valuation across Europe: WTP inevitably varies with income, with the result that valuation estimates will vary from country to country. Whilst this makes obvious sense for some impacts, such as the labour costs of repairing buildings, it is extremely controversial when applied to the non-market aspects of health effect valuation, especially mortality. This is not problematic when considering issues that are confined within national borders, but difficulties inevitably arise when considering transboundary air pollutants. EC4MACS applies an average valuation across the EU.
- Gaps in knowledge of valuation: At the present time there are some significant gaps in the literature on valuation relative to air pollution impacts. The most important concern valuation of ecosystems.
- Reliability of WTP estimates: A large number of biases have been identified that can affect the results of the contingent valuation surveys used to derive WTP estimates relating to health and other impacts.

Human health

Total health damage by country, accounting for quantified impacts of exposure to both PM2.5 and ozone is shown in Figure 5.1. The VOLY has been used in the valuation of mortality for this figure: were the VSL to be used results would be roughly twice as large. The two main drivers for the magnitude of damage in each country are, first, population size, and second, pollution levels.

Changes in emissions that are foreseen for the baseline case will lead to a significant drop in damage for the EU Member States between 2000 and 2020. Mortality impacts of PM2.5 dominate the analysis, and quantified effects of ozone make up only a few percent of total quantified health damage. These estimates are calculated based on the VOLY (Value of Life Year) concept; using the VSL (Value of Statistical Life) approach leads to a rough doubling of health estimates.

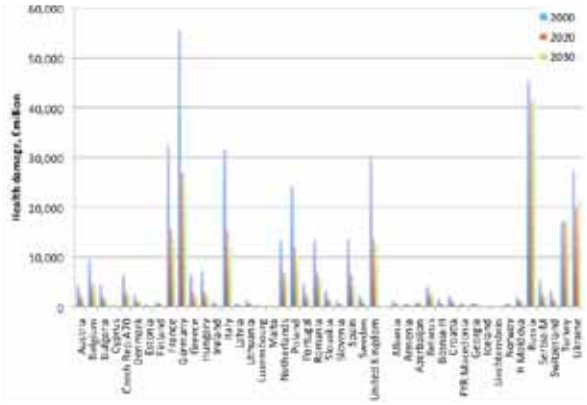

Figure 5.1: Health damage from exposure to PM2.5 and ozone, VOLY used for mortality assessment.

Table 5.1: Summary data on health damage, 2000 to 2030, €billion/year

	2000		2020		2030	
	VOLY	VSL	VOLY	VSL	VOLY	VSL
PM2.5						
Mortality	298	1090	144	598	121	505
Morbidity	130		64		52	
Ozone						
Mortality	1.3		0.9		0.8	
Morbidity	2.5		1.7		1.6	
Total for EU-27	430	1224	211	665	175	559

Note: Application of the €40,000 estimate for the VOLY from Desaigues et al. would reduce the lower bound for total health damage across the EU-27 to €353, €174 and €143billion/year in 2000, 2020 and 2030 respectively.

Ecosystems

As noted already, it is not currently possible to value impacts to ecosystems. Problems arise because of the diversity of benefits that good ecological health brings (existence values for biodiversity, recreational opportunity, water management, natural products such as berries and mushrooms and so on) and a current inability to link pollutant deposition to these effects beyond identification of areas at risk of critical loads exceedance and information on recovery times.

Given the magnitude of health benefits some commentators have concluded that adding in ecological benefits would make little difference to the results. However, this is not necessarily the case, for the following reasons:

- Early pan-European action on transboundary air pollution was directed towards acid rain controls specifically because of great concern over ecological impacts.
- Although the area of ecosystems at risk from exceedance of the critical load for acidification has been reduced as a consequence of emission controls, ecosystems in some parts of Europe remain at significant risk.
- Very large areas have been identified as being at risk from exceedance of the critical load for nitrogen / eutrophication.
- The effects of exceedance of the critical load for eutrophication on biodiversity at many sites throughout Europe can be considered profound.

On this basis, and despite the fact that ecosystem impacts are not monetised here, it is concluded that there is a good basis for considering that inclusion of ecosystem effects could increase overall benefit results significantly.

To some extent it may be considered that policies aimed at health improvement via control of particle and ozone exposures will also yield benefits for ecological protection. It is worth considering, however, what differences there may be in policies aimed primarily at protecting health or ecosystems, relative to the extent of control of each pollutant and the areas subject to the greatest level of control.

Agricultural crops

Estimates of damage of ozone to crops are shown in Table 5.2 covering the period 2000 to 2030. Quantified damages are a small fraction of those associated with health impacts and so detailed account of associated uncertainties is not considered necessary.

The crops for which the highest damage is estimated are wheat and potato, reflecting both their sensitivity and the scale of production of these two crops. Visible injury caused by ozone and fertilising effects of sulphur and nitrogen-containing pollutants have not been quantified.

Table 5.2: Economic damage to agricultural crops [€million/year]

	2000	2020	2030
Total damage	3699	1607	1295
Decrease from 2000		2092	2404
% change		-57%	-65%

Materials

Estimates of damage of acidic pollutants to materials from 'utilitarian' applications are shown in Table 5.3 covering the period 2000 to 2030. Quantified damages are a small fraction of those associated with health impacts and so detailed account of associated uncertainties is not considered necessary. Analysis has been restricted to the EU27 because of a lack of data on the stock at risk in other countries.

The large decline in impacts between 2000 and 2020 reflects the fall in SO_2 emissions, the principal pollutant associated with damage to materials.

These estimates do not, of course, include damage to cultural heritage, one of the impacts of greatest concern in the development of early legislation on European transboundary air pollution. Whilst the decline in SO_2 emissions across Europe since 1980 will have done much to bring these impacts under control, the desire for cultural heritage to be maintained in perpetuity in an original condition is not to be forgotten.

Three other types of damage that are not quantified here are effects of ozone on rubber, soiling with particles, and the promotion of algal growth through the deposition of nitrogenous pollutants.

Table 5.3: Economic damage to utilitarian building materials (€ million/year) in the EU-27

	2000	2020	2030
Total damage	2030	547	496
Decrease from 2000		1483	1535
% change		-73%	-76%

Summary

Overall benefits are summarised in Table 5.4. The range for mortality shows the effect of using the VOLY and VSL estimates. For ozone only the VOLY estimate has been applied in line with the perception discussed by Hurley et al., 2005 that only a relatively short period of life is lost to the quantified ozone effect.

Note: Application of the €40,000 estimate for the VOLY from Desaigues et al. would reduce the lower bound for total damage to health, crops and materials across the EU-27 to €359, €176 and €145billion/year in 2000, 2020 and 2030 respectively.

Table 5.4: Overview of damage calculated for the years, 2000 to 2030 [€billion/yr]

	2000	2020	2030
Mortality PM2.5	298 to 1090	144 to 598	121 to 505
Morbidity PM2.5	130	64	52
Mortality ozone	1.3	0.9	0.8
Morbidity ozone	2.5	1.7	1.6
Crops	3.7	1.6	1.3
Materials	2.0	0.5	0.5
Total damage EU-27	436 to 1230	213 to 667	177 to 561