

# *How Much is Clean Air Worth: Calculating the Benefits of Pollution Control*

## **Preface**

12 June 2013

The book is addressed to

- Researchers interested in the calculation of environmental impacts;
- Policy makers and their advisors, in energy and environmental policy;
- Graduate students and advanced undergraduates in environmental science.

In the past, decisions about environmental policy were made without quantifying the benefits. Pollution had become so bad, for instance with the Great London Smog of 1952 and rivers like the Rhine getting too poisoned for fish to survive, that the demand for cleanup became overwhelming and environmental regulations were imposed without cost-benefit analysis (CBA). The main sources of pollution and their impacts were obvious, and the regulations were clearly beneficial.

Now the remaining environmental problems tend to be more complex and so is the task of finding suitable solutions. For example, what should we do with our waste? Should what remains after recycling be incinerated or put into a landfill, either method having some harmful impacts? Fortunately environmental science has progressed to the point where the problems can be analyzed with a fair degree of confidence and CBA can help us identify the best solutions. When cost-effective measures are proposed, CBA is a powerful tool to convince the concerned stakeholders that such measures should indeed be implemented.

Calculation of damage costs of pollution (“external costs”) is multidisciplinary to the extreme, requiring expertise in engineering, environmental modeling, epidemiology, ecology, economics, statistics, life cycle assessment, and so on. Quite a challenge for writing a book on the subject. We do have a broad expertise in most of these fields, demonstrated by our publications in fields as diverse as economics, dispersion modeling, epidemiology, risk analysis, life cycle assessment, energy policy, waste treatment, and transport policy. We have been very active in all phases of the ExternE (External Costs of Energy) project series of the European Commission (EC), DG Research. That is why this book shows much more on methods and results of ExternE than on equivalent work elsewhere, even though two of us (AR and JVS) live and work both in the EU and the US.

Our goal has been to provide an introduction to the subject that is sufficiently thorough to enable readers to understand the methodologies and even to carry out their own approximate calculations. We believe that particularly in the age of powerful computers and sophisticated software it is crucial to understand the principles of the calculations and to have a sense of whether the results are plausible. This is because most policies or other options that are proposed will be contested by people who would be worse off or believe they would be worse off. Decision makers, or at least their advisors, need sufficient understanding of the issues to be able to decide whether such critiques are justified or not. Therefore we present models that are simple, transparent and suitable for first approximations. Our guiding principle has been “Better approximately right than precisely wrong”.

While our focus is on air pollution, we also touch on related burdens, such as noise, congestion, accidents and resource use, in order to enrich the presentation of applications to

power production, waste treatment and transportation. The research is rapidly evolving, but our capacities are limited and we cannot provide perfect up-to-date coverage of each topic. Experts of the respective fields may well find items to criticize, although few would have the combination of breadth and depth to offer a better comprehensive treatment of the entire subject. In fact, we have found several instances where experts of one field use the results obtained in other fields without understanding the underlying assumptions and limitations. For example the valuation of air pollution mortality has frequently been done by economists who do not understand what has been measured by epidemiologists and who use a number of deaths that is inappropriate (as we have explained in several publications and also in this book). Another example of trans-disciplinary misunderstanding is the use of site-specific numbers by policy makers when they really need typical results for an entire region.

A criticism frequently lobbed against environmental CBA is that the uncertainties are too large to inform policy assessment. In response we emphasize that it is not the uncertainties themselves that matter, but the consequences for the decisions. The relevant question is “how large is the cost penalty for making a wrong decision because of an over or underestimation of the damage cost, compared to the optimal decision if one had known the true cost?” As we have shown, the information is very valuable despite the seemingly large uncertainties, because near the optimum the total social cost does not vary much as a function of the abatement level: even a sizable error entails only a small increase in the total social cost. And what is the alternative to CBA? Is it better to guess, based on vague intuitions and preconceived ideas? Without a careful CBA the error could be so large as to entail very costly decisions. To prove these points, the book contains a substantial chapter on the analysis of uncertainties.

One of the challenges of writing a book on this subject is that a flood of new studies is continually adding new elements that should ideally be used to update all the affected results. And all the updates should account for the effect of inflation on the costs ... of course, even items with large uncertainty, such as the value of a life year, should be adjusted (and we cannot help thinking of that story of the museum director who happens to overhear one of the guides saying “this statue is 3007 years old”. He asks the guide how he comes to know that and the guide replies “when you hired me seven years ago you told me ...”). Rather than trying to keep all the numbers up-to-date, for the purpose of illustrating the methodology we think that sometimes older results can be cited. For the presentation of the main damage cost results of ExterneE in chapters 12 to 15 we have chosen the numbers of the NEEDS and CASES projects [ExterneE 2008] and we explain how they can be adjusted, in particular for changes in the cost of mortality and of greenhouse gases that we believe to be appropriate. We also present results from analogous studies in the US.

For the organization of this book two alternatives seem logical: by impact category, or in the order of the steps of the impact pathway analysis (IPA: analysis of the chain emission -> dispersion -> exposure-response function -> monetary valuation). Nonetheless we found it preferable to use a mixed approach because the exposure-response functions (ERF) determine what kind of dispersion modeling is required. Therefore we present the chapters with ERFs before the ones on atmospheric models and on multimedia models. For some burdens we treat the entire IPA in a single section. Climate change is such a complex subject that we cannot do it justice in our book and we have only one chapter where we focus on issues related to the estimation of the damage costs of greenhouse gases. The development of the IPA methodology closes with a chapter on the uncertainties, where we present both Monte Carlo analysis and a simple shorthand method that we have developed for typical calculations of

IPA and risk analysis.

The last part of the book presents results of the IPA analysis, with applications to electricity generation, waste treatment and transport. To close the book we review how the results have been used by policy makers.

Our motivation has been the desire to help bring more rationality to environmental decision making. All too often decisions have been the outcome of noisy arguments and angry power play, without evaluating costs and benefits. As a result society ends up with gross and costly inconsistencies, paying billions to avoid a death due to one particular risk while refusing to pay a few thousand when a similar death is due to a different risk <sup>1</sup>. Even if a well-documented analysis of costs and benefits may not remove disagreements, at least it provides a basis for proper and detailed discussion.

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<sup>1</sup> Documented by Tengs and Graham [1996].