How Much is Clean Air Worth?

How Much is Clean Air Worth? offers a comprehensive overview of the core methodologies and tools used to quantify the impacts and damage costs of pollution. The book begins by reviewing the tools used for environmental assessments and shows that a rational approach requires an impact pathway analysis (IPA) for each of the possible impacts of a pollutant, i.e. an analysis of the chain emission → dispersion → exposure-response functions → monetary valuation. The IPA methodology is explained in full and illustrated with worked examples, difficulties are discussed and uncertainties analyzed. In addition to detailed computer models, a very simple model (the "uniform world model") is presented, enabling readers to make estimates for cases where limited input data are available. Published results for electricity, waste treatment and transport are reviewed, with a thorough discussion of policy implications. This book will appeal to a broad mix of academics, graduate students and practitioners in government and industry working on cost–benefit analysis, environmental impact analysis and environmental policy.

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How Much is Clean Air Worth?

Calculating the Benefits of Pollution Control

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Foreword

In the Western world, it has been a long journey to achieve the current ecological and social transition. The US National Environmental Policy Act of 1969 and the European Community Environmental Action Programme of 1973 opened the way to establishing cost–benefit analysis and, later, the polluter-pays principle. The 1981 US Presidential Executive Order 12191 required Impact Assessment studies to be carried out for all major policies presented by the Federal Government, while the 1986 Single European Act stipulated that, when developing environmental policies, the European Community will take account of available scientific and technical data, and of benefits and costs of actions and lack of action.

Within this context, at the end of the eighties, the EU and USA (European Commission's DG XII – Science and Research and US Department of Energy) launched a fruitful collaboration on a joint study on fuel cycle cost that gave birth to the so-called ExternE – Externalities of Energy – project series, funded since then and with different names by the European Commission through its successive Research Framework Programmes.

Among the pioneer actors of this interdisciplinary research work, one can mention David Pearce, Ari Rabl, Anil Markandya, Olav Hohmeyer, Robert Shelton, Russell Lee, Alan Krupnick, Nick Eyre and Richard Ottinger. More recently, key researchers in the field of external costs quantification, tackling the issues of energy, environment and transport have been Mike Holland, Jacquie Berry, Rainer Friedrich, Andrea Ricci, Joseph V. Spadaro, Stale Navrud, Stefan Hirschberg and Milan Scasny.

The concept of external costs entered the European political jargon with the 1993 Jacques Delors White Paper on growth, competitiveness and employment, which stated that "energy can no longer be seen as an unlimited resource, particularly if the external costs associated with climate change, acidification and health are not taken into account (. . .). The way the Community uses its labour and environmental resources highlights some fundamental weaknesses in the incentive structure of the

Community economy attributable to public intervention (e.g. tax treatment of labour costs, transport infrastructure) as well as to market forces (environmental externalities). It is open to question whether, to an increasing extent, the economic growth figures do not reflect illusionary instead of real economic progress and whether many traditional economic concepts (e.g. GDP as traditionally conceived) may be losing their relevance to policy formulation in the future."

Since then a lot of progress has been made on external costs quantification, both from a research perspective and on EU policy implementation.

Regarding the latter, and to give some concrete examples of European policies in the last decade, it is worth mentioning references to "internalization of damage caused to the environment" in the 2000 Commission Green Paper on security of energy supply, or "the principle of recovery of the costs of water services, including environmental and resource costs, having regard to economic analysis (. . .) and in accordance with the polluter-pays principle," in the EU Water Framework Directive, adopted in 2000.

The Community guidelines on State aid for environmental protection published by the Commission in 2001 mentioned that "Member States may grant operating aid to new plants producing renewable energy that will be calculated on the basis of the external costs avoided (. . .) that must not exceed 5 euro-cents per kilowatt hour."

The 2004 European Commission Environmental Technologies Action Plan stated that getting the prices right requires the systematic internalization of costs through market-based instruments (e.g. taxes, tax breaks, subsidies, tradeable permits, deposit-refund schemes) that make producers and consumers bear the real costs of their actions or change their behavior in a cost-effective way.

The European Environmental Liability Directive, that entered into force on 1 May 2008, forces industrial polluters to pay the costs of preventing and remedying environmental damage, including where it affects biodiversity, water and human health.

The 2007 Commission Green Paper on market-based instruments adds that these "give firms an incentive, in the longer term, to pursue technological innovation to further reduce adverse impacts on the environment ('dynamic efficiency') and support employment when used in the context of environmental tax or fiscal reform."

The 2005 cost–benefit analysis of the European thematic strategy on air pollution was essentially based on ExternE research work, including the health impacts of particles. The 2008 EU Directive on ambient air quality requires that "Member States reduce exposure levels in urban areas to PM2.5 by an average of 20% by 2020 based on predicted 2010 exposure levels. Member States will be obliged to bring exposure levels below 20 μg m^{-3} by 2015 in these areas."

From an academic and research perspective, this book provides an extremely useful update and comprehensive overview of the most recent scientific developments. It clearly presents impact pathways analysis, one of the most original methodologies of ExternE: the dispersion of traditional pollutants like PM, NOx, SO_2 and VOC, as well as greenhouse gas emissions and toxic metals; the exposure–response functions and the monetary valuation, i.e. translation of the health and environmental impacts into easily understandable figures like euro-cents per kilowatt hour of coal-based electricity or euros per 100 passenger kilometres of a diesel car.

The relation between impact pathways analysis and life cycle assessment (LCA) is also a very good piece of reading. The exposure–response functions from health impacts have been cleverly thought out. They deal with mortality (loss of life expectancy), mortality due to PM and O_3, and toxic metals like arsenic, cadmium, chrome and lead.

The dispersion of pollutants is not only addressed for the air but also for the soil and water with its impacts from human ingestion, on agriculture, on ecosystems and on damage to materials.

Very concrete applications of this research work are provided for the electricity sectors covering fossil fuels, nuclear and renewable energy sources and technologies for both the European Union and the USA. External costs are also estimated for the transport sector, including an innovative comparison between conventional vehicles (gasoline and diesel) and hybrid electric vehicles.

A chapter on the change in exposure for individuals who switch from car to bicycle or to walking provides a fresh approach to addressing sustainable lifestyles and illustrating the impact of behavioral changes. The pedagogic part of this book, on economics – from the discount rate to valuation of mortality and morbidity – and on uncertainties of damage costs, demonstrates the crucial role of ethical choices.

Briefly, this Rabl–Spadaro–Holland book enriches the scientific debate on external costs, updates and completes previous research, and offers practical examples that have been or could be implemented through policy measures.

For a decade now, in upstream EU policy-making, there has been an obligation to prepare an i*mpact assessment* for any legislative or programmatic proposals. For such an exercise, quantification in monetary terms of the environmental impact is extremely useful. Furthermore, thanks to this research work, economic models can also be improved, particularly in their environmental dimension. As such, the Rabl–Spadaro–Holland book serves both policy-makers and academics.

Over forty years, combined European and American efforts on external costs quantification have transformed the concepts of "internalization of externalities" and "getting the prices right" from a purely theoretical exercise to a daily and genuine political message in the Western world.

Since the 2008 financial and economic crises some commentators have spoken about the "End of the West," the strength of "State Capitalism" or the "Decline of Europe." We are convinced that also thanks to the hand-in-hand work of researchers and decision-makers, of rigorous scientists calculating the benefits of pollution control and enlightened policy-makers implementing the right measures, a *renaissance* is possible.

This *renaissance* takes place through sustainable economic growth, a more efficient use of natural resources and the right value awarded to common goods like air, water and soil.

Domenico Rossetti di Valdalbero,
Principal Administrator at the European Commission,
Directorate General for Research and Innovation

Pierre Valette, *Acting Director,*
Directorate Environment – DG Research,
European Commission

Preface

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 becoming too poisoned for fish to survive, that the demand for cleanup became overwhelming and environmental regulations were imposed in the absence of a cost–benefit analysis (CBA). The main sources of pollution and their impacts were obvious, and the regulations were clearly beneficial.

Nowadays, 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 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 to identify the best solutions. When cost-effective measures are proposed, CBA is a powerful tool for convincing concerned stakeholders that such measures should indeed be implemented.

Calculation of the 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. This presents quite a challenge for the writing of 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 USA.

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 that they would be worse off. Decision makers, or at least their advisors, need to have a sufficient understanding of the issues to be able to decide whether or not such critiques are justified. 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 in 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 towards 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 with the optimal decision if one had known the true cost?" As we have shown, the information is very valuable in spite of 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