15. Introduction

P.E.M. Lammers[1]

1. THE OZONE LAYER DEPLETION POLICY FIELD

Ozone is a naturally occurring gas in the atmosphere, and protects the earth against ultraviolet radiation from the sun. Emissions of human-made compounds containing chlorine or bromine, such as CFCs and halons, have severe impacts on the stratospheric ozone layer. The destruction of the ozone layer was first discovered in the 1970s. Any damage to the ozone layer leads to increased ultraviolet (UV-B) solar radiation. It has been demonstrated that increased UV-B radiation is harmful to human health and terrestrial and aquatic ecosystems, and also affects the climate system (UNEP, 1993; WMO, 1995). The following three chapters provide a thorough overview of the ozone depletion problem, current scientific knowledge and possible adverse effects on human health and ecosystems. Each of the chapters in this part of the volume has been written by a recognized expert in the field of Ozone Layer Depletion (see Introduction to the contributors).

2. RELATION TO OTHER POLICY FIELDS

As outlined in the following three chapters, and as noted in the climate change chapters (Chapters 5–8), the policy field of Ozone Layer Depletion is closely related to the policy field of Climate Change. Since ozone is a naturally occurring greenhouse gas, stratospheric ozone depletion will result in radiative cooling. However, since CFCs and halons are effective greenhouse gases, overall effects on global warming are difficult to estimate. Several of the greenhouse gases also affect stratospheric ozone depletion by stratospheric reactions or indirect temperature effects. Currently, the adverse effect of ozone-depleting substances on the stratospheric ozone layer is partly counteracted by emissions of greenhouse gases. In the future, however, greenhouse gas emissions may increase the occurrence of polar stratospheric clouds. This could significantly increase the destruction of the stratospheric ozone layer.

Emissions of ozone-depleting substances and greenhouse gases are thus important indicators for both the Ozone Layer Depletion and the Climate Change policy fields. However, the indicators for climate change only take account of the (potential) effects on global warming, and the indicators for ozone layer depletion only take the effects on the ozone layer into account.

Further, the Ozone Layer Depletion policy field has links to the field of Air Pollution. Visconti (Chapter 16) points out that tropospheric pollution (ozone and particles) in industrial regions has partly masked the effects of ozone depletion in these regions. Pressure indicators for tropospheric ozone and particles have been accounted for in the Air Pollution policy field.

3. INTERNATIONAL FRAMEWORK

International Treaties

To tackle the problem of ozone depletion, the Framework Convention for the Protection of the Ozone Layer was adopted in 1985 in Vienna. The main objective of the Vienna Convention is cooperation between nations for scientific research. Although it provides the legal basis for emission reduction measures, no consensus could be reached at that time for specific reduction measures due to the considerable economic consequences and a lack of scientific understanding of the ozone problem. Soon afterwards research findings proved that an urgent need for measures existed, and the Montreal Protocol on Substances that Deplete the Ozone Layer was signed in 1987. This contained obligations for all parties to phase out the use of ozone-depleting substances by 1996. Later amendments and adjustments (London 1990, Copenhagen 1992, Vienna 1995) call for stricter measures and include more substances.

Research Activities

Besides national programmes, research on ozone depletion includes international programmes such as the stratospheric research activities by NASA (the US National Aeronautics and Space Administration), and the research of the EU in its Environment and Climate programme. The World Meteorological Organization (WMO) carries out periodic scientific assessments on ozone depletion. In 1988, several large chemical manufacturers started the Alternative Fluorocarbons Environmental Acceptability Study (AFEAS), a panel established to help resolve uncertainties regarding potential environmental effects of HCFCs and HFCs. The Chemical Manufacturing Association (also funded by NASA) has set up a reliable monitoring network for the production/consumption of ozone-depleting substances and their substitutes.

Science versus Policy-making

Scientific consensus on the risks associated with depletion of the stratospheric ozone layer turned out to be one of the major factors in the success of the Montreal Protocol. Visconti argues that at the time of the international negotiations, the risks were actually exaggerated, forcing agreement on the reduction of the production and consumption of ozone-depleting substances. In particular, the discovery of the ozone hole had an immense impact on the political process.

Although general consensus exists on the risks associated with the ozone depletion problem, policy-makers do not accept all scientific results. In his chapter Isaksen provides an overview of ozone depletion potential (ODP), a measure for the relative breakdown of the stratospheric ozone layer by the various ozone-depleting substances. The ODPs provided by Isaksen are taken from the latest Scientific Assessment of Ozone Depletion (1994) by the World Meteorological Organization, in collaboration with the United Nations Environment Programme (UNEP). However, the Conference of Parties of the Montreal Protocol did not formally accept these ODPs and maintains the earlier figures. Only the figure for methyl bromide has been adjusted, from 0.6 to 0.7 (as agreed at the seventh Conference of Parties, Vienna, 5–7 December 1995).[2]

Policy Interventions

The time scale of the ozone depletion problem is several decades, due to the long lifetime of the ozone-depleting substances. According to Isaksen, there is a delay of emissions reaching the stratosphere of about five years. Accordingly, atmospheric concentrations respond very slowly to changes in emissions.

The Montreal Protocol has had a significant impact on the emissions of ozone-depleting substances. According to Isaksen, the emissions of most CFCs, for example, were reduced by 30–65 per cent during the period 1988–92. Due to the delay of emissions reaching the stratosphere, stratospheric concentrations of bromide and chlorine are expected to reach a maximum around the year 2000, with a gradual decline thereafter. Chanin (Chapter 18) is more concerned about a full implementation of the Montreal Protocol, especially with regard to methyl bromide, which is used in agriculture.

4. OVERVIEW OF PRESSURE INDICATORS FOR OZONE LAYER DEPLETION

Figure 15.1 provides an overview of the key indicators for the Ozone Layer Depletion policy field. The selection of the indicators and corresponding scores are the results of the second-round expert questionnaire conducted for the Eurostat Pressure Indicators Project. The figure provides the ranking for each indicator on its policy relevance (the importance of the indicator for policy-makers), analytical soundness (the correlation between changes in the indicator and changes in environmental pressure), and responsiveness (the response of the indicator to policy actions, in other words: how easy it is to take action to substantially reduce the pressure indicator). The core ranking of the indicators is also presented, expressed as a percentage of experts who included the indicator in their top five list of essential indicators.

It should be noted that the scores on policy relevance, analytical soundness and responsiveness are relatively uniform and quite high for all indicators,

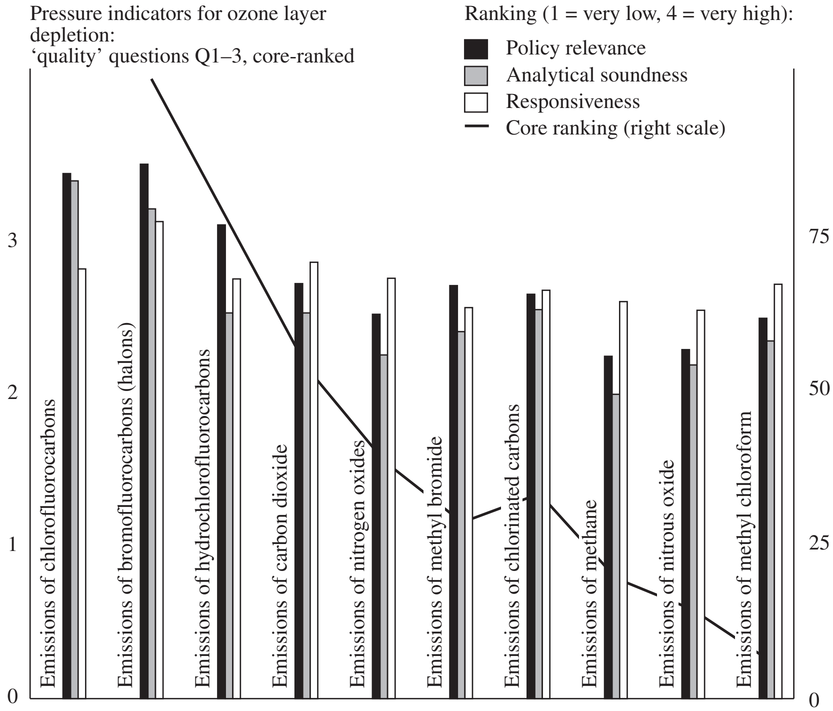

Figure 15.1 Results of second-round questionnaire for the Ozone Layer Depletion policy field

even for those indicators with a relatively low core ranking (meaning that they are not within the top five core indicators). Visconti argues that this may be explained by the fact that the scientific community is concerned about possible decreases in research funds. He suggests that by paying attention to all factors affecting the ozone layer, scientists aim to stress their importance and put pressure on governments for future research funding.

Visconti finds the inclusion of CFCs in the set of core indicators rather surprising, since the Montreal Protocol and its amendments call for a complete phase-out of these substances from 1 January 1996 onwards. This is also the case for carbon tetrachloride and methyl chloroform, as well as for halons (complete phase-out from 1 January 1994 onwards). Visconti states that he would have expected a core ranking based on an absolute level of chemical and radiative effects.

An indicator that will not change over time has no meaning as a core indicator to estimate the effects of current policy-making. On the other hand, the obligations of the Montreal Protocol allow for 'possible exemptions for essential uses', which still leads to substantial production and consumption figures. Moreover, a large black market exists for some ozone-depleting substances such as CFCs. According to Chanin, a large amount of CFCs are smuggled from the ex-USSR to Europe and the USA, coming second in a list of most-smuggled substances after drugs traffic. Visconti expects a black market for CFCs of about 10 000 tonnes, which is, however, still small if compared with the production figures of the 1990s (400 000 tonnes per year). Chanin feels that there is a great need for European integration, since all EU Member States have different control systems. Policy-makers take the problem of the black market seriously, and the Conference of Parties of the Montreal Protocol recently adopted resolutions aimed at a reduction of the black market.

Chanin is surprised by the relatively low score of methyl bromide, since this is currently a larger emission source than halons and HCFCs. To make such comparisons, the potential effects of the substances on the ozone layer, as expressed in their ODPs, also need to be taken into account.

The scores for policy relevance of the greenhouse gases are relatively high, even though any positive effects of greenhouse gases on the ozone layer are not long-term and are more than counteracted by the negative effects on climate change. The policy relevance of taking greenhouse gas emissions into account in an ozone layer depletion index is highly disputable. The effects of greenhouse gas emissions on the stratospheric ozone layer are currently positive because emissions of greenhouse gases counteract the breakdown of the ozone layer by ozone-depleting substances such as CFCs and halons. For a more detailed description of the effects of greenhouse gas emissions on the stratospheric ozone layer, see the chapter on ozone layer depletion in the

TEPI publication on *Indicator Definition*[3] and Velders (1997). Although greenhouse gases currently have positive effects on the ozone layer, emission reductions of greenhouse gases are needed to address the problem of climate change. It would be very confusing if reductions in emissions of greenhouse gases resulted in a lower climate change index and a higher ozone depletion index. Moreover, emissions of greenhouse gases are not beneficial to the ozone layer in the long run because they could contribute to a large breakdown of the ozone layer, due to the formation of polar stratospheric clouds and other mechanisms (Velders, 1997).

Chanin states in her chapter that stratospheric cooling is only due to the decrease in stratospheric ozone concentrations, and that increased CO_2 concentrations do not play a role in the ozone depletion issue. However, CO_2 emissions are expected to be mainly responsible for a large decrease in stratospheric temperature in the twenty-first century, which can on the one hand reduce the effects of ozone-depleting substances, and on the other increase the formation of stratospheric clouds which might greatly increase the depletion of stratospheric ozone in the future (Velders, 1997).

Chanin adds a few important indicators; however, these are not included in Figure 15.1 since they are considered to be state indicators. They concern the total ozone change, the change of UV-B, and the time needed for recovery of the ozone layer. Further, she argues that for reasons of communication to the general public, the indicators should preferably be expressed in terms of change.

Emissions due to volcanic eruptions are not included as pressure indicators, since these are natural and not human-induced emissions.

5. DISCUSSION AND CONCLUSIONS

The indicators for ozone layer depletion are well defined and the consensus among scientists is relatively high. The following chapters discuss the best set of core indicators, and the relative importance of CFCs and methyl bromide.

The need for ozone depletion indicators is clearly described in all three chapters. One important argument for indicators is that they will enhance the feedback mechanisms between policy-makers and scientists.

An issue not yet addressed in the chapters is how to aggregate the indicators into one ozone layer depletion index. Partly, the concept of ozone depletion potentials can be used for this aggregation. However, the effects of greenhouse gas emissions on the ozone layer are not yet well understood, and these effects have not yet been fully quantified. The chapter on ozone depletion in the TEPI publication on *Indicator Definition* provides a more detailed discussion on the various aspects of aggregation.

NOTES

1. P.E.M. Lammers is senior researcher at the Institute for Environmental Studies (IVM), Vrije Universiteit, Amsterdam. The IVM has built up considerable experience in global environmental issues. It deals with a variety of complex environmental problems using multidisciplinary approaches. For more information, contact the IVM: De Boelelaan 1115, 1081 HV Amsterdam, The Netherlands, tel: 31-20-4449555, fax: 31-20-4449553, e-mail: secr@ivm.vu.nl, http://www.vu.nl/ivm.
2. The chapter on ozone layer depletion in the forthcoming publication on *Indicator Definition* (see Foreword) includes ODPs as agreed upon by the Conference of Parties of the Montreal Protocol.
3. See Foreword.

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