Downing, T. E. and R. W. Kates, 1982. "The International Response to the Threat of Chloroflurocarbon to Atmospheric Ozone", The American Economic Review 72, No. 2, May pp. 267-272.

The International Response to the Threat of Chlorofluorocarbons to Atmospheric Ozone

By THOMAS E. DOWNING AND ROBERT W. KATES*

Although environmental problems are common in many countries or affect large regions, the threats of carbon dioxide-induced climate change and depletion of stratospheric ozone are perhaps the most credible global environmental problems presently facing humankind. While there are many differences between the CO_2 and O_3 problems the diffuse, global hazards share a number of common characteristics. The threats are due to anthropogenic chemical changes of a slow, cumulative nature. Early effects may be disguised by normal environmental variation which generates considerable scientific uncertainty. By the time all the mechanisms and consequences are known and evaluated, it may be too late to avoid the majority of effects which may persist for centuries. In addition, the climate or stratosphere so affected is not the property of any individual or nation. The vulnerable natural and social systems require on-going monitoring, research, and risk assessment as uncertainties are defined and, hopefully, reduced. In short these are threats to the global commons for which there is no precedent in human history.

This paper examines the different national responses to the threat of chlorofluorocarbon (CFC) depletion of stratospheric ozone as the first of the global atmospheric problems for which nations have taken concrete action beyond scientific study and risk assessment.

I. The CFC-Ozone Depletion Threat

The specter of the ozone layer depleted by chlorofluorocarbons was first suggested in 1974–75 in papers which identified photochemical reactions linking the buildup of CFCs in the atmosphere to ozone destruction in the stratosphere. Subsequent studies and risk assessments in the United States and Europe evaluated the effects of increased ultraviolet radiation on the biosphere and expanded the models of stratospheric chemistry and meteorology.

In late 1977 and early 1978, when Sweden and the United States issued the first restrictions on aerosol usage of CFCs, world production of CFC-11 and CFC-12 was 1550.5 million pounds per year, down from its pinnacle in 1974. The National Academy of Sciences (1976) estimated that continued releases at the 1973 rates would eventually lead to a 7 percent reduction in steady-state ozone (with a 2–20 percent range). Biologically damaging ultraviolet light, projected to increase 14 percent, would cause a 14–21 percent increase in nonmelanoma skin cancer cases per year and less than a 15 percent increase in melanoma cases and deaths. Biological and climate changes were judged likely, but not quantifiable. Since then mean estimates of ozone depletion have varied from 6–18 percent (Figure 1), and the physical and biological amplification factor for human health effects has been estimated between 2 and 8, with a fourfold average. Yet, despite marked changes in our understanding of stratospheric processes, the current assessments are similar to the estimates made in 1976, or are somewhat higher.

II. National Responses

The ozone depletion controversy has moved sufficiently far through scientific and political review to provide useful comparisons between approaches taken in the United States, Europe and elsewhere. Some sixteen countries have attended international meetings on this issue, and about twenty have endeavored to reduce CFC emissions.

In this paper we focus on the responses of six countries: Sweden, United States, Nether-

*Center for Technology, Environment, and Development, Clark University.

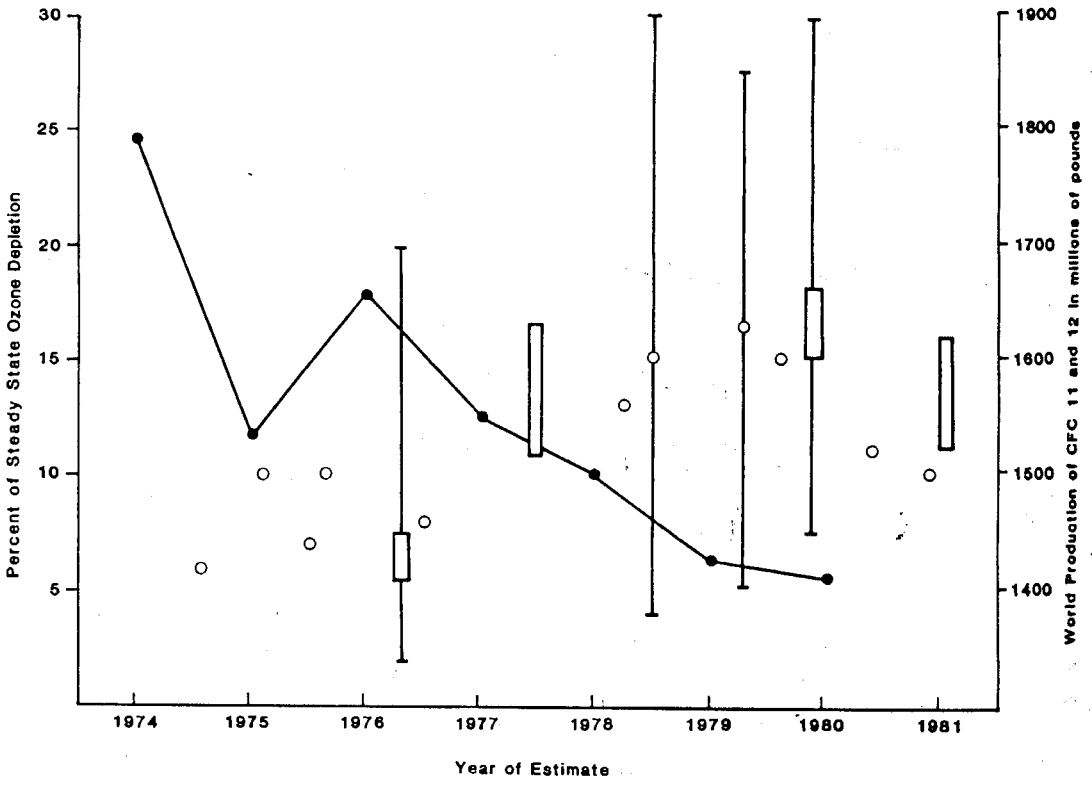

FIGURE 1. ESTIMATES OF STEADY-STATE OZONE DEPLETION FROM CFCS

lands, West Germany, United Kingdom and France. Sweden was the first country to ban aerosols using CFCs as propellants, regulations issued in late 1977 were effective in June 1979. The United States also banned nonessential aerosol uses in 1978. The Netherlands reviewed the scientific evidence and potential economic impacts of regulation in 1975–77 and issued a requirement for a warning label on aerosols in 1978, effective in early 1979. They stated their intention to subsequently ban aerosols if the scientific evidence did not change. After a review of the available evidence West Germany reached an agreement with industry to reduce CFC usage in aerosols by one-third by 1981. The U.K., a major research center for stratospheric processes, has encouraged industry to intensify the search for alternatives and endeavor to minimize releases from industrial equipment. They have also recently adopted the European Economic Community's (EEC) recommendations for a 30 percent reduction in aerosol uses of CFCs and a limit in production capacities. France has entered into research agreements with the United States and United Kingdom, but has only recently adopted the EEC regulations. While these actions are not strictly comparable and are complicated by EEC activity, it is possible to group the six countries according to the degree and rapidity of curtailment of CFC production and usage as follows: Sweden; United States; Netherlands; West Germany; United Kingdom; France. In the analysis which follows we consider alternative explanations for these different responses.

III. Five Hypotheses

A number of hypotheses, not mutually exclusive, have been suggested to explain the differences in national responses. A National Academy of Sciences report (1979) in reviewing the international aspects of the threat suggests: "Decisions made in other countries

concerning restrictions on production and use of CFCs will depend, as in the United States, on a variety of factors, including confidence in the scientific evidence of the danger, assessment of the economic and social impact of control measures, and national attitudes toward risk" (p. 23).

We find at least five sets of explanations offered for national differences. Stated as hypotheses, these are:

HYPOTHESIS 1: *Broad national attitudes toward environmental problems affected the response to the ozone controversy.*

HYPOTHESIS 2: *The regulatory authority and structure of environmental policymaking determined how governments managed the threat.*

HYPOTHESIS 3: *The importance of CFC-related industries in the national economy restrained regulation of CFC emissions.*

HYPOTHESIS 4: *Scientific uncertainty as to stratospheric chemistry and transport and the effects of ultraviolet radiation on the biosphere influenced the timing and nature of the national response to the ozone depletion threat.*

HYPOTHESIS 5: *International responses to environmental problems are prompted by flows of information and an international consensus on scientific findings and policy options.*

In evaluating the five hypotheses, we have relied upon the analysis of published documents and personal correspondence with individuals here and abroad. Formal questionnaires were mailed to 200 individuals in a dozen countries and to date some 50 replies have been received. In addition we have benefited from the work of Thomas Stoel et al.

IV. Evaluating National Response

A. *Environmental Attitudes*

To date there has been no international comparative assessment of public attitudes toward the environment involving the six countries. Common folklore among comparative analysts holds that Sweden and the United States are leaders in environmental activity (Cynthia Enloe). However, interview data, from individual and sets of countries, widely differing in questions asked, suggest substantial public support and pro-environmental attitudes in all six countries (EEC, Umwelt, Council on Environmental Quality).

B. *Environmental Decision Making*

Each of the six countries has adequate legislative authority to regulate CFC emissions, although none of the laws was entirely appropriate for controlling a substance that is only indirectly hazardous. In Sweden, the "rule of prudence" sets forth a strong mandate for environmental protection. The U.S. Toxic Substances Control Act likewise directs the administration to manage "unreasonable risks." Other environmental laws in Netherlands, France, Germany, and the U.K. are less directive and more permissive, allowing a high degree of administrative discretion.

A second characteristic of environmental decision making is the nature of relationships between the government and industry and public interest groups. In the United States, the Environmental Protection Agency (EPA) is clearly charged with protecting the environment and administrating an adversarial process in which industry and environmental groups usually conflict. In Europe, cooperation with industry is highly valued in working out consensual agreements with more limited participation by environmental groups in most countries. Only in the United States and Netherlands did the issue achieve high public involvement, with environmental groups petitioning the EPA for action in the United States, and in the Netherlands the issue entered the domestic political spotlight.

C. CFC *Production*

In 1974, the six countries accounted for 78 percent of world production of CFC-11 and CFC-12 (Table 1). Of the six, Sweden is a nonproducer and consumes only a small quantity. The largest per capita production was in the Netherlands (2.12 kg/person), followed by the United States (1.76); France

TABLE 1—CFC PRODUCTION, TRADE AND CONSUMPTION FOR SELECTED COUNTRIES

	Production: 1974[a]		Import/Export[b]	Consumption[c]
	Total	Per Capita	1974	% Aerosols
France	72.0	1.37	−27.0	—
Germany	88.3	1.43	−27.6	71.8
Netherlands	29.0	2.12	−15.0	72.1
Sweden	0.0	0.0	+5.6	45.7
United Kingdom	72.0	1.29	−24.0	72.2
United States	376.0	1.76	−14.8	55.5

Source: OECD.

[a]Production for CFC-11 and 12 in 1000 metric tons, per capita figure is 1974 production/1975 population, in kg/person.

[b]Bulk consumption minus production.

[c]Domestic and personal uses.

(1.37), West Germany (1.43) and the U.K. (1.29) had relatively similar per capita production. The four major European CFC producers exported on the average over a third of their production, while the United States exported less than 5 percent, a significant difference for countries concerned about balance of payments.

D. *Scientific Uncertainty*

Scientific uncertainty falls into two general areas: the state-of-the-art assessment (reaction rates, model parameters, atmospheric measurements, skin cancer epidemiology), and the correspondence of scientific theory to real world processes. The research in basic science is subject to well-developed review processes that have enabled scientists to agree within a fairly stable range on the first kind of assessment. For instance most models predict a 1–3 percent decrease in ozone due to the past releases of CFCs, although this has not been directly observed due to the large variations in stratospheric ozone concentrations.

The second kind of uncertainty questions the usefulness of simplified models in describing complex processes and is highlighted in the United Kingdom and United States reports. Despite their disagreement in the evaluation of uncertainty, the conclusions of the U.K. and U.S. reports are similar: respectively, a 13 percent and 15–18 percent ozone depletion. Those who question the validity of the models tend to favor an early warning system based on ozone trend analysis.

The assessment of scientific uncertainty has differed between and within countries and is cited as reason for delayed regulation and increased research. However the evaluation of the adequacy of the scientific evidence appears to reflect a general attitude toward environmental risk rather than differential evaluations of each linkage in the hazard chain. Thus while large uncertainties remain, they permit rational decision makers to differ in their evaluations, and do not themselves cause the differences.

E. *International Consensus*

There has been an impressive flow of information and personnel between countries and to the international fora of the Organisation for Economic and Community Development (OECD), United Nations Environment Programme (UNEP), and the EEC. Although there is a natural tendency to prefer domestic studies, most of the basic studies reference foreign reports and many have used foreign consultants to ensure wider participation. Each country has conducted important research on the problem. At present there is a consensus on the basic science—models from the United States and Europe are in good agreement. It appears that, after over seven years of discussion, there is not an imminent consensus on the validity of the

models and the need for regulation given the prospects for better understanding in a few years.

The most likely international regulatory group, the EEC, is constrained by its members' policies, those of the U.K. and France in particular. Thus while there has been considerable progress (production capacity limits and a 30 percent reduction in aerosol uses) the EEC policy will flow from the European national approaches. Within the European community, regulatory consensus is to some degree mandated by the prohibition of national barriers to trade. This encourages informal actions while community-wide policies are adopted. The UNEP has recently organized a working committee to draft an international convention on CFC regulation.

V. Conclusion

Hindsight, that special tunnel vision of historic explanation, suffers from a particular form of tautological myopia. Thus explanations of the differences in national response to the CFC threat is at best informed opinion. We offer ours as researchers who have read the documentation, talked freely with participants, and solicited broadly the judgment and experiences of others.

No single explanation adequately accounts for the range of national responses. Indeed, one of the many thoughtful and critical responses to our inquiries noted the difficulty of single factor explanations; rather national responses were described as resulting from a group consensus based on very different individual assessments and subject to the particular representation of personalities and experiences. Also, decisions were incremental, and explanation for one decision differs for the next.

In our judgment, the interplay of three of the five hypothesized factors—environmental attitudes, decision making, and the economics of production—can account for the differential response to the threat of CFC-ozone depletion.

The strong environmental ethic of the Swedish and American people, codified in legislation and implemented by forceful environmental agencies that not only permit but to a degree mandate environmental protection, seems to explain their early regulation of CFCs. Unilateral action was easier for countries which are not members of the EEC. In addition Sweden does not produce CFCs, and the United States is a relatively small exporter.

Conversely, the economic stake of the U.K. and France, reinforced we suspect by their involvement in the parallel SST controversy and coupled with a highly discretionary legal environmental system, led to caution in balancing the benefits and costs of regulation.

Germany and the Netherlands, also large producers and exporters of CFCs, adopted various compromise restrictions initiated by their concern for environmental protection. In the Netherlands, CFC regulation became a political issue. Their two-stage restrictions acknowledge the scientific uncertainty and the need for EEC-wide regulation in order to alleviate the economic costs of regulation. Germany's federalist structure encouraged a cooperative approach of voluntary controls.

One hypothesis, that related to the flow of information and the forging of international scientific consensus appears to be an explanation of little importance. Indeed the international interchange has been admirable. Finally the most frequently cited explanation, scientific uncertainty, appears to be a permissive rather than causal factor. In the face of uncertainty scientists and policymakers seem to rely on values other than science to balance the benefit-risk equation.

Taken as a benefit-risk decision, national response to the threat of CFC-ozone depletion has much to commend it. The balance of risk and benefit has been struck in a rational manner, marked by considerable research, rapid flows of information, and continuing oversight and monitoring; and may be reevaluated as new information develops. The regulatory timing and approach has been different in each country, but there are signs of a common convergence. Curtailment of CFC emissions has been sensitive, recognizing different economic-social impacts of regulation. In the comparative spectrum of hazard policy decision making, CFCs emerge as an example of enlightened risk assessment.

However, taken as a global commons problem the record is considerably more troubling. Seven years after the first warnings were given that a diffuse but vital screen for the earth's life support system might be damaged by a chemical, readily substituted in two-thirds of its use (in aerosols), CFC production still remains high. This is so despite the fact that the essential elements of the risk assessment have remained firm. The ethical and utilitarian case for caution in dealing with changes in our life support system, irreversible at the scale of our lifetimes, seems to us convincing.

The disturbing aspect therefore is the failure of the industrial world to quickly (seven years) pass the global commons test. The last major atmospheric commons test was nuclear fallout, which took eleven years for the test ban. At present, balancing national benefits and risks mirrors consumer and firm theories of decision making and international bargaining involves trading of national costs. Our common life-world ought not be held hostage either by individuals or by national benefit-risk balancing. The international response to CFC-ozone depletion indicates that we have not yet invented an alternative mode of analysis to protect the global commons.

REFERENCES

Enloe, Cynthia H., *The Politics of Pollution in a Comparative Perspective*, New York: David McKay, 1975.

Stoel, Thomas B., Jr., Miller, Alan S., and Milroy, Breck, *Fluorocarbon Regulation*, Lexington: Lexington Brooks, 1980.

European Economic Community, *European Barometer*, No. 3, June/July 1975.

Organisation for Economic and Community Development, *Economic Impact of Restrictions on the Use of Fluorocarbons*, ENV/CHEM/77.2, Paris, 1978.

Umwelt, No. 58, Bonn, 1977.

U.K. Department of Environment, *Chlorofluorocarbons and Their Effect on Stratospheric Ozone*, Pollution Paper 15, London: Her Majesty's Stationary Office, 1979.

U.S. Council on Environmental Quality et al., *Public Opinion on Environmental Issues*, Washington: U.S. Government Printing Office, 1980.

U.S. National Academy of Sciences, *Halocarbons*, National Academy of Sciences, Washington, 1976.

_____, *Stratospheric Ozone Depletion by Halocarbons*, National Academy of Sciences, Washington, 1979.