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KIEV ASSESSMENT:
DRAFT CHAPTER ON STRATOSPHERIC OZONE DEPLETION

Submitted by the European Environment Agency (EEA)

The thickness of the ozone layer above Europe has decreased significantly since the beginning of the 1980s and is declining at a rate of 5-6% per decade. The gradual fall in chlorine concentrations in the troposphere (on their way to the stratosphere) shows that international policies to control ozone-depleting substances are having success. The production, sale and consumption of ozone-depleting substances in Europe have fallen significantly since 1989. However, the long life of these substances in the atmosphere means that the recovery of the ozone layer may not be complete until after 2050. The remaining policy challenges for European countries are to tighten control measures, to reduce the production and use of HCFCs and methyl bromide, to manage banks of existing ozone-depleting substances, and to support developing countries in their efforts to reduce their use and subsequent emissions of ozone-depleting substances.

I. THE ISSUE

1. The ozone layer in the stratosphere, albeit very dilute, is an essential component of the Earth's atmosphere. It protects the Earth's surface from damaging short-wave ultraviolet (UV) radiation and is the main reason for the existence of the stratosphere, confining our weather systems to the lowest ten kilometres of the atmosphere. Ozone is also a greenhouse gas, but most of the warming effect comes from troposheric ozone.

2. Stratospheric ozone is produced in the upper stratosphere from oxygen by short-wave sunlight. The dynamic balance between this production and the (photo)chemical reactions dissociating the ozone determines its concentration and the total amount in the stratosphere, or the thickness of the ozone layer. Anthropogenic emissions of inert compounds containing chlorine and bromine disturb this balance. A single chlorine or bromine atom can destroy thousands of ozone molecules before being removed from the atmosphere.

3. Compounds causing significant ozone depletion include chlorofluorocarbons (CFCs), carbon tetrachloride, methyl chloroform, halons, hydrochlorofluorocarbons (HCFCs), hydrobromofluorocarbons (HBFCs) and methyl bromide. They are used as solvents, refrigerants, foam blowing agents, degreasing agents and aerosol propellants, fire extinguishers (halons) and as agricultural pesticides (methyl bromide). The extent to which an ozone-depleting substance affects the ozone layer (i.e. its ozone-depleting potential) depends on the compound's chemical characteristics. Other factors that affect the ozone layer include natural emissions, large volcanic eruptions, climate change and the greenhouse gases methane and nitrous oxide.

4. The dramatic depletion of stratospheric ozone in polar regions is caused by a combination of anthropogenic emissions of ozone-depleting substances, stable circulation patterns, extremely low temperatures and solar radiation.

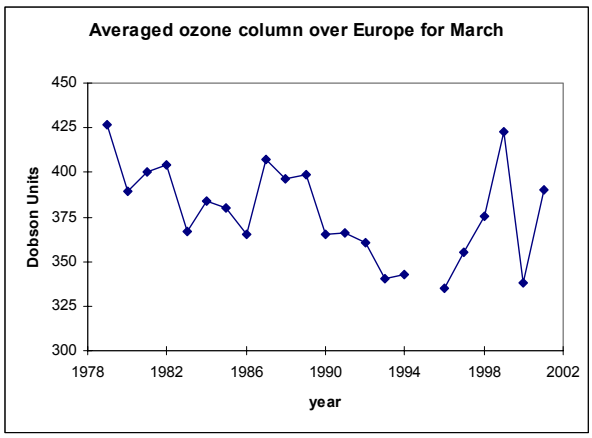
5. The ozone column (a measure of the ozone layer thickness) above Europe has decreased significantly since the beginning of the 1980s; with the largest observed trend in March, approximately –5-6% per decade (Figure I). The global trend in the whole winter/spring period at northern mid-latitudes is –5.4% per decade (WMO, 1999).

☹ The thickness of the ozone layer over Europe (March averages) has decreased significantly since the beginning of the 1980s at –5-6% per decade.

6. The effect of the measures taken is noticed first in the lower part of the Earth's atmosphere. The total potential chlorine concentration in the *troposphere* has fallen since 1994 mainly because of a large decrease in the concentration of methyl chloroform. The concentration of some CFCs is decreasing, while the increase in concentration of other CFCs is levelling off. However, concentrations of HCFCs (used as an alternative to CFCs) are increasing. The concentration of potential chlorine in the *stratosphere* stopped increasing around about 1998. Contrary to earlier expectations, the total potential bromine concentration is still rising due to increased concentrations of halons.

☹ Although total potential chlorine concentrations in the troposphere reached their maximum around 1994, total potential bromine concentrations in the troposphere are still increasing.

Figure I: Average ozone column over Europe in March. Monthly average ozone data derived from satellite instruments averaged from 35ºN to 70ºN and from 11.2ºW to 21.2ºE.



Note: 1 Dobson unit = 0.01 mm ozone column thickness at standard temperature and pressure.
Source**:** National Institute of Public Health and the Environment (RIVM), Netherlands.

7. Because ozone-depleting substances have a very long lifetime in the stratosphere, detectable recovery of the ozone layer due to the Montreal Protocol is not expected before 2020. Complete recovery is not expected to occur until after 2050 (WMO, 1999). Over the polar regions, extensive ozone depletion will continue to be observed in spring in the coming decades.

8. Ground-based measuring stations have recorded increases in the amount of UV radiation in recent years. Satellite-derived UV data and ground measurements generally agree. Increased UV radiation will continue until ozone recovery is complete, but the damaging effects of UV on human health and ecosystems are likely to persist even longer. Skin cancers, for example, only appear many years after exposure to UV. This impact will add to increased incidence of skin cancer most likely due to changes in lifestyle.

☹Observations suggest that UV radiation has increased above Europe.

II. POLICIES

9. The Montreal Protocol under the 1985 Vienna Convention of 1987 (and subsequent Amendments and Adjustments) aims to eliminate the production and use of ozone-depleting substances (ODS) worldwide. Council Regulation 2037/2000 is the European Union's current legislative instrument to phase out ODS in line with the definitions of the Montreal Protocol. The Regulation includes controls on production, import, export, supply, use, leakage and recovery of controlled substances. It also establishes a licensing procedure for all imports of ODS. Amendments to Council Regulation 2037/2000 are Regulation (EC) No 2038/2000 as regards metered dose inhalers and medical drug pumps and Regulation (EC) No 2039/2000 as regards the base year for the allocation of quotas of hydrochlorofluorocarbons.

10. Current policy challenges include:

- Ensuring full compliance with the Protocol by developing countries, as well as in the Russian Federation and other countries with economies in transition;

- Reducing remaining production of ozone-depleting compounds for essential uses and to supply developing countries;
- Stopping the 'dumping' of second-hand CFC-using equipment in developing countries;
- Taking action against CFC and halon smuggling;
- Reducing emissions of halons and CFCs from existing equipment, especially in developed countries;
- Discouraging the use of HCFCs as replacements for CFCs;
- Preventing the increased use of methyl bromide in developing countries;
- Preventing the production and marketing of new ozone-depleting substances.

III. EUROPEAN PRODUCTION, SALE AND CONSUMPTION OF OZONE-DEPLETING SUBSTANCES

11. The production of CFCs, carbon tetrachloride, methyl chloroform and halons in Europe fell substantially between 1989 and 1999, while production of HCFCs increased (Figures II and III). The sale and consumption of ozone-depleting substances shows a similar pattern (Fig. iv). This overall decline in the production and sale of ozone-depleting substances in EEA member countries is a direct result of the Montreal Protocol and EU regulations. Halon production in the EU has been banned since 1994 and THE production of CFCs, carbon tetrachloride and methyl chloroform since 1995. Limited production of certain compounds (mainly CFCs) is still allowed for designated essential uses (e.g. metered dose inhalers for medical purposes) and for use to meet the basic needs of developing countries. The production for sale to developing countries accounts for the increase in 1997. HCFCs and methyl bromide may still be produced and sold in the EU subject to mandatory limits.

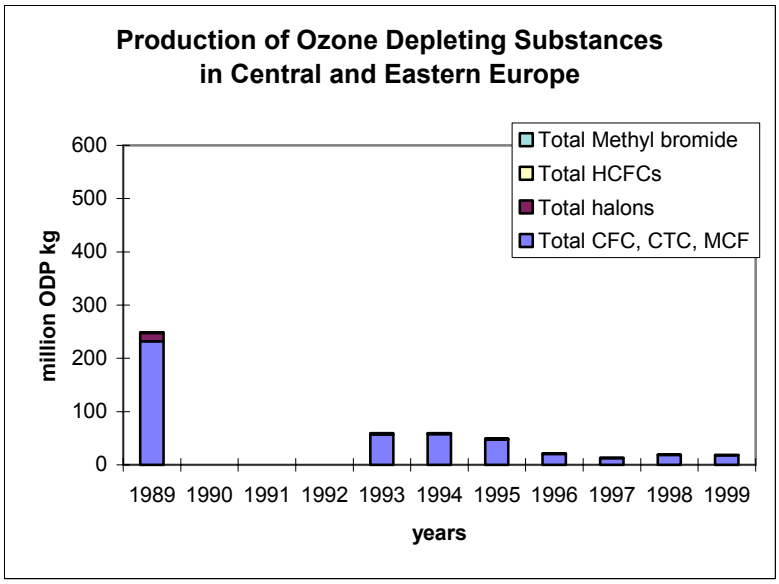
12. The production of ozone-depleting substances in EEA member countries was about 32% of global production in 1989 and about 25% in 1996. In all member countries, the use of ozone-depleting substances has fallen faster than required under the Montreal Protocol

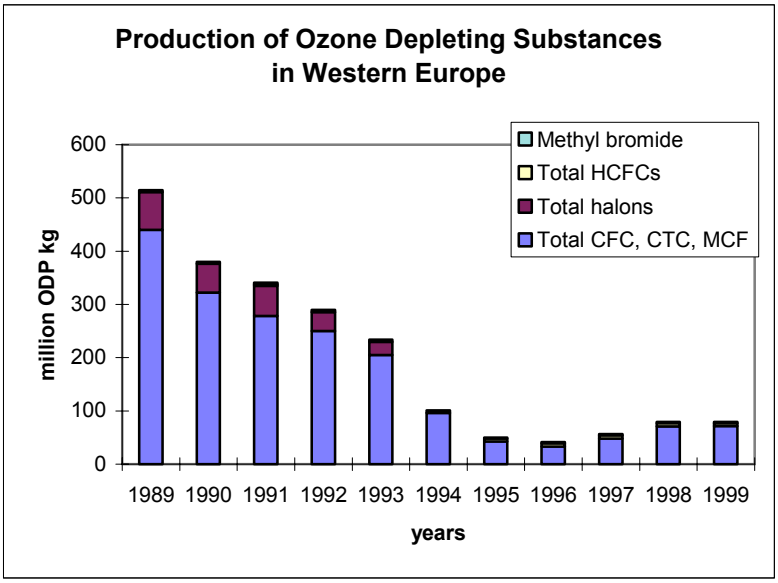
13. Global production and emissions of ozone-depleting substances have also decreased significantly. However, existing equipment and products still contain large amounts of CFC and halons, generating emissions when these are released. Emissions of ozone-depleting substances can occur within a few months of production (e.g. during the manufacture of open-cell foams) or after several years (e.g. from refrigerators, closed-cell foams and fire extinguishers).

14. Smuggling and illegal production of ozone-depleting substances are estimated at 10% of 1995 global production. These illegal activities will delay the recovery of the ozone layer by several years.

Production of ozone-depleting substances in EEA member countries has decreased by almost 90%. However, the production of HCFCs — with low ozone-depleting potential (ODP) but high global warming potential — is increasing.

Figure II: Production of ozone-depleting substances in Europe



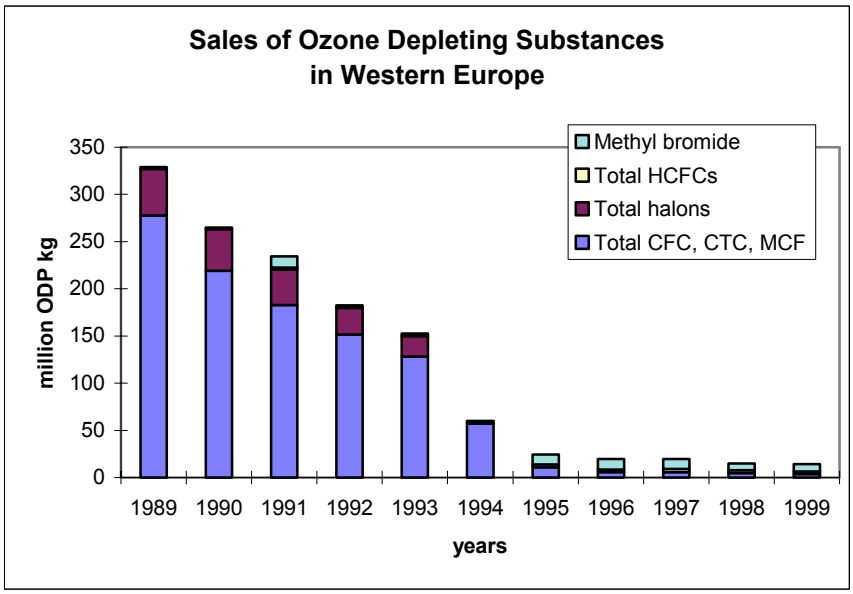


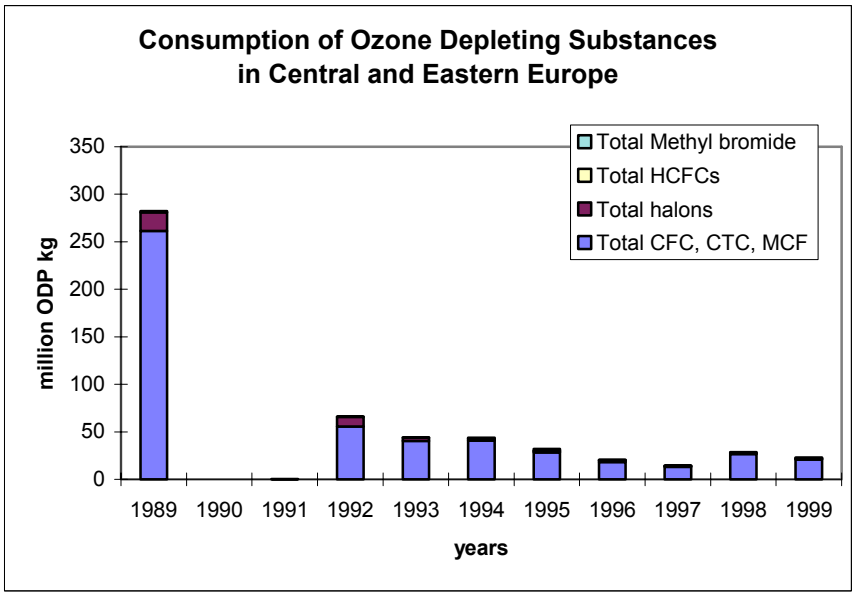
Source: European Commission 1999b; UNEP, 1998.
Notes: Production is defined as actual manufacture in the EU for dispersive uses, but excluding: imports; production for use as a raw material for the production of other chemicals; and used material recovered, recycled or reclaimed. Production data are weighted according to ozone-depleting potential (ODP).

Figure III**:** Production of HCFCs in western Europe and in other European countries

[to be presented later]

Figure IV**:** Sales of ODP in Western Europe and consumption in Central and Eastern Europe





IV. TECHNOLOGY TRANSFER TO DEVELOPING COUNTRIES

15. Europe's successes and the recovery of the ozone layer will be jeopardized unless developing countries also meet their commitments under the Montreal Protocol. These came into effect in 1999.

16. In 1990, a multilateral fund was established by the Parties to the Montreal Protocol to help developing countries implement the Protocol. Developed countries contribute to this fund, while developing countries can apply for financial assistance for particular projects.

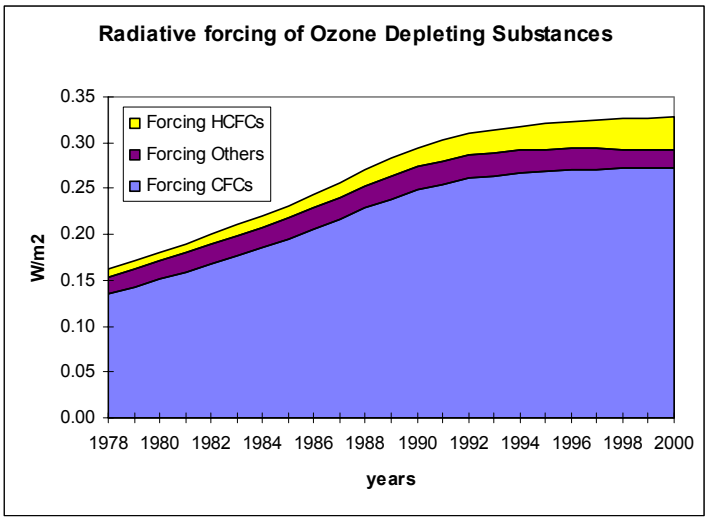
17. Western European countries contributed about US$ 560 million to the multilateral fund between 1991 and 2000. This amount is about 48% of total global payments to the fund. The total amount spent so far by the fund (US$ 936 million) is expected to result in the phasing-out of the use of 122 million ODP kg (more than twice the 1997 production in EEA member countries) and the phasing-out of the production of about 42 million ODP kg of ozone-depleting substances. European countries operating under Article 5 of the Montreal Protocol (developing countries) are Albania, Bosnia and Herzegovina, Croatia, Cyprus, Georgia. Malta, Romania, The former Yugoslav Republic of Macedonia, The Republic of Moldova, Turkey, and Yugoslavia.
[TEXT to be elaborated on the effects on implementation of the Montreal protocol]

V. THE INTERACTION BETWEEN CLIMATE CHANGE AND OZONE DEPLETION

18. Ozone is itself a greenhouse gas, but most of the warming effect comes from troposheric ozone. Some ozone-depleting substances, e.g. CFCs and HCFCs, are also potent greenhouse gases. Stratospheric ozone depletion and climate change therefore have common sources. CFCs, HCFCs and related compounds contribute about 13% to the total radiative forcing (the net extra radiation giving rise to global warming) from all greenhouse gases (Figure V).However, their emissions are not regulated under the Kyoto Protocol but under the Montreal Protocol. HFCs, which are increasingly used as substitutes for ozone-depleting substances, are also potent greenhouse gases. HFCs are covered by the Kyoto Protocol.

19. The radiative forcing of ozone-depleting substances is still increasing, but less than in the 1980s. There are a number of reasons for this. The phasing-out of methyl chloroform under the Montreal Protocol is largely responsible for the decrease in total potential chlorine. However, methyl chloroform contributes less to radiative forcing than CFCs and HCFCs. In addition, the contribution from CFCs is levelling off as a direct result of the Montreal Protocol and the radiative forcing of HCFCs is increasing as their concentration in the troposphere increases.

Figure V**:** Radiative forcing of ozone-depleting substances at a global level



Source: RIVM.

The radiative forcing of ozone-depleting substances is still increasing. This is because the radiative forcing of HCFCs is increasing, while that of CFCs is levelling off.

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