STOP ACID RAIN

*Environmental Factsheet*
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**Previous factsheets in the series:**
No. 1 Forest Damage in Europe (December 1992)
No.2 Critical Loads (February 1993)
No. 3 The UN ECE Convention (April 1993)



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# Scientific knowledge

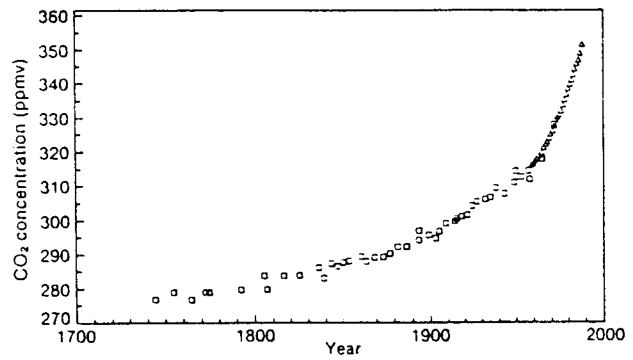
GLOBAL CLIMATE CHANGE, and its connection with man-made emissions of so-called greenhouse gases, has been a matter of increasing international concern since the mid-eighties. The plethora of information in the form of scientific reports and articles in the press has however seemingly tended to confuse the public as to what may be fact or fiction in regard to global warming. A remedy may nevertheless be found in the reports that have been published since 1990 by the Intergovernmental Panel on Climate Change. Through evaluation of a vast amount of scientific material, as well as application of personal knowledge, this international committee of scientists has been able to show what can be said to be definitely known about climate change, and what still lies in the realm of uncertainty.

The Intergovernmental Panel on Climate Change (IPCC) was established jointly in 1988 by the World Meteorological Organization and the United Nations Environmental Programme. This is a scientific and technical body with a very small secretariat but comprising 2500 scientists and experts in a worldwide network who are leaders in their fields. Its members may be nominated by national governments or intergovernmental and nongovernmental organizations.

At present there are three working groups, Working Group I assessing the available scientific information on climate change, Working Group II the scientific, technical, environmental, social, and economic information concerning its effects, as well as the options as regards the measures for adapting to it or mitigating it, while Working Group III deals with the economic and other issues that cut across that of climate change.

The first assessment report, published in 1990, comprises five sections entitled the IPCC Scientific Assessment, the IPCC Impacts Assessment, IPCC Response Strategies, the Policymakers' Summary of the IPCC Special Committee, and the IPCC Overview. The result of two years work by 170 scientists from all over the world,

**Figure 1. Atmospheric increase in $CO_2$ during the past 250 years.**




with a further two hundred involved in a peer review, this report provided a comprehensive statement of the state of scientific knowledge concerning climate change at that time, as well as the role played by mankind.

## *Known for certain*

In a summary of the IPCC findings, the Swedish chairman, Professor Bert Bolin, notes that there is a natural greenhouse effect, which is already keeping the Earth warmer than it would be without it. But, he adds, the concentrations in the atmosphere of certain greenhouse gases are being augmented by emissions – notably of carbon dioxide, methane, and nitrous oxide – that come from human activities (See Figure 1). Such increases will bring a still further warming to the Earth's surface – a warming that will moreover be enhanced by an increase in the main greenhouse gas, water vapour, as a result of the general rise in temperature.

## *Calculated with confidence*

Professor Bolin says it can be confidently stated that the burning of fossil fuels has been responsible for more than half of the progressive increase in the greenhouse effect in the past, and that a continuation can be expected (Figure 2).

He also notes that the atmospheric concentrations of the long-lived gases – carbon dioxide and nitrous oxide – adjust only slowly to changes in emissions. If emissions continue to increase at present rates we shall get increasing concentrations in the atmosphere for centuries to come. The longer this goes on, the greater the reduction will have to be if the concentrations are to be stabilized at a given level.

There can be no doubt that to stabilize the emission of long-lived gases that result from human activity, at today's levels, immediate reductions of more than 60 per cent will be necessary. A reduction of 15-20 per cent would be required for methane.

## *Projected from models*

Projections using current models show that under an IPCC business-as-usual scenario, the rate of increase in global mean temperature during the next century will be between 0.2 and 0.5°C per decade (Figure 3).

Models also show that the land surfaces will warm more rapidly than the oceans, and that in winter the warming in high northern latitudes will be greater than the global mean. The regional climate changes, too, will differ from the global mean.

Under a business-as-usual scenario, during the next century the average rate of rise of the global mean sea level will be about 6 centimetres per decade (with a mean uncertainty range of 3-10 centimetres), mainly because of thermal expansion of the oceans and the melting of the land ice. A rise of about 20 centimetres is predicted for 2030, and 65 centimetres by the end of the next century (Figure 4).

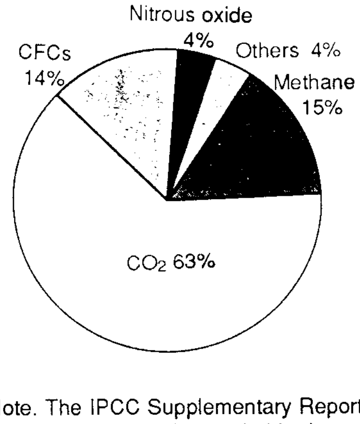
Professor Bolin does emphasize however that there are many uncertainties in the projections, particularly as regards the timing, magnitude, and regional patterns of climate change. This is due to an incomplete understanding of a) the sources and sinks of the greenhouse gases, which affect projections of future concentrations, b) clouds, which strongly influence the magnitude of climate change, c) the oceans, which influence its timing and patterns, and d) the polar ice sheets, which affect projections of rises in sea levels.

## *IPCC's judgment*

In a summing up, the IPCC noted that during the last hundred years the global mean temperature of the surface air had increased by 0.3-0.6°C, and that the seven warmest years had occurred since 1980. Over the same period the global sea level had risen by 10-20 centimetres. In neither of these cases have the increases been regular in time, or uniform over the whole globe.

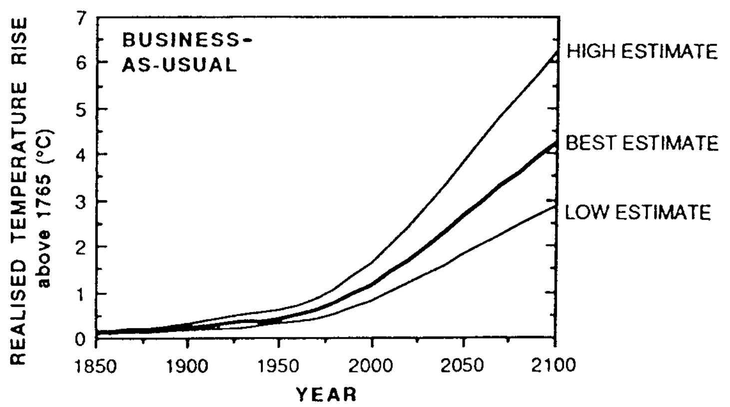
The extent of this warming up, Professor Bolin continues, while broadly consistent with the predictions of climate models, is also of the same magnitude as natural climatic variability. So the observed increase could largely be due to a natural variability – or alternatively, the natural variability, together with other human factors, might have offset a still larger greenhouse warming caused by human activities. Any certainty about this is

**Figure 2. Global emissions of greenhouse gases 1990, converted to $CO_2$ equivalent in a 100-year perspective (IPCC 1990).**




Note. The IPCC Supplementary Report (1992) states that CFCs probably give no net contribution to the greenhouse effect.

**Figure 3. Simulation of the increase in global temperature from 1985-1990 due to observed increases in greenhouse gases, and predictions of the rise between 1990 and 2100 resulting from "Business-as-usual" emissions (IPCC 1990).**




unlikely for at least another decade.

Vegetation affects climate and is in turn affected by a changing climate as well as by increasing concentrations in the atmosphere of carbon dioxide. Rapid changes of climate will alter the composition of ecocomplexes and their component ecosystems. Enhanced levels of carbon dioxide may increase the productivity of vegetation and its efficiency of water use. The effect of climate warming on mass biological processes, although as yet little studied, may actually increase the atmospheric concentrations of greenhouse gases.

## *Conclusions as to effects*

Regarding the effects of climate change in its general aspects, as seen by the IPCC, Professor Bolin warns that comprehensive estimation of change at the regional level is difficult, since there is no great confidence in the regional estimates of critical climatic factors. This, he says, is particularly true for precipitation and soil moisture, where there is considerable disagreement between the various general circulation models and paleo-analogous results. There is moreover a good deal of uncertainty in regard to the relationship between climate change and biological effects, and between those effects and socio-economic consequences. It is however clear, he says, that there might be marked effects on agriculture and forestry in many parts of the world, as well as on human activities in coastal zones.

It has not yet been conclusively determined whether the global agricultural potential will, on average, increase or decrease. There may be negative effects at the regional level, which would be severe in some cases – with declines in production in those regions that are already highly vulnerable and least able to adjust to change. These include much of Brazil, Peru, the Sahel region of Africa, the Asian part of the CIS, and China.

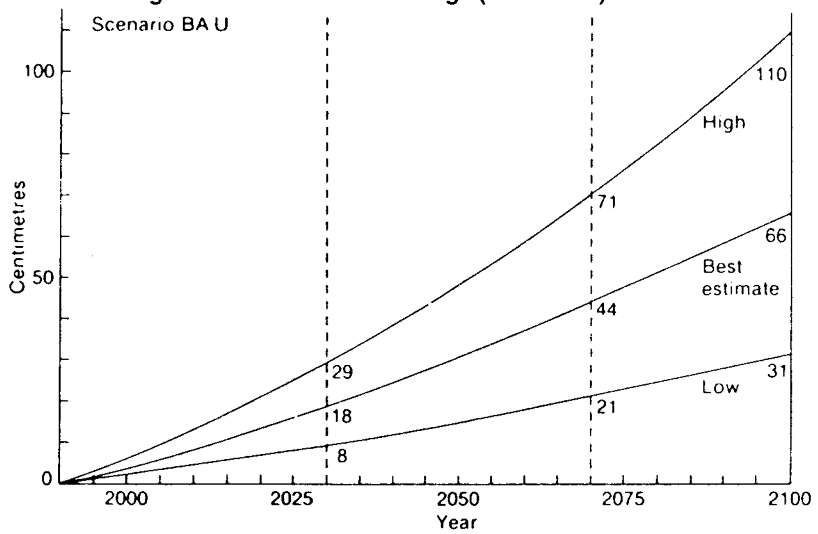
Because of a prolonged growing season in high and middle latitudes, the potential productivity might possibly increase, but it is unlikely that this would lead to any opening up of large new areas for production. The patterns of trade in farm products might be altered by a decrease in cereal growing in some of the currently high-producing areas, such as western Europe, the southern United States, parts of South America, and western Australia.

Since forests have a long period of rotation, new plantings and the present young growth will mature and decline in climates to which they are increasingly less well adapted. The actual effects will depend on the physiological adaptability of the trees and host-parasite relationship with their mycorrhizas. Large losses will occur, in the form of forest declines, from these and other factors.

The most sensitive forest areas will be those where the tree species are close to their biological limits as regards temperature and moisture. The increasing and unsustainable exploitation that may be expected will entail ever more pressure on forest investment, conservation, and sound management.

Projected changes in temperature and precipitation suggest that climatic zones, with their associated natural ecosystems, could shift several hundred kilometres towards the poles in the course of the next fifty years. Flora and fauna would lag behind these shifts. Some species might be lost because

**Figure 4. Sea-level rise predicted to result from "Business-as-usual" emissions showing the best estimate and range (IPCC 1990)**



of increased stress leading to a reduction in global biological diversity. Most at risk are those communities of species for which the possibilities of adaptation are most limited.

Relatively small changes of climate can cause problems with water resources in many areas – especially in arid and semi-arid regions, as well as in humid areas where demand or pollution has led to a scarcity of usable water.

The most vulnerable human settlements are those that are especially exposed to natural hazards, such as coastal or river flooding, severe drought, landslides, violent windstorms, or tropical cyclones. People in the lower-income groups of developing countries, residents of coastal lowlands and islands, and semi-arid grasslands are particularly vulnerable, as are the urban poor in squatter settlements, slums, and shanty towns, especially in megacities.

Global warming, concludes Professor Bolin, will accelerate the rise in sea level, modify ocean circulation, and change the marine ecosystems, with considerable socio-economic consequences. All this will come on top of the present trend towards rising sea levels.

## *Review*

An update of the 1990 report, addressing its key conclusions in the light of fresh data and analyses, followed in 1992. Background papers for this were provided by 118 scientists from twenty-two countries, while 380 others from sixty-three countries and eighteen from the United Nations or nongovernmental organizations participated in the peer review both of the background material and of this supplement.

The supplement was agreed in January 1992 at a plenary meeting of Working Group I, which was attended by 130 delegates from forty-seven countries. It can therefore be considered as an authoritative statement by the international scientific community.

While essentially reaffirming the conclusions of the 1990 assessment, the Supplementary Report also presented some significant new findings. It notes for instance that in middle and high latitudes the depletion of ozone in the lower stratosphere results in a decrease in radiative forcing that is believed to be comparable to the globally averaged contribution of chlorofluorocarbons (CFCs) to such forcing over the last decade or so.

It also says that during the past several decades the cooling effect of aerosols deriving from sulphur emissions may have offset a significant part of the greenhouse warming in the northern hemisphere. Although this phenomenon was recognized in the 1990 report, there has since been some progress in quantifying its effect.

While the rates of increase in the atmospheric concentrations of many greenhouse gases have continued to grow, or have remained steady, those of methane and some halogen compounds have slowed. There are also data indicating that the global emissions of methane from rice paddies may amount to less than previously estimated.

## *Following up*

The IPCC is to publish, by mid-1994, reports on Radiative Forcing of Climate and on Guidelines for National Inventories of Net Greenhouse Gas Emissions. A second full Scientific Assessment of Climate Change will come in 1995.

Among the matters that will receive especial attention in this second assessment are: The effects of sulphates from power plants, as well as of other anthropogenic aerosols. The problem of calculating global warming potentials (GWPs) arising from uncertainty as to how long carbon-dioxide emissions remain in the atmosphere. Methods for improving predictions of climate change at the regional level. Water resources, desertification, and drought. The effects of climate change, such as rise in sea level, and the options for response, particularly with regard to energy, human activities, and economics. Methodologies for studying the effects and making inventories of – listing and quantifying – greenhouse-gas emissions and sinks.

**Note.** In its scientific definition, aerosol is an airborne particle or collection of particles.

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