Friends of the Earth
Les Amis de la Terre
Amigos de la Tierra

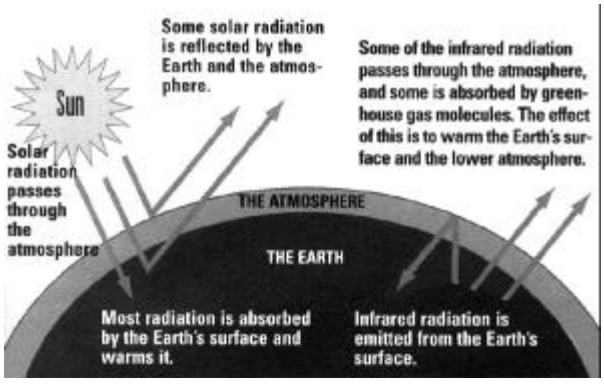
Friends of the Earth International
Climate Change Briefing

THE SCIENCE OF CLIMATE CHANGE

Modern civilisation depends on burning fossil fuels to supply our energy needs, in turn generating 'greenhouse gases' which are building up in the atmosphere. These gases are causing the earth's temperature to rise, and changing our climate, with very dangerous consequences. This phenomenon is often termed 'global warming', but may lead to cooling in some parts of the globe, and is therefore more accurately termed 'climate change'.

THE GREENHOUSE EFFECT

Most of the energy that reaches us from the sun in the form of short wave radiation arrives undisturbed at the earth's surface and warms it. Much of this energy is emitted back into space in the form of long wave (or infrared) radiation, but some of this radiation is trapped in the atmosphere by a blanket of water vapour and trace gases called 'greenhouse gases' - so called because they trap heat like the glass of a greenhouse. Without this natural greenhouse effect, the earth would be about 30°C colder than it is today.



The Greenhouse Effect

THE MAIN GREENHOUSE GASES

The main naturally occurring greenhouse gases are water vapour, carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) - they make up less than 1% of the atmosphere. Additional greenhouse gases are released by industrial processes: artificial chemicals called halocarbons (CFCs, HFCs, PFCs) and other long-lived gases such as sulphur hexafluoride (SF_6). Carbon dioxide is the most important greenhouse gas generated by mankind, due to the very large volume of CO_2 emissions, and accounts for 64% of the human-induced greenhouse effect. Human activity generates smaller quantities of the other greenhouse gases, the strength of which relative to CO_2 is known as their Global Warming Potential.

gas	lifetime (years)	global warming potential	overall greenhouse contribution (%)
carbon dioxide	50 - 200	1	64
methane	12+/-3	21	19
nitrous oxide	120	310	5.7
SF_6	3,200	23,900	0.08
CFCs	50 - 1,700	4,000 to 11,700	10
HFCs	1.5 - 264	140 to 11,700	negligible

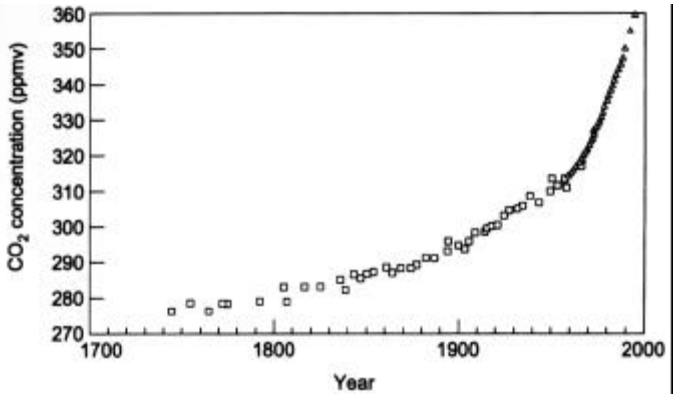
The Principal Man-made Greenhouse Gases [1]

Some man-made atmospheric pollutants cause a cooling of the globe. The most important is sulphur, generated from the combustion of coal and oil, in the form of 'sulphate aerosols' - clouds of microscopic particles which reflect

incoming radiation back out into space. However, as they are relatively short-lived in the atmosphere, their cooling effect is only very slight.

GREENHOUSE GAS CONCENTRATIONS ARE RISING.

Atmospheric concentrations of the natural greenhouse gases have remained relatively stable since the last Ice Age. Plants and animals have exchanged carbon dioxide with the atmosphere in a carbon cycle that has remained in balance for the last 10 000 years. However, since the industrial revolution (mid-18th century), human activities have disturbed this balance - mainly through burning fossil fuels (oil, coal and gas) which produces CO_2, by the destruction of forests, which releases stored carbon, and the intensive rearing of cattle and high scale plantation of rice which produces



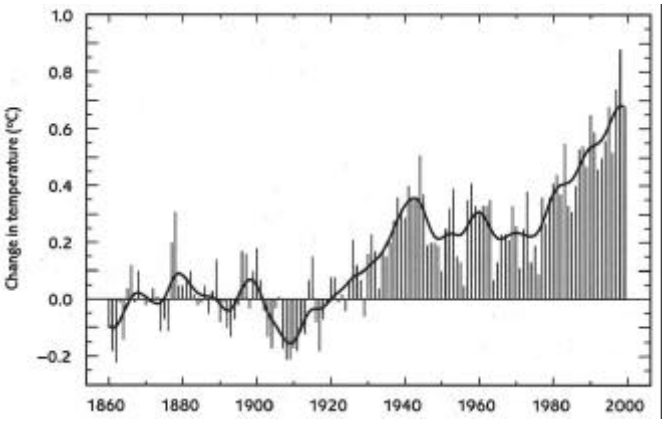
methane. Carbon dioxide concentrations in the atmosphere have increased by about 30% in the last 200 years, from less than 280 parts per million (ppm) to 368 ppm today.[2]

Atmospheric CO_2 Concentrations since Mid-18th Century [3]

If current trends in fossil fuel burning continue, atmospheric carbon dioxide will be twice pre-industrial levels by 2030, and three times that figure by 2100.

THE WORLD IS GETTING WARMER

As concentrations of greenhouse gases rise, the earth's atmosphere is becoming warmer. The global average temperature has risen by almost 0.7°C over the last century, very probably as a result of human activity - this makes the current rate of warming greater than any for 10000



years! The 1990s were the warmest decade, and the 1900s the warmest century of the last 1000 years, with 1998 the warmest year globally in the instrumental record. [4]

Global Temperature, 1860-1999 [5]

According to the Intergovernmental Panel on Climate Change (IPCC), global temperature may rise 1-3.5°C by the year 2100. This may not seem a great deal, but should be compared with the rise in temperature since the last ice age of only 3-5°C.

Even if greenhouse gas emissions were stabilised today, atmospheric temperature would continue to rise because of the long life time of greenhouse gases.

THE IMPACTS OF A CHANGING CLIMATE

Climate change is likely to have a significant impact on the global environment. The practical consequences of global warming for individual countries or regions are difficult to predict, due to the enormous complexity of the global climate system. In general, the faster the climate changes, the greater will be the risk of damage.

Sea level will rise due to thermal expansion of sea water, and the melting of glaciers and ice caps. A rise in sea level of 15-95 cm is expected by 2100. This will threaten low lying coastal areas around the globe, and may lead to 94 million people flooded annually, particularly in the countries of southern and South East Asia

[6]. It may also lead to the disappearance of some small island states, such as the Maldives which have an average height of about 1.5m above sea level.

Climatic zones, and thus ecosystems and agricultural zones, will shift towards the poles as temperatures rise, in some cases by about 200 to 300km per degree Celsius [7]. Forests, deserts, rangelands, and other unmanaged ecosystems will face new climatic stresses, and as a result many ecosystems will decline or fragment, and individual species which are not able to adapt or migrate will become extinct.

Coral reefs are an example of an ecosystem already exhibiting signs of major damage - severe bleaching of corals worldwide has occurred as a result of warmer surface water temperatures.

Arctic sea ice has thinned dramatically since the 1960s and 70s - nearly 40% in less than 30 years - threatening the variety of species it supports including polar bears [8].

The Worldwide Fund for Nature predicts that by 2100 up to one third of natural habitats may be destroyed by climate change [9]. We may have already witnessed the first documented example of a species extinction due to climate change - as a result of changing rainfall patterns, the Golden Toad has disappeared from the cloud forests of Costa Rica.

Forests and agriculture. While increased levels of CO_2 will initially lead to increased plant growth and expansion of forests in some areas, climate change may lead to very significant dieback of the forests of the Amazon and Africa. Patterns of agriculture will need to change as farmers adopt different crops to respond to new growing conditions. Africa in particular is likely to be severely affected by lower crop yields leading to greater risk of famine.

Regional Cooling? As average global temperatures rise, some regional temperatures may fall due to changes in ocean circulation. One such example is the North Atlantic Ocean circulation, whereby the Gulf Stream carries warming waters from the Caribbean to the shores of northern Europe. A reduction of these ocean currents could lead to significant cooling [10].

Changing weather patterns are predicted across the globe**.** Availability of water is particularly important - though we don't understand enough about the climate to make specific predictions for small geographical areas, climate models suggest that in areas where water availability is currently low, rainfall will decrease, while wetter areas can expect higher rainfall[11]. Overall this will mean increased likelihood of floods and droughts worldwide.

A warmer globe means more energy in the climate system, fuelling phenomena such as hurricanes, and the cyclical event known as El Niño which affects the climate all around the globe. The frequency of El Niño events appears to be increasing from every 6 years, to 3.5 yrs and leading to ever more extreme weather events [12]. The consequences of stronger and more frequent weather events are severe: according to the Red Cross, in 1998 (an El Niño year), there were more refugees from natural disasters than from armed conflict, and the cost of these disasters was put at $65.5 billion [13].

Health Impacts. Changing regional climates may lead to increase in the spread of disease, especially insect-borne diseases such as malaria, dengue fever, tick-borne encephalitis, and leishmaniasis. Up to 300 million more people worldwide could be at risk of the dangerous falciparum malaria, particularly in China and Central Asia, and we may witness re-introduction of the disease into areas such as Europe where it had previously been eliminated [14].
Some diseases will become more prevalent as a consequence of extreme weather events and the resulting destruction of infrastructure, such as cholera, typhoid, malaria and dengue fever, as witnessed after Hurricane Mitch in Central America, or the severe flooding in Mozambique.

Effects on society. Human society will face new risks and pressures. Food security is unlikely to be threatened at the global level, but some regions are likely to experience food shortages and hunger. Water resources will be affected as precipitation and evaporation patterns change around the world, and this may

lead to conflict as nations compete for limited water supplies. Physical infrastructure will be damaged, particularly by sea-level rise and by extreme weather events. Economic activities, human settlements, and human health will experience many direct and indirect effects. The poor and disadvantaged are the most vulnerable to the negative consequences of climate change. Serious economic disruption may well occur as a result of extreme weather events.

THE FUTURE

Future greenhouse gas emissions will depend on global population, economic, technological, and social trends. The link to population is clearest: the more people there are, the higher emissions are likely to be. The link to economic development is less clear - we need to separate our use of energy from the generation of greenhouse gas emissions, by developing renewable sources of energy. Industrialised nations are responsible for the vast majority of greenhouse gases which have been added to the atmosphere since the industrial revolution, and these countries continue to be the biggest source of emissions. An analysis of per capita emissions allows a fair comparison of energy use between countries: the United States, which has only 5% of the world's population, emits more than 20% of the world's CO_2, while India's 17% of world population produce less than 4% of global emissions. Future growth in emission rates will be dominated by what happens in developing countries, and whether they follow the industrial development patterns of the north.

WHAT ARE THE SOLUTIONS?

Climate scientists have suggested that atmospheric CO_2 concentrations should be kept below 450ppm, or approximately twice pre-industrial concentrations, in order to avoid catastrophic consequences. This will require first stabilisation, and then substantial reduction of global CO_2 emissions from current levels. Friends of the Earth argues that to achieve this, industrialised countries must make deep cuts in their greenhouse gas emissions of 80-90% by 2050. This will require a commitment to truly sustainable development, involving a switch from our dependence on fossil fuels to investment in renewable energy sources and energy efficiency measures, and allowing space for non-industrialised countries to develop.

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Friends of the Earth International (FoEI) is a federation of organisations from all over the world who are campaigning to protect the environment. FoEI is registered in Amsterdam under number V535338.

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