GLOBAL WARMING RESPONSES: AN UPDATE

by Lindsay Frost

THE MAIN GREENHOUSE GAS, carbon dioxide (CO_2), is a product of burning fossil fuels. Other gases, such as methane from intensive livestock farming and waste disposal, also play a part in current global warming. These denser gases absorb the Sun's heat as it is radiated from the Earth's surface. In the last 100 years, average global temperatures have increased by about 0.7°C, and things are hotting up! In 2008 the global temperature was 0.4°C higher than the 1960s–1980s average, and the warmest year ever recorded in the UK was 2004, which was 0.43°C above the 1960s–1980s average.

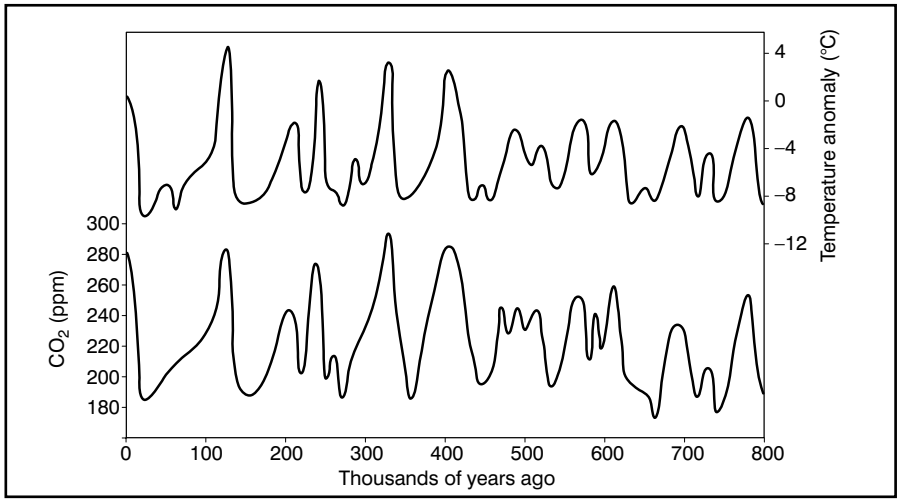

Figure 1: **Antarctic ice core data: lines of best fit for CO_2 levels and temperature anomalies**

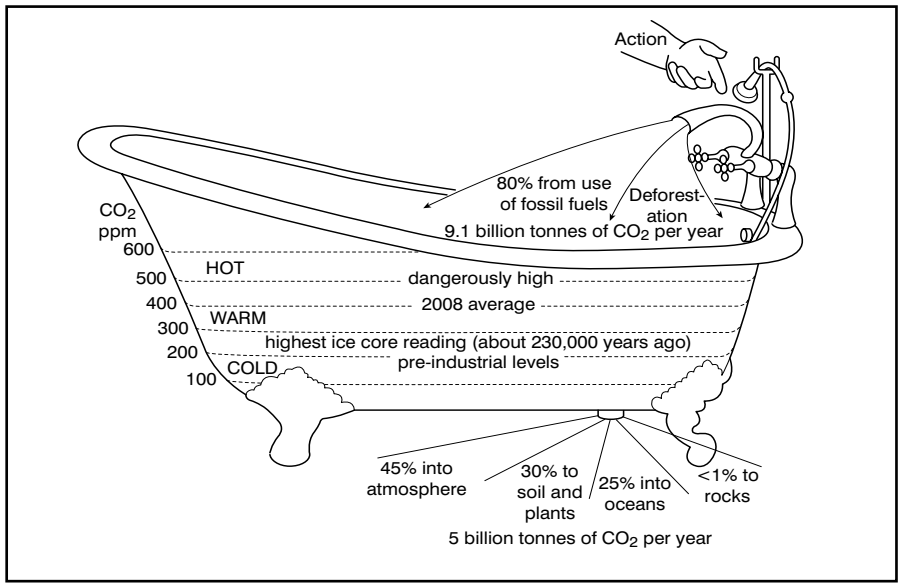

Figure 2: **The CO_2 bath**

The link between CO_2 in the atmosphere and global warming was first noticed by G.S. Callendar in the 1940s, and 1960s computer models confirmed a temperature increase (Figure 1). In 1979 the first **World Climate Conference** was held in Geneva but it was not until 1988 that the **Intergovernmental Panel on Climate Change (IPCC)** was created to co-ordinate research. Throughout the 1980s pressure groups – e.g. Worldwide Fund for Nature, Friends of the Earth, Greenpeace, and Green political parties – campaigned for action to stop negative human impacts on the world. The Rio de Janeiro **Earth Summit** in 1992 was a turning point as top international politicians acknowledged the need to do something, both at government and individual levels. It is widely acknowledged that global emissions must be cut drastically so that the greenhouse gas concentrations peak no later than 2020. Even then global warming will continue as CO_2 will remain in the atmosphere for a long time, but 'dangerous climate change' may be avoided. James Lovelock, author of the Gaia Hypothesis, says that people have gone too far and now natural systems cannot absorb greenhouse gases fast enough to maintain a balance (Figure 2).

As more and more symptoms of global warming were seen, the need for action became clearer. Such indicators included, for example:

- melting glaciers and ice, e.g. Antarctica
- rising sea levels threatening major cities, e.g. London, New York, and island states, e.g. Maldives
- stronger storms damaging structures, e.g. UK, Bangladesh

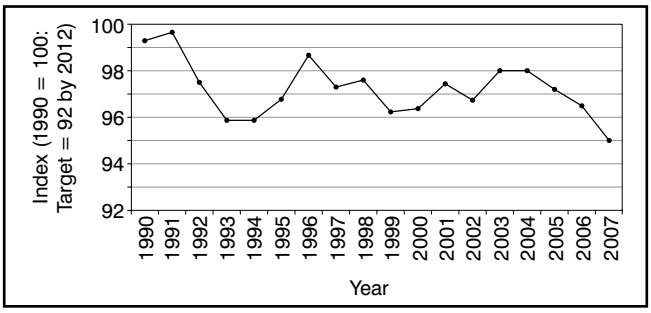

Figure 3: **EU (15) emissions of greenhouse gas compared with Kyoto Protocol target (1990–2012)**

Source: European Environment Agency, June 2009

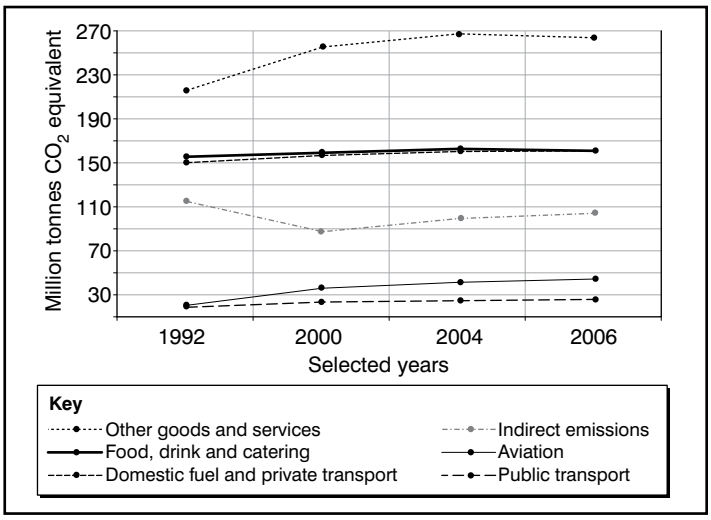

Figure 4: Changes in greenhouse gas emissions for a typical UK household, 1992–2006

Source: DEFRA, © Crown copyright

- changes to precipitation patterns affecting water supplies and causing dust storms, e.g. Sahel, Australia
- heatwaves in many countries, e.g. Europe 2003
- damage to habitats and ecosystems (including extinctions of species, e.g. polar bears, coral reefs)
- unreliable food supplies.

There are three **types of response** (from individual to world scale):

1 **Prevent** the causes of global warming.

2 **Mitigate** the effects of global warming.

3 **Adapt** to the changes brought by global warming.

Achieving a balance between technological, economic, and socio-political forces is essential if a 'low carbon future' is to be achieved.

Prevention

Protocols and accords

In 1997 an agreement was reached in Kyoto, Japan, on a protocol to create compulsory action by all developed countries. Using 1990 as the benchmark year, CO_2 emissions reduction targets for 2012 were set (5.2% below 1990 level). In addition to this the EU set an emissions reduction target of 8% by 2012, and 20% by 2020. However, it does not appear as if this target will be achieved! In 2006 the EU was 4% above the Kyoto target path (Figure 3). A major problem has been increased emissions from motor vehicles; despite compulsory catalytic converters and emissions monitoring, CO_2 from private cars went up by 13 per cent between 1990 and 2007. Many other household activities also increased or did not decrease significantly (Figure 4). Kyoto was criticised for not including developing countries (e.g. China), and for encouraging emissions trading rather than tougher reductions.

Much was expected from the Copenhagen Accord (December 2009), which was to set emissions targets for the period after 2012 and extend restrictions to developing countries. However, political and economic issues prevented a definitive new protocol (Figure 5).

It was hoped that a new legal treaty or protocol could be reached at the meeting in Mexico in December 2010.

Awareness

Non-governmental organisations such as Friends of the Earth have awareness campaigns to try and make the public and non-specialists realise the serious nature of the problem. Al Gore produced a film entitled *An Inconvenient Truth* (2006) and toured the world presenting information, and the IPCC produced a very comprehensive summary in 2007 (they were jointly awarded the

Positives	Negatives
Agreement that warming should be limited to no more than 2°C.	No new treaty agreed or a legally binding deal (but Kyoto Protocol to remain in force).
Developed countries to register new reduction targets for 2020.	EU's suggestion of 50% reduction by 2050 was blocked. No alternative target agreed.
International inspection of developing countries receiving global warming funding from developed countries.	No targets were set for developing countries, only pledges of action.
Copenhagen Green Climate Fund ($30 billion) for developing countries by 2012 to help them cope with climate change. Aim to raise this to $100 billion by 2020.	The Accord was not adopted by some countries, and not passed unanimously.
A deforestation fund to stop countries (Brazil, Congo) cutting down tropical rainforests.	

Figure 5: **Outcomes of the Copenhagen Accord**

Nobel Peace Prize in 2007). In the UK the Carbon Trust sets standards for businesses and organisations that reduce their carbon footprint. EC3 Global has a Green Globe certification system for businesses and organisations that make improvements in water, waste and energy (including greenhouse gas emissions and energy usage), e.g. Snaefellsbaer municipality in Iceland. The country of Iceland is hoping to be the first nation to get a Green Globe certificate. The Maldives government held a cabinet meeting underwater (October 2009) to publicise the possible fate of their country, which is an average of only 2.1 metres above sea level.

Geo-engineering

Some futuristic ideas include:

- placing trillions of disks in space, to block out some of the energy from the Sun
- putting sulphur into the stratosphere, thereby creating particulates that block sunlight
- spraying seawater into the atmosphere – salt crystals in the air make denser clouds which will reflect sunlight back into space
- iron fertilisation of the ocean, to increase the growth of plankton which would absorb CO_2 from the air
- carbon capture, such as splitting sea salt to increase chemical reactions that absorb CO_2, or scrubbers (e.g. CO_2 absorbing plastics) that take CO_2 out of the air to be stored underground.

Mitigation

- **Energy:** Change electricity production to alternative (renewable) energy sources such as solar (e.g. Saharan Concentrating Solar Power), wind (e.g. UK offshore wind farms), HEP (e.g. Santo Antonio dam in Brazil), biomass, air source heat pumps, or combined heat and power. This category also includes carbon dioxide capture and storage (e.g. BP into underground storage in old North Sea oilfields). Saving energy is also important (e.g. Nightwatchman for computers).
- **Transport:** The use of fuel-efficient vehicles (hybrids e.g. Toyota Prius, or electric e.g. G-Wiz or MiEv), or the use of biofuels. Use of alternative travel methods, such as walking and cycling (e.g. UK Cycle 2 Work scheme), or public transport and car sharing.
- **Buildings:** Efficient lighting and heating or cooling systems; improved insulation; use of solar and wind energy (e.g. Sainsbury's in Greenwich was the first low-energy superstore, 1999; Tesco at Cheetham Hill, Manchester, invested £86 million in 2009 to save 66,000 tonnes of CO_2 emissions); all of these incorporated into architectural designs.
- **Industry:** Same as buildings, but also recovery of wastes and energy, and more efficient use of resources (e.g. Carbon Reduction Commitment in UK). Action required in both developed and developing countries.
- **Tourism:** Take more local holidays and avoid flying; develop more ecotourism (e.g. rafting in Kerala, India; walking in Corsica; staying at a Kenyan ecocamp/lodge such as Saruni in Masai Mara).
- **Farming:** Development of energy crops to replace fossil fuels; efficient use of energy (vehicles) and chemicals; restoration of natural areas to allow more carbon capture; more organic farming; people buy local produce.
- **Forestry:** Plant more trees (afforestation and reforestation) to capture carbon (e.g. Rainforest Alliance); sustainable harvesting and management (e.g. FSC, Green Palm); stop deforestation, especially by burning.
- **Waste:** Everyone 'Reduce, Reuse, Recycle'; recover waste gases from landfill sites; any incineration of waste to include energy capture.
- **Population:** Control population growth, through birth control, as fewer people means fewer greenhouse gases are emitted ('… family planning is the most effective way to reduce the likelihood of catastrophic global warming' – Optimum Population Trust).

Adaptation

- **Water:** In areas that become drier, expand rainwater harvesting, storage and conservation; re-use water; desalination (e.g. UAE). In wetter areas avoid using floodplains because of flood risk.
- **Farming:** Adjust farming cycles to fit new seasons, or change crop varieties to suit new climate.
- **Infrastructure:** In vulnerable coastal areas relocate valuable infrastructure (e.g. power stations, settlements), or build coastal defences; Integrated Coastal Zone Management (ICZM) to include buffer zones of natural areas.
- **Human health:** National health services to be prepared for new diseases and the effects of warmer climate (heatstroke, sunstroke); improvements in clean water and sewerage systems.
- **Tourism:** Diversify activities to fit new climate; ski resorts to develop higher slopes and use more artificial snow production.
- **Transport:** Move routes away from vulnerable areas (e.g. coasts or permafrost); develop road surfaces able to withstand high temperatures, and develop efficient drainage systems for higher rainfall.
- **Energy:** Move cables underground or strengthen overhead lines in areas with more storm activity; use multiple sources of energy, especially renewables.
- **Migration:** People move to areas that are able to support more people.

Conclusion

Every year without action means that reduction targets for greenhouse gas emissions are more difficult to achieve, and the crises for future generations get worse. The Copenhagen meeting (COP15) probably involved too many countries (192); China and India wanted to flex their political muscle, and the USA made a mistake in trying to deal with just a few countries. However, groups of countries ('blocs' such as the EU) could still achieve a great deal by setting their own targets. Action at local and individual levels is also important and does not depend on international agreements; in fact this 'bottom-up' approach may be more effective at achieving sustainability, as the effects of global warming vary at the regional and local scales.

Activities

1 (a) What is meant by the term *mitigation*?
(b) Why is carbon dioxide targeted by most prevention and mitigation measures?

2 Study Figure 1. Why is there not an exact match between CO_2 concentrations and the temperature changes over the last 800,000 years?

3 Study Figure 2.
(a) Explain in words what the diagram shows is happening.
(b) Why may the bath fill up more quickly in the future?

4 Use the data in Figure 6 to create an appropriate graph.

Method of reducing emissions	**Average cost of saving 1 tonne of CO_2**
Electric vehicles	£80
Hybrid vehicles	£56
Coal power with CCS*	£43
Solar	£31
Wind	£15
Reduce deforestation	£8
Family planning	£4
*CCS = Carbon Capture and Storage	

Figure 6: **Cost-effectiveness of cutting CO_2 emissions**

Source: Optimum Population Trust 2009

5 (a) Consider the ways of mitigating the effects of global warming. Put these into rank order according to how effective you think they will be. Justify your order.
(b) Investigate the method that you placed at the top.

6 What is meant by *geo-engineering*? Choose one example that may help to solve the global warming crisis, and discuss how effective it may be.

7 Was the Copenhagen Climate Change Summit meeting (2009) a success or a failure? What obstacles had to be overcome, or still have to be overcome, to achieve success at these meetings?

8 What problems may a developing country face when trying to adapt to climate change?

9 Investigate *either*:
(a) how Colchester United and Manchester City have made ecofriendly stadiums, *or*
(b) why ASDA in Bootle (Liverpool), and Morrison's in Kidderminster can be regarded as ecofriendly.

10 Using a copy of the outline in Figure 7, create a diagram to show all of the things that Mr and Mrs Ecocitizen could do to help reduce global warming.

11 (a) Calculate your carbon footprint. You could use one of the following websites:
http://carboncalculator.direct.gov.uk/index.html
www.energysavingtrust.org.uk
www.popoffsets.com/calculator.php
(b) For either your home or your school, produce a plan to reduce greenhouse gas emissions.

12 Investigate the outcome of the UNFCCC meeting (Conference of the Parties – COP16) in Mexico in December 2010. What are the positive and negative outcomes of this meeting?

Extension

13 What is the Gaia Hypothesis?

14 Why is it necessary to have a balance between technological, economic and socio-political forces in order to achieve a 'low carbon future'?

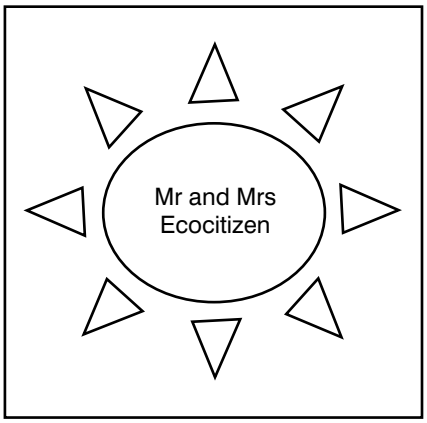

Figure 7: **Reducing global warming**