

# GLOBAL WARMING AND CLIMATE CHANGE

Variations in weather occur from day to day and variations in climate from year to year. However, in the last 50 years we have experienced extreme climatic phenomena that have killed large numbers of people. For example, natural disasters occurring between 1947 and 1980 had the following disastrous effects:

Type of disaster	Deaths caused <sup>1</sup>
1. Tropical cyclones (hurricanes, typhoons etc.)	499,000
2. Earthquakes	450,000
3. Floods	194,000
4. Tornadoes & thunder storms	29,000
5. Snowstorms	10,000
6. Volcanoes	9,000
7. Heat waves	7,000
8. Avalanches	5,000
9. Landslides	5,000
10. Tidal Waves (Tsunamis)	5,000

Since the 1980's meteorological records seem to have been broken somewhere on the planet almost every year, often with disastrous consequences for some countries and peoples. Some examples are listed below:

- October 1987 storms in South East England, Northern France, Belgium and Holland (the worst since 1703) caused enormous damage to buildings and trees. (15 million trees were destroyed in Southern England alone).
- January 1990 another storm of similar intensity swept across much of Western Europe.
- The Caribbean, Gulf of Mexico and South East USA experiences hurricanes and tornadoes on a regular basis between June and October.
- Bangladesh has experienced numerous storm surges and flooding. In 1970 250,000 people were drowned in one flood and in 1988 80% of Bangladesh was flooded.
- In China the Yangtze River region experienced devastating floods in 1991.
- The Mississippi and Missouri rivers flooded an area equivalent to one of the Great Lakes in 1993.
- Large areas of southern Africa and Australia have experienced droughts of a duration and scale unprecedented in living memory.
- The El Nino phenomena (warmer than usual temperatures in the Pacific off the coast of South America) have been associated with floods and droughts in different parts of the world. In 1990-93 this had exceptionally serious effects.

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<sup>1</sup> Source: John Houghton, "Global Warming: the complete briefing", Lion 1994, p11. This paper relies heavily on the work of Sir John Houghton F.R.S... He is an eminent atmospheric physicist, former Director of the UK Meteorological Office, Chairman of the Royal Commission on Environmental Pollution and a committed Christian. No other specific attributions are made to his work because they would be too numerous. Sir John is not responsible for the selections we have made from his work.

- Volcanic eruptions also influence the climate as dust and gases (particularly sulphur dioxide) enters the atmosphere, reduces radiation from the sun and cools the atmosphere.
- The flooding of St Louis (USA) in 1993 and the impact of Hurricane Katrina on New Orleans in 2005
- The Asian tsunami of December 26<sup>th</sup> 2004 that left 186,983 people dead and another 42,883 missing.

*The purpose of listing these disastrous events is to recognise the seriousness of climate change that has already occurred. These incidents leave no room for complacency but equally there is no call for the alarmism that inhibits a constructive response. Many people have already suffered the effects of climate change. The right response is to do everything we can to minimise further suffering. We can do no more but we should also do no less.*

## THE CAUSES OF CLIMATE CHANGE

So how do we interpret these extreme climatic events? Climatic variations are normal but are the events listed above really abnormal? In the late 1960's and early 1970's there was speculation that we were heading towards another ice age but the cold period ended. Now we see evidence of global warming. Will that end in the same way or is it something new and entirely different?

Global warming occurs because of the greenhouse effect. It happens naturally but has been enhanced by the increased production of carbon dioxide resulting from human activity. The Earth receives radiant energy from the sun and also emits its own radiation. Water vapour, carbon dioxide and other minor gases<sup>2</sup> absorb some of the thermal radiation coming from the Earth's surface, which has the effect of blanketing the planet, making it warmer than it would be otherwise. Without this blanketing effect the planet would have an average surface temperature of -6 degrees Celsius. With it the average surface temperature is 15 degrees Celsius. However, the increased emission of carbon dioxide and other greenhouse gases is increasing the greenhouse effect. If carbon dioxide levels are doubled in this century the average surface temperature of the planet will increase by 2.5 degrees Celsius with substantial consequences for our climates.

Carbon dioxide in the atmosphere has been increasing over the past 200 years and substantially over the last 50/60 years. This is attributed to human industry and, especially, to deforestation. Every year some 7,000,000,000 tons of carbon are released into the atmosphere. In the past trees absorbed much of this but the clearance of forests, especially in areas such as the Amazon Basin of South America and in Indonesia, has reduced levels of absorption. The carbon dioxide absorbs heat radiation from the Earth's surface and acts like a blanket, keeping the Earth's surface warmer than it would be otherwise. The estimated rate of increase in the average global temperature of 2.5 degrees Celsius in a century may seem small but the rate has not been this much over the past 10,000 years. (Compare this rate of change with the change in global average temperatures between the coldest part of an ice age and the warmest period between ice ages, which was only 5/6 degrees Celsius). How reliable are these estimates? Whilst there is no doubt that modern studies of climate and meteorology are highly sophisticated, how reliable is the data from the past? Is there any reason for distrusting the scientific analysis of today's evidence? Measuring sea and land temperatures around the world to calculate the average surface temperature of the planet involves an enormous amount of information. Corrections have to be made for differing

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<sup>2</sup> Methane, nitrous oxide, the chlorofluorocarbons (CFCs) and ozone.

methods used and standards applied but reputable scientists are confident about the outcomes and the conclusions they draw from them. Charting climate change over long periods of history is no easy business and allowances have to be made for the less accurate instruments used in the past. Nevertheless, the data from the past can be checked against nature's record. Sources such as ice cores<sup>3</sup>, tree rings, records of lake levels and glacial advance/retreat, and the evidence of pollen distribution can all be used. So too can human records such as private diary entries that record Londoners skating on the frozen river Thames in the 19<sup>th</sup> century. The evidence derived from these various and numerous sources suggest that over the last 8000 years climate change has been slow. However, ice core data from Greenland suggests that further back during the glacial period up to 100,000 years ago temperature variations of up to 5 or 6 degrees Celsius occurred over periods of less than 100 years. So, what we are now being told could happen in this century is not unprecedented but the cause is totally different.

If we are to expect faster than normal climate change over the next century, what could that mean for different parts of the world. For Central USA and Southern Europe the most likely consequence is a fall in average summer rainfall with prolonged periods of no rainfall at all – meaning drought, with implications for domestic and industrial water supply and for agriculture. Australia, that has recently been experiencing periods of drought, might expect that the number of days with small amounts of rainfall will decrease but the number of days of heavy rainfall could double. This would mean floods in the rainy season followed by periods of drought. In Asia, the summer monsoon season is expected to bring up to a 15% increase in precipitation and flooding.

Another probable consequence of global warming is more violent windstorms. The energy for these largely comes from the latent heat of sea water evaporated from the warm oceans which is condensed in the storm clouds releasing energy. Warmer seas might be expected to fuel more frequent and more intense storms. Climate models suggest that the Atlantic seaboard of Europe could experience more of these storms, as in 1987 and 1990.

The effects of global warming will vary from one part of the world to another. Some parts will experience a milder climate and adapt. Some will experience frequent or severe droughts, whilst others will have to contend with floods or hurricanes. Tree, plant life and agriculture will be affected, as will the fishing industry. Many species of insects and wild life will also be threatened. Low lying land will be flooded as sea levels rise and countries such as Bangladesh may become unsustainable, triggering massive people movements. Buildings will be affected, with subsidence in drought stricken areas and in sub-arctic areas where the permafrost melts, or destruction by hurricanes and tornadoes in other parts of the world. Politically, national boundaries will become increasingly irrelevant as people are forced to migrate from flooding and drought or where their traditional form of agriculture is no longer sustainable. Pollution ignores frontiers and solutions will need to be transnational. No one nation can slow down or reverse global warming on its own. The global challenge will have to be met with global solutions.

## **THE CONSEQUENCES OF CLIMATE CHANGE**

Three questions follow once we recognize that global warming will lead to significant climate changes. First, what practical differences will these changes make to the way we live? Second, why should we be concerned and prepared to change our lifestyles to reduce our carbon 'footprint' in order to moderate these changes or, at the very least, not make them any

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<sup>3</sup> For example the Russians have drilled to a depth of 2.5 Km at their Vostock Station in East Antarctica. The ice that far down fell as snow more than 200,000 years ago.

more severe for future generations? Third, what can we do that would help to make a real difference? The practical differences that climate changes are expected to make relate to the effects of rising sea levels, the impact on fresh water supplies, the impact on agriculture and the food supply, and the effects they might have on our health. Each will be examined in turn.

- **Rising Sea Levels**

There have been substantial changes in sea levels before. For example, before the last ice age the average sea level was approximately 5 or 6 metres higher than it is today.

Towards the end of the last ice age the sea level was 100 metres lower than today. That was when Britain was joined to the European mainland. In the 21<sup>st</sup> century, sea levels are expected to rise by 15 cm (by 2030), and by approximately 50cm (by 2100). Some of this will result from melting glaciers but the biggest single cause will be thermal expansion as the sea warms up. Other influences will include natural movements of the land and how much water is extracted for human use.

Rising sea levels will obviously affect most of those who live at, or near to, sea level. For the people of Bangladesh, the Netherlands, and those who live in the Nile Delta, or on one of the Indian Ocean islands, the consequences could be devastating. 7% of Bangladesh will be submerged under the sea with massive consequences for its agriculture which constitutes half of its economy and employs 85% of its population. On top of the direct effects of the rising sea level, Bangladesh will be even more vulnerable to storm surges and to the intrusion of sea water into its fresh groundwater supplies. It is a poor country: how will it cope? Where will its displaced peoples go?

The Netherlands will have similar problems in that something like 50% of its land is at or below sea level. Hitherto the Dutch have coped by building 400 km of dykes and coastal sand dunes. The dunes will have to be raised, the dykes reinforced and pumps installed to prevent the salt water contaminating fresh groundwater. One estimate is that it could cost the equivalent of 10 billion dollars to protect itself from a 1 metre rise in the sea level but the Netherlands is not a poor country like Bangladesh.

- **Fresh Water Supplies**

Fresh water is a precious resource for everybody. We drink it and use it in food production, for our health and hygiene. Water resources vary from country to country but population growth and rising living standards are increasing the demand for water. Even so only about 10% of fresh water supplies are used domestically. Agriculture consumes about 60% and industry 25% and in some countries adequate water supplies are under pressure. In others, long periods of drought threaten the survival of whole communities. Many countries share access to the same water basins and pressure on supplies could become the cause of friction between them.<sup>4</sup> Warmer climates will increase the amount of rainfall lost through evaporation and combined in some place with decreasing levels of rainfall, would mean less run-off to reservoirs and aquifers. The restrictions imposed on domestic water use in South East England in 2006 were necessary because a long dry summer meant reservoirs and aquifers were being emptied and water rationing became a possibility unless rain came in time which, fortunately, it did. In other parts of the world reduced rainfall is the consequence of deforestation. This is because in forests there is a lot more evaporation of water, producing water vapour for rain.

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<sup>4</sup> For example, the Danube flows through 12 countries which use its water. The Brandt Commission in the 1970's warned that competing demands for access to water could lead to wars in the future. The former U.N. Secretary General also said "the next war in the Middle East will be fought over water, not politics."

- **Impact on Agriculture and Food Supply**

Farming is closely dependent on climate. Crops and livestock thrive in particular climatic conditions and fail when they are absent. The relationship is complex because crops can adapt and different strains can be sown. Irrigations can compensate for reduced rainfall, if the water supply permits. Moderate climate changes combined with accurate forecasting and advanced planning will enable commercial farmers to adapt. Poor subsistence farmers will probably struggle to survive and the more extreme the climate change the greater the struggle for all farmers. Studies of the effects of climate change on agriculture suggest that with appropriate adaptation the effect of the climate change associated with a doubling of carbon dioxide in the atmosphere will be modest except where drought or floods make farming virtually impossible. The global food supply can be sustained but those in arid areas will either have to move or be depend on foreign food aid. Whether there will be sufficient food for an increasing world population is also an issue unless those in the developed world consume less. Technical developments in agriculture and improved management of water resources will be essential. The deforestation of the equatorial rain forests is another major issue. In so far as deforestation is driven by poor people seeking to make a living, stopping this may require financial aid from the rich nations.

- **The Effects on Human Health**

Atmospheric pollution, polluted or inadequate water supplies, poor quality or insufficient crops, floods, drought and violent storms can all damage human health. Warmer climates may also enable the mosquito and other disease carrying insects to breed where previously they could not, increasing the risks of malaria and other diseases. Humans can adapt their behaviour and domestic environments to moderate changes but sudden, unexpected and extreme changes such as the flooding of St Louis caused by Hurricane Katrina in 2005 can be killers. Similarly, the heat wave in France in 2005 led to the deaths of many elderly people.

- **The Financial Implications**

It is difficult, for a number of reasons to calculate the costs of coping with the effects of climate change. First, we cannot yet be certain how much effort will be made to reduce carbon emissions and how effective those measures will be. Second, whilst the costs of these measures will be incurred in the near future, many of the costs of dealing with the consequences of climate change will be incurred in 20 or 30 year's time. Third, some of those costs will fall on low income nations who will depend on aid monies from the richer nations. Four, some of the costs will be for adaptation and others will be for coping with disasters. Nevertheless, studies undertaken so far suggest that every nation will need to budget for at least 1 or 2% of their Gross Domestic Product. For poor nations that could mean shifting expenditure from other budgets, say, for education, defence or economic development, which will have knock on effects.

These financial implications may seem modest, even manageable at least for the richer nations but there are other factors to be considered. First, any delay in reducing carbon emissions now will mean more climate change and therefore more severe and costly consequences in the long run. Second, the better off nations will be on the receiving end of mass migrations from the worst affected poor nations with consequences and indirect costs in assimilating immigrants and coping with the increased demand on their public

services and the impact on their social and political stability. One estimate is that global warming will lead to 150 million migrants by 2050.<sup>5</sup>

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<sup>5</sup> 100 million migrating because of rising sea levels and 50 million because of drought and its effects on agriculture.