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COPENHAGEN AND THE CLIMATE CHANGE CRISIS

Sir John Houghton

When written in Chinese the word crisis is composed of two characters, one represents danger and the other represents opportunity.

President John F Kennedy

At the world climate change conference in Copenhagen from the 7th to the 18th December 2009, tens of thousand of delegates, representatives of NGOs and other interested parties gathered with great expectation. What was hoped for was an outcome binding the world's governments to halt damaging human-induced climate change. But no such agreements were forthcoming. Nor was there agreement over a timetable to make such agreements. All very disappointing. So what, if anything, was achieved and what needs to be done now to bring the process back on track?

The final document of the conference called the ***Copenhagen Accord*** was brokered by the United States, China, India, South Africa and Brazil and just noted by the conference (188 nations in all). It included **some important positive outcomes** namely:

- 1) A near-global consensus for a goal of 2°C for the maximum rise of global average temperature from its preindustrial value due to human activities – a tough but necessary target.
- 2) Developed countries committed to implementing quantified economy-wide emissions targets for 2020 at levels to be notified by the 31 January 2010.
- 3) Developing countries will register mitigation actions that are self-supported. Actions by developing countries that receive support from other nations will be monitored by an international inspection regime.
- 4) Funding to be provided by developed countries to developing countries to assist in their adaptation to climate change and their mitigation actions. No definite or binding agree-

ments were made and doubts were expressed whether the funding would be new and additional to existing countries' funding commitments. However an aim was declared to raise about 30 billion US dollars for the years 2010 -2012 and about 100 billion US dollars per year by 2020 from a wide variety of sources.

- 5) An assessment of implementation is to be made by 2015 including the possible need to strengthen the long term goal by changing the maximum temperature rise to 1.5°C.

The consensus in (1) above is of fundamental importance. That it has emerged intact from the conference demonstrates a high level of concern throughout the world about the damaging impacts of climate change and a general recognition that strong action needs to be taken.

For (2) above it is essential that Developed Countries offer not just token reductions by 2020, but substantial and meaningful reductions. The offer from the European Union is especially important. So far it is for a 20/30% reduction – 30% if reductions by other nations are deemed adequate. However, if it could be for 40% reduction as has already been agreed in Wales and Scotland, it would provide a serious lead for other developed nations to follow.

The agreement about international inspection in (3) above was vital for President Obama to take away from the conference. Without it, there would be real difficulty for the bill regarding reductions of greenhouse gases in the USA to be passed by the US Senate next Spring.

The funding mentioned in (4) above, which is still only an aim, is important as it indicates that developed countries recognise at least some responsibility (although as I explain below, nothing like enough) for the plight of developing countries many of which will suffer serious damage as climate change begins to bite.

The assessment in 2015, 5 years away, mentioned in (5) above can only provide a 'long stop' for the process. It is essential that within one year - by the time of the next Conference of Parties of the Climate Convention (COP16) to be held in Mexico late in 2010 - commitments and agreements are made by the world's countries adequate to meet the goal of 2°C set out in (1) above. Indications so far (February 2010) from nations, developed and developing, about their likely commitments as mentioned in (2) above are more in line with a 3 or 4°C global average temperature goal rather than a 2°C goal¹. It is vital therefore that they be substantially strengthened during this year 2010.

The mention of a 1.5°C goal eventually being necessary perhaps demonstrates the beginning of a realization that the demands presented by anthropogenic climate change are likely to become much tougher in the future.

A further positive point about the conference that can be made is that no compromise agreements, for instance regarding reductions of emissions to inadequate levels, were made at Copenhagen. Better to have no agreement rather than one that is clearly unsatisfactory.

WHAT IS NEEDED NOW?

After such a disappointing outcome in Copenhagen that began with a great sense of importance and urgency, the problem will be to get back on track. Valuable time has been lost not least in providing the world's business and industrial sector with the policy certainty necessary to generate investments in energy and other technologies on the scale required to meet the 2°C goal. The sense of urgency, now even more necessary than before, is in danger of being lost in the post Copenhagen confusion.

Previous major meetings of the parties to the Climate Convention, such as in 1992 at the Earth Summit in Rio de Janeiro and when the Kyoto Protocol was agreed in 1997, have concluded with unanimous agreements from all the participating nations. However, some of those agreements failed to materialize in practice (for instance, the withdrawal of the USA from the Kyoto protocol) and it is probably unrealistic now to expect all the world's nations to come to unanimous agreement on such a complex issue - at least without a great deal of preliminary work being done by different national groupings.

Hopefully the experiences of Copenhagen will spark initiatives of the right kind.

Preparations for the Mexico conference in 2010 must be much more thorough and detailed than those for Copenhagen and need to include serious bilateral and multilateral discussions. That such discussions can be effective is illustrated by the largely political statement called the *accord* that came out of the Copenhagen meeting and that resulted from hastily arranged discussions between the leaders of some of the nations that contribute most to carbon emissions. Of greatest importance are bilateral agreements that the US and China might be able to achieve - between them they account for nearly half the world's emissions. The G20 should also be seriously involved. If during the next year groupings of nations could work together on a time table of joint action to achieve the 2°C target, the Mexico conference later this year might be able to draw all nations into the more complete arrangement that is required².

A STRONG MORAL IMPERATIVE

At the start of the Copenhagen meeting, strong appeals and demands were made by developing nations to developed nations for a recognition that, since emissions from developed nations had largely caused the damage so far, these nations had an obligation to assist developing countries towards their adaptation to climate change and their mitigation actions. Although some progress on this issue was eventually made - though lacking definite agreement as to how much developed countries would eventually provide - developing nations were far from satisfied with these discussions across the rich/poor divide.

There is a strong moral imperative for rich developed countries to recognise (1) that the main source of their wealth has been cheap energy provided by fossil fuels, (2) that substantial damage is occurring because of the resulting climate change, disproportionately to poorer countries, and (3) that they should reduce their own emissions as rapidly as possible and show willingness to provide generous assistance with wealth and skills to enable poorer countries to adapt to climate change and to develop in sustainable ways. Christians who follow Jesus in his great concern for caring for the poor should be in the forefront in pressing this imperative.

PUBLIC ACCEPTANCE OF THE SCIENCE

Possibly the largest problem faced by developed nations like our own concerns the public acceptability of the science of human induced climate change. In the autumn of last year, polls reported that in the UK only about 60% of the general population (less than half in the USA) believe that human induced climate change is the serious problem that scientists make it out to be. Now, at the beginning of 2010, those numbers appear to have been substantially reduced, largely it seems because of recent media attention on doubts that have been raised about the underlying science and its credibility. As a result some feel they might have been steamrolled into believing something that may not be true and that may seriously impact their lifestyle. If governments are going to be comfortable about taking the necessary action, therefore, an urgent need is for better information and education about the evidence for climate change and its likely impacts to be presented to a confused public in a completely honest and open way. In addressing this need, let me first address the reliability of the science.

The most reliable source of scientific information about likely climate change is the Intergovernmental Panel on Climate Change (IPCC) that was founded in 1988 to produce accurate, balanced and honest assessments about human induced climate change³. It has involved many hundreds of scientists from many different countries, cultures and disciplines in producing major reports in 1990, 1995, 2001 and 2007. I was the chair or co-chair of the first three of the basic science reports and can vouch for the diligence, integrity and openness of our work. We had lively, heated debates in which non-scientific influences from political or personal agendas were not allowed. If in doubt we steered away from anything that might seem alarmist. These reports were subject to a very thorough review process (more details in the Box) and their Policymakers' Summaries to sentence by sentence scrutiny at meetings of delegates from the governments of around 100 countries. Because of this careful scrutiny process, the conclusions of the IPCC reports are accepted by nearly all governments and have also been endorsed by the world's major scientific academies⁴.

With the vast increase of climate data and of scientific effort that has taken place over the 20 years since the IPCC was formed, its conclusions in the later reports have become stronger. Let me summarise the most important ones.

Most people accept the fact of global warming. But is it due to human emissions of greenhouse gases such as carbon dioxide, they ask? The IPCC cites two pieces of strong evidence. First, there is no doubt that carbon dioxide has increased in the atmosphere over the last 200 years by about 40%, largely due to the burning of coal, oil and gas. That carbon dioxide absorbs infra red radiation, acting like a blanket over the earth's surface and increasing its average temperature, is a piece of science called the greenhouse effect that has been known for over 200 years. Secondly, computer models of the climate⁵ that take into account all known natural forcings of climate (due to volcanoes, changes in sun etc) and anthropogenic forcings (due to increase of greenhouse gases, e.g. carbon dioxide and methane, and atmospheric particles from various sources) give good agreement between observed and simulated global average temperatures (Figure 1⁶). Agreement cannot be achieved with either natural or anthropogenic forcings on their own. Model simulations of recent and past climates having been tested against observations provides confidence in future projections with different emissions scenarios.

The IPCC's main conclusions about future impacts on human populations relate to the effects of sea level rise on coastal communities, to changes in the frequency and intensity of climate extremes such as heat waves, droughts and floods, and to changes in available water resources. Because the Earth takes time to warm, with the climate change to which we are already committed, these impacts are likely to be substantial and will become increasingly apparent over the next decades. Further, if mitigation action is delayed or if little or no action taken, before the end of the century average sea level rise is likely to be up to about 1 m, the risk of droughts and floods in many places is likely to have increased by a factor of 5 or more from its value in the 1970s or 80s⁷ and acute shortages of water will occur in many places especially in Asia and South America⁸. Since floods and droughts are the most damaging on average of all natural disasters, more of them and increas-

ing severity is very bad news particularly for those living in the most vulnerable areas.

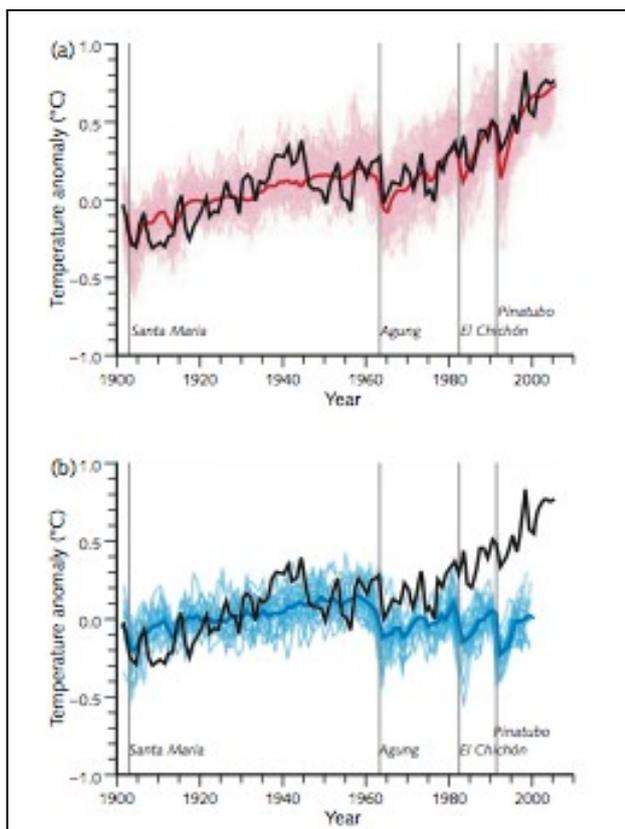


Figure 1. Global mean temperature anomalies relative to 1901-50 as observed (black) and from 58 simulations by 14 models with individual simulations shown by very thin lines. Simulations are shown with both anthropogenic and natural forcings (a) and with natural forcings only (b). The multimodel ensemble means are shown in red (a) and blue (b). Vertical lines indicate the timing of major volcanic events.

Uncertainty in IPCC Reports

Throughout IPCC Reports, statements of levels of uncertainty are frequently made; in the latest report many of these are quantified. For instance, the increased risk of extremes may be described as likely (67% likelihood) or very likely (90% likelihood). Some who look at IPCC reports interpret these references to uncertainty as an indication that the science of climate change is as a whole very uncertain. Such a superficial interpretation is quite false; the IPCC has always sought to distinguish clearly those conclusions that are relatively certain from those where there is large uncertainty. Few if any scientific conclusions concerning the climate can be completely certain but to ignore those that appear likely or very likely would be highly irresponsible.

These likely impacts have been folded into estimates of the cost of global warming in economic terms in the Stern Report by the distinguished economist, Lord Stern from the UK. He concludes, as does the IPCC, that the cost of likely damage much exceeds the cost of mitigating action. That is the case even when the damage is ignored that cannot be expressed in money terms, such as that of displacement, insecurity and misery suffered by hundreds of millions of refugees forced to move from disaster areas - and where would they go in our increasingly crowded world?

WHY HAVE IPCC CONCLUSIONS NOT BEEN ACCEPTED MORE GENERALLY?

A big factor has been the strong voices spreading contrary messages that have been widely publicised in the media and elsewhere. Ever since the International Climate Convention was signed at the Earth Summit in Rio de Janeiro in 1992 by all the world's nations, some of these voices have been orchestrated by vested interests especially in the United States with an intent of discrediting and silencing the IPCC⁹. Let me list four common characteristics of these contrary messages.

(1) The first is to emphasise the complexity and natural variability of climate together with the supposed weaknesses of the scientific methods employed. Most areas of science contain great complexity but advancements in science are constantly demonstrating that science possesses powerful methods to address complex phenomena, find and understand patterns of behaviour and draw valuable or important conclusions.

For instance in Nigel Lawson's book, *An Appeal to Reason*, he writes as follows¹⁰, "Natural disasters such as hurricanes, monsoons, droughts, earthquakes, tsunamis, ... have always occurred, and no doubt always will; to attribute them to global warming is not science but political propaganda".

I leave aside the fact that earthquakes and tsunamis are not connected with global warming and that monsoons are not in themselves natural disasters but an essential feature of the climate of regions of the world especially southern Asia. It is correct to say that it is rarely possible to attribute a single event such as a drought, hurricane or flood (that might be associated with a

THE WORK OF THE IPCC

The Intergovernmental Panel on Climate Change was founded in 1988 by two UN agencies, the World Meteorological Organization and the United Nations Environment Programme. Its mandate is to produce accurate, balanced honest assessments about human induced climate change.

The IPCC has involved hundreds of scientists from many countries and disciplines in delivering 4 comprehensive Reports – in 1990, 1995, 2001 and 2007. Each Report is in three volumes. For the 4th Report in 2007 they were around 1000 pages each, covering respectively the basic science, impacts and mitigation. Their main content is a detailed review of thousands of papers in the scientific literature - all examined for their scientific content; none are dismissed without being carefully considered.

Each Report contains a dozen or more chapters addressing different parts of the subject. Lead authors for the chapters are chosen for their scientific standing and expertise, for their writing and organising ability and for their representation of different continents and countries.

Each chapter of an IPCC Report goes through three reviews before acceptance. The first is by a restricted number of expert scientists. For the second review, a general invitation to take part is sent to the international community of climate scientists and others with an interest (including industrial and ‘green’ NGOs) and the third review is by governments. The chapter authors consider all review comments, keep a record of them and of the actions taken for each comment. For the last two IPCC Reports, during these review processes, the authors for each chapter were assisted by a Review Editor chosen to be independent of the chapter authorship. After these reviews, the chapters are formally accepted by an IPCC plenary meeting attended by delegates from around 100 countries including all the world’s largest and most influential countries.

Included in each IPCC Report is a Summary for Policymakers, typically around 10 pages, the first draft of which is based on the chapters’ summaries and prepared by a small

group that includes a representative author from each chapter. It is then scrutinised sentence by sentence at the IPCC plenary meeting over a period of three or four days. Despite being a meeting of government delegates from a wide variety of political backgrounds (e.g. from oil producing states like Saudi Arabia and Kuwait and also from some states with a strong ‘green’ ethos) it is a strictly scientific not a political meeting. Its purpose is to ensure that the Summary is clearly written, consistent, relevant to policy making and that it accurately represents scientific information without either under or overstatement. It provides an effective but very tough filter. In every case in my experience the meeting concluded with a Summary having greater clarity and accuracy than the version with which it began.

IPCC Assessments, because of their thorough process of preparation have been described as the most well researched and reviewed assessments carried out by the world scientific community. Because so many scientists and also governments are involved, the Reports possess a high degree of ownership by top scientific bodies and by governments.

In 1996 I invited Professor Richard Lindzen to be a lead author of one of the chapters for the 2001 IPCC report; I was keen that someone who had been so openly critical of the IPCC process and conclusions should see our work at first hand. Lindzen has never denied that global warming due to human influences is occurring but he has argued that the effects are much smaller in size and in importance than the IPCC has been predicting. He signed up to the chapter of which he is a lead author - although its conclusions disagree with many statements he commonly makes.

A widely quoted statement of Lindzen’s about IPCC Reports is that the chapters are fine but the Policymakers’ Summaries contain different messages and do not faithfully represent the content or conclusions of the chapters. Despite his constant repetition of this comment, he has never to my knowledge presented a single concrete example to support it. In any case discrepancies between the chapters and the Summary would never survive the scrutiny of the final intergovernmental IPCC plenary.

monsoon) to global warming. But the scientific evidence regarding the influence of climate change on extreme events, presented carefully, responsibly and with increasing confidence in the succession of IPCC Reports (more than 20 pages in the 2007 Report) leads to the likelihood of noticeable even dramatic increases in the incidence or severity of such events. To present such evidence as political propaganda means that Lawson has either not read the IPCC Reports or deliberately chosen to ignore the evidence. It also means that if Lawson's 'appeal to reason' is followed, hundreds of millions are likely to be condemned to a future dominated by disasters on a scale not experienced in the world's recent history.

(2) The second is to select from the very large amount of data available on recent or past climates, material that seems to contradict or weaken the fact of global warming. Since regional data possesses a great deal more variability than global averages it is not hard to find a few glaciers that are growing, not receding (e.g. in New Zealand) and places that where the rise in temperature is small or even negative (e.g. the continental United States over much of the 20th century). Nor is it difficult to select data over limited periods that appear not to agree with the much longer picture. The information relevant to climate change comes from the analysis of trends over decadal time scales and on continental and global space scales. What the IPCC has therefore been at great pains to do is to look at the available data for the whole global system in a balanced way and through rigorous analysis identify, without any preconceived agendas, the significant trends and their likely causes.

An illustration of this problem comes from the current attention given to the global average temperature over the past decade that shows no significant increase and which has been suggested as providing evidence against human induced climate warming. However, inspection of the level of year to year variability in the temperature record indicates that a decade is too short a period to establish a long term trend. Further, it is known that a significant amount of the shorter-term variability is associated with variations in the El Nino Southern Oscillation. In fact it is the Pacific sector that has been cooler during the past decade consistent with the La Nina phase of the phenomenon that has per-

sisted since the last El Nino event in 1998 until a new El Nino began in 2009.

(3) The third is to cast doubt on the integrity of the IPCC and to accuse it of being biased towards overstatement of the likely impacts of anthropogenic climate change¹¹. Scientists are often accused of being alarmist and of exaggerating impacts for the sake of effect. That has never been the case with the IPCC whose reports have always been on the conservative side – a point that has been frequently made by those who have read them. The IPCC review and scrutiny process tends to encourage understatement and works to eliminate exaggeration.

I personally have been called alarmist and am frequently quoted as saying 'Unless we announce disasters, no one will listen'. That is a false, mischievous and completely misleading quotation¹². I have often argued the opposite in saying 'There are those who say, 'Unless we announce disasters, no one will listen' but I believe that is not only wrong but very counter productive.' How easily false information can be conveyed! Winston Churchill was called an alarmist in the 1930s but events proved how right he was. When disastrous situations are looming, acting according to what is likely to be true is the only sensible way to proceed.

(4) The fourth characteristic is to exaggerate the cost of mitigation and the burden on rich countries and minimise the cost of damage, often by ignoring, as Nigel Lawson has done, the likely damage due to increases in extreme climate events such as droughts and floods. The evidence provided by the IPCC, the Stern Report and the International Energy Agency (IEA) – see box - is that the cost of the likely damage will be much greater than the cost of mitigating action.

There is a very large body of evidence within the volumes of the IPCC Reports. From this evidence conclusions have been drawn that are summarised in the Policymakers Summaries. However, none of the conclusions are absolutely certain, the IPCC has associated with them varying degrees of certainty and it is important that they be subject to fair and proper debate. Scientists who have been close to the IPCC process are often accused of wanting to impose the IPCC conclusions and of being unwilling to debate them. Scientists in general do not seek pub-

Evidence from the International Energy Agency

The most thorough study of the affordability of mitigation has been provided by the International Energy Agency IEA (the world's top energy body that belongs to the governments of the OECD countries). Following the G8 summit at Gleneagles UK in 2005 the IEA was asked to study how the provision and use of energy in the world could be changed in order to dramatically reduce carbon dioxide emissions so as to stabilise the climate as required by the UN's Framework Convention on Climate Change (FCCC) agreed by all nations at Rio de Janeiro in 1992. In its study published in June 2008¹³ with a goal of a maximum global average temperature increase of 2°C from preindustrial, the IEA demonstrated how such an energy transformation could be achieved. It estimated the increased investment required at around 1% of world GDP per year between now and 2050, similar to estimates made by the IPCC. It also pointed the savings that would be made in fossil fuel use (also around 1% of world GDP per year) and other co-benefits of such action for instance in terms of energy security. They stress both the programme's affordability and its achievability - but also emphasise the imperative for urgent, determined, concerted action by governments, business and industry if the necessary revolution in energy production and use is to be realised.

licity, are not keen to engage in lobbying and are not particularly good at explaining their work in ways that are well understood by ordinary people especially those with little knowledge of science. But IPCC scientists are very willing to see their conclusions debated providing the debate can take place on the basis of available evidence. They are bound to appear unimpressed by those who criticise or even lampoon IPCC's work on the basis of false information or who clearly have never taken the trouble to find out about the IPCC and the evidence it has presented.

CONCLUDING REMARKS

I have presented some reflections on the outcome of the Copenhagen Conference and

have expressed the danger that with reduced momentum in the negotiation process and the absence of any agreed timetable for getting back on track, the fierce urgency of the need for action now could be lost.

A window of opportunity exists during this year of 2010 for action to be taken to secure a future that avoids very serious future climate changes that are most likely irreversible. It is encouraging that industries and investors in many countries are keen to grow carbon-free energy projects. But urgent action by governments (acting singly, bilaterally or multilaterally) is needed to create an effective, imaginative long term policy framework that will provide confidence to business and industry to move forward, in partnership with governments as necessary, with a rapid and effective investment programme to reduce global greenhouse gas emissions. To achieve the goal of 2°C maximum global temperature increase, future global emissions must peak well before 2020, then fall as rapidly as possible to below 50% of 1990 levels before 2050 and to close to zero well before the end of the century (Figure 2¹⁴).

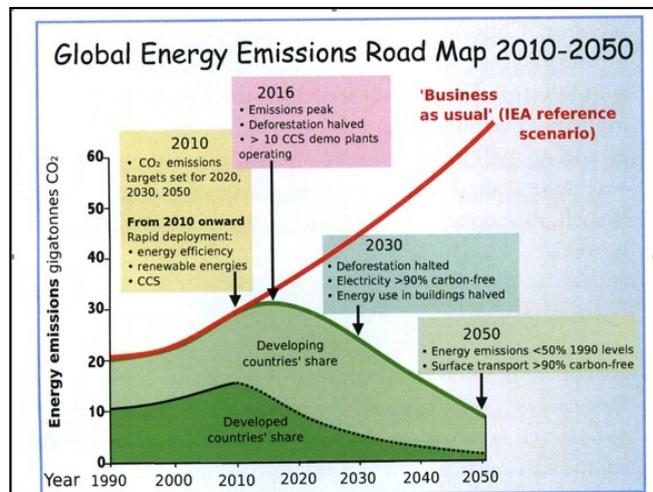


Figure 2. Waymarks for global energy emissions road map to 2050 showing International Energy Agency (IEA) Reference scenario (red) and profile (green) aimed at target of <2°C temperature rise from pre-industrial. The division between developed and developing countries from today until 2050 is based on the developed countries' share, compared with that of developing countries, peaking earlier and reducing further.

A further essential aim must be for a successful outcome to COP16 in Mexico in December 2010.

I have pointed out the very strong moral imperative that applies to the developed world to share their wealth and skills with the developing world as they adapt to damaging climate change and seek to develop sustainably. I have also argued that, for the strong necessary action by governments, business and industry to be possible, it is important for the basic facts of the science and consequences of climate change to be better understood and accepted by the population at large. Urgent consideration needs to be given to the practical measures required for this to be achieved. It presents an enormous challenge to all of us and to many organisations. I believe that grasping the challenge is particularly urgent for Christians and other faith communities whose combined action could make a large difference.

Endnotes

1. At 3 or 4°C increase the adverse impacts are very much greater – see Mark Lynas, *Six Degrees*, Harper Collins 2007, a paperback that won the Royal Society award for the best popular science book of 2008.
2. Anthony Giddens has argued for more bi- and multilateral negotiations in addition to the UN - see <http://www.policy-network.net/publications/publications.aspx?id=3510>
3. For further information about IPCC and for full text of IPCC Reports see <http://www.ipcc.ch>
4. See Royal Society (<http://www.royalsociety.org>) for recent statements on climate change from the Royal Society itself and also international Inter-academy statements.
5. Many people are ignorant about the nature of computer climate models. They are not empirical or statistical models attempting to extrapolate past climates. For the atmosphere they are based on integrations through time using the known dynamical and physical equations together with algorithms describing motions and phenomena on all scales that have been tested individually and collectively in a wide range of contexts. The models available for the first IPCC Report in 1990 were crude by comparison with models today that possess great sophistication and capability. Models provide a powerful means, in fact the only means, of adding together all the non-linear processes involved in the operation of all components of the climate system. Models are tested as thoroughly as possible by comparison with observations of current climate, the climate of the 20th century, periods that include major volcanic eruptions and with past climates, including periods when changes in the Earth's orbit had altered the distribution of solar radiation at the Earth's surface. Some of the parameters within models, for instance those concerned with clouds and aerosols, aspects of ocean circulation and ice dynamics, contain large uncertainties. Models provide

a powerful tool to explore the sensitivity of climate to ranges of values of these and other parameters so providing quantitative information about the uncertainties. More details of climate models in Houghton, *Global Warming: the Complete Briefing*, CUP 4th ed 2009.

6. Figure 5.22 from Houghton, *Global Warming: the Complete Briefing*, CUP 4th ed 2009.

7. For increase in risk of floods see T.N. Palmer & J. Rainsanen, 2002, *Nature*, **415**, 512-14; and for droughts, E.J. Burke *et al.*, 2006, *J. Hydromet.*, **7**, 1113-25.

8. Increased melting of glaciers in the Himalayas and the Andes will likely lead to reduced summer feed water for major rivers in these continents

9. Chapter 2 on 'The Denial Industry' in George Monbiot's book *Heat* provides substantial detail and references regarding this.

10. Nigel Lawson, *Appeal to Reason* page 37

11. In 2009, wide publicity was given to the hacking of emails that had passed between scientists originating at the University of East Anglia (UEA) in the UK that were purported to cast doubt on the scientists' integrity. The UEA has set up a formal enquiry that will report in the Spring of 2010. The Pew Centre in the USA has published an appraisal of the published emails and concluded that, when placed in their proper context, the suspect emails do not appear to reveal fraud or other scientific misconduct. (<http://www.pewclimate.org/docUploads/east-anglia-cracked-emails-12-09-09.pdf>)

So far as IPCC conclusions are concerned, they are not affected in any way as similar analyses to those at UEA have been carried out by other institutions (e.g. both by NASA and by NOAA in the United States) and very similar results obtained.

12. Reports of this quote have recently rapidly multiplied on the Internet to over a million sites - see page 7 of *The Independent Newspaper* for 10 February 2010 (<http://www.independent.co.uk/environment/climate-change/fabricated-quote-used-to-discredit-climate-scientist-1894552.html>)

13. *Energy Technology Perspectives*, IEA, Paris, June 2008, chapter 6

14. Scientific arguments regarding the 2°C target are presented in Houghton, *Global Warming: the Complete Briefing*, CUP 4th ed 2009.

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