

IMAGINING THE REAL LIFE ON A GREENHOUSE EARTH

In honour of Barry Jones
11–12 June 2008
Canberra
Australian Capital Territory

PROGRAM AND ABSTRACTS



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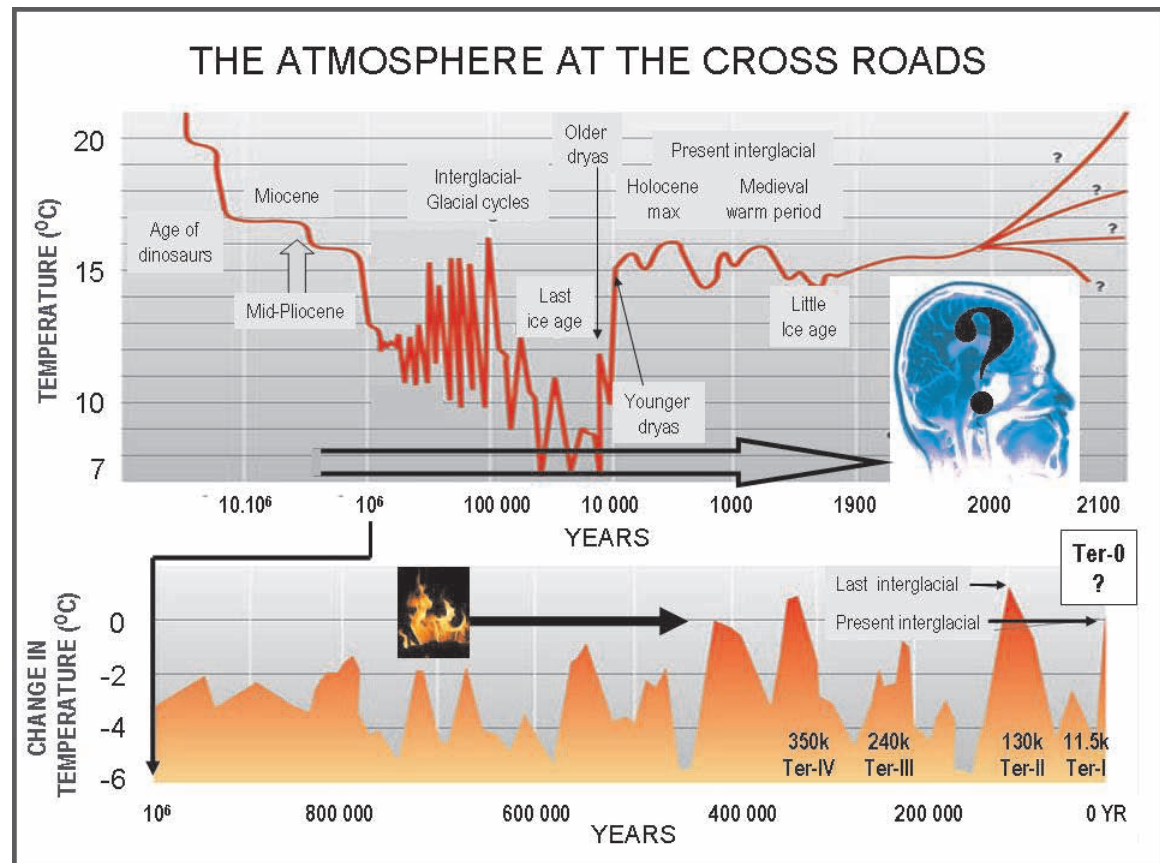
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"The inhabitants of Earth are quietly conducting a gigantic experiment. So vast and sweeping will be the consequences that, were it brought before any responsible council for approval, it would be firmly rejected. Yet it goes on with little interference from any jurisdiction or nation... We play Russian roulette with climate, hoping that the future will hold no unpleasant surprises. No one knows what lies in the active chamber of the gun, but I am less optimistic about its contents than many." ... "The Paleoclimate record shouts to us that, far from being self-stabilising, the climate system is an ornery beast which overreacts even to small nudges." Wallace S. Broecker (1987 and 1995)

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Letter from Professor James Hansen, chief climate scientist, Goddard Institute of Space Science, NASA, to Kevin Rudd, Prime Minister of Australia

27 March 2008

*The Hon Kevin Rudd, MP
Prime Minister of Australia
Australian Parliament
Canberra, Australian Capital Territory, 2600*

Dear Prime Minister,

Your leadership is needed on a matter concerning coal-fired power plants and carbon dioxide emission rates in your country, a matter with ramifications for life on our planet, including all species. Prospects for today's children, and especially the world's poor, hinge upon our success in stabilising climate.

For the sake of identification, I am a United States citizen, director of the NASA Goddard Institute for Space Studies and Adjunct Professor at the Columbia University Earth Institute. I am a member of our National Academy of Sciences, have testified before our Senate and House of Representatives on many occasions, have advised our Vice President and Cabinet members on climate change and its relation to energy requirements, and have received numerous awards including the World Wildlife Fund's Duke of Edinburgh Conservation Medal from Prince Philip.

I write, however, as a private citizen, a resident of Kintnersville, Pennsylvania, USA. I was assisted in composing this letter by colleagues, including Australians, Americans, and Europeans, who commented upon a draft letter. Because of the urgency of the matter, I have not collected signatures, but your advisors will verify the authenticity of the science discussion.

I recognise that for years you have been a strong supporter of aggressive forward-looking actions to mitigate dangerous climate change. Also, since your election as Prime Minister of Australia, your government has been active in pressing the international community to take appropriate actions. We are now at a point that bold leadership is needed, leadership that could change the course of human history.

I have read and commend the Interim Report of Professor Ross Garnaut, submitted to your government. The conclusion that net carbon emissions must be cut to a fraction of current emissions must be stunning and sobering to policy-makers. Yet the science is unambiguous: if we burn most of the fossil fuels, releasing the CO₂ to the air, we will assuredly destroy much of the fabric of life on the planet. Achievement of required near-zero net emissions by mid-century implies a track with substantial cuts of emissions by 2020. Aggressive near-term fostering of energy efficiency and climate friendly technologies is an imperative for mitigation of the looming climate crisis and optimisation of the economic pathway to the eventual clean-energy world.

Global climate is near critical tipping points that could lead to loss of all summer sea ice in the Arctic with detrimental effects on wildlife, initiation of ice sheet disintegration in West Antarctica and Greenland with progressive, unstoppable global sea level rise, shifting of climatic zones with extermination of many

animal and plant species, reduction of freshwater supplies for hundreds of millions of people, and a more intense hydrologic cycle with stronger droughts and forest fires, but also heavier rains and floods, and stronger storms driven by latent heat, including tropical storms, tornados and thunderstorms.

Feasible actions now could still point the world onto a course that minimizes climate change. Coal clearly emerges as central to the climate problem from the facts summarised in the attached Fossil Fuel Facts. Coal caused fully half of the fossil fuel increase of carbon dioxide (CO₂) in the air today, and in the long run coal has the potential to be an even greater source of CO₂. Due to the dominant role of coal, solution to global warming must include phase-out of coal except for uses where the CO₂ is captured and sequestered. Failing that, we cannot avoid large climate change, because a substantial fraction of the emitted CO₂ will stay in the air more than 1000 years.

Yet there are plans for continuing mining of coal, export of coal, and construction of new coal-fired power plants around the world, including in Australia, plants that would have a lifetime of half a century or more. Your leadership in halting these plans could seed a transition that is needed to solve the global warming problem.

Choices among alternative energy sources - renewable energies, energy efficiency, nuclear power, fossil fuels with carbon capture - these are local matters. But a decision to phase out coal use unless the CO₂ is captured is a global imperative, if we are to preserve the wonders of nature, our coastlines, and our social and economic well being.

Although coal is the dominant issue, there are many important subsidiary ramifications, including the need for rapid transition from oil-fired energy utilities, industrial facilities and transport systems, to clean (solar, hydrogen, gas, wind, geothermal, hot rocks, tide) energy sources, as well as removal of barriers to increased energy efficiency.

If the West makes a firm commitment to this course, discussion with developing countries can be prompt. Given the potential of technology assistance, realisation of adverse impacts of climate change, and leverage and increasing interdependence from global trade, success in cooperation of developed and developing worlds is feasible.

The western world has contributed most to fossil fuel CO₂ in the air today, on a per capita basis. This is not an attempt to cast blame. It only recognises the reality of the early industrial development in these countries, and points to a responsibility to lead in finding a solution to global warming.

A firm choice to halt building of coal-fired power plants that do not capture CO₂ would be a major step toward a solution of the global warming problem. Australia has a strong interest in solving the climate problem. Citizens in the United States are stepping up to block one coal plant after another, and major changes can be anticipated after the upcoming national election.

If Australia halted construction of coal-fired power plants that do not capture and sequester the CO₂, it could be a tipping point for the world. There is still time to find that tipping point, but just barely. I hope that you will give these considerations your attention in setting your national policies. You have the potential to influence the future of the planet.

Prime Minister Rudd, we cannot avert our eyes from the basic fossil fuel facts, or the consequences for life on our planet of ignoring these fossil fuel facts. If we continue to build coal-fired power plants without carbon capture, we will lock in future climate disasters associated with passing climate tipping points. We must solve the coal problem now.

For your information, I plan to send a similar letter to the Australian States' Premiers.

I commend to you the following Australian climate, paleoclimate and Earth scientists to provide further elaboration of the science reported in my attached paper (Hansen et al., 2008):

*Professor Barry Brook, Professor of climate change, University of Adelaide
Dr Andrew Glikson, Australian National University
Professor Janette Lindesay, Australian National University
Dr Graeme Pearman, Monash University
Dr Barrie Pittock, CSIRO
Dr Michael Raupach, CSIRO
Professor Will Steffen, Australian National University*

Sincerely,

*James E. Hansen
Kintnersville, Pennsylvania
United States of America*

PROGRAM

Wednesday 11 June, 2008

Chair: *Dr Michael Raupach*

9.00 Introduction and official opening

9.20 Can humanism survive in the 21st century? *Dr Barry Jones*

10.00 Current and looming climate tipping points. *Prof Janette Lindesay*

10.30 Break for morning tea

SESSION A Climate change

Chair: *Dr Elizabeth Truswell*

11.00 Recent changes in the climate system: portents for the future.

Dr Barrie Pittock

11.30 Projections for the Earth's climate system in the 21st century.

Dr Michael Raupach and Prof Will Steffen

12.00 Scenarios on a 2 to 6 degrees Celsius warmer Earth. *Prof Barry Brook*

12.30 Nuclear scenarios on a warming earth. *Dr Sue Wareham*

13.00 Break for lunch

SESSION B The origins of climate change

Chair: *Professor Graeme Pearman*

14.00 The atmosphere and mass extinctions through time.

Dr Andrew Glikson

14.30 Glacial – interglacial cycles and the nature of the Holocene.

Dr Bradley Opdyke

15.00 Prehistoric origins of environmental degradation. *Dr Simon Haberle*

15.30 Current state and future of the oceans and marine life in a high CO₂ world.

Prof Malcolm McCulloch

16.00 Break for afternoon tea

16.20 The greenhouse crisis: a summing up and a message to the Australian people.

Senator Lyn Allison

16.45 Panel discussion. Chair: *Senator Lyn Allison*

18.00 Evening break

19.00 Conference dinner at University House, Balmain Crescent & Liversidge St. Acton

Conference dinner speakers: *Dr Carmen Lawrence, Professor Graeme Pearman*

Thursday 12 June, 2008

SESSION C Orwellian scenarios on a warming planet

Chair: *Dr Barrie Pittock*

9.00 The politics of fear on a warming planet. *Dr Carmen Lawrence*

9.25 The biological and human consequences of climate change.
Prof Tony McMichael

9.50 Social and economic scenarios on a greenhouse Earth.
Dr David Denham

10.15 Human and political scenarios on a warming planet. *Tony Kevin*

10.40 Break for morning tea

Chair: *Professor Barry Brook*

11.00 The trial of crimes against the Earth. *Andrew MacIntosh*

11.25 Spin, obfuscation and climate change. *Phillip Toyne*

11.50 The phenomenon of denial with reference to climate change.
Prof Ian Enting

12.15 *Homo sapiens'* war against nature. *Dierk von Behrens*

12.40 Break for lunch

SESSION D The origins of hope

Chair: *Professor Tony McMichael*

14.00 A biorenaissance: the hope for the future. *Prof Stephen Boyden*

14.25 The philosophy of hope. *Dr Bryan Furnass*

14.50 Hope in the face of dire threat. *Dr Geoff Davies*

15.10 Premonitions of the future from art, poetry and music. *Mark O'Connor*

15.30 *Homo Prometheus'* hour of truth: the absurd, existentialism and hope.
Dr Andrew Glikson

15.50 The quest for divine salvation. *Dr Paul Collins*

16.10 Renewable energy technologies: offering hope and opportunity in the face of climate challenges. *Dr Keith Lovegrove*

16.30 Break for afternoon tea

16.50 Plenary Session: Is there a way out?

Opened and chaired by *Professor Will Steffen*

18.00 Concluding remarks by *Dr Barry Jones*

18.20 End of conference

INTRODUCTION

The evolution of Earth over billions of years has been punctuated by short, abrupt events, including comet and asteroid impacts, volcanic eruptions, solar peaks, supernovae, eruptions of methane, oceanic anoxia and glacial eras, some of which have been closely linked with sharp changes in the composition of the atmosphere and the oceans, triggering mass extinctions of species. The present human-induced climate change is occurring on a scale commensurate with the largest natural calamities, with rates of temperature rise that exceed the fastest glacial terminations by an order of magnitude to which plants and animals can hardly adapt. Since the early 1980s climate scientists, some of whom are present in this conference, have been warning that the near-two orders of magnitude increase in the rate of human-emitted CO₂ relative to past glacial terminations is resulting in dangerous climate change, only to be ignored. However, a denial industry using Orwellian “*Newspeak*” (Appendix B), in part funded by vested interests, combined with fundamentalist prophets of the “second coming”, have effectively delayed climate mitigation by more than 20 years.

Nature is not waiting for human decisions:

The atmosphere, racing along exponential trajectories, has crossed tipping points since the mid-1980s, as represented by accelerated temperature rise, migration of climate zones toward the poles, increasing storm intensities, melting ice sheets, rising sea level and ocean acidification, which are exceeding the estimates of the Intergovernmental Panel on Climate Change (IPCC). Spring melting of the Arctic Sea increased by 23 percent during 2006-07, reaching rates an order of magnitude higher than preceding decades. IPCC projections of 2 to 4°C mean global temperature rise during the 21st century underestimate the magnitude of ensuing sea level rise. The atmosphere and oceans are approaching conditions similar to 124 thousand years ago in the Eemian interglacial and even conditions of 3 million years ago in the mid-Pliocene, when sea levels rose by 25+/-12 meters. Based on present trends, the human population is expected to grow from 6.2 to 8 billion by 2050. However, as indicated by James Lovelock (29 October, 2007) (Appendix A), climate change is likely to lead to the loss of billions of human lives and the possible destruction of civilisation that originally developed thanks to stabilisation of climate conditions about 10, 000 years ago, when agriculture became possible.

This conference will explore the root causes of global warming, current developments and alternatives, and human, social and economic scenarios on a warming Earth. It will raise questions: Where can we look for hope? Will the trillions of dollars allocated for armaments and wars in the name of so-called “defence” be diverted to efforts to defend humanity and civilisation in time to protect other species, to preserve the air we breathe and the life of future generations?

We thank Frank Fenner, Barry Brook and Stephen Boyden for their comments.

Andrew Glikson and Bryan Furnass

Good planets are hard to come by

ABSTRACTS AND BIOGRAPHIC NOTES

(in sequence of presentation)

Can humanism survive in the 21st century?

Barry Jones AO, FAA, FAHA, FTSE, FASSA

Professorial Fellow, University of Melbourne. bojones@unimelb.edu.au

The impact of climate change poses unprecedented challenges not only to the environment but also to democratic practice and the pluralist values associated with western humanism. Political and psychological factors are paralysing the will to act to slow down the process of global warming, leading to denial, prevarication, crude appeals by vested interest, and a growing, but unspoken realisation that the climate system may have passed a “tipping point” and moved into an irreversible crisis.

The report to the European Union by Javier Solano and Benita Ferrero-Waldner identifies seven threats to Europe (and each will have a comparable impact on Australia): mass migration by climate refugees; political destabilisation of regions most affected by climate change; radicalisation of politics and populations; intensified north-south conflict because of the perceived injustice of the causes and effects of global warming; famines and escalation in food prices; wars over natural resources, especially reduction of arable land; and reduction of up to 30 percent in potable water.

In addition to resource competition over water, oil, wilderness and forests, there will be deep divisions between the pursuit of short term individual resource security, and an approach based on cooperation for the longer term. The complexity of tackling climate change, the lack of appropriate global instruments, apart from the failure of political will, may encourage the rise of over-simple solutions, including fundamentalism, tribalism, communal violence and a revolt against reason.

Existing ethnic and/or religious conflicts are likely to be exacerbated in the Middle East, the Balkans, Africa, and the Indian sub-continent, posing threats to democracy even greater than those that arose in the 20th century.

Australia is capable of taking a strong moral lead, and must work closely with the European Union and the United Nations to achieve it. The intellectual strength of this conference demonstrates that we can take this lead – but time is already running out and governments must be seized with a sense of urgency.

I have been talking about global warming since December 1984. Midnight is fast approaching. As Talleyrand said: “Not to choose is to choose”.

Biographic note: Barry Jones was educated at Melbourne High School and Melbourne University, where he studied arts and law. He became a school teacher at Dandenong High School. He holds honorary degrees of Doctor of Letters from the University of Technology, Sydney, and University of Wollongong, Doctor of Science from Macquarie University, and Doctor of Law from the University of Melbourne. He is a fellow of the Australian Academy of

Science, fellow of the Australian Academy of Humanities, fellow of the Academy of Social Sciences of Australia, and fellow of the Australian Academy of Technological Sciences and Engineering. He chairs the Port Arthur Historic Site Management Authority and boards of six medical research institutes and the Victorian Schools Innovation Commission. He joined the Australian Labor Party in 1950, and was a Federal candidate in 1955, 1958 and 1963, with a strong interest in education and civil liberties. He campaigned against the death penalty throughout the 1960s. Between 1972 and 1977 he was a Labor member of the Legislative Assembly. In 1977 he was elected to the House of Representatives as the member for Lalor, Victoria, a position he held until he retired in 1998. He was Minister for Science between 1983 and 1990, presiding over the growth of the CSIRO, the creation of the Australia Prize, Questacon and the Commission for the Future. He was National President of the ALP between 1992 – 2000 and 2005-06. He was the chief architect of the ALP knowledge nation education concept, a member of the council for the National Library of Australia, vice president of the World Heritage Committee (1995-1996), a member of the Executive Board of UNESCO (1991-95), and Deputy Chair of the fourth Constitutional Convention. He is the author of political and sociological books including: *Decades of Decision 1860 - 1965*; *The Penalty of Death*, 1968; *Barry Jones Guide to Modern History: Age of Apocalypse*, 1975; *Macmillan Dictionary of Biography*, 1981; *Sleepers, Wake! Technology and the Future of Work*, 1982; *Barry Jones Dictionary of World Biography*, 1994; *A Thinking Reed* (autobiography), 2006.

Current and looming climate tipping points

Janette Lindesay. Fenner School of Environment and Society, Australian National University. janette.lindesay@anu.edu.au

The concept of tipping points or thresholds in the Earth system, and particularly in the climate system, has been recognised for decades, but is now a key element in the central debate about the rapidity of current climate change, the scope and severity of climate change impacts, and the need for societal action to address these issues. Use of the term “tipping points” in relation to climate change by prominent Earth system scientists including John Schellnhuber (director of the Potsdam Institute for Climate Impact Research) and James Hansen (director of NASA Goddard Institute of Space Studies) has given the idea a degree of public recognition that reflects the increasing scientific focus of the last decade. In particular, current international policy discussion about the required extent of greenhouse gas emissions reduction and the timescale within which this is needed to avoid “dangerous” climate change is being informed by scientific concerns about the possible imminence of some tipping points.

A tipping point is the point at which a non-linear system (of which Earth’s climate is an example) moves rapidly from one state to another, generally after a period during which the system has shown relatively small responses to perturbations, or forcings. The climate system, like many components of the Earth system, is resilient to a certain amount of forcing, but cannot absorb continued forcing indefinitely. Earth’s climate is also characterised by being almost-intransitive; that is, more than one state of the system is possible at any time, and when the system is near a potential transition it can change rapidly from one state to another. Once a tipping point or threshold in such a system has been reached, positive feedbacks can occur that amplify the original change.

The issues of concern in relation to climate change are thus the likelihood that the non-linear climate system, and other components of the Earth system affected by climate change, will reach one or more tipping points during the 21st century, or even before 2050; that change at

these tipping points could be too rapid to allow human and natural systems to adapt readily, or at all; and that positive feedbacks may result in irreversible change (at least on the timescales at which human society operates).

An example of a climate tipping point is the melting of Arctic ice in summer. Rising air and sea temperatures due to global warming result in a reduction in seasonal sea ice formation. The reduced ice cover reduces the reflectivity of the surface, which then absorbs more solar radiation, leading to further warming and melting in a positive feedback loop. There is a threshold, or tipping point, beyond which the formation of summer Arctic sea ice would cease. It is not known exactly where this point is or how sensitive the threshold is, but the most recent indications are that the process is accelerating rapidly. Ecosystems provide many more examples of climate change-related tipping points, and the complex interactions among the influences on ecosystem health mean that potential thresholds are difficult to predict. Other potential climate change tipping points, discussed in a paper by Lenton et al. (2008), include the Greenland ice sheet, the West Antarctic ice sheet, the North Atlantic thermohaline circulation, the El Niño Southern Oscillation, the Indian summer monsoon, the West African monsoon, the Amazon rainforest, boreal forests and coral bleaching.

The question of irreversibility once a part of the system has passed a tipping point is an important one. Atmospheric carbon dioxide concentrations are unlikely to return to pre-industrial levels for at least several centuries, regardless of any mitigation strategies that might be implemented. From this perspective some degree of climate change is already irreversible; this is now referred to as the “committed warming”. The natural timescales of system variability provide indications of whether a return to the prior state is possible. For example, Arctic sea ice varies on decadal timescales; in the absence of continued global warming summer sea ice could possibly recover within decades. Other components of the system have longer timescales; melting of the Greenland and West Antarctic ice sheets and associated sea level rise would be effectively irreversible on human timescales. A global temperature increase of more than 2°C, now considered likely within this century and possible by 2050, brings this tipping point closer.

Human responses to climate change, from international negotiations and national policy formulation to personal actions to reduce emissions, are influenced by the assessment of risk and vulnerability. Understanding the tipping points in the system, and the possible impacts of crossing those thresholds, is fundamentally important in making informed judgments about our vulnerability to climate change and the risks to human and natural ecosystems of potential abrupt changes in key components of the Earth system.

Reference: Lenton, TM; Held, H; Kriegler, E; Hall, JW; Lucht, W; Rahmstorf, S; and Schellnhuber, HJ (2008). Tipping elements in the Earth's climate system, *Proceedings of the National Academy of Sciences*, 105, 1786-1793.

Biographic note: Janette Lindesay obtained her Honours degree in Geography, Postgraduate Teaching Diploma and Doctorate in statistical and dynamical climatology from the University of the Witwatersrand in Johannesburg. She came to ANU in 1993, where she continues to work in atmospheric science and climatology, and was Education Manager in the CRC for Greenhouse Accounting. Her principal research interests are in climatic variability during the period of instrumental record, and investigating climate change impacts and vulnerability. Current research focuses on low-frequency fluctuations in Australian rainfall in the context of the El Niño Southern Oscillation and other large-scale climate system influences, including the potential for deterministic and dynamical seasonal forecasting. Her climate vulnerability research focuses on the climatological aspects of bushfires in Australia, and temperature and

rainfall trends and extremes. She chairs the Atmosphere Reference Group for the ACT Region State of the Environment Report, and has been President of the Canberra branch of the Australian Meteorological and Oceanographic Society. She is a member of three professional meteorological societies and serves on the editorial boards of two international journals. She worked at the Hadley Centre for Climate Change at the UK Met Office on an integrated statistical and dynamical forecasting method for European winter climate, was co-convenor of the ANU Climate Vulnerability and Adaptation Initiative, and is the 2007 winner of a Dean of the College of Science Award for Excellence in Teaching.

SESSION A: CLIMATE CHANGE

Recent changes in the climate system: portents for the future

Barrie Pittock. Honorary Fellow, CSIRO. barrie.pittock@csiro.au

Observational records indicate that since the 1850s the Earth has warmed by some 0.7°C, that since the 1870s global average sea level has risen by some 15 cm, and since the 1920s northern hemisphere snow cover has decreased, especially since the 1980s. These changes have now been well explained, largely by an enhanced greenhouse effect, with some regional cooling in the northern hemisphere for a few decades after World War II being due to a rapid increase in airborne particulate pollution from the burning of sulphur-rich fuels. The latter has now decreased, revealing more rapid global warming. Despite numerous and oft-repeated arguments from the so-called climate “skeptics” (mostly denialists, as they are highly selective and one-sided in their skepticism), the Intergovernmental Panel on Climate Change (IPCC) in its latest review of the evidence, states categorically that “Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.”

Recent evidence points to a number of indications that climate change and sea level rise are accelerating. This paper will review that evidence and examine the implications, including what it says about the IPCC process. The upshot is that climate change and sea level rise are happening faster than expected, partly due to a more rapid increase in greenhouse gas emissions than was projected by IPCC, but also due to a number of glaciological and climate feedback processes that are at present not adequately represented in climate and sea-level rise models. Serious implications follow, for the urgency of reducing global greenhouse gas emissions, and also for the need for rapid adaptation to climatic dangers including coastal impacts, food and water shortages, loss of species and other concerns. These threats suggest that a climate and environmental crisis is rapidly taking shape that will require an emergency response. Such a response is possible, and far less costly than the present huge expenditure on military security. Given the will, we can rise to the challenge.

Biographical note: Barrie Pittock did a PhD in physics at Melbourne University in 1963. He did a post-doc at the National Centre for Atmospheric Research in the US, investigating stratospheric ozone (and American Indian affairs). He joined CSIRO in 1965 and worked on stratospheric ozone, solar-weather relationships, surface climate change, the climatic effects of nuclear war, and the greenhouse effect (and Aboriginal rights in his spare time). Barrie organised an international conference on “Climatic Change and Variability” in 1975, and edited the resulting book. In 1986 he was lead author of an international report on the environmental consequences of nuclear war. In the 1990s he led the Climate Impact Group in CSIRO, until his retirement in 1999. He contributed to or was a lead author of the 1990, 1995, 2001 and 2007 reports of the Intergovernmental Panel on Climate Change and contributed to many other reports and papers. Since retiring from CSIRO, he has written *Climate Change: An Australian Guide to the Science and Potential Impacts*, for the Australian Greenhouse Office, and *Climate Change: Turning Up the Heat*, for CSIRO Publishing and Earthscan. Currently he is a CSIRO Honorary Fellow and has an updated book, *Climate Change: Challenge and Opportunity* in press.

Projections for the Earth's climate system in the 21st century

Michael Raupach and Will Steffen

Michael Raupach. CSIRO Division of Marine and Atmospheric Research.

michael.raupach@csiro.au

Will Steffen. Director, Fenner School for the Environment and Society, Australian National University. will.steffen@anu.edu.au

By Michael Raupach: Climate change through the 21st century will depend on future pathways of radiative forcing from greenhouse gases (carbon dioxide, methane and others) and from non-gaseous agents such as aerosols. Using a now-standard set of assumptions about how these radiative forcings will evolve, the IPCC Fourth Assessment has made a set of projections for physical climate change that include significant warming, changes in rainfall patterns (with likely increases in drought in mid-latitude regions such as southern Australia), ice losses, and sea-level rises. The projected physical changes will lead to a wide range of ecological and social impacts. It is possible to evaluate these projections in two broad ways: first, projections can be compared with present trends. This shows that most major climate indicators are changing at rates comparable to projections, and in some cases near or beyond the more severe end of the uncertainty range. Second, uncertainty in future climate predictions needs to be evaluated. Critical sources of uncertainty arise from climate feedbacks and from future pathways of emissions. Although both sources are very hard (perhaps impossible) to reduce, enough is known to state with confidence that the threat from global climate change is somewhere between severe and extreme. In coping with climate change, globally and locally and through both mitigation and adaptation, we have to live with this uncertainty and must not allow ourselves to be crippled by it.

By Will Steffen: The work of the Intergovernmental Panel on Climate Change (IPCC) has summarised a range of projections of the behaviour of the climate system through the 21st century. The range of these projections continues to be very large, from an increase in global mean temperature of a little over 1°C compared to late 20th century values to nearly 6°C. The primary causes of the large uncertainties continue to be the sensitivity of climate to a given level of greenhouse gases in the atmosphere and the net emission rate of greenhouse gases from human sources. After outlining these projections, this talk will focus on feedback mechanisms within the Earth system that may change the rate at which climate changes through this century. Two types of mechanism will be described. The first is the ice-albedo feedback, with a focus on the northern high latitudes and the rate at which Arctic sea ice is diminishing. The second deals with the carbon cycle, with a focus on processes in both the oceans and on land that currently act as significant sinks for carbon but could weaken as the century progresses. Finally, this presentation will place the 21st century projections for the climate system in the context of much longer time scales.

Biographic notes:

Michael Raupach is a research scientist in CSIRO Marine and Atmospheric Research, with broad interests encompassing land-air interactions, micrometeorology, the fluid mechanics of turbulent flows, particle transport and soil erosion by wind, global and continental carbon and water cycles, and carbon-climate-human interactions. He is a co-chair of the Global Carbon Project of the Earth System Science Partnership. He received a PhD in micrometeorology at Flinders University, South Australia. After a postdoctoral position at the University of Edinburgh, he

joined CSIRO in 1978. He is a Fellow of the Australian Academy of Technological Sciences and Engineering.

Will Steffen is Director of the Fenner School of Environment and Society at the Australian National University, Canberra, and is also Science Adviser, Australian Greenhouse Office, Australian Government. From July 2004 through October 2005, Steffen was Visiting Fellow, Bureau of Rural Sciences, Department of Agriculture, Fisheries and Forestry. From 1998 to mid-2004, he served as Executive Director of the International Geosphere-Biosphere Program, based in Stockholm, Sweden. His research interests span a broad range within the field of Earth System science, with a special emphasis on terrestrial ecosystem interactions with global change, the global carbon cycle, incorporation of human processes in Earth system modelling and analysis, and sustainability and the Earth system. Steffen shared the 2007 Nobel Peace Prize with many colleagues worldwide for contributions to the Intergovernmental Panel on Climate Change Fourth Assessment Report.

Scenarios on a 2 to 6 degrees Celsius warmer Earth

Barry Brook. School of Earth & Environmental Sciences, University of Adelaide, South Australia. barry.brook@adelaide.edu.au

A stark appraisal of the synthesis report of the IPCC 4th assessment (AR4) reveals some disturbing things. First, stabilisation scenarios indicate that to have a reasonable chance of avoiding 2 to 2.4°C warming, we will need to achieve global emissions reductions of 50 to 85 percent by 2050, relative to year 2000 emissions and a levelling off by no later than 2015. On a globally equitable basis, the burden on developed nations will be higher (80 to >95% by 2050) because of their disproportionately high per capita emissions. Second, there is no mitigation scenario proffered for <2°C, yet the models do take us into the intemperate realm of 4.9 to 6.1°C of planetary heating.

The IPCC, it seems, is not at all confident that global society will be able to implement the wholesale socioeconomic restructuring required to stave off substantial global warming this century. It seems, therefore, quite necessary to assess, at the MCH conference, the likely implications of scenarios for a 2 to 6°C warmer Earth.

Analogue climates from deep time may help in this “imagining the real” – when the real is something never before witnessed by humanity, or indeed, at its most extreme, by most species now occupying the planet. The average lifespan of a species is 1 to 10 million years, and yet to approach conditions 4 to 6°C hotter than today’s climate, we must look back to the world of the Eocene, some 35 to 50 million years ago. The world was then a very different place – there was no permanent ice cap shrouding Antarctica, sea levels were considerably higher than today, and deserts were more widespread. The tundra and boreal forests were limited or non-existent.

The cooling descent into the icehouse conditions of the Quaternary, 2 million years ago through to the present, was a slow progression that took place over tens of millions of years – an unimaginably vast stretch of time. Although this slide from a Cretaceous greenhouse world towards a “modern climate” was punctuated by occasional rapid climatic reversals, the globally hot conditions of the deeper past were never again re-visited. Now, through the actions of modern civilisation, we risk returning to the Eocene (or earlier) within the geological wink of an eye – a matter of a mere century or two. How will Earth, and its diaphanous clothing of life, cope?

Simply put, even under the most stringent mitigation scenario proposed by the IPCC AR4 (scenario I, in which CO₂ equivalent is limited to 445 – 490 ppm), there is a high confidence that a slew of what can only be described as catastrophic impacts (30 percent species loss, major coastal flooding, most corals bleached, significant global water stress), will unfold! Indeed, beyond the mitigation scenarios, the fossil-fuel intensive business-as-usual – right to the bitter end – runs off the chart of possible impacts, with a disturbingly plausible risk of up to 6.8 – 8.6°C heating. This would truly be “game over” for humanity and most other life on this planet.

In this context, I will focus on describing a range of potential future impact scenarios and tipping elements, under scenarios of 2 to 6°C warming. These include the instability of the large polar ice sheets, which threatens major sea level rise, possible collapse of major carbon sinks in the ocean and on land – exacerbating committed climate change, increased intensification of the hydrological cycle and the related problems of desertification and water stress, severe impacts on biodiversity and ecosystem services – interacting with ongoing stressors such as habitat loss, and erosion of the natural, agricultural and infrastructure capital that is required to support modern civilisation. I will present an overview of recent scientific research in this area of extreme outcomes, and speculate on some of the more worrying “low risk, high consequence” tipping points that we risk breaching, beyond 1 to 2°C of warming.

It is no less than a damning indictment on our collective vacillation, inaction and deliberate stalling to date, in facing up to this problem (Australia and the US being two historically prominent curmudgeons), that we are now facing the stark choice between a bad situation, a catastrophic situation, or a civilisation-terminating situation. The European Union somewhat arbitrarily defined “dangerous anthropogenic interference with the climate system” (what we were supposed to avoid, according to the 1992 UN Framework Convention on Climate Change) as being anything over 2°C warming - and many claim this is already too much for comfort, given the changes we are witnessing already, at 0.8°C warming. Given what is at stake, there is some dark humour to be had in contemplating that only 6 of 177 AR4 mitigation scenarios actually allow for the possibility of avoiding 2.5°C!

There is good news, however, if policy makers will just take heed. The costs involved in moving fast to address the emissions problem and avoid the catastrophic global scenarios that threaten to “awaken the Balrog” of 2 to 6 degrees of heating, are incredibly small, or perhaps even beneficial overall, and that's before we count the social and environmental cost of not taking action.

Biographic note: Professor Barry Brook is an international research leader in global ecology and conservation biology. He holds the Foundation Sir Hubert Wilkins Chair of Climate Change and is Director of the Research Institute for Climate Change and Sustainability at the University of Adelaide. He has authored two books and over 120 scientific papers on various aspects of human impacts on the natural environment and biodiversity, including climate change, deforestation and overexploitation of populations. His research methods focus primarily on the statistical analysis, interpretation and computational modelling of long-term data, and meta-analysis of large-scale databases. Likely future impacts are modelled at a global, regional and a local scale, to provide a robust scientific underpinning for scientific management and government policy. The principal motivation for his research is to identify ways and means of reducing extinctions and mitigating the worst ravages of global change. In 2006, he was awarded both the Australian Academy of Science Fenner Medal for distinguished research in biology and the Edgeworth David Medal by the Royal Society of New South Wales, and in 2007, the H.G. Andrewartha Medal by the Royal Society of South Australia and was listed by *Cosmos* as one of Australia's top 10 scientists under 40.

Nuclear scenarios on a warming Earth

Sue Wareham. Medical Practitioners Against Nuclear War. warehams@ozemail.com.au

The need to arrest climate change and attempt to mitigate at least some of its effects, globally, is widely accepted. The fact that action thus far has been unconscionably slow is not as readily acknowledged by many governments. This talk will add further cause to the need for urgent action, and explore links between climate change and both nuclear power and nuclear weapons. Many scenarios are possible, but most of my comments will relate to scenarios that are likely if we attempt to reduce greenhouse gas emissions through greater reliance on nuclear power. It's important at the outset to recognise the severe limitations of nuclear power in addressing climate change. Even if the nuclear fuel chain did not emit carbon at practically every stage, which it does, many hundreds, if not thousands, of nuclear power stations would have to be built to make any significant impact. Economic and other limitations prohibit this.

The net effect of expanding nuclear power would, however, be even more negative than this implies, because of the long lead times needed to build the plants, during which time climate change would become more entrenched. In addition, the financial and other resources needed to increase nuclear power would leave little capacity for parallel development of other technologies. Thus, while the risks associated with nuclear power (especially weapons proliferation, accidents, and nuclear waste) would grow, the reality of climate change would worsen.

As nuclear power cannot come close to providing all the world's energy needs, there would still be heavy reliance on fossil fuels, especially for the first two decades or more while additional nuclear facilities were being built. Therefore there would be ongoing competition for resources, particularly in the Persian Gulf region, which holds two-thirds of the world's oil. The possible consequences include not only the devastation of "conventional" war, but also the distinct possibility of nuclear war, as the region remains one of the world's nuclear hot spots.

In addition, there would emerge competition also for a different finite resource, uranium, with the likelihood of serious tensions when supplies of it also start to dwindle. Thus we may simply be consigning our children to suffer ongoing wars to secure their energy supplies, with the ultimate need to find alternatives to both fossil fuels and uranium anyway. A smarter way forward would be to use the existing alternatives that do not rely on any depletable resource.

A scenario advocated by some to address climate change is a greater use of reprocessing, so that plutonium can be used as fuel again and again, thus obviating the need for new uranium sources. The problems associated with reprocessing are so great, especially the enormous security risks of stockpiles of plutonium, that it would merely replace the nightmare scenarios of climate change with nightmare scenarios of nuclear war.

An expansion of nuclear power, or even maintaining current levels, carries with it the inevitable creation of nuclear bomb fuel, either enriched uranium or plutonium, and this is its greatest danger. The acquisition of the fissile material is generally the greatest obstacle to building a nuclear weapon.

The combination of nuclear weapons capacity and global warming is particularly perilous, for global warming itself is likely to increase levels of armed conflict. Among the consequences of climate stress are food and water insecurity, large-scale migration of refugees and fear - all of

which are powerful risk factors for ethnic clashes and violence. UN Secretary-General Ban Ki-Moon reported in *The Washington Post* in June 2007 that “the Darfur conflict began as an ecological crisis, arising at least in part from climate change”.

The 2007 *International Alert* report “A Climate of Conflict: The links between climate change, peace and war” estimated that there are 46 countries – home to 2.7 billion people – in which the effects of climate change interacting with economic, social and political problems will create a high risk of violent conflict. While armed conflict must be avoided for many reasons, when it arises in a nuclear-armed region, the possible consequences rise exponentially and become global in their impact. Consider, for example, Pakistan and the possible outcomes if glaciers retreat further, there are severe water shortages, political instability, and the military with its nuclear weapons comes under the control of Jihadists.

Recent research from the University of Colorado at Boulder, Rutgers University and the University of California, has drawn attention also to a compounding factor - the climatic consequences that could follow a “limited” nuclear war. The detonation of 100 Hiroshima-sized weapons, say in South Asia, would release vast amounts of carbon and debris into the atmosphere, with a likely drop in the earth’s surface temperatures, reduced growing seasons, reduced global rainfall, a large reduction of the Asian summer monsoons, and complete crop failures. The report estimated there could be one billion deaths from global famine alone, followed by major outbreaks of infectious illness, immense potential for food riots, and aggravation of ethnic tensions. Nations dependent on food imports would be likely to use whatever means available to them to maintain access to food.

None of these scenarios are pre-ordained. We have choices to make. It’s a matter of whether we choose to address climate change with real solutions or further problems. Climate change and nuclear weapons are the two greatest threats to human survival as we know it. Both require urgent and real solutions.

Biographic note: Dr Wareham qualified in medicine from the University of Adelaide in 1975, and currently works in general practice in Canberra. Since the early 1980s, Dr Wareham has been a very active member of the Medical Association for Prevention of War (Australia), which works for the elimination of nuclear weapons and for the promotion of peace and disarmament generally, and she has spoken and written widely on these issues. From August 2007 she has been MAPW National President, a position she also held from 1997 to 2005. MAPW is the Australian affiliate of International Physicians for the Prevention of Nuclear War, which was awarded the Nobel Peace Prize in 1985. Dr Wareham was the Regional Vice-President of IPPNW, and a member of the Board of Directors, from 1996 to 2000. Dr Wareham has campaigned on other issues related to peace and justice also. In April 1999 she took part in an international delegation to Iraq, sponsored by IPPNW, to raise awareness of the devastating impact of economic sanctions on the Iraqi people; and in December 2006 travelled to Lebanon with a delegation to document the effects of cluster bombs on civilian populations. In 2006 Dr Wareham was awarded the Medal of the Order of Australia in the General Division (OAM) “for service to the community and to the peace movement, particularly through the Medical Association for Prevention of War”.

SESSION B: THE ORIGINS OF CLIMATE CHANGE

The atmosphere and mass extinctions through time

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Mass extinctions of terrestrial species, including the late Anthropocene mass extinction, are intimately related to abrupt changes in the physical and chemical conditions of the atmosphere and hydrosphere on which species depend. Such events have been triggered by comet and asteroid impacts, volcanic events, eruptions of methane and possibly supernovae (Table 1). Each of the major mass extinctions, barring the Anthropocene, has been perpetrated by a combination of asteroid impacts, combined with extensive volcanic activity possibly triggered by asteroid impacts. Biogenic effects on the composition of the atmosphere include emanation of CH₄ by bacteria, absorption of CO₂ and enrichment of atmospheric oxygen by plants, reverse processes by animals, and major carbon emissions by humans. The Anthropocene climate change (Crutzen and Stoemer, 2000; Ruddiman et al., 2003; Ruddiman, 2005), enhanced from the mid-19th century, represents a phenomenon similar in terms of its scale and consequences to the earlier largest mass extinctions, requiring consideration of its natural rationale.

Several factors underlie major greenhouse events through the Earth's history. Asteroid and comet impacts triggering evaporation of carbon-rich and/or carbonate-rich sediments occurred in the late Devonian (374-359 Ma), the K-T boundary (65 Ma) and the P-T boundary (~251 Ma) (Table 1). Major mass extinctions were associated with the release of sulphur aerosols and greenhouse gases triggered by basaltic volcanism of the Norilsk basalts (~ 251 Ma); Late Triassic opening of the Atlantic Ocean (~ 200 Ma), and Deccan plateau volcanism (~ 65 Ma) (Glikson, 2008). A greenhouse event associated with extinction at the Paleocene-Eocene boundary (~55 Ma) may have been related to volcanic injections into methane-rich sediments. In several instances the age of major asteroid impact clusters overlaps the age of major volcanic events, possibly hinting at impact triggering of mantle melting episodes caused by large impacts.

In the wake of the Sturtian glaciation (~600 Ma), enrichment of atmospheric oxygen and appearance of multicellular eukaryotes heralded the onset of the Phanerozoic, where greenhouse conditions were interrupted by periods of strong CO₂-sequestration through intensified capture of CO₂ by marine plants, onset of land plants and burial of carbonaceous shale and coal (late Ordovician. Carboniferous-Permian, late Jurassic, late Tertiary-Quaternary). A progression from late Mesozoic and early Tertiary greenhouse conditions to late Tertiary-Quaternary ice ages was related to sequestration of CO₂ by rapid weathering of the emerging Alpine and Himalayan mountain chains. A number of peak warming and sea level rise events include the late Oligocene, mid-Miocene, mid-Pliocene and Pleistocene glacial terminations.

The late Tertiary-Quaternary ice ages were dominated by cyclic solar-triggered terminations that involved CO₂-feedback effects from warming seas and the biosphere and albedo flips related to ice sheet melting. Since ~1750AD human emissions to date totalling ~305 Gigatons of carbon, as compared to ~750 GtC of the atmosphere, ensue in a fast evolving greenhouse

process. Total emissions constitute ~12 percent of the terrestrial biosphere and ~10 percent of the known global fossil fuel reserve of ~4000 GtC. Combustion of this reserve would compare with the ~ 4600 GtC released to the atmosphere during the K-T impact event at 65 Ma, with associated mass extinction of species. Current growth rate of atmospheric greenhouse gases and global mean temperatures exceed those of Pleistocene glacial terminations by more than an order of magnitude. The relations between temperatures and sea levels (SL) for the last few million year project future SL rises toward time averaged values of more than 10 metres per 1°C (Hansen et al., 2007; Glikson and Brook, submitted). The instability of ice sheets suggested by the Dansgaard-Oeschger glacial cycles during 50-20 kyr, observed ice melt lag effects of glacial terminations, spring ice collapse dynamics and the doubling per-decade of Greenland and west Antarctic ice melt, indicate the IPCC-2007-projected SL rises (~ 60 cm) for the 21st century may be exceeded (Hansen et al., 2007; Glikson and Brook, submitted).

About the mid-1980s a climate change threshold (“gate”) appears to have been crossed, with accelerating rise of greenhouse gas levels, temperatures, sea ice and continental ice melt rates, pole-ward migration of climate zones, changes in precipitation and drought patterns, frequency of the El Niño and intense storms. By 2006, when James Lovelock’s *The Revenge of Gaia* was published (for a sequel see Appendix A), half a century after Rachel Carson’s *Silent Spring*, major evidence confirms the Earth’s atmosphere—the lungs of the biosphere—is in runaway crisis. By 2007 spring melt rates of the Arctic Sea ice increased by 23 percent in two years, an order of magnitude higher than in previous decades. The release of over 300 billion tons of CO₂ (GtC) into the atmosphere, compared with the atmospheric inventory of about 760 GtC, increasing by some 8 GtC per year, is having its mark. The optimal climate conditions of the Holocene, which allowed Neolithic cultivation from about 10,000 years ago and emergence of civilisation in the wake of sharp rises of sea level, are fast eroding as a Promethean carbon-emitting species is burning the fossil biomass of some 400 million years of evolution. An imminent rise of CO₂ levels to and above 500 ppm threatens to melt the polar ice caps, raise sea levels to their Eocene levels, +70 metres above present levels, and terminate the late Tertiary and Quaternary glacial-interglacial era (Hansen et al., 2008), which allowed mammals to flourish at the surface of Earth. The underlying rationale of this phenomenon in terms of natural selection may never be understood.

It is barely conceivable that nature may interfere with a decline of solar insolation toward the next glacial cycle. If this occurs in time, humanity may gain by luck, not by good management.

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Table 1. Major past mass extinctions (after Stanley, 1987; Sepkoski, 1996; Keller, 2005; Impact Data Base GSC/UNB)

Time	Impact/geological episodes	Extinctions/radiations
Paleocene-Eocene boundary (55 Ma);	Eruption of methane associated with volcanic effects on C-rich sediments	Extinction of Plesiadapidae, Champsosaurus Appearance of primates
Cretaceous-Tertiary boundary (65.5±0.3 Ma)	Chicxulub and Boltysh impacts, affecting C-rich and carbonate-rich sediments; Deccan Plateau basalts	Extinction 47% of Genera, including plankton, marine invertebrates (including reef builders), marine reptiles, dinosaurs
		Flowering plants become dominant on land
Jurassic-Cretaceous boundary (145.5±4 Ma)	Morokweng, Gosses Bluff, Mjolnir impacts; dyke systems; ocean spreading	Extinction of 20% of Genera, including marine invertebrates, dinosaurs
		Appearance of early birds
End-Plinianian (183±1.5 Ma)	peak Karoo volcanism	Extinction of marine invertebrates
End Triassic (~201 Ma) Late Triassic (Norian-Rhaetian (216.5 Ma)	opening of the Atlantic Ocean; Manicouagan [214±1 Ma], Saint Martin [220±32 Ma], Rochechouart [213±8 Ma]	Extinction of 33% of Genera, including marine invertebrates and reptiles
		Earliest mammals evolve
Permian-Triassic boundary (251.7±0.4 to 251.1±0.3 Ma)	Siberian Norilsk plateau basalts; Araguinha impact 252.7±3.8 Ma, affecting C and carbonate-rich sediments	Extinction of 78% of Genera, including sea floor protozoans, marine invertebrates, reef builders, reptiles
		Vertebrates invade land
End-Devonian (374-359 Ma)	Woodleigh [359±4 Ma], Siljan [361.1 Ma], Alamo [360 Ma] impacts	Extinction of 30% of Genera
Late Devonian (Frasnian-Famennian (383 Ma)		Extinction 58% of Genera
Late Ordovician (443.7±1.5 Ma).	Meteorite shower	Extinction of 60% of Genera, including trilobites.
		Earliest fish evolve
End-Cambrian (488 Ma).		Extinction of 41% of Genera
End-lower Cambrian (513±2 Ma)	Kalkarindji volcanism, 507±4 Ma).	Extinction of 42% of Genera
580 Ma	Acraman impact.	Extinction and radiation of acrytarchs species

Biographic note: Andrew Glikson (BSc, MSc, PhD) is an Earth scientist at the Australian National University, focused on studies of the crustal records and geological evolution of the early Earth, with particular reference to the role of asteroids and comets as triggers of tectonic and igneous episodes and mass extinctions, evolution of the atmosphere and the effects of abrupt atmospheric perturbations on the biosphere, subjects on which he published over 150 scientific papers. His other interests include the philosophy of science, science-based existentialism and poetic expressions of scientific and philosophical themes. Since 1964 his work has hinged on regional geological field surveys and geochemical and petrological studies of terrains in Western Australia and central Australia, reported in national and international publications. Since 1998 he has concentrated on the search for and discovery of impact structures, including discovery jointly with Robert Lasky of the 120 km-large Woodleigh

structure and the 75 km-large Gnargoo probable impact structure in Western Australia. As a tribute to his work on the early crust and asteroid impact research, Eugene M. Shoemaker named an asteroid and an impact structure after him. He was the editor of the ACT Branch of Scientists Against Nuclear Arms, and has written articles about aspects of the nuclear issue, philosophy and ethics. He writes and publishes essays and poetry, including the book *Gondwanaland Flower: A Poetic and Photographic Journey Through Time*. In 2005 he convened the Manning Clark House conference on "Science and Ethics: Can *Homo sapiens* survive?" and in 2007 a conference "From Stars to Brains" in honour of Paul Davies. At present his research hinges on the relations between atmospheric changes and mass extinctions.

Glacial - interglacial cycles and the nature of the Holocene

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In the mid-1980s a Columbia Professor by the name of Wally Broecker said there would be surprises in the Greenhouse. Specifically he was talking about the Icehouse to Greenhouse transition we are now experiencing. Perhaps the most profound surprise we have encountered so far is the rapidity with which the Arctic, including Greenland, is melting. Over the past two years glaciologists have declared a group *mea culpa*. Almost all of their predictions of a decade ago have been proven astonishingly conservative. Each new field season reveals accelerating speeds of ice movement and melting processes within the ice that have never been witnessed before. Many Paleo-oceanographers think that at present day atmospheric CO₂ levels Greenland ice is already doomed to melt. This represents about 6m of sea level rise. The important questions then become "How fast will it melt?" and "Will there be significant additional melting from the Antarctic ice sheet?"

So what does this have to do with the history of ice melt during the Late Pleistocene? There have been many periods of ice growth and melting during the past 2.5 million years. The argument for a mechanism of cycles in the Earth's orbit and tilt are convincingly correlated to the heartbeat of glacial-interglacial cycles recorded in the sedimentary record and in ice cores. Changes in energy received at 50 degrees north of the Equator are remarkably subtle, but magnified by a series of feedbacks we are only just starting to understand. This, of course, is strongly related to the natural cycles of ice melt that we are starting to look at so seriously. Arguably sea level rise poses the single greatest threat to the future of our civilisation, particularly if the rate of sea level rise is high enough.

So how fast has sea level risen during the last deglacial? Typically, no faster than about 1 cm per year or 1 metre per hundred years. Some authors argue that this is the natural limit to how fast the ice can melt or sea level can rise. This ignores a number of factors, but most importantly, that forces acting on the system now are orders of magnitude more intense than the natural glacial to interglacial changes. At the moment sea level is rising at a rate of more than 3mm per year, and given the exponential rate at which this rate is rising, we expect sea level rise to reach the level of 1 cm per year in about 20 years.

If we look at sea level records for the Late Pleistocene, it would appear that sea level highs (the interglacials) throughout this time have been close to those seen on Earth for the past 6000 years. If we look at Marine Isotope Stage (MIS) 5e, at between 118 and 128 thousand years ago, from data compiled from around the world, it appears sea level was 3-5m higher than

today. We do know that the orbital forcing that preceded Stage 5e was stronger than that preceding the Holocene. If sea level was 3m higher, then it would imply a significant portion of the current Greenland ice sheet melted at that time. However, the melt area could have been a mix of the region around the Antarctic Peninsula and Greenland, as we are seeing today. Was the MIS 5e climate forcing anywhere near what we are experiencing today? No. Did the Arctic sea ice melt then to the extent it is melting each northern hemisphere summer over the past several years? No, the paleo-oceanographic evidence suggests that it did not. We anticipate the impact of an ice free Arctic Ocean on the rate of Greenland melt will be large and unprecedented when compared to the paleoclimate records of the past 2.6 million years. If we look further back in time, back to the Pliocene (between 2.6 and 6my), when there were no significant ice sheets in the northern Hemisphere, sea level appears to have stood at a quantum approximately 20m higher than today. We still need much more detailed data from this time interval to see what the sea level variation really was during the Pliocene, but this is the kind of sea level rise we can anticipate given the kinds of “safe” levels of atmospheric CO₂ now being debated today in policy circles. One can argue we have already passed a tipping point with respect to “dangerous” climate change.

Biographic note: Bradley Opdyke studied at Columbia University and graduated at the University of Michigan in carbonate geochemistry, paleoceanography, carbon cycle modelling and coral reef sedimentology. His current research includes studies of (1) the Quaternary palaeoceanography of the Indonesian region; (2) Modern to Late Quaternary history of carbonate sedimentation from the Southern Great Barrier Reef, evidence from both the sediments and the water column; (3) Methane Hydrates and the Cretaceous Carbon Cycle, and (4) quantifying Holocene shallow water carbonate sedimentation. This includes studies of stable isotopes of carbon and oxygen of planktonic foraminifera and trace metal signatures, the mass flux of carbonate carbon to shallow water deposits like Coral Reefs, and determination of carbonate produced and transported to deep water from the Great Barrier Reef.

Prehistoric origins of environmental degradation

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One of the greatest drivers of environmental degradation and a significant contributor to climate change, as we know it today, is the widespread and ongoing clearance of forest around the globe. Deforestation results in a net flux of carbon to the atmosphere because forests contain 20–50 times more carbon per unit area than agricultural lands. In recent decades, the tropics have been the primary region of deforestation and the islands to the north of Australia continue to be under threat from logging interests, agriculture and rapidly expanding populations. Australia itself has also experienced massive forest loss over the last 220 years of European settlement, with only small remnants of ecosystems that could be considered to represent the state of the vegetation in 1788 existing today. What was the vegetation like at the time of, and prior to, European settlement of our region? Is there evidence for earlier environmental degradation associated with human activity?

In this talk I will explore the emerging evidence for significant prehistoric environmental degradation in the Australian-New Guinea region that suggests prehistoric human-influenced landscapes have played a role in the development of contemporary landscapes and may have contributed to increased vulnerability to future degradation. For example, the influence of the

Australian monsoon during the most recent glacial to interglacial cycle may have been confounded by the arrival of people in northern Australia and New Guinea in the last 50 ka. Recent work by Miller et al. (2007) suggests that the strength of the monsoon has been reduced due to vegetation change as a result of the impact of an anthropogenic fire regime that destroyed woody habitats and caused dependant giant browsing animals (“megafauna”) to go extinct. Further degradation of the vegetation appears to have followed the intensification of human-landscape interactions around 6000 years ago associated with expanding populations across the region and the development of agriculture in New Guinea (Haberle and David 2004). In sum, these examples suggest that if Aborigines had not changed the vegetation-climate system, then the biodiversity of the region would have been fundamentally different from that which we see today.

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Biographic note: Simon Haberle is a Senior Fellow in the Resource Management in Asia-Pacific Program and the Department of Archaeology and Natural History at ANU. His research is currently focused on the application of high-resolution palaeoecological analysis to our understanding of the impact of climate change and variability and human activity on terrestrial ecosystems of the Pacific and Indian Oceans during the Quaternary (last 2.6 million years). His interest in the Australian monsoon lies in its impact on fire regimes and vegetation dynamics through time that is revealed in pollen records from southern Papua New Guinea and northern Australia. He is also developing e-Research tools in palaeoecology such as the Australasian Pollen and Spore Atlas and the PalaeoWorks website.

Current state and future of the oceans and marine life in a high CO₂ world

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The oceans play a key role in global climate change, being responsible for taking up nearly one-half of the anthropogenic CO₂ that has been released so far. However, unlike the atmosphere where CO₂ causes warming through its strong physical interaction with infrared radiation, in the oceans it is a highly reactive species causing a major perturbation to the chemistry of surface waters. This perturbation arises from dissolution of CO₂ in surface waters, resulting in an increase in the concentration of carbonic acid, which in turn is leading to an overall increase in acidity. Rapidly rising levels of atmospheric CO₂ have thus resulted in a significant reduction in seawater pH or what has become known as “ocean acidification”, presenting many challenges and problems.

Over the past century atmospheric CO₂ has risen by over 30 percent, from pre-industrial values of ~280 ppm to present-day levels of over 380 ppm, and is continuing to rise at an unprecedented rate of ~2 ppm per year. To put these changes in perspective, on geologic timescales they are more than two orders of magnitude faster than occurred, for example, during the last deglaciation, when an increase of from 200 to 280 ppm accompanied a major change in the Earth’s climate from a glacial “icehouse” to our present-day warmer and still relatively benign “interglacial” conditions. Since the mixing times between the surface and deep

ocean waters are in the order of a thousand years, it is clear that mankind's "experiment" of rapidly increasing atmospheric CO₂ represents a major perturbation to the chemistry of surface ocean waters, the likes of which have not been seen for over 55 million years. From a scientific perspective, the root cause of the problem is the major disequilibrium that now exists between the surface and the deep oceans. Since the deep ocean sink for CO₂ is extremely large (>39,000 GtC) compared to the atmosphere (~750 GtC), the response of the oceans to this major perturbation is clearly critical. Why should a few tenths of a unit reduction in seawater pH, as is already occurring and predicted to rapidly increase in the coming decades, be of such major significance? The reason for this lies in Figure 1, which shows how the carbonate ion concentration in seawater is extremely sensitive to even small changes in pH.

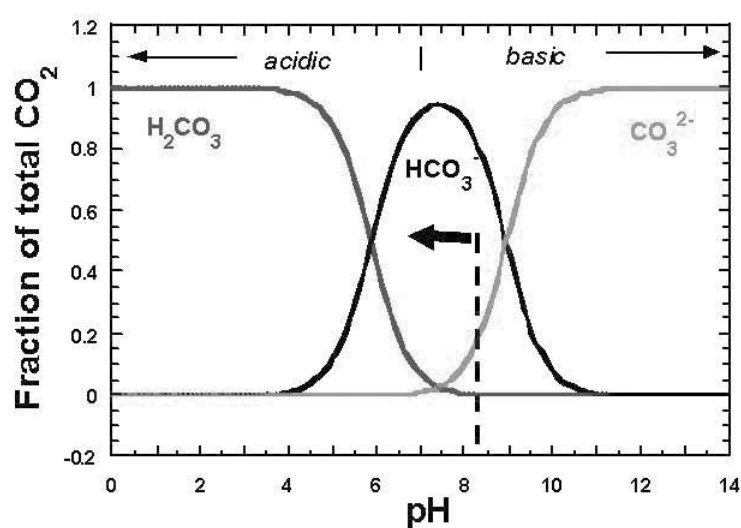


Figure 1. Seawater carbonate equilibria showing the dependence on pH. The term "ocean acidification" refers to the process of decreasing pH, but the oceans are not expected to become technically acidic (i.e. pH < 7). A reduction of only a few tenths of pH units however has a major effect on carbonate ion (CO₃²⁻) concentrations. This is important as calcification occurs via: $\text{Ca}^{++} + \text{CO}_3^{2-} \rightleftharpoons \text{CaCO}_3$.

It is estimated, for example, that even an apparently small shift in pH from a mean value of ~8.2 to ~8.0 expected for a doubling of atmospheric CO₂ will reduce carbonate ion levels by nearly 40 percent. This has major implications for marine calcifying organisms since calcification is dependent on the carbonate ion concentration in seawater.

Calcifying organisms are amongst the most sensitive ecosystems to the effects of increasing atmospheric CO₂, with recent experimental studies now indicating a high sensitivity to the degree of carbonate oversaturation. Tropical reef waters are oversaturated ($\Omega > 1$), with values typically from 3 to 4, but a doubling of CO₂ will decrease carbonate levels by over 40 percent. Constraints on the dependence of biologic calcification have been mainly conducted over relatively short timescales in experimentally controlled tanks where it is difficult to replicate the full range of interacting environmental factors (e.g. light, nutrients) found in the natural environment. Despite these limitations it is clear from existing experiments that calcification appears to generally have a very strong dependence on the degree of oversaturation (i.e. $\Omega > 1$). If correct, this would indicate catastrophic declines in calcification of ~60 percent by the

year 2065. In this talk these issues, the extent of the present-day changes in seawater pH and their likely future impact on calcification in the world's oceans will be discussed.

Biographic note: Professor Malcolm McCulloch received his undergraduate and graduate training in the physical sciences at Curtin University of Technology (formerly WAIT). PhD studies were undertaken in the Division of Earth and Planetary Sciences at the California Institute of Technology. After completing his PhD he returned to Australia in 1980 to take up a Research Fellowship at ANU, in the Research School of Earth Sciences. At ANU he has been responsible for establishing a new range of geochemical methods based on naturally occurring long-lived isotopic systems to determine how the Earth's continental crust and mantle have grown and evolved. Until recently he was Head of Earth Environment at RSES and is an Associate Director of the ARC Centre of Excellence in Coral Reef studies. His research is focused on how increasing ocean temperatures, ocean acidity and river runoff are affecting the long-term sustainability of coral reefs and he is an internationally recognised leader in the field of the geochemistry of Earth System Science.

SESSION C: Orwellian scenarios on a warming planet

The politics of fear on a warming planet

Dr Carmen Lawrence. Professorial Fellow, University of Western Australia.
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As most people now seem to agree, climate change is one of the greatest challenges facing the human race. No one is immune from its effects - although the poor are likely to suffer most - and we have all contributed to its development - although the wealthy and the wealthy nations are largely responsible for the current state of affairs. By continuing to burn fossil fuels and clear forests, we are inevitably worsening the problem. While scientists and policy makers advance various proposals to deal with climate change, few stop to consider the most effective ways of producing the necessary and substantial changes in our individual and collective behaviour. Whether it is modifying our transport use, energy use, patterns of settlement, food consumption and the design of our homes or accepting higher prices for some products and services, there is no doubt that just as human behaviour lies at the root of the problem, so it must be a major part of the solution. Fundamentally, it is human behaviour that must be modified to ameliorate global warming. And on a scale that has never before been contemplated.

While much money, time and energy have been devoted to understanding the consequences of human action on the climate, there has not been a corresponding effort to understand how we can stimulate the changes in human behaviour needed to forestall (or even adapt to) the predicted outcomes of global warming. What is needed is a comprehensive analysis of which changes in human behaviour are most likely to reduce global warming and how such changes can be facilitated. This in turn requires a better understanding of how people perceive and experience climate change and which modifications to human systems people are more likely to accept and adapt to. For example, climate friendly behaviour may be induced by marketing and information strategies, which alter demand for various products and services, or by changing the products and services that are available through technology, pricing and regulation. In either case the public's acceptance of such policies, including their judgments about the fairness and efficacy, are critical to their success.

Many of the proposals for modifying our patterns of consumption and energy use to reduce greenhouse gas emissions take the form of exhortations to change accompanied by dire warnings about the catastrophic consequences of failure to act – from drowning to burning. Much of the resistance to accepting the science and refusing to ratify Kyoto was also justified by an appeal to fear - the threat of economic destruction and the slide into grinding poverty. In both cases, fear appears to have been selected as the motivating force most likely to produce – or prevent - the needed change. Climate change is commonly presented through an alarmist prism as awesome, terrible, immense, indeed as beyond human control. The language conjures up visions of Armageddon, sometimes with a “quasi-religious register of death and doom”.¹ Words and phrases like “time bomb”, “havoc”, “catastrophe”, “devastation”, and “annihilation” appear repeatedly in scientific and media reports, implicitly reinforcing a counsel

¹ Institute for Public Policy Research (2006) *Warm Words: How are we telling the climate story and can we tell it better?*

of despair. But fear is an emotion that should be approached with caution. For one thing, people constantly reminded of their own mortality may actually become more materialistic and resistant to messages of restraint. In using fear to try to engender a sense of urgency in the community, many scientists and commentators may, in fact, be producing the opposite effect to the one they desire, particularly if their messages are not accompanied by recommendations for action that people believe are likely to make a difference. One of the possible consequences of engendering high levels of fear is that it may cause paralysis in those who are threatened; a sense of powerlessness and inertia, rather than effective action, may be the result. In societies already riddled with fear arousing messages, such appeals to fear may inadvertently position climate change as just another media beat-up, which will disappear when the next big bogey-man has been fashioned.

Even if people do experience the fear and sense of alarm these messages communicate, their responses may not translate into climate-friendly behaviours. There is a substantial public health literature, which has examined the circumstances in which fear appeals directed toward encouraging health behaviour such as stopping people smoking or moderating their drinking, produce the desired attitude and behaviour change and, conversely, when such appeals backfire, causing people to use psychological defence tactics to resist the message, minimising and denying the risk. Little is known about whether and in what circumstances fear-based persuasive techniques will change attitudes and stimulate environmentally friendly behaviours such as saving energy. Ultimately our success in dealing with climate change will depend on understanding how we can change human behaviour, with and without the use of fear. Social scientists expert in understanding persuasive communication and behaviour change should be in the forefront of efforts to mitigate global warming. At the moment, they are nowhere to be seen.

Biographic note: After training as a research psychologist at the University of Western Australia and lecturing in a number of Australian universities, Dr Lawrence entered politics in 1986, serving at both State and Federal levels for 21 years. She was at various times WA Minister for Education and Aboriginal affairs and was the first woman Premier and Treasurer of a State government. She shifted to Federal politics in 1984 when she was elected as the Member for Fremantle and was appointed Minister for Health and Human Services and Minister assisting the Prime Minister on the Status of Women. She held various portfolios in Opposition, including Indigenous Affairs, Environment, Industry and Innovation and was elected national President of the Labor Party in 2004. She retired from politics in 2007. She is now a Professorial Fellow at the University of Western Australia, where she is working to establish a centre to undertake research and to facilitate discussion on the processes of persuasion and indoctrination and the factors contributing to the development of fanatical ideas and extreme, including violent, behaviour.

The biological and human consequences of climate change

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Throughout their industrial adolescence human societies have fouled and contaminated local environments. Chemical pollutants have been added to the longer history of microbiological contaminants. By analogy, this has approximated throwing “spanners in the works” – thereby causing localised risks to health via specific exposure agents. Today, in contrast, the hypertrophic human enterprise is also disrupting the actual “works” themselves – that is, disrupting and changing the systems of the natural world. Species are being lost, ecosystems disturbed, aquifers emptied, soils depleted, oceans acidified, and the global climate changed. This weakening of Earth’s life-support systems necessarily poses serious health risks. Global climate change is emblematic – and, as the scientific evidence accrues, increasingly ominous.

Human-induced climate change is, now, being recognised as a fundamental threat to biological processes and life-support systems. This is overdue – we have been unduly preoccupied with the threats to the economy, jobs, physical infrastructure, tourist amenity and iconic species. Climate change necessarily endangers, and is already affecting, biota and ecosystems everywhere (e.g. marine life, livestock and their infectious diseases, agricultural yields). For humans the biological consequences of climate change include thermal stress (including impaired physiological function), health impacts (physical and mental) of extreme weather events, effects on food yields and quality, changes in infectious disease patterns, mental health impacts, and the exacerbation of conflicts over natural resources (e.g. Darfur, Kenya).

The risks to human population health have great significance, underscoring:

- The extent of the risk/danger posed by a change in global climatic conditions
- The need for societies and their governments to look to wider horizons, and accord primacy in policy making to protecting ecological systems and population health
- The moral challenge posed by the geographic, socioeconomic and inter-generational disparities in climate-related exposures

As we come to terms with this dimension of climate change, we will understand better the fundamental rationale for, and goal of, “sustainability”. Popular rhetoric aside, maintaining economic, social and environmental conditions is *not* the “bottom line”. The primary task for human societies and their governance is to ensure the achievement, equitably and enduringly, of human happiness, wellbeing, health and survival. Responding to climate change may yet help us achieve that cultural and ecological transition towards “biosensitive” ways of living.

Biographic note: Tony McMichael, medical graduate (Adelaide University) and epidemiologist, is an NHMRC Australia Fellow at the National Centre for Epidemiology and Population Health, The Australian National University, Canberra. He was previously Professor of Epidemiology at the London School of Hygiene and Tropical Medicine, 1994-2001. His epidemiological research has spanned occupational diseases; diet, nutrition and disease (10 years with CSIRO Division of Human Nutrition); and environmental influences on health and disease. Over the past decade he has been an international leader – including being an adviser to the World Health Organization, other UN agencies and World Bank – in the development of research priorities and methods on the health risks of climate change. This has included pursuing his particular interest in the changing global ecology of infectious disease patterns and risks. Tony has

recently worked, via both research and published commentary, to connect the domain of public health research and health promotion with the wider emerging agenda on global changes, urbanisation, climate change and sustainability. He contributed to the Federal Government's recent *Sustainable Cities 2025* enquiry and strategy formulation. During 1993-2007 he played a central role in the scientific work of the UN's Intergovernmental Panel on Climate Change (IPCC) assessment of health impacts. (He therefore shared around one two-thousandth of the 2007 Nobel Peace Prize!) He co-chairs the "Global Environmental Change and Human Health" project of the International Council of Science (ICSU). He is a Director of the Climate Institute (Australia) and a member of the Australian Climate Group (updated national policy-oriented report to be released in April 2008). His books include *Human Frontiers, Environments and Disease: Past Patterns, Uncertain Futures* (CUP 2001) and *Climate Change and Human Health: Risks and Responses* (WHO, 2003).

Social and economic scenarios on a greenhouse Earth

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Too many people: If there were only one billion people on planet Earth, as in 1800, we could probably cope with the IPCC's "business as usual scenario" of a 3°C of global temperature increase by 2100. Unfortunately, by that time there are likely to be close to 10 billion people on our planet and we will not have the luxury of being able to move them around to cope with a warming planet and sea level rise. Even with the present global population of about 6.8 billion, a one metre sea level rise will affect about 100 million people and inundate about 1 million km² of land. This is a loss of less than 0.7 percent of the Earth's land area and could have been dealt with in 1800. The challenges of trying to move 100 million people in the next 100 years are much more difficult to overcome. Even without global warming there are serious sustainability issues for life on Earth for humans. I would like to focus on two main concerns: *energy* and *food*.

Energy: The world energy consumption is expected to quadruple from 1960 through 2030 from 4 billion tonnes of oil equivalent (~ 1.7 to 6.7×10^5 PJ) to 16 Btoe. This is due to an increase in global population and an increase in the annual energy consumption per capita, due mainly to the increase in per capita income. In 2005, for example, the annual energy consumption ranged from about 2 GJ for very poor countries like Malawi with an annual GDP per capita of about US\$600 to 600 GJ for UAE, which had an annual GDP per capita of about US\$50,000. The relationship between annual GDP per capita and annual energy consumption is very linear when the latitude corrections are applied. The bottom line is that on a global scale wealth is increasing and with it the demand for energy. This would not necessarily be a serious issue but as the demand for energy increases, the greenhouse concentrations in the atmosphere increase, the global temperatures increase, and in a double whammy, the energy resources become depleted. At present about 80 percent of the world's energy is derived from non-renewable sources (oil 34 percent, coal 25 percent and gas 21 percent) and these sources are running out quite rapidly. Peak oil production will be reached before 2010, with gas production to peak later in this century. Even coal production may well peak in a similar time frame. So the future for energy supplies does not look good, even without global warming. And what does this mean in terms of the future of human life on Earth?

Food: The food scenario is very similar. In the last two years the price of food has soared; for example, prices for both wheat, and oils and fats have doubled. The reasons for this are not

hard to see. The global population is increasing rapidly, the wealth of most of the inhabitants is also increasing and therefore global demand is rising. Although research outcomes have increased crop yields, they are not making any more arable land. In fact the area available for agriculture is diminishing with the relentless spread of urban areas. There is also strong competition in the food markets. Do you feed people or do you feed cars? And the farmer will always go for the highest price. So it seems to me that the days of the forests are numbered. The pressure for food will just to be too much.

Then there is water. We all know that we are not managing the world's water resources sustainably. And when we need 20 tonnes of water to produce one kilo of coffee, 11 tonnes to produce a hamburger and 7 tonnes to produce a T-shirt the problems become just a little clearer.

Furthermore we have climate change, and this is where global warming will make a huge impact, because the climates in the regions where food is grown are changing very rapidly. Perhaps the greatest impacts will be in areas where the glaciers are melting. In India and Pakistan, for example, the melting of the Himalayan glaciers will remove the water stored in the ice, so there will be heavy rains during the monsoon periods and then drought in the winter months because there will be reduced flow in the rivers. In Australia we will miss out on the winter rains in the Sydney/Perth latitudes and even the hardy grape will be affected. Even now heat stress in the Riverina is reducing the value of the crop there.

What are the outcomes? I hope I am wrong but I can see a future where competition for food and energy will become so intense that the world will become a more dangerous place to live.

Oil and politics have never been far removed. The Soviet Union collapsed when its oil revenues dried up after Saudi Arabia flooded the market with cheap oil. We saw the politics of oil in Iraq, where oil supplies were certainly part of the rationale for the invasion in 2003. If we are not careful we will see the strong countries using military power to obtain resources whether they are food or oil. And we will see the same situation with water. I cannot see how there will not be armed conflicts over water – there is just too little of it to go round.

The military options will become more common in a more desperate world. As Sydney Harris said: “*Terrorism* is what we call the violence of the weak, and we condemn it; *war* is what we call the violence of the strong and we glorify it”. Be prepared for more of the same. We should also bear in mind that humans do not have a good track record for solving major problems. From the first Easter Islanders chopping down all the trees and ensuring that they could not escape, to the death and destruction caused by an assassin's bullet in Sarajevo in 1914, humans have not behaved well. Wars have usually been fought for misguided reasons.

So we must: Persuade governments to adopt a sustainable population policy to reduce pressure on resources. Make a serious effort to generate more useful energy from the Sun – after all 1 kW/m² over the surface of the Earth provides a lot of energy. Encourage governments throughout the world to introduce carbon taxes. Continually push for policies that encourage, rather than discourage, more efficient energy use. Make a big effort to use our water resources more efficiently and here is the tricky bit. Manage all this when, whatever we do in Australia, will be dwarfed by the developments in India, China and the rest of the world.

Biographic note: David is the Editor of the Australian Society for Exploration Geophysicist's *Preview* magazine. He has spent over 40 years involved with many aspects of the Earth

Sciences and has worked in both industry (with BP) and government - with BMR and the Australian Geological Survey Organisation (now Geoscience Australia). When he retired in 1999 he was Chief of the Minerals Division of AGSO. Previously he was Chairman of the Governing Council of the International Seismological Centre 1994-97; President of the Geological Society of Australia 1996-98; Vice-President of the Federation of Australian Scientific & Technological Societies (FASTS) 1999-2003; and President of the Australian Geoscience Council 1999-2004. He has served on the Boards of three cooperative research centres and in 1984 he became a Member of the Order of Australia, for Service to Seismology. He has published many papers on topics such as earthquake seismology, crustal structure, stress patterns in continental terranes, geothermal energy and improving signal-to-noise ratios in seismic recordings.

Human and political scenarios on a warming earth

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I forecast sequential disruptive economic crises - societal tipping points. I cannot say when, because crises are ipso facto unpredictable in time (cf. chaos theory).

Disruptive global warming is now inevitable, because governments' CO₂ emission reduction measures will always be too little, too late. The global warming crisis worsens in step with the growing hydrocarbons scarcity crisis, each exacerbating the other. Having passed peak oil, we now see disruptive oil price gyrations around an exponentially accelerating price trend. Producer cost inflation leads to sequential market panics, industry failures, recessions. At a certain point, the finely-tuned international market economy will lose its collective nerve - a global Great Depression.

Food –the most climate-dependent and energy-intensive commodity – is becoming relatively more expensive. Relative demand for discretionary goods and services will decline, as household budgets are exhausted by basic needs, and as relative prices move in response to climate change and hydrocarbons scarcity. The poor will feel it first, the rich will insulate themselves longer. Eventually, a disruptive economic simplification will take hold across societies - whole industry sectors will fade away. Large numbers of workers will become redundant, unemployable in market economies. Yet society will need to sustain high-tech capacities in renewable energy [RE], in science and technology, in IT and communications, in public health and medicine. How will society choose what technologies and production resources to retain, what to sacrifice?

International politics will become more ruthless: forced population movements, border security wars, or energy/water/food-growing basin resource wars. Wars will exacerbate environmental pressures on a warming and hydrocarbons-exhausted planet. Disruption will occur within poorer sovereign states. Some states will collapse into local feudalism. Those that survive will become command societies.

Free-market economic rationalism (FME) cannot help manage these disruptive transitions, because it assumes smooth substitutability of production and consumption, under unlimited natural resources and orderly markets. FME has no answers for declining natural resources, hydrocarbons scarcity, and socio-economic disruption.

In production, non-renewable energy [NRE] will be progressively replaced by new combinations of RE and human labour: a new Industrial Revolution, reversing 300 years of labour-saving technology through NRE. We will have to retro-engineer society towards a new world of RE combined with labour-using technologies. In the end, there should be enough RE to support a decent mass standard of living - we will not need to live sick and hungry in cold dirty caves. But it will be a vastly different work-leisure environment. Trying to hold onto everything exactly as we have it now, resisting necessary lifestyle changes, will make the inevitable transitions more disruptive. The risk is in getting from here to there. Will we move harmoniously to a new lower-energy sustainable production-consumption equilibrium, a RE plus human labour world? Or through failure to adapt, will we destroy our chances of a stable civilised society? Our species must learn to recognise what is happening, to cope cooperatively and compassionately with massive changes, or we will go mad. In the worst case, there could be an unravelling of the whole global system, and its replacement by local nihilistic "Mad Max" style tyrannies, permanently at war and in socio-economic decline.

Useful policy models that might help us to keep our heads:

1. The Christian/Buddhist/secular common humanity ethical vision. As free-market neo-rationalist economics breaks down, we have to hand this alternative ethical vision of society, based on an ideology of compassion, altruism and common global humanity. We have nothing else.
2. Maintenance of international cooperation based on an international rule of law and supporting international institutions.
3. Keynesian economics. As consumer demand declines, channelling idle labour and plant into well-planned physical restructuring for RE and sustainable production capital works. Starting early will be an antidote for despair, offering a hopeful vision
4. War economics. Britain and Germany have useful WW II experience of managing scarcity while maintaining cohesion and order. The most severe phases of RE restructuring will be akin to a war crisis and will call for similar levels of social discipline
5. Decline and fall of the Roman Empire, a useful case study of how a complex finely balanced unitary "global" system disintegrated into a multiplicity of simpler, more locally self-sufficient societies.

Biographic note: Tony Kevin retired from the Australian foreign service 1998, after a 30-year public service career during which he served in the Foreign Affairs and Prime Minister's departments, and was Australia's ambassador to Poland and Cambodia. He is currently an honorary visiting fellow at the Australian National University's Research School of Pacific and Asian Studies. He has written extensively on Australian foreign, national security, and refugee policies in Australia's national print media, and is also the author of the award-winning book *A Certain Maritime Incident: the sinking of SIEV X*. His other publications include *Walking the Camino: a modern pilgrimage to Santiago*. He is writing a third book, *Portraits in Diplomacy*.

The trial of crimes against the Earth

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Since global warming first attracted widespread interest in the late 1980s and early 1990s, economists have had a substantial influence on policy debate and direction. A relatively small band of conservative economists undertook cost-benefit analyses on climate change, concluding that the optimal course of action would be to postpone significant abatement until later decades when the social cost of carbon increases as warming intensifies. This evidence provided a convenient excuse for governments, which were already reluctant to act, to stall abatement efforts. It also reinforced perceptions amongst many policy makers that climate risks were often exaggerated.

The response from some who were eager to see more aggressive near-term abatement was to undertake their own cost-benefit analyses. The work of Sir Nicholas Stern and William Cline are the two standout examples. The Stern Review in particular was critical in reframing the climate debate in late 2006 and 2007.

The resulting tit-for-tat utilitarian debate on the merits of near-term abatement is based on unstable ground. The estimates of the social cost of carbon devised by both sides are unreliable as a guide for policy making. Their greatest technical weaknesses stem from the scientific uncertainties and the subjective elements of the exercise, typified by the attempts to price non-market impacts and devise appropriate discount rates. The marginal abatement cost estimates suffer from less uncertainty, but there is still a significant range of projected outcomes.

At a more philosophical level, the utilitarian ethic that underpins the cost-benefit approach is challengeable. It suggests that the impacts on minorities and those who bear little responsibility for the problem are irrelevant provided overall global welfare is maximised by adopting the desired course of action. This approach runs counter to international legal principles concerning the rights of states to territorial integrity and the so-called “no harm rule”, which requires that states ensure that activities within their jurisdiction and control do not harm the environment of other states and areas beyond national jurisdiction. Under domestic law, tort actions like negligence and nuisance provide rights for citizens that may form the basis for legal actions against governments and polluters.

Beyond existing legal principles, there is an ethical argument that communities and states have a right to life and environmental security. This concept could be extended to species and ecological communities. The most realistic expression of this rights-based ethic is that people should not threaten the stability of an essential global common and thereby transfer risks onto others (including future generations) when there are economically viable alternatives that would support their material aspirations (i.e. the rights to life and environmental integrity are qualified by reasonableness and proportionality). This is more consistent with existing international legal principles concerning the no-harm rule as it applies to climate change. Rawlsian-derived ethics suggest another possible decision rule: assuming at least a mild aversion to the risk of a climate catastrophe and that climate decisions are made behind a veil of ignorance as to societal and generational position, what level of mitigation and adaptation would the rational self-interested decision-maker choose? Logic suggests the outcome would be greater near-term abatement than has been taken to date.

The legal and ethical arguments that support more aggressive near-term abatement have largely been ignored by policy makers, both in Australia and abroad. Many governments have steadfastly refused to acknowledge the risks associated with climate change and have acted accordingly. Others have been trapped in a prisoners' dilemma; expressing a willingness to respond but stalling until others lead. The result has been a clotting of the policy arteries, leading to skyrocketing emissions and further postponement of adaptation measures.

Meanwhile, the natural sciences have continued to provide alarming information about the state of the climate system and the resulting impacts. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) contains data on stabilisation scenarios that includes climate-carbon cycle feedbacks that have been excluded from previous modelling. The data suggest that the window for avoiding a climate catastrophe (e.g. warming in excess of 4°C) may be closing rapidly. In the jargon of the utilitarians, it appears the date at which the climate system pushes the social cost of carbon beyond the marginal cost of abatement may have already arrived.

Given the nature of the scientific data and the ongoing refusal of most governments and major emitters to take decisive action, are there grounds for governments, companies and individuals to be held accountable for "crimes against the Earth"? This paper will explore this possibility, with reference to new phrases like "climate genocide" and "climate refugees". The paper will cover existing grounds for legal liability at the international and domestic levels and discuss whether there should be laws governing "climate criminals".

Biographic note: Andrew Macintosh is a Research Fellow at The Australia Institute. He has a combined Bachelor of Commerce and Bachelor of Law degree from the University of Sydney and a Graduate Diploma in Environmental Studies from the University of Tasmania. Andrew has worked as an environmental adviser to the Australian Democrats and as a legal and policy adviser at the World Wide Fund for Nature Australia. He also has had approximately five years experience in legal practice specialising in environmental and planning law. Andrew taught law at several colleges at Cambridge University in 2004-05 and he is currently completing a part-time doctorate on the history of the High Court of Australia during the war years. His publications include papers on federal environment law, property rights in land and water resources, the politics of environment groups, schools and discrimination.

Spin, obfuscation and climate change

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The history of the response to climate change best illustrates the three stages of environmental awareness: (1) The denial that a problem exists and an attack on the messenger; (2) Acceptance that the problem exists; challenge the science and argue the primacy of the economy, and the disaster that will follow if the necessary responses are taken; (3) Accept the problem as self-obvious, which of course needs urgent action and identifies many business opportunities.

The world has not been caught by surprise by global warming. Scientists have been warning of the impending problem for decades. The Australian Conservation Foundation began campaigning on the issue in the mid-1980s, along with the Commission for the Future. The initial reaction of business and those politicians who served them ranged between

dismissiveness and hostility. Coal industry began its early moves to dismiss the concern at the same time as the nuclear industry began to realise opportunity in describing climate change as the greatest threat to world, with nuclear power as the only answer.

We are now aware of the huge influence that industry companies and their lobbyists exert in manipulating political opinion and policy. The paper will examine some examples in both the US and Australia. It looks at the positive impact of well-informed public opinion on the decisions of governments and even their overthrow.

Biographic note: Phillip is one of Australia's best known environmentalists. He was formerly Head of the Australian Conservation Foundation and Deputy Secretary of the Commonwealth Department of Environment. From 1994 to 1997, Phillip was Deputy Secretary in the Commonwealth Department of Environment, where he played a major role in the international policy arena on issues such as biodiversity, sustainable development and climate change. Between 1992 and 1994 Phillip was a visiting Fellow at Australian National University, where he taught environmental law and policy, wrote the book *The Reluctant Nation* and developed the national ABC radio series based on the book. Between 1986 and 1992, Phillip was Executive Director of the Australian Conservation Foundation, where he led successful campaigns on mining in Kakadu, the Wet Tropics, Antarctica, and began the long process of merging green and Aboriginal partnerships. He also developed the National Land Care program with NFF head Rick Farley, a movement that has radically changed land use practices in Australia and that is now moving to Africa and America. Before ACF, Phillip spent 14 years in the desert, first as a schoolteacher in a remote Aboriginal community at Haast Bluff, and then as the first lawyer for the Pitjantjatjara Aboriginal people. During that time, Phillip successfully negotiated the passage of the Pitjantjatjara Land Rights Act, and then led the negotiations for the traditional owners of Uluru (Ayers Rock), resulting in them receiving title to the National Park. The leaseback arrangement and the joint management arrangements for the Park were a world first, and are used as a model today around the world in reconciling Indigenous and environment issues. Phillip is President of the Australian Bush Heritage Fund and serves on the Lake Eyre Basin Coordinating Committee. He is a former member of the National Land Care Advisory Committee, the Genetic Manipulation Advisory Committee, Australian Population Council, the Prime Minister's Ecologically Sustainable Development Round Tables, and a Murray Darling Basin Commissioner.

The phenomenon of denial with reference to climate change

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As a movement, “greenhouse denial” fails in its claim to represent a viable alternative science because it ignores its own internal inconsistencies. In my book, *Twisted* [3], I take pains to distinguish this from the skepticism that is essential for the progress of science. In discussing greenhouse denial, I want to consider the context, the motivations, the methods and the institutional aspects.

The most important context for greenhouse denial is the question of “when?”. When did legitimate skepticism, as opposed to denial, cease to be possible? Certainly, not with Arrhenius’ 1896 paper. Hopefully, Arrhenius’ estimate that doubling CO₂ would cause a 5 °C warming is an underestimate. The main significance of Arrhenius’ work today is to show that the dominant physical processes involved in the greenhouse effect are not incomprehensibly complex.

Crucially important for providing a justification for concern and action was the work of Dave Keeling in measuring CO₂. By the early 1960s he had shown that human activity could change the composition of the atmosphere on a global scale. These results provided a new view of humanity’s place in the world, which has justly been compared to the changes in perspective created by Nicholas Copernicus, Charles Darwin and, in Freud’s opinion, by Sigmund Freud.

A report by W. Kellogg in 1977, endorsed by the World Meteorological Organization’s Panel of Experts of Climate Change, suggested a 3 °C warming by 2050 [8]. This reality contrasts with the oft-repeated denialist myth that in the 1970s scientists were predicting an ice age, a claim apparently based on one scientific paper and an equivocal article in *Newsweek*.

In Australia we had the work of The Commission for the Future from 1986 to 1996, one of whose major successes was raising the public profile of the threats of global warming. Of greater global significance were the 1985 declaration of scientists at the Villach Climate Conference and the 1988 testimony to US Congress by James Hansen, to the effect that global warming was happening. Since 1990 the Intergovernmental Panel on Climate Change (IPCC) has reported every 5 or 6 years with assessments on the science of climate change. This represents a mobilisation of scientific effort on an unprecedented scale. Thus, while there is no precise date at which “greenhouse denial” ceased to be a scientifically-credible position, by the second half of the 1990s, there was overwhelming evidence for both the reality of human-induced global warming and the inconsistency of skeptics’ positions.

Only a small fraction of greenhouse deniers have scientific qualifications, but many of these come from geology. Some of this may reflect employment-related financial interest. Also, the study of geology may possibly foster the view that nothing on a timescale smaller than a million years matters. As Ian Plimer notes correctly, but with dubious relevance, human-induced climate change will not be as bad as natural events such as asteroid impacts.

Given the extensive distortions of climate science, it is hard to expect that those involved in greenhouse denial will be open about their motives. Apart from those with a direct financial interest in delay, some of the opposition is ideological. However, identifying this is difficult since, as noted below, one denial tactic has been to create spurious linkages between climate science vs. greenhouse denial and existing ideological polarities. One that appears from time to

time is the attempt to link climate science to genocide, either implicitly, through comparisons to eugenics, or explicitly, most recently by the Citizens Electoral Council. Often, particularly in the US, isolationism — and the spectre of world government — are used to encourage denial of a problem whose solution requires coordinated international action.

Al Gore [5] compared climate change denial to the denial of the dangers of asbestos, but made the strongest comparisons to the disinformation activities of the tobacco industry. Many of the greenhouse denial techniques follow on from those used in tobacco denial. In the US a number of the same people have been involved as “scientific experts” on first health, and then climate. The objective of tobacco denial was famously captured in the internal memo stating “doubt is our product” [5]. Apart from CSIRO appointing a former tobacco lobbyist as head of communications, the link between greenhouse denial and tobacco denial seems to have been much weaker in Australia.

The “doubt is our product” approach allows the promulgation of a range of mutually inconsistent messages. These include “warming not happening”, the warming not due to CO₂”, “warming small and benign”, “it will be cheaper to adapt than to mitigate”. There is even a fringe view that the 20th century increase in CO₂ was not due to human activity — claimed by Ian Plimer, appearing in early versions of *The Great Global Warming Swindle* and currently propounded by the Citizens Electoral Council.

Among the techniques for greenhouse disinformation described in *Twisted...* [3], are outright lies and distorted statistics. I also illustrate the role of “factoids”, statements that are true, but which actually prove nothing relevant. A related technique is “bait and switch” where a substitution of seemingly similar terminology converts a true statement into something untrue.

The “small and benign” view of human-induced global warming has long been proposed by Pat Michaels, and extensively promoted by Bjorn Lomborg. In a recent US Supreme court case, a group of “greenhouse skeptics” intervened with a brief that sought to downplay the seriousness but acknowledged that the expected warming, over the 21st century, due to greenhouse gases was 1.8°C. This had an interesting echo in Australia when four parliamentarians inserted a minority denialist appendix to a committee report on geosequestration of CO₂. Among the most prominent of their “science advisors” were two of the authors of the Supreme Court brief. Presumably those involved judged that the Parliament of Australia would be more gullible than the US Supreme Court — such cynicism does little credit to the parliamentarians involved.

A broader tactic of greenhouse denial has been to try to build wider coalitions of opposition by creating spurious linkages. Concern about climate change has been commonly, but artificially, linked to left-wing politics. In a newspaper interview, Martin Durkin, producer of *The Great Global Warming Swindle*, suggested that concern about human-induced climate change was mainly the preserve of the political left. His argument is considerably weakened by the fact that his actual “documentary” describes concern over climate change as being promoted by Margaret Thatcher to break the power of the mining unions.

Another linkage, used particularly in the US, is to portray climate science (and other areas of science) as anti-religion [6]. These linkages are often communicated using “dog whistle politics”[4], messages with key words to be understood only by target audiences. Thus when John Howard, or later Archbishop Pell, denounce “alarmism” or “scaremongering” they can, if pushed, claim to be referring to the excesses of the media, while conveying to their target audiences a suggestion that all concern about climate change is scaremongering.

Australia has generally been poorly served by the media, partly because many have accepted the spurious ideological linkages and partly because a highly polarised representation makes it easier to write engaging stories. Thus we often see alarmism on one side vs. any available piece of junk science on the other.

In 2006, a UK judgment placed restrictions on the distribution of Al Gore's movie to schools (while endorsing the key aspects of the science). *The Australian* and the *Herald-Sun* trumpeted this as a defeat for Gore, while *The Age* appeared to ignore the case altogether.

A more recent example is when the Pope called "for assessments in this regard to be carried out prudently, in dialogue with experts and people of wisdom, uninhibited by ideological pressure to draw hasty conclusions" noting "Prudence does not mean failing to accept responsibilities and postponing decisions". [1] The UK *Daily Mail* reports this with the headline "Pope Benedict XVI condemns the climate change prophets of doom". The *Weekend Australian* followed up by claiming this fabrication, cited in the *Daily Mail* as a "suggestion", was a direct quote from the Pope: "Fears over man-made emissions melting the ice caps and causing a wave of unprecedented disaster are nothing more than scaremongering".

Government participation in greenhouse denial has mainly occurred in Australia and the US, and also in Russia in the leadup to Russian ratification of the Kyoto Protocol. In the US, the main tactic seems to have been to deny the existence of human-induced global warming. In Australia, a major thrust of government influence was ignoring consideration of mitigation. This was accompanied by efforts to suppress research in such areas — easier in a relatively small country.

There are real uncertainties surrounding climate change, but the seriousness of the threats means that decisions will need to be made before the uncertainties are resolved. It has been eloquently argued that many other aspects of human decision making face much greater uncertainties [9]. My conclusion of *Twisted*, suggesting that the need to assess probabilities and risks will lead to a new round of misrepresentations in an attempt to delay action, seems increasingly likely.

1. Benedict XVI. Papal Message for World Peace Day, 2008, www.vatican.va/holy_father/benedict_xvi/messages/peace/documents/hf_ben-xvi_mes_20071208_xli-world-day-peace_en.html
2. M Durkin (producer) *The Great Global Warming Swindle* (television program – progressively shortened from the original 90 minutes as the more outrageous claims were deleted).
3. IG Enting. *Twisted: The Distorted Mathematics of Greenhouse Denial*. I Enting/AMSI, 2007.
4. J Fear. "Below the Radar: Dog-Whistle Politics in Australia". *Discussion paper 96*, The Australia Institute, 2007.
5. A Gore. *An Inconvenient Truth*, Bloomsbury Publishing, 2006.
6. A Gore. *The Assault on Reason: How the Politics of Fear, Secrecy and Blind Faith Subvert Wise Decision-Making, Degrade Democracy and Imperil America and the World*, Bloomsbury Publishing, 2007.
7. C Hamilton and S Maddison. *Silencing Dissent: How the Australian Government is Controlling Public Opinion and Stifling Debate*, Allen & Unwin, 2007.
8. WW Kellogg. "Effects of Human Activities on Global Climate", *Technical Note 156*, World Meteorological Organization, 1977.
9. HM Pollack. *Uncertain Science...Uncertain World*, CUP, Cambridge, 2003.

Biographic note: Ian Enting is a Professorial Fellow at the ARC Centre of Excellence for Mathematics and Statistics of Complex Systems, supported in part by CSIRO. He worked in CSIRO Atmospheric Research from 1980 to 2004, participating in the CRC for Southern Hemisphere Meteorology from 1993 to 2000 and more recently in the development of the CSIRO Complex Systems Emerging Science Activity. He was one of the lead authors of the chapter "CO₂ and the Carbon Cycle" in the IPCC report *Radiative Forcing of Climate Change*, and is the author of over 140 scientific papers in carbon cycle studies, statistical physics and other aspects of complex systems. His book *Inverse Problems in Atmospheric Constituent Transport* was published by CUP in 2002.

Homo sapiens' war against nature

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There are inherent tensions in this topic; since the publication of Charles Darwin's *The Descent of Man* in 1871, we know human beings are a product of nature. We are also an integral part of nature. Like other animals we are totally reliant on plants and thus on nature for our food, oxygen, etc. Any fight against nature is also, therefore, a fight against at least a part of ourselves, and against the plants and ecosystems, as well as the other animals we depend on. Translated from Latin, "Homo sapiens" means "wise human [being]". If we are part of nature yet simultaneously fighting it, we cannot possibly be wise. But that is what we are doing. Examples of our fights against nature are legion:

Extinction crisis: Scientists agree the world faces mass extinction. The complex web of life on Earth, what scientists call "biodiversity," is in serious trouble. A quarter of mammals "ace extinction" within 30 years, according to a United Nations report. Lions are "close to extinction". Lion populations have fallen by almost 90 percent in the past 20 years, leaving the animal close to extinction in Africa, Laurence Frank, a wildlife biologist from the University of California, has warned. A new global study concludes that 90 percent of all large fishes have disappeared from the world's oceans in the past half century, the devastating result of industrial fishing.

These are enormous, irreplaceable losses. Each species represents the outcome of billions of years of gradual and punctuated evolution. The current rate of species loss is 100 to 1000 times the natural background rate. We are in danger of losing within decades half of all life forms, when possibly many more species than are known are as yet undescribed by science. The living web of life with all its interdependencies is being torn apart, with what consequences? This sixth such crisis is as bad as that which led to the extinction of the dinosaurs some 65 million years ago! These losses also amount to irreparable information losses. The repeated destructions of the Library of Alexandria, particularly the one by the Christians around the year 390 of the Common Era (CE), resulted in loss of some 500,000 manuscripts. The loss of any one population and species is equivalent to such a loss, yet we are losing species hourly. Genetic sequencing of individual animals or plants cannot possibly capture the diversity essential to the survival and maintenance of the species they sample.

Pollution crisis: *Marine:* 90 percent of Asia's sewage is discharged into the marine environment waters without treatment, threatening fisheries, mangrove forests, coral reefs and coastal wetlands. Plastic bags and their breakdown products are at a density of over one per cubic meter in many parts of the world's oceans down to a depth of 2 km. They may take up to

500 years to disintegrate. Meanwhile they kill and go on doing so. Degraded plastic pieces outweigh surface zooplankton in the central North Pacific Ocean by a factor of 6-1. That means six pounds of plastic for every single pound of zooplankton. *Land-based pollution*: Many regions are running out of land-fill sites. Toxic sludge and materials are exported to developing countries and dumped there, often with disastrous consequences, including deaths. Spin-doctors are often cheaper than remediation, leading to such incisive books as: *Toxic sludge is good for you: Lies, Damn Lies and the Public Relations Industry* by John Stauber.

Population crisis: Population growth causes ecological, economic, and social problems, including: overexploitation, e.g. overgrazing; resulting soil erosion and loss; rapid urbanisation; inadequate employment and service provision; slum ghetto development; increased drug use in response to social stresses; heightened criminality and lawlessness. Population growth rates don't generally level off without undesirable ecological, economic or social stressors, e.g. pestilence, diseases and epidemics; famine; war. These stressors lower both survival rates and life's quality. The earth's carrying capacity, meanwhile, is decreasing, due to accelerated destruction of environment and resource depletion. Solutions include: delay of childbearing; small families; conscious regulation of fertility; repeal of legislation that restricts or hinders contraception, abortion, or sterilisation. Quality, not quantity of life, must be emphasised.

Resource extraction crunch: Peak oil has been in the news for years. At the time of drafting this abstract (11 March 2008) the price per barrel stood at \$US 107.20 and rising. What is the latest price? Phosphorus, an essential nutrient, is becoming ever scarcer since guano islands such as Christmas and Nauru have been mined to exhaustion.

Physical assaults on the environment: *Soil erosion*: I well remember the carved inscription in a Kapunda shed teetering on collapse because the soil had washed away both field and around its stumps: "Thanks dad for the farm, but where's the soil?" *Salinisation*: This is the buildup of salt within the soil. It is one of the greatest environmental threats facing Australia today. Salinisation could devastate up to 12 million hectares of land during this century. It already costs at least \$500 million a year in Victoria alone. *Waterlogging*: This occurs when excess water accumulates in the root zone, preventing plants from obtaining adequate oxygen. It is often associated with over-irrigation of agricultural areas. "Waterlogging" is the state of land in which the subsoil water table is located at or near the surface so that the yield of crops grown on it is reduced, or the land cannot be put to its normal use because of the high water table. *Ecosystem destruction*: This comprises clear-felling of old growth forests; agricultural conversion of native ecosystems, including: grasslands, mallee, shrublands, swamps and forests; bottom-trawling of marine areas; mining of important habitat, including cave systems. *Biological assaults on ecosystems, habitats and gene pools comprising:*

- weed introduction and spread, both deliberate, e. g: Salvation Jane, also called Patterson's Curse and Rosie Dock, and accidental, e.g. Chilean Needle-grass
- Feral animal introductions, both deliberate, e.g.: rabbit, hare and fox, deer, blackbird and Indian mynah, and accidental, e.g. domestic cat, Black and Norwegian rat
- Genetically engineered organisms. Each species' gene-pool is an internal ecosystem of interacting and interdependent genes. Simplistic gene substitutions can lead to complex consequences

Conclusion: Either we are not wise, have misnamed our species and will face the fate of the Easter Islanders, or we will learn from them and avoid the worst of the collapse of our civilisation and that of the Earth's current ecosystems.

Biographic note: Dierk von Behrens studied Agricultural Science and Arts, was a high school teacher and an education officer at the South Australian Museum of Natural History. He became a lecturer on Australia in Germany, served on the secretariats of the Committee on Overseas Professional Qualifications, and later on the Australian Population and Immigration Council. He was an Australian consul in New York and Toronto, and administered aspects of the Adult Migrant English Programs and humanitarian settlement schemes. He was a founding secretary of the Humanist Society of South Australia, and became president of this Society in the ACT branch. He contributes to *The Australian Humanist* and *Green – The Magazine of the Australian Greens*. He was vice-president of the Conservation Council of Canberra and the SE Region before standing for the Greens. He is active in the establishment and/or expansion of several conservation areas.

SESSION D: THE ORIGINS OF HOPE

A biorenaissance: the hope for the future

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1. Biorealism. This paper begins with three truisms:

- We humans are living beings – products of nature – and totally dependent on the processes of life, within us and around us, for our very existence
- Life processes underpin, permeate and make possible our whole social system and everything that happens within it
- Keeping these processes healthy must be our first priority – because everything else depends on them.

The dominant culture of our time has lost sight of these fundamental realities. They are not reflected in governmental policies, political platforms, the structure of educational programs or the lifestyles of the majority of people

2. Gloom and doom. Global climate change is currently the most critical of many very serious symptoms of an overall societal malady arising from the massive and rapidly increasing scale of human impacts on the natural environment. Humankind is overstepping the mark on this planet on a massive and frightening scale.

The great surge in the number of people on Earth and the explosive intensification of resource and energy use and waste production are causing serious progressive damage to the planet's ecosystems. The human species is now using about 12,000 times as much energy and discharging about 12,000 times as much CO₂ as was the case 450 generations ago when our ancestors started farming. Ninety percent of this increase has occurred in my own lifetime.

It does not take much imagination to appreciate that there must be a limit to the amount of damage that human society can do to the ecosystems of the natural environment before they cease to support us. The biosphere – as a system capable of supporting our civilisation – will not tolerate this onslaught indefinitely. If present trends in population and human activity continue, the ecological collapse of society is inevitable. The crucial question is: How far are we from reaching these limits?

3. Hope for the future. The survival of civilisation and the future wellbeing of humankind will require big changes in human societies across the world.

We must move rapidly towards a new kind of society that is based on understanding and respecting the processes of life and that satisfies the health needs of all sections of the human population as well as those of the ecosystems of the biosphere on which we are all totally dependant. We call this a “biosensitive society”.

A biosensitive society will be in tune with nature – in tune with our own biology and in tune with the living world around us.

This will mean changes right across the board. A biosensitive society will be characterised by biosensitive lifestyles, biosensitive governments, biosensitive technologies, biosensitive farms, biosensitive transport systems, biosensitive design and a biosensitive economic system.

In a biosensitive society, top priority will be given in governmental and corporate decision-making to the health and wellbeing of both people and the natural environment.

The achievement of a biosensitive society will require reversing the current spiral of resource and energy use and breaking free from the treadmill of consumerism. And all responses to global warming must be biosensitive. It will also mean moving towards a smaller human population.

The paper will include a brief summary of the essential characteristics of a biosensitive society (e.g. population levels, patterns of energy use, lifestyles and the economic system).

A biosensitive society will mean healthier people and a healthier and safer planet.

4. Achieving this hope. What are the chances of the processes of cultural reform overcoming the current cultural maladaptations? The reform movement is, of course, already underway. But it has a very long way to go. The crucial question is: Will it proceed quickly enough to prevent massive irreversible degradation of the living systems of our planet that support us?

I am personally convinced that there will be no effective move towards biosensitivity unless and until there comes about a revolutionary transformation in our dominant culture. It will not come about unless and until this culture comes to embrace, at its heart, a basic understanding of the processes of life and of the human place in nature, and as a consequence of this understanding a profound sense of respect for the living world.

Let us call this *biunderstanding*.

I am talking here not just of an increase in environmental awareness, but rather of a dramatic shift in the dominant culture's world view and priorities that is in keeping with the fundamental realities with which this paper began.

It will be a culture that totally rejects the ecologically insane and ultimately suicidal ideology of evermoreism that is so characteristic of the dominant culture of our society today (i.e. the cultural delusion that human welfare necessarily requires an ever-increasing consumption of material goods). Biunderstanding has immense practical meaning for every human individual and for society as whole. By far the most urgent need at the present time, therefore, is in the realm of education, at all levels and right across the community – including, of course, politicians.

We must aim for a society in which biunderstanding is part of the shared knowledge of all people. Only then will there be sufficient appreciation of the urgent need for change and sufficient motivation to take the necessary steps to achieve biosensitivity – and hence ecological sustainability, equity and the survival of civilisation.

The paper concludes with the assertion that this new understanding is unlikely to come about unless we create a new kind of institution in our midst – an institution with a focus is on life and the health of living systems (including humans) and which:

- promotes understanding across the community, of the story of life on Earth, of the human place in nature and of the health needs and interdependencies of humans and of the ecosystems on which we depend
- promotes the concept of a biosensitive society
- provides a framework for lively creative discussion and debate about how to achieve a biosensitive society – communicating the outcome widely through the internet and the media
- provides opportunities for convivial social interaction and for celebrating life on Earth – through music, song, dance, art, photography and other creative and enjoyable activities.

Biographic note: Stephen Boyden graduated in Veterinary Science in London in 1947 and received his PhD in immunology from the University of Cambridge in 1951. He worked for a year at the Rockefeller Institute in New York (1949-1950), and for a year at L'Institut Pasteur in Paris (1951-1952). From 1952 to 1960 he was in charge of the World Health Organization's Tuberculosis Immunization Research Centre in Copenhagen. He then moved to the John Curtin School of Medical Research at the Australian National University (ANU) in Canberra, where he continued his research in immunology until 1965. He was elected Fellow of the Australian Academy of Science in 1996. From 1965 to his official retirement, Boyden, as Professorial Fellow at ANU, engaged in research and writing in human ecology and biohistory. In the early 1970s he initiated and directed the Hong Kong Human Ecology Program, which was the first comprehensive ecological study of a city. He also initiated the undergraduate Human Sciences Program at ANU in the early 1970s and was in charge of this program for its first three years. He was a UNESCO consultant to the Man in the Biosphere Program from 1973 to 1989, and from 1988 to 1990 he was leader of the Fundamental Questions Program at the Centre for Resource and Environmental Studies, ANU. He was elected Fellow of the Royal Society of Arts (UK) in 1990. Soon after retirement in 1990 Boyden founded the Nature and Society Forum. This is a non-profit NGO committed to (1) improving understanding across the community of the processes of life and human and ecological health; (2) promoting the concept of a biosensitive society; and (3) encouraging informed discussion and debate about the social changes necessary to achieve ecological sustainability, population health and equity. In 1998 Boyden was awarded Membership of the Order of Australia. He is at present Visiting Fellow at the John Curtin School of Medical Research, ANU. Apart from numerous scientific papers, Boyden has published the following books: *The impact of civilization on the biology of man* – as editor (ANU Press); *The ecology of a city and its people: the case of Hong Kong*, with S Millar, K Newcombe, B O'Neill (ANU Press, 1980); *Western civilization in biological perspective: patterns in bio-history* (Oxford University Press, 1987); *Our biosphere under threat: ecological realities and Australia's opportunities*, with S Dovers and M Shirlow (Oxford University Press, 1990); *Bio-history: the interplay between human society and the biosphere – past and present* (UNESCO and Parthenon Press, 1992); *The biology of civilization: understanding human culture as a force in nature* (UNSW Press, 2004); *People and nature: the big picture* (Nature and Society Forum, 2006). A book entitled *Learning from nature: pathways to a biosensitive society* is in preparation.

The philosophy of hope

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"Sweet are the uses of adversity,
Which, like the toad, ugly and venomous,
Wears yet a precious jewel in its head;
And this our life, exempt from public haunts,
Finds tongues in trees, books in the running brooks,
Sermons in stones, and good in everything."

As You Like It. William Shakespeare.

In Greek mythology, Zeus presented the first mortal woman, Pandora (meaning all gifts), with a box, from which escaped all the evils that beset humankind, leaving Hope behind in the box. Apollo bestowed on Cassandra, daughter of the King of Troy, the power of prophecy, but since she did not return his favours, he decreed that, while she would always tell the truth, no one would believe her. Until recently, climate scientists have suffered a similar fate.

Hope implies perseverance - i.e. believing that a positive outcome is possible even when there is evidence to the contrary. In literature, concepts of hope vary from Alexander Pope's *Essay on man*: "Hope springs eternal in the human breast", to Dante's *Inferno*: "Abandon hope all ye that enter here".

False hope, believing that a situation can easily be fixed, and despair, implying that no solution is possible, are just as dangerous as denial, since they lead to inaction. True hope may be realised by steering a course between false hope and despair, as did Odysseus between the twin perils of Scylla and Charybdis.

In clinical medicine, hope shared with the physician, nurse, relatives and friends can be an important contributor to recovery in patients who are critically ill. Hope has also been vital for the survival of individuals, societies and nations under conditions of privation and conflict.

Climate change is the result of human-induced acceleration of planetary entropy, through a combination of profligate combustion of ancient solar capital stored as fossil fuels and destruction of photosynthetic carbon sinks, which have hitherto kept atmospheric gases in balance. Climate change outcomes are complicated by the arrival of Peak Oil, which could have negative or positive effects, depending on human responses to the energy crisis.

Hope lies in the harnessing of social and political will to slow the entropic process by conserving and restoring carbon sinks and by introducing a suite of clean renewable energy technologies, while improving energy efficiency and reducing waste throughout construction, agricultural, manufacturing, domestic and transport sectors.

Energy initiatives will include progressive replacement of fossil energy capital by the capture and transmission of endlessly renewable solar currency, directly and indirectly, both at central and local locations. Contrary to some economic and political opinions, such measures will not necessarily "harm the economy", but will rather provide many employment and export opportunities. Excessive fossil fuel subsidies, which constitute the greatest case of corporate

welfare in economic history, will need to be transferred to provide incentives to create a sustainable energy future.

Generation of the present environmental crisis might be described in terms of the four "Ps" - Population, Poverty, Pollution and Preparation for warfare. Its mitigation may be summarised as the wise application of the four "Es" - Enlightenment, Ecology, Education and Ethics.

Our best hope for the future lies in the younger generation, many of whom are disenchanted with our materialistic hyper-consumption ethic, and who may develop immunity to the affluenza virus more readily than their parents. Frugality was successfully achieved in wartime Britain. Indeed, the evidence is that, provided deprivation is not too severe, human wellbeing and the capacity for creativity and community bonding are enhanced by the challenge of adversity and changing lifestyles. Successful reduction in civilian energy consumption and equitable distribution of resources during wartime was a necessary prerequisite for the survival of a nation. Global reduction in inequalities and replacement of dirty, wasteful non-renewable energy by a clean renewable energy economy will be necessary for the sustainability of our own and countless other species.

Despite the prevailing human destructive behaviour against our own species and the biosphere, a philosophy of hope might reside in the recognition and application of the ABC of enlightenment, namely, Awe, Beauty and *Caritas* (caring with acted responsibility) - for people and Nature. Only then can some of the evils be returned to Pandora's box and the self-appointed accolade *sapiens* applied to genus *Homo* be justified.

Biographical note: After Manchester Grammar School, Bryan Furnass acquired his basic education in physiology and "internal medicine" at Oxford University and the Middlesex Hospital, London, where he conducted research on human energy metabolism. Immigrating with his family to Australia in 1960, Bryan practised for a year in the Goulburn (NSW) Medical Clinic. He moved to Canberra in 1961 as a consultant physician in private practice. In 1966 he was appointed Foundation Director of the Australian National University Health Service, with a bias towards preventive medicine and health promotion. He was made a Member of the Order of Australia in 1994 for services to health education and promotion. On retiring from clinical practice, Bryan developed an interest in what he likes to call "external medicine", recognising the important interdependence between health of humans and health of the natural environment, particularly in relation to climate change. He has arranged conferences and publications on applied exercise physiology, health and wellbeing, infectious diseases, nutrition, and sustainability.

Hope in the face of dire threat

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The lesson from history is clear. There have been societies that have continued blindly with their quests for status, power and control, oblivious to the approaching collapse that soon engulfed them. There have been other societies that have foreseen peril, faced up to it, and escaped a collapse. We are in peril. Can we face up to our peril? Even if we face it, can we escape a collapse?

The means for our escape are available, and have been available for some time. The obstacles to reducing our emissions of greenhouse gases are not technical and economic, they are political and social.

We need not, if we are smart, revert to an impoverished way of life. We might, if we are smart, improve the quality of our lives as we save ourselves and the planet.

The first requirement for hope is to face the truth, no matter how threatening it may seem. Winston Churchill, during Britain's darkest days, set up special communication channels through which news could flow to him, no matter how bad. He realised people might find him intimidating and be afraid to tell him the worst. He recognised that he could not be effective unless he understood the situation accurately, no matter how dire. To maximise hope, he had to maximise his effectiveness as a leader.

Sugar-coating the truth leads to false hope, which leads to despair, or failure, or both. As the 2003 bushfires threatened Canberra, authorities hesitated to declare an emergency for fear of alarming or panicking residents. When the fires hit there *was* panic, and we were very lucky not to lose more people. However, as the reality became apparent, people rallied to fight the fires and to help each other. It is a mistake to try to hide the truth from people. Londoners are famous for rallying in the face of terror and defying Hitler's blitz.

Our situation is dire. Recent estimates of the "safe" limits for global warming are between 0.5 and 1°C of warming, and between 300 and 350 parts per million (ppm) of atmospheric carbon dioxide. At this moment we have 0.8°C of warming and 383 ppm of CO₂. So we seem to be beyond the safe limits. If we can reduce atmospheric CO₂ quickly, we may escape the worst. If we do not, a series of climate dominos may fall rapidly. The rapidly dwindling Arctic sea ice must be seen as the first major domino. In the worst case, which is quite plausible, the climate could be 6-8°C warmer, the world very different, up to half of our species extinct and a substantial fraction of humanity dead from famine, wars and pandemics.

We would not tolerate this level of risk in aircraft design, bridge building or even road safety.

The key to saving ourselves is to dramatically improve the efficiency with which we use energy. There are multiple beneficial spin-offs. Many improvements save money as well as energy. As energy efficiency improves, renewable energy sources become more sufficient. Wastage of other resources can be reduced at the same time, thus reducing our total footprint on our trampled planet.

Chemical giant DuPont cut its greenhouse gas emissions by over 70 percent, and *saved two billion dollars* in the process. Five other large corporations cut their emissions by at least 60 percent and saved another two billion dollars between them. Amory Lovins, energy expert and Director of the Rocky Mountain Institute, says “Increasing energy end-use efficiency ... is generally the largest, least expensive, most benign, most quickly deployable, least visible, least understood, and most neglected way to provide energy services”. A number of major studies, the most recent from McKinsey consultants, agree, documenting many ways we can quickly and cheaply reduce greenhouse gas emissions.

The key to dramatic improvements in efficiency is good design. Energy has been so cheap we simply haven't paid attention to how wastefully we use it. Europeans use only half as much energy as we do, but have a comparable material lifestyle. Houses can be built to use little or no energy. Energy efficient appliances are available in Europe. Improvements in industrial efficiency can be as simple as using fatter electrical wire, planning straight, fat pipes and air ducts and using modern, efficient pumps and fans. Billion-dollar carpet company Interface Inc. improved its resource efficiency by *a factor of six*, eliminated toxins, improved the quality of its carpets and tripled its profits.

The public discussion so far is dominated by finding new supplies to plug our wasteful habits into, rather than reducing demand. The public discussion is dominated by suppliers – who of course only want to continue supplying. But they are the problem, not the solution.

Fossil fuel and nuclear options spin off multiple problems. If energy costs go up then household bills go up, whereas efficiency could keep household bills the same. They generate fewer jobs. Carbon capture and storage is still under development. “Clean coal” would reduce emissions by perhaps 30 percent. Nuclear power would require global transportation of dangerous materials that would be vulnerable to accident or terrorist assault, wastes must be stored safely for tens of thousands of years, nuclear weapons potential would get a big boost, and nuclear power would produce only a modest fraction of the energy required. Most of all, these big, expensive, under-developed technologies would be *too late*. We must act now.

We cannot continue business as usual. We cannot continue energy as usual. We cannot continue economics as usual. We must let go of the claim that unfettered markets will deliver what we need – there is no basis in theory or practice for this great myth of our times. We must manage the incentives under which markets operate so it becomes profitable to nurture people and save the Earth, rather than being profitable to exploit people and trash the Earth - it is not as hard as it might sound. We must stop using GDP as a measure of quality of life, and stop insisting the GDP must always *grow*. In a sensible world GDP can shrink as our quality of life improves.

Here is another harsh truth we must face: consumerism is killing the planet. It is no use recycling our garbage if we allow ourselves to be manipulated into feeling we must use an SUV to get to work or go shopping.

We cannot continue politics as usual. Many of the people who have been advising governments are the problem, not the solution. Politicians must stop depending on big money, and listening to big money, and paying off big money. They must govern for every Australian, for everyone in the world, and for everyone who will come after us. They must recognise that this *is* an emergency, a *planetary emergency*. It can't wait another decade, or another year. We must act *now*.

Can we, politicians, consumers, intellectuals and all, step out of our petty competitions for status and power, stop trying to satisfy our emotional needs by buying stuff, and recognise the reality we are so desperately denying? The means to save ourselves are at hand. The hope is real. Can we act?

Biographic note: Dr Geoff Davies is a scientist, an occasional commentator, and the author of *Economia: New Economic Systems to Empower People and Support the Living World* (ABC Books, 2004). He is a Senior Fellow in geophysics at the Australian National University and has authored one hundred scientific papers and a scientific book. In 2005 he was awarded the inaugural Augustus Love medal for geodynamics by the European Geosciences Union, and he has been honoured as a Fellow of the American Geophysical Union. His day job does not directly involve either climate science or economics, but he has long experience in assessing fractious debates on difficult topics. His commentaries have appeared in *New Matilda*, *Australasian Science* and *The Canberra Times*. www.geoffdavies.com.

Premonitions of the future from art, poetry and music

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Premonitions comes from Latin *prae* – meaning ahead, or first, and – *monere/monitum* meaning to warn. Premonitions are first warnings, inklings of disaster. Yes, art, poetry and even music can deliver such pre-warnings, but in doing so they will be spreading fear rather than hope. So where's the optimism in the arts? After all, for them to be optimistic about greenhouse might be to discount it, to be complacent, to fail to warn.

I suggest that optimism lies in the reasonable hope that literature and the arts can spread the warnings, the premonitions of greenhouse disaster, so effectively that we may avoid that disaster. As well, the arts and literature can rouse, express, confirm, and strength those higher “spiritual” values that we need to defeat human selfishness and human chauvinism.

To grasp how that might be, we need to understand how the arts work—as much on the emotional and feeling side of humanity as upon its intellect—and also one very simple point about humanity. It has been said that one chimpanzee is no chimpanzee. That is, that they are social creatures, only themselves in a group. Well, humans are a bit like that when it comes to ideas. Individuals may like to claim they invented a given idea; but the reality is that the idea probably emerged out of ideas developed by hundreds of other humans; and it is unlikely to have much effect—especially if it is an idea about the need to modify everyone's behaviour, everyone's greenhouse emissions—until millions take it on board. That is why the arts and literature can be so important: because they turn mere ideas into tangible realities, sensuous constructs, about which we can have not merely opinions, but emotions. And emotions motivate behaviour. Walls, even Berlin walls—even the forts of fossil fuel-dom—tumble when art produces a change in zeitgeist.

It may seem odd to propose literature, or even the visual arts, as ways of effecting communal and governmental changes in attitude. The arts in the service of group thinking!? Surely the artist, the writer, is a high and lonely individual, a leader, never one of the crowd that follows.

Well, yes. That is the high ideal. But I'm talking about realities rather than ideals. There are artists, including some very great ones, who are like The Cat Who Walked By Himself. Judith Wright giving the Australian Conservation Foundation a dressing down for its failure to speak out on population, greenhouse, and ozone depletion was both a great artist and as an intellectual, streets ahead of many of her fellow environmentalists. But most artists are very much of their time. Their skills are in the techniques of handling their medium, and in the rousing and ordering of emotions. When it comes to scientific facts like just how few plane journeys and car journeys we can each make if the Earth is to be healed—well, they may be well informed and astute, but basically they will take advice from the experts. The arts are the chorus, not the soloist. Yet it is only when that chorus comes booming in behind the once-despairing soloists that we know the battle has been won, and a new set of cultural and, yes, moral assumptions are in place. Consider, as a first example, this piece of literary art, called "Package for the Distant Future":

*Dear Inheritor,
 Since you have dared to open this container
 you must be living in some far-distant
 unimaginable future.
 . . . The selection is not scientific, just
 flotsam and jetsam of our civilization.
 I hope you like them.
 We had a lot of things we did not like
 and could have lived without.
 Do not invent gods.
 I hope the earth is nearly clean again.
 Sow the lilac seeds in damp soil
 and if they grow and flower, and if you can,
 smell them after rain.*

by Sylvia Kantarizis

Now there are grounds for both fear, and hope!

Biographic note: Mark O'Connor is a professional poet with a special interest in the natural environment. He has published several books of poetry on regions of Australia such as the Great Barrier Reef and the Blue Mountains, often collaborating with renowned nature photographers. Mark's work is widely represented in contemporary Australian anthologies of poetry, and in international publications. For instance, in the fifth edition of Oxford University Press's massive international chronological anthology *Seven Centuries of Poetry in English* (edited by J. Leonard, ISBN 0 19 551420 3), he is allocated more space than any poet under the age of Seamus Heaney. Mark has won several national and international prizes and awards, and he has undertaken fellowships throughout the world including USA, Europe, Russia, China and India. In 1999 he was appointed H.C. Coombs Creative Arts Fellow at the Australian National University, and in 2000 he was given a grant from the Australia Council to write poetry about the 2000 Olympic Games. He is also the editor of the much reprinted Oxford anthology *Two Centuries of Australian Poetry*.

Homo Prometheus' hour of truth: the absurd, existentialism and hope

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Of all the species on Earth, only the genus *Homo* has ever mastered fire, becoming *Homo Prometheus*, proceeding to manipulate the electromagnetic spectrum, split the atom and travel to other planets. Possessed by a conscious fear of death, craving for God-like immortality and omniscience, the species has developed the absurd faculty to simultaneously create and destroy, perpetrate the demise of terrestrial forests, extinguish other species and, lately, erode the very atmospheric conditions that allowed its appearance in the first place. The biological rationale that has transformed tribal warriors into button-pushing automatons capable of triggering global climate changes or a nuclear winter remains inexplicable. The enigma is related to the little-understood process of top-to-base causation, explored among others by George Ellis, who states; "although the laws of physics explain much of the world around us, we still do not have a realistic description of causality in truly complex hierarchical structures." ("Physics, complexity and causality", *Nature*, 435: 743, June 2005):

The descent from greenhouse Earth conditions into glacial-interglacial cycles about 34 million years ago, related to CO₂ sequestration through the rise of the Himalayan and Andean mountain chains, has allowed the flourishing of mammals and eventually humans on land. By altering the composition of the atmosphere through carbon emissions, *Homo Prometheus* has triggered a return of the Earth towards the greenhouse conditions that existed 3 million years ago (mid-Pliocene: Dowsett et al., 2005; Overpeck et al. 2006) and, from current rates of emissions, potentially tracking toward an ice-free Earth at a rate many species may not be able to survive.

Homo Prometheus lives in a realm of perceptions, dreams, myths and legends, in denial of critical realities (*Janus: A summing up*, Arthur Koestler, 1978). Humans have the privilege to wake up for a brief moment from infinite universal time to witness a world as cruel as it is beautiful, a biosphere dominated by the food chain. Just as the Australian kangaroos will never learn not to cross the highways and be killed, so do humans blindly perpetrate a sixth mass extinction in the history of Earth. In metaphoric terms, a reverse relation may exist between the level of consciousness achieved by a species and its longevity, creating machines it can not control. If looking into the sun may result in blindness, so, according to as yet little-understood laws of entropy, the deep insights into nature that humans have achieved may bear a terrible price.

While individual members of the species may have a finite ability to make choices, hence the belief in *free will*, this cannot mask the blindness of the species that follows a course of evolution it cannot comprehend. If the meaning of biological sanity amounts to life-enhancing conduct, can *Homo sapiens*, polluting its planet, be defined as a viable species?

The sixth mass extinction may be understood in a number of ways, including:

1. *Homo sapiens* is a self-limiting species: overpopulation and over-exploitation of its food sources will result in environmental deterioration.
2. *Homo sapiens* is unconsciously modifying its environment through the emission of greenhouse gases in order to avoid the next ice age.

A truly intelligent species would have not overcompensated for this eventuality through the emission of more than 300 Gigatons of carbon.

Homo sapiens, being controlled by an underlying natural intelligence and information laws it only begun to perceive, has only a dim comprehension of the web of life, or *Gaia*, nor is the life of the species governed by the sense of reverence toward Earth expressed by Carl Sagan: "For we are the local embodiment of a Cosmos grown to self-awareness. We have begun to contemplate our origins: starstuff pondering the stars: organized assemblages of ten billion billion billion atoms considering the evolution of atoms; tracing the long journey by which, here at least, consciousness arose. Our loyalties are to the species and the planet. We speak for the Earth. Our obligation to survive is owed not just to ourselves but also to that Cosmos, ancient and vast, from which we spring." (Carl Sagan, *Cosmos*, 1980).

Where does hope come from?

The realisation of the enormity of the consequences of the short sojourn of *Homo sapiens* on Earth challenges every faith and ideal humans have ever held. Existentialist philosophy allows a perspective into, and a way of coping with, what defies rational contemplation. Ethical and cultural assumptions of free will, which may apply in individual lives, rarely govern the behaviour of societies or nations, let alone an entire species. But hope is possible on the scale of individual lives. As for Sisyphus, Albert Camus' hero, individual members of *Homo sapiens* are rewarded by the emergence of a conscious dignity devoid of illusions, looking death in the eye without flinching, grateful for a moment of awareness of this world. "Having pushed a boulder up the mountain all day, turning toward the setting sun, we must consider Sisyphus happy" (Albert Camus, *The Myth of Sisyphus*, 1942).

The quest for divine salvation

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Divine salvation can mean a number of things. What does the word "quest" mean in this context?

Are we seeking "a god to save us", to misquote Martin Heidegger's famous phrase? And what does "salvation" mean in this context? Does it mean that somehow or other the divine will interfere to halt the consequences of human stupidity in its tracks and "save" the planet from global warming and environmental destruction? The fact is that at face value, "the quest for divine salvation" could, theologically, describe several processes.

First, if it means that the divine (for the sake of brevity at least, can we agree to call "the divine" "God"?) will intervene directly to save us from our own blindness regarding global warming and environmental destruction, the answer is an unequivocal "no". This is the kind of fundamentalist nonsense that turns God into a master manipulator who constantly interferes in the usual processes of nature, human behaviour and logic on behalf of his devotees (in this view God is always a "he") or, in the specific context of global warming, to indulge a completely anthropocentric vision of the world whereby we do not have to answer for our actions, or more specifically for the actions of a neo-Capitalist (and, in the past, Marxist) economic structure that "religiously" believes in "infinite" growth.

Second, if it means that God is actually the Enlightenment's absentee landlord who doesn't really give a toss about environmental destruction and global warming, the answer is a more carefully qualified "no". For there is a real sense in which God does stand back from the world, doesn't constantly interfere in nature, does allow human and natural processes to take their course, is not an interfering busybody imposing his "will" on a species to which he has given a high level of self-consciousness, moral responsibility and a considerable amount of freedom. In other words, it's primarily our job to care for creation and our responsibility if, in our stupidity, we believe in the religious nostrum of infinite growth at any cost.

Third, but it is also true that God is profoundly concerned with the world. For theologically the world is ultimately not only the creation of God, it is also the image of God. In fact I would argue that our planet and cosmos are far more important images of God than we humans, which in our self-engrossed myopia so often promote ourselves as the primary images of God. Theologians as diverse as Saint Thomas Aquinas and Archbishop Willi Temple never made such gross presumptions.

So we end up with a rather complex explanation of the quest for divine salvation. It is true that in order to really deal with the dire threat we face from global warming, ecological extinction and environmental destruction, we need to re-imagine the world, not merely as matter to be exploited for capitalist gain, but as a theophany (an appearance of God) to be appreciated and explored. We need to recover the sense that the world and nature and its species point beyond themselves, that its significance is deeper than its mere value as a resource, that essentially it is sacramental, that it leads us into deeper vectors that not only make us more human, but curiously lead us both into and out of ourselves at the same time. It is only when we value the world for its theological resonances that we will begin to gather the moral and ethical courage to confront and ultimately eliminate the massively destructive, yet extremely powerful economic forces that are at work within our civilisation. In other words, we face a massive shift in economic and cultural values. Perhaps, therefore, Heidegger was right when he said "only a god can save us"?

Biographic note: Born in Melbourne, Paul Collins is an historian, broadcaster and writer. A Catholic priest for thirty-three years, he worked in varying capacities in TV and radio with the ABC from 1986-96, and for three years was Specialist Editor- Religion. He resigned from the active priestly ministry in 2001 due to a dispute with the Vatican over his book *Papal Power* (1997). He is the author of eleven books and numerous articles in leading newspapers and magazines in Australia and overseas, and he writes regularly for *The Australian*, *The Sydney Morning Herald*, *The Age*, *The Canberra Times*, as well as the *London Tablet*, the *National Catholic Reporter* in the US and several magazines in Germany and Austria. He is well known as a commentator on Catholicism and the papacy, and he also has a strong interest in ethics, environmental and population issues, and his book *God's Earth* has been made into a major TV documentary by the ABC. He has a Master's degree in theology (ThM) from Harvard University, and a Doctorate in Philosophy (PhD) in history from the Australian National University. He lives in Canberra.

Renewable energy technologies; offering hope and opportunity in the face of climate challenges

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The issue of human induced climate change from greenhouse gas emissions has the potential to be overwhelming and depressing and carries the risk of inaction resulting from fatalistic acceptance. The majority of our emissions are linked to the energy sector and it is in this sector that most change must take place.

A theme in the lobbying on the side of less response rather than more has been that whilst renewable energy technologies are “nice”, they are not technically mature enough; cannot be built on a large enough scale; cannot provide base-load power etc. This presentation will instead demonstrate that renewable energy technologies have enormous potential for rapid implementation and represent a significant economic opportunity for Australia in particular.

Australia’s main source of export income is coal. Examination of our annual energy flows shows that we export nearly twice as much primary energy as we use internally; approximately two-thirds as coal and one-third as uranium. In considering future energy scenarios, we must consider that demand for coal may one day drop and for uranium and gas, it may continue to grow. In the case of gas, all known reserves in Australia would be consumed in less than a decade if we somehow replaced all our consumption and export of energy with gas. The recent “Uranium Mining and Processing and Nuclear Energy Review” confirms that with conventional approaches, nuclear reserves could not meet our energy needs in entirety for very long either. Importantly for Australia as an exporter, the value of uranium exports per unit of energy is only around 1/20 of that of coal, so a big shift in demand would also damage revenue.

On the other hand, Australia has the highest average solar radiation levels per unit area of any continent. It also has excellent wind resources. The total amount of solar energy intercepted by the planet in a single year dwarfs all total reserves of every other depletable energy source. An area measuring 138km x 138km would provide all of Australia’s primary energy needs using existing technology and allowing for realistic spacing between collectors. An area approximately five times this would meet all of Japan’s primary energy needs and provide massive export income if a feasible way of transporting the energy were found.

On the technology front, the large scale wind turbine industry is one of the huge success stories of recent decades. Growth has consistently been around 30 percent since the 1980s and shows no signs of reducing. If it continued at that rate, all of our electricity would be provided by wind in just a few decades. The production of solar photovoltaic systems based on silicon has also been growing at similar compound rates and costs are dropping in correlation. Extrapolation suggests that it will become the norm for North-facing building roofs to have panels installed much sooner than most people realise.

This presentation will also discuss in more detail the potential for solar thermal power, the author’s main area of expertise. Solar thermal power stations using trough shaped mirrored concentrators have been working consistently for over 20 years in the Californian desert. Other approaches include paraboloidal dishes and power towers with heliostat fields.

The last two years have seen a surge of interest in these approaches. It is noteworthy that the generation systems proposed use the standard steam turbines to which the electricity industry is accustomed. Manufacture of collectors is relatively “low tech”, relying on steel and glass, and so can be ramped up rapidly. The first 64megawatt plant in several decades was completed in Nevada in 2007 in just 15 months. Solar thermal systems are particularly suited to offering energy storage. The higher temperature dish and tower approaches also offer a route to large scale liquid fuel production for transport and energy export, via the use of solar driven chemical reactions.

Biographic note: Associate Professor Keith Lovegrove is the leader of the Solar Thermal Group in the Department of Engineering at the Australian National University. He is also teaches undergraduate and postgraduate courses in Energy Systems and Systems Engineering within the Department of Engineering. The Solar Thermal Group works on a range of high temperature and low temperature thermal technologies. The group has continued on from the pioneering work that was begun in the ANU in the early 1970s. A highlight of the work has been the completion of the world’s first experimental solar-driven closed loop thermochemical energy storage system based on ammonia dissociation. The group operates experimental facilities centred around the ANU’s 400m² and 20m² paraboloidal dish solar concentrators. (For more see <http://engnet.anu.edu.au/DEResearch/solarthermal/>). Dr Lovegrove has had a long involvement with the Australian and New Zealand Solar Energy Society, a section of the International Solar Energy Society. The society is a non-profit organisation of renewable energy professionals and supporters and includes among its members, most of the renewable energy researchers in Australia. Dr Lovegrove has served in the past as Chair, Vice Chair and currently as Treasurer. During his time as Chair, he initiated the well known “Solar House Day”, held across both countries each September. He was also Chair of the organisation’s Solar 2006 conference organising committee. (For more see www.anzsos.org and <http://www.solarhouseday.com/>). He has authored or co-authored over 100 research papers and contributed to many media interviews and reports on the renewable energy field.

APPENDIX A

JAMES LOVELOCK'S MESSAGE: CLIMATE CHANGE ON A LIVING EARTH

*Lecture delivered by James Lovelock to a public meeting of the Royal Society
29 October 2007*

Most of you will know by now the main conclusions of the greatly respected Intergovernmental Panel on Climate Change's 2007 report and I am sure that we all are proud that they were awarded this year's Nobel Peace Prize together with Al Gore. The report itself speaks of the real possibility of severe climate change but it is written in properly cautious scientific language and gives the impression that global heating is serious but the worst consequences are avoidable if we take appropriate action now. Inevitably the conclusions of the report need constant revision in the light of real climate change. Sadly, even the most pessimistic of the climate prophets of the IPCC panel do not appear to have noticed how rapidly the climate is changing.

My first intimation that we might be on the brink of disaster came in May 2004 when my wife Sandy and I visited the UK's primary climate research centre, the Hadley Centre. It is a place of excellence and an important part of the IPCC. While there we talked with a range of scientists; some were concerned with the melting of ice floating on the Arctic Ocean, others with Greenland's vanishing glaciers, and still others concerned with global heating in the tropics. Later in the day we heard from Peter Cox and Richard Betts about the way that the great tropical and boreal forests were changing as the world grew hotter. And we talked of our own concern about the way the ocean life was disappearing as the surface waters warmed.

These climate scientists with whom we talked spoke of their observations and models of global heating in the regions that each of them were investigating. Taken separately, each of these regional investigations presented convincing evidence of positive feedback and accelerating change. They told of their research in detail but in a detached - properly scientific manner - almost as if they were describing some other planet, not the Earth.

This was in itself disturbing; much more so was the fact that those concerned, for example, with the melting of polar ice, although aware of a similar vanishing of the tropical forests, seemed to present their own research as something separate from the heating of the whole planet. There was also a tendency to present the whole Earth system as if it was no more than the simple addition of its parts. Something, I knew was rarely ever true of a dynamic system. Sandy and I left with a deep sense that what we had heard was truly serious and the visit profoundly changed my view of the future.

In defence of my friends at the Hadley Centre, I have to say that almost everyone concerned with climate change in 2004, and that included me before the visit, had this detached approach to climate research. We were worried, but there was no sense of pressing urgency. I must add that this was what we all perceived was the correct and objective way to speak.

When I looked at the IPCC report again - it was with a new sense of awareness - I now saw it as the scariest official document I have ever read. It was all too clear that the message from climate scientists was not reaching the public and especially not in the USA, this of course was

before Al Gore presented his book and film. I now take an apocalyptic view of the future because I see 6 to 8 billions of humans faced with ever diminishing supplies of food and water in an increasingly intolerable climate.

You may well ask how we scientists have let this potentially disastrous future steal up on us unaware. There are several reasons: among them is our success at solving the important but more manageable problem of stratospheric ozone depletion; I suspect that it has given us false confidence in our ability to deal with the far greater and more complex danger of global heating. Another reason for the slow recognition of the threat of adverse climate change is the division of Science into almost unconnected specialties.

If you look back at the writings of Earth scientists 40 years ago you will find them confident that the composition and climate of our planet were completely explicable from chemistry and physics and that life was just a passenger. Life scientists of the same time were equally confident that organisms evolved according to Darwin's great vision and adapted to the Earth described by their Earth science colleagues in the building across the campus.

This harmful and irrational division of science is slowly fading but it still persists and has led to the deplorable separation of the assessment of global change between two different international bodies: one based on physical science, the IPCC, and the other on biology, the Millennium Ecology Assessment Commission. The Earth is not so divided and so long as we treat it as two separate entities, the geosphere for the material Earth and the biosphere for life, we will fail to understand our planet.

Forty two years ago I was working at the Jet Propulsion Laboratory in California and was given the wonderful opportunity to see at first hand evidence about the nature of Mars and Venus. They were quite obviously dead planets and quite different from our lush and lively world, almost as different as is one of us from a stone statue. The Earth has an atmosphere that is wholly unstable in a thermodynamic sense; gases such as oxygen and methane are massively produced yet coexist at a stable dynamic equilibrium. I introduced the hypothesis that life at the surface of the Earth regulates the composition and chemistry of the atmosphere so as to keep it habitable. My friend, the Nobel Prize winning novelist William Golding, suggested I call the hypothesis Gaia.

Later during the 1970s I developed the idea further in collaboration with the eminent biologist, Lynn Margulis, but we soon discovered that what we called the Gaia hypothesis was far from popular with scientists. Biologists were particularly outspoken and in the 1970s they rubbished the infant hypothesis in the mistaken belief that it was like creationism, contrary to evolution by natural selection. The demolition was so effective that even today few scientists are happy with the word Gaia and many still see it as mere New Age fantasy. I went on to refute their criticism with evidence of self regulation gathered from the Earth and by mathematical models that illustrated how planetary self regulation of climate takes place. Gaia theory is a top down, a physiologist's view of the Earth system, and sees the Earth as a dynamic responsive planet and it explains why it is so different from Mars or Venus.

In different times these arguments would have merely been part of the natural history of science. Now, they seriously interfere with the evolution of a proper understanding of the Earth system when we badly need it. We need it to understand the consequences of adding greenhouse gases to the air and equally the consequences of removing natural forests for farmland; each of these acts disable the Earth system's capacity to regulate itself.

Most of the large climate models used to predict future climates still rely mainly on atmospheric physics, and this includes the models on which the IPCC report is based. The influence of the clouds and the ocean are incompletely included and that of the Earth's natural ecosystems hardly at all. Present day climate models are good at explaining past climates but seem unable to agree on the course of global heating beyond about 2050, by the end of the century predictions vary over a wide range.

This stark view was reinforced in May this year by the publication by Rahmstorf and his colleagues ["Recent Climate Observations Compared to Projections", *Science* 4 May 2007: Vol. 316. no. 5825, p. 709] of high quality measurements of the rise in global mean temperature, sea level and CO₂. These showed that even the gloomiest predictions of the IPCC were underestimating the severity of climate change now.

In 2001 there was a serious attempt to bring the Earth and Life sciences together. At a major scientific meeting at Amsterdam in the Netherlands, over 1000 Earth and life scientists signed a declaration that had as its first point: the Earth System is a self regulating system comprising all life including humans, the atmosphere, oceans and surface rocks. My friends who were at this meeting wrote to tell me that Gaia was now endorsed in science. But in science as in all human affairs the perceived conventional wisdom does not change easily or quickly. At Amsterdam scientists acknowledged Earth System Science but continued to work separately as before. One day we will unite as a single science, they said, but not yet.

It is easy to see why scientists are reluctant to abandon their familiar and comfortable paths. Darwinian biology in the hands of the distinguished Fellows of this Society, William Hamilton, John Maynard Smith and our previous president Lord May, has been a wonderfully rich and productive branch of science. But just as Newtonian physics was found incomplete at the particle and cosmic scales, so Darwinism is incomplete when it tries to explain the world beyond the phenotype.

In particular it fails to see that organisms do more than adapt to a dead and fixed world. They are naturally selected in a world that was changed by their ancestors and in turn their interaction with the material environment sets the scene for the next round of evolution. The air the ocean and the surface rocks are all either direct products of life or else massively altered by its presence.

Our difficulty in understanding the Earth can be compared with that of understanding economics. The 18th century economist, Adam Smith, is respected for his intuition of an invisible guiding hand that makes rampant commercial self interest somehow work for the common good. Two hundred years later we face a similar paradox. We know that the Earth is a benign and comfortable place for life and has been so for most of its history; so how have selfish genes allowed the evolution of an altruistic planet? It is easy now to see how fit organisms are naturally selected but how can the common good for all life also come from natural selection?

What we have discovered through Gaia theory is that as the Earth system matures it keeps its climate and its chemistry always fit for life, and the invisible hand that regulates is feedback between its living and non-living parts. But this knowledge has only just entered the domain of science and is not yet conventional wisdom. It took a long time before we recognised that feedback between social and market forces cannot be ignored, so I suspect that we face a similar slow learning process about our relationship with the Earth.

Meanwhile we are still trying to shape it to our ends and needs and we ignore, even disable, its own powerful guiding hand. In our hubris we believe that we can be stewards of the Earth long before we understand it; perhaps Earth science and economics have more in common than we used to think. A few weeks ago the distinguished economist P. Dasgupta compared the complexity and non linearity of economic systems with that of climate systems.

The long term history of the Earth suggests the existence of hot and cold stable states. What the geologists refer to as the greenhouses and the ice houses. The best known hothouse happened 55 million years ago at the beginning of the Eocene period. In that event between one and two teratons (Tt) (1 Tt = 1000 Gt) of carbon dioxide were released into the air by a geological accident. We are fairly sure about this from measurements made by Professor Elderfield of Cambridge University and his colleagues and from the researches of Henrik Svensen and colleagues of Oslo University.

Putting this much CO₂ in the air caused the temperature of the temperate and Arctic regions to rise 8C and of the tropics 5C and it took about 200,000 years for conditions to return to their previous state. In the 20th century we injected about half that amount of CO₂ and we and the Earth itself are soon likely to release more than a Tt of CO₂.

Global heating 55 million years (My) ago took place much more slowly than now; the injection of gaseous carbon compounds into the atmosphere may have taken place over a period of about 10,000 years, instead of about 200 years as we are now doing. The great rapidity with which we add carbon gases to the air is as damaging as is the quantity. The rapidity of the pollution gives the Earth system little time to adjust and this is particularly important for the ocean ecosystems; the rapid accumulation of CO₂ in the surface water is making them too acid for shell forming organisms. This did not happen during the Eocene event because there was time for the more alkaline deep waters to mix in and neutralise the surface ocean.

There are other differences between the Earth 55 My ago and now. The sun was 0.5 percent cooler and there was no agriculture anywhere so that natural vegetation was free to regulate the climate. Another difference was that the world was not then experiencing global dimming - the 2 to 3 degrees of global cooling caused by the atmospheric aerosol of man-made pollution.

This haze that covers much of the Northern hemisphere offsets global heating by reflecting sunlight and more importantly by nucleating clouds that reflect even more sunlight. The aerosol particles of the haze persist in the air for only a few weeks, whereas carbon dioxide persists for between 50 and 100 years. Any economic downturn or planned cut back in fossil fuel use, which lessened the aerosol density, would intensify the heating. If there were a 100 percent cut in fossil fuel combustion it might get hotter, not cooler. This is why I say we live in a fool's climate. We are damned if we continue to burn fuel and damned if we stop too suddenly.

It is not difficult to make a numerical model of a live Earth with an ocean and land biota taking an active part in climate regulation and then try the experiment of adding a terraton of carbon dioxide to the model world as we are doing. I did this in collaboration with the geochemist Lee Kump and we published it in the science journal *Nature* in 1994 ["Failure of climate regulation in a geophysiological model" by James E. Lovelock & Lee R. Kump, *Nature* 369, 732-734, 30 June 1994].

You may ask why we should take this model seriously when so many of the world's climate scientists are in agreement on the IPCC predictions. First, although simple, it is a model of the

whole Earth system and not merely one based almost entirely on atmospheric physics. Perhaps the most important message from this simple model is its implication that the ocean ecosystems dominate the cooler periods of the Earth's history and the Land ecosystems the stable hot periods. Andrew Watson and Corinne LeQuere, both from the University of East Anglia, have led groups who report this week an adverse change in the carbon dioxide sink of the northern and southern oceans. It could be that the malign effects of stratification are extending in the surface waters of the ocean.

What I have so far said seems to imply that there is little that can we do to prevent the Earth System moving to the hot stable state but in no way do I mean that there is no hope for us. I see our predicament as like that faced by any nation that is about to be invaded by a powerful enemy; now we are at war with the Earth and as in a *blitzkrieg* events proceed faster than we can respond. We are in the strange position of living on a planet where climate and compositional change is now so rapid that it happens too fast for us to react to it. For this reason alone, it is probably too late for sustainable development. Enlightened living of this kind might have worked 200 years ago in Malthus's time but not now.

The positive feedback on heating from the melting of floating Arctic and Antarctic ice alone is causing an acceleration of system driven heating whose total will soon or already be greater than that from all of the pollution CO₂ that we have so far added. This suggests that implementing Kyoto or some super Kyoto is most unlikely to succeed.

Geoengineering schemes, such as sunshades in Space as described by Woods, stratospheric aerosols to reflect sunlight (Budyko, Dickinson Crutzen and Caldeira), and the artificial generation of marine stratus clouds (Latham), all have the potential to temporarily halt global heating and could be part of a comprehensive treatment. These technological fixes should not be condemned without considering their value as an extender of the time we have to act. In a longer run they are probably no more a cure than is dialysis for kidney failure but who would refuse dialysis if death was the alternative

There is a third approach that is less invasive and it is to think of the Earth as a live self regulating system and devise ways to alter the sign of the feedback from one or more of the five main climate regulating processes from positive to negative. The charity, Cool Earth, has proposed using its funds to pay indigenous peoples to protect their natural forest ecosystems not cut them down. Another example would be the biosynthesis of food using CO₂, nitrogen and water from the environment. This would sequester CO₂ in a constructive and profitable way and return farm land to its natural state as an ecosystem.

Chris Rapley and I raised the possibility that feedback from the ocean ecosystems that are 70 percent of the Earth's surface might be made negative by mixing cool nutrient rich subsurface water with the stable but barren floating layer of the ocean ["Ocean pipes could help the Earth to cure itself" - letter to *Nature* from James Lovelock and Chris Rapley, 26 September 2007.]. This would feed algal growth and make the surface a more efficient sink for CO₂ and algal growth would release DMS (dimethyl sulphide), a precursor of clouds. This could be achieved by a relatively simple system of pipes and would be driven automatically by wave energy. Small scale attempts to do this have been described and they appear to work.

We were well aware that there could be practical reasons why this simple idea might not work; such as that the waters of the deeper ocean are richer in CO₂ than the surface and to bring them up would add to the release of CO₂ to the atmosphere. We raised the idea to show the

value of thinking of the Earth as a living system whose gigantic stores of energy might be available for use in its and our interest. We hoped that our idea might stimulate other proposals of this kind and that among them was one or more that could do the job. We also wanted to show that the Gaian approach of stimulating the Earth to cure itself was more than mere rhetoric.

Perhaps our first task is to stop thinking blindly that reducing our carbon footprint is enough? We have to understand that by abrading the skin of our planet to provide farm land we have destroyed more than 40 percent of the Earth's natural ecosystems and these were what previously served to sustain a stable climate. Most of all, we have to understand that the Earth System is now in positive feedback and is moving ineluctably towards the stable hot state of past climates. I cannot stress too strongly the dangers inherent in systems in positive feedback. Imagine a wooden house whose occupants have built too large a fire to warm them and the furniture near the fire was smoldering. If they did not act immediately, positive feedback would ensure that the whole house was consumed by fire in minutes.

Few seem to realise that the present IPCC models predict almost unanimously that by 2040 the average summer in Europe will be as hot as the summer of 2003 when over 30,000 died from heat. By then we may cool ourselves with air conditioning and learn to live in a climate no worse than that of Baghdad now. But without extensive irrigation the plants will die and both farming and natural ecosystems will be replaced by scrub and desert. What will there be to eat? The same dire changes will affect the rest of the world and I can envisage Americans migrating into Canada and the Chinese into Siberia but there may be little food for any of them.

When we were hunter gatherers and only a few million of us occupied the earth we were in balance with Nature and the CO₂ we breathed out was absorbed by the plants in its entirety. Now the air we breathe out adds 2 Gigatons (Gt) of CO₂ to the air every year, four times the total of all the airlines of the world and the agribusiness food plants are no longer in balance with our breathing. We now face the stark choice between a return to a natural life as a small band of hunter gatherers or a much reduced high tech civilisation also in balance with nature. Paul and Ann Ehrlich were right to say in 1980 that it was preposterous to imagine as possible a population of six billions living a first world lifestyle.

Because it might help slow the pace of global heating, we have to do our best to reduce emissions and lessen our destruction of natural forests to feed and house ourselves; but this is unlikely to be enough and we will have to learn to adapt to the ineluctable changes we will soon experience.

During the early Eocene global heating there was no great extinction of species and this may have been because life had time to migrate to the cooler regions of the Arctic and Antarctic and remain there until the planet cooled again. This may happen again and humans, animals and plants are already migrating. Scandinavia and the oceanic parts of northern Europe such as the British Isles may be spared the worst of heat and drought that global heating brings. This puts a special responsibility upon us to stay civilised and give refuge to the unimaginably large influx of climate refugees.

Perhaps we must steer a path between the counsel to perfection of Gro Brundtland's concept of sustainable development and the alternative counsel to perfection of the deep ecologist's vision of a return to living a life balanced within the Earth system. This middle way, which was touched on by Lord Rees in his book *The Final Century* will require some difficult choices on

what technologies to abandon and what to retain; we should look on our path as a sustainable retreat. My friend Sir Crispin Tickell says we need a climate catastrophe recognised as such by everyone, and strong effective leadership.

Perhaps the saddest thing is that if we fail, Gaia will lose as much or more than we do. Not only will wildlife and whole ecosystems go extinct but in human civilisation the planet has a precious resource. We are not merely a disease; we are through our intelligence and communication the planetary equivalent of a nervous system. We should be the heart and mind of the Earth, not its malady. Perhaps the greatest value of the Gaia concept lies in its metaphor of a living Earth, which reminds us that we are part of it and that our contract with Gaia is not about human rights alone, but includes human obligations.

APPENDIX B

GEORGE ORWELL'S *NEWSPEAK*

From "The principles of *Newspeak*", 1984 by George Orwell:

"The purpose of *Newspeak* was not only to provide a medium of expression for the world-view and mental habits proper to the devotees of *Ingsoc*, but to make all other modes of thought impossible. It was intended that when *Newspeak* had been adopted once and for all and *Oldspeak* forgotten, a heretical thought - that is, a thought diverging from the principles of *Ingsoc* - should be literally unthinkable, at least so far as thought is dependent on words... Take for example the well-known passage from the (American) Declaration of Independence: "We hold these truths to be self-evident, that all men are created equal, that they are endowed by their creator with certain inalienable rights, which among these are life, liberty, and the pursuit of happiness. That to secure these rights, Governments are instituted among men, deriving their powers from the consent of the governed. That whenever any form of Government becomes destructive of those ends, it is the right of the People to alter or abolish it, and to institute new Government." It would have been quite impossible to render this into *Newspeak* while keeping to the sense of the original. The nearest one could come to doing so would be to swallow the whole passage up in the single word *crimethink*. A full translation could only be an ideological translation, whereby Jefferson's words would be changed into a panegyric on absolute government."

NOTES



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