

*Rethinking Basic Assumptions...*

# The Ecologist

Volume 29 No 2

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SPECIAL ISSUE

## Climate Crisis

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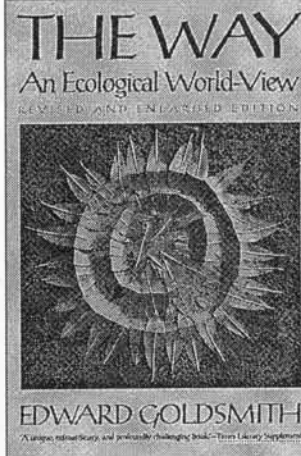
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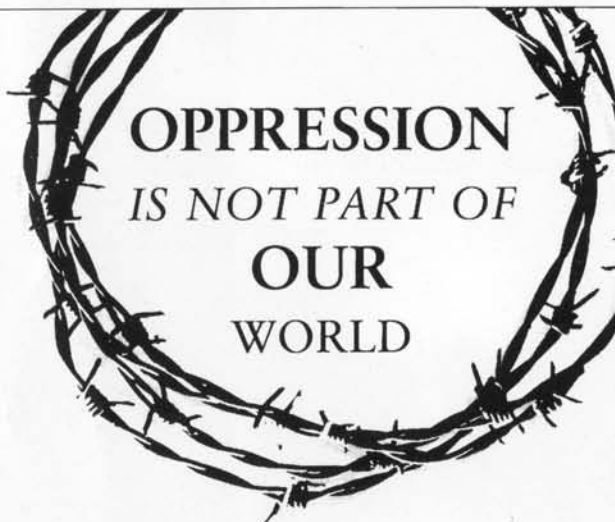
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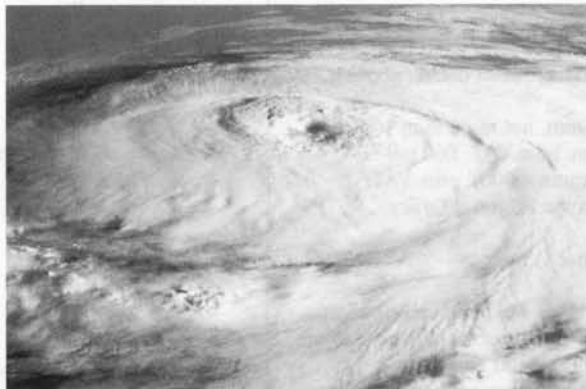
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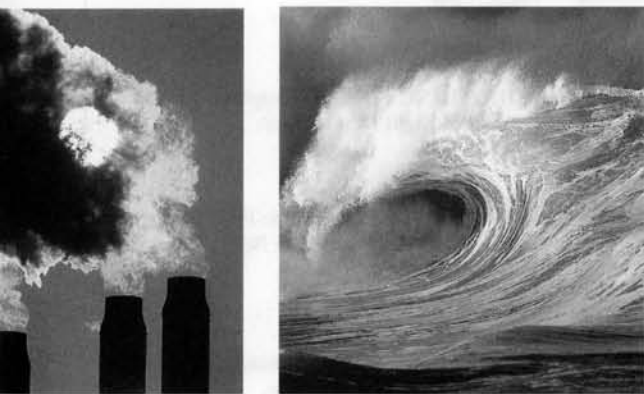
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THIS SPECIAL ISSUE OF *The Ecologist* IS DEVOTED entirely to climate change – probably the most serious problem we face today. As the first part of the magazine shows, if nothing is done, climatic destabilisation could actually be far worse than predicted, especially if hitherto neglected positive feedbacks come into play and if the world's tropical rainforests continue to be destroyed. We show, too, that the prospects for life in such a destabilised climate are likely to be dire, as agriculture, human health and whole economies are gravely affected and as millions of people are driven from their homes. Yet, as the third section of the magazine illustrates, our governments have done virtually nothing to prevent the worst from happening and, all too often, have seemed to collude with vested corporate interests intent on sabotaging meaningful change. We cannot afford to accept such behaviour, and, as the final section of this special issue shows, we do not have to, as there is still a great deal that can be done to avoid the worst.

We are aware that some of the findings we present and scenarios we outline are controversial and are not found in most climate models. But that is largely because many climatologists are not willing to endorse views – even when obvious to most sensible people – for which they have not obtained what they regard as 'scientific evidence' or 'scientific certainty.' However, no laboratory experiments can provide such evidence or certainty, as it is impossible to reproduce in laboratory conditions all the complex inter-relationships over time between our industrial activities, marine and terrestrial life and the atmospheric environment. Nor can such evidence or certainty be provided by mathematical models, as there is no methodology for assuring that they take into account all the relevant variables, let alone all the possible inter-relationships between them. All that climatologists and indeed scientists in general can establish, and fortunately many admit this, is that a particular thesis is probably true. That is all that we claim to establish in this special issue of *The Ecologist*, and, indeed, all that needs to be established if scientific method is to be reconciled with the all-important precautionary principle.

The stakes are far too high for us to take the luxury of time to ponder on whether more radical action is scientifically justified. It took our scientific establishment until 1995 to accept that "there is a discernible human influence on global climate," – almost a century after we were first told by the Swedish chemist and Nobel Laureate, Svante Arrhenius, that the accumulation of carbon dioxide in the atmosphere, as a result of industrialisation, would give rise to global warming. The long delay before scientific certainty could be established has meant that it is now too late to avoid some serious climatic dislocation. If we wait any longer for conclusive evidence to corroborate what we know to be likely, it will be too late to avoid the very real possibility of catastrophic, runaway climate change that – in the century to come – could make much of our planet effectively uninhabitable.

It is to alert people to the need to avert such an outcome that we are launching this special issue of *The Ecologist*, together with the accompanying declaration calling upon governments to take immediate, preventive action. We have certainly been encouraged by the widespread support the declaration has already won, and hope that this will mark the beginning of a successful campaign for change.

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# The Ecologist's Declaration on Climate Change

# W

E, THE UNDERSIGNED, CALL UPON THE world's political and corporate leaders to take immediate action to prevent seriously disruptive climate change. Evidence of human impact upon the Earth's climate is now irrefutable. We have emitted enough greenhouse gases into the atmosphere to commit the climate to change. If we carry on as we are, we can expect a rapidly worsening situation that – because of the long life of emissions in the atmosphere – will continue for centuries to come. Within a global trend of rising temperatures that could reach levels in the next century that our species has never previously experienced, our climate will become more and more unstable, marked by extreme and unseasonal weather.

Such climatic destabilisation will have dire consequences for every part of the world, every sector of society and every aspect of our lives. Our health and food supplies will be affected dramatically by increased droughts, heat-waves and the spread of disease-bearing insects and pests in response to rising temperatures. Agricultural land and our towns and cities will also suffer substantial damage from rising sea-levels, and increased flooding and violent storms, with huge costs for industry and ordinary people as their homes and livelihoods are destroyed. The scientists of the UN's Inter-governmental Panel on Climate Change predict that millions of people worldwide will die and millions of others will become environmental refugees as a result. The effects of climate change are being felt even now. Global temperatures are rising at a rate faster than for 10,000 years, with the 12 hottest years in recorded history occurring since 1980. There has also been a sharp rise in extreme weather events, with a significant increase in the last 20 years in the frequency and intensity of hurricanes, tornadoes, large floods and heat-waves that have left a trail of devastation to infrastructure and agriculture in their wake.

The extent of climatic destabilisation is likely to be even more severe than previously thought if greenhouse gas emissions continue to rise unchecked. As warming increases, vital natural processes upon which we depend to absorb or contain three-quarters of our greenhouse gas emissions – such as the carbon dioxide-absorbing function of the world's forests and oceans – would weaken and even cease to operate. Instead of being net 'sinks', they will become net sources of greenhouse gases.

Hence, if emissions continue to rise unchecked, we risk releasing billions of tonnes of carbon into the atmosphere as rising temperatures trigger a huge die-back of

trees, causing billions of acres of South American rain-forest to turn into desert before 2050, the UK Met Office's Hadley Centre predicts. If this and other positive feedbacks occur – and they could well do so within the next few decades – we could find ourselves in a situation of catastrophic, runaway climatic destabilisation.

• • •

Yet the political and corporate response to this problem has been grossly inadequate. To stabilise greenhouse gas concentrations at non-catastrophic levels, the UN's Inter-governmental Panel on Climate Change stated in 1990 that greenhouse gas emissions from human sources would have to be reduced immediately by at least 60 per cent below 1990 levels. At Kyoto, however, developed countries agreed to a cut of just 5.2 per cent, to be achieved between 2008 and 2012. Worse, the US Congress has refused to ratify the US' Kyoto commitment. Even if the Kyoto targets were met, given that developing countries are under no obligation to prevent their emissions from continuing to increase, global emissions would rise to 30 per cent above 1990 levels by 2010.

We deplore the lack of serious political action to address this issue and we deplore attempts by many large corporations to block meaningful change. For short-term gain, they seem willing to jeopardise the welfare, indeed survival, of a large part of humanity.

• • •

If catastrophic climate change is to be avoided, we call upon our governments to take the following action without delay:

- Accept the goal of reducing carbon dioxide concentra-

tions in the atmosphere to 1990 levels – around 350 parts per million by volume (ppmv), whilst never exceeding 400ppmv. A higher concentration (including that proposed by the EU of 550ppmv – almost twice the pre-industrial level) would involve straying into a danger zone of catastrophic climatic instability.

- To achieve this goal, a target of 30 years to have cut CO<sub>2</sub> emissions by 70-80 per cent below 1990 levels, and 50 years for a near total phase-out of fossil fuels should be adopted. This is the very minimum that the current crisis demands. While it may be challenging for many countries, it is the political will to implement policy options which is the biggest challenge, not the technological one.

- Implement nothing less than a crash programme to meet these targets. Measures should be put in place to significantly reduce energy use. Our remaining energy requirements should be met by a combination of existing renewable energy technologies – quite feasible if invested in sufficiently and produced on a large enough scale.

- Transfer all public subsidies and encourage the transfer of private investment away from supporting fossil fuels and cars towards supporting ecologically sustainable renewables and public transport. This applies in equal measure to loans and investments to developing countries from the industrialised world and the international financial institutions. It should be recognised that in developing countries, where dependence upon fossil fuels is less, it will be far easier to turn rapidly towards a renewable energy path. Everything should be done, therefore, to enable this.

- Change taxation systems to reflect the need to discourage the use of fossil fuels and cars.

- End the exploration and development of new oil, coal and gas reserves immediately.

- Set in place a far more effective, inclusive and hence equitable international political mechanism to curb the consumption of fossil fuels in *all* countries. The only realistic means proposed so far of achieving this is a formal global programme of "Contraction and Convergence", as advocated by GLOBE International (the Global Legislators Organisation for a Balanced Environment) and by an increasing number of governments in Europe, Africa and the majority of Southern countries in the so-called Group of 77 and China.

- Recognise that the avoidance of serious climate change cannot succeed without the protection of the planet's natural sinks.

- Hence, take immediate action to stop the continued destruction of the world's remaining forests, particularly tropical rainforests – *critical* for the stability of global climate. At the international level, legally-binding forest protection must be negotiated, even if this requires the provision of compensation to those countries that possess the principal standing forests. In developed countries, consumption of wood and wood-derived paper will have to be reduced by two-thirds. Measures should also be put in place to ensure massive reforestation, while avoiding monoculture plantations of fast-growing exotics where possible.

- Take immediate action to eliminate *all* ozone-depleting chemicals – responsible for a hole in the ozone layer that in 1998 was larger than ever – and that are still being produced despite the Montreal Protocol. Also, make the removal of CFCs from all appliances prior to disposal a legal requirement. Unless this is achieved, the phytoplankton in the oceans, upon which we depend

to absorb carbon dioxide, will continue to be destroyed by increasing ultraviolet radiation.

- Transfer all public subsidies away from supporting industrial agriculture, which is largely responsible for the unrelenting destruction of our agricultural soils – another important sink for carbon dioxide – and for substantial emissions of carbon dioxide, nitrous oxide and methane. Instead, a rapid transition to low-impact, ecologically-based organic farming for local consumption should be promoted.

- Reverse the current subordination of ecological and social imperatives to the short-term interests of corporations and investors and the maximisation of world trade. Large-scale global trade massively increases the distance goods are transported, resulting in more greenhouse gas emissions, whilst simultaneously exerting powerful deregulatory pressures that inhibit governments from raising environmental standards.

Hence, the provision of subsidies and the signing of treaties that increase this trend should cease. A change of direction towards the nurturing of a network of more self-sustaining, local economies and an end to undemocratic corporate influence on the political process is essential.

• • •

Whilst the changes that are required may seem great, we are not calling upon people to make huge sacrifices. All of the measures that we have outlined, essential to prevent dangerous climatic disruption, are needed whether or not our climate is in danger, as they will help solve many of the other major problems that confront us today, such as unemployment, ill health and threats to peace. Implementing these measures will ensure that –

- more jobs are created and income saved from the development of new renewable technologies and from the re-emergence of strong local economies;

- a vast improvement in our health takes place with clean air in our cities;

- greater world security is achieved as tensions over the control of oil in the Middle East and elsewhere are diminished;

- the planet's rainforests, the lungs of the world and home to 50-80 percent of animal and plant species, are saved from destruction;

- greater food security and better health are attained with ecologically sustainable methods of agriculture.

Whilst avoiding the worst impacts of climate change, our entire quality of life will also improve. The benefits of such action are clearly huge and the costs low when compared with the massive costs of *inaction* which climatic destabilisation would inevitably inflict.

• • •

It is for these reasons that we call upon our political and corporate leaders to face their responsibilities and take immediate action to protect our climate.

We urge members of the public and all non-governmental organisations to organise grass roots movements to exert pressure on our governments to ensure they achieve this goal.

Too much time has already been wasted and it is running out fast. We cannot wait until major climate catastrophes strike the developed world and wake us from our slumber – by then it will be too late. We need political action *now*. A crash programme is therefore an imperative. We have no alternative.



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# Gaia's Fever

— BY JOSÉ LUTZENBERGER —

The range of temperatures within which life can exist and flourish – that is, the range of temperatures that makes biochemistry possible, the chemistry of proteins, carbohydrates, hydrocarbons, nucleic acids, the building of living cells and organisms, which is also the range in which water can coexist in its three physical forms, liquid, gaseous and solid – is extremely narrow when compared with the temperatures that prevail in the universe at large.

The temperatures range from close to absolute zero, 273 degrees Centigrade below zero in interstellar and interplanetary space or on our far out planets such as Neptune and Pluto, to between 400 and 500 degrees Centigrade on Venus, close to 40 degrees below zero in summer at noon on the equator on Mars, about 6,000 degrees on the surface of our sun, close to 20 million degrees in its interior, much, much hotter in bigger stars and up to hundreds of billions of degrees Centigrade in the furnaces of imploding stars, the supernovas. If we were to represent this existing range of temperatures on a line where every degree is one millimetre, the line would be several hundreds of thousands of kilometres long. It would reach far beyond the Moon. The range propitious to life ranges from a few degrees below zero, where life survives by resting, to about 80 degrees above zero for a few organisms, some bacteria and algae that manage to live in hot springs, which makes a total of about 100 degrees. When plotted against that line it would cover ten centimetres. Ten centimetres on several hundred thousand kilometres!

As seen from this perspective, we realize how precious is our world. It is even more precious when we learn that life, for over three and a half billion years, has been able to counteract forces tending to make the Earth much hotter or much colder. We know from cosmological considerations that the Sun is today between 20 and 30 per cent hotter than it was when life began to structure itself in the primeval oceans. Our planet could have ended up in a situation of a runaway greenhouse effect, like Venus: a little cooler, but still around two hundred degrees above zero. The oceans would have evaporated.



REX FEATURES

*We know we are messing up all the mechanisms of climate control, with too much carbon dioxide, methane, nitrous oxide, freons, forest destruction and desertification. How long can we abuse the system? How long will it take for Gaia to catch a fever?*

Or, if for some reason, at the time of the first stirrings of life, with the cooler Sun, there had been too much cloudiness, the runaway could have gone in the other direction. The higher albedo – that is, the higher reflectivity for light – would have sent much of the incident solar energy back into empty space. Less heat, more snow, still more albedo, still less heat. The Earth could have become an ice-covered ball. Either way, Gaia would not have come into existence or would soon have perished.

And yet, we know we are messing up all the mechanisms of climate control, with too much carbon dioxide, methane, nitrogen oxide, sulphur oxide, freons, hydrocarbons, forest destruction and desertification. How long can we abuse the system? How long will it take for Gaia to catch a fever? Do we really have to know all the details in order to act?

If things go wrong now, they don't even have to go wrong all the way. We don't have to have another ice age or a melting of the ice caps on Greenland and the Antarctic, with flooding of major cities and highly populated territories. An exacerbation of the climatic irregularities we already have will soon leave us in a situation where we cannot count on safe harvests any more. We are now nearly six billion people. Food reserves are getting shorter.

What good would nice beach weather be on Spitzbergen if we had nothing to eat? And what about the social calamities and upheavals that would result, with figures like Saddam Hussein and others having access to weapons of mass destruction?

What for Gaia in the lifespan of ten billion years, with at least another five billion to go, may be a soft and momentary fever, could be the end of civilisation for us.

A wise person may risk learning from mistakes, but will avoid experiments where, if things go wrong, the consequences are unacceptable and irreversible. How can we make the powerful understand that Modern Industrial Society is engaged in just this kind of experiment?

José Lutzenberger is the former Brazilian Minister for the Environment. He is now President of Fundacio Gaia in Brazil.

# We're Changing Our Climate! Who Can Doubt It?

— BY SIMON RETALLACK AND PETER BUNYARD —

*The reality of human-induced climate change is now beyond question. While certain vested interests and elements of the mass media like creating the impression of an ongoing debate, in truth, there is an overwhelming consensus among scientists that human-induced climate change is happening.*

**T**he facts are indisputable. First, take the physics of gases such as carbon dioxide, methane, nitrous oxide and CFCs: they are radiatively active – they trap heat in the Earth's atmosphere. So, if you put heat-trapping gases up into the atmosphere, through the burning of fossil fuels and the destruction of natural forests, you will trap heat. And that, of course, is precisely what humans have been doing with particular zeal since the industrial revolution of the mid-19th century – no one denies that emissions and consequently atmospheric greenhouse concentrations have been soaring for decades. As a consequence, it should come as no surprise that humans are heating the planet.

Official confirmation came in 1995, when the Inter-Governmental Panel on Climate Change (IPCC) – the official scientific body established in 1988 by the UN to investigate climate change – published its Second Assessment Report, written and reviewed by some 2,000 scientists. It stated that “the balance of evidence suggests there is a discernible human influence on global climate.”<sup>1</sup>

A consensus now undeniably exists that human-induced climate change is real and has to be tackled. In the words of the then Chair of the IPCC, Bert Bolin, “All the summaries [of the IPCC] have been agreed at the plenary meetings without dissent and none of us has received any subsequent letters of complaint from scientists regarding the final version. The process provides justification for the description of substantial scientific consensus.”<sup>2</sup> As James McCarthy, chairman of the Scientific Committee for the International Biosphere Programme, moreover, declares: “There is no debate among any statured scientists [i.e. those currently engaged in relevant research and whose work has been published in the refereed scientific journals] about what is happening.”<sup>3</sup>

*A consensus now undeniably exists that human-induced climate change is real and has to be tackled.*

The relationship between greenhouse gases and climate that has now been established is supported by evidence from isotopic studies of ice-core material from both Antarctica and Greenland. The evidence shows that every period of global cooling has gone hand-in-hand with a drop in both carbon dioxide and methane in the atmosphere, and every time the planet has thawed, a surge has taken place in those same gases.<sup>4</sup>

## **The climate is changing before our very eyes**

Rising temperatures are already the clearest sign of climate change. So far, according to the IPCC, global average temperatures have risen 0.6°C above the pre-industrial average. Nine of

the hottest years on record have occurred since 1988; six of the first eight months of 1998 were the warmest since records began in 1866; and July 1998 was the hottest month ever. According to the IPCC's latest coupled ocean-atmosphere models, if emissions continued to rise on current trends, greenhouse gas concentrations would reach double pre-industrial levels – higher than for several million years – by 2080. Were this so, we would see a global average increase of 2.5°C, with perhaps 4°C over land masses, particularly in the northern high latitudes, 3°C to 4°C over parts of the Arctic or Antarctic, and possibly substantial regional variations from the global average. If the increases in temperature seem modest, it should be noted that a 3°C cooling brought on the most recent ice age. What is more, the climatologists of the IPCC predict that if emissions continued to rise on current trends, a second doubling of pre-industrial levels of CO<sub>2</sub> could lead to a catastrophic rise of around 10°C. Even these predictions may understate the speed and scale of change (see ‘Misreading the Models’, p75).

*The destabilising effect of planetary warming upon our climate systems is already being felt. Over the past decade, worldwide, we have seen virtually every climate record broken since reliable record-taking began a century ago.*

The implications for life are immense. With higher temperatures, there is more energy driving the Earth's climatic systems, which in turn causes more violent weather events. Severe storms, floods, droughts, dust storms, sea surges, crumbling coastlines, salt water intrusion of groundwater, failing crops, dying forests, the inundation of low-lying islands, and the spread of endemic diseases such as malaria, dengue fever and schistosomiasis is on the cards if the consumption of fossil fuels is not phased out. Agriculture worldwide would face severe disruption and economies could tumble. There would also be millions upon millions of environmental refugees – people fleeing from the intruding sea, or equally from the deserts they have left in their wake after stripping the land of its vegetation. Those are the prospects and scientific advisers to the UK government are warning that millions will die worldwide because of the processes of global warming that have already been unleashed.

The destabilising effect of planetary warming upon our climate systems is already being felt. Over the past decade, worldwide, we have seen virtually every climate record broken since reliable record-taking began a century ago. There has been a marked increase in the frequency and intensity of droughts, heat-waves,



forest fires, flash-floods, tornadoes, hurricanes and tropical storms, all of which have killed people, destroyed property and crops and left many millions homeless and destitute across the world in what seems a never-ending and worsening catalogue of disaster (see Climate Chaos map on the next page). Even the increase in severe winter weather events is consistent with and indeed the likely product of an overall global pattern of warming.

The correlations between warming and climate catastrophe are clear. In north-west Canada and Alaska mean annual temperatures a metre below the surface have risen a full degree Centigrade since 1989. There, as in Siberia, this is causing the permafrost to melt, releasing its store of methane, which is adding to the ever-growing increment of greenhouse gases. We are now seeing plants, insects, birds and mammals – and diseases – migrating northwards into regions too cold for them before, with all that means for the spread of disease and decimation of crops. In low-lying islands in the South Pacific farmers are having to abandon their fields because of sea-level rise and some islands have had to be vacated.

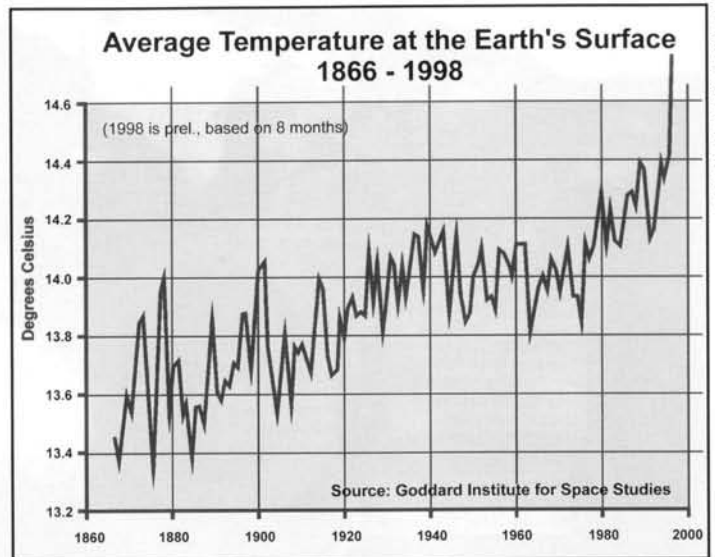
No group could be more pragmatic about disasters than the insurance companies and their consortia. They are in no doubt that climate is changing disastrously: they see it in their rapidly escalating pay-outs for those who are fortunate enough to be insured. As Paul Kovacs, an analyst with the Insurance Board of Canada, remarks, "Every five years or so the costs of weather-related disasters have doubled, with the last three years the costliest in history for the Canadian insurance industry." According to him, Canadian insurers will pay out \$1.5 billion in weather-related claims by the end of 1998. That's in addition to \$1.2 billion in direct assistance from federal and provincial governments. Globally, damage from extreme weather events simply in the first ten months of 1998 surpassed the total of all such losses during the entire decade of the 1980s.

The Munich Reinsurance Corporation – one of the world's largest underwriters – estimates that the bill worldwide for severe weather over the past three years has topped \$180 billion. Over the past ten years, claims Munich Re, the cost of all natural catastrophes, many relating to climate, has mounted 85 times above the cost for the 1960s, adjusted to present values.<sup>5</sup>

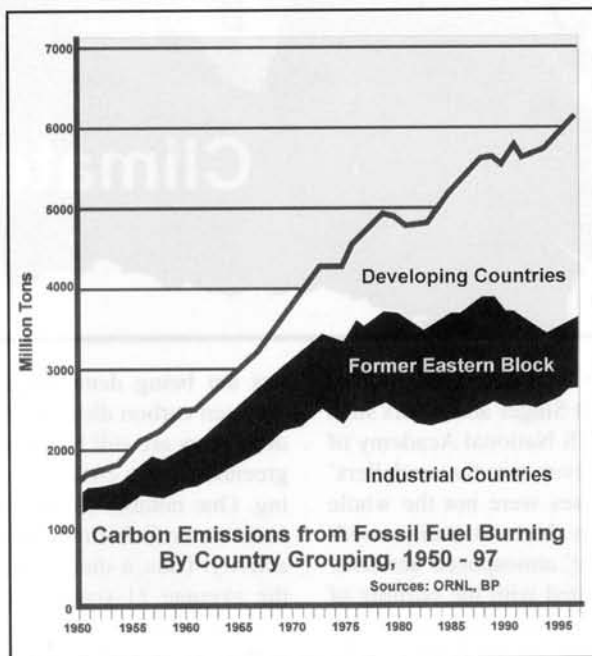
### Flawed science of the climate change sceptics

Despite the evidence of their eyes and of the growing body of science, a very small number of self-created experts, set up to represent the powerful interests of the fossil fuel lobby in the United States and the oil-rich nations of the Middle East (see 'Corporate Hijacking of the Greenhouse Debate', p119), continue to lecture the world that current global warming either has nothing whatsoever to do with human activities, or that it is simply not happening. As laughable as such fly-by-night pundits may be, their influence over governments and in particular the entrenched Republican majority in the US Congress is particularly dangerous in preventing vital, immediate action to stem the ever-growing carbon emissions into the atmosphere.

One of the most vociferous of the band of climate change sceptics – Patrick Michaels, professor of climatology at the University of Virginia – has travelled the world to pooh-poo the idea of global warming. But even he has been put on the defensive as the science gets more sophisticated and the models show vastly



GRAPHS: MALCOLM GRANT



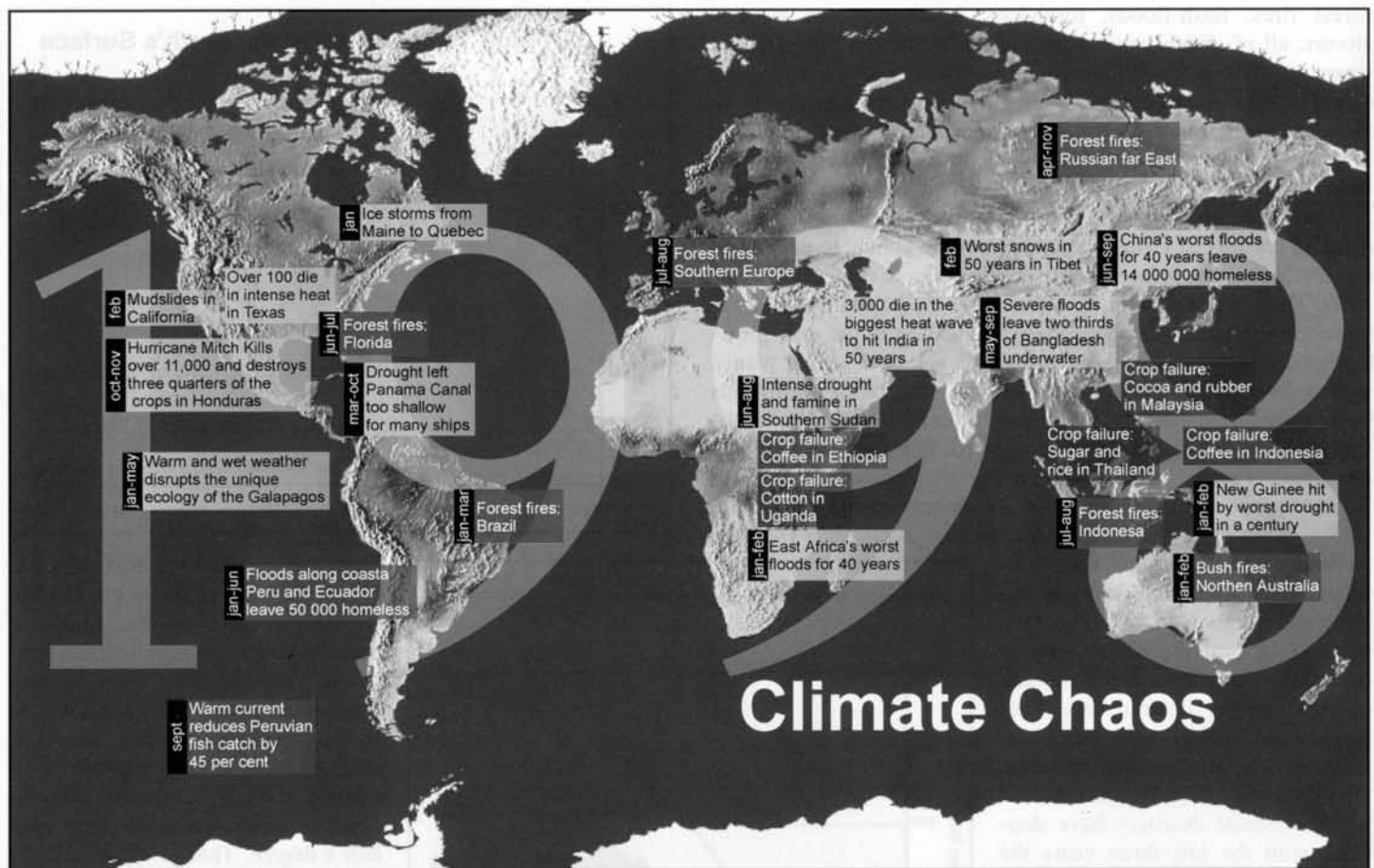
improved correlations. Just a decade ago, the General Circulation Models (GCMs), as they were then, indicated that the global average surface temperature should have risen by one degree Centigrade. The global warming sceptics were quick to point out that by the climatologists' own admission the actual overall temperature increase was little more than half a degree. That gave the sceptics considerable ammunition for deriding the efforts of the IPCC's scientific committee. And to add fuel to their cause, the lower atmosphere, about 3.5 kilometres up in the troposphere was found from satellite measurements to have cooled by 0.05°C. "The theories were flawed," pronounced the sceptics. Instead of a 'warming', the Earth was in the throes of a cooling, and who would

want that! By drawing attention to the apparent cooling some kilometres up they ignored the obvious discrepancy that average surface temperatures were increasing by 0.13°C per decade and that the lower stratosphere was cooling by as much as 0.5°C per decade – both facts evidence for a significant surface warming.

That troublesome discrepancy has now been resolved. Frank Wentz of Remote Sensing Systems in Santa Rosa, California points out that the data being beamed down from satellites had been interpreted as if the satellites were in a stationary, unchanging orbit. No-one, he remarks, took account of the slippage over time of the satellites as they were inexorably pulled in closer to the Earth because of atmospheric friction. The slippage of 1.2 kilometres every year gradually alters the angle at which the measurements are made, therefore giving a spurious result. Wentz re-did the calculations to account for the real angle and discovered a warming trend of 0.07°C per decade – just what would be expected from the readings from other strata in the atmosphere.<sup>6</sup>

To add weight to the evidence that surface warming is occurring, scientists from the British Antarctic Survey – that same body of scientists who were responsible for the discovery of the ozone hole in the mid-1980s – have discovered that the outer atmosphere is shrinking at the rate of one kilometre every five years, because, with more heat trapped at the surface, less is getting out to the outer atmosphere, which in fact is getting colder.<sup>7</sup>

Global warming critics, such as Fred Singer, President of the US Science and Environmental Policy Project were quite right to



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criticise the GCMs of the early 1990s for their over-prediction of the average surface temperature rise. What Singer and others such as Frederick Seitz, past President of the US National Academy of Sciences, patently failed to mention, however, was the modellers' awareness that the 'extra' greenhouse gases were not the whole story and that their models, to be one step closer to reality, needed to take on board the effect of 'offending' atmospheric aerosols. By realising that the sulphur dioxide emitted with the burning of fossil fuels has had a cooling effect on the Earth's surface through reflecting incoming light back out to space, the modellers at the UK's Met Office's Hadley Centre are now able to get good correlations with the records of past surface temperatures. Once again the discrepancy has been cleared up: the model shows a warming of little more than 0.5°C since 1860, just as has been found from measurements on the ground.<sup>8</sup>

In fact, the upward trend in temperature over the past 130 years has been in fits and starts rather than being a steady increase. The reason for the jerkiness becomes clear once the industrially-generated sulphate aerosols are included, which, in sharp contrast to the greenhouse gases, with an atmospheric lifetime of roughly 50 to 200 years, have an atmospheric lifetime of two weeks at most, together with a distribution that is extremely patchy. When industrial activity is high, for instance during the two World Wars, the emissions of sulphur go up, and since their effect on the atmosphere is immediate but short-lived they tend to dominate in the short-term. When high industrial activity is followed by a slump, as in the Great Depression, the concentration of atmospheric sulphur rapidly falls and the impact of the greenhouse gases comes shining through. We therefore have the paradoxical situation that cooler periods in the past resulted from greater industrial activity and warmer periods from economic and industrial recession. Clearly, as we institute sulphur-scrubbing to reduce sulphur emissions on an international basis, in accord with the Helsinki Protocol, the skies will become clearer and the full warming impact of the added greenhouse gases will be revealed.

Even as the theories of the small band of climate change sceptics

are being demolished, discrepancies or lack of correlation between carbon dioxide levels and climate over the past few hundred years are still being manipulated as evidence that our current greenhouse gas emissions cannot be correlated with global warming. One notable claim is that the Sun is largely responsible for such 'natural' fluctuations in climate through variations in sunspot activity. Thus, a shorter cycle of around nine years, compared with the average 11-year cycle, is generally associated with greater sunspot activity and there is evidence that those periods coincide with warmer surface temperatures, such as in late Roman times and in the Middle Ages. By the same token, periods of cool surface temperatures, such as between AD 1400 and 1510, a period known as the Spörer minimum, and the Maunder Minimum of the seventeenth century – when the Sun's brightness fell by at least 0.4 per cent – coincided with low sunspot activity.<sup>9</sup>

As various scientists have pointed out, the sunspot cycle is now months shorter than it was one century ago, implying more solar activity and presumably a warming. But, far more important than the actual length of the solar cycle is the number of sunspots in evidence at any one time, and they have been declining since 1960 – an indication that the Earth should be getting cooler, at least on the surface. Hence, the only possible remaining reason for the warming is the rise in greenhouse gases which are now swamping fluctuations in sunspot activity.

Still, climate change sceptics argue that climatic changes we may be witnessing today are a consequence of natural phenomena – such as El Niño. Whilst El Niño is normally a natural phenomenon, its recent extreme manifestation is highly likely to be the consequence of severe aggravation by human activities, including human-induced global warming and tropical forest destruction. In fact, according to some climatologists, if natural variability were the overriding factor, far from causing warming, it would currently be leading us into a period of cooling – a glacial. Writing 20 years ago, those climatologists were basing their argument on what was known of the Earth's orbiting around the Sun – known as the Milankovitch Wobble. The Earth's orbit shifts from being



## The Rise of Greenhouse Gas Concentrations

Atmospheric concentrations – the accumulation of emissions – of greenhouse gases have grown significantly since pre-industrial times as a result of human activities.

**Carbon dioxide** concentrations – the most important greenhouse gas apart from water vapour – has increased more than 30 per cent from 280 ppmv (parts per million by volume) in the pre-industrial era to 365 ppmv by the late 1990s. The current rate of increase is around 1.5 ppmv per year. Unfortunately, a large proportion of the carbon dioxide we put into the atmosphere remains there, warming the planet, for around 200 years.

**Methane** – on a weight-per-weight basis some 20 times more powerful as a greenhouse gas than carbon dioxide – has

more than doubled its concentration, from 700 to 1,720 parts per billion, by volume, (ppbv), primarily because of deforestation and the growth in rice and cattle production. Natural gas leaks are another source. Methane's residence time in the atmosphere is relatively short – approximately 12 years.

**Nitrous oxide**, associated with modern agriculture and the heavy application of chemical fertilisers, has increased from preindustrial levels of 275 ppbv to 310, with a current annual growth rate of 0.25 per cent. On a weight-per-weight basis it is more than 200 times more powerful as a greenhouse gas compared with carbon dioxide. Its residence time in the atmosphere is around 120 years.

**The chlorofluorocarbons, CFC11 and**

**CFC12**, both with growth rates of 4 per cent per year during the past decade, have now reached levels of 280 parts per trillion by volume (pptv) and 484 pptv respectively. They have a 'greenhouse gas potential' that is many thousands of times greater than carbon dioxide on a weight-per-weight basis, and they remain in the atmosphere for several thousand years.

When we take the residence time in the atmosphere of the different gases and their specific effectiveness as greenhouse gases into account, carbon dioxide's contribution is some 55 per cent of the whole, compared with 17 per cent for the two CFCs and 15 per cent for methane. Other CFCs and nitrous oxide account for 8 and 5 per cent respectively of the changes in radiative forcing.

circular to elliptical over the course of 100,000 years. Its tilt varies too, from 21.8 to 24.4 degrees over a 40,000-year period and is currently tilted at 23.44. The more tilted the Earth the greater the impact of the seasons. Which hemisphere is closest to the Sun during its summer or indeed winter varies over a 25,000-year cycle. The northern hemisphere is now closest to the Sun during its winter and furthest away in the summer, which means that it receives approximately 5 per cent less summer sunshine than it received 12,000 years ago. The Earth's current trajectory is one which has more in common with a cooling period and therefore we should be heading towards another ice-age. Recent history of the Earth suggests that ice-ages last 90,000 years with 10,000 years of interglacial. On that basis the timing is right for the development of another ice-age. The current spate of warming is therefore indicative that new factors – human emissions of greenhouse gases and mass deforestation – have been introduced which are counteracting and even overwhelming the consequences of a natural process.<sup>10</sup>

### Waiting for 'more certainty' cannot be an option

The handful of climate change sceptics enjoy repeating the mantra that too many uncertainties exist in the science of climate change and that these must be eliminated before we take economically 'costly' mitigating action. Such arguments are false and in leading to prevarication they are extremely dangerous: all the evidence of the IPCC has been properly peer-reviewed by the best climatologists in the world and it shows without doubt that global warming is a human-induced phenomenon that has a significant statistical base. The only elements of uncertainty concern the precise effects global warming will have on the rest of the Earth's climate-stabilising systems, and the speed with which changes will occur. But that must not be used as a reason for delaying action. Quite the opposite, for such uncertainty encompasses the possibility of highly disruptive, extremely long-lasting climatic change. The longer we delay reducing our greenhouse gas emissions, the more likely it is that the warming we have set in motion will increase to the extent that it causes new factors to come into play – such as the collapse of the planet's natural greenhouse-gas-absorbing sinks, which will in turn feed back on the warming process, causing climatic changes that are potentially catastrophic and effectively irreversible for centuries if not millennia to come (see 'How Climate Change Could Spiral Out of Control', p.68).

If such effects were unleashed, we would not be able to return rapidly to where we were by simply switching off the emission of greenhouse gases and deforestation that caused the impact in the

first place. For, once carbon dioxide is in the atmosphere, between 40 and 60 per cent of it remains there for a historically long period – some 200 years when the carbon sinks are in healthy operation.

Waiting for 'more certainty' or more damage to occur is an extremely dangerous and irresponsible position to take for another reason. The radiative thermodynamic physics of the greenhouse effect are such to cause a long delay between the emission of carbon dioxide into the atmosphere and the time when the effects on the climate actually manifest themselves. Hence, the CO<sub>2</sub> that we emit and accumulate in the atmosphere now will only act on the climate 50 to 80 years in the future. Conversely, climatic changes, such as temperature increase, extreme weather events and damage to crop yields that we are experiencing today, are occurring in response to the CO<sub>2</sub> that we emitted half-a-century or more ago – when atmospheric concentrations were much lower than they currently are. It therefore follows that in 50 to 80 years from now, we will experience incomparably more damage than today.

Our politicians should therefore understand that if they only take action proportionate to the damage they see now, they will dramatically and catastrophically underestimate the damage that will actually take place, and they will hence underestimate the degree of action that is needed to avert it. Measures to prevent such severe climatic disruption cannot therefore be taken soon enough. The reality of climate change and the need for preventive action is now inescapable – no one should doubt it.

Simon Retallack is guest editor of this special issue of *The Ecologist*. Peter Bunyard – Science Editor of this special issue is the author of *Gaia In Action: Science of the Living Earth*. His forthcoming book on climate change is called *The Impact of Global Warming*.

### References:

1. IPCC's Second Assessment Report, Summary for Policymakers, Cambridge University Press, 1995.
2. Ross Gelbspan, *The Heat is On*, Addison Wesley, 1997.
3. Ross Gelbspan, Climate change: local and global, article 1998.
4. Climate Change, The IPCC Scientific Assessment, Processes and Modelling, WMO/UNEP, 1990.
5. Stephen Hume, *The Vancouver Sun*, December 30, 1998.
6. Frank Wentz, Matthias Schabel, *Nature*, Vol. 394, p.661, August, 1998. Also see James Hansen *et al.*, *Science*, Vol. 281, p.930 and Jeff Hecht, *New Scientist*, August 15, 1998.
7. Martin Jarvis, British Antarctic Survey, *Journal of Geophysical Research*, Vol. 103, p.20 774.
8. UK Climate Impacts Programme: Technical Report No. 1, The Met Office, October 1998.
9. John Eddy, Solar History and Human Affairs, *Human Ecology*, Vol. 22 No1, 1994.
10. David Waugh, *Geography: an Integrated Approach*, Nelson, second edition, 1995.

# Is El Niño Now a Man-made Phenomenon?

— BY ALAIN-CLAUDE GALTÉ —

*Instead of appearing every four to seven years, El Niño has now been appearing consecutively for a number of years and in a stronger form than ever before in human history — severely disrupting agriculture and economies across the planet. Could it be that global warming and the destruction of tropical rainforests are responsible for the change?*

**W**e have been warned; we are now beginning to experience the convulsions of a climate that is changing fast. And nothing could be more indicative of that change than the 1997/98 El Niño, which in the UK Met Office's own words was "the most extreme on record". El Niño, the 'Christ-child' — so-called because it tends to show its face around Christmas — is a natural phenomenon, something that the world has experienced since time immemorial. That makes it all too easy to blame the strength and violence of the latest El Niño on a phenomenon which has nothing to do with us. El Niño has become the scapegoat for practically all the appalling weather experienced over the past year. That is a dangerous misconception: it lets us off the hook when, because of global warming, and particularly because of our destruction of the environment in the Tropics, we are setting the scene for catastrophic changes to the basic nature of El Niños. They are becoming more violent and they are lasting longer. Particularly worrying too, for all the growing sophistication of our climate models, is that we were unprepared for this El Niño when it came. The best our models could do was to indicate that the year of the next El Niño would be 1998/99 and not 1997/98. If we can be as wrong as that, then we clearly have to question the basis of our understanding of what goes on in generating such a major switch in the world's largest ocean.<sup>1</sup>

## **The impact of the 1997/1998 El Niño**

The latest El Niño involved massive releases of energy from the Pacific Ocean. The 1997/98 El Niño took hold in the late summer and autumn of 1997. The first signs were a sudden warming of the tropical waters off the coast of Peru by as much as 6°C, combined with violent downpours and landslides in what is one of the driest deserts in the world — the Atacama. It also spawned Hurricane Pauline that hit the south-west of Mexico early in September, destroying roads and bridges as well as demolishing entire coffee plantations in the mountains of western Oaxaca. Across the other side of the Pacific, where giant cumulo-nimbus clouds normally bank up as a prelude to the monsoon rains, the skies remained clear and open to the scorching sun. The monsoon rains barely arrived and South-east Asia was left with withering heat and devastating drought. Papua New Guinea had to declare a state of emergency as crops failed; starvation was only staved off because of airlifts of foods and medicines from Australia and New Zealand. The lack of rain had dire consequences right across the globe and fires continued to rage over a 200-square-kilometre region in Indonesia's East Kalimantan, months after they were first lit by forest clearers. The fires burrowed down into the massive peat bogs associated with Indonesian forests, releasing into

the atmosphere carbon that had been stored over the past 10,000 years.

Conditions in Brazil's northern Amazon were just as bad. There, fires destroyed over 6,000 square kilometres. And late in 1998, after months of burning, forest fires in the Khabarovsk district of Russia on the Pacific coast had already wiped out two million hectares. That's an awful lot of carbon dioxide sent pluming into the air and it can be no coincidence that the amount of carbon dioxide accumulating in the atmosphere in 1998, as measured at Mauna Loa, Hawaii, jumped upwards by one-seventh compared with the previous peak.<sup>2</sup> Just the fires in the world's tropical regions released as much carbon dioxide as is vented from all of Western Europe's agriculture and industry in one year. And not one of those fires can be called 'natural': they were all lit by humans, mainly in their attempt to convert tropical rainforest into plantation crops and cattle ranches.

Fires, too, and desperate drought were the order of the day during the year of the 1982/83 El Niño. Thousands died of starvation

*The general belief is that the Southern Pacific Ocean acts like a capacitor, mopping up energy in the form of heat, until a point is reached when the system overloads and dumps the energy in one dramatic moment. Although the mechanism is not clear, the extra heat going into the oceans because of global warming appears to have tipped the balance to more frequent El Niños as well as more severe ones.*

in the Sahel countries of Africa and at least 36,000 square kilometres were destroyed by fire in Borneo. Meanwhile, rainfall over the Amazon went down by 30 per cent. That implies an enormous energy change in the climate system — close to 160 terawatts — and equivalent to some twelve times the total amount of energy now used by humans across the globe.

It seems that El Niño hits hardest where we have already begun to degrade the environment. Indeed, we can see with dramatic effect what tropical storms can do to the environment when it has been degraded and destroyed. The horrendous damage that hurricane 'Mitch' caused in Honduras and Nicaragua was largely the result of deforestation, which left soils exposed and vulnerable to sheet erosion and massive landslides that buried whole villages (see picture). Having lost 34 per cent of its pine and deciduous for-





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The devastating impact of Hurricane Mitch in Honduras - blamed on El Niño

est through logging between 1964 and 1990, Honduras is still continuing to destroy its native upland forests at the rate of 80,000 hectares each year. The situation is even worse in Nicaragua: there, 150,000 hectares of forest are destroyed each year as a result of commercial timber extraction, the advancing agricultural frontier, slash-and-burn farming and human-lit forest fires. The country has lost nearly 60 per cent of its forest cover in the last 50 years.

What could be a more obvious prelude to disaster? And were El Niño to become the norm that would play havoc with our systems of agriculture. We would experience torrents of unseasonal rain where before the weather had been dry and catastrophic drought where before we experienced summer monsoons.

### El Niño and La Niña in normal times

Until twenty years ago El Niños would occur every four to seven years, last for one year, and give way to the opposing climate regime, which as a consequence has been dubbed La Niña. La Niñas therefore follow hard on the heel of El Niños, but where El Niño brings drought, La Niña brings rain and vice versa. As far as the Pacific Ocean goes, El Niño goes hand in hand with an expanding region of warm waters, while La Niña presents the 'cool' side, with strong upwellings in tropical waters of cold currents from Antarctica. The more usual climate pattern occurs in the intervals between such oscillations. 'Normal' therefore means monsoon rains over South-east Asia, a rain-drenched Amazon, rains over arid Sahel in Africa, some dousings of rain over Australia and extremes of high pressure over the west coast of South America, south of the Equator. La Niña, as well as a 'normal' Pacific Ocean, bring rich fish harvests to the Peruvian fishermen and account for the mountains of 'guano' — bird manure — that have accumulated because of the gathering of millions of seabirds. In such years, the Trade Winds blow strong and drive the waters of the Pacific Ocean from East to West, so that by the time they have piled up against South-east Asia they have burdened



NIGEL DICKINSON/STILL PICTURES

themselves with massive amounts of water vapour that are released as the air rises up over the opposing air currents pushing up from the Indian Ocean. The movement of water across the Pacific allows the cold waters of the Humboldt Current to surface along the South American coast south of the Equator. Loaded with vital nutrients, the Humboldt Current hosts a profusion of life.

When the normal regime gives way to El Niño, then the Humboldt Current is held down by a thick cap of warm waters. Without the nutrients, the rich biological cycle is broken. Without the phytoplankton, the populations of the minute plankton-feeding zooplankton crash, and so on, to the fish and then to the seabirds. The difference is momentous. In a good year, such as in 1970, Peruvian fishermen took 12 million tons of anchovies from the sea. Three years later, an El Niño year, the catch plummeted to less than two million tons.

### Causes of violent El Niños - global warming?

The New Zealand climatologist Ken Trenberth, now at the National Center for Atmospheric Research in the United States, was the first to pinpoint the four-to seven-year cycle of El Niños. He therefore sees the sharp change in pattern of El Niños since the mid-

1970s as evidence that a switch in climate has begun to take place. Nothing like it, he says, has been seen for at least 2,000 years, and he believes the change in behaviour of the Pacific Ocean to be a consequence of global warming.<sup>3</sup>

The general belief is that the Southern Pacific Ocean acts like a capacitor, mopping up energy in the form of heat, until a point is reached when the system overloads and dumps the energy in one dramatic moment. Indeed, as they warm, the surface waters of the central Pacific can move hundreds, if not thousands, of miles eastwards. Although the mechanism is not clear, the extra heat going into the oceans because of global warming appears to have tipped the balance to more frequent El Niños as well as more severe ones. El Niños therefore reflect an instability in the climate system and in that respect, signal that climate is changing dramatically.

The amount of moisture in the climate system is a good indicator of the additional heating that the Earth is now undergoing. And more water vapour in the atmosphere means "a significant increase in the energy available to drive storms and associated weather fronts", according to scientists at the US Global Change Research Program. Meanwhile, atmospheric moisture has grown by five per cent per decade since 1973 over the United States and by 10 per cent over temperate regions of the northern hemisphere over the past century. Some climate simulations show El Niño-like conditions developing over the Pacific as carbon dioxide levels in the atmosphere double: they add weight to the notion that global warming is having a major impact on climate and weather patterns.<sup>4</sup>

### The volcanic catalyst

Global warming on its own, however, may not be enough to cause an El Niño. One idea that has been gaining ground is that some of that kick-start energy comes from volcanic activity in the ocean bottom. Oceanographers have now discovered large flows of magma from the mid-ocean Pacific ridge that over a period of approximately five years could release a good proportion — perhaps as much as ten per cent — of the heat that is normally associated with changes in the sea surface that go with El Niños. Even more extraordinary is the correlation between volcanic eruptions that send debris and gases into the atmosphere. Major volcanic eruptions, such as El Chichon in Mexico in 1982 and Pinatubo in the Philippines in 1991, prevented as much as ten per cent of sunlight getting down to the Earth's surface over the northern Tropics. According to Paul Handler and Karen Andsager, of the University of Illinois, that cooling will have led to substantial shifts in the amount of air building up over the Eurasian continent

## Climatic Dislocation in Colombia.

The 1990s have been marked by the phenomenon of El Niño, which used to occur once every five years and now makes itself felt every three months. The radical change in its frequency has had a major effect on the quantity and distribution of water all over Colombia, causing a decline in the yield of crops, in cattle-raising and bringing about problems in the production of hydro-electricity, with severe repercussions for the economy.

"Even though Colombia has been well aware of the existence of El Niño and La Niña," says meteorologist Max Henríquez, "it has taken us completely by surprise through lasting so long. Every time there is drought, however intense, it has an impact on ecosystems. Given the new frequency of such events, there is no time for recovery. As a result, we could experience serious deterioration of biodiversity in the west of the country, in what is one of the world's richest habitats, the biogeographic region known as the Chocó."

Equally, the snow-clad peaks in Colombia, as elsewhere in the world, are also experiencing a rapid shrinking in snow both in area and depth brought about by global climate change. Although volcanic activity has brought about some melting, that does not account for Colombian glaciers having lost almost 40 per cent of their cover over the past forty years: their total disappearance seems increasingly likely. In general the country is suffering from frequent and unexpected floods, while the prolonged droughts are causing a series of forest fires in different regions of the country, as well as famine and disease.

*By Mónica del Pilar Uribe Marín, a Colombian journalist.*

during the winter months. As a result, the air mass that normally feeds the Trade Winds is much weaker and conditions are set for an impending El Niño. On the basis of such a scenario, volcanic eruptions are most effective in bringing about an El Niño when they inject their debris over the low latitudes of the northern hemisphere, just as El Chichon did in 1982. The correlation held for 1997, which saw the volcanic eruptions on the Caribbean island of Montserrat — in the right place and at the right time.<sup>5</sup>

### Deforestation and El Niño

But whereas volcanoes and the four-to seven-year El Niño cycle are all natural phenomena, we have now introduced another player in the process, aside from global warming. The massive and continuing destruction of tropical forests may be responsible for the abrupt change in the behaviour of El Niños. Tropical forests, particularly when intact, are responsible for prodigious releases of energy in the form of water vapour into the atmosphere — equivalent to the energy that would be released by exploding some 5-6 million atomic bombs every day just over the Amazon Basin.<sup>6</sup> That energy is then transferred in the global circulations from the Equator up into the higher latitudes and is crucial for the movement of air masses. Those same air masses form the 'highs' and 'lows' that provide the basis of global weather. The tropical forests of the world, including those of the Amazon, of Central Africa and of Indonesia, lie judiciously at the point along the Equator where tropical thunder-

YAFFA SYNDICATE



*Not bad... for a little fella.*



storms develop. But they are not just fortuitous recipients of rain: they actually generate rain, first by pumping water vapour into the atmosphere through transpiration and second by releasing volatile hydrocarbons, such as isoprene, that act as cloud-condensation nuclei. Consequently, as much as three-quarters of all the rain that falls over the rainforest in the humid tropics gets returned to the atmosphere by means of evapo-transpiration.

*Given the crucial role of tropical forests in re-distributing the energy that falls over the Equator and given our destructive obsession with chopping them all down, we could well be in for a spate of exceedingly destructive switches between El Niños and La Niñas.*

Hence, heated air masses rise above the forests and become rivers of air which cross the Pacific from west to east. They then cool down and descend where the waters are coolest, towards the American coasts, where they feed the trade winds. Rainforests therefore appear to act as thermal machines and, above all, as regulators of atmospheric and oceanic systems which control the climate.

Even though the El Niño/Southern Oscillation has existed as a phenomenon for longer than history, the wholesale destruction of tropical forests over the past forty years will have seriously jeopardised the efficiency with which energy gets transferred from the Equator to the higher latitudes. Other climatologists, Ann Henderson-Sellers for example, have begun modelling rainforests into the climate system. Their models indicate that rainforest destruction is having a significant impact on the jet-streams that wedge their way between the various atmospheric circulation cells. By shifting

the air masses of the major circulation systems both south and north, east and west, the jet-streams have a profound effect on regional climate. Forest destruction in the tropics is therefore changing climate and is sending weather systems spiralling off in new and unpredicted directions.<sup>7</sup>

Given the crucial role of tropical forests in re-distributing the energy that falls over the Equator and given our destructive obsession with chopping them all down, we could well be in for a spate of exceedingly destructive switches between El Niños and La Niñas. A spate of powerful El Niños would play havoc with tropical agriculture, with vast areas of the Tropics becoming irreversibly desertified through a successive drying out. Yet that is where we are heading. The 1997/98 El Niño is a warning: we cannot afford to destroy more forests; nor can we afford to pump great volumes of greenhouse gases into the atmosphere. As a warning to humanity of the dangers of aberrant behaviour, perhaps El Niño was aptly named.

Alain-Claude Galtié is a French ecologist and is on the board of editors of *Silence* magazine.

#### References:

1. Stephen Zebiak and his colleague, Mark Cane, at the Lamont-Doherty Earth Observatory at Columbia University, New York, are considered among the top experts on El Niño. Their models led them to believe that 1998 would be the year of El Niño and not 1997 (*New Scientist*, May 31st, 1997).
2. Fred Pearce, Quick Change, *New Scientist*, 14 November, p.15, 1998.
3. Ken Trenberth, quoted in University Cooperation in Atmospheric Research, edited by Carol Rasmussen, Winter 1997.
4. *ibid*
5. Paul Handler & Karen Andsager. El Niño, Volcanism and Global Climate. *Human Ecology*, Vol. 22, No.1, 1994.
6. Eneas Salati, The Forest and the hydrological cycle, in *The Geophysics of Amazonia*, ed. Robert Dickinson, Wiley, 1987.
7. H. Zhang, K. McGuffie and A. Henderson-Sellers, *Journal of Climate* Vol. 9, 1996.

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# How Climate Change Could Spiral Out of Control

— BY PETER BUNYARD —

*As temperatures rise, a dangerous self-feeding process may take hold in which life – a key player in the processes that generate climate – is so affected that it actually destabilises the climate system irrevocably. Existing climate models, however, have yet to take this possibility properly into account.*

The latest reports from the Hadley Centre of the UK Met Office make no bones that worldwide we are sliding inexorably into a period of global warming and, according to its analyses, within fifty years – simply no time in the history of our planet – we will face disturbances in climate that could well put our future at stake.<sup>1,2,3</sup> When we begin to account for some of the essential positive feedbacks, in particular those involving life, then we begin to see how much *more* dangerous the situation is than anything we may have envisaged.<sup>4,5,6</sup>

In testing their general circulation models, climatologists try to get as close correspondence as they can against data of surface temperatures going back over the past 140 years. By averaging out temperatures over a succession of 30-year periods they therefore obtain a 'reference temperature' for each year. Then, once relatively good correspondence is achieved, they feed into their models special parameters such as rising CO<sub>2</sub> levels to accord with different scenarios of greenhouse gas emissions, the intention being to obtain predictions of such phenomena as sea-level rise, air circulation systems, precipitation and not least surface temperatures in different parts of the globe. But whereas the parameters used to establish concordance with the past may have proved adequate, the likelihood is that they will prove deficient in the future, the reason being that complex feedbacks are now coming into play that have not yet been modelled in, such as, for example, the impact of ocean warming on populations of phytoplankton, which in turn will affect carbon dioxide absorption. In fact, from 1860 until World War Two changes to the global environment were limited, but over the past fifty years we have seen a massive worldwide surge in 'economic development'. Changes to the environment have been radical and destructive and processes have been set in motion, such as forest die-back and desertification, that have become self-reinforcing. In that respect, the recent past will be no guide to the future.

Up to now, modellers have failed to recognize in their models that climate is largely a construct of living processes and is therefore fundamentally affected by what happens to life, and not just to physics and chemistry. This omission is largely due to the difficulty of quantifying life-driven fluxes and flows of carbon-based matter.

Nevertheless, if the climate models are going to get near to estimating the full impact of global warming in a hundred years' time, let alone in twenty years, they will have to take life properly on board and that means incorporating not only the functions of life into the equations, but also the human impact on those functions. And that impact – of one species alone – is absolutely without precedent.





### Impact on the ecosphere

Our concern is largely with positive feedbacks – triggered in this instance by global warming and other impacts of economic development. Changes to the environment, like rising temperatures and the destruction of natural ecosystems, may become amplified in a feedback process that then spirals out of control – producing a ‘runaway’ warming. Another complicating feature of positive feedbacks is the tendency for distinctly different processes to feed on each other in synergistic interactions. For instance, global warming causes soils to dry out and that in turn leads to the die-back of forests. The die-back of forests leads to further drying out of soils as well as to the release of carbon dioxide and methane. The additional greenhouse gases add to warming and hence to further deforestation. Meanwhile, surface winds increase over the deforested areas because of greater contrasts in day to night temperatures. The soil, now dry and decomposed, starts blowing off: some falls out on sea-ice in the Arctic, darkening the surface so that it absorbs rather than reflects sunlight. More heat is now held at the surface, so adding to global warming. True, the dust in the atmosphere will reflect light away and hence lead to some cooling,

but that will be more than counteracted by all the other self-feeding and hence synergistic, impacts.

Life is engaged in two major processes that have an impact on climate. First, life is fundamentally implicated in the carbon cycle whereby carbon in the form of carbon dioxide is drawn down from the atmosphere in the process of photosynthesis and returned again through respiration and decomposition. Second, life has a profound effect, both directly and indirectly, on the albedo of the planet – the degree to which sunlight is reflected away or absorbed by the Earth’s surface.

Aware that without life properly integrated their models are deficient, climatologists in the UK have begun looking at the response of life to climate change and in turn are trying to see how the changes to life might impinge back on climate. Richard Betts from the Hadley Centre and his colleagues from Sheffield University have tried to get the measure of what will happen to vegeta-

**The Amazon rainforest, like other vast terrestrial sinks, could die-back as temperatures rise, leaving us with a surge in greenhouse gases.**



ANDRE BARTSCH/STILL PICTURES

tion as a result of increases in atmospheric carbon dioxide and climate change.<sup>7</sup> They get a mixed bag of results. More carbon dioxide means better growth and more efficient use of water. But that supposed efficiency may have its drawbacks, especially in the Tropics where evapo-transpiration is an important mechanism for cooling and for feeding rain-clouds so that the forest remains well-watered. Meanwhile, more vigorous growth in the high latitude, boreal regions, can accentuate warming by bringing about earlier snow-melts and so exposing the leaf-darkened surface to the sun.

*Rising temperatures, through the melting of permafrost, could bring about the release into the atmosphere of as much as 450 billion tonnes of carbon in the form of carbon dioxide and methane. Such a release would in itself be a self-reinforcing feedback, since more global warming, brought about by the release of carbon as greenhouse gases, would entail more temperature rise and further releases.*

A conifer, for example, is aptly shaped to shed snow, thus exposing the dark, green needles to the first rays of the spring sun. The great boreal forests therefore bring winter to an end much faster than would other vegetation, while equally extending the summer. Should global warming cause the northwards spread of conifer forests, that will bring about more warming.

In fact, as Lee Klinger of the US National Center for Atmospheric Research in Boulder, Colorado, has graphically shown, over much of the permafrost area, boreal forests are in competition with sphagnum moss. Bog mosses make the soil acid through the release of sulphides which form acids on oxidation. Acidity favours mosses against other plants, not only stimulating the growth and spread of *Sphagnum* but also, by preventing bacterial decomposition of organic matter, favouring the accumulation of peat. Estimates vary between 500 and 860 gigatonnes as being the size of the organic carbon pool in the world's peatlands – therefore of the same order of magnitude as the amount of carbon in the atmosphere. In addition, the moss generates a wet misty climate that reflects away sunlight, keeping the local climate cool and helping to generate the conditions for the moss to extend its domain, which includes the formation of a permafrost layer.<sup>8</sup>

Global warming could be pushing the climate towards a regime that favours boreal forests at the expense of sphagnum moss. That being so, rising temperatures, through the melting of permafrost, could bring about the release into the atmosphere of as much as 450 billion tonnes of carbon in the form of carbon dioxide and methane. Such a release would in itself be a self-reinforcing feedback, since more global warming, brought about by the release of carbon as greenhouse gases, would entail more temperature rise and further releases, until the original wetlands had released most of their carbon. We already have cause for concern. Siberia, much of which is covered in permafrost, is warming faster than almost anywhere on the planet.

### **Terrestrial sinks, but then sources**

On the basis of a steady 'business-as-usual' increase in carbon dioxide, the UK Met Office's Hadley Centre predicts a sharp increase in the mass of tropical forests over the next fifty years. That all sounds like good news. But there is a terrible sting: the entire tropical ecosystem then collapses abruptly. The forests, which currently absorb about one third of the carbon dioxide we emit, will no longer be able to cope with the drastic reduction in rainfall combined with temperature rises as high as 8°C.<sup>9</sup> Not only will the forests decompose as they die-back, but their carbon diox-

ide-absorbing mechanism will no longer function and we will be left with a surge in greenhouse gases. Tropical forests contain approximately 40 per cent of the carbon contained in terrestrial biomass, which amounts to some 550 billion tonnes in total. The release of most of the carbon now contained in the world's tropical forests would be equivalent to one-third of the carbon in the atmosphere.

We might be misled into thinking that the modellers have shown us the worst. Yet, by their own admission "the model describes the potential natural vegetation that would exist without interference by humans, such as the recent rainforest fires."<sup>10</sup> However, the actual situation is fundamentally different from the one they are modelling. We have wreaked destruction all over the planet and whatever its potential, natural vegetation is not being given a chance. When we chop down and burn great swathes of tropical rainforest, we actually alter the health of the remaining ecosystem by subtly affecting rainfall and the flow of water through the system. That way, the ecosystem collapses well in advance of its vanishing under a changing climate. If they are to give us something approaching a realistic view of the future, the models will have to feature our impact on the Earth's beleaguered ecosystems.

In just 50 years we have lost approximately half of the world's tropical forests and at the rate we are going it will not be long – possibly as little as 30 years – before we have lost the rest. During the 1980s the destruction of forests was responsible for as much as one-fifth of all carbon emissions from human sources – approximately 1.4 billion tonnes (Gt) a year. In 1998 five million hectares of tropical forest worldwide – an area the size of Costa Rica – went up in flames, 40 per cent of it in Brazil. Add to that 3.9 million hectares of tropical forest in Brazil being converted to charcoal for pig iron manufacture, and we have mass forest destruction on our hands. But where do we see such destruction accounted for in the general circulation models? Nowhere!

Under those circumstances can we take at all seriously the Met Office's prediction that a surge in tropical forest growth over the next fifty years will haul in an extra billion tonnes per year of carbon from the atmosphere, so taking the total terrestrial carbon sink per year from two billion to three billion tonnes? If in fact that extra sink is not there, because of 'premature' forest destruction, the terrestrial sink will have turned all too soon into an emission source.

Certain feedbacks are inevitable and the modellers do their best to incorporate such processes in the latest Global Circulation Models (GCMs). Albedo is critical in climate change – as critical as the greenhouse gases. And since water governs more than three-quarters of the planet's albedo and, as vapour, is the main greenhouse gas, whatever governs the movement and transformation of water into its different phases will have a major impact on climate.

A classic is sea-ice and continental glaciers: with a warming trend, ice that has formed over the winter months will melt sooner, with the first rays of the spring sun. Water absorbs sunlight: ice and snow reflect it. Less ice means more sunlight is absorbed which means that less ice will form, such a seasonal shift pushing the trend ever onwards. That trend will reinforce others, such as the thermal expansion of sea water, combined with a gradual rise because of increased fresh-water flow into the ocean. The flooding of low-lying land causes vegetation to decompose, so bringing about the release of greenhouse gases such as nitrous oxide, methane and carbon dioxide. More greenhouse gases means more heating which means more thermal expansion of sea water, more flooding and all the consequences that accompany it.

Global warming could be on the verge of triggering the destruction of the West Antarctic ice-sheet. Its three million cubic kilometres of ice, enough to raise sea-levels worldwide by up to six metres should it collapse and come adrift, is perched on an archipelago of submerged islands with ocean water flowing beneath the



**The oceans contain fifty times more carbon dioxide than is in the atmosphere. As the oceans warm, the solubility of carbon dioxide drops significantly. Instead of a vital sink for carbon dioxide, the oceans could turn into a net source.**

ice. The fear is that warm waters could release the entire ice sheet into the ocean, causing a worldwide rise in sea levels that would be more than ten times greater than current predictions. The Greenland ice-sheet, grounded as it is on land, is far more stable than the West Antarctic ice-sheet, but were it to melt because of rising temperatures, it would add another six metres to sea-level rise. And, as the Met Office reminds us, global warming will be at its most intense over the Arctic. By its predictions, were greenhouse gases to increase at their overall current rate of one per cent per year over the next 50 years, some regions in the Arctic Circle would warm by as much as 6 °C compared with today – a rate of warming that would be two to three times greater than the global average.

Warmer oceans could have another important consequence. According to the US Geographical Survey, 10,000 billion tonnes of methane are currently trapped under pressure in crystal structures – methane hydrates – on the edges of continental shelves, making them the Earth's largest fossil-fuel reservoir. But if the temperature in the surrounding water or sediment is increased to the point where a methane hydrate becomes unstable, methane gas is released overnight. Hence, where water is relatively shallow and thus easier to heat, as in the Arctic (which is already warming fast at two to three times the global average), tens if not hundreds of billions of tonnes of methane could be released. The consequences would be dire: only a little methane hydrate would need to be melted to boost the greenhouse effect greatly. It has happened before – some 55 million years ago – and it could happen again.

### **Losing our ocean sinks**

The continued function of the oceans as a net sink for atmospheric carbon dioxide is of critical importance for a stable climate. Were that sink to be lost, then that would unleash another dangerous positive feedback which the climate models have yet to take fully into account. In fact, the circulation of the oceans is vital in both the uptake of carbon dioxide from the atmosphere and the transport of heat from the Equator to the high latitudes. That system depends on the surface waters in the North Atlantic becoming sufficiently cool and salty such that they are heavier than the waters beneath. They then sink and carry the absorbed carbon dioxide along the ocean bottom all the way to Antarctica. Meanwhile, the process of sinking draws in waters from the Tropics and so the Gulf Stream is brought into being, with its transportation of great quantities of heat. (See 'How Global Warming Could Cause Northern Europe to Freeze' p79.). Between 500 and 1000 years later, when those sunken waters surface again in the Tropics, the dissolved carbon dioxide starts bubbling out again. That circula-



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tion is therefore of prime importance in steadying and maintaining carbon dioxide levels in the atmosphere, and again a curtailing or stalling of the 'conveyor belt' will have repercussions on the ocean's role in taking up anthropogenic carbon dioxide from the atmosphere. Some two billion tonnes of carbon is at stake, between one third and one quarter of the carbon dioxide emitted from fossil fuel and forest destruction.

Phytoplankton in the surface waters of the north Atlantic play a crucial role in drawing down carbon dioxide. Total primary production in the oceans runs to some 40 billion tonnes of carbon photosynthesized each year, of which between 10 and 40 per cent sinks out from the surface as particles, including plant cells and faecal material. Most of the primary production is quickly recycled back to carbon dioxide through plant and animal respiration. A very small proportion makes it to the sediments where it is retained. The downward flow of dissolved organic carbon – believed to be some 5 billion tonnes per year – is of vital importance as a mechanism for taking some of the fossil fuel derived carbon dioxide out of the atmosphere.<sup>11</sup>

The evidence for phytoplankton activity is startling. Satellite shots reveal an impressive 50-to 100-fold range of chlorophyll concentrations in the oceans, indicating where high levels of photosynthesis are taking place. Not surprisingly the regions with the

highest concentrations of chlorophyll overlie precisely the same areas of ocean where carbon dioxide uptake is at its highest, as in the north Atlantic. The link between the success of phytoplankton and the amount of carbon dioxide and methane in the atmosphere is firm. Through analysing air bubbles trapped in polar ice, climatologists can follow the history over the past 440,000 years of carbon levels in the atmosphere as well as of phytoplankton activity. The correlation is striking: when the plankton are thriving, the concentrations of carbon dioxide in the atmosphere go right down and the concentrations of carbon go up when phytoplankton activity is depressed. As Lovelock has remarked, life in the ocean prefers a colder climate.<sup>12</sup>

As long as the surface waters get stirred up because of rough weather and storms, the nutrient supply is sufficient to support a rich surface life. Those conditions are ideally met in the north Atlantic and satellite images show blooms of phytoplankton that stretch for hundreds of miles off the west coast of Britain during the spring and summer. Stagnation of the surface waters because of a disruption of ocean circulation, as occurs during El Niño episodes in the south-eastern Pacific, plays havoc with phytoplankton activity and the drawing down of carbon dioxide. Equally, as the oceans warm, the surface waters tend to form a cap that prevents mixing and restricts the flow of nutrients. Oceanographers believe that if it had not been for the activity of marine biota the atmospheric levels of carbon dioxide in the immediate pre-industrial era would have been 450 ppmv rather than the actual level of 280 ppmv.<sup>13</sup>

*The oceans, instead of a vital sink for carbon dioxide, could turn into a net source. With their fifty times more carbon dioxide than is in the atmosphere, it takes no more than a subtle change in the exchange between the oceans and atmosphere for greenhouse gas levels to double.*

Disruption of oceanic currents and in particular the Gulf Stream 'conveyor-belt' would bring about formidable self-enhancing feedbacks. If the population of phytoplankton begins to crash because of a combination of warmer surface waters, a curtailing of the conveyor belt, and by exposure to ultra-violet from the hole in the ozone layer, then inevitably much less carbon dioxide will be drawn down into the ocean depths: hence more warming. As it happens, because of the build-up of carbon dioxide in the atmosphere, the surface waters are enriched in CO<sub>2</sub> by more than 40 micromoles/kg compared with those of a century ago and at least four-fifths of the carbon dioxide derived from fossil fuel burning and the destruction of forests is still to be found in the upper 750 metres of the great subtropical ocean gyres.

Even without taking changes in biological activity into account, Jorge Sarmiento and Corinne le Quéré at Princeton University find from their models that both stratification (in which the warm surface waters form a distinct layer which prevents nutrients coming up from below, thereby starving the phytoplankton of essential nutrients) and a slowing down of the conveyor belt will result in as much as a 50 per cent reduction in carbon dioxide absorption into the ocean.<sup>14</sup> This is not just a theoretical possibility. Because of a rise in temperature of the surface waters off the coast of California, phytoplankton numbers there have already declined significantly, with all that entails for carbon absorption. Given that approximately 10 or more parts per million by volume of carbon dioxide would vent out of the oceans for every degree rise in temperature, a warming of the oceans by an average 5°C from a quadrupling of carbon dioxide in the atmosphere would lead over time to an additional 50 ppmv of CO<sub>2</sub> – one-seventh of

## When Could the Gaian Thermostat Fail?

In a letter to *Nature*, James Lovelock and Lee Kump, from the University of Pennsylvania, show how ocean warming and the forming of a stratified 'thermocline' can put paid to the role of phytoplankton in helping to maintain an equitable global climate through their cloud-generating ability. Once large areas of the oceans' surface waters exceed 12°C, then phytoplankton productivity goes rapidly into decline. That would be a powerful positive feedback that in one fell swoop would jack up the surface temperature another notch. Terrestrial vegetation also has its limits, a critical factor being temperature and water stress. The average surface temperature is now some 15°C. The model indicates that were the average surface temperature to go up another 3°C – all on the cards with global warming – then terrestrial vegetation would begin to succumb to the effects of drier summers and water stress.<sup>17</sup>

current levels in the atmosphere.

Not only are we on the threshold of losing a two billion tonnes-per-year sink of carbon dioxide but, as the oceans warm the solubility of carbon dioxide drops significantly. We will therefore begin to see the 'additional' carbon dioxide in those surface waters bubbling out. The oceans, instead of a vital sink for carbon dioxide, could turn into a net source. With their fifty times more carbon dioxide than is in the atmosphere, it takes no more than a subtle change in the exchange between the oceans and atmosphere for greenhouse gas levels to double.

## Clouds — the key to climate

Even this possible scenario does not take into account the impact of global warming on water vapour and clouds. By far the most significant greenhouse gas is water vapour, accounting as it does for as much as 70 per cent of greenhouse gas warming. In general water vapour is not included as a greenhouse gas in the reduction basket for negotiations on the grounds that it needs the initial background warmth provided by carbon dioxide and methane, as well as the other greenhouse gases such as nitrous oxide, for it to vaporise. What we have here is a classic self-generating feedback in which the more warmth in the atmosphere, the more the atmosphere warms. A point is finally reached when the dynamics of water evaporation, followed by precipitation, balance each other out. However, should global warming occur, then the amount of water vapour held in the atmosphere will also increase, so accentuating the warming. From their global models and using data from satellites, climatologists believe that when carbon dioxide concentrations in the atmosphere double from their pre-industrial levels, water vapour will increase global surface warming by a factor of 1.6. Therefore, if a doubling of carbon dioxide from pre-industrial levels were to raise surface temperatures by 1.2°C, the water vapour drawn into the atmosphere by the raised temperature would amplify the temperature increase to 1.9°C.<sup>15</sup>

Add in clouds and you have a complicated picture. Clouds have a two-fold effect: one, the dominant effect, is to reflect light away and so help cool the Earth's surface. The other effect is to hold back heat radiating upwards from the Earth's surface. Clouds overall bring about a net cooling of as much as 13 watts per square metre over the Earth's, equivalent to five per cent of the sun's energy input to the surface of the Earth. When we take all of water's reflecting and absorbing attributes we find that in its different states of ice, snow, liquid and vapour it actually accounts for as much as three-quarters of all the planet's albedo. Whatever, therefore, governs the different states of water, it will have a major impact on climate. Since life is an extremely important player in accentuating the flows and movements of water in its different phases, it perforce is a major actor in both determining and regulating climate.



We find, in fact, that life in the oceans plays an active role in cloud formation, as does life on land. Terrestrial life in addition is extremely important in pumping water back into the atmosphere, from which it then generates clouds. The formation of clouds over the oceans is helped in particular by a species of phytoplankton, prominent among them the coccolithophores. Probably to help them flourish in the salt-rich waters of the north Atlantic and the saltier waters of the ice-age, coccolithophores manufacture an osmolyte – a ‘biologically inert’ chemical – that prevents water from being ‘sucked out’ from their single chalk-plated cells by the concentration of salt in the sea. When the organisms die the osmolyte breaks down into di-methyl sulphide (DMS) which is highly volatile and rises into the atmosphere where it is swiftly oxidised by hydroxyl to sulphur dioxide and methane sulphonate. The sulphur dioxide acts as a cloud condensation nucleus around which marine stratus clouds form. As a result of the work of James Lovelock, Bob Charlson and others, we now know that DMS provides the most important source at sea of cloud condensation nuclei.<sup>16</sup>

That cloud-forming attribute of the phytoplankton is of vital importance for climate. Less clouds means a warmer ocean which, because the surface waters become stratified and resist mixing with deeper waters, means less phytoplankton and less clouds. When we add in this feedback to that of carbon dioxide uptake into the oceans, we have a formidable combination on our hands that can transform global climate in a matter of years.

Meanwhile, terrestrial vegetation in the Tropics and in the Boreal regions have powerful climatic impacts, particularly through their effect on albedo and energy transfers. The energy in the form of water, pumped into the atmosphere by the Amazon rainforest, is practically equivalent to the energy transported northwards in the Gulf Stream. But, not only are the rainforests of the Tropics powerful pumps, driving water into the atmosphere, they also simultaneously release cloud condensation nuclei in the form of hydrocarbons such as isoprenes. Yet that cloud-forming energy-transporting system, seemingly so robust, is extraordinarily vulnerable because of its dependence on adequate watering.

Break the pattern of watering, through for instance triggering a succession of El Niños, and the Amazon rainforest is doomed — that at least emerges from the Hadley Centre models. At the same time, deforestation in the Tropics is one major factor in generating powerful and longer-lasting El Niños in a classic positive feedback. Under those circumstances, what could be more suicidal than the destruction of rainforests? Their function as climate-regulators goes far beyond anything we could have imagined when we started their wholesale destruction.

We can therefore easily imagine that any deterioration in the state of phytoplankton in the ocean or of tropical forests will lead to less clouds being formed. But, current data lead us to believe that a warmer atmosphere will necessarily lead to the atmosphere becoming cloudier. We cannot make that assumption: certainly the atmosphere will become more humid on account of global warming, but that clouds will form, so maintaining precipitation, is not necessarily contingent. Instead, we are likely to see a much reduced precipitation over much of the globe, and in particular over tropical areas, as deforestation wipes out the remaining rainforests.

To make matters worse, those clouds that do form are likely to be higher in the atmosphere once warming takes hold. A higher cloud is a colder cloud and its ability to emit heat out to space is therefore reduced — as a consequence more heat is held back on the surface. It looks as if global warming has yet another temperature-enhancing feedback. Indeed, the global warming induced by a change in the altitude of clouds is likely to be every bit as significant as the global warming induced by increased concentrations of greenhouse gases.

**The Hadley Centre predicts that global warming will cause much of the Amazon Basin to become desert by 2050. Under such circumstances, what hope is there that life will be able to maintain global climate at levels in which we can live?**



VIVIAN M. PEEVER/STILL PICTURES

The activity of life in the two domains, the oceans and the continents, in terms of cloud formation and the hydrological cycle, is therefore of crucial importance in climate, *yet such feedbacks are not currently integrated into the climatologists' general circulation models.*

### Living on a knife-edge

We can see how critically balanced it all is. Taken together, life in the oceans and on the continents is responsible for a flow to and from the atmosphere of around 100 billion tonnes of carbon every year. Since the atmosphere holds some 750 billion tonnes in total of carbon, in the form of carbon dioxide and methane, that living

*The general circulation models do not come near to evaluating the impact of our activities on global climate. Life is the key and we must incorporate feedbacks on life if we are to come near to grasping the consequences of our rampage across the planet.*

exchange is equivalent to 13 per cent of the total every year. Of an average 360 parts per million (by volume) of carbon dioxide, life exchanges some 50 parts per million per year of carbon with the atmosphere. That is a two-way process: were life to reduce its activity by 10 per cent that would mean a 5 ppm per year rise in the atmosphere — or 500 ppm over a century and hence, by itself, practically doubling the pre-industrial levels in the atmosphere.

The point is disturbingly clear. The general circulation models, although vastly improved in recent years and based on excellent science, do not come near to evaluating the impact of our activities on global climate. Life is the key and we must incorporate feedbacks on life if we are to come near to grasping the consequences of our rampage across the planet. The issue is not just greenhouse gases and global warming — that issue is undoubtedly crucial — it is equally our destruction of vital ecosystems. We call that destruction progress. We build dams to harness water for irrigation and hydro-electricity, so setting in motion dramatic changes to oceanic circulation because of a decline in the flow of fresh water. We are methodically compacting, eroding, salinizing

*We know from ice-cores that the global climate is perfectly capable of making dramatic shifts in a decade or less. A five-degree Celsius lurch in temperature, for instance, occurred in just three years, about 14,600 years ago.*

and desertifying our agricultural land. Indeed, for every hectare of 'improved' land for modern intensive agriculture we leave another behind that has become desert. We are grubbing out coral reefs for cement works and road-building; we are draining our wetlands to accommodate yet more export-oriented monoculture; and we have already destroyed more than half the world's tropical forests, with little to stop the rest going within the first decades of the coming century.

We are in dire straits. All of those transformations have climatic consequences: adding greenhouse gases, changing albedos, disrupting energy flows across the planet and threatening oceanic currents. Indeed, our attack on fundamental life-support systems is beginning to back-fire against us. We have already set in motion forces we cannot control and which are bound to get stronger as the momentum in the system takes hold. A four-fold increase in the greenhouse gases from pre-industrial times appears inevitable if we carry on as we are. That would take the levels of carbon dioxide even beyond 1100 ppmv. That would be the highest the levels have been for more than 100 million years. And, we know

from ice-cores that the global climate is perfectly capable of making dramatic shifts in a decade or less. A five-degree celsius lurch in temperature, for instance, occurred in just three years, about 14,600 years ago, according to Jeff Severinghaus of the Scripps Institute of Oceanography in California.<sup>18</sup>

We now face the danger that many interconnected, though separate positive feedbacks could be triggered at the same time, all acting synergistically to exaggerate the impacts of the other, and it is most unlikely that we have identified all the positive feedbacks. Currently the atmosphere contains some 750 billion tonnes of carbon, equivalent to 365 parts per million by volume of carbon dioxide. Were 450 billion tonnes of the carbon from the wetlands to add to the levels already there, it would take the total atmospheric carbon content to over 515 parts per million. Add in as well the collapse of terrestrial ecosystems such as tropical forests, thus turning the land surface into a net source of carbon, and over a hundred years we would have at least an 'extra' 200 billion tonnes of carbon in the atmosphere, approximately equivalent to an extra 100 ppmv. Imagine too, that we continue to emit at least 6 billion tonnes per year of carbon from fossil fuel burning, (it has been up to 6.3 billion tonnes) and a hundred year's hence, from that source alone, we would see a tripling of pre-industrial levels of carbon dioxide. In addition, we are still relying on the oceans to draw down some two billion tonnes per year of fossil fuel carbon emissions. What if the ocean carbon 'sink' also collapsed? In 100 years' time, rather than the doubling of carbon dioxide anticipated by climatologists, we would see a quadrupling, with unthinkable consequences to climate. The current models — the GCMs — do not take into account the occurrence of such a chain of horrifying events. Instead we have a somewhat more benign picture of the future and as warnings as to what to expect, the best of the current GCMs, even with their dire predictions, are near to useless as the soothsayer's reading of entrails.

Our choices are therefore extremely limited: we must step back from our current destructive and mindless activities. We must immediately curb our emissions of greenhouse gases. Equally important, we must protect essential ecosystems, in particular tropical rainforests. The crisis we are facing from global warming and climate change is not simply about the levels of greenhouse gases in the atmosphere: it is primarily about the fundamental damage to ecosystems resulting from our industrial and agricultural activities. We are unleashing powerful positive feedbacks, many undoubtedly still unknown to us, that, unless we act vigorously now to curb our impact on the planet, will combine in a deadly combination of destruction.

### References:

1. IPCC. Climate Change 1995. Cambridge University Press, 1995
2. The Met Office. Climate Change and its impacts: a global perspective. Met Office, Nov 1998.
3. The Hadley Centre. Modelling Climate Change: 1860-2050. Met Office, Feb 1995.
4. G.P. Hekstra. Global Warming and Rising Sea Levels: the Policy Implications. *The Ecologist*, Vol.19, No.1, 1989.
5. The Met Office. Climate Change Scenarios for the UK. Met Office, Oct, 1998.
6. Robin McKie. Last Chance to Turn the Heating Down. *The Observer*, 30 Nov, 1997
7. Richard Betts, Peter Cox, Susan Lee & Ian Woodward. Contrasting Physiological and Structural Vegetation Feedbacks in Climate Change Simulations. *Nature*, Vol. 387, p. 796, 19 June 1997.
8. Lee Klingner, paper delivered at Second Oxford Gaia Conference, April 1997.
9. *Op.cit.* 2.
10. *Ibid.*
11. Joint Global Ocean Flux Study, Science Plan, Report No. 5, August 1990.
12. James Lovelock, First Oxford Gaia Conference, April 1995.
13. An Introduction to JGOFS, Oceans, Carbon and Climate Change, December 1990.
14. Jorge Sarmiento and Corinne le Quéré, *New Scientist*, 30 Nov 1996.
15. *Op.cit.* 1.
16. Charlson, R. J., Lovelock, J. E., Andreae, M. O. & Warren, S. G. *Nature*, 326, 655-661, 1987.
17. James E. Lovelock & Lee R. Kump, Failure of climate regulation in a geophysiological model, *Letters to Nature*, Vol. 369, 30 June 1994.
18. Fred Pearce. Quick Change. *New Scientist*, 14 Nov 1998.



# Misreading the Models: the Danger of Underestimating Climate Change

What governments decide with regard to controlling greenhouse gas emissions depends critically on what they understand about the risks from delaying action or taking none at all. Yet, whether because the truth is too unpalatable or out of ignorance, those bargaining over cuts in emissions of greenhouse gases to counter global warming are failing to take on board the full implications of the climate models used by the IPCC in its 1995 Second Assessment Report.

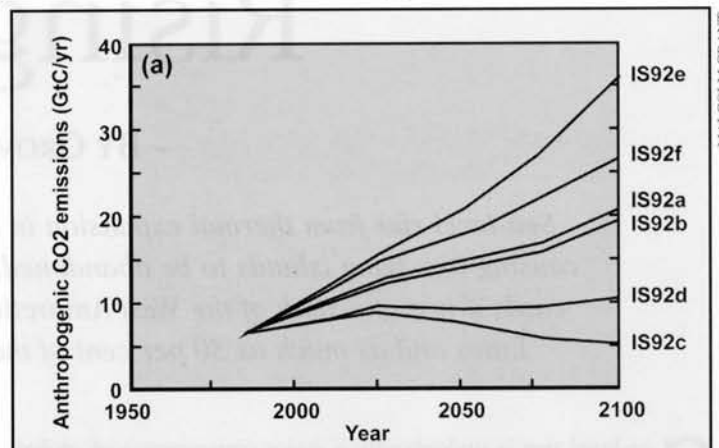
According to the eminent astrophysicist, Alberto di Fazio, of the Astronomical Observatory of Rome and the Global Dynamics Institute,<sup>1</sup> if we follow the trends of the current emissions of greenhouse gases, we find that they will bring about at least a quadrupling of total carbon dioxide concentrations in the atmosphere compared to pre-industrial levels within a century from now. Policy-makers, however, do not seem to be taking this disquieting fact into account. On the contrary, almost all the governmental delegations to the international negotiations on climate change tend to behave as if a business-as-usual emission scenario would lead in a century's time to no more than a doubling of atmospheric carbon dioxide, as implied in some of the IPCC's intermediate emission rates. We are therefore heading for disaster 'full-steam ahead' while kidding ourselves that the reading on the speedometer is about half of what it actually is.

At current emission rates the CO<sub>2</sub> concentrations will reach and possibly surpass 1300 parts per million by volume (ppmv) at the end of the next century compared to the 280 ppmv of pre-industrial times and the 364 ppmv of the year 1999. Indeed, unless drastic action is taken now to reduce emissions, CO<sub>2</sub> levels in the atmosphere will double every 27 years. That is a very different scenario from a doubling of CO<sub>2</sub> – around 560 ppmv – by 2080, on which most policymakers are basing their understanding of what the future holds in store.

The implications are enormous. On the basis of its models of the consequences of CO<sub>2</sub> concentrations in the atmosphere stabilising at 560 ppmv, the IPCC predicts a best estimate increase in global surface temperature of approximately 2.5°C. But, as di Fazio emphasises, if we go on as we are – and the longer we delay the more drastic the action required – average temperatures across the planet will rise by at least 10°C and as much as 14°C. According to Dr Jerry Mahlman, director of the Geophysical Fluid Dynamics Laboratory, part of the National Oceanic and Atmospheric Administration, the warming is expected to be particularly large in most mid-latitude continental regions, including North America and Asia. All manner of non-linear, runaway effects would come into play with such temperature increases. How life would operate under such circumstances is more than we can know, but our survival would undoubtedly be at stake.

That is where we are headed. It is terrifying that just to get agreement to reduce the CO<sub>2</sub> emissions of the industrialised countries by five per cent from their 1990 levels has taken practically a decade and that another decade will be needed before such action is accomplished, assuming countries do not renege or wriggle out of their commitments. Indeed, even with that agreement to curb emissions in hand, the trajectory along which atmospheric concentrations are rising is far steeper than that indicated in the fastest increasing 'business-as-usual' trend used by the IPCC (in its IS92e trajectory).

But, the evidence that we could be heading for climatic catastrophe is not only derived from climate models based on the rate of CO<sub>2</sub> emissions, it also comes from examination of the Vostok Antarctic ice-core data and extrapolating from what we see there.<sup>2</sup> First and foremost the data shows an extraordinary correlation



The IPCC has projected carbon dioxide concentrations in the atmosphere over the next century contingent on different scenarios of anthropogenic emissions. The two lower curves, IS92d and IS92c would result from a drastic reduction in greenhouse gas emissions, equivalent to cuts of between 60 and 80 per cent of emissions as they were in 1990. The highest curve, IS92a, would result from a business-as-usual scenario with minimal curbing of greenhouse gas emissions compared to those of 1990. In a century's time atmospheric concentrations would be close to four times pre-industrial levels of carbon dioxide. In fact, emissions have increased worldwide since 1990 and the current growth in atmospheric levels of carbon dioxide are taking us on a slope even steeper than that indicated by IS92a.

between carbon dioxide concentrations, as captured in the entrapped air bubbles, and temperature fluctuations. And now that we are pushing CO<sub>2</sub> concentrations in the atmosphere almost up to 400 ppmv, it is important to realise that over more than 200,000 years of data analysed from the Vostok ice core, the total extent of the fluctuation in CO<sub>2</sub> was between 175 ppmv and 280 ppmv, with temperatures for the most part being several degrees colder than now. The big exception was some 125,000 years ago when the temperature had risen to almost 2°C higher than at present.

By extrapolating from the Vostok data and taking the CO<sub>2</sub> concentration up to 500 ppmv, di Fazio shows that the increase in temperature over Vostok, Antarctica, would lie between 12°C and 17°C. That rise would be four or five times greater than indicated from the main general circulation models. We know from palaeoclimatic data going back more than 100 million years that the surface temperature over the planet was 7°C to 9°C warmer than now, adding credibility to the possibility that a 10°C rise globally could result from a 500 ppmv CO<sub>2</sub> concentration. Yet we are heading for more than double that concentration level by 2100, a trajectory that the slow speed of the international negotiations ensures we will remain on for at least another 14 years. If nothing changes, the consequences could thus be dire. These are the considerations that policy makers should make when evaluating the degree of action that needs to be taken.

*The Editors*

## References

1. The Global Dynamics Institute is a new institute in Rome of Italian scientists working on climate change, accredited at the Conference of the Parties to the UNFCCC. Email address: difazio@oarhp1.rm.astro.it
2. As the Vostok scientific station in east Antarctica is 1,300 km from the ocean and on a large plateau, the climate variations in space there are smoother than on the shores of Antarctica, and all Global Circulation Models show excellent inter-agreement on the climate simulations for the Vostok area. The Vostok data is therefore very reliable.

# The Threat of Rising Seas

— BY GROVER FOLEY —

*Sea-level rise from thermal expansion in response to rising temperatures is already causing low-lying islands to be abandoned. A one-metre rise in sea-level, easily on the cards if just one-sixth of the West Antarctic ice-sheet melts, would cause many major cities and as much as 30 per cent of the world's total cropland to be swamped.*

Sea-level rise is undoubtedly a major consequence of global warming. For the past 1,500 years the sea has risen at the rate of about 10 centimetres a century: that rate has now virtually doubled.<sup>1</sup> With a doubling of CO<sub>2</sub> from pre-industrial times to approximately 600 ppmv, the UK Met Office gives a rise of around 44 centimetres by 2080, just from the expansion of water from higher temperatures.<sup>2</sup> The Met Office also points out that were carbon dioxide levels to increase by one per cent per year for the next 70 years and then stop, sea-level rise from thermal expansion will continue to increase by as much as 70 centimetres over the following 500 years, long after we should have stopped emitting greenhouse gases.

Moreover, that rise does not include any melting of the ice over Antarctica or Greenland. Should the west Antarctic ice-sheet collapse, come adrift and melt in its entirety that would add as much as six metres to current sea-levels. The melting of the Greenland ice-sheet would add another six metres. The prospects are increasingly poor. Whereas several years ago scientists claimed that it would take a phenomenal amount of surface warming over

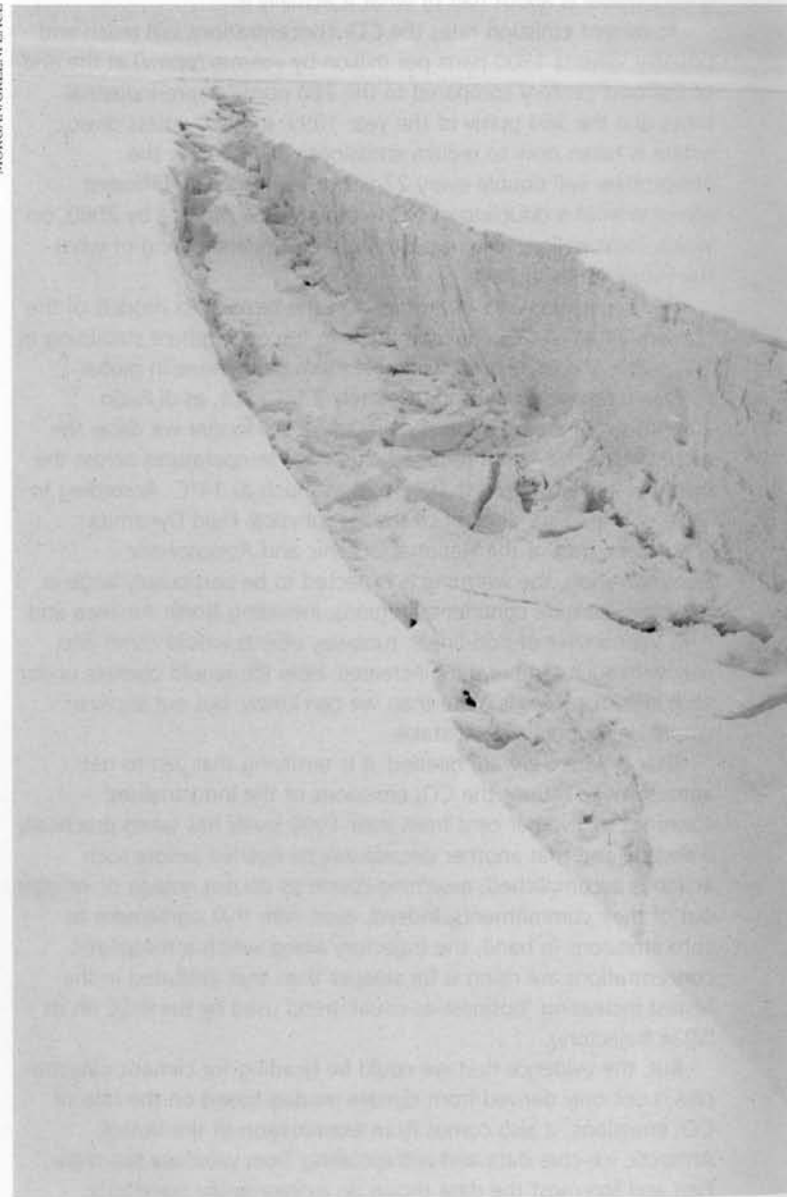
*In January 1999, Peter Barrett, a geologist at Victoria University in Wellington, warned that the entire West Antarctic sheet, which is grounded below sea-level, was becoming unstable and could soon break away.*

*Massive chunks of ice, covering some thousands of square kilometres, are already breaking off and melting, as they drift northwards into warmer waters.*

Antarctica to destabilise the ice sheet, opinions are now changing. In an international ministerial meeting on Antarctica organised by the New Zealand government in January 1999, Peter Barrett, a geologist at Victoria University in Wellington, warned that the entire West Antarctic sheet, which is grounded below sea level, was becoming unstable and could soon break away. Massive chunks of ice, covering some thousands of square kilometres, are already breaking off and melting, as they drift northwards into warmer waters. In the mid-1990s the Larsen A ice-shelf toppled and broke away. It was some 8000 square kilometres in surface area. But that was a dwarf compared with Larsen B, which in early 1998 showed signs of following suit (see picture) and, with a surface area equivalent to twice the size of Norfolk, would be the single largest iceberg to be spawned over the past fifty years. As for the Greenland ice-sheet – traditionally viewed as being less vulner-

able – that too could now be at risk if warming proceeds as rapidly as forecast in the more aggressive 'business-as-usual' scenarios of the IPCC<sup>3</sup> (see *Misreading the Models*, p75). Indeed, according to aerial surveys by the US space agency Nasa, the eastern and southern parts of the ice sheet covering Greenland are already thinning by up to a metre a year<sup>4</sup>. Disturbingly, these changes are occurring at a rate that is much faster than predicted by climate models.

MORGAN GREENPEACE





The 'general circulation models' (GCMs) the Met Office use understate the problem in another way. Sea level rise is likely to be much greater over the next century and beyond than accounted for because of a far more rapid rate of warming produced by powerful feedbacks between current human activities and the health of the biosphere. No feedback works in isolation – one will impact on the other, leading to gross, tangible consequences such as changes in rainfall patterns and more sea-level rise.

### The impact of rising seas

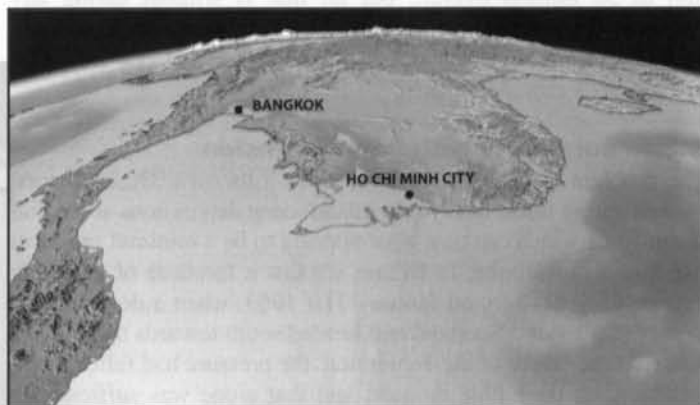
Small, low-lying islands, such as atolls will be the first victims of global warming as the expanding seas rise and swamp them. Already some islands in the Maldives group have become uninhabitable. The cost to save such islands will be disproportionately high given the relationship between land area and coastline. Tropical and subtropical islands are also increasingly being subjected to destructive cyclones, such as those devastating Bangladesh. These violent storms are arising because the area of ocean with temperatures above 27°C has expanded considerably over the past 40 years. That temperature rise has had a devastating effect on corals which are now dying across the globe. Australia's Great Barrier Reef is disintegrating because of coral death. The famous corals of the Caribbean too are in a desperate plight. This is significant because corals help protect coastlines, particularly around atolls, which comprise many of the islands of Polynesia in the Pacific Ocean.

But it is not only tropical islands that will be affected. The

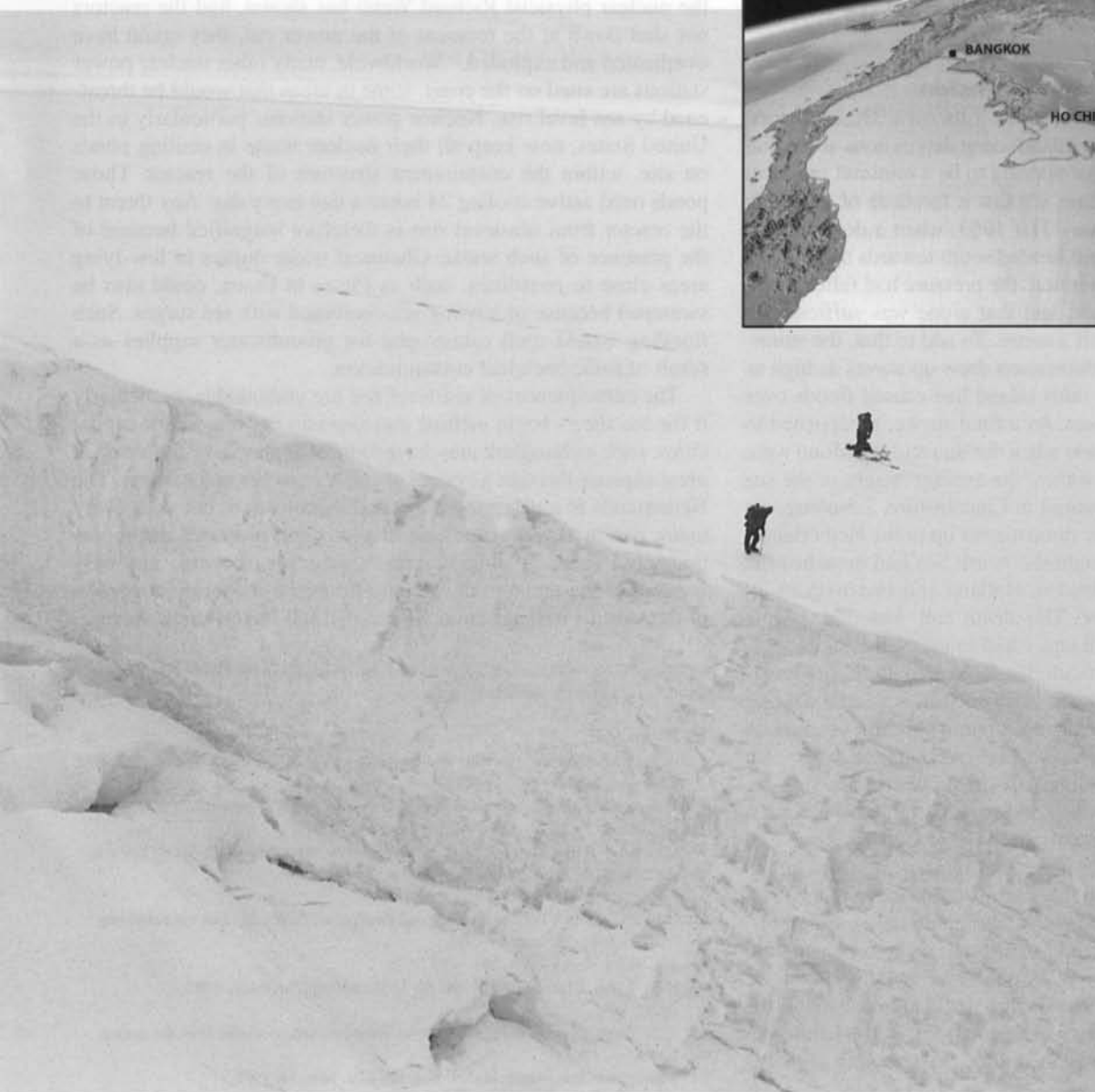
world's coastline is between half a million and a million kilometres long. A one-metre rise in sea-level, easily on the cards if just one-sixth of the West Antarctic ice sheet melts, would affect up to 5 million square kilometres, therefore three per cent of the total land area of the planet, including many of the world's major cities, such as New York, London, Bangkok. Crucially, it would also affect as much as 30 per cent of the total cropland in the world.<sup>5</sup> The loss of land that would go with a sea-level rise of several metres would be simply catastrophic. Half the population of the US, for example, lives within 50 miles of a vulnerable coastline. Even in 1990, the Environmental Protection Agency estimated that the United States



MALCOLM GRANT



Above: The melting of the West Antarctic ice-sheet would raise sea levels by five to six metres, inundating much of Florida, including Miami, and other low-lying areas along the US coast, including New Orleans. It would also flood many large river deltas and neighbouring cities, including Bangkok and Ho Chi Minh City.



Left: A giant crack develops in the Larsen B ice shelf in Antarctica as a consequence of rising temperatures.

## Soaring Temperatures at the Poles

Antarctica appears to be warming faster than anywhere else on the planet and grass is now beginning to push up from what was frozen wasteland just a few years ago. Penguins, in particular, are suffering from the heat and a number of their breeding colonies are now threatened with extinction.

Meanwhile, in the Alaskan Arctic, Eskimo communities are becoming increasingly worried at the signs of warming all around them. The ice is melting, the tundra is drying, summer rainfall is significantly less and the winters markedly warmer. Melting permafrost is threatening communities with unprecedented landslides and storms at sea are getting wilder. All such signs have been predicted in the IPCC models, but not for now – for fifty years hence.<sup>6</sup>

might have to spend up to \$300 billion just for coastal protection.<sup>7</sup>

The Met Office estimates that with coastal protection remaining as it is but the sea rising, in the mid-21st century as many as 78 million people worldwide, but especially in south Asia and the small island states, could be at risk from wild storm conditions. That evaluation takes population growth into account and especially the demographic factors which lead to more people settling in low-lying coastal areas. The claim is that with 'evolving protection' the numbers of people at risk would be reduced by 28 million to 50 million overall: but all that is without taking any Antarctic ice-melting into account. The number at risk would rise tenfold or more were the sea to rise at double the rate indicated from today's climate models.<sup>8</sup>

### Storm surge and salt-water intrusion

The problem is not just sea-level rise on its own. Other factors, such as spring tides, heavy rain inland, deep depressions at sea and storm-force winds can turn what appears to be a minimal sea-level rise into a catastrophe. In Britain we saw a foretaste of what can happen 45 years ago, on January 31st 1953, when a deep depression swung around Scotland and headed south towards the Netherlands. At the centre of the depression, the pressure had fallen by 56 millibars, an incredible amount, and that alone was sufficient to raise the level of the sea by half a metre. To add to that, the storm-force winds generated by the depression drew up waves as high as six metres. Meanwhile heavy rains inland had caused floods over low-lying land towards the coast. As a final stroke, it happened to be the time of a strong spring tide when the Sun and the Moon were aligned. Quite apart from the waves, the average height of the sea was two metres higher than normal in Lincolnshire, 2.5 metres up in the Thames estuary and over three metres up in the Netherlands. By the end of that ferocious night the North Sea had breached the line of dykes protecting the land in Holland and one-sixth of all Holland was under sea-water. The death toll was 264 people drowned in south-east England and 1,835 in the Netherlands.<sup>9</sup>

The Chinese coast is particularly subject to high sea-levels because of strong depressions and storm-force winds. During typhoons, surges of up to five or more metres are not unusual. A sea-level that started a metre or so higher combined with such storms would wreak havoc. Some parts of the world are sinking, for instance around the Black Sea and parts of Indonesia. Generally such subsidence is at a rate of around 30 centimetres a century, although much higher rates of several metres are also known. Indonesia has 15 per cent of all the world's coastlines and as much as 40 per cent of its land surface is vulnerable to rising sea-levels. As elsewhere in the Tropics, one of the most important natural defences against the incursion of the sea – the mangroves – have been decimated to make way for shrimp. In Thailand, around the Bight of Bangkok, the destruction of the mangroves has led to sea-water intruding inland far enough to make rice-growing impossible over a wide area.<sup>10</sup>

Salt-water intrusion is already a serious problem in the mouth of the River Rhine, penetrating as much as 50 kilometres upstream. In the Netherlands, according to Gerrit Hekstra in the Ministry of the Environment, it might become necessary to flood reclaimed land with fresh water from the Rhine, just to keep sea-water at bay. In the UK too, the government has decided to abandon the age-long struggle to protect vulnerable coastlines, such as along the Norfolk coast: instead, the idea is to allow salt marshes to re-establish themselves as the primary barrier against sea rise and sea surges.

### Flooding nuclear power stations

Meanwhile, several of the UK's nuclear power plants, such as at Hinkley Point and Sizewell, are vulnerable to sea-level rise and storm-force sea surges. The Magnox station, Sizewell A, for instance, is sited just a few metres above sea-level in an area where sea-levels are rising at twice the national level. And the reactor at Bradwell is even lower.

The threats to safety from storms and flooding are not idle. In the late 1980s storm-force winds and incoming sea spray knocked out the incoming electricity supply to the Hinkley Point site. The operators, the Central Electricity Generating Board, had difficulty getting auxiliary power back-up switched on and the site was without power for as long as 20 minutes. It was potentially an extremely dangerous situation, with the twin AGR reactors heating up because of the failure of the gas coolant pumps to take away the residual heat produced by fission products in the fuel. As the nuclear physicist Richard Webb has shown, had the reactors not shut down at the moment of the power cut, they could have overheated and exploded.<sup>11</sup> Worldwide, many other nuclear power stations are sited on the coast, some in areas that would be threatened by sea-level rise. Nuclear power stations, particularly in the United States, now keep all their nuclear waste in cooling ponds on site, within the containment structure of the reactor. Those ponds need active cooling 24 hours a day every day. Any threat to the reactor from sea-level rise is therefore magnified because of the presence of such waste. Chemical waste dumps in low-lying areas close to coastlines, such as Pitsea in Essex, could also be swamped because of a rising sea combined with sea surges. Such flooding would spell catastrophe for groundwater supplies as a result of toxic chemical contamination.

The consequences of sea-level rise are unthinkable, particularly if the ice-sheets begin melting and slip into the sea. Major capital cities, such as Bangkok may have to be abandoned, or protected at great expense through a system of massive dykes and barriers. The Netherlands is a past master at coastal protection, but with every metre rise in sea-level the cost of protection increases disproportionately. There is already great cause for concern, not only because of the threat to cities, but also because a large proportion of the world's best agricultural land will fall victim to the waves.

Dr Grover Foley works as a writer in Sydney, Australia and in the Philippines. He was formerly an editor for the Gaia Foundation.

### References:

1. G. P. Hekstra, Global Warming and Rising Sea Levels: The Policy Implications, *The Ecologist*, Vol. 19, No. 1, 1989.
2. Climate Change and its impacts: a Global Perspective, The Met Office, 1997, p14.
3. Rick Frolich, *New Scientist*, Vol. 124, Nov. 4, 1989.
4. W. Krabill, Rapid Thinning of Parts of the Southern Greenland Ice Sheet, *Science*, Vol. 283, No. 5407, Issue 5 March 1999, pp 1522-1524.
5. *Op.cit.1.*
6. US EPA Office of Policy, Planning and Evaluation: Policy Options for stabilizing Global Change, December 1990.
7. R. Scherer, *Science*, Vol. 281, p.82, 1998.
8. H. H. Lamb, *Climate History and the Modern World*, Methuen, 1982
9. *Op.cit.1.*
10. R. E. Webb, Hinkley Point: Nuclear Accident Hazards, available from the author, June 16th, 1989.
11. Kieran Mulvaney, Arctic Voices, *New Scientist*, Nov. 14, 1998.



# How Global Warming Could Cause Northern Europe to Freeze

— BY PETER BUNYARD —

*Warmer temperatures over Greenland and the Arctic because of global warming could cause the Gulf Stream – on which northern Europeans depend for their mild climate – to slow down and even cease. Were that to occur, Northern Europe would be plunged into winters that resemble those of the frozen wastelands of Labrador and Siberia.*

Every year 3,300 cubic kilometres of fresh water run off into the Arctic Ocean, adding some thirty centimetres of fresh water to the surface and reducing its salinity. That input of fresh water is a critical component of the process that drives the major ocean currents, first by making the sea less salty so that the freezing point rises and second, as a consequence of ice forming more easily, leaving saltier, denser, waters behind that tend to sink. In effect, the freshwater flow impinges on the rate and timing of the sinking of the surface waters of the upper north Atlantic. Once the waters have sunk, they flow back along the sea-floor all the way down to Antarctica where they join the circumpolar current before moving back to the Tropics and up north. The complete journey – oceanographers call it the conveyor belt circulation – may take up to one thousand years.

That 'thermohaline' sinking of the surface waters in the north Atlantic has a major consequence for the countries of northern Europe, in particular Ireland, Britain and Scandinavia as well as the countries such as the Netherlands. It draws the Gulf Stream along behind it, together with all the heat that the ocean has

absorbed when down in the Tropics.

In its full glory the Gulf Stream carries warm water to a depth of up to 100 metres at rates of up to 8 kilometres an hour and penetrates right up into the Arctic Circle, to the north of Scandinavia, bearing with it a climate that makes life just about tolerable, even in the thick of the winter. The energy it carries in the form of heat is equivalent to 100 times the entire use of energy in human societies across the world or put another way, more than 27,000 times the UK's electricity-generating capacity. In terms of temperature the Gulf Stream heats the surface over a wide area by at least 5°C. Were the Gulf Stream to fail, temperatures over northern Europe would plummet by more than 10°C during the winter months. North Europe would have a climate comparable to Labrador or conceivably Siberia: just how it would support its current population is difficult to imagine. Both Labrador and Siberia are 'wastelands' with very small populations relative to their size.

If the Gulf Stream were like 'ole man river that just keeps on rolling' we would have little to worry about, at least on that score. But, as we have recently discovered from looking at fossilised life

## When the Gulf Stream Runs Cold

Computer simulation shows global warming could eventually shut down the Gulf Stream, plunging Britain into a mini ice age

As the pumps weaken, the currents slow down and may suddenly switch off

The Gulf Stream brings warm water from the tropics as part of a worldwide network of ocean currents

### Arctic

The pumps are powered by high salt concentrations near the waters surface. Melting ice dilutes the salt and weakens the pump

3

Pump

Greenland Sea

2

The system depends on so-called "natural pumps" around Greenland which draw warm water up towards northwest Europe and send cold water back southwards

Labrador Sea

4

Pump

North Atlantic Ocean

London

Calgary

*Were the Gulf Stream to fail, temperatures over northern Europe would plummet by more than 10°C during the winter months. North Europe would have a climate comparable to Labrador or conceivably Siberia: just how it would support its current population is difficult to imagine.*

on the ocean floor and from geological evidence, the Gulf Stream has had a history of stalling or having its circulation greatly curtailed, leaving northern waters deprived of its vital heat and climate-moderating influence. Paradoxically that 'stalling' appears to have occurred following somewhat warmer periods during ice-ages when vast chunks of ice have slid from the interior of the North American continent through Hudson Bay and into the northern ocean. In essence, the injection of vast quantities of fresh water into the sea prevented the sinking of cold salty waters. Climatologists are now concerned that the flush of fresh water

entering the north Atlantic because of global warming could once again curtail the sinking so that the great conveyor-belt circulation grinds to a halt.

Over the past year climatologists at the Met Office's Hadley Centre have modelled the flow of the Gulf Stream under different global warming scenarios to determine how much, if at all, the conveyor-belt circulation of warm tropical waters to the high northern latitudes would stall if carbon dioxide levels rose at the rapid rate of two per cent per year, then stabilised at four times the present concentration. The model shows that the strength of the Gulf Stream circulation will decline sharply by one-quarter. With a growth in carbon dioxide levels as assumed in the IPCC's 'business-as-usual' scenario, the decline in the circulation sets in around the turn of the current century and in a matter of 30 years falls to one-third its current level. That decline represents a substantial loss in energy transfer. One-third down means we are therefore talking about a loss to the British Isles and northern Europe of some thirty times the energy used by all humanity.

*According to Vittorio Canuto and others at NASA's Goddard Institute for Space Studies... it would take no more than one-quarter of one per cent more fresh water flowing into the north Atlantic from melting glaciers in Greenland and northern Canada to bring the northwards flow of the Gulf Stream to a shuddering halt.*

Although contentious, the Met Office climatologists claim that such a loss will be more than offset by the warmer temperatures that go with the direct effects of global warming: according to them, temperatures over north Europe will still rise. That basically tells us that the underlying trend towards global warming will be very strong indeed.

### **Ocean current flip**

A salutary warning as to how abruptly a switch can take place comes from the recent discovery that from one year to the next the currents in the Mediterranean have undergone a complete about-turn. In the past, cooler waters from the Adriatic flowed along the bottom in an eastwards direction to the Aegean Sea and the Levantine coast. The Adriatic waters were replaced by the westwards flow of warm water from the Aegean. Now, that has abruptly changed: the warm waters of the Aegean, instead of their westwards flow, are now sinking to the bottom rather than remaining on the surface, and are flowing eastwards. The system has flipped.

Wolfgang Roether of the University of Bremen puts the blame for the flip on increased evaporation – because of a warmer climate – and a sharp decline in the amount of freshwater flowing in – because of increased urban use and the use of dams, such as of rivers like the Dnieper, the Nile and the Danube – which has led to the surface waters becoming much saltier and therefore more dense than the underlying waters. Those warm, salty waters are now sinking, stalling and even completely reversing the circulation that presumably has always prevailed until now. The current switch indicates the potential impact of global warming and the uncertainties we face in the future from abrupt climate change.<sup>1</sup>

Although climatologists at other institutes in the United States and Continental Europe all agree with the general principle that global warming will cause a critical change in the flow of the Gulf Stream, differences have emerged in the degree to which stalling occurs under a global warming regime. Paradoxically, the saltier waters flowing back into the Atlantic from the Mediterranean could keep the conveyor-belt going. According to Eelco Rohling of the Southampton Oceanography centre, the waters from the

Mediterranean flow north, deep below the surface up to the Faroe Isles where they rise, mix and then sink rapidly, drawing down surrounding water, including those of the Gulf Stream. The more salty the waters from the Mediterranean the stronger the pull. That process would seem to counter the potential seizing-up of the Gulf Stream in its northern stretches. Yet again, another factor – the more rapid melting of Greenland's ice-sheets – could intervene and sweep away the saltier water. Again, we would be in line for a slowing down and even closure of the Gulf Stream.<sup>2</sup>

### **Fearful prospects**

Climate models, matched to evidence derived from ocean sediment cores, indicate three different modes of north Atlantic circulation: one, a 'warm conveyor belt mode' such as has operated over the past 10,000 years. Two, a 'glacial conveyor-belt mode' which operated during the past ice-age – it was shallower and did not extend further north than the south of Iceland. Three, a 'weak conveyor-belt' resulting from large amounts of melt-water capping off any circulation through forming a surface 'lens' of fresh water. That last mode is one that climatologists fear could be repeated through global warming generating more dilute and warmer surface waters. Stefan Rahmstorf of the University of Kiel in Germany, has identified another mode, also the result of a large influx of fresh water into the north Atlantic, in which the conveyor belt remains vigorous, but with the sinking taking place much further south than is currently the case. The evidence is that whenever the Gulf Stream stalled, or was pushed south, North Europe was pitched into cold. According to Rahmstorf, by disrupting the conveyor-belt, we could be triggering a calamitous cooling throughout Europe. "The consequences for ecosystems, agriculture and society could be severe."<sup>3, 4, 5, 6</sup>

According to a personal communication,<sup>7</sup> Vittorio Canuto and others at NASA's Goddard Institute for Space Studies in New York claim that it would take no more than one-quarter of one per cent more fresh water flowing into the north Atlantic from melting glaciers in Greenland and northern Canada to bring the northwards flow of the Gulf Stream to a shuddering halt. And should equivalent carbon dioxide levels in the atmosphere rise to four times their pre-industrial levels, then the Gulf Stream, again according to the model, will be permanently shut down, this time because of insufficient cooling of the surface waters.

The oceans are thus clearly essential components of the climate system, transporting heat, drawing down greenhouse gases from the atmosphere and regulating weather patterns across the globe.<sup>8</sup> We are now disrupting every one of those processes and we are on the threshold of entering a new phase in the history of climate in which we can no longer guarantee a reasonable climate for a major proportion of the Earth's population. For once, it looks as if the dense populations in the highly industrialised countries of northern Europe will be those most at risk from global warming and the transformation of ocean currents – that is unless we take urgent action now to curb greenhouse gas emissions.

### **References:**

1. Debora Mackenzie, Ocean flip puts modellers on Med alert *New Scientist*, 2 September 1995, Vol.147, No.1993 p. 8.
2. Robin McKie, Last Chance to turn the heating down, *The Observer*, 30 November, 1997.
3. Fred Pearce, Will global warming plunge Europe into an ice-age? *New Scientist*, 19 November 1994, Vol.144, No.1952 p. 20.
4. Gabrielle Walker, Diluted ocean threatens Western Europe's weather, *New Scientist*, 11 November 1995, Vol.148, No.2003 p. 20.
5. Stefan Rahmstorf Grinding to a Halt? UNESCO SOURCES, No. 96, December, 1997.
6. Stefan Rahmstorf, Ice-cold in Paris, *New Scientist*, 8 February 1997.
7. Vittorio Canuto, personal communication at Agenda 21 meeting in Porto Alegre, May 1996.
8. Wallace S. Broecker, Thermohaline Circulation, the Achilles Heel of our Climate System, *Science*, Vol. 278, 28 November 1997.



# Eradicating the Amazon Rainforests will Wreak Havoc on Climate



— BY PETER BUNYARD —

*The Amazon Basin plays a number of key, often neglected roles – including that of a giant ‘heat-pump’ that sends energy from the Tropics into the colder high latitudes – that produce a climate in which we can live. But at the current rate of destruction, much of the Amazon rainforest will be gone in a few decades.*

What would have seemed obvious to any clear-thinking ecologist is now becoming disturbingly apparent: the destruction of the world's great tropical rainforests, and that of the Amazon in particular, will have a devastating effect on climate. It represents a veritable triple whammy: first by turning a net carbon sink into a source; second, by throwing a spanner in the works of an extraordinary heatpump that gives the people of Northern Europe a climate in which they can live; and third, by causing tropical ecosystems to collapse, as the ecological base provided by the intact forest system and vital for forest regeneration is destroyed, with all that means for agriculture across Latin America, in South-east Asia and Africa.

## Carbon emissions from forest destruction

The tropical forests of Central and South America are unique among tropical forests in the world in their capacity to grow, even when seemingly mature. Oliver Phillips and his colleagues report in *Science*<sup>1</sup> that they have measured as much as one tonne per hectare per year of growth in such intact forests. Consequently, one of Phillips' colleagues, John Grace from the University of Edinburgh, estimates that if all the forests of the Brazilian Amazon, covering some 360 million hectares, put on biomass in that way, the Amazon in Brazil alone would be an annual sink of up to 0.56 billion tonnes of carbon.<sup>2</sup>

When forest destruction takes place, however, that significant sink becomes a net source. Carbon release as forests get destroyed

**Above:** The tropical forests of the Amazon, as long as they are intact, generate hot, humid air that rises and develops into cumulo-nimbus thunder clouds that water areas further downwind and release vast amounts of energy bound up as ‘latent heat’ back into the atmosphere, driving the great air masses that influence our climate.

is what ecologists and environmentalists have, for the most part, focussed on in gauging the impact of tropical forest destruction on the world's climate, pointing out the obvious fact that such releases add to total emissions of carbon dioxide to the atmosphere. Much of the time they have wrangled over the exact rate of destruction and the amounts of carbon released – anywhere from 0.5 to 4 billion tons of carbon per year from forest destruction worldwide, but mostly in the Tropics. If the figure of nearly 9 million hectares of tropical forest destroyed by fire worldwide during 1998 is correct, then, on the basis that a hectare of tropical rainforest contains between 100 and 250 tonnes of carbon in its biomass and three-quarters of the total burns or decomposes, the carbon emissions will have totalled between one and two billion tonnes from that source alone – equivalent to one-third of the emissions from fossil fuel burning across the world. To make matters worse, when areas are cleared of trees the surrounding forest suffers die-back and disintegration. Carbon emissions from areas of the Amazon that have been cleared are likely to be at least seven per cent higher than previously thought because of that die-back – the equivalent of felling one million more hectares than are actually felled.<sup>3</sup>

## The Amazon as heat-pump for northern Europe at stake

Whilst the impact of tropical forest destruction on the uptake of carbon has now been modelled, rarely have climatologists taken into account a potentially more important and devastating consequence of the destruction of tropical rainforests: the process by which heat over the Tropics is carried away in massive rain clouds and distributed by means of the mass circulation of air towards the cooler, higher latitude regions. That way the energy of the Sun – some 2.5 times greater annually over the Equator than the Poles – gets evened out over the entire planet. We are now discovering that without that intact forest, the energy-transfer mechanism could collapse. Climate models, however, do not take this into account. In treating ecology as a set of disconnected processes, we have obstinately shut our eyes to the extraordinary interconnectedness of life on this planet and its role in generating climate. Nothing better exemplifies the single process of climate and ecology than the rainforests of the Amazon Basin.

All tropical forests contribute to the process of energy transfer, but of all the regions of tropical rainforests, the Amazon is by far the most important by dint of its sheer size – some seven million square kilometres in total. Any reduction in the mass movement of water vapour as a result of rainforest destruction will perturb climate every bit as powerfully as the addition of greenhouse gases.

According to the Brazilian physicist, Eneas Salati, between 50 and 75 per cent of all the water falling as rain over the Amazon is evaporated and transpired back into the atmosphere, from where it falls again as the Trade Winds blowing across the tropical Atlantic Ocean deposit it up to seven times across the entire 4,000 kilometre expanse of the Amazon Basin in an extraordinary and unparalleled leap frogging.<sup>4</sup>

In a healthy rainforest, transpiration, by which vegetation pumps water through its stomata into the atmosphere, accounts for 60 per cent of the humidity in the air over central Amazonia and evaporation from the leaves and stems of vegetation for the remaining 40 per cent. When the forest is intact virtually no evaporation occurs from the soil, but rather directly from the above-ground biomass, therefore from the stems and leaves of the vegetation. That evapotranspiration constitutes enormous quantities of solar energy

and according to the Brazilian climatologist, Luiz Carlos Molion<sup>5</sup>, takes up as much as 80 per cent of all the energy directed down over the forests from the Sun. Salati estimates that the energy flow across the Amazon Basin is equivalent to 5 to 6 million atom bombs exploding every day. Over the intact forest, with its powerful evapotranspiration pump, 75 per cent of that energy is used to evaporate water. The hot, humid air generated over the rainforest then rises rapidly and develops into cumulo-nimbus thunder-clouds that simultaneously water areas further downwind and release the energy bound up as 'latent heat' back into the atmosphere. There it drives the great air masses that are carried aloft in the atmosphere travelling west across the Amazon Basin until they hit the mountain chain of the Andes. The flow then splits into three branches. The central part jumps over the mountains into the Pacific and continues west along the Equator, following the convergence of the warm northern sea current; the southern stream is deflected by the Andes and passes over Patagonia via the Brazilian cerrado (savanna) while the northern stream, carried aloft in the circulation of the air mass between the equator and the upper reaches of the tropics – the Hadley Circulation, as it is referred to – crosses the Caribbean, touches the eastern seaboard of the US and goes over the Atlantic towards northern Europe.

However, without the intact forest, the amount of solar energy that can be carried away towards the higher latitudes is cut by a fifth or more. Just that cut alone could be sufficient to cause a significant cooling over temperate zone countries such as Britain in the north Atlantic. Combined with a seizing-up of the Gulf Stream, that loss in heat transfer would be a devastating blow to the climate of northern Europe and Scandinavia.

Moreover, as a result of improved modelling it now appears that the changes in the energy transfer from the tropics to the subtropics brought about through destruction of the Amazon rainforest will, in the mid and high latitudes, lead to the generation of strong, turbulent, jet streams of air (Rossby Waves) that drive like a wedge between the major circulation cells of the global circulatory system.<sup>6</sup>

The polar front jet stream, the most northerly branch of the Rossby Wave, is the most powerful of all the jet streams. It drives between the air masses that form in the polar region and those which form between the tropics and the temperate zone. It therefore cuts its way at high speed between the warm air of the tropics and the cold air of the North Pole. Just how far south that jet stream pushes makes all the difference to the weather. When it pushes south it brings cold, dry bracing air with it. When it retreats northwards, then we get the warm, water-laden air of the tropics with all that entails in terms of heavy rainfall, high surface winds and atmospheric depression. The further south the polar jet stream pushes, the colder the weather. If the Hadley Circulation becomes weaker because it has gathered less energy because of deforestation, then the jet stream will have more push and power to force the entire weather system of the northern hemisphere down towards the equator. That will mean less rain and more cold over the temperate zone. That shift, closely linked as it would be with the weakening of the Hadley Circulation and combined with a seizing-up of the Gulf Stream, would clearly play havoc with Britain and northern Europe's weather.

We in Britain currently have to thank those jet streams for making our weather system so extraordinarily variable with its fluctuations between wet, gusty south-westerlies and the cold, bracing air that sweeps down from the Arctic. Indeed, a change in what happens to the jet stream, because of deforestation over the Amazon, could be sufficient to plunge us into a weather regime such as we have not seen for thousands of years. We should be warned: the last glaciation was associated with an Amazon Basin virtually devoid of humid tropical rainforests.

Just a 10 or 20 per cent drop in the amount of water vapour being carried in the system makes a substantial difference to the

## The Miracle of the Rainforest

The Amazon rainforest, especially over the unflooded *terra firma*, is a remarkable self-contained system that depends crucially on the integrity of the whole to sustain itself. The soils are among the poorest on the planet – washed out after millennia of heavy rains – yet the vegetation and the unparalleled richness of living organisms would seem to suggest a luxuriance that derives from plenty rather than from deprivation. That paradox is the miracle of the rainforest. As Harald Sioli, who in the 1980s directed the Max Planck Institute for Limnology in Germany points out,<sup>9</sup> the entire system serves to retain virtually all the nutrients within the biomass. Leaks of vital nutrients, such as are common in temperate ecosystems would spell disaster. A dense root mat system, combined with fungal mycorrhiza bridges, literally sucks up any decomposing matter from the forest litter.

Most of the fauna live in the canopy and the system of tall trees, with their extraordinary profusion of epiphytes – the ferns, orchids and bromeliads that have attached themselves to the stems and branches of the great trees – take up any nutrients that are flushed down with the heavy rains. The fauna too are therefore perfectly integrated into the nutrient recycling system by providing the sustenance for the lateral extension of the forest. As a result, says Sioli, 'the greatest number of plant and animal species we are aware of (estimated at between 1.5 and 2 million species) divides the general nutrient cycle into an immense number of sub-cycles.'



total energy flow – a reduction equivalent in energy terms to more than 20 times the total energy used in industry and agriculture across the entire planet. Relatively small changes in energy build-up in the Pacific Ocean can cause a climate system to switch, just like the 1997/98 El Niño. That should give us cause for reflection on what we are doing to the Amazon as well as to the tropical forests of other regions of the planet.

### Baking the Amazon Basin

Forest destruction is also likely to have severe local impacts. If a significant proportion of the forest is destroyed – perhaps little more than that already gone – the system of heat transfer will begin to collapse, both because the leap-frogging of the water cycle across the Amazon basin needs the intact forest to fuel it through evapotranspiration and will therefore run out of 'steam'; and second, with less water vapour in the clouds, less energy will get carried away to the higher latitudes. The ultimate consequence is that the Amazon Basin will heat up and begin to bake, with inevitable impact on the soil, while equally the higher latitudes will cool.

That view is corroborated by the work of J. Lean and P. R. Rowntree of the UK Met Office who find from their improved models that deforestation over the Brazilian Amazon could lead to rainfall over the Colombian Andes, during certain seasons, falling by as much as 65 per cent. That fall would be drastic for agriculture. They also corroborate Salati's contention that the regrowth of forest within areas that have been cleared of forest, as well as the survival of forest in outlying areas, are likely to be threatened by an extended dry season combined with less rainfall at other times of the year.<sup>7</sup>

Deforestation clearly has a major and immediate impact on the distribution of water. A 350-hectare tea plantation in tropical Africa showed a two-fold increase in moderate flooding and a four-fold increase in more serious flooding compared with the nearby natural forest. Molion points out that the Amazon forest canopy intercepts on average about 15 per cent of the rainfall and that its removal would lead to as much as 4,000 cubic metres (tonnes) per hectare per year hitting the ground. Because of soil compaction much of that water would run off directly into the rivers, rather than being retained and maintaining some soil moisture. The net result would be 'sandification' whereby the heavy drops of rain hitting the ground cause the selective erosion of finer clay particles, leaving behind increasingly coarse sand. With time, the remaining 'soil' would have virtually no water-retaining properties and the forest would be unable to regenerate itself. Soil under intact forest absorbs ten times more water compared with nearby areas that have had pasture for five years. Outside the forest and away from its soil-protecting attributes, erosion increases a thousand-fold.<sup>8</sup>

Moreover, when the forest is cleared, the contrast between day and night temperatures becomes more extreme, so leading to gustier winds that dry out soils and send dust swirling into the air. Even if some forest is left around the edges of clearings it will be under siege from water-stress as the water table plummets. Large areas of the Amazon Basin are far closer to water-stress than scientists once thought and the clear cutting and burning of large areas of rainforest would inevitably precipitate die-back and death of the nearby forest.

We have no idea just what proportion of forest must be left for



Logs in the Brazilian Amazon waiting to be transported to a saw mill. If such destruction continues, an important climate-stabiliser will be lost.

JOHN MAIERSTILL PICTURES

the system to be self-maintaining. It may be three-quarters; perhaps even less: if so, with 20 per cent already gone, we are terrifyingly close to those limits. How ludicrous then to propose, as the presidents of the World Bank, the WWF and Brazil did in February 1998, saving 10 per cent of the Brazilian Amazon, which would be nowhere near adequate.

### Accelerating destruction

The terrifying fact is that tropical forests are being destroyed across the planet at accelerating rates. Current estimates indicate that as much as 17 million hectares of tropical forests are being destroyed each year, with up to six

million hectares alone of that destruction taking place in the Brazilian Amazon, when destruction from charcoal manufacture for pig-iron production is also taken into account.<sup>10</sup> Quite aside from charcoal production, more than 50 million hectares of the Brazilian Amazon have gone in a matter of a few decades: if so, that would entail a loss the size of France and one-sixth of the total three and a half million square kilometres of Brazil's rainforest.<sup>11,12</sup>

Deforestation in the states of Para and Maranhão to the north of the Amazon and on the eastern plains has been continuing inexorably. By the end of 1988, as much as 21 million hectares had gone. Just a decade later the total was 27.5 million hectares, an area greater than the UK. That is the official figure; on the other hand, the government has been minimising the impact of the charcoal-fired pig-iron industry which has increased six-fold over the past eight years to a production of more than 1.5 million tons.<sup>13</sup> Deforestation in the state of Para may therefore be much worse.<sup>14</sup> According to the former Brazilian minister for the environment, José Lutzenberger, when all destruction in those two states is taken into account, the remaining forest there may well be gone in a matter of years. The destruction of rainforest in the states of Acre and Rondônia has been equally severe and, after gold was discovered in the Yanomami lands of Roraima, has now spread there like a cancer. In 1998, in part because of the exceptionally strong El Niño, but equally because of drying out through deforestation, unprecedented fires raged in the natural standing forest in Roraima. The forest is dying in front of our very eyes.

Yet international financial institutions and governments still actively promote heavily-subsidised forest destruction. Everywhere, the International Monetary Fund (IMF) is forcing governments of Third World debtor countries to cash in their forests in order to maximise foreign exchange earnings so that Western bankers may be paid their due.<sup>15</sup> The Brazilian government, for instance, under its President Fernando Henrique Cardoso, has recently launched a new aggressive programme of selling off Brazil's patrimony of natural resources to foreign investors. As a result of the new structural adjustment plan imposed by the IMF, Brazil has had to agree to cut its budget for environmental issues by 66 per cent and has even been forced to give up its plan to spend 1.5 million US dollars for the protection of just 10 per cent of the Brazilian Amazon.

It is a scandal that the forests of Amazonia and the rest of the world, which provide us with so many irreplaceable social and ecological services and which, not least, play such a critical role in assuring climatic stability, should be annihilated for short-term cash gains. With the Amazon rainforest destroyed, the world will discover too late that it has pulled down one of the most important underpinnings of a stable, global climate.

## References:

1. Oliver Phillips *et al.*, Changes in the Carbon Balance of Tropical Forests: Evidence from Long-Term Plots, *Science*, Vol 282 16 Oct, 1998.
2. J. Grace, *Forests and the Global Carbon Cycle*, S. It. E. Atti, 1996, 17:7-11.
3. William Laurence, *Science*, Vol. 27, p. 1117.
4. Eneas Salati, The Forest and the hydrological cycle, in *The Geophysics of Amazonia*, ed. Robert Dickinson, Wiley, 1987.
5. Carlos Molion, *The Ecologist*, Vol.19, No.6, 1989.
6. H. Zhang, K. McGuffie and A. Henderson-Sellers, Impacts of Tropical Deforestation. Part 11: The role of Large-scale Dynamics, American Meteorological Society, *Journal of Climate*, Vol. 9, p. 2498.
7. J. Lean and P. R. Rowntree, A GCM simulation of the impact of Amazonian deforestation on climate using an improved canopy representation, *Q. J. R. Meteorol. Soc.* 119, pp. 509-530.
8. Harald Sioli, The Effects of Deforestation in Amazonia, *The Ecologist*, Vol. 17, No. 4/5, 1987.
9. *The Ecologist*, Vol. 17, No. 4/5, 1987.
10. Charcoal production for pig-iron manufacture in the States of Para and Maranhão has steadily increased and in 1998 pig-iron exports from Amazonia may top 1,500,000 tons, six-fold up from 260,000 tons in 1990. That manufacture requires some 3.9 million hectares of forest a year.
11. José Carlos Carvalho, *Amazonia: Heaven of a New World*, Editora Campus, Brazil, 1998.
12. According to the Institute of World Resources, tropical forests are being destroyed worldwide at a rate of 0.8 per cent each year. Over the last decade a total of 1.54 million square kilometres have gone – equivalent in area to three Frances. (*El Espectador*, Colombia, 23 December, 1998).
13. *Op.cit.* 10.
14. José A. Lutzenberger, The climatic effects of the destruction of the rainforests, FoE campaign, Dec 4, 1988. An update, December, 1998.
15. Victor Menotti, Globalization and the Acceleration of Forest Destruction since Rio, *The Ecologist*, Vol. 28, No.6, Nov/Dec., 1998.

## Modern Industrial Agriculture: Exacerbating Climate Change

When all activities associated with farming are accounted for worldwide, agriculture is responsible for approximately one-quarter of anthropogenic emissions of carbon dioxide, nearly 60 per cent of methane emissions and up to 80 per cent of nitrous oxide emissions.<sup>1</sup> This is not surprising as the soil contains about 1,500 billion tonnes of carbon, which is three times more carbon than is found in all terrestrial vegetation.

Meanwhile, nitrous oxide is generated through the action of denitrifying bacteria in the soil when land is converted to agriculture. When tropical rainforests are converted into a pasture, nitrous oxide emissions increase by three times. All in all, land conversion is leading to the release of around half a million tonnes a year of nitrogen in the form of nitrous oxide.

Nitrous oxide is some 200 times more potent than carbon dioxide as a greenhouse gas, though fortunately atmospheric concentrations of nitrous oxide are currently over 1,000 times lower than that of carbon dioxide – 0.31 ppmv compared with 365 ppmv. Nitrogenous fertilisers are another major source of nitrous oxide. Around 70 million tonnes a year of nitrogen are now applied to crops and are contributing as much as ten per cent of the total annual nitrous oxide emissions of 22 million tonnes. With fertiliser applications increasing substantially, especially in developing countries, nitrous oxide emissions from agriculture could double over the next 30 years. In the Netherlands, the site of the world's most intensive farming, as much as 580 kilograms per hectare of nitrogen in the form of nitrates or ammonium salts are applied every year as fertiliser.<sup>2</sup> At least ten per cent of that nitrogen gets straight back into the atmosphere, either as ammonia or as nitrous oxide.

The growth of agriculture is also leading to increasing emissions of methane. In the last few decades, there has been a substantial increase in livestock

numbers – cattle, in particular – much of which has been made possible by the conversion of tropical forests to pasture. Cattle emit large amounts of methane and the destruction of forests for cattle-raising is therefore leading to increased emissions of two of the most important greenhouse gases. Worldwide, the emissions of methane emitted by livestock amount to some 70 million tonnes. With modern methods of production, cattle are increasingly fed on a high-protein diet – especially when fattened in feedlots. Such cattle emit considerably more methane gas than grass-fed cattle. Even the fertilisation of grasslands with nitrogen fertilisers can both decrease methane uptake and increase nitrous oxide production, which thereby increases atmospheric concentrations of both these gases.<sup>3</sup>

The expansion of rice paddies has also seriously increased methane emissions. Rain-fed rice produces far less methane than inundated rice fertilised with nitrogen fertiliser. Once again, the modernisation of agriculture increases methane gas emissions as well as nitrogen emissions, thereby increasing its effects on climate change. Clearly a considerable reduction of livestock populations is required, and there must be an end to the destruction of forests to accommodate increased paddy production. That should be accompanied by aggressive reforestation of denuded hillsides and marginal lands, which will have the double benefit of conserving vulnerable soils and of allowing the build-up of soil and vegetative carbon.

In addition we must return to farming systems that use a multiplicity of techniques, to restore the organic content of degraded and depleted soils. As Rahul and Jacob Nellithanam relate in *The Ecologist*,<sup>4</sup> farmers in the state of Madhya Pradesh are turning their backs on the Green Revolution and the irrigated production of wheat in favour of traditional rain-fed varieties. They now use methods that involve

the use of green manures plus farmyard manure to enrich the soil. They have returned to undersowing the cereal crop with a leguminous crop which adds nitrogen to the soil without having to use nitrogen fertiliser. The traditional long-stemmed varieties of wheat, like those of rice, have long, penetrating roots that can seek out moisture during the dry season and which push down deeper than those of weeds, most of which are legumes. The weeds therefore do not properly compete: on the contrary, they benefit the soil and crop. Here, indeed, we have lessons which we must follow to counter the rampaging destruction engendered by most modern industrialised farming methods.

There is every reason to suppose, what is more, that small-scale organic agriculture based on traditional farming methods, rather than modern high-input agriculture, provides the most effective way of feeding the world.<sup>5</sup> This has been confirmed by numerous studies published in the last 30 years by the USDA.<sup>6</sup>

By Edward Goldsmith

## References:

1. Bunyard, P., "Industrial Agriculture – Driving Climate Change", *The Ecologist* Vol.26 No.6, Nov/Dec. 1996, pp.290-8.
2. *Ibid.*
3. Moser, A., *et al.* "Methane and nitrous oxide fluxes in native fertilized and cultivated grassland", *Nature*, Vol.350, March 1991.
4. Nellithanam, R. and J., "Return of the Native Seeds", *The Ecologist* Vol.28 No.1, Jan./Feb. 1998, pp.29-33.
5. See *The Ecologist's* Dossier on Traditional Agriculture, available from Stephanie Roth, The Ecologist, 46 The Vineyard, Richmond, Surrey, TW10 6AN. Please enclose a cheque for £8 made payable to "The Ecologist". Also, de Selincourt, K., "Intensifying Agriculture – The Organic Way", *The Ecologist*, Vol.26 No.6, Nov./Dec.1996, pp.271-2.
6. For a list of them see Hodges, R.D., "The Case for Biological Agriculture", *The Ecologist Quarterly* No.2, Summer 1978, pp.122-143



# How Ozone-Depletion Increases Global Warming

— BY PETER BUNYARD —

According to scientists from the US National Oceanic and Atmospheric Administration (NOAA),<sup>1</sup> the ozone hole in the Antarctic spring is now bigger than ever and stretches over an area larger than North America. Meanwhile, the layer of destruction extends from 15 kilometres up to 21 kilometres and is higher than ever seen before. As David Hoffman of NOAA points out, by October 5, 1998, the total amount of ozone over Antarctica had fallen to 92 Dobson units, when the normal, pre-1980 concentration would have been close to 280 Dobson units. That means two-thirds of the ozone in the column of air above Antarctica is now being destroyed during the southern spring.

With far less ozone over the Polar stratospheres compared with 20 years ago, an ever-increasing proportion of ultraviolet B is able to penetrate unimpeded into the lower atmosphere. There, the ultraviolet causes additional heating and so adds to global warming. Ultraviolet B (UV-B) that reaches the Earth's surface, meanwhile, has a serious impact on plankton and hence on plankton's pivotal role in drawing down carbon dioxide into the ocean, especially in the southern ocean around Antarctica. In clear waters, such as around Antarctica, where the stratospheric ozone hole is at its deepest and largest, UV-B can penetrate more than 20 metres. In its 1994 summary, the Montreal Protocol Environmental Effects Assessment Panel reports that a 16 per cent depletion of ozone could result in a five per cent loss of phytoplankton.

Vegetation on land is also seriously affected by increased levels of UV-B. Of some three hundred cultivated food species tested, two-thirds have shown some sensitivity to UV-B in terms of impaired growth. Recent research on maize has brought another hazard of increased exposure to UV-B, that of 'jumping *Mutator* genes' in which genes that are currently stable, start 'jumping' from one site on the genome to another, where they cause disruptions of the plant's development and fertility.<sup>2</sup>

Human health is also jeopardised by increased penetration of

UV-B. A one per cent loss of stratospheric ozone translates into an increase of approximately three per cent of non-melanoma skin cancers and one per cent of fatal melanomas in a country such as the United States. The UK had more than 40,000 new cases last year and the rate seems to be doubling every decade.

Human-induced ozone depletion thus has wide-ranging ramifications for life. Normally, ozone in the stratosphere is a greenhouse gas because it blocks incoming ultraviolet B from the Sun. In the process the UV-B loses some of its energy and degrades to heat, while the ozone breaks down and transforms to oxygen. However, with less ozone around over the Antarctic stratosphere when the spring sun first makes its appearance in October, the stratosphere can retain less heat. Thus, according to Melvyn Gelman of NOAA, the stratosphere tends to cool as the lower atmosphere warms, with Antarctic winter temperature falling below minus 78°C.<sup>3</sup> That cold, combined with a relatively new phenomenon – the appearance in the stratosphere of faint, icy clouds – are critical elements in the destruction of ozone.

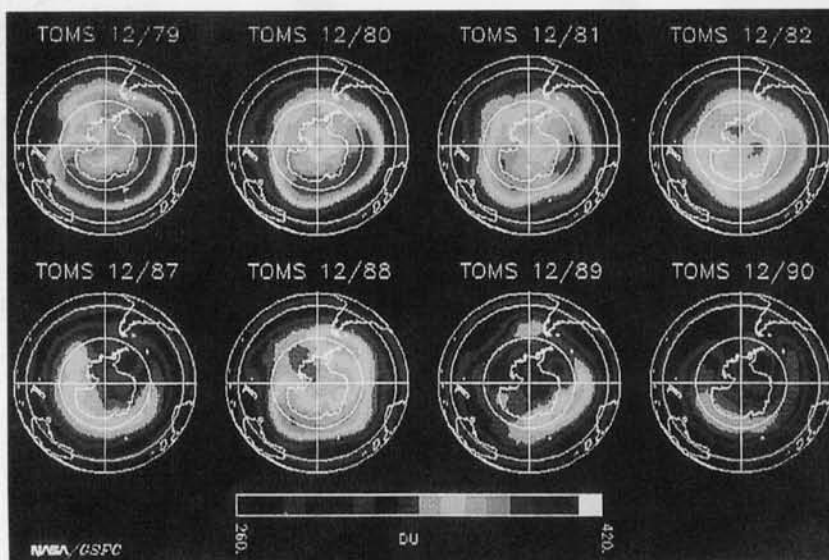
And here we have a direct connection to tropical forest destruction, the post-war increase in cattle ranching, the feeding of cattle with a high-protein diet in feedlots, and the conversion of forestlands to artificially-fertilised and flooded rice paddy. Those land-use changes lead to the production of methane which percolates up into the stratosphere where it is oxidised to water. That water, in the bitter cold of the polar winter, forms the clouds that attract and hold the chlorine break-down products of chlorofluorocarbons (CFCs) and other halide-containing substances, such as methyl bromide – widely used as a pesticide – a significant ozone-depleter.

Overall the concentration of CFCs in the air has increased five-fold since the mid-1970s, with ten per cent having been oxidized. That oxidation in the stratosphere leads to the production of chlorine monoxide which reacts with a single oxygen atom to form free chlorine and an oxygen molecule. One free atom of chlorine in the stratosphere will probably destroy as many as 100,000 molecules of ozone before the chlorine gets removed or inactivated. Hence, scientists believe that to avoid additional ozone depletion, chlorine in the stratosphere should not exceed two parts per billion. Yet today, levels are at least three times that and show few signs of falling. Moreover, on a weight-per-weight basis, CFCs – which will remain in the atmosphere for several thousand years – also trap many thousands of times more heat than carbon dioxide and already account for 17 per cent of greenhouse gas activity. The situation is critical. Immediate action to prevent the production and release of all ozone-depleting substances is therefore imperative.

## References:

1. Richard Kerr, Deep Chill Triggers Record Ozone Hole, *Science*, Vol. 282, 16 October, 1998.
2. Virginia Walbot, *Nature*, Vol. 397, p.398, 2 February, 1999.
3. *Op cit.* 1.

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The Total Ozone Mapping Spectrometer measures the decline in ozone concentrations over Antarctica – for the years 1979, '80, '81, '87, '88, '89, '90,

# A Hungrier World

— BY PETER BUNYARD —

*If we continue pumping greenhouse gases into the atmosphere and we fail to curb our destruction of the world's forests, we can expect our crops to shrivel from increased heat-waves and drought, get them washed away by unprecedented rainstorms and floods, and be ravaged by the spread of pests and weeds. The prospects for feeding the growing human population are appalling unless we take action now.*





**A**viable agriculture needs a stable climate. If we cannot anticipate from one year to the next what and when to sow and what sort of harvest to expect because the climate is going through all sorts of unpredictable convulsions, then we are in serious trouble. Yet, once again, we are lulled into a 'business-as-usual' mode of thinking because, according to current general circulation models, the worst impact on agriculture will not be in the mid to high latitude developed countries of the northern hemisphere, nor indeed in China, but in Africa, the Middle East and the Indian sub-continent. Indeed, we are told, most of Europe and the humid tropical countries of South-East Asia, will benefit from global warming, at least until the 2080s. With trade liberalisation gathering steam, the premise is that more food will be made available – for those who can afford to shop. As for the rest, who is going to worry about them?

However, the models used to justify a 'business-as-usual' approach are fundamentally flawed because they treat the Earth's land surface as it would be had we not destroyed great tracts of natural vegetation. The models therefore ignore the impact of

global agriculture on climate – they ignore too the impact of deforestation of tropical forests on the air circulation systems of the planet (see 'Eradicating the Amazon Rainforests Will Wreak Havoc on Climate,' p81), nor do they take into account the massive and rapidly advancing desertification caused by deforestation in the semi-arid regions of the world, such as the Sahel. In general, they also fail to account for all the possible synergies and positive feedbacks caused by the destruction of the natural world. In addition, the models underestimate the impact of agriculture on the release of greenhouse gases, such as nitrous oxide and methane, and not least their effect on the ozone layer. Nor do they take into account the devastation that would be caused by long and far more frequent heat-waves and other extremes of weather.

### Drought, heat-waves and floods

It is all very well to talk of average rainfall decreasing or increasing, as if we can adapt and accommodate to such trends under a business-as-usual regime, when in fact the decrease in rain may be associated with searing summer heat or, vice versa, the increase in rainfall result in cloudbursts that wash away soil and crops in specific areas and at specific times. These are events that would not figure in statistics that are based on average values. Lack of rain and scorching sun, for instance, caused the 1988 drought in the southern states of the US, the result of which cost the federal government over \$3 billion in direct relief payments to farmers. Equally the deluges during the spring and summer of 1993 led to unprecedented flooding of the Mississippi and Missouri rivers, with several billion dollars worth of damage to farm produce, damage to property and loss of lives. A return to the conditions that led to the 'dust bowl' in the US Mid-West during the 1930s, when yields of wheat and maize plummeted by as much as 50 per cent, would be catastrophic. According to the US Geophysical Fluid Dynamics Laboratory, warmer, drier summers over the US Great Plains, Western Europe, Northern Canada and Siberia because of a doubling of effective carbon dioxide concentrations from pre-industrial times, would lead to soil drying out by at least 20 per cent during the crucial growing season. Such being the case, say Rosenzweig and Hillel,<sup>1</sup> the drought conditions brought on by global warming would even outdo those that led to the 'Dust Bowl'.

In '*Climate, Change and Risk*', Megan Gawith, Thomas Downing and Theodore Karacostas<sup>2</sup> look at the likelihood of increased heat-waves from global warming for two locations, Oxford and Thessaloniki. By the middle of the next century they anticipate – on the basis of the UK Met Office's climate models – that, over July and August, Oxford, and hence Southern England as a whole, will experience at least ten times more heat-waves compared with now. In Greece, not only is there likely to be a doubling of the length of heat-waves, from 50 hours to over 100 hours, but whereas 50 hour events are relatively rare now, the 100-hour events will become the pattern for most years. Such heat-waves, combined with drought conditions, will clearly play havoc with most crops, unless they can be well irrigated.

The year 1976 has become synonymous with 'drought' in the UK. Rainfall between April and August was down by more than 20 per cent on average, with a significant impact on cereal yields. Sufficient winter rain is crucial to mitigate the impact of a dry spring and summer. The UK Department of the Environment estimated (1991) on the basis of 'business-as-usual' greenhouse gas emissions that the probability of a summer as hot as 1976 occurring in any year would increase a hundredfold from 0.1 per cent to 10 per cent by 2030 and to 33 per cent by 2050, hence once in every three years. *Such a high incidence would clearly change the face of farming.*

Based on the UK Met Office's high resolution general circulation model, Paul Brignall<sup>3</sup> and his colleagues at the Environmental Change Unit of Oxford University have investigated the likelihood of severe agricultural drought affecting Europe over the



Tilling barren soil: a vision of the future for millions more people as climate change sets in.

NEIL COOPER/PAFOS PICTURES

next fifty years because of global warming. The model indicates that by 2050 all Europe south of 48°N will get drier, the Iberian Peninsula 20 per cent more so; above that latitude most regions will get more of a soaking. The probability of severe drought therefore increases substantially for Southern Europe, but in their model lessens for the UK because of the increased precipitation.

On the other hand, the 'Oxford' model takes no account of what might happen to rainfall over Britain were the Amazon Basin to lose its forests. As we have seen, the implications are that cold, dry air would tend to shift southwards and displace the wet weather fronts that come surging up across the Atlantic from the sub-tropics. Not only could we be in for a succession of warmer, drier summers but colder, drier winters as well. Drought conditions could then become the norm in Britain, playing havoc with agriculture right across the board.

Drought obviously leads to water stress in plants. Heat-waves, on the other hand, are acute episodes which, if the temperature is high enough, above 40°C for instance, lead to wilting and death, because of structural damage to essential proteins. The problem is that plants react by closing their stomata when subjected to water stress, so shutting down on transpiration and conserving water. But rather as the body would overheat dangerously if it shut its pores to prevent sweating, so in a plant the shutting of the stomata will cause internal temperatures to rise and may well cause permanent damage, if not death. According to Fitter and Hay,<sup>4</sup> temperatures above 45°C will damage most plants if lasting for half-an-hour or more. High soil temperatures will also damage roots and prevent nutrient uptake. And should dry, hot conditions prevail during a sensitive time in a plant's maturation, as during reproductive phases, then the result could be catastrophic for yields, even though the adult plant survives.

David Pimental,<sup>5</sup> from the College of Agriculture and Life Sciences, Cornell University, points out that each crop has its optimum temperature and length of growing season for maximum yields. Rice generally grows best when temperatures are between 30°C and 33°C, yet it will still 'fruit' and generally produce as long as temperatures do not fall below 18°C. Some varieties will tolerate temperatures rising to as high as 40°C. In contrast potatoes do badly if temperatures rise above 28°C and do best when they lie between 15 and 20°C. Hence global warming and temperature rises could have a deleterious effect on the main cereal crops, especially towards the margins of a particular crop's range.

Already global warming appears to be having an impact on agriculture. Lester Brown<sup>6</sup> of the Worldwatch Institute tells us that thirteen of the warmest years since record-keeping began in 1866



Crop damage in Honduras following Hurricane Mitch.

all occurred over the past twenty years. As a result, he remarks, "Three times in the last nine years the United States grain harvest has been reduced 17 per cent or more by weather."

As it happens, the 1988 drought caused the grain harvest per hectare to fall by 22 per cent from the year before, with the result that for the first time in recent history US grain production dropped below consumption. Fortunately, the US still had considerable grain reserves, so it still managed to satisfy demand abroad, but resources have since shrunk to an extremely low level. The United States is responsible for nearly half of the world's exports of grain. Such losses are therefore still of major concern and, were the US's high productivity in yields, particularly of corn, to flounder because of heat-waves and disturbed patterns of rainfall, the world would indeed be in trouble, especially in Asia, where imports are soaring because of the loss of land to urbanisation and the ever-greater demand for meat in the diet.

### Sea-level rise and storm surges

Unlike heat-waves, wind storms and downpours, sea level rise is not something that manifests itself all of a sudden and takes us by surprise. Nevertheless, the sea's slow, inexorable rise, getting on for half a metre by 2080 merely from the thermal expansion of water, according to the UK Met Office,<sup>7</sup> will have a major impact on agriculture by the inundation of low-lying coastal regions and salt intrusion of coastal aquifers with seawater. However, because of a number of powerful feedbacks, sea level rise is likely to be considerably greater over the next century than taken into account in the main climate models, such as that used by the Met Office. Indeed, the greatest surge in sea level is likely to come from the melting of the West Atlantic Ice Sheet and possibly that of Greenland – a real possibility now that it has been reported that the entire West Atlantic sheet is becoming unstable and could soon break away (see 'The Threat of Rising Seas,' p76).

The melting of the ice sheets could add several metres to sea-level and such a rise would be devastating for world agriculture, since even a rise of one metre – all possible because of the thermal expansion of seawater without any glacial melting – would threaten one-third of all the world's current cropland.

A combination of factors, such as severe weather depressions, strong onshore winds and spring tides can lead to sea surges in which the level of the sea rises by five or six metres above its norm and that is not taking the height of the waves into account. The 1991 tropical storm that hit Bangladesh raised the waters by six metres and caused serious damage to crops. In fifty years time the sea could surge as much as 160 kilometres inland, therefore covering 40 per cent of the country. A one-metre rise in the sea would put paid to at least 16 per cent of rice production in

### Extreme Cold Destroys Orange and Lemon Crop in the Golden State

On 27 December 1998, California citrus farmers tried to rescue the last of their fruit as a week of unusual freezing weather inflicted \$600 million of damage, wiping out a quarter of the lemon crop and more than half the oranges. Thousands of migrant workers from Mexico who depend on the annual winter harvest are now without work, and many farmers have lost their fruit. The Golden State's \$1.5 billion crop produces 90 per cent of America's lemons, and 80 per cent of oranges eaten as fruit. In California's central valley, where most of the crops is grown, winter temperatures do not often dip more than a couple of degrees below freezing. But in the last week of December, thermometers plunged to around 20° Fahrenheit, causing the juice to turn to ice, pop the skin and ruin the fruit. Harvey Bailey, a grower with 4,000 acres in the valley, reported that 90 per cent of his crop had been ruined just as he was preparing to harvest.

Christopher Reed, *The Guardian*, 28 December 1998



Bangladesh and probably considerably more because of the salinisation of all the coastal soils and aquifers. Bangladesh would be devastated in an inexorable inch-by-inch process of attrition.

Most deltas are vulnerable to sea-level rise and to tropical storms and sea surges: Bangladesh, China, Egypt, Indonesia, the Netherlands and, in the US, Louisiana and California. As Martin Parry,<sup>8</sup> the Asian Development Bank and others have pointed out, a considerable proportion of rice paddies in South-East Asia will be seriously affected by the rising sea. Indonesia has 15 per cent of all the world's coastlines and as much as 40 per cent of its land-surface is vulnerable to rising sea-levels. Moreover, 75 per cent of the world's population live in the tropics, with two-thirds dependent on agriculture for their livelihoods. Nor would Britain escape, with its extremely vulnerable eastern flank around the Wash and East Anglia.

The problem of sea rise and intrusion is exacerbated through the extraction of water from aquifers, a case in point being the penetration of seawater 35 kilometres inland into the Nile Delta in Egypt. In fact, Egypt is already losing as much as 50 metres a year at the head of the Nile at Rashid, mainly because the Aswan Dam is retaining the silt that would have been carried down to the river's mouth. With a rise of one metre in sea-level, as much as 15 per cent of the existing agricultural land in the Nile Delta may be lost. According to Daniel Hillel,<sup>9</sup> maize and wheat yields in the Delta may drop by as much as 30 per cent and in Middle Egypt by as much as 50 per cent. In Israel, the world leader in irrigation technology, ten per cent of coastal aquifers are already too salty to use on crops because of sea intrusion.

### Rainfall and water stress

In temperate latitudes crops need at least 250 millimetres of rain a year and in the tropics 500 millimetres. However, it is not just the *amount* of precipitation, but *when* the bulk of it occurs that is important. The Canadian prairies generally get sufficient rainfall during the growing season of the summer months, whereas the same is not necessarily true of the Mediterranean, even though the total rainfall over southern Europe is more than adequate. Some crops, such as maize grown in the US corn-belt need rain during the ripening period, whereas others, such as coffee, require a dry period during the final maturation and harvesting of the beans. Global warming will undoubtedly play havoc with a crop's specific needs, both through increasing surface temperatures, which itself will lead to a greater likelihood of water stress on vegetation because of enhanced evaporation from soils, and through distorting rainfall patterns. A failure of the monsoon spells disaster for India as does just a small decline in the amount of rain over the semi-arid countries of the Sahel.

On average, each of us needs about one million litres of fresh-water a year for all our needs, including the growing of food, which takes up about three-quarters of the whole. One-third of the world's population are now living in countries which suffer periodic shortages of water, with serious consequences for agriculture. The anticipated increase in population by 2025 could lead to as much as two-thirds of the world's population living in countries that suffer water stress, and that is without taking climate change into account. In broad terms any country which uses 20 per cent of its available water supply suffers water stress and severe water stress when the ratio of water used to that available goes up to 40 per cent. Global warming, according to Nigel Arnell,<sup>10</sup> of Southampton University, who applied those criteria to the latest Hadley Centre model, will cause an additional 66 million people to be living in water-stressed countries by 2050 and an additional 170 million people to be living in countries that are severely water-stressed.

What about the impact on crops? As David Pimental<sup>11</sup> notes, water is the primary limiting factor for crop production worldwide. To get maize up to a production of 8 tonnes per hectare

requires access to 5 million litres – the equivalent of 500 millimetres of rain. Wheat and other grains need some 1,000 litres to produce one kilogram: that has to be multiplied by 100 to produce a kilogram of beef. Even so the amount required is only a fraction of that needed to fall as rain. For maize the amount needed as rain is approximately 10 million litres per hectare, therefore double the plant's basic requirements. But even that will be insufficient once surface temperatures rise and the rate of evaporation from the soil surface goes up.

### Irrigation – reaching its limits

Although used on just 17 per cent of total cropland in the world, irrigation, with two or three crops in a year now feasible, enables agriculture to supply 40 per cent of the world's food. After a rapid expansion during the 1960s and 1970s, the area dedicated to irrigation reached 250 million hectares by 1994, but the rate of growth has now slowed and, at best, is unlikely to exceed more than 0.3 per cent per year over the next half-century. The main reason is that as rapidly as new areas for irrigation are opened up, old areas are being discarded because of salinisation and water-logging which occur just about wherever modern irrigation methods are adopted in the tropics. Costs too are increasing rapidly as water tables fall. Indeed, according to Pimental, to pump water from a depth of no more than 30 metres, needs more than three times more fossil fuel energy for corn production than for rain-fed production of the same amount.

Surface temperatures affect the amount of water required in irrigation, not only because of evaporation from soils and irrigation channels and, when used, from reservoirs, but also because of increased evapotranspiration. An obvious consequence of global warming will be to increase demands for irrigation water without necessarily an increase in yields. A study on irrigation requirements in the United States indicated that were precipitation to increase by even 10 per cent, an increased surface temperature of 3°C would push up water requirements.

A decline in rainfall combined with warmer temperatures will therefore clearly have a profound impact on the future of irrigation. Extraction of water from the vast Ogallala aquifer in the mid United States is very much a case in point, since over-extraction is already taking its toll, less than fifty years after exploitation began. By 1982 some 8 million hectares – 12 per cent of the cropland in the southern portion of the Great Plains – was under irrigation, but excessive mining of the water, especially for cotton-growing in the Texas Panhandle, has brought about serious depletion of the aquifer and thousands of hectares have had to be abandoned. As Rosenzweig<sup>12</sup> and Hillel point out, a dust-bowl climate in the central United States caused by global warming would reduce the flows and collection of water by more than one quarter in the Missouri and upper Mississippi. Whilst clearly having an impact on irrigation, such a drop in available water would also have an impact on hydroelectricity, which in some instances would have to be reduced by one-half or more.

Dry river basins, where the river and tributaries flow through semi-arid and arid regions, such as those of the Nile and Zambesi, will be particularly affected by climate change. Wet river basins, in the humid tropics less so. However, changes in the pattern of rainfall rather than in total precipitation, can lead to major episodes of flooding and crop destruction, especially when the river systems have little extra capacity for storage. Heavier downpours, anticipated with global warming, can be extremely destructive in causing landslides and soil erosion.

Worldwide some 75 billion tonnes of soil are eroded each year, with at least 60 per cent of that quantity getting washed away into rivers and out to sea. According to Pimental,<sup>13</sup> that loss in nutrient terms is equivalent to several billion tonnes of fertiliser, an amount close to the total fertiliser applied each year across the globe. In the United States alone the fertiliser losses in terms of nutrients are

equivalent to some \$20 billion. Higher soil temperatures will increase the rates of oxidation and hence loss of nutrients and organic matter. Less organic matter means less soil organisms such as earthworms and insects that do so much to improve the ground. The soil is likely to compact more and the rate of run-off to increase, so adding to potential problems of water stress.

### Global warming and pests

Modern agriculture, especially in the form of monoculture farming, offers a rich harvest for the tens of thousands of pest species as well as for weeds that are waiting in the wings for ground to be cleared. The numbers are staggering and, according to Pimental, despite \$30 billion spent annually on the application of 2.5 million metric tonnes of active pesticides, more than 40 per cent of world food, forage and fibre production is currently destroyed by a combination of pests, plant pathogens and weeds. The loss is estimated at \$500 billion per year.

Within the context of modern industrialised farming, global warming and warmer temperatures with milder winters in temperate zones will lead to a surge in pathogens and pests. Not only will some pests be able to take advantage of rising temperatures to spread to higher latitudes and altitudes, but also to increase their rate of reproduction by adding an additional generation. During the growing season some insect pests can produce 500 progeny per female every two weeks and as many as 3,000 in a single generation. The European corn borer, for example, a pest that can devastate maize, is able, when the conditions are right, to produce four generations a year. A 1°C rise in temperature will enable the corn borer to extend its range northwards by as much as 500 kilometres. Locust swarms may become common in southern Europe. A 3°C rise would see a major expansion in such insects as the tobacco cut-worm, southern green stink bug, rice stink bug, lima bean pod borer, soyabean stem gall, rice weevil and soyabean pod

*Locust swarms may become common in southern Europe... Animal diseases such as African swine fever are also likely to jump countries in a warmer world and may begin breaking out as far afield as North America.*

borer. Animal diseases such as African swine fever are also likely to jump countries in a warmer world and may begin breaking out as far afield as North America.

In general, losses to insects and mites are higher in warmer regions of the world. As Pimental points out, potato growers in Maine average losses of around 6 per cent to insects whereas in Virginia the losses rise to 15 per cent, despite the use of more insecticide. As the world warms, the losses to insects could double from 15 per cent of production. Fungal and bacteria pests in plants will also thrive in a warmer world, especially should it be wetter. Mild winters, which are now becoming the norm in Britain, encourage outbreaks of fungal diseases, such as powdery mildew and strip rust in cereals, as well as of potato blight.<sup>14</sup>

### Crop response to global warming

Agronomists are quick to point out that the impact of global warming on agriculture will be tempered by the response of vegetation to increased levels of carbon dioxide, which may cause plants to photosynthesize more efficiently and as a result to grow more vigorously. This effect is especially true of the C3 plants, which include temperate grasses and cereals such as wheat and rice, but is less true of C4 plants that include maize, sorghum and sugar cane. In fact, of the 86 plants that contribute 90 per cent of per capita food supplies worldwide, 80 are C3 plants.

In their modelling of the potential impact of climate change on agriculture, Rosenzweig and Parry assume that an increase in car-

## How Plants will Fare with More CO<sub>2</sub>

C3 plants are so-called because the first product of photosynthesis in a sequence of reactions is an organic compound with just three carbon atoms. When C3 plants are exposed to the carbon dioxide levels now found in the atmosphere – approximately 360 ppmv – they burn off some of the carbon that has been ‘reduced’ during photosynthesis in order to make more carbon dioxide available inside the leaves. In that kind of ‘boot-strap’ operation a proportion of the photosynthetic gains are therefore lost to the plant. However, as carbon dioxide concentrations in the atmosphere increase, less burn-off is required to get the requisite concentrations of carbon dioxide and stops completely once atmospheric concentrations have reached 1,200 ppmv – hence about four times pre-industrial CO<sub>2</sub> concentrations.

That improvement in efficiency of C3 plants as atmospheric CO<sub>2</sub> levels rise, at least up to the point of saturation, translates into increases in growth which, if channelled into seeds, should mean higher yields. C4 plants, on the other hand, operate more efficiently at the relatively low carbon dioxide levels of today and have less to gain in terms of rising atmospheric levels of the gas.

In addition, many C3 plants are weeds and a likely consequence of increased carbon dioxide levels will be to stimulate an epidemic of aggressively-growing weeds. That unwanted growth would certainly threaten the yields of C4 crops such as maize, sorghum, millet and sugar cane and will lead to raised costs in weed control.

Studies have shown that when carbon dioxide levels increase in the atmosphere the stomata tend to shut down. Water, which is normally transpired through the stomata is therefore conserved. Hence, increased carbon dioxide has a twin effect, especially in C3 plants, first to increase net primary productivity and second to conserve water. However, transpiration also serves another important function in keeping the surface of the leaf cool; hence, when temperatures rise in a world of higher atmospheric concentrations of carbon dioxide, the leaf surface could well over-heat with significant reductions in plant growth.

bon dioxide from 330 ppmv to 555 ppmv will increase net photosynthesis in C3 plants by as much as 20 per cent, with associated gains in water use of around 50 per cent. But any such gains must be offset against losses in the overall ecosystem, which includes the enhanced activity of soil organisms that are benefiting from the increases in the total amount of organic carbon being generated.

In their paper, ‘Dynamic responses of terrestrial ecosystem carbon cycling to global climate change’, Mingkui Cao<sup>15</sup> and F. Ian Woodward have modelled the physiological implications of climate change on the terrestrial carbon cycle. Using the UK Met Office’s general circulation model to predict climate change over the coming century, with an assumption that carbon dioxide will increase at a rate of one per cent per annum, they then look for broad-brush consequences for vegetation and how much carbon is likely to be sequestered from the atmosphere.

With global warming and the physiological impact of increased carbon dioxide both operating together, the model shows that between 1860 and 2070, as much as 309 billion tonnes of carbon should have accumulated in soils and vegetation across the planet. Were that in truth to happen, the amount of carbon sequestered by net gains in biomass growth would be the equivalent of 50 years of emissions at the rate of 6 billion tonnes of carbon a year. The model actually indicates that 58 billion tonnes of carbon should have accumulated over the period 1861–1990, therefore accounting historically for about two-thirds of the carbon from anthropogenic sources that will have found its way into terrestrial biomass.

The model tells us that we should not be over-worried by a dou-



bling of atmospheric carbon dioxide and its impact on surface temperatures. Even so, once carbon dioxide exceeds some 600 ppmv and global temperatures continue to rise, the stimulus to higher growth actually vanishes and net gains begin to turn to net losses in the accumulation of carbon. Furthermore, such computer experiments take no account of anthropogenic changes to the landscape, including the transformation of vast territories to agriculture through the destruction of forests. The conversion of 'virgin' lands to agriculture leads to massive losses of soil carbon to the atmosphere, so enhancing anthropogenic emissions. We must therefore not be beguiled by simplistic models that can cope only with a few parameters and that take no account whatsoever of the massive impact of human activities on natural processes.

Although Cao and Woodward's model shows a net carbon uptake by vegetation over the past century, we must not make the mistake of extrapolating from the past. Today, one-third of all the terrestrial surface, including the steep slopes of mountains, has been converted for human use basically through the degradation and destruction of forests, and much of those changes have taken place in the past 40 years. Furthermore, the increase in greenhouse gases, especially carbon dioxide over the next century, could be four times pre-industrial levels rather than double as used in their model (see 'Misreading the Models,' p75). If this were so, the average surface rise in temperature would be far greater than the 4°C maximum predicted by the IPCC. Such changes will inevitably lead to severe disruptions of 'normal' climate systems, with a tenfold or more greater likelihood of devastating heat-waves and storms. Under these circumstances, it is unlikely that vegetation will draw down more carbon from the atmosphere than would be emitted from soils and decaying forests.

### The problems of agriculture today

Even without climate change, it is not as if all is well with agriculture today. The great post World-War-2 surge in food production is grinding to a halt and yet the world's population is increasing by the size of another India – some one billion people – in just over a decade. According to the World Health Organisation, as many as 3 billion people are currently malnourished – approximately half the world total. As David Pimental points out, worldwide per capita increases in yields have been declining since 1983. That is largely because of soil erosion, desertification and salinisation (in the case of irrigated land), reducing the return on fertiliser use, which has fallen by 25 per cent, and leading to a 12 per cent reduction in the amount of land under irrigation.

But still the Food and Agriculture Organisation (FAO) feeds us with anodyne figures, as if all will be better in the future rather than worse. The expectation is that cereal production will continue to grow by about one per cent per year – a doubling over the next 70 years – with increases in global production from 1,800 million metric tonnes in 1990 to 3,500 million tonnes in 2050. The combination of that growth in supply, plus global trade and the supposed enhanced purchasing power of the world's population, because of 'industrialised' development, is the recipe, according to such economic models, of better access to food and the banishing of hunger.<sup>16</sup> In any case, there is absolutely no mention of the impact of global warming in that projection.

When the modellers add in the impact of climate change, 36 million more people are seen to be at risk from hunger in 2020 compared with the FAO figures. That number accelerates rapidly as global warming takes hold in the mid to latter part of the 21st century and, by 2060, could be as many as 350 million more than anticipated by the FAO. Indeed, according to the UK Met Office's Hadley Centre model, by 2080, as many as 40 million more Africans could be at risk from climate-induced food shortages compared with no climate change. All those estimates depend on population increases as forecast by the United Nations and on the impact of global warming being as predicted from the models. As

we have pointed out, the models understate the problem.

Moreover, through the need to average climate data over a 30-year period in order to minimise the natural 'noise' in the climate system – to iron out the ripples caused by 'freak' events – we will have introduced a lag in the extrapolation just when changes are beginning to take off. In that respect how seriously can we take pundits such as Cynthia Rosenzweig,<sup>17</sup> of the Goddard Institute of Space Studies in New York, and Martin Parry, of the Environmental Change Unit at Oxford University, who in their 1994 paper to *Nature* tell us that farmers should be able to adapt in time to global warming, such that overall yields will barely decline from the optimistic forecasts of the FAO?

The adaptations they propose have all to do with industrialised agriculture and they include changes in the date of planting, so as to profit from milder soil temperatures in high latitude zones; changes in the varieties and crops used; and finally changes to the irrigation and fertiliser regime. They take it as 'read' in their model that irrigation water will make up for any major shortfall in the water available to crops and that irrigation will be 100 per cent efficient, irrespective of the impact of climate change. But when we look at the state of irrigation today, with as much and perhaps more land coming out of production than going in; with rapidly falling water tables because of over-exploitation, as is occurring with the Ogallala aquifer in the United States; and if we consider the extent to which crop yields are falling because of waterlogging and soil salinisation, especially in the bread-basket zones of Pakistan, India, the countries of the Ex-Soviet Union – we can only conclude how dangerously optimistic such projections are.

According to the United Nations, agricultural mismanagement has damaged more than 552 million hectares – 38 per cent of today's cultivated area – since World War 2 and that overall, between 5 and 10 million hectares a year are currently being lost. Just 100 years at that rate would leave the world with but a patch of the land for agriculture that it has today.

Given the unpropitious conditions of farming today, the impact of global warming on agriculture can only be considerably worse. Indeed, all the indications are that our systems of agriculture will be in serious trouble if we follow a 'business-as-usual' strategy and do not take immediate measures to reduce our impact on the climate.

### References:

1. Cynthia Rosenzweig and Daniel Hillel, *Climate Change and the Global Harvest: Potential impacts of the Greenhouse Effect on Agriculture*, Oxford University Press, 1998, p.29.
2. Megan Gawith, Thomas Downing and Theodore Karacostas, "Heatwaves in a changing climate," in *Climate Change and Risk*, Editors Thomas Downing et al., Routledge 1999, p.279.
3. Paul Brignall et al. Agricultural drought in Europe, *ibid.* p.79.
4. A.H. Fitter & R.K.M Hay, *Environmental Physiology of Plants*, Academic Press, London, 1987.
5. David Pimentel, *Global Climate Change and Agriculture*, College of Agriculture and Life Sciences, Cornell University, Nov. 3, 1998.
6. Lester R. Brown, *The Agricultural Link: How Environmental Deterioration could disrupt Economic Progress*, Worldwatch Paper 136, August 1997.
7. *Climate Change and its Impacts*, The Met Office, Crown Copyright, November 1998.
8. Martin Parry and Rachel Duncan, *The Economic Implications of Climate Change in Britain*, Earthscan, 1995.
9. *Op.cit.* 1.
10. Nigel Arnell, *Climate Change and its Impacts*, The Met Office, Crown Copyright, November 1998.
11. *Op.cit.* 5.
12. *Op.cit.* 1.
13. *Op.cit.* 5.
14. Peter Bunyard, Industrial Agriculture – Driving Climate Change, *The Ecologist*, Vol. 26, No.6 Nov/Dec 1996.
15. Mingkui Cao and F. Ian Woodward, *Nature*, Vol 393, May 21, 1998.
16. See *The Ecologist's* special issue on the FAO, 'Promoting World Hunger,' Vol.21, No.2, 1991.
17. Cynthia Rosenzweig and Martin Parry, letters to *Nature* (Vol. 367, 13 January, 1994).

# Human Health On the Line

— BY PAUL KINGSNORTH —

*"Climate Change is likely to have wide-ranging and mostly adverse impacts on human health, with significant loss of life." Thus, the 2,000 scientists of the IPCC condemn future generations to the sort of battle against deadly diseases which the wonder drugs and scientific miracles of the twentieth century were supposed to have banished forever.*

**O**f the many scientists who have projected, predicted and warned of the likely health effects of climate change, almost all agree on the basics: they will be widespread and unpredictable, they are likely to be severe, and many, many people across the world will die as a result.

The likely health effects are best divided into two categories: direct and indirect. Direct effects will result from direct exposure to the weather extremes that climate change will cause, for example: heat-stroke, hypothermia and deaths or injuries resulting from tidal waves, floods, hurricanes etc. Indirect effects will result from subsequent changes in environment and ecosystems – for example: the spread of vector-borne diseases into new areas, nutrition problems resulting from crop failure, diseases spread by algal blooms in warming seas, and even the mental health problems which may result from social and political dislocation.

## Direct effects

We are already seeing examples of some of the more obvious direct effects of climate change on human health. Just a few examples give some idea of the scale of the problem. In 1996, North Koreans were reduced to eating leaves and grass, following flash floods that destroyed their crops. Many suffered from malnutrition. That same year, 60 people in Spain died after a flash flood in the Pyrenees. In 1997, the worst rains in 30 years destroyed half of all Bolivia's crops, with hunger resulting, and a November typhoon in Vietnam resulted in 2,500 dead or missing. In 1998, heat-waves in India and the mid-USA killed over 4,000 people. Hurricane Mitch in Central America killed or injured an estimated 11,000. The Indonesian forest fires, started by man and exacerbated by warmer and drier-than average-weather, caused a massive

increase in respiratory illnesses; crops were drowned in several countries, and fisheries failed, leading to an increase in hunger. Almost every one of these events was record-setting or breaking, and there are hundreds more such examples that could be quoted.

Predictions for the future point to more – much more – of the same, on a wider scale. The latest predictions from the UK's Hadley Centre, published in 1998 and based on an updated computer model, predict that at least 170 million people will be living in areas which are "extremely stressed" through lack of water in the next century, with death and severe illness the likely result. The Hadley Centre also predicts that 18 per cent more of the African population will suffer from hunger and malnutrition due to climate change than at present, and that, globally, over 20 million extra people each year will be at risk of flooding.<sup>1</sup>

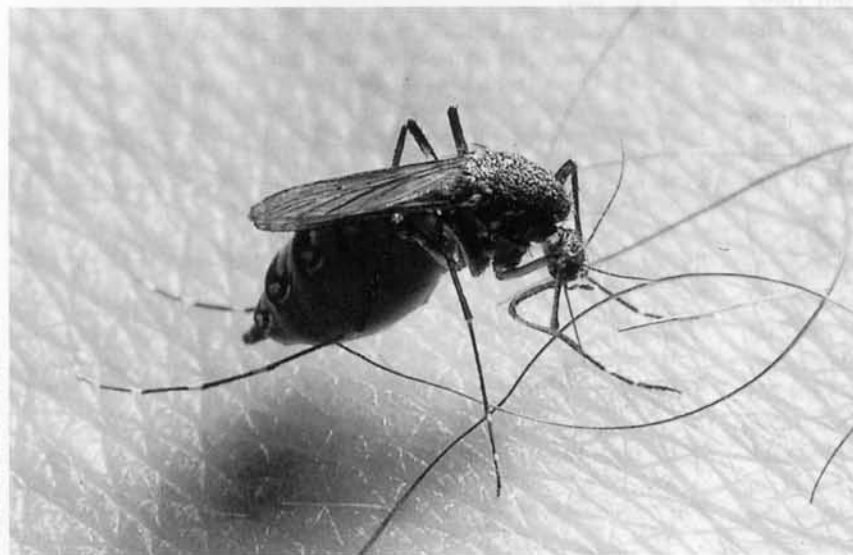
One health problem that is likely to become much more widespread in the 21st century is that known by scientists as 'thermal stress' – in everyday language, the effects of getting too hot or too cold, particularly during ever-more-frequent heat-waves and extreme winters. Detailed studies of the effects of extreme weather on mortality rates have been conducted in many countries and, unsurprisingly, report a close correlation, particularly amongst children, the elderly and the infirm. Deaths from stroke, various cardiovascular illnesses, heat-stroke, hypothermia and influenza, in particular, are much more common during extremes of weather; and this applies to 'developed' as well as 'developing' countries.<sup>2</sup>

## Indirect effects

A recent issue of *New Scientist* magazine reported that "human disease is emerging as one of the most sensitive, and distressing, indicators of climate change." It is accepted by virtually all climate scientists that the likely increase in, and spread of, potentially fatal diseases is likely to be the single most dangerous threat that climate change poses to human health. If many of the direr predictions are right, the flowering of diseases as the climate changes is very likely to negate the benefits of twentieth-century medical advances, and see the rebirth of diseases currently assumed to be 'conquered'.

A major threat will come from an increase of so-called 'vector-borne' diseases – those spread by pests, insects and other small creatures, such as snails. Dr Paul Epstein, of the Harvard Medical

**The range of malaria-carrying mosquitoes is predicted to increase as a result of the warming of previously temperate areas – including parts of Europe and North America.**



ALBERT VISAGE/STILL PICTURES



The number of people who will suffer from dehydration and malnutrition is predicted to rise significantly as the climate changes.

School, who has produced numerous studies and reports on this subject, believes that the spread of these diseases could be even more serious than currently feared.

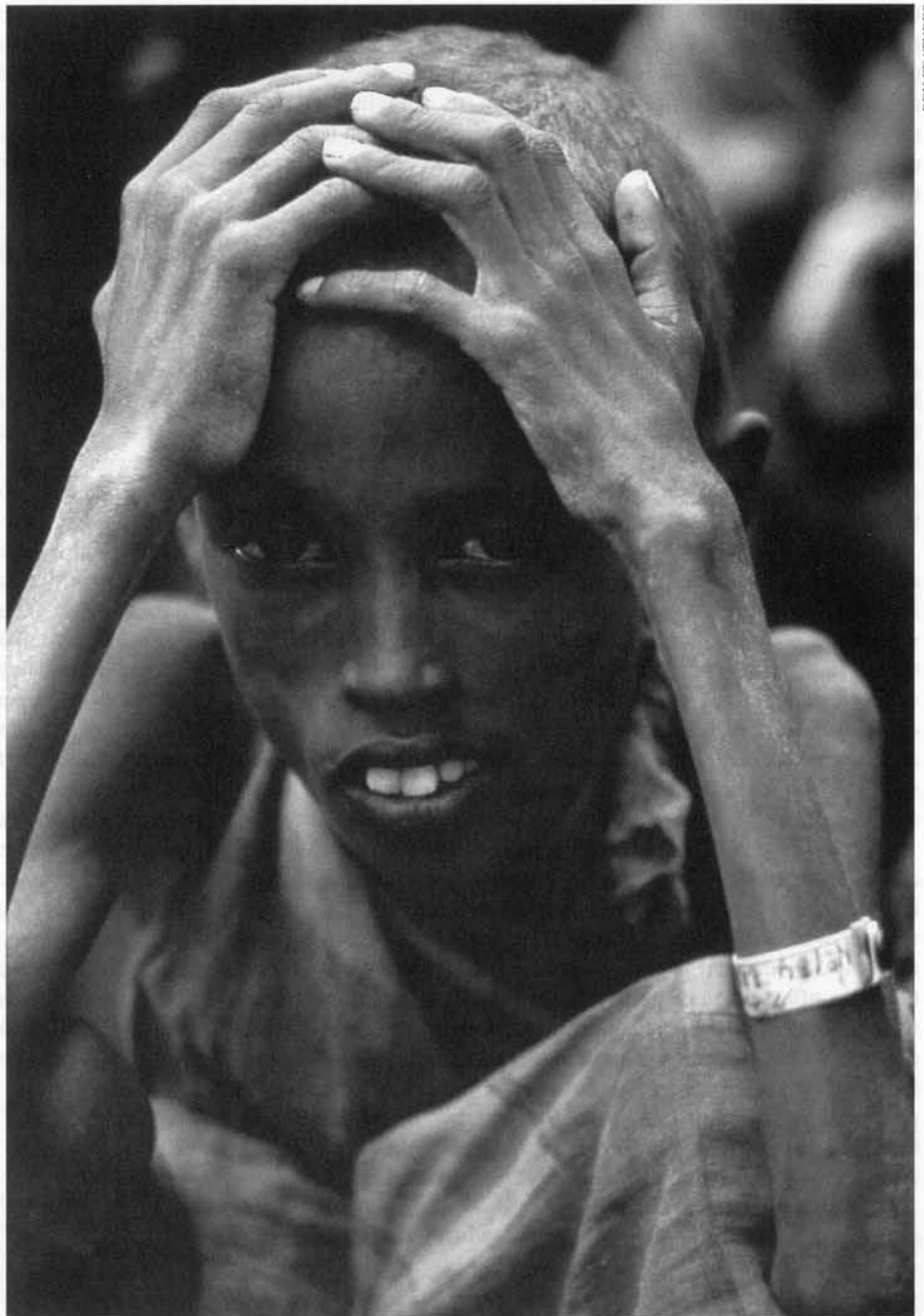
'Pests' such as rodents, insects and weeds, points out Epstein, are 'opportunists': they reproduce rapidly, have huge broods and wide appetites, and can quickly overrun an ecosystem if left to themselves. In a healthy

*A 1996 report from the London School of Hygiene and Tropical Medicine... calculated that, of ten of the world's most dangerous vector-borne diseases (malaria, schistosomiasis, dengue fever, lymphatic filariasis, sleeping sickness, Guinea worm, leishmaniasis, river blindness, Chagas' disease and yellow fever), all but one were likely to increase, or in some way change their range as a result of climate change.*

ecosystem, there will be enough predators – lizards, birds and bats to eat the mosquitoes; owls and snakes to eat the rodents, etc. – to keep pest populations under control. However, the effect of global climate change will be to destabilise ecosystems across the globe, and disrupt predator-prey relationships. The result, in many places, is likely to be a vast increase in disease-carrying pests.<sup>4</sup>

Epstein recently produced a study showing that, in many parts of the world, climatic disruption is already causing rodent-borne diseases to spread – and in some cases actually causing new diseases to emerge. In the early 1990s in the USA, for example, a combination of prolonged drought – which killed predators such as coyotes, snakes and owls – followed by heavy rains, precipitated a ten-fold increase in the rodent population (rodents thrive in and around water, even if it is contaminated). This plague of rodents led to the emergence of a new disease – Hantavirus Pulmonary Syndrome – which was apparently transmitted to humans via the rodents' droppings. Similar hantaviruses have also emerged, in similar climatic conditions, in several European nations, particularly Yugoslavia, while other rodent-borne diseases, like leptospirosis and viral haemorrhagic fevers, have spread across Latin America.<sup>5</sup>

While localised and regional climatic changes are likely to lead to an increase in vector-borne diseases, the average global rise in temperature will also exacerbate the same trend. Many disease-carrying insects – most obviously the malarial mosquito – thrive in warm conditions; as the world warms, they will begin to find more places in which they can breed. A 1996 report from the London School of Hygiene and Tropical Medicine illustrated this point clearly when it calculated that, of ten of the world's most dangerous vector-borne diseases (malaria, schistosomiasis,



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dengue fever, lymphatic filariasis, sleeping sickness, Guinea worm, leishmaniasis, river blindness, Chagas' disease and yellow fever), all but one were likely to increase, or in some way change their range as a result of climate change.<sup>6</sup>

Malaria is the world's most prevalent mosquito-borne disease; two million people die from it every year.<sup>7</sup> But it is likely to get worse. One scientist has called malaria "an old disease with the potential of re-emerging as a new disease, especially in association with climate change,"<sup>8</sup> and virtually all experts seem to agree that one effect of climate change will be to increase the range of the malarial mosquito. The IPCC predicts that malaria will spread from affecting 45 per cent of the population, as it does today, to affecting 60 per cent by the latter half of the next century – of the order of 50-80 million additional annual cases.<sup>9</sup> The Hadley Centre's 1998 study predicted a significant spread in the mosquito's range, largely as a result of the warming of previously temperate areas – including parts of Europe and North America. Malaria is also likely to spread to high altitude areas, such as the Andes, as their average temperature rises.<sup>10</sup>

Again, it seems that in some places this is already beginning: malaria has already begun to affect the previously mosquito-free African highlands,<sup>11</sup> and upland rural areas of Papua New

Guinea.<sup>12</sup> Urban centres are beginning to suffer as well: many central African cities are experiencing urban malaria for the first time,<sup>13</sup> and two recent cases in New York City were traced to local mosquitoes.<sup>14</sup> Furthermore Paul Epstein, in studying cases of malaria linked to the recent El Niño, has found that large and deadly outbreaks across Asia were one result of climatic upheavals there.<sup>15</sup>

Other vector-borne diseases are likely to become more common – and hence more deadly – too. Again, the spread is already beginning. Mosquito-borne yellow fever has recently invaded Ethiopia, and dengue fever, spreading through the Americas, has already reached Texas. Recent floods in north-east Kenya caused Rift Valley Fever, a cattle disease, to jump the species barrier and kill hundreds of people.<sup>16</sup> In 1994, the pneumonic plague resurfaced in India, during a summer in which temperatures reached as high as 124 degrees Fahrenheit.<sup>17</sup> We should expect more of the same as the thermometers of many nations are thrown out of kilter by man-made climate change.

And it is not just vector-borne diseases that are likely to take advantage of the changing climate. Other infectious killers are likely to enjoy a resurgence too, particularly diseases associated with water supply and sanitation. A 1996 WHO report laid out the threat starkly: “climate change could have a major impact on water resources and sanitation by reducing water supply. This could in turn reduce the water available for drinking and washing, and lower the efficiency of local sewerage systems, leading to increased concentration of pathogenic organisms in raw water supplies.”<sup>18</sup>

This was the situation in 1991, when Peru was devastated by a cholera epidemic (which quickly spread across Latin America, killing over 5,000 people in eighteen months) linked with the warmer waters of El Niño. “Of course,” wrote Karen Schmidt, in the *New Scientist*, “it is really global warming that is involved.”<sup>19</sup> Cholera, often assumed to be largely a disease of the past, may well become common again in the 21st century, as global warming bites. Paul Epstein’s pioneering work has also pointed out a hidden threat in this area, too: not only is cholera associated with poor sanitation and polluted inland waters, but it can also be harboured in marine plankton. Epstein believes that this was the original cause of the 1991 epidemic in Latin America.<sup>20</sup>

Apart from cholera, other water-borne and water-related-diseases are also likely to increase and spread too, for the same reasons: typhoid, hepatitis A, diarrhoeal diseases (major killers of young children in ‘developing’ countries), scabies, trachoma and schistosomiasis, to name but a few.<sup>21</sup> But water-and-climate-change-caused diseases are linked in another way, too: the ocean itself could become, and may even already be becoming, a new vector for fatal diseases.

In January this year, the *New York Times* reported that previously unknown bacteria, fungi and viruses are beginning to bloom in the oceans as they warm, killing coral and fish, and threatening human health. Joan B. Rose, from the University of South Florida, reported that human viruses were spreading into the warming seas from the 1.8 million septic tanks along the Florida coast. “Many people are becoming infected with viruses picked up while swimming, windsurfing or bathing in infected waters,” she confirmed. James W. Porter, from the University of Georgia, believes that this unprecedented problem is linked to a rise of 1.8 degrees Celsius in ocean temperature which climate change has already caused in the area.<sup>22</sup>

Paul Epstein has studied the relationship between climate change, ocean pollution and disease, too, and has produced equally worrying conclusions. His suggestion that cholera can be transmitted by marine plankton has already been mentioned, but he has also postulated that coastal algal blooms already being seen in many of the world’s seas – as a direct result of the warming of the water – are also transmitters of disease, often via fish and shell-

fish. In the summer of 1992, for example, after a long warm period, blooms known as *Alexandrium tamarense* developed in the seas around Newfoundland, infecting shellfish with a disease known as Paralytic Shellfish Poisoning (PSP) which was transmitted to humans who ate the shellfish. Similar PSP incidents have since occurred in waters around the east coast of the USA, Canada and the UK. Toxic ‘brown tides’ have poisoned scallops and eels, and numerous other episodes of fish intended for human consumption being poisoned by algal blooms have been catalogued by Epstein.<sup>23</sup>

One obvious, but often overlooked, consequence of the health problems which climate change is preparing to visit on us, is the financial cost of dealing with the problem. Economists and industrialists who insist that taking any action to combat climate change will threaten the world’s economies might like to consider the economic costs of doing nothing. In terms of human health, some of those costs are already being borne: Epstein reports that the 1991 cholera epidemic cost Peru over \$1 billion, while airline and hotel industries lost between \$2 billion and \$5 billion from the 1994 Indian plague. Cruise boats are already avoiding islands in the Indian Ocean plagued by dengue fever – and are threatening the area’s \$12 billion tourist industry in the process.<sup>24</sup>

This short article has only scratched the surface of this issue. It has not even begun to address some of the threats that are more difficult to predict, such as the potential diseases of the mind which could stem from the chaos caused by a changing climate – what psychiatrists call the ‘psychosocial’ problems associated with economic collapse, institutional breakup and social upheaval.<sup>25</sup> Hundreds of papers, millions of words and many laboratories and books have been dedicated to predicting the likely effects of climate change on human health. But the simple fact is that many of those effects are likely to catch us unawares. In medical terms, it is more than likely that, as Paul Epstein succinctly puts it, we are “vastly underestimating the true costs of ‘business-as-usual’; and underestimating the benefits to society as a whole of using the resources we have inherited efficiently.”<sup>26</sup>

Paul Kingsnorth is a writer and environmental campaigner.

## References:

1. Climate Change and Its Impacts, Met Office/DETR, November 1998.
2. McMichael, A.; Haines, A.; Slooff, R.; Kovats, S (Eds.), *Climate Change and Human Health*, WHO, 1996, Ch. 4.
3. Pearce, F. ‘Health Crisis’, *New Scientist*, 19 December – 2 January 1999, p.33.
4. Epstein, P. ‘Health Consequences of Climate Change’, unpublished manuscript, 1998.
5. *Ibid.*
6. McMichael, A., quoted in Martens, P. *Health and Climate Change*, *Earthscan*, 1998, p.29.
7. *Op. cit.* 2, p.78.
8. Colwell, R. ‘Global Climate and Infectious Disease: The Cholera Paradigm’, *Science*, Vol 274, 20 Dec. 1996, pp. 2025 – 2031.
9. *Climate Change 1995: IPCC Second Assessment Report (summary)*, UNEP/WMO, 1995, p.36.
10. *Op. cit.* 2.
11. *Op. cit.* 3.
12. *Op. cit.* 4.
13. *Op. cit.* 4.
14. *Op. cit.* 6.
15. *Op. cit.* 4.
16. *Op. cit.* 3.
17. *Op. cit.* 4.
18. *Op. cit.* 2, p.96.
19. Schmidt, K. ‘Testing The Waters’, *New Scientist*, 15 November 1997, p.46.
20. *Op. cit.* 4.
21. *Op. cit.* 2, p.97.
22. ‘As Oceans Warm, Problems from Viruses and Bacteria Mount’, *New York Times*, 24 January 1999.
23. Epstein, P. ‘Emergent Stressors and Public Health Implications in Large Marine Ecosystems: An Overview’, US EPA, 1996.
24. *Op. cit.* 4.
25. *Op. cit.* 4, p.139.
26. *Op. cit.* 4.



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# The Looming Environmental Refugee Crisis

— BY GROVER FOLEY —

*The impact of climate change around the world is set to create millions upon millions of new refugees, as whole regions become uninhabitable through food and water shortages, and as towns and cities fall victim to rising seas, increased flooding and violent storms. Where will they go? What will we do?*

Climate change, at a conservative estimate, will increase the number of environmental refugees six-fold over the next fifty years: from 25 million to 150 million.<sup>1</sup> How will climate change create refugees?

As the planet warms, food and water grow scarcer. In 1998, the Hadley Centre for Climate Prediction and Research forecast major decreases in crop yields by 2050. These would above all affect the tropical countries of South America, Russia and western Africa. As for water scarcity, the Hadley Centre forecasts that by 2050, about 170 million people will suffer severe stress: their countries will be using over 40 per cent of their water resources. Badly affected areas will include the US, North Africa, Europe, Turkey, the Gulf states and China. Global warming may also endanger the monsoon, with effects much greater than those of drought alone – particularly in India given that 70 percent of India's rainfall comes from the monsoon. Indeed, the Asian Pacific region as a whole, which has half the world's population, likewise depends on the monsoon.<sup>2</sup>

Besides drought, sea-levels are predicted to rise greatly and storm surges increase as a result of global warming (see 'The Threat of Rising Seas,' p76). Few countries will have the resources to contain the rising waters. Should the rise reach one

*In China, at present, the government estimates that 30 million people are already being displaced by climate change. Some authorities set the figure higher, at up to 72 million. A one-metre rise of sea-level would flood all of Shanghai, plus 96 per cent of the province around it. The population of Shanghai is over twelve million; by 2030, it is expected to be 27 million.*

metre, even Holland would find it difficult to cope. Hundreds of millions of people would be at risk from such flood damage – given that a considerable proportion of the world's population lives close to coastlines, including in major cities, such as Shanghai, Bangkok, Miami and not least London.

In China, at present, the government estimates that 30 million people are already being displaced by climate change. Some authorities set the figure higher, at up to 72 million. A one-metre

**Refugees fleeing their homes in Rwanda. Scenes such as this are likely to be replicated on a vast scale throughout the world as climate change wrecks millions of homes and communities.**



rise of sea-level would flood all of Shanghai, plus 96 per cent of the province around it. The population of Shanghai is over twelve million; by 2030, it is expected to be 27 million.<sup>3</sup> Egypt would lose 12-15 per cent of its arable land, creating 14 million refugees. As the sea encroached, salt water would move into the foreshortened Nile, threatening the irrigated lands that produce almost all of Egypt's food. In some areas, more destructive river flooding is also predicted, for instance through a heavier than usual monsoon. In Bangladesh, melting glaciers in the Himalayas would add to such floods.<sup>4</sup>

Rising sea levels also threaten delta areas – such as the Mekong in Vietnam, the Yangtze in China, the Irrawaddy in Myanmar, the Tigris-Euphrates in Iraq, the Indus in Pakistan, the Orinoco in Venezuela and the Amazon in Brazil – that hold more than one billion people (two billion by 2050). The Mekong delta, for instance, is home to ten million people, on land one metre or less above high tide. In such deltas lie mega-cities such as Jakarta, Bangkok, Bombay, Manila and Buenos Aires that by 2050 will be home to 200 to 220 million people.<sup>5</sup>

While these threats are bad enough, each may intensify the others. Due to synergisms, two problems may have not twice but many times the expected impact.<sup>6</sup> Just as deforestation increases warming, and warming increases loss of forests, so loss of forests increases migration, while these migrants may of necessity cut down forested areas into which they have moved. The resulting poverty, moreover, produces malnutrition, disease, flight from the land, growth of megacities, unemployment, brain drain to the richer countries, and still greater disparity of wealth.

Despite hundreds of articles and many books about climate





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change, few discuss the issue of environmental refugees. The 1995 report of the Intergovernmental Panel on Climate Change (IPCC) for instance, has a 431-page volume on "Economic and Social Dimensions of Climate Change". Yet the subject of refugees receives only one-third of a page (along with unrealistically low estimates of their future number).<sup>7</sup> Is the refugee problem already too great and too divisive, pitting the humanitarians against the 'realists'? Certainly both Europe and the US face hard decisions.

Most of the refugees to Europe are expected to come from the sub-Saharan nations – the source of half of the world's current total of refugees and states that are projected to suffer severe impacts from climate change. By 2010, the population of these countries is expected to increase by half, from 600 to 900 million. Of the extra 300 million, about 100 million are predicted to be destitute and are likely to rely on international aid.<sup>8</sup> These potential refugees will far outnumber today's 12 million refugees from that area. Worse could come: by 2050, the population of sub-Saharan Africa is likely, on present admittedly shaky forecasts, to grow not 50% but 116%, to 1.3 billion.<sup>9</sup> Where will the extra 691 million live and grow their food? If 11% (100 million) were destitute in 2010, how many of the extra 700 million will be so?

If today's 25 million refugees become 150 million by 2050 (a conservative estimate), will this six-fold increase mean not 100,000 illegals in Spain but a million? Instead of 30,000 asylum seekers in London, 180,000? Given the prospects of far worse desertification in Africa, plus climate change in Britain, 180,000 could be a huge under-estimate. True, a large percentage will lack the money to make their way into Europe. They face starvation in their own countries or in internment camps. But those who have

some money will keep on coming.

Consider the estimate we noted at the outset: a six-fold increase in environmental refugees by 2050. That could mean, for the US, not one million but six million people crossing from Mexico every year. Already, African nations like the Congo and the Sudan ban or intern starving refugees from neighbouring states. Would the governments of Europe be more hospitable if under similar environmental pressures, or create a Fortress Europa, ringed with machine guns? Far more sensible, surely, to try to get to the root of the matter now – the fossil-fuel-based industrialisation that is causing climate change and many of our other environmental problems.

#### References:

1. Norman Myers, 'Environmental Refugees in a Globally Warmed World,' *Bioscience* V. 43 No. 11, Dec. 1993, p.758.
2. Hadley Centre for Climate Prediction and Research, 'Climate Change and its Impacts,' (The Met Office, London), November 1998.
3. B. Wang, C. Shenling, Z. Keqi, & S. Jiang, 'Impacts of Sea-Level Rise on the Shanghai Area,' *J. Coastal Res. Special Issue No. 14*, cit. Myers CTB, p.143.
4. J.C. Topping, A. Qureshi, & S.A. Sherer, *Implications of Climate Change for the Asian-Pacific Region* (Climate Institute; Washington DC), 1991, cit. Myers 1993, p.756.
5. United Nations Population Division, *World Urbanisation Prospects* (New York), 1992, p.756.
6. Eugene P. Odum, *Ecology and Our Endangered Life Support Systems* (Sinauer Assoc.; Sunderland, MA), cit. Myers 1993, p.760.
7. J.P. Bruce *et al.*, eds. *Climate Change 1995: Economic and Social Dimensions of Climate Change* (Intergovernmental Panel on Climate Change; Cambridge University Press, Cambridge), 1996, Section 6.2.11, 'Migration,' p.199.
8. *Op.cit.* 1, p.3.
9. *Op.cit.* 1, p.6.

# The Economic Costs of Climate Change

— BY EDWARD GOLDSMITH AND CASPAR HENDERSON —

*Industrialists who continue to lobby governments to prevent them from taking the necessary action to combat climate change try to persuade themselves that inaction is in the best interests of their businesses and the economy itself. Given the enormous financial costs climate change will inflict, such an attitude is short-sighted in the extreme.*

The first and most obvious way in which climate change will affect the economy is by the predicted sea-level rises. These, as the reader will have noted, can increase from a mere 20cm to several metres, depending on the effect of global warming on the Arctic and Antarctic ice-sheets. According to the Organisation for Economic Co-operation and Development (OECD)<sup>1</sup>, economic damages and losses arising from climatic destabilisation could cost the global economy up to \$970 billion – on the basis of the present models which, as we have seen, (see ‘Misreading the Models’, p75 and ‘How Climate Change Could Spiral Out of Control’, p68.) tend to be optimistic. The opponents of appropriate preventive action must realise that a one-metre rise will be sufficient to flood most of New York City, including the entire subway system and all three major airports. New York, like many of the world’s largest cities, is situated along the coast. The population densities of China’s eleven coastal provinces average more than 600 people per square kilometre. Already nearly 40 per cent of the world’s population lives within 100 kilometres of a coastline and more and more people are moving to coastal areas which are being increasingly degraded.

*According to the Organisation for Economic Co-operation and Development, economic damages and losses arising from climatic destabilisation could cost the global economy up to \$970 billion – on the basis of the present models which, as we have seen, tend to be optimistic.*

Let us not forget too, that the biggest industry of the world today is tourism. Most of it is in coastal areas and brings in billions of dollars in revenues every year<sup>2</sup>. It would be foolish to suppose that tourism would not be affected by the consequent flooding of most of the beaches bordering tourist resorts, or by drastic heat-waves, water shortages and recurrent storms of greater and greater intensity, not to mention the effect on winter sports of retreating glaciers and ever thinner snow at ski resorts.

It would be equally foolish to suppose that the growing hordes of refugees (see ‘The Looming Refugee Crisis’, p96) will not affect the economy. It is only a question of time before state services are overwhelmed by a vast population of destitute people in the cities. The corresponding increase in crime and social disorder is very likely to interfere with commercial activities.

The insurance industry is particularly vulnerable of course, and is becoming seriously concerned about what the future holds out for them. As Jeremy Leggett, who made a special study of this issue when he was Science Director of Greenpeace, notes, “Given only a slight increase in the scope for windstorms, drought-relat-

ed wildfires, and floods, the \$2 trillion insurance industry would be in danger of global collapse, with knock-on economic consequences which are completely ignored in most analyses of climate change.”<sup>3</sup> Property-catastrophe losses have already been enormous in recent years. 1992 was, at the time, the worst year ever, with global climatic natural catastrophe losses of over \$22 billion, up 87 per cent on 1991, even allowing for inflation. 1993 was also



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*As Jeremy Leggett notes, "Given only a slight increase in the scope for windstorms, drought-related wildfires, and floods, the \$2 trillion insurance industry would be in danger of global collapse, with knock-on economic consequences which are completely ignored in most analyses of climate change."*

Fire ravages a suburb of Los Angeles, at huge financial cost.

### Infrastructural damage following a hurricane in Western Samoa.

a very bad year for disasters, especially flooding. In 1995, weather extremes caused \$100 billion worth of damage, the highest figure ever, in 1996 the figure stood at \$60 billion,<sup>4</sup> and in 1998, costs to insurance companies rose to \$90 billion,<sup>5</sup> and it can only get worse.

"Comparing the figures for the 1960s and the last ten years, we have established that the number of great natural catastrophes is three times larger," says Dr Gerhard Berz, Head of Geoscience Research at Munich Re, the world's largest reinsurer. "The cost to the world's economies after adjusting for inflation is nine times higher, and for the insurance industry three times as much".

According to research by Munich Re, there were more than 700 so-called 'large loss events' around the globe in 1998. These accounted for 85 per cent of economic losses and killed around 50,000 people. The most frequent natural catastrophes were windstorms, of which there were 240 significant ones, and floods, of which there were 170. In 1995, the previous most calamitous year, there were 100 fewer large loss events. In Britain the losses from flood damage for 1998 may top £1 billion – "the worst floods anyone can remember, and happening twice within one year," says one observer.

Munich Re clearly fingers global warming as the culprit for the extreme weather that has caused these mounting losses. Dr Gerhard Berz argues that a "further advance in man-made climate change will almost inevitably bring us increasingly extreme natural events and consequently increasingly large catastrophe losses."

Julian Salt, a disaster assessment expert at the Loss Prevention Council, says "the reinsurance pool contains between \$200bn and \$300bn. A couple of big storms in the wrong place – major cities on the US mainland, for example – could pretty much wipe that out." At the very least, he says, this would cause major dislocations to the world economy as insurers, facing heavy losses, pulled in their horns. Insurance companies are major investors in pension



GERARD AND MARGI MOSS/STILL PICTURES

funds that contribute around a third of the capital in world financial markets. If they were to collapse then the effects on the economic system would be devastating.

The insurance industry's dire prospects clearly augur ill for every sector of the economy, including manufacturing industry. Industrialists who still insist on opposing and preventing any action from being taken, on the grounds that it would cost too much, should enter the real world and wake up to the fact that the costs inflicted upon them through inaction will be enormous. If greenhouse gas emissions are allowed to continue to rise and global warming run its course, we will be facing by far and away the greatest catastrophe that our species has ever faced. *Whatever may happen to the economy, what is absolutely certain is that we cannot live without a relatively stable climate* and in particular one to which we and all the other forms of life with which we share this planet have been adapted by their co-evolution. To continue, therefore, to destabilise climate in order to satisfy what are referred to as economic requirements (but which in effect are those particular economic requirements needed to satisfy the immediate interests of the large transnational corporations that have come to dominate the economy), is at once an absurdity and a crime. Those who control these corporations, the governments,

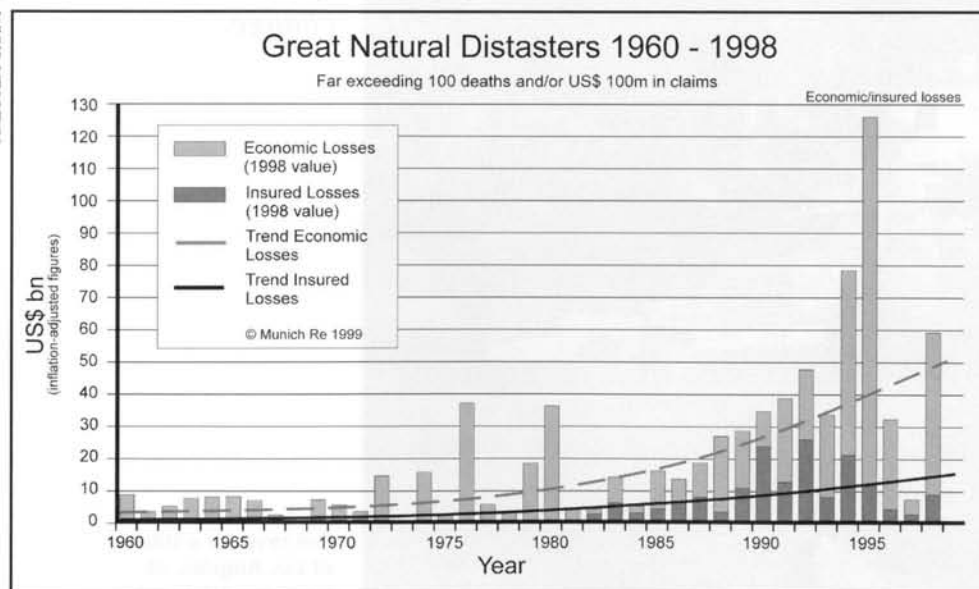
and the public at large, must recreate an economy that can function satisfactorily without disrupting our climate and indeed without continuing to pillage the natural world on whose integrity a stable climate ultimately depends.

Caspar Henderson is a writer and analyst based in Oxford, UK.

### References:

1. Anne Platt McGinn, in Lester Brown and others, *The State of the World 1998*, Worldwatch, Washington DC.
2. Anne Platt McGinn, p.78 *The State of the World 1991*, Worldwatch.
3. J Leggett (Ed), *Climate Change and the Financial Sector*, Munich, 1996, p.42.
4. *Ibid*.
5. Source: Munich Re – the world's largest reinsurers, *The Guardian*, 30.12.1998.

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A grayscale map of Ecuador with a white circle highlighting a specific location in the northwestern part of the country. The text "project area" is written above the circle, and "Ecuador" is written below it.

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# Wildlife in Danger

— BY SIMON RETALLACK —

*The rate of human-induced climate change is occurring faster than wildlife has had to deal with for over ten thousand years,<sup>1</sup> and there is a very real prospect that many natural ecosystems and individual species will not be able to adjust fast enough.*

Participants of the 1987 Villach Climate Conference were of the opinion that a global mean temperature rise of about 1°C per century was about the limit to which most ecosystems could adapt, and even then, they would not be able to do so indefinitely. The 1990s have so far been about 0.5°C warmer than the 1961-90 average,<sup>2</sup> and on a business-as-usual scenario global temperatures are set to increase by an average of at least 3°C over the next century.<sup>3</sup> Climate change is set to give rise to huge ecological instability, leading to vast migrations, population explosions (largely of micro-organisms, including human pathogens), as well as to sharp increases in the already alarming rate of extinctions, as species are less able to adapt to one another or to their habitats.

Wetlands will be adversely affected by droughts, threatening many bird species. Sea-level rise, combined in some cases with developmental pressures, will result in "about 40-50 per cent of the world's coastal wetlands being lost"<sup>4</sup> by the 2080s, according to the UK's Hadley Centre – a staggering loss. Under threat include the vast tracts of tidal mudflats, salt marshes and sand dunes of the Netherlands, Germany and Denmark which are the feeding and recuperating grounds for many migrating birds and which contain 50 per cent of the world's population of Brent Geese. Also threatened by rising sea-levels are the wetlands of the Mediterranean, the deltas of the Nile in Egypt, the Camargue in France, the Po in Italy, the Ebro in Spain which is lived in or visited by more than 300 species of birds,<sup>5</sup> and at least 13,000 hectares of English shoreline, much of it vital wildlife habitat, which according to English Nature will disappear in the next 20 years.<sup>6</sup> Climate change is also predicted to lead to the disappearance of the mangrove forests of the west African coast, east Asia, Australia and Papua New Guinea, which act as breeding and feeding grounds for many fish and other marine and bird species. Given only a slight warming of tropical waters, coral reefs – the

second most diverse ecosystem on the planet and the very foundations of many nations – face ecological holocaust. Many other marine ecosystems are under immediate potential threat as waters warm, with grave implications in particular for already stressed fisheries.

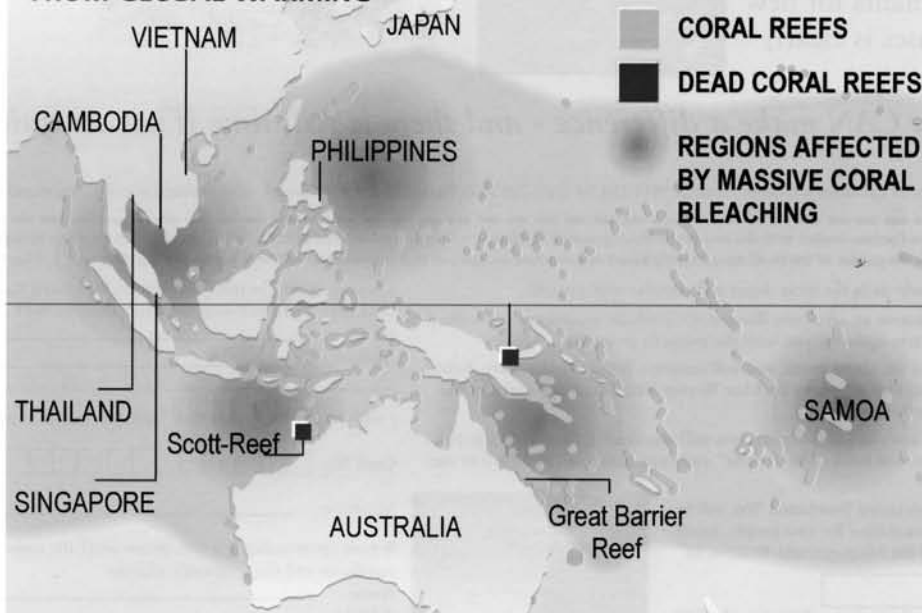
The vegetation of a third of the world's forests may also undergo major changes. According to recent research by the Hadley Centre based on its new climate model, by the 2050s tropical forests, home to between 50 and 80 per cent of the world's animal and plant species, will die back in many regions, most notably in northern Brazil because of decreases in rainfall of up to 500mm per year and increases in temperature of up to 7°C. In other areas of the world such as India, Africa and North America, tropical grasslands will be transformed to desert or temperate grassland. Temperate grassland will also expand into regions of Europe and North America which are currently dominated by temperate or coniferous forest, resulting in significant loss of productivity and biomass. By contrast, there is likely to be a northwards expansion of coniferous and temperate forest in both North America and Asia.<sup>7</sup>

As far as individual species are concerned, most vulnerable to climate change are thought to be those high in the food chain such as whales, polar and grizzly bears, Indian tigers and giant pandas. In developed countries, in particular, there is limited land available for other species to migrate into. And even if there is open land, other factors such as soil conditions and food supply may not be suitable. Species at the limit of their range may be lost if they are unable to migrate to cooler latitudes because of barriers such as oceans or the lack of higher elevations.

Climate change is already affecting ecosystems and wildlife populations around the globe. In southern Siberia and Alaska large tracts of forests (over 1.7 million hectares in Alaska alone<sup>8</sup>) are dying off as various insect forest pests expand their ranges north-

As the world's oceans warm, coral reefs are dying on a massive scale, their skeletons bleached white, devoid of life.

## CORAL REEFS UNDER ATTACK FROM GLOBAL WARMING





ward in response to changes in temperature and moisture. In Alaska, warmer temperatures are inflicting another injury: some stands are drowning as the trees sink into the melting permafrost,<sup>9</sup> which together with the thawing Alaskan Tundra is releasing the methane and CO<sub>2</sub> that it has absorbed over thousands of years, back into the atmosphere. Warming is also triggering the retreat of most of the world's glaciers, at accelerating rates. Twenty years ago, the largest glacier in the Peruvian Andes was retreating by 4 feet a year; today it is shrinking by 99 feet a year.

Of equally great concern is the recent disclosure that high sea temperatures have killed most of the coral reefs in the Indian Ocean, western Pacific and eastern Pacific. Corals in the Caribbean and Brazil have also been badly damaged. As the foremost world expert on corals, Dr Thomas Goreau, has said, "This is an unprecedented disaster. The corals cannot take any more. If global warming goes on we will lose all our reefs and the life that

*Climate change is set to give rise to huge ecological instability, leading to vast migrations, population explosions (largely of micro-organisms, including human pathogens), as well as to sharp increases in the already alarming rate of extinctions, as species are less able to adapt to one another or to their habitats.*

depends on them."<sup>10</sup> This is also a disaster for many developing countries because about one-ninth of the world's annual fish catch comes from coral reefs. Warming has had another devastating impact for marine life. In 1995, researchers discovered that warming waters had led to a 70 per cent decline in the population of zooplankton off the coast of southern California, creating an ocean wasteland and jeopardising the survival of several species of fish.<sup>11</sup>

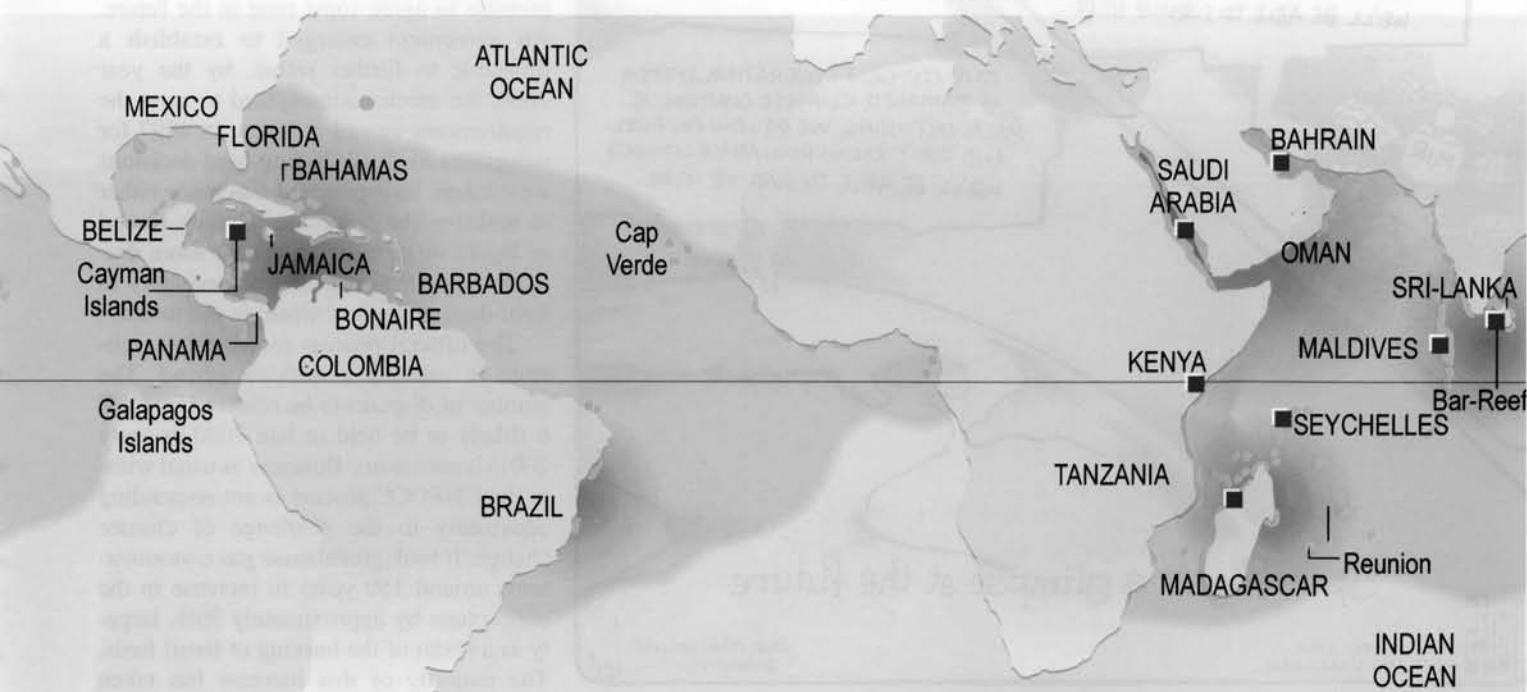
Just as revealing is the impact of climate change on other individual species. As Dr Frances MacGuire of Friends of the Earth, says: "Like the canary used by miners to indicate danger underground, mounting evidence shows that wildlife is acting as an early warning of changes in the Earth's climate."<sup>12</sup> Described in the *New Scientist* as "the first clear victim of global warming",<sup>13</sup> Edith's checkerspot butterfly is vanishing from southern latitudes and low altitudes in Canada, western USA and Mexico, as conditions are too warm for the host plant on which it depends. Simi-

larly, the Golden and Harlequin Toads have become locally extinct in rainforest in Costa Rica because of decreased rainfall.<sup>14</sup> Toucan populations in Costa Rica have retreated to higher elevations due to changes in rainfall and temperature,<sup>15</sup> and there have been sharp declines in the numbers of the Adelie Penguin in Antarctica because of a reduction in pack ice.<sup>16</sup>

We are even altering the timing of the seasons – in the US, spring appears to be arriving three weeks early.<sup>17</sup> In the UK, 20 bird species, whose natural life cycles are controlled by natural triggers such as temperature, have been observed to nest an average of nine days earlier,<sup>18</sup> and early leafing appears to be taking place in certain tree species in England, such as oak. Furthermore, alpine plants are migrating upwards in the Austrian and Swiss Alps in response to warming temperatures, with the area of suitable habitat available to them diminishing in size. Other indications of the onset of climate change include the confusion of migratory birds, the migration northward of trees and small animals in Canada, and the northward migration of marine organisms in California, all in response to warming air or sea temperatures. These recent changes in climate on wildlife are already sufficient to trigger deep concern about the effects on biodiversity of the larger climate changes forecast for the next century.

#### References:

1. Wildlife in the Greenhouse, Friends of the Earth.
2. The Met Office, UK Climate Impacts Programme Technical Report No.1, 1998, p.v).
3. The Met Office, *Climate Change and Its Impacts*, 1998, p.2.
4. WWF, Keeping the Seas at Bay.
5. *Ibid.*
6. English Nature.
7. *Op. cit.* p.2.
8. BBC Wildlife, September 1998.
9. A.T. Mattoon, Boggling Down in the Sinks, *WorldWatch*, Nov/Dec 1998.
10. T. Goreau, in P. Brown, Coral Alarm Dwarfs Pact to Cut Gasses, *The Guardian*, 13, Nov. 1998.
11. D. Roemmich and J. McGowan, Climatic Warming and the Decline of Zooplankton in the California Current, *Science*, Vol.267, 3 March 1995.
12. WWF and Birdlife International, Climate Change and Wildlife.
13. Edith Butterfly flees north, *New Scientist*, 31 August 1996, p.9.
14. Climate change is believed to have caused a disastrous population crash of amphibians in Costa Rica, with no less than 40% of frog and toad species in a study area of 30 sq km becoming extinct in the past 10 years. Friends of the Earth, UK.
15. Friends of the Earth, UK.
16. Warmer weather has led to a decrease in the frequency of very cold winters when heavy sea-ice occurs, leading to a decrease the numbers of Adelie Penguins, probably because suitable feeding sites are too scarce or distant. Friends of the Earth, UK.
17. *Wildlife in the Greenhouse*, Friends of the Earth, p.2.
18. Friends of the Earth, UK.



# The International Politics of Climate Change

— BY CHARLIE KRONICK —

*International progress to prevent serious climate change is being achieved at a grossly inadequate rate. But, as long as negotiations continue to be based upon the polarised positions of power politics and a persistent reluctance to embrace radical change, global greenhouse gas emissions will go on rising.*

The Fourth Conference of the Parties of the Framework Convention on Climate Change (COP4 of the FCCC) took place in Buenos Aires in November 1998. It was the next step in the official process to protect the climate from anthropogenic (human-induced) climate change, following and building on the agreement reached in Kyoto in December 1997 – the Kyoto Protocol – committing Governments in the developed world for the first time to legally binding obligations to reduce six greenhouse gases. In the run-up to COP4 at least two polarised visions of political reality had emerged.

One was the fundamentally “Northern View”: the next steps in protecting the climate required two things. The first was a means of ensuring the eventual participation of the developing world in greenhouse gas emissions reductions. The second was the development or refinement of the mechanisms that would begin the slow incremental reduction of those gases without causing undue financial hardship to those developed countries making the cuts. The other position can be characterised as the “Southern View”: that the current state of the negotiations continues to deny to the developing world their right to benefit equally from the protection of what is a common resource belonging to the entire global population: the atmosphere. The challenge for COP4 was to unite those two visions.

## Progress at Kyoto?

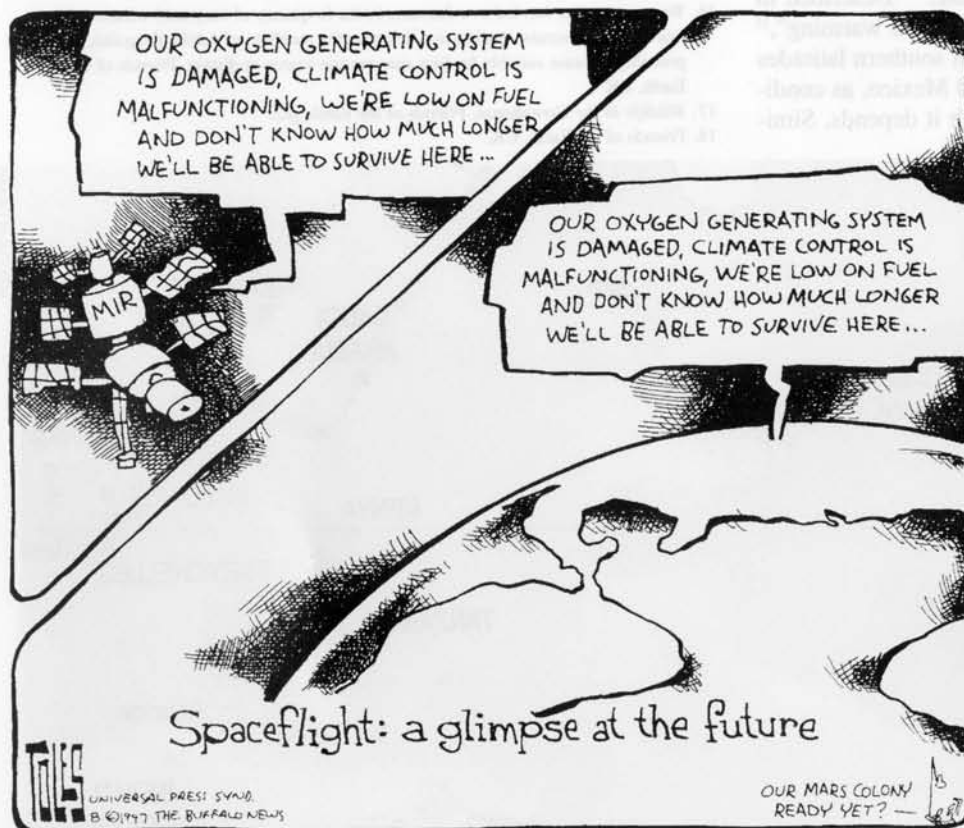
Yet as the smoke clears and the hundreds of negotiators and lobbyists return to their respective homes from COP4, is that unity of vision any clearer? The complex rituals of the climate negotiations are not converging on consensus. First, examine the concrete results of the meeting: in spite of a deepening knowledge of the increasing damage to the climate system, action to reduce emissions of greenhouse gases is not accelerating. The reverse is actually true – in both the developed and developing worlds, emissions are currently increasing.

Under the Kyoto Protocol, whilst developing countries are not obliged to accept any emission reduction or stabilisation targets, the industrialised world collectively agreed to a cut of just 5.2 per cent below 1990 levels by 2012, with the European Union agreeing to a reduction of 8 per cent, the USA 7 per cent, Japan and Canada 6 per cent and Australia winning an *increase* of 8 per cent. Even if these targets are to be achieved, when emissions from developing countries are added to those of the industrial countries, the global total is projected to increase to some 30 per cent *above* 1990 levels by 2010 and by 2020, emissions are projected to be up by 60 per cent, even with compliance. These figures are likely to be higher still given the potential loopholes built into the Kyoto Protocol, such as emissions trading and sink accounting (see box on page XX) that could allow industrial nations to inflate their emissions.

## Achievements at Buenos Aires?

The Buenos Aires Action Plan is in fact a promise to agree some time in the future. An agreement emerged to establish a timetable to further refine, by the year 2000, the mechanisms agreed to meet the requirements agreed at Kyoto in 1997 for reductions by 2012. But no hard decisions were taken; little progress was made either in realising the reductions already agreed in Kyoto or in reaching the far more dramatic reductions that will be necessary to limit damage to the climate in the future.

The official process to protect the climate is entering a difficult period. The number of disputes to be resolved by COP 6 (likely to be held in late 2000 or early 2001) is enormous. Business as usual within the UNFCCC process is not responding adequately to the challenge of climate change. It took greenhouse gas concentrations around 150 years to increase in the atmosphere by approximately 30%, largely as a result of the burning of fossil fuels. The majority of that increase has taken





place in the last 50 years. It will take nearly another 13 years of negotiations to reduce *emissions* of greenhouse gases by around 5 per cent. Concentrations will still continue to rise into the next century. Can this be characterised as success?

*In spite of a deepening knowledge of the increasing damage to the climate system, action to reduce emissions of greenhouse gases is not accelerating. The reverse is actually true – in both the developed and developing worlds, emissions are currently increasing.*

Probably not, yet in the wake of COP4, John Prescott, UK Deputy Prime Minister – representing one of the most “progressive” governments engaged in the climate change negotiations, and Stuart Eisenstadt, the chief US negotiator – speaking for unquestionably the most retrograde – both hailed the progress achieved. “The important steps were taken”; “the process is still on track”.

In truth the political process to protect the climate is becoming increasingly arcane, not just because all global negotiations are

complex, but because they are now based on an increasingly complex set of assumptions. Initially, these assumptions were simple opposites: “global warming” was “real” or it was an unproven theory, supported by ecological extremists who wanted to disrupt the global economic system. Now the gradations of belief are beginning to rival those of the medieval church. In addition to the nay-sayers, there are those who have turned to “voodoo economics”. For them it doesn’t matter if climate change is real, it is simply “too expensive” to reduce emissions. This group is largely located in the industrialised north – principally North America – and is committed to maintaining the global industrial and economic status quo. In the parlance of the poll tax riots in the UK in the late 1980s: “Can’t act, won’t act”.

Further along the continuum are the more progressive industrial interests, still largely in the North, who have identified business “opportunities” largely within the Kyoto Mechanisms. These instruments were formerly known as the “flexible mechanisms”, but the word flexible has been dropped, largely for its negative connotations: flexibility was perceived to be equivalent to prevarication. Emissions trading, joint implementation, the Clean Development Mechanism (CDM) all provide institutions as varied as the Sydney Futures Exchange, Shell, BP and the World Bank with

## The Flexible Mechanisms

The flexible mechanisms – emissions trading, joint implementation, the clean development mechanism and the use of carbon sinks to meet obligations to reduce emissions – were essential to ensure and maintain the participation in the Kyoto negotiations of the United States – the largest single emitter of greenhouse gases – as well as Canada, Japan, Australia and New Zealand.

These measures add up to a global market in carbon emissions and have subtly changed the attitudes of some of the participants in the climate change debate, especially those in business. Perhaps the single most important feature of the flexible mechanisms is the ability to provide overall cost savings to the developed countries that use them. What are the characteristics of the various mechanisms, and some of their potential drawbacks?

### Joint Implementation and the Clean Development Mechanism

These initiatives are intended to allow credit to be claimed in one country for measures implemented elsewhere. This was proposed in the spirit of economic efficiency: if it was more “cost effective” to invest in CO<sub>2</sub> reduction abroad, then why not address the problem in those countries first? Such “Joint Implementation” (JI) is only to be allowable between developed countries, that is where both parties would be required to make reductions in any case. JI projects must result in savings that are “additional to any that would otherwise occur” and JI credits will be “supplemental to domestic actions.”<sup>1</sup> The body and means of deciding what is or is not “supplemental” or “additional” was not

defined in the Kyoto Protocol.

The “Clean Development Mechanism” (CDM) is a form of joint implementation that allows developed countries to institute projects in countries without legally binding emission obligations, not just to accelerate sustainable development in those countries, but also to be credited towards “part” of emissions reductions in the industrialised country contributing to a project. Like JI, the projects and reductions must be “additional” to what would have been achieved otherwise. Also like JI, the details of how this is to be determined still need to be decided. The CDM is intended to be “certified” on an individual project basis by “operating entities”. While these operating entities too are undefined, CDM projects are intended to create emission credits for the developed country partner from the year 2000.

### Emissions Trading

Trading can be described as another “low-pain option” for those industrialised countries unable or unwilling to commit to carbon reductions at home in the short term. The complexities of such a regime are undeniable. Who can trade with whom, what percentage of a country’s reductions may be achieved by trading, which greenhouse gases can be traded, what body regulates and verifies the trading regime – these and many other variables were not resolved in Kyoto and have been the subject of vigorous debate in many fora since Kyoto, continuing at COP4 in Buenos Aires; and will now carry on until COP6 in the year 2000 or 2001.

As currently defined, the central feature of an emissions trading regime will allow

for notional pollution reductions, where *country one* can “buy” the “unused” emissions of *country two*. In the period up to 2012, this ‘hot-air’ trading could actually lead to an increase in global emissions.

Under the protocol, Russia and the Ukraine secured the right to stabilise their emissions at 1990 levels by 2012. Since their economies collapsed after 1990, Russia and the Ukraine’s emissions are currently far below 1990 levels. On paper, these two countries will thus be allowed to increase their emissions by 50 and 120 percent respectively by 2012.<sup>1</sup> However, their industries will not conceivably be able to grow this fast. Instead, they will be able to sell much of that entitlement to other countries. The United States has already made clear its intention to purchase this ‘hot air’ in order to achieve up to 75 per cent of its reduction requirement.

If the Russia-US deal goes ahead, emissions that were avoided are simply going to be traded back into the atmosphere, with no actual emission reduction taking place. It could even enable the United States to turn the notional seven per cent cut in emissions to which it has signed up to, into a real increase of up to ten per cent.<sup>2</sup> The selling countries would not even have to invest the money they received from the sale into developing renewable or cleaner sources of energy and thereby avoid future greenhouse gas emissions.

### References:

1. In C. Flavin, Last Tango in Buenos Aires, *WorldWatch Magazine*, Nov/Dec 1998, p.15.
2. In F. Pearce, Playing dirty in Kyoto, *New Scientist*, 17 January 1998.

visions of new global markets from which to profit. Then come the developing countries or interests within those countries who see opportunities for an increased cash-flow from North to South, notably through the CDM.

Interest groups in the South are willing to participate in such deals to boost their expectation for increased development. There are those which feel that any participation in the process by developing countries who bear no historical responsibility for the damage to the climate is to mortgage the prosperity of future generations. Finally, there are the apocalyptic who believe that damage to the climate system is nearly (or already) so great that a catastrophic disruption of the climate system such as a shutting down of the Gulf Stream/deep ocean conveyor system, or the collapse of the West Antarctic ice-sheet is now almost inevitable. Within that range the variations continue almost *ad infinitum*.

How does the process of protecting the climate system and the billions of people who depend on it relate to this argument? One thing upon which almost all parties agree is that the process itself is flawed. As long as progress of climate protection is dependent upon the consensus of governments with wildly divergent interests, the chances for success are slim. Why would a member of OPEC – whose GDP and prosperity are derived almost exclusively from the sale of fossil fuels – or the United States – with less than 5 per cent of global population, but responsible for around 25 per cent of global greenhouse gas emissions – converge on an outcome similar to that of a low-lying island state facing inundation by rising sea-levels?

*One thing upon which almost all parties agree is that the process itself is flawed. As long as progress of climate protection is dependent upon the consensus of governments with wildly divergent interests, the chances for success are slim. Why would a member of OPEC... converge on an outcome similar to that of a low-lying island state facing inundation by rising sea-levels?*

Different assumptions support different outcomes. Yet OPEC can – and did – equate reduced fossil fuel revenues to inundation by rising sea level as an “adverse effect of climate change”. The meeting in Buenos Aires was nearly derailed as a result. Is it any wonder that some question the value of the Framework Convention on Climate Change and its attendant protocols? It is based upon power politics as crude as those of the Cold War, or more recently of the establishment of the GATT and the WTO, and is possibly less relevant to the global political process.

If negotiations continue on the basis of “real politik”, the dri-

As political progress on climate change proceeds at a snail's pace, the frequency and violence of hurricanes such as this are increasing rapidly.



NASA/STILL PICTURES

ving motivation will be to keep the process alive, much as it was in the run-up to Buenos Aires. An agreement can be reached, but not enough will be done to protect the climate or vulnerable ecosystems, communities or populations. Hence the contrasts between the emissions reductions currently agreed – 5.2 per cent reduction from the developed world – and those required to protect the climate – immediate cuts of 60 per cent to 80 per cent.

What then are the options still available to those interested in climate protection? While the procedures designed to protect the climate are probably flawed, the central principle driving the treaty is sound.

The UN Climate Convention has a clearly expressed objective:

*The stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.*

The Convention also begins to detail how this might be done:

*Governments party to the convention will agree measures that would protect the climate, “within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner”.*

There is a wealth of technologies, including energy-efficiency technologies and sources of renewable energy such as wind and solar power, already available. With many more on the near horizon of commercial viability, dramatic reductions of greenhouse gas emissions in the first decades of the next century are clearly plausible. But the issue of climate change is not just technical or environmental: it is political.



Decisions taken now, on the implementation of FCCC, will be as significant for their context as for their content. The decision not to act to reduce emissions, or to act slowly, or to expend more time and energy on developing a profitable market in carbon emission futures than in actually protecting the climate, needs to be clearly mapped out to retain any political credibility or the remote chance of effectiveness. Regardless of assumptions, in the physical world of the atmosphere, there are environmental limits to the

*If negotiations continue on the basis of "real politik", the driving motivation will be to keep the process alive, much as it was in the run-up to Buenos Aires. An agreement can be reached, but not enough will be done to protect the climate or vulnerable ecosystems, communities or populations.*

climate system. Yet on the basis of recent experience, while knowledge of the climate system may continue to deepen, the political process designed to protect the climate is unlikely to accelerate as a result. In a world dominated by information, arguments are rarely won by the aggregation of "facts." There are simply too many "facts" in circulation.

It's time for the recognition that these processes are driven by

values as well as by science. The FCCC may represent the only global institution for dealing with the global problem of climate change, but as an instrument, it appears increasingly unlikely to achieve its fundamental goal. Unilateral actions by more progressive governments, the formation of mass movements, of powerful new regional alliances made up of interest groups that cross national or even regional boundaries, including environmental, religious, labour, farmer, consumer and insurance groups, are likely to emerge as the drivers of global environmental progress, if it is to emerge at all. We should not despair. Before the phenomenal growth of the personal computer, world computer "experts" famously rated the potential global market for computing equipment as highly limited. The "experts" were not just proven wrong, but very nearly irrelevant; the information world has been transformed beyond all recognition. In the future, the same will be said of revolutionising means of generating energy. The situation facing the institutions responding to global climate change is not strictly analogous, but unless a transformation of similar magnitude takes place, the outcome of the process is likely to be at best deeply unfair and at worst catastrophic.

Charlie Kronick is the Director of Climate Action Network, UK.

#### Reference:

1. United Nations, 1997, Kyoto Protocol to the United Nations Framework Convention on Climate Change Article 6, FCCC/CP/1997/L.7 Add.1.

## Sink Accounting: a Potential Kyoto Loophole

A central source of concern with the Kyoto Protocol revolves around the issue of 'sinks' – those natural processes that absorb more carbon than they give out. The Kyoto Protocol allows countries to count such carbon absorption by forests, and perhaps later by agricultural soils and other carbon sinks, as offsets against CO<sub>2</sub> emissions. Under the agreement, each industrialised country's net total emissions will be calculated by subtracting the amount of carbon absorbed by forestry and land-use change from each country's gross emissions. Countries will thus be able to claim credit for any increase they make to their carbon sinks. Put another way, a country that plants trees to absorb carbon dioxide can emit that much more CO<sub>2</sub> from burning fossil fuels.

This approach is extremely politically convenient. Since forest cover is increasing in most industrialised countries, including forestry will almost always produce a lower emissions figure. Already, the chair of President Clinton's Council of Economic Advisors has told Congress that sinks "could comprise a significant

portion" of the country's total required emissions reduction. Such an approach will no doubt be encouraged by a recent, controversial article published in *Science* magazine which claims that forests in North America could be sinking as much carbon as the continent emits.

These developments are all the more worrying because, as biologists point out, there is not yet enough data on natural carbon cycling to establish full accounting and verification procedures for carbon sinks. The science simply does not exist to be able to predict exactly how much carbon is being absorbed

by a country's sinks and how long the carbon moving into industrialised-country forests will actually stay there. The proposed scheme for including sinks is likely to be exceedingly complex and could become even more so if countries such as the US get their way and succeed in including additional sinks in agriculture, range and pasture-lands. This complexity derives from not only uncertain science but also from accounting maze which complicates monitoring and enforcement and could encourage governments to fiddle with the figures. Furthermore, rather than

saving the world's existing forests, the sink provision contains the potential to create perverse incentives to cut down old growth forests and jeopardise other natural ecosystems. In response to these concerns, the provisions on sinks have been sent back for scientific review, which is to be completed by 2000.

Of course, if the sink provision in the Protocol ends up being implemented in such a way that encourages practices that would protect and extend the world's forests and diverse ecosystems then all well and good. But if it simply becomes a creative accounting mechanism for ratifying business as usual, then little will have been accomplished and the legitimacy of the Protocol itself may be undermined. A potential loophole will have been built into an agreement that may already be too weak to accomplish its ostensible purpose.

Adapted from an article in the Nov/Dec 1998 edition of *Worldwatch* magazine by Ashley Mattoon – staff researcher at the Worldwatch Institute and contributing author to the Institute's two annual publications, "State of the World" and "Vital Signs."

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The conference hall where the Kyoto climate change negotiations took place in 1997.

# The World Bank: Funding Climate Chaos

— BY DAPHNE WYSHAM —

*Over the past six years the World Bank has spent billions of dollars in developing countries on fossil fuel-related projects that will contribute nearly double the amount of carbon dioxide emitted by all the world's countries in 1996. Now the bank hopes to profit from these very emissions by entering the market in emissions trading.*

The gathering in Buenos Aires in early November was supposed to be about climate change, but it felt more like a trade show. Instead of focussing on how to prevent global warming, attendees jostled to get a piece of a lucrative emerging market: trading in pollution credits.

Leading the pack was the World Bank, which has become the largest public financier of carbon-emitting oil, gas and coal projects in developing nations. Not only are the bank's projects contributing to climate change, but the bank is also hoping to double-dip – by funding fossil fuel projects in poor countries at the front end, then reaping financial benefits from the resulting pollution.

The consequence of this daisy chain is to lock developing countries into a fossil fuel energy path, repeating the mistakes of the First World rather than leapfrogging to newer and cleaner energy technologies. And the ultimate consequence is rapid, perhaps irreversible, global climate change.

The World Bank's stated mission is to alleviate poverty and promote sustainable development. Energy consumption is a key indicator of a nation's economic growth, so it is no surprise that roughly a fifth of the World Bank's lending goes toward increasing energy and power supply in poor nations.

What is surprising is that the World Bank is doling out billions of dollars a year for fossil fuel projects – the single greatest contributor to climate change. Between 1992 and mid-1998, the bank has in fact spent 25 times more money in fuelling climate change through fossil fuel projects than in averting it by renewable energy generation. This is despite the bank's acknowledging that climate change is disastrous for poor nations, and that efficiency and

renewable resources such as solar power are the best ways to serve the two billion rural poor worldwide who have no electricity.

Nevertheless, more than three-fourths of its energy loan portfolio is devoted to fossil fuels. Since the Rio de Janeiro Earth Summit in 1992, the World Bank has spent \$13.6 billion on coal mines, oil and gas fields and fossil-fuelled power plants in developing countries and the former Soviet bloc; an additional \$3.9 billion in loans and credits is pending. And each taxpayer-backed World Bank dollar paves the way for five or six additional dollars in private investment for such projects.

Together, these projects will have a significant impact on the global climate. Fossil-fuel burning from post-1992 World Bank projects will eventually contribute an immense burden of carbon dioxide to the Earth's atmosphere – 38 billion tonnes in total – equivalent to 1.7 times the total emitted by all the world's countries in 1996.

## Profiting from emissions: plan to enter market in trading pollution

It is these emissions from which the bank now hopes to profit. Under a proposal that has been kept tightly under wraps, the bank plans to enter the market in pollution credits – estimated to reach \$150 billion in trading by 2020 – and skim five percent from each trade it brokers. (See Stop Press at the end of this article).

Two types of emissions trading exist under a system approved at the Kyoto climate conference last December. The first is trades between industrialised nations. These nations pledged at Kyoto to reduce their emissions to below 1990 levels by 2008. Some countries have reached this goal already, so they have the "right" to pollute more. They can sell that right to other nations. The climate doesn't know the difference, or so the logic goes.

The second type of emissions trading consists of trades involving a specific project in which two nations co-operate. Under these so-called "joint implementation" deals, one nation gets outside investment and allegedly cleaner technology than it could afford alone. In return, the other does not have to reduce emissions as much within its borders. That might be a good idea – if it worked. But the concept behind emissions trading fails on several counts.

First, the rationale for emissions trading is that fossil fuels are the only economically viable way for developing countries to get the energy they need to grow. Yet already, the health and other costs from burning coal in China are estimated at five per cent of China's gross domestic product. And hurricanes such as Mitch, which are expected to increase in intensity with climate change, cause incalculable damage in countries such as Honduras or Nicaragua.

Second, emissions trading assumes energy services will 'trick-



The Headquarters of the World Bank in Washington DC





RAY PORTNER/STILL PICTURES

**Obscuring the sun: the World Bank is spending billions of dollars on coal-burning power stations such as this.**

le down' to the poor, who will then be able to use that energy for cooking, heating or lighting. In fact, the opposite is happening. That is because some World Bank-supported projects encourage the export of fuel to wealthy nations, such as the pipelines that extract oil and gas from Nigeria and Chad. Others produce power for the urban middle-class or for heavy industry, including energy-intensive industries that migrate to these countries as soon as energy is available and cheap. And the poor, whose energy needs go unmet, continue cutting down trees for fuel – which adds to the problem of global warming.

#### **Incentive to pollute: deliberate inefficiency can boost later profits**

A third problem is that early evidence shows emissions trading may actually increase pollution, by giving parties an incentive to inflate artificially their baseline figures, i.e. the amount of CO<sub>2</sub> they are actually emitting.

The World Bank is already being tempted, internal documents suggest. The bank could exaggerate the progress on carbon reductions by building inefficiency into its own fossil fuel projects, so that the projects (virtually all of which would involve coal-fired power) were not as efficient as they could be, in contravention of the bank's own guidelines. The bank would then provide technology or assistance to make these projects more efficient – as an add-on package – and sell the emissions 'captured' by this technology that would otherwise have been released to a wealthy country like the US. The wealthy country would, in turn, have the 'right' to emit an amount of emissions equivalent to the amount 'captured' by the World Bank's add-on package. The bank would pay the developing country a fee for these emissions, the wealthy country would pay less for 'reducing' emissions than it would at home, and the World Bank would take a five per cent commission

on the overall transaction cost. In this 'win-win' strategy, with the World Bank picking the 'low-hanging fruit' first, the bank estimates it can net \$100 million a year by 2005.

In the real world, how could such a mechanism work? Imagine a situation like that which exists in Nigeria, riddled with corruption, crime and poverty. Who will monitor the emissions 'captured' in some distant swamp of the Niger Delta? Who will ensure that they are actually 'additional' to what would have taken place under any circumstances?

This situation is already being played out in Nigeria itself, where the World Bank is proposing to help finance a gas pipeline from Nigeria's impoverished Delta to power plants in Ghana. The gas fields and pipeline, owned largely by Chevron, will 'capture' emissions that are now being flared because they are too costly to Chevron to re-inject underground, causing harm to the natural environment and public health in nearby communities.

Does Chevron have the right to receive a subsidy for its gas pipeline, in this case from the Clean Development Mechanism (another one of the variations on emissions trading allowed under the Kyoto Protocol), simply because it will no longer be flaring – or burning – gas in the Delta but shipping it off to Ghana? Why don't the nearby communities get compensation for 40 years of gas flaring? This economic logic – equivalent to criminals being paid not to commit crimes – would provide even greater incentives to other companies to follow Chevron's irresponsible example.

Domestically, trading in pollution credits has produced similar problems, with the deliberate creation of inefficiency to boost later profits. Two pioneering efforts in Los Angeles are being challenged in court by environmental justice groups. In both cases, pollution increased as companies raised their baselines so that they could look good later by 'reducing' emissions.

The Los Angeles trading had another side effect: it allowed companies to concentrate pollution in poor neighbourhoods while getting credit for environmental efforts in other arenas. This 'hot spot' phenomenon is already plaguing developing countries like

India, whither energy-intensive industries such as aluminium smelters are migrating to avoid the inevitable ceiling on greenhouse gas emissions in industrialised nations.

That points up a fundamental flaw with emissions trading as the United States and the World Bank envision it: without limits on developing nations' emissions, and without limits on how much industrialised nations can trade, an increase in pollution is inevitable. In other words, carbon trading encourages an unregulated increase in greenhouse gas emissions globally – the exact opposite of its intended outcome.

### **Business perks: companies enjoy fossil fuel benefits**

So why is such a plan being pursued? For the answer, follow the money as it goes round and round, from corporations to politicians to the World Bank and back to corporations.

The biggest beneficiaries of emissions trading will be large global corporations. These are the same corporations that squawked loudly over the Kyoto Protocol, claiming it was unfair because it didn't impose targets on developing countries. Yet they are doing brisk business exploiting fossil fuels in those countries, thus increasing emissions, with the aid of World Bank contracts. Nine out of ten energy projects financed by the World Bank benefit at least one corporation headquartered in the wealthy Group of 7 nations. The G-7's collective financial muscle is extraordinary, accounting for about two-thirds of the global economy. The United States, as the World Bank's largest contributor, has the most influence over bank projects – which it does not hesitate to use.

One way is in contracts from the World Bank, which are big business. For every dollar the US government contributes, it gets \$1.30 in contracts for US-based corporations to build projects in developing countries. Many of these corporations, in turn, are members of the Global Climate Coalition, a powerful US lobbying group that aims to prevent any action by the United States in reducing its own massive greenhouse gas emissions. Although polls show the American public wants strong action on climate change, the coalition does not. Instead, it pushes 'free market' policies such as pollution credits. Now, it is urging the Clinton administration to push for unlimited emissions trading. That way, the companies could make all of their emissions reductions in poorer countries, at one-third the cost of creating cleaner energy at home.

### **Process rolls on: disaster looms worst for the poor**

And so the process rolls on, unchecked. In the past year, the World Bank spent \$1.35 billion on four new coal-fired power projects, the dirtiest of all forms of energy generation, in China alone – a country that already burns more coal than any other. Sources inside the bank say the most recent China project was pushed through in violation of a US law requiring 120 days to assess environmental impact of World Bank projects; it also violated the bank's own less-than-stringent environmental policies.

Moreover, whilst the world's top scientists agree that to burn more than one-quarter of the existing reserves of petroleum means to risk suffering the worst impacts of climate change, the World Bank is assisting the fossil fuel industry in opening up new reserves. In the process it is destroying some of the last remaining pristine and ecologically fragile regions of the planet, home to thousands of indigenous peoples. The bank, for example has recently approved \$310 million towards a massive gas pipeline project running from Bolivia to Brazil. The Bolivian gas fields are to be developed by many of the world's largest fossil fuel companies, including Enron, Shell, British Gas, BHP Petroleum and Exxon.

The bank is also considering a \$370 million-plus package for the development of oil fields in Chad controlled by Exxon, Shell

and Elf-Aquitaine, and a \$200 million pipeline and oil terminal project that would tap into bank-backed fields in Azerbaijan, in which Amoco, Exxon and Unocal are major investors. A proposed Nigeria-to-Ghana pipeline is also being considered by the bank for a \$260 million loan, to the benefit of either Chevron or Shell. In all, the bank has approved over \$5.4 billion in financing for coal, oil and gas extraction and distribution since the 1992 Earth Summit, with another \$930 million under consideration.

The greatest irony is that most of the power and energy projects financed by the World Bank in the name of increasing prosperity are further impoverishing the poor – as illustrated poignantly by the recent Nigerian pipeline explosion that killed hundreds of people, mostly women and children, as they scavenged for fuel. The world's poorest citizens have also been affected most mercilessly by homelessness, crop failure, disease, hunger and death as a direct consequence of extreme weather phenomena – expected to increase in a warmer world – such as the recent flooding in Bangladesh and hurricanes in Central America.

Meanwhile, World Bank loans are lining the pockets of undemocratic Third World regimes and the richest and most powerful corporations, many of whom oppose any action on climate change. And the bank, which should be jump-starting the global market for clean and renewable energy, is instead using our tax money to create a self-fulfilling prophecy of rising greenhouse gas emissions, dirty profits and rapid climate change.

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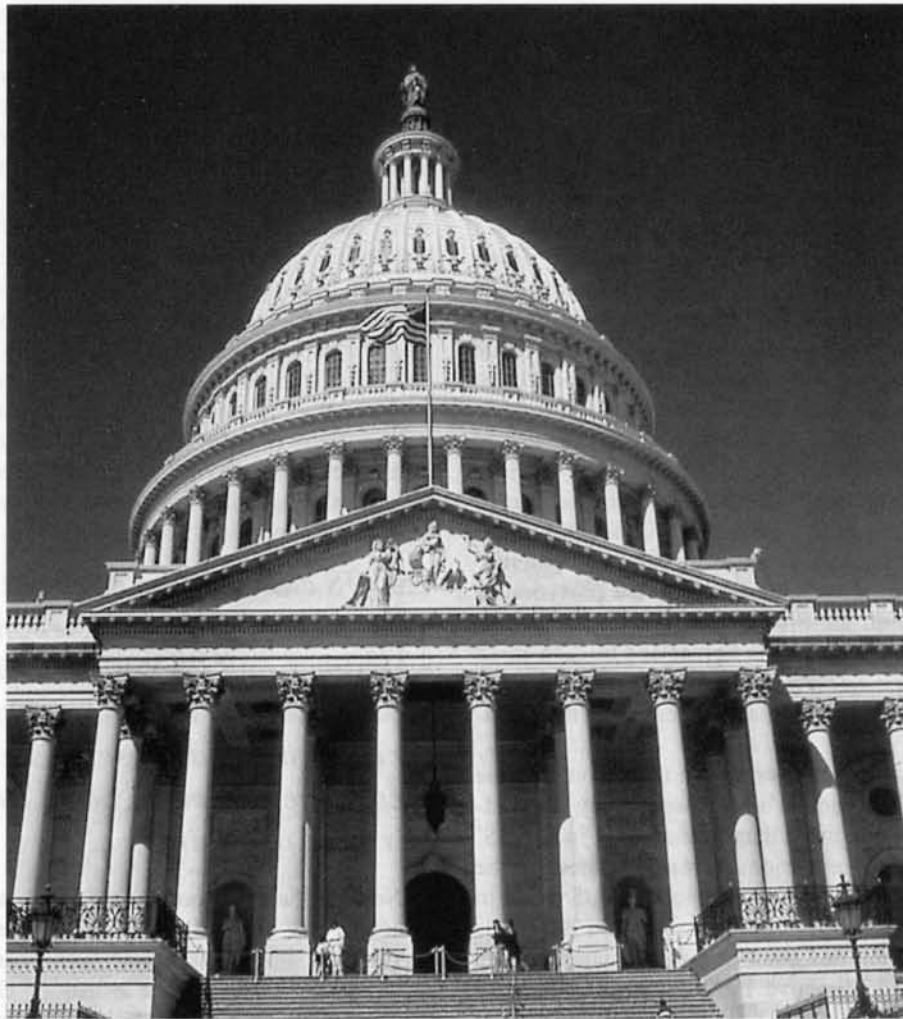
**STOP PRESS.** As this article went to press, the World Bank began to meet with NGOs, explaining their plans for the Prototype Carbon Fund (PCF) in greater depth. Bank staffers claim their privately proposed five percent commission for the PCF is now to be replaced by a net loss for the World Bank. They also claim that the PCF will likely conclude operations in 2012, but that there "is a possibility we would keep on running the Fund" beyond that time. Bank staffers also claim that PCF projects would typically be renewable in nature, contradicting earlier internal Bank memos. Finally, Bank documents recently released on the PCF suggest the pivotally important certification of emissions reductions will be characterised by a lack of transparency and accountability to civil society in the interests of business confidentiality.

## **Hold the World Bank to Account**

The World Bank's plans to "jump-start the market in carbon globally" have now been put on hold until June. To take action on this issue, please write to the World Bank and call on it to take the following steps:

- Openly calculate greenhouse gas emissions which will be released as a consequence of all World Bank lending before project approval, with transparent guidance for this methodology provided by the IPCC.
- Set an immediate benchmark for reduction of greenhouse gas emissions associated with projects for which the World Bank provides financing of 10 per cent per year.
- Institute a moratorium on lending or guarantees for any project that involves new exploration for fossil fuels.
- Phase out lending and guarantees for any projects that involve coal and oil extraction.
- Beginning in 1999, devote at least 20 per cent of its energy- and power lending portfolio to renewable energy and energy-efficiency projects, increasing the amount of finance it provides for such projects by 10 per cent per year, and create an energy-efficiency unit to help bolster its energy efficiency work.
- Drop its plan to take on the dual role of energy financier and emissions trader; it must avoid this and other implicit conflicts of interest in an issue as critical to all of us as climate change.





REX FEATURES

# How US Politics is Letting the World Down

— BY SIMON RETALLACK —

*When it comes to climate change, much of the US political establishment still has its head in the sand, oblivious to the tide that's coming in. To discover why, and what the prospects are for change, the author talked to some of the people most involved in shaping US policy on this issue, in the White House, Congress and the environmental community.*

There can be no satisfactory solution to the problem of escalating climate change without the full and active participation of the United States. With only four per cent of the world's population, the US is responsible for nearly a quarter of total global greenhouse gas emissions. Per capita, the US emits five times the global average, more than any other country in the world. Failure to take meaningful action to reduce US emissions and to ratify the Kyoto Protocol would therefore be hugely damaging. Coming from the world's leading economy and last remaining superpower, such behaviour would send a disastrous signal to the rest of the world that inaction is an acceptable response. The

international treaty process would collapse and dangerous climatic disruption would be the inevitable consequence. The nature of the United States' political establishment's response to the problem of climate change is necessarily therefore of great consequence to the rest of the world.

## **The Clinton administration's record**

It is widely acknowledged that Bill Clinton and Al Gore are the first political leaders of the United States to have publicly recognised the seriousness of the problem of climate change. As their senior advisor on international environmental issues, David San-

dalow,<sup>1</sup> says, "I don't think there are any leaders on this planet who know more about the issue [of climate change] than Bill Clinton and Al Gore." As a result, Sandalow claims, climate change is "a top presidential priority".

The Clinton Administration has had some success in establishing the legitimacy of the problem of climate change amongst the American people over the past two years. And in US diplomacy, David Sandalow maintains that climate change has "reached a level reserved for the other truly great issues of our age". There have also been a number of worthy domestic initiatives. The Administration has established a new 'partnership' with the US' big three car manufacturers (Ford, GM and Chrysler) to produce cars that achieve 300% the fuel efficiency of today's models by the year 2001, and, to encourage their purchase, a \$3000 tax credit will be provided. Clinton has also increased public investment in mass transit systems and renewable energy and energy efficiency programmes, bringing the total to be spent on climate change efforts in 1999 to \$1 billion – a 25% increase. In June 1997, Clinton announced the goal of placing solar energy panels on one million roofs around the country by 2010, aided by the provision of low-cost loans, and in 1998, the President launched the 'PATH' project to cut energy use by 50% in new homes and by 30% in 15 million existing homes. The Administration has also set new standards in equipment and appliances that will enhance their efficiency.

Whilst these initiatives are praiseworthy in themselves, as the sum total of the Federal Government's programme they stand little chance of making anything more than a small dent in the US' rapidly rising greenhouse gas emissions. Even measured by the yardstick of fulfilling the voluntary commitment the US made in Rio in 1992 to reduce its greenhouse gas emissions to 1990 levels by the year 2000, US policy has been an unambiguous failure. Emissions currently stand 13% above 1990 levels and are set to reach 30% above 1990 levels in only 11 years. The Administration of course claims that it has "managed to knock off emissions from where they would otherwise have been" and "would have liked" to do more. But there is no escaping the reality that the measures it has taken have been, in the words of Brent Blackwelder, Director of Friends of the Earth USA and seasoned Washington observer, "woefully inadequate".

Most of the Administration's measures to address climate change are voluntary – consisting of relatively weak public-private partnerships (which industry loves because it makes them look green without costing anything), with optional reporting and no government authority to decree mandatory measures. In the electric utility sector, which is responsible for a third of all US CO<sub>2</sub> emissions, there is no requirement at the federal or state level for distribution companies to purchase portions of renewable power for their electricity portfolios (although the Administration is "supportive" of the idea), and no levy on fossil-fuel-based electricity. Renewable incentives are therefore far too weak, explaining why the proportion of the total amount of electricity currently generated in the US from renewable sources is less than 3 percent, a figure which the Clinton Administration only aims to increase to 5.5% by 2010.

The situation is further exacerbated by the fact that the US continues to subsidise the fossil fuel industry directly by more than \$18 billion a year<sup>2</sup> and to provide it with tax breaks for exploration, production and foreign royalties, as well as military protection around the world to ensure the continuous flow of oil through the maintenance in power of regimes friendly to US interests in oil-rich states at the cost of \$57 billion per year.<sup>3</sup> There is also simply no awareness of the need to prevent the development of new oil and coal fields. "That's not the type of policy that we have looked at," Sandalow says, which might explain why the Vice President's Office is promoting US oil-company exploration in the Caspian Sea: a vast untapped deposit of up to 200 billion

barrels of petroleum. In contrast, there is comparatively little investment going into developing clean fuels and renewable sources of energy, and in helping to bring down the price of consuming them. Even the Million Solar Roofs Initiative has yet to be implemented and not enough is being done to achieve the billions of dollars of energy efficiency savings that have been identified.

Of considerable significance, despite the Clinton Administration's past efforts in this regard, the US climate plan does not include any new taxes on energy use or carbon dioxide emissions, and the country's fuel prices remain among the lowest in the world, necessarily encouraging heavy use of energy. There no longer even seems to be an aspiration to alter this state of affairs. As David Sandalow informed me, "this administration is absolutely opposed to increases in energy taxes and more specifically gas taxes." There is little hope then of achieving the 25-60% reductions in emissions by 2020 that the Inter-governmental Panel on Climate Change identifies from implementing energy taxes in countries where prices are currently low.

*The US climate plan does not include any new taxes on energy use or carbon dioxide emissions, and the country's fuel prices remain among the lowest in the world, necessarily encouraging heavy use of energy. There no longer even seems to be an aspiration to alter this state of affairs.*

New-car fuel economy in the US is now declining, due partly to greater use of sport utility vehicles and the absence of meaningful mandatory automobile fuel economy standards. As for reducing car usage, in the words of Greenpeace's US climate change campaign director, Kalee Kreider, "I just have to laugh – getting cars off the road is not even on the radar screen in the US." In fact, car use is subsidised by as much as \$121 billion annually which the Federal Government spends on roads, including new ones, which will only serve to increase car use. To put the Administration's claims into perspective, for every dollar of federal funds given to public transport, the car receives \$7.<sup>4</sup>

The continued decimation of the world's forests is another process which requires urgent political attention if we are to avoid serious climate change. And yet, when asked whether the US Administration was doing enough to address the problem, David Sandalow was candid enough to admit, "No, not by the US or other countries of the world." Overall, the Clinton Administration's record in implementing policies to reduce greenhouse gas emissions, in the words of Kalee Kreider, has been "fairly abysmal". It clearly falls far short of what needs to be done.

The targets the US Government has set itself to reduce greenhouse gas emissions are another cause of great concern. To stabilise greenhouse gas concentrations at safe levels, we know from the IPCC's *First Assessment Report* that we would need to reduce emissions below 1990 levels immediately by at least 60-80%, and possibly by even more, given what we now know about the possible devastating impacts of positive feed-backs. At Kyoto, however, the US pledged to reduce emissions by only 7% below 1990 levels by 2012.

"Pathetic" and "minuscule" are just two of the words environmental campaigners have used to describe this ecologically inappropriate target. When questioned about this, the President's advisors were worryingly dismissive. Sandalow characterised the criticisms of the targets as "utterly inaccurate." He defended the targets as "realistic and achievable" and "aggressive and appropriate", and higher ones would have been "meaningless".

The only way in which the Administration can possibly make these claims is by describing the US targets as reductions from





REX FEATURES

**Bill Clinton's White House has made some progress in addressing climate change, but not nearly enough.**

'business-as-usual'. As Al Gore's and subsequently Bill Clinton's principal environmental policy advisor over the past ten years and Chair of the White House Council for Environmental Quality until November 1998, Katie McGinty says, "In twelve years' time, to reach our target of 7% below 1990 levels we're talking about reducing the emissions of greenhouse gases by about 35% from where they would otherwise be on a business-as-usual course. That's a huge undertaking." But it would not be if the Government had prevented emissions from running out of control. And that is its problem. The failure of the US Government, Congress included, to take adequate action to reduce emissions means that the US is heading towards being 30% over 1990 levels by the time its Kyoto targets are supposed to be met in 2012.

Furthermore, a glance at the Government's own press release on the issue reveals that the US' Kyoto commitment does not even represent a real cut of 7%. "The 7% target represents at most a 3% real reduction....," we are frankly informed. "The remaining 4 percentage points result from certain changes [the US made at Kyoto] in the way gases and sinks are calculated and do not reflect any increase in effort..."

It is another revealing indication of the nature of the United States' attitude towards addressing the problem of climate change that instead of facing up to the challenge of cutting its own emissions it has sought easier ways out. The most notable potential loophole, or 'flexible mechanism', to use the diplomatic euphemism, that the US succeeded in introducing at Kyoto relates to Emissions Trading. The precise rules are yet to be established, but if the mechanism were to proceed in the manner in which the United States would like and is pushing hard for, and with a low price attached per carbon tonne, its Kyoto target would not only shrink to a cut of 3%, but it could translate into an actual *increase* in emissions (see 'The International Politics of Climate Change,' p104).

If nothing else, emissions trading will enable the United States to avoid having to take substantial domestic action to reduce its own emissions. "And why," as Brent Blackwelder asks, "should-

n't you clean up your own backyard?" Especially, as he points out, the same processes that emit greenhouse gases are also responsible for "causing massive air pollution problems in the United States where 100 million people still breathe degraded air". Reliance on buying emission quotas from abroad would store up other problems for the US. Unless clean technology is developed now domestically, as Jennifer Morgan, policy officer on climate change at WWF, explains, US political leaders will find, in the second international budget period, that "they are going to be less prepared to take on the deeper cuts that will be asked of them" because they won't have put in motion the transformation of their economy to one that runs without fossil fuels. Even Bruce Rich, Senior Attorney and Director of International Programmes at the Environmental Defence Fund (EDF) – the organisation responsible for designing much of the emissions trading regime – admits to having "mixed feelings" about it. He acknowledges, "It is not very convincing for the rest of the world if the biggest emitter is not doing a lot to reduce its emissions at home," because it "will purchase most of its reductions abroad." It could send a disastrous signal to other countries that it is too costly to take serious action to reduce CO<sub>2</sub> emissions.

It is for these reasons that most environmental NGOs and European governments argue for placing a stringent cap on the amount of a country's reduction target that can be achieved through trading and buying emission quotas abroad. The Clinton Administration, however, is vehemently opposed even to this suggestion. On the one hand Clinton's advisors maintain, "it is our priority to achieve those emissions reductions at home" – and on the other they still insist on having the unfettered right to purchase all of their cuts abroad. For David Sandalow, "A quantified cap is like designing the brake for the vehicle before you've designed the engine and it would be hugely administratively complex and expensive, and there's just no reason to do it." A much more revealing response came from Katie McGinty. "Putting big caps on that system is tantamount to saying 'I'm opposed to emissions trading' – and that is not acceptable to us or to the planet, because killing those emissions trading regimes is tantamount to saying that there will not be meaningful action to reduce greenhouse gas pollution: not another country in the world has a responsible or

effective idea of how they will actually implement this Treaty and bring those emissions down." Her words speak for themselves.

Without emissions trading, it seems, the US has indeed *no* effective idea or plan to meaningfully reduce its own greenhouse gas emissions. So what accounts for this worrying state of affairs? Why have Clinton and Gore, self-proclaimed champions of the environment, not achieved more to address what Gore calls "the most serious problem we have ever faced"?

### Accounting for the lack of executive action

Part of the blame must rest on the shoulders of the Clinton Presidency itself. Given the dramatic nature of the likely consequences of climate change, what was required from the White House was dramatic leadership to get those emissions down, to go to the American public and aggressively challenge the Republican Congress and big oil on this issue. Instead, Clinton, who did not really learn about climate change until 18 months ago, who as Governor of Arkansas had a poor environmental record, and whose own former Labour Secretary Robert Reich describes as "the most conservative Democratic President this century"<sup>6</sup>, chose to make other issues his priority.

In contrast to his behaviour on climate change, Clinton placed enormous energy into forcing through NAFTA, even though the public feared job losses and falling wages. To get it passed, any favour any Congressman asked for was granted. As Brent Blackwelder explains: "The Clinton Administration put all its marbles into the free trade bag, with NAFTA, GATT, the MAI, Fast Track, trying to apply NAFTA to Latin America, and trying to cover up

the sins of the IMF by putting more money into it. It's all economic globalisation." The fulfilment of such an agenda will, moreover, have a number of negative effects on the world's climate [see box on right].

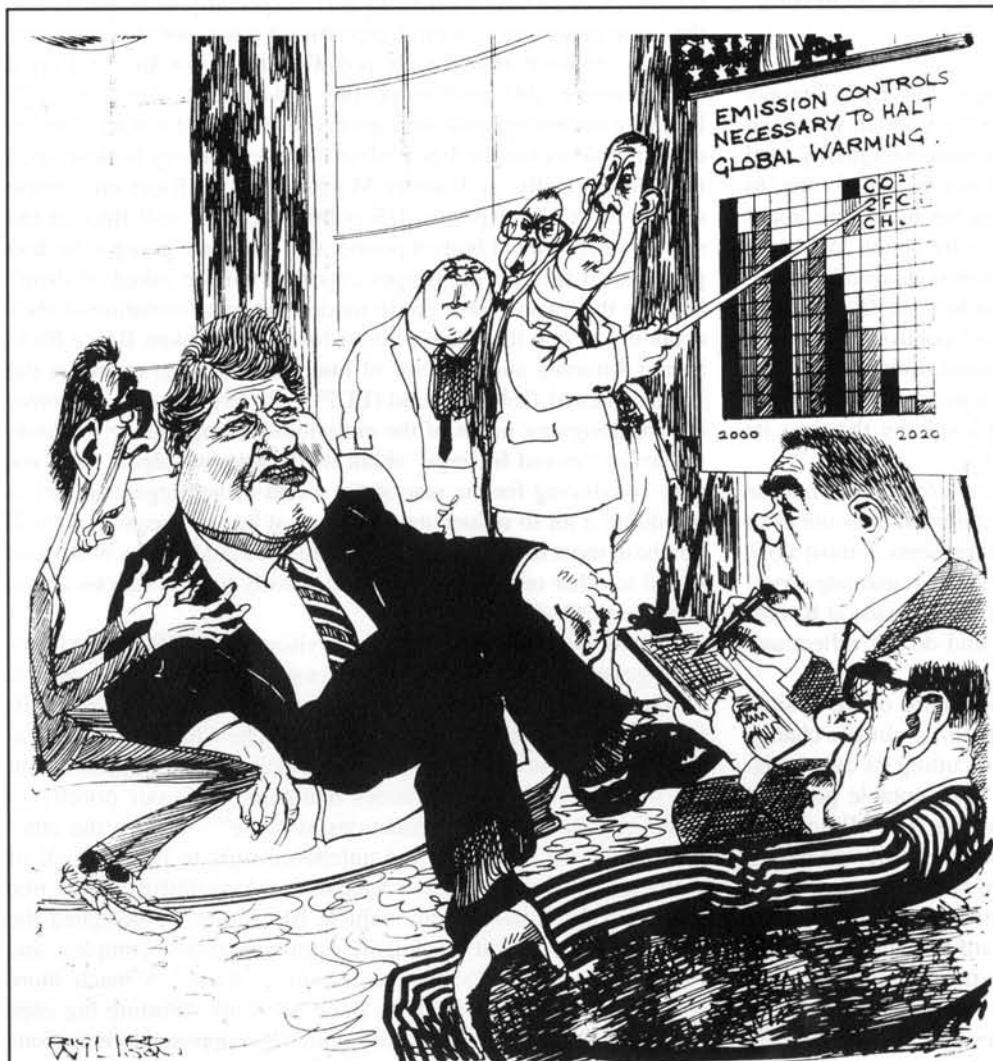
So far, Clinton and Gore have failed to ensure that their economic policies, particularly with regard to trade and taxation, are compatible with their avowed goal of preventing climate change. They have, on the whole, confined themselves to being weather reporters: speaking of the dangers of climate change, but not doing nearly enough to implement the solutions. Despite all the rhetoric, action on this issue Brent Blackwelder says was left as "an afterthought and what they came out with is what you get when it's an afterthought."

According to Kalee Kreider at Greenpeace, the Clinton Administration's efforts on climate change, especially in the lead-up to Kyoto, have been a shambles. During this period, Kreider says, a "struggle developed over who would head up the US policy effort on climate change." The struggle was waged between conservative economists such as former World Banker Larry Summers at the Treasury, and more committed officials like Tim Wirth and Eileen Klausen at the Department of State. Revealingly, both Wirth and Klausen resigned from the State Department just before Kyoto.

Other observers such as Jennifer Morgan at WWF support the view that a significant problem with the Administration's approach to climate change has been that "the economists of the Administration," such as Treasury Secretary Robert Rubin, "have taken over", and consequently, "everything is driven by economics on this issue." Analyses carried out by WWF suggest that the US could "take a much deeper cut and do it in an economically viable manner." Yet, Morgan explains, "The Treasury Department or the Council of Economic Advisers don't even integrate energy efficiency improvements or technology improvements into their models to come up with how much this is going to cost." Instead, "they use top-down models that often assume a huge carbon tax, which is not going to happen in this country, and they look at it from a marginal abatement cost per tonne, rather than the net economy."

Jennifer Morgan, like many of her colleagues, believes that it is the pressure of the oil, coal, utility and automobile companies that "drives the attention to the cost of this issue," and "pushes this Administration not to do anything". If this is currently the case, it is in no small measure because a Presidential campaign is coming up soon, and, as Kalee Kreider points out, the Administration has "to raise money from the same industries as do the Republicans, and the oil and coal industries are the largest private interest in the history of the world."

The Clinton White House has already received at least \$12 million in Democratic party and candidate contributions from big fossil fuel corporations. Individual oil and utility executives contributed an additional \$400,000 to the 1996 Clinton-Gore



*In conclusion, Mr President, we at Exxon feel that human survival may simply not be economic.*



## Globalisation and Climate Change.

Economic globalisation is bound to increase local dependence for food and other products on distant world markets, thus increasing the distance such products have to be transported, resulting in more greenhouse gas emissions. Also, by forcing everyone to produce for export rather than for themselves, it dramatically increases the vulnerability of individual countries to the needs of global competitiveness, playing right into the hands of those who argue that the US will lose its competitive edge if it takes domestic action to reduce emissions. Under such an economic system, deregulatory pressures are necessarily applied, effectively prohibiting governments from raising environmental standards and enabling companies to externalise their environmental costs. Economic globalisation, moreover, is leading to the global proliferation of technologies and systems of agriculture that are fossil-fuel-intensive, and, with the unrelenting push for exports, the further logging of vital forest sinks, all of which can only exacerbate climate change. Indeed, if the Clinton Administration succeeds in introducing the Global Free Logging Agreement (that would remove all tariffs on forest products) via the World Trade Organisation, it would vastly accelerate deforestation world-wide.<sup>7</sup>

campaign. The coal unions and Labour in general have also been "pretty sketchy on this issue", says Jennifer Morgan, "and you should never forget the role of Labour in US politics." Organised labour contributed \$50 million to the 1996 Democratic campaign, making it a key constituency for Clinton and Gore. All in all, Brent Blackwelder sums up, "the fossil fuel network has too many dominant influences in the Administration."

In their more understated, diplomatic way, the President's advisors confirm this view. "We have literally hundreds of billions of dollars of invested infrastructure," David Sandalow explains, "in a fossil-fuel-dependent energy system, and it's like turning an ocean liner." He confirms that the Administration has been subject to significant lobbying by the fossil fuel industry. "The White House," he says, "is very aware" of business concerns about the economic costs of taking radical action. "We take stock of what they say. This is not a dictatorship; it's a democracy in which constituencies have important roles and we need to persuade those people to take action." The level of commitment provided to 'persuade' or regulate these vested interests, however, has fallen far short of what is necessary. Clinton, a natural compromiser, eager to please everyone, has been unwilling to take on any large economic sector and has been too obsessed with wooing upper-middle class swing voters to risk leading any radical action on climate change.

Nevertheless, there is no doubt that members of the Administration would have liked to do more, and have indeed tried to do more. If they have not succeeded, it is in no small measure because of the substantial obstacles to progress that lie outside the Administration.

### The polluters' Congress

From the perspective of the White House, Katie McGinty claims "opposition on doing anything on climate change comes from those on Capitol Hill who do the bidding of polluters on every environmental issue." The Republican Congress' behaviour is damned by every single environmental campaigner. Bruce Rich at Environmental Defence Fund (EDF) describes it as "troglydytic," Annie Petsonk, also at EDF, as "outrageous", and Brent Blackwelder at FoE as "light years behind, back in the Neanderthal Age... a hundred times worse than the Administration." Blackwelder depicts most members of Congress as "know nothings". It's "the Flat Earth Society that's been running the House and Senate in the Republican Party", he says. Jennifer Morgan at WWF

even believes Congress is "to the right of most of the business in this country," which is truly saying something. She describes it as "completely irresponsible; short-sighted, inaccurate; driven by politics; driven by money; and driven by self-interest..."

The general atmosphere in which Congress treats this issue is one of hysteria. According to Daphne Wysham, research fellow with the Washington-based Institute for Policy Studies and co-ordinator of the Sustainable Energy and Economy Network, "Climate change is like the new Communism: I've been told by people in the Treasury Department that we cannot mention the words climate change in our language [to Congress] on appropriations for the World Bank; if we do it will be struck from the record."

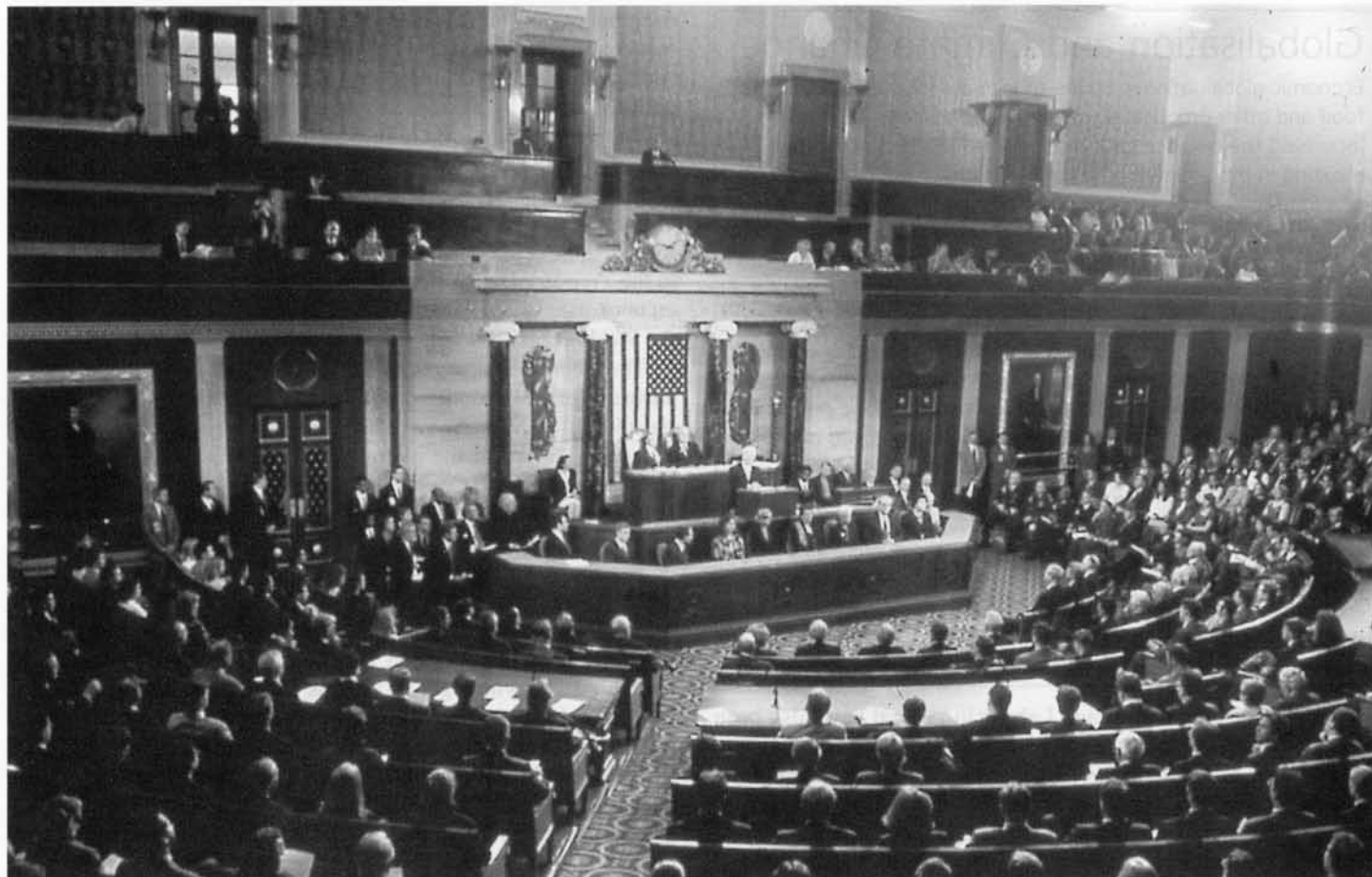
The Republicans in particular have waged a systematic war of attrition with the Administration over almost every single piece of meaningful legislation to reduce greenhouse gas emissions, and because they are in the majority, they have nearly always won. Under their control, Congress has barred the Administration from requiring car-makers to build more efficient vehicles by increasing automobile fuel economy standards (which have remained at more or less the same level since 1978). Indeed, Congress has tried to destroy what little fuel economy standards are in existence in the US by successfully inserting an exemption for giant sport utility vehicles which now account for one out of every two cars being purchased and which get as little as 14 miles to the gallon. Congress has also prevented the Clinton Administration from increasing the BTU or energy tax, as well as from increasing the 1999 budget for the development of renewable energy and energy efficient technology to \$3.6 billion as the White House requested. It has even rejected the President's policy that fossil fuels produced on public land should be subject to market-based royalty rates rather than the subsidised rate currently in existence.

The most significant act of Congressional subversion is the Byrd-Hagel Resolution, passed unanimously by the Senate, 95 votes to 0, in June 1997. It effectively prevents the ratification of the Kyoto Protocol by stipulating that any UN protocol on climate change which failed to mandate "new scheduled commitments to limit or reduce greenhouse gas emissions for developing countries within the same compliance period", and which would "result in serious harm to the economy of the United States" would be unacceptable. Since developing countries refuse to consent to limits or reductions in their emissions because they want the industrialised world to act first, the US Senate will not pass the Kyoto Protocol. For most Congressmen, the Byrd-Hagel Resolution is thus seen as a perfect formula for international stasis that guarantees business-as-usual. Over the past year and a half, the situation has barely changed. According to Kalee Kreider, "if the Kyoto agreement were put before Congress today, there are only about three Senators who would come out and say that it was worth ratifying."

Meanwhile, Congress has done everything in its power to prevent its implementation. The right-wing Republican Joe Knollenberg, whose constituency includes Detroit, the capital of the US car industry, sought to attach riders to the 1999 budget to forbid implementation of Kyoto, the *contemplation* of its implementation and even "conducting educational outreach or informational seminars on policies underlying the Kyoto Protocol...". As a result, new programmes designed especially to fulfil the US' Kyoto commitments are now outlawed. This will give irresponsible Republican Congressmen a tool to hold an inquisition every time anything is done that has the impact of reducing emissions, distracting the Environmental Protection Agency from its proper business.

Al Gore describes Congress' attitude to the issue as one of "know nothing, do nothing, say nothing". One of the outstanding practitioners of this approach is the Republican Senator from Nebraska, Chuck Hagel, co-author of the Byrd-Hagel Resolution.

"I don't accept the theory," Senator Hagel told me, "that man-made greenhouse gas emissions are going to lead our world to global climate disaster: that's complete folly – unproven histori-



The Republican-dominated US Congress of the past five years has blocked nearly all meaningful attempts to reduce US greenhouse gas emissions.

cally – it doesn't make any sense." He does not accept the basic laws of physics which stipulate that if heat-trapping gases like carbon dioxide are put into the atmosphere, heat will be trapped – "it's not proven to be the case," he says. Nor does he accept that temperatures worldwide have been increasing – "there's been no change," he claims. For Hagel, the evidence of any man-made impact is "very uncertain". Whilst he dismisses the significance of the fact that the scientists who share his view are in a clear minority, Hagel is keen to claim that his opinions are held by "thousands of meteorologists and geologists and physicists". Unfortunately for Hagel's credibility, the 'Global Warming Petition' containing these 'thousands' is full of phoney scientists, including all of the 'doctors' from the cast of MASH and a Spice Girl – hardly contenders for the Nobel Prize in Physics. The handful of more genuine scientists that remain are renowned for being biased because they work for and receive funds from the fossil fuel industry. Yet Hagel rejects this well-known fact as "simply nonsense". In any case, just to cover his back, he maintains, "it's far better for the world to be a little warmer than a little colder."

When it is not the science Senator Hagel disputes, it's the economics of taking action. But whilst the science of climate change can no longer credibly be denied, it is likely that the economics of the issue will determine the prospect and extent of US political action to address it. Congressional opinion in this regard needs, therefore, to be taken more seriously, and to date it has not been encouraging.

For Senator Hagel, even the nominal 7% reduction in greenhouse gas emissions the US signed up to under the Kyoto Protocol would require "dramatic drastic action" which "would devastate our economy". This belief is based upon two principal suppositions. First, that the "only" way of achieving such cuts is by increasing taxes on energy, and second, that under the Kyoto

Protocol "we would be subjected to mandatory requirements in the United States whilst China, Mexico and 132 other nations would not." This combination, Hagel argues, would put US industry at a terrible competitive disadvantage. Based on this rationale, Hagel claims "every economic study that's come out shows tremendous damage done to our economy as industries move outside the United States." As a result, he contends, the US "would lose hundreds of thousands of jobs".

*Hagel is keen to claim that his opinions are held by "thousands of meteorologists and geologists and physicists." Unfortunately for Hagel's credibility, the 'Global Warming Petition' containing these 'thousands' is full of phoney scientists, including all of the 'doctors' from the cast of MASH and a Spice Girl – hardly contenders for the Nobel Prize in Physics.*

These arguments (which as the final article in this issue shows are deeply flawed) result in a belief that government should in no way attempt to make industries reduce their greenhouse gas emissions. Hagel argues that "the market place is the best arbiter of these things because it is in the self-interest of a company to find the most productive way of producing a product." Thus, Hagel claims, government does not have to tell companies to, for instance, use less coal, since "they do everything humanly possible to use less coal." Hagel dismisses cleaner, renewable technologies entirely, for, according to him, "there are no magic technologies or techniques sitting out there on the shelf waiting to be used." Nor does he even seem to care about the loss of competitiveness that US industries will experience in the global market by not investing in renewables. "The only thing that will hurt



American companies," he says, "is the bunch of idiots in government putting more regulations on them and trying to inhibit their productivity."

Thus the real argument for inaction is made. The short-term priorities of industry are Hagel's primary concern, not the interests of his own constituents in the agricultural state of Nebraska, who stand to lose much more from inaction on climate change, and the extreme weather events and droughts that would ensue, than from any action that might be taken to prevent it. Hagel admits he is quite content with the deadlock over action to prevent climate change that his Senate resolution has created. For Senator Hagel and the majority of his fellow Congressmen have only one real goal: to delay for as long as possible any serious government attempts to reduce greenhouse gas emissions, using all and any possible means and arguments at their disposal.

### Congressional motives

However, the US public is no longer with Congress on this issue. People can see that the climate is not the same as it has always been. According to a poll released in October 1998 by the World Wildlife Fund, 57% of Americans believe climate change is already happening, 79% support the Kyoto agreement to reduce greenhouse gases, and over two-thirds think the US should act now, *unilaterally* to reduce CO<sub>2</sub> emissions, *regardless* of what scientists think.<sup>8</sup> But Congressmen like Chuck Hagel conveniently dismiss these findings. Polls, Hagel believes, should not be taken seriously, especially given that "people don't know what is in the Kyoto Protocol", (adding revealingly, "most of my colleagues don't even know what's in the Kyoto Protocol.") Moreover, he says, "I didn't come here to make policy based on polls..."

Indeed, it seems many Congressmen come to Washington with very different goals in mind. According to Brent Blackwelder, most Republicans simply want to destroy Clinton and "think anything he does they have got to fight because it's keeping an evil person in office." For extreme conservatives, opposition to action to address climate change is ideologically motivated. As Blackwelder says, "These people are out to defeat any effort to deal with global warming because they think it's an attempt to destroy industrial civilisation." Their opposition is also grounded in concerns about national sovereignty, government control and a mentality that interprets freedom only as the absence of constraints. This freedom is symbolised in particular by unfettered access to the car and to cheap petrol, and by the right to do business in any way one wishes. For such right-wingers, taking action to prevent climate change is perceived as a fundamental challenge to their freedom, and it appears they would rather run all the risks of a changing climate than buckle under that challenge.

But there is an even more insidious aspect of the US political system that, above all else, explains Congressional opposition to taking action on climate change. It is of course the US electoral system's voracious appetite for money. For those who seek a place in the US Congress, money is the key to success. A recent article in the *Washington Times* pointed out that in 280 of the 435 recent mid-term Congressional races there was no race because in those

seats the victor was outspending his or her opponents 10 to 1. As Kalee Kreider at Greenpeace says, "the amount of money which needs to be raised in order to run a credible campaign for Senate or for the House is pretty extraordinary." Members of the House of Representatives face re-election every two years, Senators every six, and much of the funding to finance this endless campaign comes, of course, from industries that produce and consume fossil fuels.

It is a matter of fact that the Republicans, and the Democrats to a lesser extent, in both houses receive millions of dollars each year from the oil, gas, coal, utility, automobile, and other energy-intensive industries. In 1997-1998 alone, oil, gas, coal and electricity utility companies spent \$9.4 million on Political Action Committee (PAC) contributions to federal candidates.<sup>9</sup> Senator Byrd, co-author of the Byrd-Hagel Resolution, for example, represents the big coal state of West Virginia, and received \$199,700 in 1996 alone



**Senator Chuck Hagel: arch-climate-change-skeptic and co-author of the resolution that prohibits the US Senate from ratifying the Kyoto Protocol.**

RICK L. HOUCHIN/HASTINGS TRIBUNE

*It is a matter of fact that the Republicans, and the Democrats to a lesser extent, in both houses receive millions of dollars each year from the oil, gas, coal, utility, automobile, and other energy-intensive industries. In 1997-1998 alone, oil, gas, coal and electricity utility companies spent \$9.4 million on Political Action Committee (PAC) contributions to federal candidates.*

from fossil-fuel-related industries, coal prominent among them.<sup>10</sup> Senator Hagel himself, who was seen by Jennifer Morgan of WWF "right after the Byrd-Hagel Resolution got passed, talking to the auto and coal guys", received \$148,000 from fossil-fuel-related companies in 1996.<sup>11</sup>

Indeed, most of the major players in the Senate and the House of Representatives receive substantial sums from the fossil fuel industry. Ultra-climate-change-skeptic Representatives McIntosh, Knollenberg and Barton received \$159,557, \$75,390 and \$251,921 respectively from fossil-fuel-related companies in 1996 alone.<sup>12</sup> Whilst serving as out-and-out bribes in certain cases, campaign donations certainly give corporate donors unparalleled access to public officials, access which is used to influence and shape public policy. The correlation appears undeniable. For the small investment of \$63.4 million pumped into the coffers of both main US political parties between 1992 and 1998, the energy elite receives a huge return in direct federal subsidies and congressional obstruction.

### The prospects for change

So what hope is there? What are the prospects that the United States will respond fast and far enough to this desperately serious problem? Much depends on the ability of environmental groups to do a better job than they have so far in mobilising public opinion, to generate sufficient public pressure to force the political and



REX FEATURES

**If elected President, would Al Gore take more radical steps to prevent climate change than Bill Clinton?**

business establishments to change their ways. For, as several Senators are on record as saying, the political establishment will not be able to counteract the influence of the fossil fuel lobby in Congress without an uprising of popular support. However, the odds in favour of this happening in time are not high, as Brent Blackwelder says, "There's maybe a 10% chance that we can change this around."

The prospect of any substantial change in direction on this issue from the US political establishment is certainly slight in the near future. Al Gore will probably be running for President in 2000 and it is likely that the Republicans will challenge him on his stance on environmental issues. According to Kalee Kreider at Greenpeace, "Gore's staff people are very nervous that this could hurt him, particularly if he goes up against a wealthy Republican like Governor George Bush from a big state." When I asked David Sandalow, who works closely with Gore, if he believed the Vice President would not want to promise much action on climate change in case it damaged his election chances, Sandalow was less than reassuring: "I...er... I doubt it," he replied. However, if a Republican were to win the election, the consequences for progress on climate change would almost certainly be disastrous. Even a moderate like Bush comes from a background in big oil and is highly unlikely to take this issue any further forward. Gore would undoubtedly do better, but could he be relied upon to do enough?

Whilst Al Gore may be counted on to show the same zeal as Bill Clinton in seeking to further expand the global economy, Jennifer Morgan at WWF argues that Gore is likely to be "less timid" than Clinton in taking on the vested interests in fossil fuels. "Al Gore," she says, "has spent a good chunk of his life understanding the problem of climate change and wanting to push the issue forward, so if he does become President, he's starting from a much higher bar than Clinton." Morgan believes Gore's credibility is at stake on this issue, "and so the likelihood of action is greater." There is, therefore, a chance that a big push may come, with intelligent use of the presidential pulpit to work on public opinion. As Kalee Kreider says, "ultimately, you need money to run but you need votes to win."

The difficulties cannot be overstated however. For at least two years there is not even any chance that the Administration will submit the Kyoto Protocol to the Senate for ratification. "If we did," Sandalow says, "it would be voted down." Submission will only happen "when we have meaningful participation from developing countries and adequate rules on emissions trading and sinks." And

that might not be for some time. Moreover, Sandalow is adamant that Congress' "long tradition of strong political opposition to increases in gas taxes" is "not going to change any time soon."

The Administration puts on a brave face, however. "With hard work," Sandalow says, "the American people and the US Senate will be persuaded." As for the even more formidable opposition of the powerful players at the heart of the fossil fuel industry, will that be overcome in time? "I don't think it's impossible," says David Sandalow, "but I don't want to minimise the challenge. It's a huge challenge, but one we accept."

The actions of the American political elite to date, however, give little indication that they have any appreciation of the urgency and revolutionary nature of the task that lies before them. The following remarks ring all too true: "Minor shifts in policy, marginal adjustments in ongoing programmes, moderate improvements in laws and regulations, rhetoric offered in lieu of genuine change – these are all forms of appeasement designed to satisfy the public's desire to believe that sacrifice, struggle and a wrenching transformation of society will not be necessary." It was no long-haired extremist who wrote these words. It was Al Gore, in 1992.

What ever happened to Gore's call to arms? If he and Clinton truly appreciate the dangers that lie ahead and the opportunities too, why continue to allow the short-sighted conservative economists and corporate chiefs to dictate such a painstakingly slow pace of change? Where is the level of commitment, leadership and courage that is required to take on the vested interests? Governments, surely, exist to defend the interests of all the people – not just business executives – a principle the Republican Congress in particular seems either to have forgotten or to treat with complete contempt. Too obsessed with ensuring that their corporate cheques keep coming in and with getting into an artificial frenzy about Presidential sex and other such trivialities, too stupid and myopic to understand what climate change means, all the signs are that Congressmen's heads will still be in the sand when the tide comes in. If the US oil giants continue to use their unparalleled wealth to block a transition to a sustainable economy, they might as well be filing their own bankruptcy suits, for the biosphere is one thing that cannot be bought or negotiated with. Should they choose to ruin themselves by continuing to ignore that the difficulties of changing will pale into insignificance compared with the costs of not changing, they are free to do so. But both the political and corporate leaders seem to forget that they are not alone on this planet: they all have children. It is for them, if for no other reason, that they should set aside their fear of change, and with strong leadership from the highest office-holder in the land and the unsung heroes of the environmental movement, they and the public can be made allies of reform and severe climate change can be averted.

#### References:

1. David Sandalow is Senior Director for Environmental Affairs on the National Security Council and Associate Director for the Global Environment at the White House Council for Environmental Quality.
2. C. Flavin and S. Dunn, Responding to the Threat of Climate Change, *WorldWatch*, 1997, p.117.
3. E. S. Rothschild, Oil Imports, Taxpayer Subsidies and the Petroleum Industry, Washington DC, *Citizen Action*, May 1995, p.15
4. C. Flavin and S. Dunn, Responding to the Threat of Climate Change, *WorldWatch*, 1997, p.117.
5. The Kyoto Protocol on Climate Change, Bureau of Oceans and International Environment, January 15 1998.
6. Robert Reich in *The Guardian*, 20.12.1998.
7. For more information on the FLA and to learn what you can do, contact the International Trade and Forest Program, on (+1) 202 547-9230, or by email: antonia@americanlands.org.
8. WWF, Summary of Public Opinion Research Findings, October 17 1998.
9. Center for Responsive Politics.
10. *Ibid.*
11. *Ibid.*
12. *Ibid.*



# Corporate Hijacking of the Greenhouse Debate

— BY SHARON BEDER —

*The use of front groups, PR firms, think tanks, and willing scientists and economists has provided corporations with the means to confuse the public and obstruct political attempts to reduce greenhouse gas emissions. In the US and Australia in particular, such tactics have enabled the fossil fuel industry to hijack the greenhouse debate.*

The outcomes of the Kyoto conference on climate change were disappointing but not surprising given the strength of industry opposition to an effective treaty. The governments of the US and Australia, which produce the world's highest per capita emissions of greenhouse gases, have for many years obstructed international greenhouse gas reduction measures being taken. This reflects the power of industry in these countries rather than any lack of concern on the part of their citizens.

In the lead-up to the Kyoto conference a US consortium of 20 organisations launched an anti-climate treaty campaign. These industry groups representing oil, coal and other fossil fuel interests spent an estimated \$US13 million on television, newspaper and radio advertising in the three months leading up to the Kyoto conference to promote public opposition to the treaty. Speaking at a news conference on this campaign, the President of the National Association of Manufacturers, Jerry Jasinowski, argued that the treaty would mean energy prices would go up, jobs would be moved to developing countries, and businesses, farmers and con-

sumers would suffer.<sup>1</sup>

In 1998 the New York Times reported on internal American Petroleum Institute (API) documents showing that fossil fuel interests intended to raise \$5 million over two years to establish a Global Climate Science Data Center as a non-profit educational foundation to help with their goal of ensuring that the media and the public recognise the uncertainties in climate science. The documents state that victory will be achieved when climate change becomes a non-issue and those promoting the Kyoto treaty using existing science appear "to be out of touch with reality".<sup>2</sup>

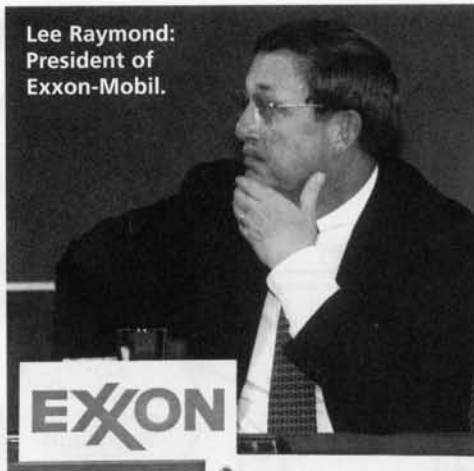
This is just the latest phase in a corporate funded campaign to discredit global warming predictions and undermine the political will necessary to reduce greenhouse gas emissions. Corporations have used corporate front groups, public relations firms and conservative think tanks to cast doubt on predictions of global warming and its impacts, to imply that we do not know enough to act and to argue that the cost of reducing greenhouse gases is prohibitively expensive.

## Primary Target: Derailing International Negotiations

International attempts to prevent climate change have been a primary target for corporate guns. Their aim throughout has been to delay, damage and, if at all possible, destroy the rather feeble measures that have been proposed. Perhaps the most damaging behaviour has come from oil industry chiefs like Lee Raymond, President of Exxon-Mobil, now one of the three largest corporations on the planet. He has been travelling around the developing world telling the governments of countries like China that if they want to continue to attract inward investment from corporations such as his own, they should not participate in the international treaty process on climate change.

At the negotiations themselves, corporate lobby groups like the Global Climate Coalition have worked hard to achieve the same end. They have operated closely with OPEC and other developing country delegations to stall progress, rejoicing when the chairman of the Kyoto negotiations found 'no consensus' and had to throw out proposed paragraphs setting terms for developing countries to agree future targets for their greenhouse gas emissions.

Lee Raymond:  
President of  
Exxon-Mobil.



The base hypocrisy and deceitfulness of these corporate tactics is evident when one considers that back in Washington these very same industries and their lobby groups have been angrily demanding targets for developing countries, and have succeeded in blocking the ratification of the treaty in the US precisely because such targets were lacking.

By Simon Retallack

Fostering doubt is a well known public relations tactic. Phil Lesly, author of a handbook on public relations and communications, advises corporations:

"People generally do not favor action on a non-alarming situation when arguments seem to be balanced on both sides and there is a clear doubt. The weight of impressions on the public must be balanced so people will have doubts and lack motivation to take action. Accordingly, means are needed to get balancing information into the stream from sources that the public will find credible. There is no need for a clear-cut 'victory.'...Nurturing public doubts by demonstrating that this is not a clear-cut situation in support of the opponents usually is all that is necessary."<sup>3</sup>

The success of this strategy was evident in US Gallup polls in October and November 1997. They found that 37 per cent of those surveyed thought that scientists were unsure of the cause of global warming.<sup>4</sup>

Perhaps nowhere has the fossil fuel industry been more successful

than in Australia whose government represents fossil fuel industry interests as being synonymous with the national interest. In 1988 when the National Greenhouse 88 Conference was held in Australia there was unprecedented public interest in the issue. This has been systematically eroded through a well-orchestrated international campaign to portray global warming as little more than a theory that scientists can't agree on.

### Front groups

Various front groups and so-called Astroturf (synthetic grassroots) coalitions have been formed by big oil, coal and car companies to oppose measures to prevent global warming, particularly in the US, and to give their Congressional shopping expeditions a populist coloration and the appearance of legitimacy. They include the Global Climate Information Project which was formed just before the Kyoto meeting and spent millions on newspaper and television advertising aimed at scaring the public about what an agreement at Kyoto might mean in terms of increased prices. The Coalition for Vehicle Choice, which is funded by car manufacturers including Ford, GM and Chrysler, also ran advertisements in the lead-up to Kyoto.<sup>5</sup>

Another front group, the Advancement of Sound Science Coalition (TASSC) held a sweepstake to encourage grassroots lobbying against a treaty. TASSC was funded by corporations such as 3M, Amoco, Chevron, Dow Chemical, Exxon, Philip Morris, Procter and Gamble and General Motors.<sup>6</sup> The Information Council on the Environment, which was a coal industry front group, incorporating the National Coal Association, Western Fuels and Edison Electrical Institute amongst others, was formed in 1991 to "reposition global warming as theory (not fact)."<sup>7</sup>

The Global Climate Coalition, a coalition of 50 US trade associations and private companies representing oil, gas, coal, automobile and chemical companies and trade associations, put together with the help of PR giant Burson-Marsteller, has spent millions of dollars in its campaign to persuade the public and governments that global warming is not a real threat.<sup>8</sup> On its home page it describes itself as "A voice for business in the global warming debate" with membership representing "a broad spectrum of virtually all elements of US industry including the energy producing and energy consuming sectors."<sup>9</sup>

In the negotiating sessions leading up to the Kyoto Conference, industry representatives made up most of the observers, under a provision that enables organisations 'qualified in matters covered by the Convention' to attend. They did not represent their firms at these meetings but represented corporate front groups such as the Global Climate Coalition and the International Petroleum Industry Environmental Conservation Association.<sup>10</sup>

Some of these corporate front groups have come and gone as they have been exposed, only to be replaced by others. The Greening Earth Society was established in April 1998 by Western Fuels Association to convince people that "using fossil fuels to enable our economic activity is as natural as breathing".<sup>11</sup> Another recent addition to the campaign has been the Center for the Study of Carbon Dioxide and Global Change, which according to CLEAR, the Washington-based Clearinghouse on Environmental Advocacy and Research, seems to have a strong working relationship with both Western Fuels and Greening Earth Society.<sup>12</sup>

### Scientists

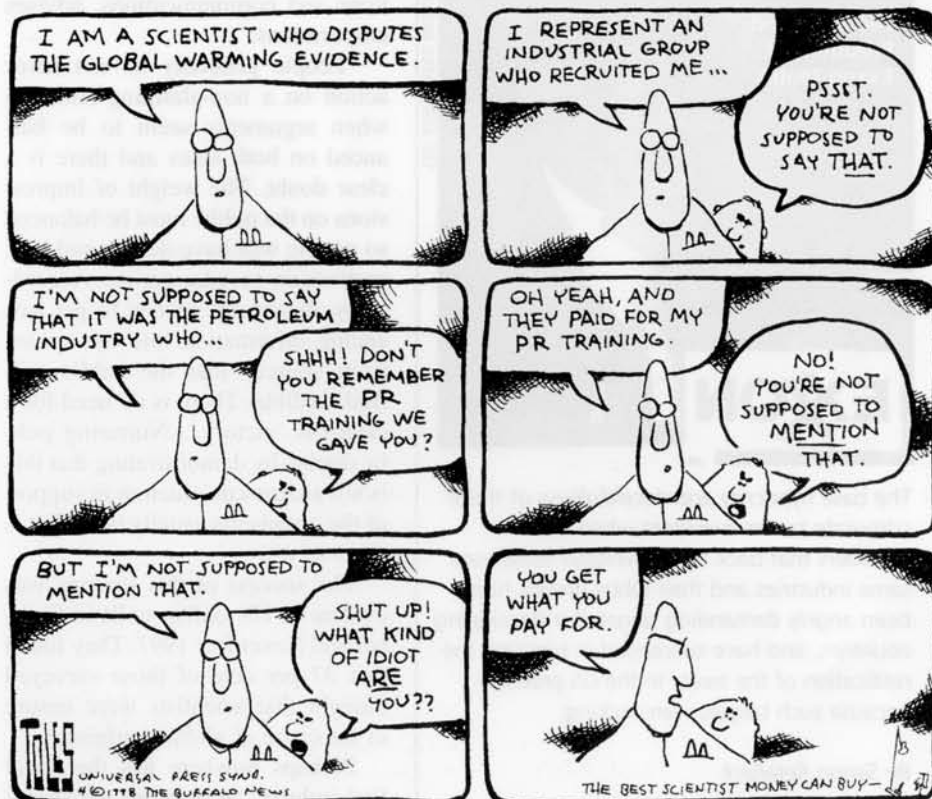
Corporations and their front groups have used a handful of dissident scientists to foster uncertainty about the reality of global warming, the seriousness of the threat posed by it, and the level of consensus among the climate scientists regarding both. The scientists who oppose the general scientific consensus on global warming have had their voices greatly amplified by fossil fuel interests. The deep-pocketed industry lobby has promoted their opinions through every channel of communication it can reach. Regrettably, many newspaper and broadcast editors are too uninformed about climate science to resist.

The climate change skeptic scientists do not, of course, disclose their funding sources when talking to the media or before government hearings. They have thus been able to achieve extraordinary success in playing down the threat of global warming. Their arguments have directly contributed to the defeat of proposals to cut greenhouse gas emissions in California and Colorado. US Congressmen have also used their testimony to justify cutting climate research budgets and to discredit the scientific findings of the Inter-governmental Panel on Climate Change.

One skeptic scientist is Patrick Michaels, who is generally described in the media as being from the University of Virginia.

Michaels edits the World Climate Report, which is funded by Western Fuels Association (a consortium of coal interests) and associated companies. Additionally Michaels has received funding for his research from Western Fuels Association, Cyprus Minerals Company, the Edison Electric Institute and the German Coal Mining Association. Michaels is on the advisory board of TASSC and was at one time on the advisory board of the Information Council on the Environment.<sup>13</sup>

Michaels has travelled the world on behalf of anti-climate treaty interests. In October 1997 he attended a conference in Vancouver organised by the conservative think tank, The Fraser Institute. Michaels also spoke at a conference in Canberra organised by the US Frontiers of Freedom Institute, a conservative corporate-funded US think tank, and the Australian APEC Study Centre. The conference, entitled Countdown to Kyoto, was organised, according to Malcolm Wallop, who heads the Frontiers of Freedom Institute, as "the first shot across the bow of those who expect to champion the Kyoto Treaty."<sup>14</sup>





Other scientists involved in the campaign to discredit greenhouse emission reduction targets include Dr Richard Lindzen, Dr Robert Balling, and Dr S. Fred Singer. Lindzen is a consultant to the fossil fuel industry, charging \$2500 a day for his services.<sup>15</sup> Balling is also heavily funded by fossil fuel interests. Balling is reported in *The Arizona Republic* as saying that he had received something "like \$700,000 over the past five years" from coal and oil interests in Great Britain, Germany and the US. A report by Ozone Action also details how Balling received research money from the Kuwait Government. His book, *The Heated Debate*, was commissioned by the Pacific Research Institute for Public Policy, a think tank opposed to environmental regulation.<sup>16</sup> Balling was also on the advisory council for the Information Council on the Environment, and has represented the Global Climate Coalition and the Competitive Enterprise Institute – both leaders in global warming skepticism.

Fred Singer is executive director of the think tank, the Science and Environmental Policy Project (SEPP). This project was originally set up in 1990 with the help of the Washington Institute for Values in Public Policy (funded by the Rev Sun Myung Moon's Unification Church) which provided it with free office space. (SEPP is no longer affiliated with Moon and receives its funding from various foundations.)<sup>17</sup>

SEPP argues that global warming, ozone depletion and acid rain are not real but rather are scare tactics used by environmentalists. Singer speaks and writes prolifically on these subjects and is in demand by anti-environment groups.<sup>18</sup> He is on the advisory board of TASSC. Two of the leading Australian conservative think tanks have sponsored him to tour Australia, putting his views on global warming. Most recently he toured Austria in November 1997, prior to the Kyoto conference, and presented a speech to the Austrian parliament. He has worked for companies such as Exxon, Shell, and Arco.<sup>19</sup> According to Peter Montague of the Environmental Research Foundation:

"For years, Singer was a professor at the University of Virginia where he was funded by energy companies to pump out glossy pamphlets pooh-poohing climate change. Singer hasn't published



**Dr Fred Singer: funded by energy companies to discredit the science of climate change.**

original research on climate change in 20 years and is now an 'independent' consultant, who spends his time writing letters to the editor, and testifying before Congress, claiming that ozone-depletion and global warming aren't real problems."<sup>20</sup>

While Michaels, Singer, Linzen and company continue with their tireless efforts, recently uncovered internal documents from the American Petroleum Institute indicate that moves are afoot to increase their ranks. The plan is to "Identify, recruit and train a team of five independent scientists to participate in media outreach... this team will consist of new faces who will add their voices to those recognized scientists who are already vocal."<sup>21</sup>

### Think tanks

The SEPP is just one of the many conservative think tanks in various parts of the world that

seek to undermine the case for global warming preventative measures. Corporate funded think tanks have played a key role in providing credible 'experts' who dispute scientific claims of existing or impending environmental degradation and therefore provide enough doubts to ensure governments 'lack motivation' to act.

The Heritage Foundation is one of the largest and wealthiest think tanks in the US. In October 1997 it published a backgrounder entitled "The Road to Kyoto: How the Global Climate Treaty Fosters Economic Impoverishment and Endangers US Security." It began "Chicken Little is back and the sky is falling. Or so suggests the Clinton Administration..." and went on "By championing the global warming treaty, the Administration seeks to pacify a vociferous lobby which frequently has made unsubstantiated predictions of environmental doom."<sup>22</sup>

In its Environmental Briefing Book for Congressional Candidates the Competitive Enterprise Institute (CEI) argues that "the likeliest global climate change is the creation of a milder, greener, more prosperous world."<sup>23</sup> One of CEI's publications is *The True State of the Planet* which was partially funded by the Olin Foundation, founded by Olin Chemical. In it Robert Balling (mentioned earlier) claims that the "scientific evidence argues against the existence of a greenhouse crisis, against the notion that realistic policies could achieve any meaningful climatic impact, and against

## Dr Patrick Michaels: His Masters' Voice

The authoritative scientific view is that Patrick Michaels' work "has been considered, and judged to be irrelevant. His work simply does not pass muster scientifically..." in the words of Dr. Tom Wigley, senior scientist at the US National Centre for Atmospheric Research.

In 1995, Michaels revealed under oath that he had received more than \$165,000 in industry and private funding over the previous five years. Not only did Western Fuels help fund both periodicals with which he was involved but it provided a \$63,000 grant for his research. Another \$49,000 came to Michaels from the German Coal Mining Association, as did \$15,000 from the Edison Electric Institute. Michaels also listed a grant of \$40,000 from the mining company Cyprus Minerals.

Despite the ample evidence that

Michaels is heavily funded by fossil fuel interests, he has appeared as a star witness at several congressional hearings, most notably before the House Senate Committee. There, Michaels has been afforded more scientific credibility than climate scientists who are recognised authorities in their fields, such as Jerry Mahlmann and Tom Wigley.

The media seem equally untroubled by the fact that skeptics are heavily backed by fossil fuel interests, preferring instead to portray them as independent experts: Michaels, for example, is generally described in the media as being from the University of Virginia, with no mention made of the origin of the money backing him.

Like the tiny, booming individual hiding behind the curtain in 'The Wizard of Oz',

the amplification provided by fossil fuel money inevitably gives the impression that the skeptics have greater stature and authority than is actually the case. Thus, in response to criticism of the documentary series 'Against Nature', which strongly attacked calls for action against global warming, Michael Jackson, Chief Executive of Britain's Channel Four Television, wrote:

"I am sure you would agree... that the fact that a significant number of leading scientists do not subscribe to the theory of global warming needs to be examined, however much you hold an opposing view." (*Letter to the author*, 11.1.98).

By David Edwards – researcher/writer for the International Society for Ecology and Culture. His latest book *The Compassionate Revolution* is published by Green Books.

the claim that we must act now if we are to reduce the greenhouse threat."<sup>24</sup>

Think tanks in other parts of the world are also seeking to cast doubt upon global warming predictions. In Britain the newly formed Environmental Unit of the Institute of Economic Affairs (IEA) launched *Global Warming: Apocalypse or Hot Air* in 1994.<sup>25</sup> The Australian Institute of Public Affairs (IPA), which gets almost one third of its budget from mining and manufacturing companies<sup>26</sup>, has also produced articles and media statements challenging the greenhouse consensus.

Brian Tucker, previously Chief of the CSIRO Division of Atmospheric research, is now a Senior Fellow at the IPA where he trades on his scientific credentials to push an ideological agenda. In 1996 in a talk on the ABC's *Ockham's Razor* he stated that "unchallenged climatic disaster hyperbole has induced something akin to a panic reaction from policy makers, both national and international."<sup>27</sup>

### Economists

In both the US and Australia, think tank economists have been influential in the debate over the costs of greenhouse gas abatement. In Australia the Commonwealth government has relied heavily on figures provided by the Australian Bureau of Agricultural and Resource Economics (ABARE). ABARE raised \$1.1 million from oil companies and industry lobby groups by offering them the opportunity to pay \$50,000 to sit on the steering committee and "have an influence on the direction of the model development" (as stated in ABARE's literature).<sup>28</sup> Those who took advantage of the offer included Mobil, Exxon, Texaco, BHP, Rio Tinto, the Australian Aluminium Council, the Business Council of Australia, and Norwegian oil company Statoil. According to Clive Hamilton, from the Australia Institute (an environmental think tank), 80 per cent of the funds for ABARE's climate change modelling come from the fossil fuel industry.<sup>29</sup>

Not surprisingly ABARE's model (MEGABARE) predicts huge costs in jobs and income if emission reduction targets are to be met. This is disputed by environmentalists and alternative energy experts, as well as by 131 Australian economists who signed a joint statement that said "the economic modelling studies on which the Government is relying to assess the impacts of reducing Australia's greenhouse gas emissions overestimate the costs and underestimate the benefits of reducing emissions."<sup>30</sup>

In the US a frequently cited computer model of economic costs of climate change, the International Impact Assessment Model (IIAM), was originally commissioned by the American Petroleum Institute, although this is seldom mentioned when referring to the findings of the model. This model also predicts large costs if emissions targets have to be met and that it would be cheaper to reduce emissions later rather than earlier.<sup>31</sup>

The Heritage Foundation predicted that the Kyoto Protocol would cost "as much as \$30,000 in lost income per family and up to two million lost jobs each year".<sup>32</sup> The Global Climate Coalition publicised a study that estimated that the costs of energy for the average household would increase by up to \$1,740 annually and that petrol would increase by up to 66c per gallon.<sup>33</sup> It also published estimates of job losses for each state. It then released a study immediately prior to the Buenos Aires meeting purporting to show that six out of ten Americans thought the treaty would be expensive for American households and should not be implemented.<sup>34</sup>

Throughout 1998 vested interests lobbied against the US ratification of the Kyoto Treaty. Vested interests are thus preventing effective solutions from being found to the global warming problem by continuing to focus the debate on whether it is worth spending money on a problem that may not materialise. We should have moved on from that question a long time ago.

Dr Sharon Beder is author of *Global Spin: The Corporate Assault on Environmentalism*, Green Books, Devon, UK, 1997 and Associate Professor of Science and Technology Studies at the University of Wollongong, NSW, Australia.

### References:

- Vicki Allen, 'Industries launch anti-climate treaty ad campaign', Reuters News Service, 10 Sept 1997.
- Documents attached to National Environmental Trust, 'Big Oil's Secret Plan to Block the Global Warming Treaty', Corporate Watch Features, <http://www.corpwatch.org/trac/feature/climate/culprits/bigoil.html>, October 1998.
- Philip Lesly, 'Coping with Opposition Groups', Public Relations Review, Vol. 18, No. 4 (1992), p.331.
- Alec Gallup and Lydia Saad, 'Public Concerned, Not Alarmed About Global Warming', The Gallup Poll, <http://www.gallup.com/POLL.ARCHIVES/1997/971202.htm>, 1998.
- Bob Burton and Sheldon Rampton, 'Thinking Globally, Acting Vocally: The International Conspiracy to Overheat the Earth', PR Watch, Vol. 4, No. 4 (1997), p.5.
- 'Alert: Global Warming 'Sweepstakes'', Clear View Mailing List, 19 November 1997.
- Ozone Action, *Ties that Bind: Industry Influence on Public Policy and Our Environment*, Ozone Action, Washington D.C., 1997, p.5.
- Anon., 'Coalition urges resistance to greenhouse gas demands', Chemical Marketing Reporter, Vol. 246, No. 8 (1994); Bette Hileman, 'Plan to prevent climate change pleases industry', Chemical & Engineering News, Vol. 71, No. 11 (1993); Burton and Rampton, 'Thinking Globally, Acting Vocally', p.3.
- Global Climate Change, web page, <http://www.globalclimate.org/>, 1998.
- Ute Collier, 'On the road to Kyoto: the dynamics of the international climate negotiations', WGES Newsletter (Summer 1997), p.17.
- Quoted in 'A CLEAR Special Report: Western Fuels Association's Astro turf Empire', CLEAR View Mailing List, 10 November 1998.
- Ibid.*
- Ozone Action, *Ties that Bind*, p.4.
- Frontiers of Freedom web site, <http://www.ff.org/ff/kyoto/>, October 1997.
- Ross Gelbspan, 'The Heat is On: The Warming of the world's climate sparks a blaze of denial', Harpers Magazine, December 1995.
- Quoted in Ozone Action, *Ties that Bind*, pp.2-3.
- Carl Deal, *The Greenpeace Guide to Anti-Environmental Organizations* (Berkeley, California: Odian Press, 1993), pp. 89-90; David Helvarg, *The War Against the Greens: The 'Wise-Use' Movement, the New Right, and Anti-environmental Violence* (San Francisco: Sierra Club Books, 1994), p.21.
- Ibid.*
- Andrew Rowell, *Green Backlash: Global Subversion of the Environment Movement* (London and New York: Routledge, 1996), p.143.
- Peter Montague, 'Ignorance is Strength', Rachel's Environment & Health Weekly, No. 467 (1995).
- Documents attached to National Environmental Trust, 'Big Oil's Secret Plan to Block the Global Warming Treaty', Corporate Watch Features, <http://www.corpwatch.org/trac/feature/climate/culprits/bigoil.html>, October 1998.
- Angela Antonelli, Brett Schaefer and Alex Annett, 'The Road to Kyoto: How the Global Climate Treaty Fosters Economic Impoverishment and Endangers US Security', Heritage Foundation Backgrounder 1143, 6 October 1997.
- CEI, 'Global Climate Change', Environmental Briefing Book for Congressional Candidates, Competitive Enterprise Institute, World Wide Web, <http://www.cei.org/ebb12.html>, 1996.
- Robert C. Balling, 'Global Warming: Messy models, decent data, and pointless policy', in Ronald Bailey (eds), *The True State of the Planet* (New York: The Free Press, 1995), p.84.
- Rowell, *Green Backlash*, p.328.
- Bob Burton, 'Right Wing Think Tanks go Environmental', Chain Reaction, No. 73-4, 1995, p.27.
- Brian Tucker, 'A Rational Consideration of Global Warming', Ockham's Razor, ABC Radio National, 18 August 1996.
- 'ABARE Research: GIGABARE', ABARE, <http://www.abare.gov.au/research/gigabare/GIGABARE/Gigabare.html>, 1998.
- Murray Hogarth, 'Climate research alleged to be biased', Sydney Morning Herald, 5 August 1997.
- Gavin Gilchrist, 'Too Much Hot Air', Sydney Morning Herald, 30 August 1997, p.5.
- Ozone Action, *Ties that Bind*, p.12.
- Angela Antonelli and Brett D. Schaefer, 'Why the Kyoto Signing Signals Disregard for Congress', Heritage Foundation Executive Memorandum, No. 559, 23 November 1998.
- Anon., 'GCC: Government Study a Dose of Economic Reality', PR Newswire, 9 October 1998.
- Anon., 'Polls show strong opposition to Kyoto Treaty', PR Newswire, 9 November 1998.



# An Interview with the Global Climate Coalition

*The myopic nature of the corporate response to the issue of climate change lies at the root of the lack of political action to reduce emissions. SIMON RETALLACK talked to the chief spokesman of the Global Climate Coalition, the most notorious of industry groups lobbying against action to prevent climate change, to discover just how he could justify GCC's stance.*

The Global Climate Coalition's first line of defence is still based upon denial. The GCC's principal spokesman, Frank Maisano, formerly from the auto industry, pulls out the old bogus arguments: "measurements from satellites have actually shown a cooling trend", and "severe weather and global warming have almost nothing to do with each other." His favourite line of defence is to state that there is "so much uncertainty surrounding the problem", failing to appreciate that the logical conclusion of this argument is that we should be even more concerned about the possibility of severe human-induced climate change, not less. The GCC's pronouncements are clearly designed with tactics in mind: in this case the goal of instilling an artificial sense of uncertainty about the science of climate change in the public mind.

Could the GCC deny, I asked, that manipulation of the science went on? In a surprising admission, Maisano told me, "There is a politicisation of this on all levels," industry – apparently – included. There are a lot of ways to look at all aspects of the issue of climate change, I was told, and "depending on the way you look at the issue, you can get it to come up the way you want. It is just like a political poll. You get the result you want." The dishonesty of such an approach does not seem to register with the GCC.

Similarly, the fossil fuel lobby has no qualms about splashing out on politicians in order to influence the policy process on climate change in a dangerously biased way. In fact, Maisano does not even try to argue that money has no impact on the process: "I am not saying that totally; I don't want to be in total denial," he concedes: "industry has spokespeople in Congress." He has no scruples about this though because he insists that "there are just as many resources being spent on all sides," so that "there is equal access to influence the chief policy-makers for all groups."

The GCC's scientific position, however, is clearly untenable. There is an undisputed consensus in the scientific community that human-induced climate change is happening. Maisano could not deny it. Indeed, he seems to be unconvinced by his own rhetoric, admitting that "no one could disagree that there has been a one degree temperature rise in the last hundred and seventy years." Furthermore, by insisting that GCC members "have been very

active and aggressive in promoting voluntary action to reduce greenhouse gas emissions," he makes an implicit admission that climate change is a genuine problem – why else bother to take any action? "The fact that greenhouse gases are rising is a problem," Maisano concedes, astonishingly. "Now, are they human induced? Maybe, maybe not."

His response constitutes part of the dying remnants of the GCC's very confused, inaccurate battle against the science of climate change. A leaked memo from one of its own members, the American Petroleum Institute, confirms that it has lost the battle on the science with the public. There has subsequently been a subtle shift in their public statements, away from total denial towards arguing that even if climate change is happening, radical change would simply be too expensive, and that there is time to take a long-term approach.

In support of such arguments, the GCC claims that any meaningful action to prevent climate change would damage productivity, economic growth and jobs in the developed world because such action would necessarily push up energy costs and make Western industry uncompetitive compared to developing countries, which are not obliged to participate in international efforts to reduce greenhouse gas emissions. Once again, such claims are



The aftermath of Hurricane Andrew in Florida. As the GCC works to derail preventive action, more and more damage is wreaked on American towns as a result of the sharp increase in the frequency and violence of extreme weather events arising from climate change.

PERRINE/GREENPEACE

often derived from economic studies that GCC members have funded themselves and which are clearly flawed.

When it boils down to it, industry is actually *frightened* of being forced to change, to risk its vast profit-making operations. According to Maisano, "binding restrictions on an expedited timetable is somewhat unrealistic and impractical in an industry perspective. Industry has to be given a shelf-life of longer than 2008 to be able to retool their whole line of doing things." How long would it like? "Between 2040 and 2050 would be a more realistic option for significant action," Maisano claims. 2100 would be even better, because "it allows you to develop the new technology to replace the existing capital stock." Voluntary action would continue meanwhile, but nothing more: "what is being done now is enough," Maisano claims. For the GCC, even the Kyoto Protocol "is asking industries to jump off a cliff into an unknown abyss in 10 years." Progress will only be achieved "through the market process taking its role."

However, the GCC and the fossil fuel industry generally make the fatal mistake of assuming that there is time to spare, that the world's climatic systems will sit back and wait until industry is prepared to change or until the market responds. To assume, as the GCC does, that as long as technological changes are made slowly over time, "you're not going to get any costs from climate change," is extremely foolish (see 'The Economic Costs of Climate Change' p98). As Brent Blackwelder, Director of Friends of the Earth USA says, "Any businessman who can read and understand scientific journals ought to be scared to death, because we are fundamentally perpetrating a major climate experiment on all future generations." Unfortunately, US industry, in particular, is incredibly short-sighted. It is still absurdly shackled to the suicidal principal of generating immediate profits for shareholders no matter what, which leads company directors to focus exclusively on near-term costs at the expense of the long-term. As Blackwelder says, "business is supposed to be rational, but they are not, they do not pay attention here."

Too many large companies also falsely assume that only pain lies in store for those who change now. The development of new sources of energy and clean technology will bring great benefits. Even Maisano admits that "jobs are being created" through invest-

ment in renewables, and that money is already being made and saved by being more efficient and "producing products cheaper". So why not accelerate the pace and do more? Why continue to invest billions of dollars in developing or exploiting fossil fuels?

To be fair, there are signs that a small number of companies are beginning to ask themselves these very questions, and, partly as a result, the actual power of industry-sponsored lobby groups, like the GCC, is now starting to wane. Their reputations are undeniably tarnished and their cover blown, as politicians and media alike have condemned their distortion of the science and economics of the issue. Former US Under-Secretary of State Tim Wirth, for example, has dismissed them as "naysayers and special interests bent on belittling, attacking and obfuscating climate change science", while the *New York Times* accused them of waging a "systematic campaign of disinformation". Moreover, their ambition to block all international action on climate change is failing, and their advertisements have back-fired with a rise in the number of people who now think the US government should take action to prevent climate change. Even some of their own corporate members are now deserting them.

*Could the GCC deny that manipulation of the science went on? "There is a politicisation of this on all levels," industry – apparently – included. "depending on the way you look at the issue, you can get it to come up the way you want. It is just like a political poll..."*

Joining Shell and BP, in November 1998 Amoco announced that it was pulling out of the GCC, and, together with Ford, General Motors and even Southern Electric (the US' largest utility which has poured millions into the pockets of anti-treaty lobbyists), has decided to change tack and work with the Kyoto climate convention. They are not alone. The CEO of American Electric Power (AEP) recently announced, "It's no longer possible to say there is not a problem", deciding that human-induced climate change was the most likely explanation. In May 1998, AEP joined Boeing, Enron, Lockheed Martin, 3M, United Technologies (which has pledged to reduce its own energy use 25% by 2007) and seven other companies as founding members of the Pew Center on Global Climate Change, formed to search for ways to prevent climate change.

The motives of these companies are not particularly noble: all have been lured by the prospect of profits to be made from carbon trading and from cornering the market in renewable technologies, as well as a desire to have a hand in writing the policies that will deal with this issue in a way they find congenial. The extent and speed with which their rhetoric will translate into serious action is also open to doubt, not least because they continue to pour the vast majority of their investments into fossil-fuel-oriented projects. Nevertheless, their new positions mark a potential source of optimism for the future and an important recognition that industry cannot afford to ignore and oppose the overwhelming view of the global political, scientific and environmental communities and, more importantly, the laws of nature. It is high time that the rest of the corporate community realised this too.





# Fossil Crunch: The Arithmetic of Climate Protection

— BY MATTHEW SPENCER —

*Whatever the claims of the more 'progressive' oil companies, none has grasped the arithmetic of climate protection. Rather than slowing the exploration for new fossil fuels, they are escalating the race for new reserves. By doing so they fundamentally undermine our ability to avoid massive climate disruption.*

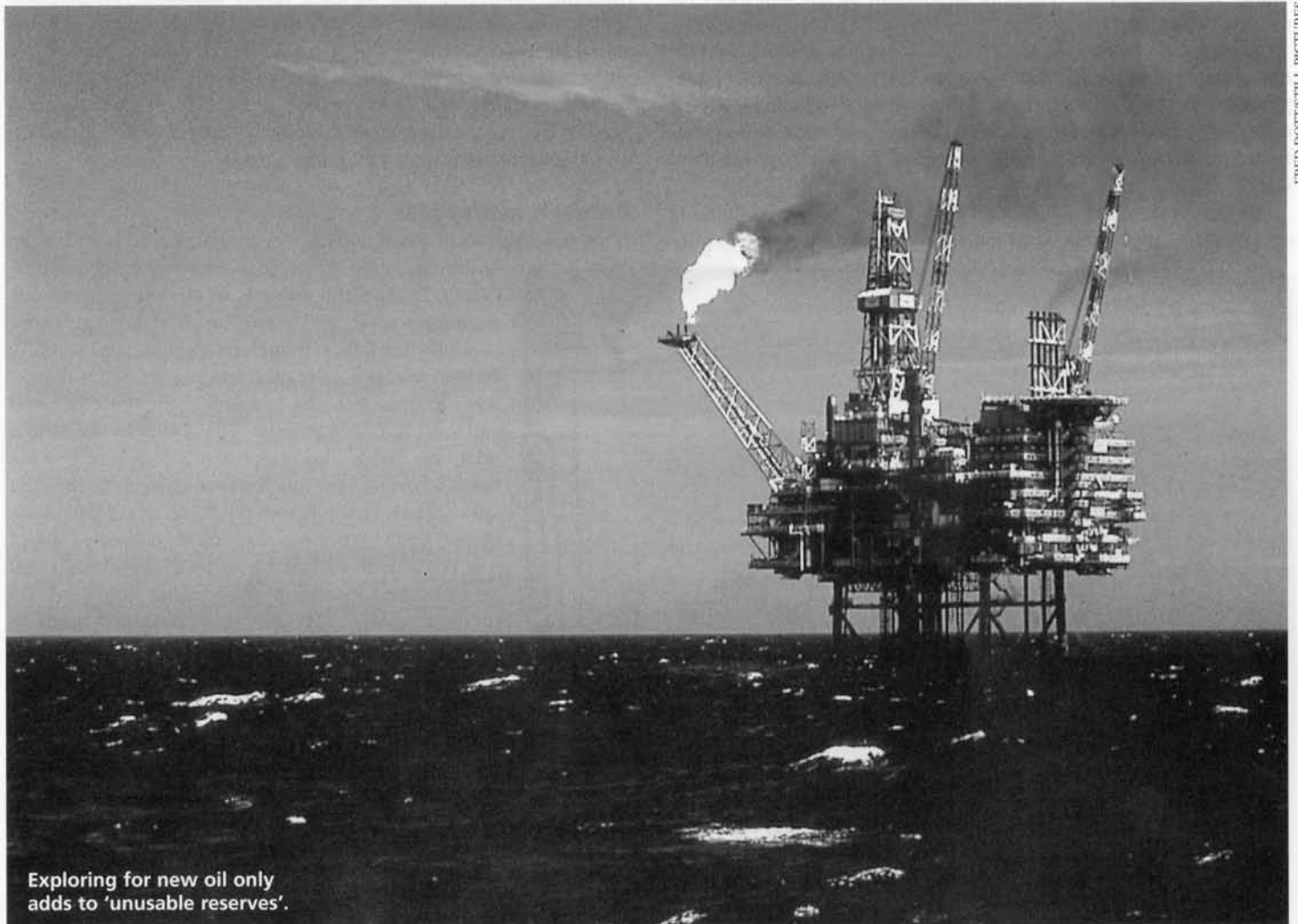
**T**he two years of intense political manoeuvring that led up to the Kyoto Protocol were tough for the oil industry. Under the pressure, the industry's painted smile began to crack. First BP, and then Shell, took the major step of admitting that human-induced climate change was an issue that had to be addressed.

This seismic shift was followed by a concerted effort to portray their activities in a new light. Shell began to talk with glee about their new renewable energy business and the prospects for solar energy and wind power. For BP the green theme became central to John Browne's orthodoxy of 'distinctiveness', key to his mission of separating his company's public image from that of the rest of

the oil industry.

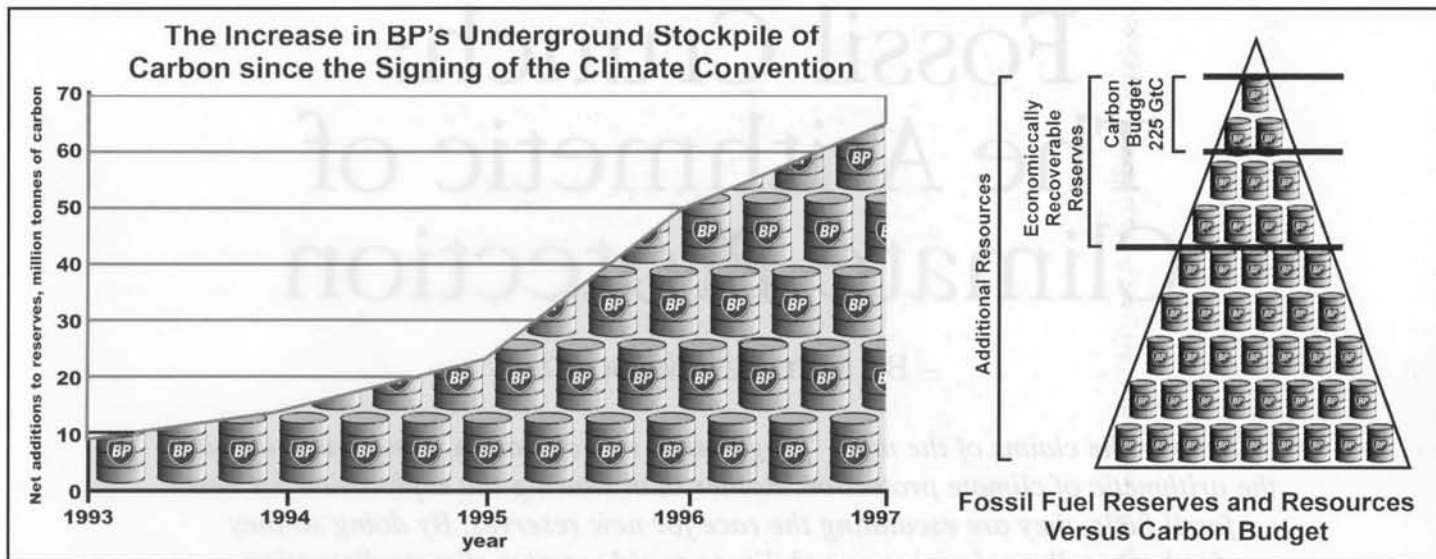
As a result, the perception of these companies amongst many policy-makers and politicians has shifted. The part that they played in splitting the oil industry's opposition to the Climate Convention means that they are now seen as having a positive role in the politics of the climate.

But has the Kyoto shakedown resulted in a real shift in company strategy? When BP's chief environmental officer was quizzed by a business magazine about the company's new environmental position it was clear that he didn't expect it to affect their core business: *Q: 'To what extent does BP's policy shift represent a change to the company's commitment to petroleum?' BP: 'It doesn't.'*



Exploring for new oil only  
adds to 'unusable reserves'.

FRED DOTT/STILL PICTURES



MALCOLM GRANT

In a world where climate protection can only mean massive reductions in the use of fossil fuels will such complacency wash with the public they seek so hard to impress? It seems unlikely – just when Big Oil thought it had mastered the language of environmental love, a trap-door opened beneath its feet. Ten years after governments first met to discuss action on climate change, the thinking on fossil fuels suddenly began to shift.

#### Oil shock

Cardiff, a capital built on coal wealth, is an unlikely place for a major Western government to reveal this shift in thinking on industrial policy but in September 1998 John Battle MP, the UK Minister of State for Energy & Industry, did just that. He took the highly unusual step of venturing an opinion on the end point for climate protection:

"The Kyoto targets are not enough. If we are to meet the ultimate objective of the Climate Change Convention, and avoid dangerous man-made climate change, then we need to stabilise global emissions at half the current level ... So our aim must be to greatly reduce our use of fossil fuels, indeed to eventually phase them out."<sup>2</sup>

Evidence that this was a sign of a wider change in thinking came shortly afterwards when the Royal Commission on Environ-

*Greenpeace's analysis suggests that we will be able to afford to burn less than 225 billion tonnes of carbon before breaking precautionary 'ecolimits' and making major ecosystem damage very likely... even assuming the world's forests don't become a major source of carbon, this carbon budget provides for less than 40 years of current fossil fuel use.*

ment and Pollution, the UK Government's think tank on the environment, confirmed that its next report would investigate the 'implications of phasing out fossil fuels'.<sup>3</sup> As part of the study it called for evidence on key policies needed to replace fossil fuels with renewable energy by the middle of the next century. Suddenly the assumption that the interests of a major oil exporting nation like the UK are the same as an oil industry committed to increased oil exploration and use is being challenged.

#### Nature's arithmetic

If the new rhetoric of fossil fuels is worrying to the oil industry the arithmetic upon which it is based is totally intimidating. In the ultimate analysis climate protection is a numbers game, and it's a game that they can't win.

Unfortunately, official climate policy is currently framed in terms of relative emissions, but it is possible to approach the problem from the other end and look at absolute limits. The ability to maintain a relatively stable climate system comes down to the bottom line of how much stored carbon reaches the atmosphere. Given that every barrel of oil and tonne of coal that is burnt increases atmospheric warming, it is possible to estimate how many fossil fuels can be burnt before certain temperature and sea-level limits are broken. By adopting ecological limits to temperature and sea-level changes, a carbon budget for human activity can be calculated. It makes the implications of avoiding dangerous climate change for energy policy immediately clear:

Greenpeace's analysis suggests that we will be able to afford to burn less than 225 billion tonnes of carbon before breaking precautionary 'ecolimits' and making major ecosystem damage very likely (see box). Carbon pollution from the burning of fossil fuels is currently contributing six billion tonnes of carbon to the atmosphere a year, so even assum-





ing the world's forests don't become a major source of carbon, this carbon budget provides for less than 40 years of current fossil fuel use.<sup>4</sup> It amounts to nothing less than the need for a fossil fuel phase-out within a generation.

The real shock for the fossil fuel industry is the 'crunch' that comes when such carbon budgets are compared with the oil, coal and gas reserves that have already been found. The carbon sitting in already discovered and economic reserves stands at approximately 1,000 billion tonnes, four times what can safely be burnt. Whether you make optimistic or pessimistic assumptions about how the climate works, something will have to give. Either millions of tonnes of oil, gas and coal which are already licensed for extraction will have to be kept under ground, or the world will see catastrophic instability in the climate system.

Exploration for new fossil reserves only exacerbates this conflict by digging even deeper into the mountain of carbon that can't be burnt. If yet-to-be-discovered and unconventional fossil fuels are added to this equation geologists estimate that another 3,000 billion tonnes of carbon lie under the Earth's surface.<sup>5</sup> In other words less than five per cent of the planet's total fossil carbon can be burnt before dangerous climate change becomes very likely.

The contrast between this reality and the behaviour of Big Oil could not be starker. In the last ten years the Petroleum Industry has obtained licences for new exploration covering a geographical area equal to the whole of Europe and the USA. In 1997, the year that the Kyoto Protocol was agreed, the oil industry spent an estimated \$39 billion on adding to carbon stockpiles by seismic testing and wildcat drilling for new oil in areas outside existing reserves.<sup>6</sup>

### The race for reserves

The desirability of opening up new hydrocarbon frontiers is an article of faith for the major oil companies. Some, such as BP, have specialised in being able to find and extract oil from frontier environments. It is currently leading the dash for deep-water oil in the European Atlantic Frontier using vast drilling ships that can reach to the very edge of the continental shelf. The technology is new, untried and untested, but BP knows that if it can perfect it in the UK, where an oil-friendly tax regime allows them to write off many of its development costs, it can sell its expertise to other companies trying to find new deep-water reserves.

The speed of the technological drive in the oil industry is breathtaking, and it allows the oil industry to continue to increase reserves at the same time as increasing extraction and driving down costs. In 1976 the maximum water depth for oil production was 200 metres.<sup>7</sup> By 1987 the 500-metre barrier was broken and in the last two years the 1,000-metre barrier came crashing down. Industry observers expect oil companies to be able to extract oil 3,000 metres below the surface of the sea in the next few years.<sup>8</sup>

In Alaska, where BP dominates the oil sector, the company is

## Working Out the Carbon Budget

### ECOLIMITS

In 1990 the United Nations Advisory Group on Greenhouse Gases specified the following 'ecolimits' for rates and magnitude of temperature and sea-level rise in order to protect both ecosystems and human systems from dangerous climate change:

#### Global mean temperature:

- Maximum rate of 0.1 degree C per decade
- Maximum increase of 1.0 degree C

They found that temperature increases beyond 1.0 degree C "may elicit rapid, unpredictable and non-linear responses that could lead to extensive ecosystem damage."

#### Sea-level rise:

- Maximum rate of rise 20mm per decade
- Maximum 20cm increase above 1990 levels

A 20mm limit on sea level rise would "permit the vast majority of vulnerable ecosystems, such as natural wetlands and coral reefs to adapt. Beyond this rate of rise damage to ecosystems will rise rapidly".

### CO<sub>2</sub> CONCENTRATIONS

The rate and magnitude of global temperature increase are primarily governed by the amount of CO<sub>2</sub> or its equivalent concentrated in the atmosphere.

If we continue to burn fossil fuels at current rates, CO<sub>2</sub> concentrations will double by the year 2060. According to the Intergovernmental Panel on Climate Change, a doubling of CO<sub>2</sub> in the atmosphere could cause temperatures to rise between 1.5 and

4.5 degrees C depending on how easily CO<sub>2</sub> in the atmosphere causes global climate to change (climate sensitivity). If the Earth's climate is less sensitive to CO<sub>2</sub> (or its equivalent in other gases), the increase will be at the bottom of this range. If it is more sensitive it will be at the top. Although the 'best guess' used by most governments is 2.5 degrees C, the IPCC have noted that the actual pattern of temperature change best fits an assumption of 3.5 degrees C.

To stay within the ecological limits defined above, taking a climate sensitivity of 3.5 degrees C as a prudent and precautionary approach, levels of CO<sub>2</sub> in the atmosphere have to be stabilised at or below 350 parts per million by volume (ppmv). This means bringing them down below current levels.

### THE CARBON BUDGET

Given the knowledge that keeping the long-term temperature increase below 1.0 degree C requires stabilisation of atmospheric CO<sub>2</sub> at 350 ppmv it is possible to calculate a carbon budget giving the total amount of fossil fuels that can be burnt.

Assuming a climate sensitivity of 3.5 degrees C, and making the optimistic assumption that destruction of the world's forests is halted, the total amount of carbon that can be released from the burning of fossil fuels is 225 billion tonnes. Current reserves total more than four times this amount.

If deforestation continues at the present rate the total budget for fossil fuels is even lower – approximately 145 billion tonnes of carbon.

pouring billions of dollars into new technology that will allow it to develop the first major oil field in offshore Arctic waters. If successful the Northstar project will have the first sub-sea pipeline under ice-infested water anywhere in the world, and it will mark a breakthrough in the colonisation of the poles by the oil industry.

Sadly, we can have little hope that oil, and still less other more carbon-intensive fossil fuels, will run out in time to prevent massive climate change. The result of all this frantic frontier bravado is that companies end up stockpiling reserves for the future, despite increased extraction and use of oil. Far from declining, proved reserves outside OPEC countries and the ex-Soviet Union countries have tripled over the last 20 years even while production has increased.<sup>9</sup>

Between the date of the signing of the Climate Convention in 1992 and the creation of the Kyoto Protocol in 1997 BP exploration activity led to the stockpiling of 60 million tonnes of carbon as oil reserves.<sup>10</sup> This is almost certainly just the tip of the iceberg, because companies are so secretive about their discoveries. Surprisingly it is Exxon, the most ideologically rabid of the oil companies that allows outsiders a glimpse of these hidden stockpiles. In line with industry practice they give an annual figure for their 'proven reserves', which in 1997 stood at 14 billion barrels of oil equivalent, but they also reveal that their total resource base stands at three times that level at 40 billion barrels of oil equivalent.<sup>11</sup>

Globalised competition fuels a carbon arms race against the

atmosphere because it creates the incentive for companies to increase production from existing reserves and to discover and open up new ones. Competition, and the technology-push it generates, has every company frantically trying to keep up with competitors on new reserve additions and guaranteeing massive atmospheric overload of carbon in the future.

### Jam tomorrow?

There is little or no advice to companies from governments about the wisdom of investments that generate these stockpiles. The dissonance between the time-scale that government is working to in the Climate Convention and the investment cycles of corporate oil is glaringly obvious. The Kyoto agreement reaches out feebly 10 to 15 years from now but oil companies are investing in deepwater and arctic developments with projected lives of 30 to 40 years. Faced with huge uncertainty around the returns from oil in 20 or 30 years one might expect the companies to be engaging in serious bet-hedging, and directing big flows of cash towards renewable energy. BP and Shell have recently trumpeted investments in solar photovoltaics as a sign of their good intent, but they fall far short of what is needed to make the technology widely available. The amount that Shell plan to spend on renewable energy in the next five years is less than 0.4 per cent of its turnover in one year.<sup>12</sup>

BP has used its tiny investments in solar power to wrap the company in a golden glow of environmental worthiness but it hasn't changed the availability of solar on the ground. Tony Blair may not have forgotten his visit to BP's ritzy solar hospitality suite at last year's G8 conference in Birmingham but a few months on it's still impossible to find or buy a solar panel anywhere in the city.

Through intensive PR around their solar subsidiaries Shell and BP have perfected the art of promising jam tomorrow. A recent BP leaflet announced with a great flourish "Solar's time has come: this will be one of the great enterprises of the 21st century".<sup>13</sup> But neither company has shown any sign of wanting to break solar out of its current high price ghetto. A BP-led study showed that solar electricity could be competitive with coal and oil if a big enough factory was built to bring production costs down.<sup>14</sup> The cost of making this breakthrough was estimated at £350 million, equivalent to just nine weeks of BP's exploration spend in 1998. BP has no plans to build such a factory. Most tellingly their business strategy for solar power continues to assume that solar can only be viable in 'niche' markets like telecommunications and navigation and makes no attempt to challenge markets where fossil fuels are dominant. Despite the fact that solar power could provide electricity for millions of homes in the Southern and the Northern world BP maintains the line that solar will not replace hydrocarbons in the near term, and should be viewed as an add-on rather than as a competitor to traditional energy sources.

### The end game

If the actions of oil companies continue to subvert environmentally-driven energy policy, what hope is there that they could adapt if the rules of the game were changed? In many ways the low oil price crisis facing the oil industry is a dry run for a world in which climate protection mechanisms start to bite. The current oil glut is testing the companies' ability to act together to curb supply – exactly what it would need to be able to do in a world where use of fossil fuels declined dramatically. The signs are not good – even the action of OPEC, the largest industrial cartel in the world – has failed to stop over-capacity and the resulting slide in oil prices. The failure of the industry to tackle the problem has demonstrated what independent observers have known for a very long-time – Big Oil is incapable of co-operating effectively even when it is in its own interest to do so. The companies with the cheapest reserves have least to lose from a glut, and in the end every company competes to beat each other's price.

The industry is a prisoner of its own dilemma – to avoid its

business crashing as fossil fuels lose favour requires a level of collaboration and foresight that has always eluded it. Instead individual companies use their political power to try to gain advantage and by doing so strengthen the walls of their own predicament. Rather than pushing for government intervention to spread the collective cost of lower demand for oil, the industry lobby pushes for lax tax regimes which encourage oil exploration and exacerbate oversupply.

*It is the Norwegian, the British and the Irish Governments that grant oil extraction licences to the sea floor of the Atlantic Frontier, the Clinton administration that decides whether to give permits for the use of dangerous new technologies in the Alaskan Arctic. By withholding these licences, these governments could massively increase the chances of avoiding severe damage to economies and ecosystems from climate change.*

Ultimately it is governments that have the responsibility to bring down the fortifications around fossil fuels. It is the Norwegian, the British and the Irish Governments that grant oil extraction licences to the sea floor of the Atlantic Frontier, the Clinton administration that decides whether to give permits for the use of dangerous new technologies in the Alaskan arctic. By withholding these licences, these governments could massively increase the chances of avoiding severe damage to economies and ecosystems from climate change. But while they wring their hands over the impacts of extreme weather they remain wedded to the principle of maximum oil supply at any cost.

The right of oil companies to dig the world deeper into the mire will continue to be challenged by Greenpeace for as long as government energy policy contradicts its commitment to stop dangerous climate change. It is only when the tap is turned off and oil exploration is halted that the oil industry supertanker will begin to turn. Only then will companies like Shell and BP be able to avoid the fossil crunch that will come with protecting the climate.

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### References:

1. Mike LaGraff, Head of BP Group HSE, interviewed in *Tomorrow* No. 5, Vol. VII, Sept-Oct 1997.
2. Speech by Mr. Battle to the Wind Energy Association Conference, 2 September 1998, Cardiff.
3. News release from the Royal Commission on Environmental Pollution, 23 September 1998.
4. Hare, Bill (1997) *Fossil Fuels and Climate Protection*, Greenpeace International.
5. The Second Assessment Report of the IPCC (1995).
6. Kretzmann, S. and Wright, S. (1998) Drilling to the Ends of the Earth: the ecological, social, and climate imperative for ending petroleum exploration, Project Underground, Washington DC, USA.
7. The Offshore Challenge, Shell Briefing No.2, 1993.
8. Mackay, T. "Industry explores into ever-deeper waters", *The World Energy Yearbook* 1998.
9. Mitchell, J., Beck, P. and Grubb, M. (1998) *The New Geopolitics of Energy*: RIIA/Earthscan.
10. BP Financial & Operating Information 1997.
11. Exxon Press Release 4 February 1998. "Exxon replaces 121% of Production in 1997: New Field Resource Additions Total 1.6 Billion Barrels."
12. Millais, C. (1998) Reputation and Reality: Shell's record on fossil fuels and renewables, Greenpeace briefing.
13. BP Solar leaflet 'Solar: this will be one of the great business enterprises of the 21st century' (1998).
14. Bruton, T. (1997) "A study of the manufacture at 500MWp p.a of crystalline silicon photovoltaic modules", 14th European Photovoltaic Conference, Barcelona, July 1997.



# Making Progress Towards a Fossil Free Energy Future

— BY STEWART BOYLE —

*'Unprecedented' is the word most often used by energy analysts in describing the challenge of shifting the global energy system away from fossil fuels over the next few decades. Yet such a shift must take place. What changes are required in our energy and economic systems to achieve this?*

The Fossil Free Energy Scenario, developed by the Stockholm Environment Institute (SEI) for Greenpeace International in 1993/94,<sup>1</sup> is one of the few existing scenarios that achieves greater than 50% fossil fuel reductions within 30-50 years, and gets close to a 'carbon logic' budget. While the base data is mainly from 1988-90, the technological assumptions and outcomes are still largely valid.

In the main scenario, the conventional assumptions made include growth in the global economy from \$15.4 trillion to \$212.3 trillion, population up from 5 to 11.3 billion, and energy consumption up from 338 exajoules (EJ) to 987 EJ.

While global GDP output is based on World Bank figures to allow cross-comparison with other scenarios, the relative level of GDP per capita is assumed to converge significantly over time, such that by 2100 there is no more than a factor of two difference between the regions of the world. This compares to a factor of 32 difference today. It is an acknowledgment that a global binding compact on carbon reductions is unlikely unless a path of 'contraction and convergence' is followed. The overall scenario results show that global carbon emissions are halved from current levels by 2030, and down by 70% by 2075.

*The important point to note is that technologies for all of these appliance target reductions all currently exist, either in commercial or near-commercial status.*

What would a world like this look like? In essence, the main changes would be in buildings, transport systems, industrial processes, and machinery. Assumptions include buildings which use less than 20% of current average consumption levels, appliances using 10-15% of current average levels, vehicle efficiencies approaching 100 mpg (Imperial) for the global fleet, much more effective and widespread mass transit systems in cities, the significant use of biofuels for transport and products formerly made from chemicals, and a clear presence of wind power, solar PV and thermal systems, and energy crops in the landscape.

More specifically on the energy supply side, hydrogen kicks in strongly after 2030, produced mainly from solar and other renewable sources such as wind. Modern biomass for industrial applications occurs strongly after 2030, and cogeneration from biomass provides a significant level of heat and electricity in all sectors and regions. One important point of equanimity to note in most of the scenarios referred to here, is that renewables contribute at least 200 EJ of supplies by 2050.

A significant improvement in energy efficiency is assumed in the scenario. For appliances, the energy intensity in the OECD

## Factor Four in a Global Context

'Factor four: Doubling Wealth – Halving Resource Use'<sup>2</sup> provides 50 detailed examples of a world where, according to authors Amory and Hunter Lovins and Ernst von Weizsäcker, "resource productivity can quadruple. Thus we can live twice as well – yet use half as much." It is based upon a host of practical examples around the world, including:

- Super-efficient homes in Frankfurt, Germany, which use 90% less heat and 75% less electricity than normal German homes
- Super-efficient and ultra-light 'hypercars' using hybrid engines giving 100 mpg in the short-term and 200 mpg-plus in the longer-term
- A commercial bank headquarters (ING Bank) in the Netherlands which is 12 times more efficient than its predecessor building
- Clever appliance design and minimum standards-setting in Denmark which can cut electricity use by 74% compared to 1988 levels
- Simple but effective technology and power management can cut office equipment electricity use by 80-90%. If extended globally, this would cut electricity consumption for this sector by 90 TWh over a seven-year period.
- A Chinese engineer in Singapore has designed the world's most efficient air-conditioning systems, using 60-70% less electricity than the norm
- Over a 11 years, a single dedicated Dow Chemicals engineer in Louisiana implemented more than 700 energy-efficiency projects giving payback periods of less than a year
- Modern chlorine-free paper-mills in Germany use 40 times less water than they did in 1974
- An integrated transport system in Curitiba, Brazil, has bucked the 'norm' of extensive car use. With a cheap and effective bus network, 70% of the inhabitants use the system, leading to a 30% lower petrol use when compared to other Brazilian cities

region reduces by a factor of four to five. This is at a greater rate than all the other scenarios apart from the The World Energy Council (WEC) 'Ecologically Driven' scenario.

*The important point to note is that technologies for all of these appliance target reductions currently exist, either in commercial or near-commercial status (see Factor Four box above). A similar pattern occurs for vehicles and buildings less so for industry. As Amory Lovins has noted: "Modern cars, after a century of devoted engineering refinement, use only 1% of their fuel energy to move the driver. An ordinary light-bulb converts only 3% of the power-plant fuel into light. The entire US economy is only about*



*To achieve anything even close to the levels outlined by the IPCC would require a global agreement to embrace high levels of energy efficiency, and a wholesale adoption of renewable energy technologies. At the same time, controls on fossil fuel use through carbon taxes and pollution quotas would have to be tough and well policed.*

land available for food. The resources needed for solar, wind and other renewable energy systems would also be very significant.

A range of FFES variants were hence modelled to test out the impact of different types of economic growth, as well as a much lower rates of population growth. Ranging from 20 to 35% lower GDP levels, a shift from materials to services, and a global population of 6.4 to 8 billion by 2100, the main impact is to reduce energy needs by up to 35%. While this significantly reduces pressures on land utilisation (to as low as 2%) and materials use for renewable technologies, it does not significantly impact on CO<sub>2</sub> emissions, which are already reducing at a very rapid rate. Conversely, if energy efficiency improvements proceed at only two-thirds of the rate assumed, energy consumption is 40% higher in 2100 and cumulative carbon emissions reach 400 billion tonnes.

#### **Forestry and biomass issues**

A key assumption in the scenario is that forestry ecosystems will return to net carbon sinks, rather than the net emissions that are occurring today. Background work for the FFES<sup>4</sup> suggested that a co-ordinated, international effort could halt net tropical deforestation by shortly after 2025, while 'industrial' plantations ranging from woodlots to agroforestry could attain a net sink of 0.57 billion tonnes of carbon per year by 2020. Added to commercial biomass, the net carbon flux would move from net emissions to a net sink around 2020, increasing from 0.5 billion tonnes of carbon to as much as 2.71 billion tonnes in 2100. Making this a reality would require significant policy intervention, broad acceptance of these measures by local people, sympathetic approaches to re-afforestation by commercial plantation owners, and strict policing.

#### **How much does change cost?**

This is a problematic area for any observer. The huge variation in results is mainly due to the model and assumptions used. A guide by the World Resources Institute to 162 predictions by the 16 top climate/economy models found that seven underlying assumptions explained 80% of the differences in their results.<sup>5</sup> Depending on, for example, whether there was any assumption on a 'back-stop' energy source, such as renewables, or whether tax revenues can be recycled efficiently, for a 60% carbon reduction in 2020,

A wind farm, generating renewable energy, overlooking the Atlantic in Galicia, Spain.

2% energy-efficient compared with what the laws of physics permit. National materials efficiency is even worse: only about 1% of all industrial material flows are actually put into and remain in the average product six weeks after its sale. Thus, despite impressive achievements so far, America still wastes upwards of \$300 billion a year worth of energy: more than the entire military budget, far more than the Federal budget deficit, and enough to increase personal wealth by more than \$1,000 per American per year.<sup>12</sup>

#### **Fossil Free Energy Scenario (FFES) variants – lower population, GDP and de-materialisation**

If the standard GDP assumptions of a 13-fold increase appear unrealistic to some – though 100 years at even small levels of GDP growth ends up with huge numbers – many environmentalists believe that major pressures on resources and carrying capacity will occur before this point. It is doubtful whether a new global impact on climate, and dramatically reduced energy needs and carbon emissions can be achieved if developing countries follow the West's pattern of economic growth. This would place tremendous demands upon resources and technology. Very large areas of land mass would be needed to grow energy crops for alternative fuels for example: up to 9%. This would place major pressures on the



# Likely Climate Impacts of the FFES8

Assuming a 2.5°C climate sensitivity

- Decadal warming rate falls to below 0.1°C per decade by 2020, before falling to a negative rate by 2060
- Mean temperature increases are limited to less than 1.5°C by 2040 before falling to 1.25°C by 2100
- Mean sea level rise kept to less than 25cm

the seven main assumptions can predetermine whether the model shows a 7% reduction or a 5% increase in GDP.

In the FFES, costs were calculated using bottom-up engineering models which assumed cost competitiveness of efficiency and renewable technologies by certain dates, plus policy interventions such as minimum energy efficiency standards and utility regulation. In addition, a range of carbon tax levels was simulated on a partial equilibrium model to see if a near fossil fuel phase-out

*There is a huge amount that can be done to cut carbon emissions deeply and quickly. What is currently lacking is the political will to do so.*

could take place.<sup>6</sup> Three tax levels were simulated, at \$17.2, \$100 and \$150/t CO<sub>2</sub>. The global GDP impacts were generally negligible, mainly due to the assumptions made on reducing renewable energy costs. However, assuming a higher level of solar costs, the biggest impact compared to a 'business-as-usual' scenario was 1.12% of GDP in the year 2050. This is a modest figure when set against the GDP assumptions made in the model. While the transition costs are difficult to determine, and significant R & D and initial subsidy support to renewables is essential, even the WEC scenario assumes that this would amount to only 0.1% of the annual GDP in the year 2000 assuming all of the expenditure took place in one year.<sup>7</sup> In practice, it would be spread over several decades.

In contrast to current trends which have taken warming rates above 0.1°C per decade and absolute temperature increases on a path to between 3°C-3.5°C by 2100 (assuming the higher climate sensitivities which recent Hadley Centre models suggest), the FFES brings significant climate benefits. These are summarised below.

## Policies to move towards a fossil free energy future

"If technology was the problem, we would have solved the climate crisis years ago." The speaker was a senior negotiator in the UK Government's climate change team, frustrated and tired with the slow progress of negotiations, in the small hours of the morning in Buenos Aires (COP-4) in November 1998.

As this brief look at global energy scenarios and technologies has suggested, there is a huge amount that can be done to cut carbon emissions deeply and quickly. What is currently lacking is the political will to do so. Political will to implement policies which change our current perverse taxation system, currently encouraging people to use more polluting energy. Policies to cut out the most inefficient and dirty technology which causes a disproportion-

ate amount of pollution, while rewarding technology at the top end through tax breaks and other incentives. Policies to give renewables a level playing field, including fair access to the electricity grids, a fair price which reflects their low environmental impact, and procurement initiatives to bump-start a market.

Based on successful examples all over the world, documented by the IEA<sup>9,10</sup>, Lovins et al<sup>11</sup>, and the Dutch Ministry of Finance<sup>12</sup>, a package of policies to implement a fossil free future should include the following:

- Introducing energy taxes which reflect the damage caused by energy use, with recycling of tax revenue to reduce labour taxes and provide investment incentives for energy efficiency, cogeneration and renewable energy
- Removing all remaining subsidies for fossil fuels and nuclear power, estimated by the OECD to amount to \$215-235 billion per annum<sup>13</sup>
- Removing the wider range of market barriers to energy efficiency and renewable energy. Lovins documents 27 of these<sup>14</sup>
- Setting tough minimum efficiency standards for buildings, appliances, industrial processes and vehicles
- Local and national government purchasing programmes for energy efficient equipment and renewable energy technologies
- Shifting energy research and development away from fossil fuels and nuclear power towards efficiency and renewables

All of these policies are critical in setting the market conditions for companies to plan new investment strategies over the next few decades and beyond. Given a market price for carbon for example, the share of investment given by businesses for renewables would increase very rapidly.

# Energy Microsofts vs Energy Dinosaurs

The Worldwatch Institute has postulated a future where a new breed of energy companies, involved in fuel cells, wind turbines, solar PV cells, cogeneration and electric vehicles, become the dominant companies involved in global energy demand and supply.<sup>16</sup>

No one can predict the outcome of the business world in the energy sector. Few analysts predicted today's oil prices of less than \$10/barrel even a few years ago. The important point to grasp is that change will impact on every major energy company operating today, and not all will survive. Expect significant turbulence, takeovers, break-ups and rapid growth in companies who bet correctly on new technologies and fuels.

COMPANY	TECHNOLOGY	START-UP DATE	CAPITALISATION
<b>(SM)</b>			
<b>The Energy Microsofts?</b>			
Ballard (Canada)	Fuel cells	1979	2,360
Vestas (Denmark)	Wind Turbines	1987	204
Trigen Energy (USA)	Cogeneration	1986	182
Energy Conversion Devices (USA)	Solar PV cells,	1960	74
	Electric batteries		
Solectria (USA)	Electric batteries	1989	n.a.
<b>Transition Companies?</b>			
BP (UK)	Oil, gas, solar	1901	88,618
Enron (USA)	Gas, solar, wind, efficiency services	1985	17,627
Shell (UK-Neth's)	Oil, gas, coal, solar, biomass	1907	164,156
<b>Dinosaur Companies?</b>			
Exxon (USA)	Oil, gas	1911	172,212
Rio Tinto (Formerly Cra Ltd)	Coal	1995	16667

(The merger companies are much older than this)

Additional Sources: Times 500 1999, Fortune 500; op cit ref. 33; Shell, Exxon, BP-Amoco, Rio Tinto web sites.

## Germany – Leading the Way in Preventing Climate Change?

The new German SPD-Green coalition government holds out the hope of building a sustainable society that minimises its impact on climate.

It has reaffirmed Germany's commitment to a 25% reduction below 1990 levels of CO<sub>2</sub> emissions by 2005. To achieve this, road tax is to be replaced by a tax based on mileage. The development of a three litre car and 'Transrapid' maglev railway system is also promised. German car companies have already made very substantial progress towards developing cars that will be able to run on non-polluting hydrogen. The government's 100,000 solar roof project, Europe's largest solar initiative, aims at kick-

starting and lowering prices for solar energy. Wind energy has gained enormous popularity and already provides 17% of Schleswig-Holstein's energy. The use of biodegradable products to create heat is common and could save 8.2 bio. Kw/h p.a.

The coalition treaty between Chancellor Schroeder's SPD and the Greens also assigns particular importance to socio-ecological research – funding projects on renewable energies with 300 million DM (£100 million). This is likely to be accompanied by a periodical increase of the ecological tax to generate more revenue for renewables and to create a real incentive for energy-saving.

German taxpayers currently subsidise nuclear power to the tune of 50 billion DM (£17 billion) every year. The general elections showed that they are unwilling to do so any longer. The government's pledge to abandon nuclear energy by 2030 proved an electoral success and will pave the way to a transfer of funds to much more cost-effective and ecologically sustainable renewable technologies. Whilst the German Environment Minister Jurgen Trittin's draft legislation to phase out nuclear power generation has not as yet been accepted, it will be re-examined towards the end of March.

*By Stephanie Roth*

### Conclusions – unprecedented changes to achieve fossil fuel phase-out

BP has now set itself a target reduction of 10% in carbon emissions by 2010 and places a higher emphasis upon BP Solar as a growth business. Shell International has made a similar target and has made Shell Renewables an operational company, with solar, biomass and possibly wind as growth technologies.<sup>15</sup> At this stage, the level of investment is not yet commensurate with the risks of climate change. But while fossil fuels still provide the bulk of their earnings, the intent and direction has at least been indicated.

The scale of the changes needed in the global energy system will require many such companies to undertake dramatic transitions away from fossil fuel investments. As the World Energy Council has noted, achieving greater than 50% of energy supplies from renewable energy will require "a comprehensive and sustained new effort of the entire international community that includes the realignment of priorities and economic policy". That indeed is the challenge.

As will be clear from this short paper, the changes needed in the global energy system are certainly unprecedented. Significant energy efficiency improvements of the order of 2-2.5% per annum took place in the midst of an oil price crisis from 1973-86 (Schipper and Meyer)<sup>17</sup>. However, there is no precedent for sustaining a rate of improvement of 1.5-2% per annum over 40-60 years (the long-term average is around 1% per annum). Sustaining renewable energy growth rates at 20-40% per annum will also be needed over many decades. Sustaining political focus for many decades will be a major challenge.

There are many examples of effective policies and practices in some countries which are developing wind technologies, cogeneration, and efficient buildings and appliances. However, to achieve

anything even close to the levels outlined by the IPCC would require a global agreement to embrace high levels of energy efficiency, and a wholesale adoption of renewable energy technologies. At the same time, controls on fossil fuel use through carbon taxes and pollution quotas would have to be tough and well policed. This is a tall order for a world where free markets and economic globalisation are the dominant way of thinking for most politicians and multilateral institutions.

'Unprecedented' does not mean impossible. It is not the technological aspects of climate change that are the biggest problems facing human beings on the planet today. We already have most of the technologies needed to shift economies on to a high efficiency and low-carbon path, though efficiency and cost improvements are needed. We also have many examples of effective policy in a range of countries which encourage more sustainable business investments. The biggest challenge of all is that of will, and to bend the political system to serve the people at a time of crisis, rather than the vested interests it too often serves.

Stewart Boyle is a freelance writer and energy consultant. He was previously European Director of the International Institute for Energy Conservation.

### Notes:

1. Stockholm Environment Institute, *Towards a Fossil Free Energy Future: The Next Energy Transition*, Boston, 1993.
2. Amory B. Lovins & L. Hunter Lovins, *Climate: Making Sense and Making Money*, November 1997.
3. Ernst von Weizsäcker and Amory Lovins et al., *Factor Four: Doubling Wealth – Halving Resource Use*, Earthscan, 1996.
4. Roger Kayes, *Carbon Sequestration: A Technical Analysis*, in *Towards a Fossil Free Energy Future: The Next Energy Transition*, Boston, 1993.
5. R. Repetto & D. Austin, *The Costs of Climate Protection: A Guide for the Perplexed*, WRI, Washington DC, 1997.
6. P. Wade and S. Boyle, *Economic Appraisal of Fossil Free Energy Scenario*, Stockholm Environment Institute, *Towards a Fossil Free Energy Future: The Next Energy Transition*, Boston, 1993.
7. UN Development Programme, *Energy After Rio*, New York, 1997.
8. P. Wade, *Likely Impacts of the FEES*, Stockholm Environment Institute, *Towards a Fossil Free Energy Future: The Next Energy Transition*, Boston, 1993.
9. IEA report for Aarhus Environment Ministers Conference, *Energy Efficiency Initiative*, 1998.
10. IEA, *Renewable Energy Issues*, Paris, 1998.
11. *Op.cit.* 3.
12. W. Vermeed & J. van der Vaart, *Greening Taxes: The Dutch Model*, Kluwer Academic Publishers, Dordrecht, April 1998.
13. Laurie Michaelis, *Reforming Coal and Electricity Subsidies*, Working Group Paper No.2, OECD, 1996.
14. *Op.cit.* 2.
15. see [www.shell.com](http://www.shell.com).
16. Lester R. Brown et al., *State of the World 1999*, Worldwatch Institute, Norton, Washington DC, 1999.
17. S. Meyers & L. Schipper, *Energy Efficiency and Human Activity: Past Trends and Future Trends*, Cambridge University Press, 1992.



Emission-free transport: a solar-powered car.



# Solar PV: Talisman for Hope in the Greenhouse

— BY JEREMY LEGGETT —

*In staving off severe climate change, solar photovoltaic (PV) energy could offer our biggest hope. Possibly the single most important thing we could now do is build a PV-manufacturing plant big enough to allow the economies of scale that would allow PV to generate electricity at the same price as carbon fuels.*

**B**efore the last British general election, Michael Meacher and John Battle – future Ministers of Environment and energy – asked me to set up an industry taskforce to advise the Labour government about PV. It was to be an industry solar taskforce, rather than a solar industry one: a body representative of key sectors across a wide range of British industry. Eastern Electricity joined from the utility sector, NatWest from banking, General Accident from insurance, Foster and Partners from building, and so on. BP and Intersolar represented the solar industry. This taskforce concluded in 1997 that the global warming threat was so dire that all renewable and efficient energy technologies were “vital”, but – let me emphasize this – “solar PV could be the single most important long-term means of achieving the deep cuts in greenhouse-gas emissions which are the ultimate agreed Objective of the Convention on Climate Change.”

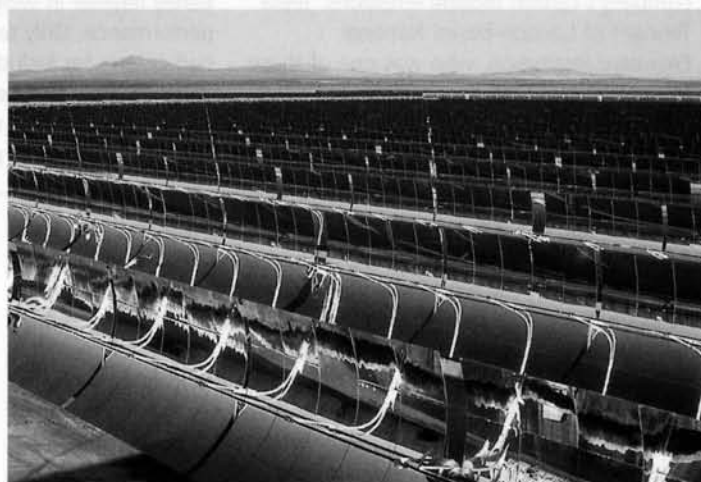
How could such a heavyweight body of business players draw such a conclusion about a technology currently far more expensive than coal- and gas-fired electricity, with a global manufacturing capacity less than a tenth the size of a typical coal-fired power station? That they did speaks volumes for the technical potential and readiness of PV.

The fact is that with existing solar PV technology, a home, office or factory can today generate more electricity than it draws from the grid. If necessary, a building can in effect act as a stand-alone pollution-free power plant, needing no mains electricity, no gas, no oil – even in cloudy northern latitudes. The roof, the walls, even the windows can all be trapping the heat of the sun and turning it directly into electricity via solar PV cells. Solar-thermal collectors can trap still more of the sun’s rays, turning them into plentiful hot water.

High-efficiency batteries and fuel cells can store electricity for later use. Solar electricity can be turned into hydrogen to be burned as pollution-free fuel. Cars, lorries, and buses could be pollutionless solar vehicles, battery vehicles, hydrogen vehicles, or a combination of these. Indeed, solar PV could in principle supply all the world’s energy demands many times over, cutting global energy-related greenhouse-gas emissions close to zero.

So why is it that today PV – having been powering satellites since the dawn of the space age – meets only a tiny fraction of one per cent of global energy demand? Given that we now know we are in the process of cooking our own planet with greenhouse gases from oil, coal and gas, imagine trying to explain this negligence of PV use to an extra-terrestrial visitor. The thought would be hilarious if the situation were not so tragic.

The best and cleanest of the various PV technologies is probably amorphous silicon thin film. Thin-film technology is less efficient but much cheaper than the older and better known crystalline



A solar energy plant in the USA.

silicon technology. The biggest thin-film-PV-manufacturing plant in the world today produces less than 10 megawatts (MW) per year. The biggest crystalline silicon plant produces only 25 MW, and global PV production of all types last year was only 160 MW. It is because of these low volumes of production that price is so relatively high. The vital point is this. Economies of scale when manufacturing PV in a thin-film plant producing 100 MW per year would mean that PV solar panels can be manufactured at a cost allowing electricity generation at prices competitive with coal and gas.

Exxon and the American oil companies deny that PV is particularly relevant to any energy policy debate, just as they continue to profess that global warming is nothing much to worry about. BP and Shell have recently discharged themselves from that lunatic asylum, to their credit. For them, global warming is a problem, and solar PV is indeed a solution. But they profess that a 100 MW per year thin-film-manufacturing plant cannot be built yet. Shell has entered the PV markets by manufacturing small amounts of crystalline silicon, saying they are waiting on technological improvements in thin-film technology. BP is still in the business of putting solar PV on petrol stations, ostensibly to test how well it works. (And yes, you guessed it: they sell more petrol in those stations. People like the idea of PV).

Half a century after we split the atom, a quarter century after we put a person on the moon, how can BP and Shell expect us to accept that solar PV still needs this kind of testing? How do they know they can’t build a 100 MW manufacturing plant when they haven’t tried?

How much would it cost to build a price-busting plant? The

DANIEL DANCER/STILL PICTURES

## How has the Insurance Industry Reacted to Climate Change?

Concern about climate change has been building in the insurance industry for some time. Since the early 1990s, when Greenpeace suggested ways that insurers – that are also in effect investment bankers – could influence investment decisions so that risks might be reduced, initiatives have multiplied. Among the most significant are an Insurance Industry Initiative for the Environment set up by the United Nations Environment Programme in partnership with some leading companies, and increasing funding from the industry for scientific research into climate change.

In November 1997, UNEP launched a corporate global warming indicator (GWI). This provides a single-figure estimation of a company's carbon dioxide emissions. Tessa Tennant of London-based National Provident Institution, who was one of those to develop the GWI, says the reception has been good but much more work is needed: "The next step is to reach greater

agreement on a standardised approach across sectors, which is now happening with the World Resources Institute. The big accountancy firms must buy into the methodology too. Then [the results] must be disseminated widely and translated into other languages so that a case can be put at the next Conference of the Parties [to the Framework Convention on Climate Change] for governments to adopt and promote it as part of their national accounting standards."

But the GWI will run into a lot of complacency in the mainstream. A UN Development Programme survey last year of US financial analysts and chief financial officers showed that environmental factors barely register in weighing corporate performance. Only ten per cent said they had criteria for including environmental issues in their analyses. "The gut instinct of most is to say this is nonsense, that if you want environmental performance it will be

at the expense of financial performance," says one observer. In reality, a three-year test has shown that companies with strong environmental management outperformed the Standard and Poor's index of top 500 US companies by 3.5 per cent.

Andrew Dlugolecki is among those pushing for change. "We encourage our investment analysts to inquire what their target market is doing by way of strategy to cope with global warming, both in terms of direct impacts and government policies in their sector. For instance, are motor manufacturers really taking notice of the need to cut fuel consumption?" He believes UNEP's initiatives will gather strength, but that many aspects of the challenge will have to be tackled at a national level under democratic scrutiny.

*By Caspar Henderson: a writer and analyst based in Oxford, UK.*

answer is about \$100 million. A single oil rig can set you back \$4,000 million these days. We are talking about less than a leg off an oil rig to show the world that electricity can be generated by the sun as cheaply as it can by burning fossil fuel, pretty much anywhere we want it, even in cloudy latitudes.

When the first of these plants is built, the world in general and perhaps China in particular will look at it and say "we want one of those." In fact, many of those. The solar revolution would have started, and a crucial seed of hope would have been planted. Solar PV is a disruptive technology, attractive for many reasons other than simple clean air. It would in all probability bite its way into the global electricity supply market – a market on track to soon reach the trillion dollar mark – with the speed of mobile phones and microcomputers combined.

The Solar Century knows how to build the first 100 MW thin-film-PV-manufacturing plant. We are working hard with our partners to try to do it. You can help us. We open for business in the UK in late March. We begin by seeking pioneer customers for rooftop PV in the UK's electricity supply market, which deregulates in April. Because of the small volumes of PV production today, we can't hope to compete on electricity price with utilities burning coal. But we can ease the pain of the high cost of today's PV for our pioneers. NatWest will be allowing our customers to spread the cost across a 25-year home mortgage. Potential customers will be able to see our PV roof tile products at the Earth Centre, and on our website, [www.solarcentury.co.uk](http://www.solarcentury.co.uk). They will be able to visit our small showroom/office, and our demo home – the UK's first solar PV roof tile home – in Richmond, Surrey UK.

Within a year, we hope to have installed PV roofs for our first hundred pioneer customers. At the same time we will be working with progressive financiers to capitalise the first 100 MW plant, so that as soon as it begins production, we will be able to compete on equal terms with the utilities burning coal. The more evidence of consumer support we have, the better our chances of being able to build the big price-busting plant.

We are not alone in pursuit of that goal, and others may beat us to the target. Fine. We will rejoice along with them. But we hope very much to be first. We believe there will be additional advantages for the global environment, not to mention sustainability and social equity, if we are. We will be giving away at least five per

cent of our gross margin – our income after direct cost of sales – for use to empower the neediest in developing countries with PV. Our charity, the Solar Century Global Community Fund, will exist only to empower those most in need. We will be the first company anywhere to do such a thing. We hope to show the way to a capital and technology flow from North to South which addresses another of the great environmental imperatives of our times.

There are two other reasons why we hope people will be keen to help us. Unless China can be persuaded to take up solar power, and eschew coal, nothing else that can be done in terms of environmental improvement around the world will ultimately matter. There is enough coal in China to cook the planet several times over if it is burnt and, as things stand, the Chinese seem set to burn it. The Solar Century is setting up an office in Beijing with the sole intention of making clear the solar alternative. It seems we cannot rely on Shell to help here. On a recent British government renewable energy trade mission to China, Shell sent not a representative of their new renewables company but the head of public relations for Shell Oil in south-east Asia.

Finally, The Solar Century has worked for several years now to persuade the numerous insurance companies that have professed to be worried about unmitigated enhancement of the greenhouse effect to amend their investment behaviour accordingly. Insurers have for years been investing a river of capital in technologies and industries which fuel – quite literally – a threat of mass bankruptcy in the global insurance markets. Their efforts to redress this potentially suicidal behaviour have been, with a few noble exceptions, utterly inadequate (see box). But of late, pioneering insurers like Swiss Re have succeeded in diverting a small stream of capital from the dysfunctional river flowing to carbon fuels. The Solar Century aims to create investment vehicles around the world which provide a platform for that trickle of change to become a flood. We hope to fashion a magnet that will progressively attract enough capital from carbon to solar to kick-start the solar revolution.

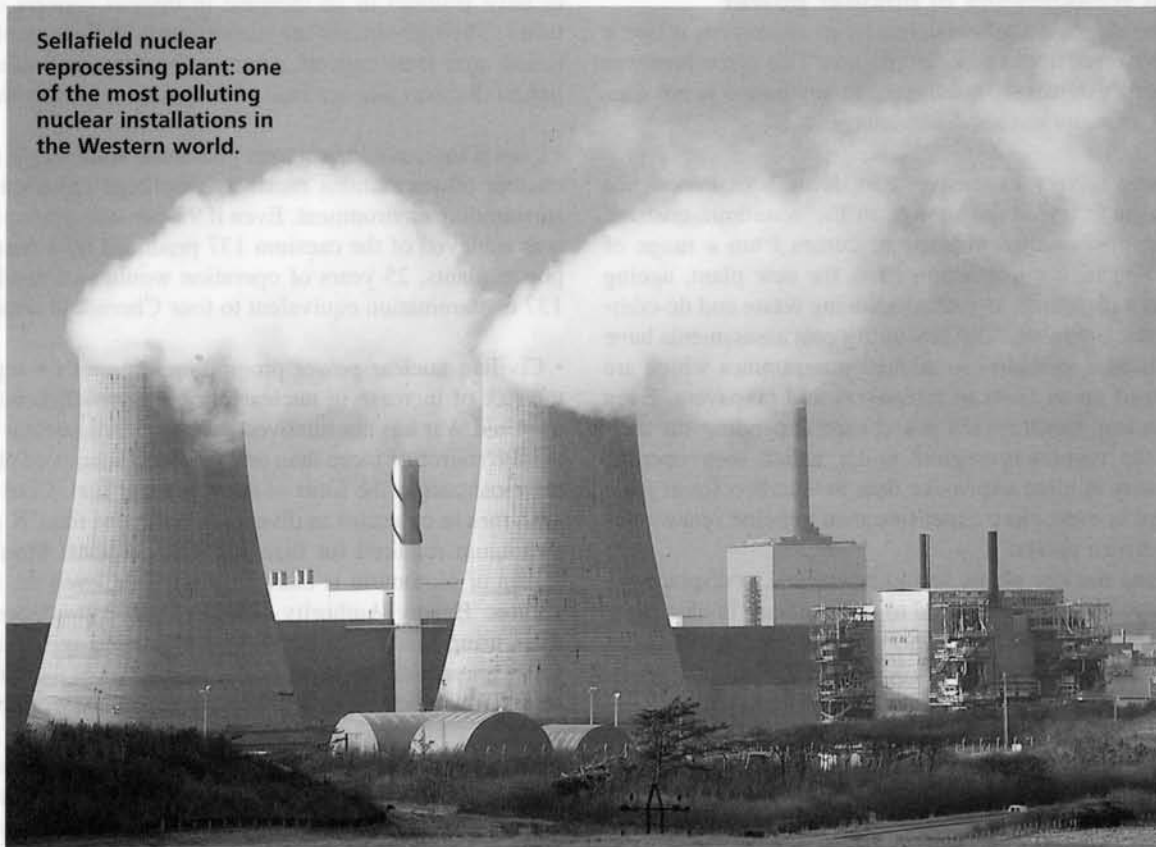
Jeremy Leggett is Chief Executive of The Solar Century, an international solar developer. He is the Charterhouse Fellow in Solar Energy at Oxford University's Environmental Change Unit, where he directs a team researching solar energy funded by a British merchant bank.



# Nuclear Power and Climate Change

— BY CHARLIE KRONICK —

Sellafield nuclear reprocessing plant: one of the most polluting nuclear installations in the Western world.



DAVID DRAINSTILL PICTURES

*Hoping to reverse its recent decline, the nuclear industry is now presenting itself as a key carbon-free alternative to other forms of electricity generation. Policy-makers, however, should beware: to reduce carbon emissions, nuclear is three to four times more expensive than a mix of renewables, energy-efficiency and co-generation, and retains unacceptably dangerous and insurmountable liabilities.*

Since the late 1980s the nuclear industry has been in steep global decline, particularly in Europe and North America. After the massive accident at Chernobyl<sup>1</sup>, construction of nuclear power stations has reached an almost complete standstill. Within the EU, seven of the fifteen countries have either phased out nuclear power or never built reactors. All the other countries, only France has one reactor under construction and this is scheduled for completion in 1999. Sweden, the Netherlands and now Germany have phase-out programmes. In others, such as the UK and Spain there are no plans for new reactors, making a de-facto phase-out for the nuclear industries there.

Nuclear waste management has proved an intractable problem worldwide: geologically stable and politically acceptable waste repositories are proving elusive. In any case, a waste dump does not make the waste safe; it merely relocates the problem.

The expensive and hazardous nuclear fuel reprocessing industry in the UK and France (based at Sellafield and Cap de la Hague)

are now threatened by shrinking profitability and increasing restrictions on releases of radioactivity into the environment.<sup>1</sup> Nuclear technology with its complex matrix of unattractive characteristics, has proved "fearsome to manage both socially and politically".<sup>2</sup>

## A change in the weather?

In such an environment, the nuclear industry has unsurprisingly embraced climate change as a sign of a potentially welcome change in its fortunes. The industry is heavily represented at the negotiations of the FCCC, with 150 officially registered delegates – compared with only 21 registered by the Global Climate Coalition – the principal fossil fuel lobbying group. At Bonn in June 1998 and in Buenos Aires in November 1998, the industry continued to present itself to negotiators, government representatives and commentators as a carbon-free alternative to other forms of electricity generation.

Within its own constituency, the nuclear industry is surprisingly frank in its assessment of the opportunity provided by climate change: the "global climate issue is good for nuclear but the industry needs to build bridges with some environmentalists[!] ...plants have to be economical; global warming will not justify high cost operation".<sup>3</sup> Yet while the nuclear industry may see the climate issue as "good" news, not all stakeholders have proved open to nuclear industry persuasion. Even the European Union – no hotbed of environmental radicalism – is sceptical about the claims of the industry. EU Energy Commissioner Christos Papoutsis questions the assertions of the nuclear industry while endorsing renewable forms of energy.<sup>4</sup>

### The critical weaknesses of nuclear power

The basis of the claims made for nuclear by its champions is that it is low in, or even free from carbon emissions. This claim however – which has been extensively questioned in any case – is not adequate to offset its many serious disadvantages.

- Nuclear power is very expensive: two decades of experience have shown a huge uncertainty range in the economic costs of nuclear power; cost escalation pressure comes from a range of sources including high construction costs for new plant, ageing and maintenance problems, as well as growing waste and de-commissioning costs. Unrealistically low utility cost assessments have created huge hidden subsidies to nuclear programmes which are inevitably passed on as costs to ratepayers and taxpayers. Even once built, nuclear facilities are not cheap: depending on their location and the regulatory regime under which they operate, nuclear electricity is more expensive than low carbon fossil fuels such as gas and is even more expensive than genuine renewables like wind and hydro power.<sup>5</sup>

Five thousand nuclear plants would be needed to displace the 9.4 TW (terawatts) of coal estimated to be necessary in electricity generation in the world by 2025. This is clearly in the realms of fantasy when account is made of the deployment of capital necessary for the task. It would necessitate a new plant starting con-

*In terms of carbon abatement, nuclear energy is also expensive. A mix of renewables, energy efficiency and co-generation is three to four times cheaper than nuclear power for reducing carbon emissions compared with coal-fired power stations.*

struction every 2.5 days, even with a favourable six year completion time. On the basis of highly optimistic assumptions concerning capital costs and plant reliability, total electricity generation cost would average \$525 billion per year, with the share burdened by developing countries amounting to \$170 billion. That share would be for 155 times more nuclear capacity in developing countries compared with today.<sup>6</sup>

In terms of carbon abatement (the cost of reducing CO<sub>2</sub> emissions compared to 'business as usual') nuclear energy is also expensive. A mix of renewables, energy efficiency and co-generation is three to four times cheaper than nuclear power for reducing carbon emissions compared to coal-fired power stations.<sup>7</sup>

- The nuclear industry has not and cannot economically solve the problems of waste and decommissioning: the failure of Nirex in the UK to obtain permission to build the first stages of an underground waste repository for medium-level nuclear waste illuminates the political aspect of this problem. In any policy environment policy, the timescales – literally hundreds of millennia – required for management of nuclear waste underline the impossibility of any such repository ever being 'safe' or 'sustain-

able'.

Reprocessing of nuclear waste does not eliminate it; it transforms small(er) volumes of spent nuclear fuel into medium- and low-level wastes, plus highly concentrated high-level waste. Both of the major reprocessing plants in Europe – Sellafield in the UK and Cap de la Hague in France – have been responsible for large discharges dangerous radioactivity into the air and sea.

- Nuclear power is subject to the risk of a major accident. The financial costs of such an accident are difficult to assess, but have been estimated to range from several billion US dollars<sup>8</sup> to *several thousand* billion US dollars.<sup>9</sup> Costs in human terms are also difficult to assess, but the accident at Chernobyl in 1986 is calculated to have resulted in an increase in thyroid cancers of up to 100 times. Thyroid cancers are seen as early indicators of other, additional, non-fatal cancers, genetic disorders and other radiation-linked diseases that are likely to manifest at a later date.

- Even if there could be a total guarantee of no major accidents, all nuclear power stations routinely discharge radioactivity into the surrounding environment. Even if 99-per-cent perfect containment was achieved of the caesium 137 produced by a hundred nuclear power plants, 25 years of operation would still result in caesium 137 contamination equivalent to four Chernobyl accidents.<sup>10</sup>

- Civilian nuclear power programmes cannot be separated from the risk of increase in nuclear weapons proliferation. The end of the Cold War has not removed that risk; civil nuclear programmes are the source of more than one thousand tonnes of plutonium, for the most part in the form of spent nuclear fuel. Civil nuclear programmes in countries as diverse as India and the UK produced the plutonium required for their nuclear weapons. Monitoring these stocks of plutonium is extremely difficult; even the International Atomic Energy Authority (IAEA) lacks confidence in its own monitoring system: "the IAEA's verification system cannot physically prevent diversion of nuclear materials or the setting up of an undeclared or clandestine nuclear weapons programme."<sup>11</sup>

- Nuclear power is not free from carbon emissions, as an analysis of the entire cycle of producing nuclear energy makes clear. Producing nuclear power requires the mining of uranium ore, the enrichment of uranium, as well as the steel, concrete and other materials needed to build a nuclear power station (which is com-

### The Nuclear Cycle: a Growing Source of CO<sub>2</sub>

Niger Mortimer, of Sheffield Hallam University, pointed out at the Hinkley Point Inquiry that the total amount of CO<sub>2</sub> the nuclear cycle is responsible for will be even larger than it currently is when one takes into account the fact that present nuclear power generation is contingent upon current high grades of uranium ore, which is not in boundless supply. For thermal reactors, such as PWRs, the recoverable reserves of uranium at economic prices are limited, according to recent estimates, to around 10 million tonnes. Once we turn to the poorer grades of uranium ore (below 100 parts per million), then not only do the energy returns fall commensurately, but the environmental impact increases. For example, at uranium ore grades of around 50 ppm, the energy returns in a thermal nuclear programme are no better than those that would be obtained from a coal-fired power station. Using fossil fuels to mine such uranium ores and to extract the uranium would lead to the annual emission of some 230,000 tonnes of CO<sub>2</sub> per year for each reactor, a 45 times increase in emissions in optimum conditions over current rates.<sup>14</sup>



prised mainly of materials and services derived from fossil fuels). A life cycle analysis of a nuclear plant shows that emissions range up to 60gms [carbon]/KWh.<sup>12</sup> A typical Pressurised Water Reactor (PWR), such as Sizewell B, operated under UK conditions, is responsible for indirect CO<sub>2</sub> emissions of up to 63,000 tonnes per year.<sup>13</sup>

While this may be favourable when compared purely in supply terms with coal, oil or gas, nuclear power suffers when compared with a strategy employing energy-efficiency measures, renewable energy and co-generation.

### Nuclear power's real threat to climate protection

The obvious liabilities of nuclear power stand out in stark relief when discussing the possibility of new nuclear power stations as a response to climate change. Costing up to £2 billion to build, with a long list of future decommissioning and waste management costs, such new stations are unlikely to be attractive in any energy market that can reasonably be imagined. It is significant that in the USA no new nuclear reactors have been ordered since 1978 and 124 that were previously commissioned have been cancelled.<sup>15</sup>

The strategy of the industry has now changed subtly to emphasise the role of prolonging the life of existing power stations, both in the EU and North America, and more worryingly in Eastern Europe and the former Soviet republics. "Plant life-extension" and "up-grading" are euphemistically described as sensible responses to the costs already sunk into expensive nuclear facilities. A case in point is Britain's 27 Magnox reactors: originally built to last 25 years, but never able to function at their full capacity, it was decided to extend their lives first to 30 years, later, up to 35 years, and then for some, 40 years, partly at least, to make the nuclear industry appear more profitable before privatisation.

The nuclear industry is keen to refashion its profligate and dangerous image. Keeping existing plants in operation – even those

*The obvious liabilities of nuclear power stand out in stark relief when discussing the possibility of new nuclear power stations as a response to climate change. Costing up to £2 billion to build, with a long list of future decommissioning and waste management costs, such new stations are unlikely to be attractive in any energy market that can reasonably be imagined.*

built with dangerous Soviet-era technology – is now being characterised as prudent resource management. It also makes it possible for the nuclear industry to try to take advantage of the potential opportunities of joint implementation – one of the 'flexible mechanisms' negotiated at Kyoto which currently dominate the climate negotiations. Joint implementation, emissions trading and the clean development mechanism (a form of joint implementation between the developed and developing world) are being promoted on the basis of cost-effectiveness for responding to climate change, when compared with domestic reductions by the big emitters.

Under joint implementation, the nuclear industry could per-

sue the government of a high-emitting industrialised country to spend money on nuclear plant life-extension, refurbishment and upgrading in another developed country. Because the plant would continue to generate electricity without CO<sub>2</sub> emissions, it would thereby earn the donor country carbon credits that would count towards meeting its legal greenhouse gas reduction requirement without having to make those reductions at home. The German nuclear industry, facing imminent closure in its home markets, is already looking to relocate to Eastern Europe.<sup>16</sup> But any expenditure on nuclear power is a distraction from climate protection, because it perpetuates an environmental problem whilst failing to provide a cheap alternative to fossil fuels.

Nuclear power is expensive and it is dangerous. In the language of the balance sheet, liabilities swamp its limited assets. Even politicians are beginning to understand this: German environment Minister, Jürgen Trittin stated that a nuclear phase-out would be an essential prerequisite for climate protection, as "Various studies show that the continued use of nuclear energy will jeopardise real climate protection."<sup>17</sup> At best, nuclear energy tempts governments to divert resources from genuine efforts to reduce emissions adequately to prevent serious damage to the climate, through cheaper and safer investments in renewables. At worst, it perpetuates ongoing radioactive pollution and the possibility of a serious nuclear accident, as well as the proliferation of nuclear weapons. It has, and should have, nothing to do with responding to climate change.

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### References:

1. OSPAR Commission for the protection of the North-East Atlantic, 1998. OSPAR Strategy with regard to radioactive substances, paragraphs 1.1, 4.1a. OSPAR Secretariat, New Court, 48 Carey Street, London WC2A 2JQ, UK.
2. P. Slovic. 1990. Conference proceedings, 'Perceptions of risk and the future of nuclear power.' 1st MIT International Conference on the Next Generation of Nuclear Power Technology.
3. Roger Gale, Darrel Nash, Sophie M. Ras, Howard Shapar. 1998. A new nuclear consensus. Washington International Energy Group. Washington.
4. Reuters. 28 September 1998. EU says nuclear not answer to global warming.
5. These arguments are well rehearsed in many publications; for more in-depth analysis, see for example: Florentin Krause and Jonathan Koomey. 1994. The Future of Nuclear Power in Western Europe. Energy Policy in the Greenhouse, Volume Two, Part 3E. International Project for Sustainable Energy Paths, El Cerrito California, USA.
6. W. Keepin and G. Kats, Greenhouse Warming. Comparative Analysis of Nuclear and Efficiency Abatement Strategies, Energy Policy, December 1988.
7. Peer de Rijk. 1998. Carbon-free nuclear energy? in Hotspot, October 1998, CNE Brussels. Further information on nuclear power and carbon emissions: WISE PO Box 59636, 1040 LC Amsterdam, Netherlands.
8. OECD/NEA. 1994. Liability and Compensation for Nuclear Damage – an International Overview. OEDC. Paris.
9. Fanny Missfeldt. 1998. Strategic aspects of nuclear safety in Eastern and Western Europe. PhD thesis, Stirling University. Stirling.
10. J. Goffman, Radiation Induced Cancer From Low Dose Exposure: An Independent Analysis, Committee for Nuclear Responsibility, 1990.
11. International Atomic Energy Agency. 1997. The IAEA's Safeguards System: Ready for the Twenty-First Century. IAEA. Vienna.
12. CRIEP. 1995. Comparison of CO<sub>2</sub> emission factors between process analysis and I/O analysis. Working Document prepared for IAEA, Tokyo.
13. P. Bunyard, Nuclear Power: Way Forward or Cul-de-sac?, *The Ecologist*, 1992, p.51.
14. N. Mortimer, Aspects of the Greenhouse Effect, FoE Proof of Evidence No 9, 1989.
15. Annual Energy Review 1997, Energy Information Administration, Washington D.C.
16. AFP-Exel News Ltd. 1998. VIAG AG is considering taking stakes in foreign nuclear power plants.
17. Uranium Institute. 1998. Weekly briefing 17th November.



**Nuclear power is far too dangerous and expensive to replace fossil fuels as the energy of the future.**

# A Policy Imperative: Save and Plant Trees

— BY TONY JUNIPER AND SARAH TYACK —

*Forests and climate change are inextricably linked. If forests are cleared, they become a source of carbon released from the decay or burning of biomass. If trees are planted, carbon is removed from the atmosphere. In the battle to stabilise climate the logic for policy is clear: protect and expand the world's forests.*





That drastic action is now urgently needed is no longer a matter for serious debate. But what that action should be remains fiercely controversial. The proposed responses to forest management arising from climate change have often been driven by commercial interests. For example, the British supermarket chain Tesco has proposed to charge a premium for petrol and to use the money to plant trees, and the governing body of Formula One has launched a scheme to plant trees in Mexico<sup>1</sup>. Whilst such an offer might make public relations sense, more effective approaches involving incentives to get customers out of their cars are nowhere to be seen. This example is part of a wider trend involving companies from British Airways to car manufacturer Mazda who are seeking carbon-neutral business activities through tree planting<sup>2</sup>. Whilst some tree planting activities are well intentioned and conceived as part of wider environmental programmes (for example to promote conservation of biodiversity by

planting native species on degraded sites) they do in the end amount to diversions from the real priority of halting the clearance of remaining natural forest or slashing emissions from fossil energy sources. If these two issues are not addressed, tree planting cannot make an effective contribution to slowing climate change.

That old-growth forests are not being protected by new tree planting is clear. Whilst Tesco and Mazda promote allegedly climate-friendly petrol and cars, pictures of massive forest fires burning out of control over thousands of square kilometres of tropical rainforest are beamed to households round the world. That a serious contradiction in approach is taking place is undoubted. Tree planting will not make a difference until deforestation is halted.

Whilst it is true that young trees absorb more carbon dioxide as they are growing, old-growth and natural forests generally contain more carbon in the form of stored biomass<sup>3</sup>. Thus if old forest is cleared to be replaced by young trees – a policy advocated as acceptable by the forestry industry on climate change grounds<sup>4</sup> – there will be an overall net contribution of carbon to the atmosphere<sup>5</sup>. There will also be a net reduction in biodiversity.

We therefore argue that the situation is now sufficiently urgent for there to be a moratorium on the clearance of remaining old-



Buttress roots  
of the Blue  
Kwandong,  
Queensland,  
Australia.

KLEIN/HUBERT/STILL PICTURES

## Logging – the Collusion of Power and Money

Unless the vice-like grip of big timber interests – and miners, ranchers, and related resources extractors – can be broken, all bets for forest conservation are off. In the US timber States of Washington and Oregon the Wood Products Industry outspent environmentalists 6 to 1 in contributions to Congressional candidates between 1985 and 1982. During those years grateful members of Congress from these States set higher logging targets for national forests in their districts than the Forest Service itself recommended.

Logging in Malaysian Borneo is driven by the collusion of power and money. By tradition, elected leaders in Malaysian provinces have authority to distribute contracts to exploit public resources, notably timber. This prerogative has become a crucial part of their power-base. Officials distribute logging concessions to loyal supporters, who level the trees for quick profits – estimated in hundreds of millions of dollars. A share of the proceeds helps keep the loggers' patron in office and may make him a millionaire as well.

With varying degrees, this bond between timber money and political power is found in all the world's major timber economies. Indonesian timber magnate Prajogo Pangestu,<sup>1</sup> who owns concession rights and wood products industries worth an estimated \$5 billion, continues to expand his control of the nation's forests with the help of those at the highest levels of government. Similarly, the Philippine Congress is packed with loggers and members of logging families.

Papua New Guinea appointed a commission to investigate the enforcement of national forestry laws, particularly on foreign timber companies, in New Ireland province.<sup>2</sup> The commission reported that foreign timber companies were "roaming the countryside with the self-assurance of robber barons; bribing politicians and leaders, creating social disharmony, and ignoring laws in order to gain access to rip out and export the last remnants of the province's valuable timber."

By Edward Goldsmith

### References:

1. Alan Durning, Worldwatch Paper No. 117, "Saving the Forests: What will it take?" December 1993.
2. Beryl Marshall, 'The Plantation Economy of Logging', *The Ecologist*, Vol.20, no.5, 1990.

growth forests, for the large-scale yet selective and qualified expansion of secondary forests and also for policies aimed at dramatically reducing the consumption of forest products. For the conservation of biodiversity and climate protection are consistently undermined by the insatiable and growing demand for paper and wood. In order to maintain remaining natural forests, permit the sustainable management of secondary forests (including plantations and managed regrowth) whilst meeting people's needs for wood and paper on an equitable basis, Friends of the Earth has estimated that wood and paper consumption must be reduced by about two thirds in most developed countries<sup>6</sup>. The same study further estimated that the recycling and re-use industries associated with such reductions in overall consumption would contribute significant numbers of new jobs – some 10,000 in the UK.

But the problems go far wider than demand for paper and wood as drivers of deforestation. The large-scale clearance of natural forest to make way for cash crops, displaced agriculturalists and mines also plays a pivotal role in the contribution of forest loss to global climate change. These impacts are generated by unsustainable macroeconomic trends that are in turn linked to the activities of transnational corporations, global institutions (especially the World Bank and International Monetary Fund) and the short-term extractive policies that arise from pressures to meet international debt repayments<sup>7</sup>.

Nor should it be forgotten that forest loss cannot be comprehensively halted until fossil-energy-induced climate change is dramatically slowed. Even if massive reforestation took place globally (assuming that there would be enough land available), this would only serve to postpone the need to drastically cut carbon emissions. This is because once the forest reached maturity, it would cease to absorb carbon, but would become a carbon store. Eventually, through rotting or deforestation, the carbon would be released once again into the atmosphere.<sup>8</sup> The recent predictions from the UK's Hadley Centre, that eastern Amazonia will by 2050 be transforming from dense rainforest to savanna, grassland and even desert<sup>9</sup> and in so doing contribute billions of tonnes of carbon to the atmosphere, is a good case in point.<sup>10</sup>

So what should be done? Available evidence shows that large-scale reductions in fossil fuel use, massive shifts in patterns of paper and wood consumption (especially in the northern developed countries), a moratorium on further old-growth forest clearance, the cancellation of the international debts owed by the developing countries and a restructuring of the global economic order – away

## Climate Change and Deforestation

### *The crash programme that is needed now*

- Cancellation of debts owed by the poorest countries to international institutions, private banks and OECD governments in accordance with the demands of the Jubilee 2000 coalition
- Overhaul of the policies promoted by the IMF, the World Bank and the WTO, such that measures to promote GDP growth through increase in exports and the exploitation of natural resources are assessed against impacts on ecosystems and the global climate
- Defence of local economic activity globally such that the conservation of ecosystems under local use is not undermined by policies geared to further economic globalisation
- A minimum 60% reduction in the level of consumption of paper and wood products in OECD countries
- Speedy implementation of the Kyoto Protocol with the early negotiation of much deeper longer term emission cuts such that further climate change-driven forest degradation is avoided
- International moratorium on the further clearance of natural forests negotiated through the UN climate change or biodiversity conventions
- Adoption of a worldwide, selective expansion of secondary forests in ecologically appropriate areas.

from the "export-at-any-cost" policy of the IMF and WTO, and in favour of the meeting of local needs from local products and services – must all be components of any credible remedial strategy. This mix of policies can be pursued now and could generate quality of life, employment, local economic and environmental benefits. It is however an approach that directly challenges the dominant political and economic ideology and power centres and is unlikely to be advanced before fundamental shifts occur in the assumptions held by large corporations, national governments and international institutions. With positive feedbacks in the climate system already generating further forest loss, it is clear that time is very short, the stakes increasingly high and leadership vital; the question is, who will provide it?

Tony Juniper is Friends of the Earth UK's Policy and Campaigns Director. Sarah Tyack is the organisation's Forest Campaigner.



### References:

1. Nutall N. (1997), "Drivers Urged to Plant Trees To Beat Pollution", *The Times*, 12/6/97.
2. See Future Forests Ltd, Hill House, Castle Cary, Somerset, BA7 7JL (Tel: 01963 3503465).
3. Harmon *et al.* (1990) "Effects on carbon storage of conversion of old-growth forests to young forests", *Science*, 247: pp699-702.
4. For example, the Finnish Forest Industries Federation (1995), "The Way of Wood: Forest Industry and the Environment", Helsinki, Finland.
5. Harmon *et al.* (1990).
6. Rice T. (1995), "Out of the Woods: Reducing Wood Consumption to Save the World's Forests – A Plan for Action in the UK", Friends of the Earth.
7. Hogg D. (1993), "The SAP in the Forest. The Environmental and Social Impacts of Structural Adjustment Programmes in the Philippines, Ghana and Guyana", Friends of the Earth.
8. Larman JG & Sedjo RA (1992), "Global Forests: Issues for Six Billion People", McGraw-Hill Inc, USA.
9. "Amazon forest 'will be dead in 50 years'", Michael McCarthy, *Independent*, 3 November 1998.
10. Climate Change and its Impacts, November 1998, The Hadley Centre for Climate Prediction & Research, The Met Office, London Rd, Bracknell, Berkshire. Published by the Met Office and DETR.



# Contraction and Convergence

— BY JOHN BROAD —

*The adoption of a global programme of 'Contraction and Convergence' offers the potential to break the stalemate in the international negotiations on climate change and to set in place a far more effective and inclusive political mechanism to curb the consumption of fossil fuels in all countries.*

**T**he climate change negotiations being held under the auspices of the United Nations are stuck in an apparently intractable impasse. The US Congress refuses to allow ratification of the Kyoto protocol until major developing countries commit themselves to curbing their own greenhouse gas emissions. Congress argues that if energy demand continues to rise on current trends, developing countries will be responsible for more than half of global emissions by 2020. Hence they have the potential to undermine any cuts, however dramatic, undertaken by the industrialised countries.

Developing countries, meanwhile, argue that historically, emissions from industrialised countries are the main cause of global warming; that, on a per capita basis, developing countries emis-

*The fundamental advantage of this approach is that its per capita basis provides an organising principle for the negotiations which all the parties recognise as fair and equitable. Essentially, humanity is facing a global security crisis and needs to drastically ration what is currently a vital resource, the absorptive capacity of the atmosphere. As Europeans discovered in two World Wars, a rationing system works best when it is perceived to be fair. As the Global Commons Institute puts it, this is equity for survival.*

sions are up to 30 times less than those of industrialised states; and that their priority is development, for which they want to use fossil fuels as the North has done; and that the North should use its accumulated wealth to solve the problem.

Partly as a result of this impasse, the Kyoto Protocol, which is the culmination of eight years of negotiations, and which in some respects is a historic achievement, is totally inadequate by com-



HARTMUT SCHWARZBACH/STILL PICTURES

**By bringing developing countries into the international framework to curb the consumption of fossil fuels, the adoption of 'Contraction and Convergence' could mean that scenes such as this in Sudan become more common in the future.**

parison with the kind of comprehensive, long term, global agreement which is necessary if humankind is to solve the problem of climate change. Target reductions in greenhouse gas emissions are set only for the industrialised

countries, and at implied rates of reduction which are much lower than that which climatologists have suggested is necessary. *Nothing is said about the cuts which must be achieved globally, or about a target date for achieving them.* Even if the industrialised countries all ratified and implemented the treaty, global emissions are likely to grow. Who is to say whether this would result from industrialised countries not cutting their emissions sufficiently or from the developing countries letting their emissions rise too much?

If the current logjam is to be unblocked the diplomatic process must find a means of answering this question. The only one so far proposed is called "Contraction and Convergence". This is a programme devised by the Global Commons Institute and advocated by GLOBE International (the Global Legislators Organisation for a Balanced Environment). An increasing number of governments in Europe and the south are signalling that they too see it as the basis of a long term solution.

How would "Contraction and Convergence" work? "Contraction" refers to the need to reduce global emissions of greenhouse gases to a level that would result in establishing what science regards as a probably tolerable atmospheric concentration. Effectively this would create a global "budget" of greenhouse gas emissions. This budget necessarily declines over time until a stable point is reached (and as the science improves, our perception of what that point is may change, so any treaty must contain provisions for changing the global budgets).

"Convergence" allocates shares in that budget to the emitting nations on the basis of equity. This has three components. First, the budget is global; every country has shares in the atmosphere and any treaty that allocates its absorptive capacity only to a selec-

tion of countries effectively deprives the others. Second, the current situation whereby allocations are generally proportional to wealth would cease. Third, allocations should converge over time to a position where entitlements are proportional to population. After convergence, all countries would contract their greenhouse gas emissions equally until the necessary contraction limit is reached. No inflation of national budgets in response to rising populations would be permitted after an agreed set date.

The fundamental advantage of this approach is that its per capita basis provides an organising principle for the negotiations which all the parties recognise as fair and equitable. Essentially, humanity is facing a global security crisis and needs to drastically ration what is currently a vital resource, the absorptive capacity of the atmosphere. As Europeans discovered in two World Wars, a rationing system works best when it is perceived to be fair. As the Global Commons Institute puts it, this is equity for survival.

Implementation of this mechanism could help overcome the current international stalemate by addressing a number of the key concerns of the major players. Acceptance by Northern governments that the global emissions budget should converge to equity would be a major step and would encourage Southern governments to accept a cap on their own emissions. This in turn would fulfil the demands of the US for an international process which committed all countries to reduce or limit their greenhouse gas emissions, as stipulated by the Byrd-Hagel Resolution passed unanimously by the US Senate.

There are practical implications of reaching a long-term global agreement on an equitable basis which quickly become apparent. Developing countries would have a direct incentive to conserve energy and transfer quickly to renewable, non-fossil-fuel-based energy paths. For under the "Contraction and Convergence"

mechanism, they will acquire surplus emission entitlements which they can sell on the open market to finance the creation of renewable energy infrastructures. These in turn will increase their surplus entitlements.

Industrial countries, with their much higher per capita energy use and thus greenhouse gas production, may choose to buy emission permits to gain a little time. But they will need to make major cuts and their main efforts would need to go into conservation and renewable technologies. With appropriate monitoring, verification and enforcement, this trading mechanism, administered by a democratically accountable international body, could help achieve overall contraction more rapidly and cheaply, and certainly it should not suffer from the "leakage" expected to result from the sub-global mechanisms set up under the Kyoto protocol. But the result might be much more positive. The world might discover, for the first time, that it is possible to co-operate at a global level and work towards a common goal; it might prove to be much easier than expected to de-link the historic connection between the burning of fossil fuels and the creation of human wealth.

"Contraction and Convergence" thus has the potential to be the most rational, effective and rapid means to end the consumption of fossil fuels globally. In the words of Aubrey Meyer, Director of GCI, "The integrated implementation of this 'Contraction and Convergence Allocation and Trade' programme can turn a presently dangerous global vicious circle of political stalemate and ecological dissipation into virtuous cycles of recovery and renewal. The consensus for survival needs this structure. Political and ecological anarchy is an alternative that guarantees nothing but increasing tragedy."

John Broad is Chairman of the Global Commons Trust, a charitable foundation.

## The Ecologist Climate Change Dossier

This is a dossier of articles on climate change that have been published in *The Ecologist*. The complete set (140 pages in a binder) is available for £12, including UK postage – for overseas orders please add £2 for postage. Send cheques, made payable to "The Ecologist", to Stephanie Roth, *The Ecologist*, 46 The Vineyard, Richmond, Surrey, TW10 6AN, UK. Please allow 7-14 days for delivery.

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# The Crash Programme: A Solution-multiplier

— BY EDWARD GOLDSMITH —

*The crash programme required to restabilise global climate can be funded by mobilising funds that are either currently wasted or used in destructive ways. The real cost for humanity is negative since the programme has to be undertaken in any case to solve nearly all the other critical problems that confront us today.*

What must be done to prevent climatic disaster and how could such preventative action come about? If the date today were 1950 instead of 1999 the problem would be much easier. However, virtually nothing has been done and the problem is becoming rapidly more serious and less tractable. We cannot afford to wait any longer. Effective action must be taken immediately. What is more, because of the time we have wasted, action must now take the form of a crash programme in which the necessary changes must be compressed into a period of time that is undoubtedly too short for comfort. Otherwise all sorts of potentially synergistic effects and positive feedbacks might become operative. We might then find for instance that the Gulf Stream had changed its course causing a freezing up of north-western Europe, that a major part of the Antarctic ice-sheet had collapsed,

*A Tobin tax (named after the economist and Nobel laureate Dr James Tobin, who first proposed it) on international currency transactions should be introduced. These transactions are estimated to be in the order of \$1.3 trillion per day. A tax of merely 0.25 per cent would yield \$150-200 billion annually.*

with the resulting sea-level rises, that the monsoon had shifted, causing famines in south and south-east Asia, or that Amazonia has become a desert with further serious climatic consequences for the planet. As Bill Hare in Greenpeace's 'Carbon Logic' notes,<sup>1</sup> such catastrophes once triggered are effectively irreversible, at least on a historical time-scale, and the longer we put off effective action the more likely they are to materialize. It is essential that Governments, industrialists and the public at large are made to understand this.

However, the transition to renewables, within the time frame set out in Greenpeace's Carbon Logic, (see 'Fossil Crunch,' p125), is likely to prove politically and economically difficult. The monetary costs, it is argued, are going to be high, particularly with regard to replacing the infrastructure of our fossil-fuel-powered economy. Where then is the money going to come from? There are a number of obvious sources.

## Reforming taxation

The tax system must be reformed. Taxes must be increased exponentially on all those economic activities that give rise to greenhouse gases. In this way, they will provide the necessary incentive for companies and the public to make the appropriate changes as quickly as possible. Clearly, this means above all the introduction of a carbon tax which must increase from year to year until such a time as it becomes prohibitive. The principle could be adopted as a means of phasing out the other economic activities that con-

tribute to climate change, such as logging of old growth forests, the production of chlorine-based ozone layer depleting chemicals, and agro-chemicals. The extent of the tax and the rate at which it increases over time must of course depend on the rate at which the activities in question must be phased out.

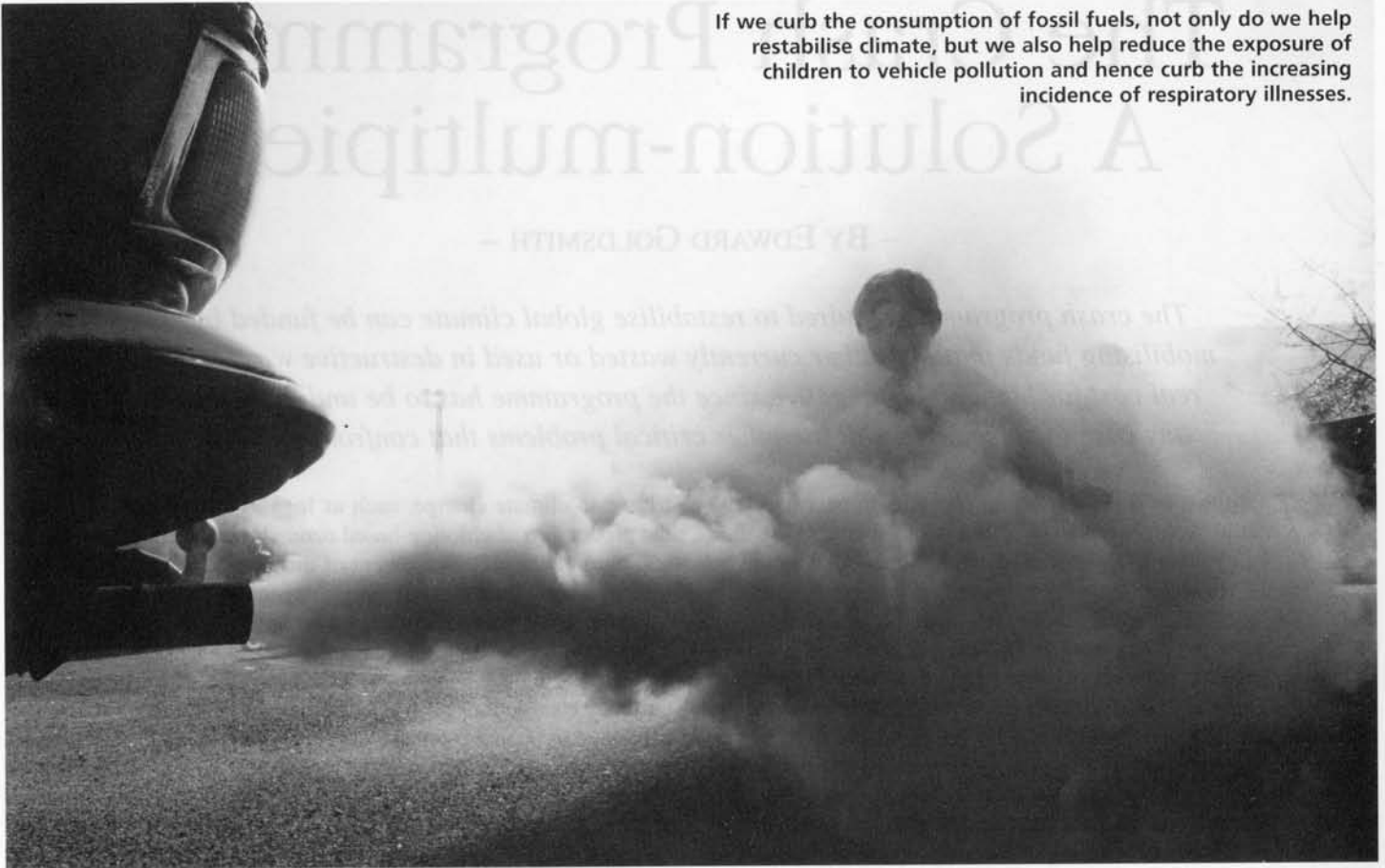
In addition, a Tobin tax (named after the economist and Nobel laureate Dr James Tobin, who first proposed it) on international currency transactions should be introduced. These transactions are estimated to be in the order of \$1.3 trillion per day. A tax of merely 0.25 per cent would yield \$150-200 billion annually. A tax of 0.5 per cent would thereby yield \$300-400 billion every year, assuming that this did not reduce the volume of transactions, though even if it did, the sum yielded would still be very considerable.<sup>2</sup>

## Redirecting subsidies

Another huge source of funds for subsidising the transition to renewables must be the redirection of the vast amount of money spent each year in actually subsidising fossil fuels and other activities that contribute to global warming. According to the watchdog group Alliance to Save Energy, the energy sector in the US is subsidised at the rate of \$21-36 billion annually.<sup>3</sup> As if this were not sufficient, electric utilities are about to receive another major windfall from taxpayers in order to facilitate the deregulation of the industry. It seems that so-called "stranded costs" will be passed on to taxpayers and consumers. These costs have been incurred by investing in highly uneconomical installations such as nuclear power plants whose true costs have been known for years to be incomparably higher than the industry admits. The value of the bailout according to Moody's Investor Services is between \$50-300 billion. Consumer and environmental activists say it could be as much as \$500 billion.<sup>4</sup>

Worldwide, it appears that subsidies to the fossil fuel industry are at present close to \$300 billion. David Roodman tells us<sup>5</sup> that even developing countries spent some \$65 billion in 1991 to fund price controls on fossil fuels, including kerosene and diesel, which the poor increasingly depend on for heating and lighting purposes. In addition, \$46 billion was handed out by developing countries in 1991 to compensate power companies for the lower prices prevalent at the time. Eastern bloc countries apparently also spent \$135-180 billion dollars that same year – as much as 10 per cent of their GDP – to keep fuel costs to a fraction of what they were in the West. Another \$34-39 billion dollars was spent in the same countries on electricity subsidies.

Subsidies for fossil fuels are actually very much higher if we take into account the national security cost of oil, that is the cost of maintaining regimes friendly to the West and to US interests in power in oil-rich parts of the world. This has been estimated by Edwin S. Rothchild, Energy Policy Director of Citizen Action,<sup>6</sup> to be in the area of \$57 billion per year or approximately \$9.19 per



If we curb the consumption of fossil fuels, not only do we help restabilise climate, but we also help reduce the exposure of children to vehicle pollution and hence curb the increasing incidence of respiratory illnesses.

barrel of the oil used in the US. Costs of course can run very much higher when there is an acute security problem such as when Iraq invaded Kuwait, threatening the US's main oil supplies. 'Operation Desert Storm' – America's response to this crisis – cost more than \$60 billion,<sup>7</sup> spread out among all the governments that participated. If fossil fuels are to be phased out then clearly all of these subsidies must quite logically be shifted very rapidly to investments in renewable energies.

*According to David Roodman, "governments at present pour at least \$500 billion a year into environmentally-destructive activities," and he considers that the full amount may be far greater.*

A further source of funds to be tapped in order to pay for the transition must be the money poured into the Third World by the World Bank (see Daphne Wysham's article, 'The World Bank: Funding Climate Chaos,' p108) to fund large-scale fossil fuel power stations, environmentally destructive infrastructural projects like large dams, and highways through forested areas. The same applies to the other multinational development banks and to bilateral aid agencies such as the Overseas Development Agency (ODA) in the UK and the United States Agency for International Development (USAID) in America, whose main function is not helping the poor, but subsidizing UK and US companies seeking to put up often destructive infrastructure projects in the Third World.

Of equal importance is the re-direction of government subsidies that currently go to the nuclear industry, in particular on research and development, the extent of which has been massive. According to Roodman,<sup>8</sup> such subsidies have amounted to some \$34 billion since 1948. However, there are also indirect subsidies. In the US, the Price-Anderson Act of 1959 took over the responsibility of paying costs of the damage caused by nuclear accidents,

leakages from nuclear waste dumps and other installations, over a specific sum of money. If the nuclear industry were to pay for its own liability insurance it would cost it an estimated \$3 billion a year over and above the cost of its normal operations.

It also appears that, since 1974, \$247 billion in nuclear research and development has been paid by the governments of OECD countries for nuclear programmes, including conventional reactors, breeders and nuclear fusion research. Government support for nuclear power worldwide contrasts only too strikingly with the tiny subsidies provided for renewable energy. The main reason of course is that, as Steven Gorelick notes, "nuclear energy meets the needs of a large-scale industrial economy, while decentralized renewable energies – like rooftop solar water heaters – inherently run against the grain of the centralized industrial model."<sup>9</sup>

But it is not just the fossil fuel and electricity industries that are subsidized worldwide. So, of course, is the motor industry, as governments spend enormous sums on building highways to accommodate the industry's most basic requirements. According to David Roodman,<sup>10</sup> "governments at present pour at least \$500 billion a year into such environmentally-destructive activities," and he considers that the full amount may be far greater. This too must be re-directed, not least to improve public transport.

### **Curbing military expenditure**

Yet a further source of funds must be the almost unbelievable amount of money spent world-wide on armaments. According to Michael Renner,<sup>11</sup> global military expenditure since World War 2 has been in the area of 30 to 35 trillion dollars. This includes indirect costs such as "the scrapping of stocks of obsolete armaments, the decontamination and rehabilitation of polluted land and facilities that have been used to produce, test and maintain weapons, the destruction and dislocation caused by wars, the loss of harvests, and the cost of humanitarian assistance to refugees and their resettlement". Renner estimates that if we take all these factors into account, the total cost of the Iran/Iraq war of 1980 to 1988 was in the area of 416 billion dollars and that of the Gulf war of 1991 of



676 billion dollars, (the Arab Monetary Fund's military estimate).<sup>12</sup> Once the use of fossil fuels has been phased out and the necessary move towards a largely low-tech localized economy has been achieved, there will be a drastic reduction in the need for these expenditures – reducing by the same token all the human, social and ecological costs involved.

### The 'costs' in perspective

Hence, it is clear that the funds could clearly be made available if the political will were there to overcome the formidable opposition from large sections of industry. What the US industry opponents to prevent climate change, in particular, fear most is that action to prevent climate change would make US industry uncompetitive. Yet a World Research Institute (WRI) study<sup>13</sup> clearly shows that the most important part of the requisite programme – the phasing out of fossil fuels – need not make US industry uncompetitive. Its arguments are as follows:

- Over two-thirds of US trade and investment is with other industrialized countries that generally have higher energy prices and are also bound to the same (and in some cases higher) emissions reductions under the climate treaty.
- US foreign direct investments in energy-intensive sectors are not flowing to developing countries with low-energy prices, but rather to other industrialized countries with higher energy prices.
- Among US industries that produce goods that can be traded, less than two per cent of jobs are in energy-intensive sectors. Energy costs are an insignificant share of the value of most tradeable goods and services. More than 80% of output and 90% of employment in tradeables is in industries in which energy costs represent no more than 3% of the value of sales.<sup>14</sup>

Moreover, energy reforms in developing countries are generating significant trade and investment opportunities for US firms that can help provide cleaner and more efficient energy sources. As Brent Blackwelder, Director of Friends of the Earth USA, says,<sup>15</sup> the US will not lose its competitive edge: quite the reverse – “wherever the US becomes the leader we tend to bring others

along with us. If we start running our economy on a solar efficiency basis, China will do the same.”

Conversely, those countries and companies that remain bolted to the status quo should realise that they are heading down a fatal cul-de-sac. Unless fossil fuel companies start investing in renewable energies and efficient technologies now, and on a very large scale, they will indeed become uncompetitive in comparison with those companies, particularly in Europe, which are already begin-

*In the US, studies show that reducing greenhouse emissions by 2010 to just 10% below 1990 levels (through the expansion of public transport, rapid development of renewable energy sources and increases in energy efficiency) would generate 773,000 new jobs and save the average household \$530 a year in energy bills.*

ning to go down the renewable route. Even more importantly, unless those corporations which are currently preventing necessary action from being taken reverse their positions, they will incur devastating financial costs from worsening climatic destabilisation (see ‘The Economic Costs of Climate Change,’ p98). If they continue to ignore this reality, they do so at their peril.

Moreover, it is not as if many of the challenges that are faced are technically insurmountable. Indeed, the US has been one of the most technologically advanced and innovative nations this century, and so to argue that Americans cannot employ their talent to fight climate change is simple nonsensical.

### Job creation

Another argument used by industrialists who oppose effective action on climate change is that it would lead to a huge increase in unemployment. This need not be so. In the US, studies show that reducing greenhouse emissions by 2010 to just 10% below 1990 levels (through the expansion of public transport, rapid develop-



To restabilise climate, it is essential that we shift direction towards nurturing local economies in which food is produced locally for local consumption. Not only would this reduce transport emissions, it would also create more jobs.

ment of renewable energy sources and increases in energy efficiency) would generate 773,000 new jobs and save the average household \$530 a year in energy bills.<sup>16</sup> A study for the European Foundation for the Improvement of Living and Working conditions found that the adoption of the best available energy conservation technologies could create 500,000 extra jobs in the EU.<sup>17</sup> A study by Friends of the Earth in the UK shows net job gains of 130,000 in the UK through a reduction in passenger road traffic of 10% by 2010 from 1990 levels and a switch to public transport and cycling.<sup>18</sup> An EU study calculates a job gain of over 500,000 jobs following a 35.6% increase in rail passenger kilometres by the year 2010 and a concurrent decrease in passenger car kilometres by 21.4%.<sup>19</sup> Belgian government economists estimate that the original EU's carbon energy tax (£10/bbl of oil) proposal, if adopted, would lead to the creation of 700,000 new jobs in the EU largest member states.<sup>20</sup> Moreover, a study by the SAFE Alliance shows that after a conversion from a chemical to an organic farm in the UK, (a requirement to protect our carbon-absorbing soils and to phase out nitrous oxides), there was a 60% increase in unpaid family labour, an 80% increase in full-time labour, a 100% increase in part-time labour, and a 550% jump in casual labour.<sup>21</sup>

### **A new economic direction: the real solution-multiplier**

We must realise, however, that this increase in employment cannot be sustained within the context of a global economy controlled, as it must be, by highly automated, cost-cutting transnational corporations that rapidly put small enterprises, except highly-controlled sub-contractors, out of business. In such an economy, employment levels must be unacceptably high.<sup>22</sup> According to the Institute for Policy Studies, in Washington D.C., the 200 largest transnational corporations that control 28% of the global economy provide less than 1% of jobs.<sup>23</sup> The bulk of the jobs in the US and elsewhere is provided by small and medium-sized companies, which means that as the global economy develops, and these are replaced by TNCs, unemployment can only increase.

In China, in the late 1970s, it was decided to set up a large number of small enterprises to cut down on the massive influx of people to the cities – an inevitable concomitant of the globalisation process. By 1991, there were 19 million of these small companies and they provided 112 million new jobs.<sup>24</sup> However, it seems unlikely that these will survive economic globalisation – unless of course they were all highly subsidised, as small farms and small shops have been in Japan until very recently.

Indeed, it is in the rural areas of highly populated Third World countries such as India and China that the worst unemployment will occur. In a country like India, for instance, at least 600 million people live off the land as small farmers, small shopkeepers, street traders and artisans. None has any future whatsoever, as India industrializes: the vast bulk of them will by necessity be forced into the slums of the nearest conurbations – where unemployment levels may already be up to 20-30%.

To render it conceivable to provide the inhabitants of our planet with a proper livelihood, we have no alternative but to move our society in a very different direction, towards an economy that is run by small and medium, relatively low-tech companies, catering for mainly local, regional, and national markets, rather than an economy controlled by massive high-tech transnationals catering for a world market. In other words, we must shift towards a localised rather than a globalised economy. It is also precisely in this direction, of course, that our society must move if we are to restabilise our climate, as the process of economic globalisation significantly increases the emission of greenhouse gases in many different ways (see the box on the global economy in 'How US Politics is Letting the World Down', p111).

Indeed, we change direction in order to reduce the present

unparalleled destruction of our natural environment as a whole. For at the rate at which we are presently destroying our forests, draining our wetlands, grubbing up our coral reefs, compacting, eroding, salinising, desertifying and paving over our agricultural land, and polluting our soil, our rivers, our oceans, the food we eat, the water we drink and the air we breathe, we will have rapidly made this planet uninhabitable, even without climate change.

We must move in this new direction too because only a localised economy can provide an economic infrastructure for renewed families and communities that have always provided humans with their most fundamental source of security. This is critical today as surrogate sources of security, such as jobs and welfare, can no longer be counted upon. What is more, it is only within the context of renewed families and communities that the cultural patterns that have traditionally held societies together; that life can re-emerge and once again acquire a meaning; so that we can be rescued from the appalling nihilism that prevails today, and that leads to so much crime, delinquency and sheer despair. Finally, only in this way can we create the conditions under which real democracy can flourish. For it is only at the level of the community that individuals can make their voices heard and their views acted upon. The alternative is yet further growth in corporate control with more and more human, social and ecological imperatives sacrificed on the altar of corporate financial interests. In such a world there is no hope for humanity, nor, for that matter, for life itself.

The adoption of the programme required to restabilise climate, therefore, does not in reality lead our society to incur any extra costs at all – as it is indispensable for solving most of the other major and otherwise intractable problems that confront us today.

### **References:**

1. Bill Hare, 'Fossil Fuels and Climate Protection: The Carbon Logic', Greenpeace
2. Declaration, World Energy Movement, Brookline, Mass, November 1988, p.9.
3. Alliance to Save Energy, Federal Energy Subsidies: Energy, Environment and Fiscal Impacts, cited in Shelby, M., Shackleton, R., Shealy, M. and Cristofaro, A., The Climate Change Implications of Eliminating US Energy (and related) Subsidies, 1994, p.4, quoted in Small is Beautiful, BIG is subsidised, Principal author Steven Gorelick, p.24.
4. Gil Friend, Stranded Assets. Why can't you ever find a capitalist around when you need one? The New Bottom Line. The Strategic Perspectives on Business and Environment, Vol.6 No.17, 1997.
5. D.M. Roodman, Paying the Piper: Subsidies, Politics and the Environment, Worldwatch Paper No.133.
6. Rothschild, E.S., 'Oil Imports, Taxpayers Subsidies and the Petroleum Industry', Washington DC, Citizen Action, May 1995, pp.9-11, quoted in Small is Beautiful: BIG is Subsidised, ISEC.
7. S. Gorelick, Small is Beautiful: BIG is Subsidised, ISEC, 1998.
8. *Op.cit.*7, p.48
9. *Op.cit.*9
10. *Op.cit.*7, p.6
11. Michael Renner, Budgeting for Disarmament, WorldWatch Paper 112, p. 10.
12. *Ibid.* p.11.
13. Repetto, R., Maurer, L., Bird, G., 'US competitiveness is not at risk in the climate negotiations', World Resource Institute, 1997.
14. *Ibid.*
15. Brent Blackwelder in an interview with Simon Retallack.
16. Reaping the Double Dividend – Climate Change and Jobs, Friends of the Earth, 1997, p.2.
17. Less Traffic, More Jobs: The Direct Employment Impacts of Developing a Sustainable Transport System in the United Kingdom, Friends of the Earth, 1997.
18. Ecotec (1994), The Potential for Employment Opportunities from Pursuing Sustainable Development, report to the European Foundation for the Improvement of Living and Working Conditions, Birmingham/Brussels.
19. Bossier, F. and Brechet, T. (1995), 'A fiscal reform for increasing employment and mitigating CO<sub>2</sub> emissions in Europe', Energy Policy 23 (9) pp.789-793.
20. SAFE Alliance (1997), Double Yield: Jobs and sustainable Food Production, p.16.
21. Kane, H., 'Enterprise', Worldwatch, March/April 1996, p.17.
22. J. Rifkin, New Technology and the End of Jobs, in J. Mander and E. Goldsmith, The Case Against the Global Economy and For a Turn Towards the Local, Sierra Club, 1996.
23. J. Cavanagh, in Sadruddin Aga Khan (Ed.), Policing the Global Economy, Cameron May, London, 1998, p.56.
24. Friends of the Earth Special briefing sheet based on modelling work of independent consultants 'Energy for Sustainable Development.'



# MAKE YOURSELF HEARD

Use your power as a voter and an individual to try to influence governments and corporations.

Write to your MP or national representative, your Prime Minister or President, a government minister, your local and national newspapers. Tell them your concerns about climate change. Tell them you want action. Tell them that radical steps are needed to cut down emissions and switch to renewables. If enough people tell them, they'll eventually get the message.

If you write to your government, or to other politicians, some of the actions you can urge them to take might include:

- Accepting a target of 30 years to have cut CO<sub>2</sub> emissions by 70-80 per cent below 1990 levels, and 50 years for a near total phase-out of fossil fuels.
- Instituting ecological tax reform: taxing fossil fuels and energy-inefficient production, and lowering taxes for renewable production.
- Ending direct subsidies for fossil fuel production and consumption and switching them to support renewables.
- Regulating new energy developments.
- Legislating strict new fuel economy standards for cars and other appliances.
- Adopting new ecological building codes.

You could also write to the heads of major companies from which you purchase goods or services. Tell them you are concerned about climate change, and ask them what they are doing to reduce their emissions and energy use. Tell them that you intend to make their actions on climate change a major factor in your future purchasing decisions.

It is only when enough people start to voice their concern that serious, radical action will be taken by the authorities. *That starts with you!*

## Climate-Change-related Events in 1999

SUSTAIN '99, THE WORLD SUSTAINABLE ENERGY TRADE FAIR

**Organised by:** European Marketing Media

**Date:** 25-27 May 1999

**Place:** R.A.I Exhibition and Congress Centre, Amsterdam

**For further info:** European Marketing Media,

**Tel:** 0181 289 8989

**Fax:** 0181 289 8484

**E-mail:** sustain@emml.co.uk

THE CLIMATE CHANGE

SECRETARIAT are organising the following meetings/conferences:

**Date:** 31 May – 11 June 1999 and 25 October – 5 November 1999

**Place:** Both are being held at the Hotel Maritime, Bonn, Germany.

**For further info:** Information Officer: Nardos Assefa,

**Tel:** (49-228) 815 1526

ET'99 – the only integrated event covering management, technology and services in the water, waste and environmental sectors – promoting business opportunities and environmental solutions.

**Organised by:** The ET Partnership

**Date:** 8-10 June 1999.

**Place:** NEC Birmingham

**For further info:** Jim Hughes, Reed Exhibition Companies Ltd.

**Tel:** 0181 910 7853

**Email:** jim.hughes@reedexpo.co.uk

IMPLEMENTING THE KYOTO PROTOCOL

**Organised by:** The Royal Institute of International Affairs.

**Key note speakers:**

The Rt Hon John Prescott MP, The Hon Simon Upton (Minister for the Environment, New Zealand) Dr Robert Watson, Chairman, IPCC Michael Zammit Cutajar, Executive Secretary, UNFCCC – Secretariat

**Date:** 14 and 15 June 1999

**Place:** Chatham House, 10 St James' Square, London SW1Y 4LE

**For further info:** The Royal Institute of International Affairs,

**Tel:** 0171 957 5700

**Fax:** 0171 957 5710

**Website:** <http://www.riia.org>

HEALTHY PLANET FORUM (covering the health effects of climate change)

**Organised by:** UNEP-UK

**Date:** 15-18 June

**Place:** Westminster Central Hall

**For further info:** UNED-UK.

**Tel:** 0171 839 7171

**Fax:** 0171 827 5868.

**Email:** 106655.1325@compuserve.com

THE THIRD MINISTERIAL

CONFERENCE ON ENVIRONMENT AND HEALTH

**Organised by:** World Health Organisation

**Date:** 16-18 June 1999

**Place:** QE11 Conference Centre.

**For further info:** The WHO

**Website:** [www.who.dk/](http://www.who.dk/)

SYMPOSIUM ON THE CHANGING STATES OF LARGE MARINE ECOSYSTEMS OF THE NORTH ATLANTIC AND GLOBAL ENVIRONMENTAL TRENDS.

**Organised by:** UNESCO

**Date:** 16-18 June

**Place:** Bergen

INTERNATIONAL WORKSHOP ON CLIMATE CHANGE ISSUES

(The center will also be looking at a number of more specific projects related to climate change).

**Organised by:** World Conservation Monitoring Center:

**Date:** mid-1999.

**For further info:** contact: [info@wcmc.org.uk](mailto:info@wcmc.org.uk),

**Tel:** 01223 277314,

**Fax:** 01223 277136 WCMC, 219

Huntingdon Rd, Cambridge, CB3 0DL

**Website:** [www.wcmc.org.uk](http://www.wcmc.org.uk)

OCEAN CLIMATE OBSERVATIONS CONFERENCE

**Organised by:** UNESCO

**Date:** 18-22 October

**Place:** St Raphael, France.

## EARTH DAY 2000's INTERNATIONAL "NEW ENERGY FOR A NEW ERA" CAMPAIGN

In 1990, over 200 million people in 141 countries on every continent participated in Earth Day celebrations. Earth Day 2000 – the millennial Earth Day – aims to catalyze the political and cultural will to make a global shift to clean energy possible. It will create networks between thousands of citizen groups, while inspiring campaigns on energy/climate change and other critical issues of our time.

Earth Day 2000's International "New Energy for a New Era" campaign will focus on the need to replace polluting fossil fuels with clean, renewable sources of energy. The "New Energy for a New Era" campaign will:

- Highlight successful projects that have leapfrogged over the industrial-era reliance on fossil fuels in favour of renewables. India, for example, has made legislative changes that have made wind energy projects more possible. The Solar Energy Light Fund (SELF) utilizes technology and innovative financing to bring photovoltaic cells to remote villages in China. By highlighting such successful strategies, we hope to inspire activists around the world to press for change in their own communities and countries.

- Contribute to the efforts underway to convince the World Bank and other institutions to shift

funding from outmoded fossil fuel projects to those producing clean energy.

- Work with Earth Day Strategic Partners to create innovative programmes to promote clean energy. Co-ordinating with an organization that represents small island nations of the world, for example, we will organize a race to see which island nation can be the first to move away from reliance on fossil fuels.

To participate in this campaign, contact Mark Dubois or Shalini Ramanathan at (+1) 206.264.0114, [mdubois@earthday.net](mailto:mdubois@earthday.net), [sramanathan@earthday.net](mailto:sramanathan@earthday.net), or 91 Marion St. Seattle, WA 98104, USA.

# The Hammer-Bashing Society

## *A Parable for our Times*

By Edward Goldsmith

**“Y**OU PROMISED to tell me why I can’t have a hammer”, said the little boy. “It’s a long story,” answered the old man. “But I want to know,” the child insisted. “All right”, sighed the old man. “It all started a long time ago, in the country where I was born, when they began hitting each other on the head with hammers. It caught on and soon everybody was doing it. Eventually they did almost nothing else, and our country was soon changed beyond recognition.

“Businessmen started making hammers of all sorts. They couldn’t produce them fast enough, nor of sufficient different varieties – utility hammers, foldable flick-hammers, double-headed hammers, slenderline hammers, spring-loaded hammers, rubber hammers for use in schools. Yes, even education was transformed.

“Mineralists started developing new alloys for super duper extra rough or extra light hammers.

“Special hospitals opened to treat the victims of hammer-bashing. All sorts of new medical specialities came into being and each soon had its own jargon, textbooks, learned journal and professional association.

“Hatmakers cashed in with ever-smarter and more elaborate protective headgear and wigmakers rapidly climbed on to the bandwagon with lightweight protective toupees lined with the most appropriate new alloy.

“Punting on the hammer-bashing pools, attending professional hammer-bashing tournaments and viewing the latest hammer-bashing drama on the telly became the main diversions of those who could not be more directly involved.

“Politicians, basking in the glory of the new prosperity, engendered by an ever-expanding hammer-bashing economy, vied with each other in offering rebates and subsidies on the latest hammer-bashing accessories and ever more comprehensive state services to cater for the victims.

“Academics wrote ever more learned treatises bristling with tables, charts, figures, equations and computer print-outs to provide the theoretical and empirical rationale for the new course on which our country had embarked.

“In fact our society was soon organised to accommodate, in a myriad different fashions, the hammer-bashing lust of its ever more depraved citizens.

“What is more, neither our politicians, nor our industrialists nor our trade unionists nor our scientists nor our technologists nor even our priests would be diverted in any way from the overriding goal of assuring the continued expansion of the hammer-

bashing economy, for it was only in this way that they could maintain their credibility, enhance their professional status and assure their continued prosperity.

“For the same reason they had no choice but to turn a blind eye to the unfortunate side-effects of the activity to which they were so uncompromisingly committed – the hundreds of thousands of fractured skulls, brain-lesions, neuromas, cerebral haemorrhages, brain-seizures, tumours and aneurisms that had to be treated in our hideously overcrowded hospitals, and the proliferating hordes of the epileptic, the neurotic, the schizophrenic, the manic depressive, the paranoid, the amnesiac and the partially or totally paralysed into which categories could eventually be classified the great majority of our citizens including those who directed our major institutions and on whose sound judgements hinged the fate of untold millions. Surprisingly enough, few people seemed to worry too much about these little problems. Most of us were easily persuaded that they were but part of the very acceptable price that had to be paid for the incomparable benefits of hammer-bashing progress.

“However, one day, a little group of people on the periphery of our hammer-bashing society started making an awful fuss, suggesting that hammer-bashing was anti-social and should not only be discouraged but actually outlawed. The reaction to this proposal was brutal to say the least. Those who supported it were denounced as dangerous lunatics bent on destroying the very basis of social order – ‘enemies of society’ to use Paul Johnson’s phrase. If they were taken seriously, we were assured, our hammer-bashing economy would be prevented from further expansion. Businessmen would be deprived of their profits, scientists of their research grants, technologists of their development programmes, working men and women of their jobs, politicians of their electoral support, in fact the whole hammer-bashing economy together with the society that had become its appendage would be condemned to immediate and irreversible collapse.

“Needless to say, these rebels were treated with the disdain they so fully deserved and hammer-bashing continued to monopolise our thoughts, our working days and leisure hours until the last enfeebled and demented survivors succumbed under a hail of weak and badly aimed hammer-blows.”

“It won’t happen here will it, grandpa?” asked the little boy. “Oh no”, the old man answered reassuringly. “The gods of one civilisation are the devils of the next, that is why in our society, hammer-bashing is taboo.”







# Letter Forum

## Science Bashing

Dear Editor,

You recently sent me a free copy of *The Ecologist* because you thought I might wish to subscribe. When reading the editorial concerning the Cassini mission I saw that you used the phrase "there is the hubris of scientists generally, who presume the right to gamble with the future of the planet, and defend that right by appealing to the higher god of scientific progress." If "women" or any racial or religious group had been substituted for "scientists" I hope there would be a scandal. No doubt some scientists have the outlook you condemn and I argue with any I meet, but many others do not.

Some scientists are bad at science, and some have bad attitudes, but the same is true of artists. A certain Mr Hitler was not only not a very good artist, but also a very, very bad man. This is not an art versus science (or anti-science) issue. It relates to the misapplication of science, but the arts can also be misapplied, for example in Nazi banners. At a deeper level, it is about honesty and dishonesty, and acts that are constructive or risk being destructive. To refer to scientists in general in such terms is neither honest or constructive, the same charges that I think you are bringing against the users of the radioisotope power sources in space.

From personal knowledge I can say with certainty that there is widespread opposition among scientists to the very attitudes you condemn as being general among scientists. Such opposition ought to be universal, but the fact that it is not does not mean it is non-existent or even rare.

Moreover, when talking of scientists' attitudes, you should remember that many scientists have a passion for the arts and other "non-science" aspects of life. Stereotyping and compartmentalisation are themselves reductionist. I shall continue to be a member of the Green Party but I will not subscribe to your magazine.

Yours sincerely, Horace Regnart

P.S. Isn't ecology a science?

**Zac Goldsmith replies:** While practically no group of people are blameless for the catastrophic path which humanity has set itself, it would be wrong to suppose that the responsibility should be borne equally by all. You suggest that a 'scandal' would have

*been a suitable outcome had we substituted the word 'scientists' with either 'women' or 'religious groups'. But such a substitution could never be made for the simple reason that women (as a group) cannot fairly be considered responsible for having paved the way for nuclear power, for creating and justifying the use of deadly poisons on our fields, for putting life on Earth at risk through their perfectly useless experiments. Science, as you point out, is a wide term, but our readers on the whole are able to discriminate between the disciplines of botany and, for example, nuclear physics. There is certainly room for scandal - not resulting from the semantics in our editorial, but rather from the information it contains.*

*We might note, furthermore, that unaesthetic paintings do not generally kill people or render environments uninhabitable.*

## Unjustified Attack

28 January, 1999

Dear Editor,

I have only recently read the March/April 1998 number on Cancer. I consider Martin Walker's attack on Richard Doll unjustified. I have worked with Doll and have great respect for his honesty and integrity. Neither the ICRF nor Doll deny the importance of other agents in causing cancer. Doll writes "I conclude that the effects of ionizing radiation less than (say) 0.2 Sv are small but are certainly real and potentially harmful to human health." (J.Radiol Prot 1998 18 163-174 Effects of small doses of ionising radiation).

In my opinion there is no single person in this country who has done more for the prevention of cancer worldwide. It is quite wrong for Martin Walker to call Doll "a questionable pillar of the cancer establishment".

I am very surprised that so little attention was paid to the effects of tobacco in a major issue on cancer. The WHO estimates that there are currently 3.5 million deaths a year from tobacco worldwide, a figure expected to rise to about 10 million by 2030, of which 70% will be in developing countries. It is accepted that about 30% of deaths in this country alone are due to smoking. *The Ecologist* should surely have done much more to emphasise this in an issue devoted to cancer. While you rightly challenge the transnational companies such as Monsanto, you hardly mention the appalling role of the

tobacco companies in spreading disease.

I believe that *The Ecologist* has a very important function, but if it is inaccurate in some of its statements it will lose the respect of the many whom it aims to influence.

Yours sincerely, Dr Keith Ball

**Z.G. replies:** Richard Doll has had a long and distinguished career. In the beginning his work served to seriously disrupt the highly destructive tobacco industry, and, as we point out in our special issue on cancer, he "could have been considered a radical". But the overall effect of his work since then has been to justify the use of numerous highly dangerous chemicals and practices, from asbestos and Agent Orange to the nuclear industry itself. It was he, we should remember, who invented the notion, for which there is not the slightest shred of evidence, that Leukaemia viruses were the cause of cancer clusters which surround virtually every nuclear installation.

We accept that smoking is a major cause of cancer, but according to all the evidence we gathered, it is clear that the smoking of tobacco (responsibility for which can be placed on the shoulders of the individual) has become a scapegoat for other causes of cancer, and is used to deny the dangers of man-made chemicals (responsibility for which must be placed on the shoulders of governments and industry).

Furthermore, there has never been, to my knowledge, a study into the effect of the many hundreds of different chemicals incorporated into most brands of cigarettes. When combined and heated, the effects of the synergy which is known to result would be impossible to calculate, or at best would take many hundreds of years to do so. The distinction has rarely if ever been made between tobacco itself, and tobacco contaminated by hundreds of chemical additives.

There are 70,000 chemicals currently in commercial use. Many of them are highly carcinogenic. In mixtures, they are likely to be more so. The tobacco industry is certainly responsible for a great many cancers and should be held accountable, but not to the benefit of the chemical industries which are equally guilty.

Whether or not Sir Richard is a good or bad man is irrelevant. The effects of his highly questionable research are bad, and have for too long justified the unnecessary suffering of a great many people.



# Classified

*The Alternative Careers Fair in Cambridge, advertised in the Classified section of The Ecologist Jan/Feb 1999, took place on 19th January and not 19th February. We apologise for this and any inconvenience caused.*

## DIARY

**16 March, 1999:** The Academic Inn dinner-discussion. "Genetic Hooliganism", **Zac Goldsmith**. New Cavendish Club, 44 Great Cumberland Place, London W1. 6.30 for 7.30 pm. For more information, contact The Academic Inn, 24 Abercorn Place, London NW8 9XP. Tel: 0171 286 4366.

**19-21 March, 1999:** *Creative Environment: a green hands approach*. Old Ship Hotel, Brighton, UK. A programme of environmental studies including local visits, workshops, competitions and quizzes. For further details, please telephone National Association for Environmental Education (NAEE) on 01922 631200.

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<b>6-7 November</b>	The Clarendon Suite, Birmingham
<b>20-21 November</b>	Cheltenham Town Hall

For more information, contact The Natural Health and Ecology Show, 33 Beechmount Drive, Weston Super Mare, Somerset BS24 9EY, UK. Tel/Fax: 01934 813407; EMail: <nheshow@aol.com>

**23 March, 1999:** *Organic Farming: Implications for the Environment*.

**24 March, 1999:** *National Air Quality Strategy Implications for Industry*. Society of Chemical Industry, London. For further information, contact SCL, 14/15 Belgrave Square, London SW1X 8PS. Tel: +44(0) 171 235 3681; Fax: +44(0) 171 235 7743; EMail: <conferences@chemind.demon.co.uk>; WebSite: <http://sci.mond.org>

**25-6 March 1999:** *International Sustainable Development Research Conference*, University of Leeds, UK. Over 85 papers from 21 different countries. For further information, contact Elaine White, Conference Coordinator, ERP Environment, PO Box 75, Shipley, West Yorkshire, BD17 6EZ. Tel: +44(0) 1274 530408; Fax: +44(0) 1274 530409; EMail: elaine@erpenv.demon.co.uk; WebSite: <www.erpenvironment.org>

**22-24 April 1999:** *Twentieth Century Values*. Central Missouri State University, Warrensburg, MO, USA. Keynote speakers David Gauthier, Antony Flew, Jan Narveson, Thomas Magnell. For more information, contact Kenneth Cust, Center for Applied & Professional Ethics, Central Missouri State University, Warrensburg, MO 64093, USA. Tel: +1 (660) 543 4268; Fax: +1(660) 543 8445; WebSite: <http://cape.cmsu.edu>

**25-27 May 1999:** *The World Sustainable Energy Fair*. R.A.I. Exhibition and Congress Centre, Amsterdam, The Netherlands. For free entry to the fair, please contact European Media Marketing Ltd., P.O. Box 259, Bromley, BR1 1ZR, UK. Tel: +44(0) 181 289 8989; Fax: +44(0) 181 289 8484; EMail <sustain@emml.co.uk> Visit the website at <http://www.emml.com>

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