

Global Warming: a debate re-visited.

Below is the near final draft of what became chapter 9 of my book *Risk*, published in 1995. The process writing it transformed me from a firm believer in man-made global warming into a climate change agnostic – a position to which I still adhere

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Since the 1940s the northern half of our planet has been cooling rapidly. Already the effect in the United States is the same as if every city had been picked up by giant hands and set down more than 100 miles closer to the North Pole. If the cooling continues, warned the National Academy of Sciences in 1975, we could possibly witness the beginning of the next Great Ice Age. Conceivably, some of us might live to see huge snowfields remaining year-round in northern regions of the United States and Europe. Probably, we would see mass global famine in our lifetimes, perhaps even within a decade. Since 1970, half a million human beings in northern Africa and Asia have starved because of floods and droughts caused by the cooling climate."

This dire prospect comes from a book entitled *The Cooling*, published in 1976. Since then the outlook has apparently become more threatening - but for the opposite reason; we now face the prospect of a runaway greenhouse effect. In *Global Warming: the Greenpeace Report* we are warned

... in a "business-as-usual" world in which greenhouse gas emissions continue at today's rates, we are heading for rates of temperature-rise unprecedented in human history; the geological record screams a warning to us of just how unprecedented ... And this conclusion pertains only to existing model predictions, not the natural amplifications [positive feedbacks] of global warming which the world's climate scientists profess are "likely"..."

Intriguingly the new concern about global warming is led by some of the same scientists who were previously responsible for the concern about an impending ice-age. In *The Genesis Strategy* published in 1976 Stephen Schneider, now one of the leading advocates of international action to combat global warming, repeated the warnings of several well-known climatologists that 'a cooling trend has set in.' By 1990 he was insisting that 'the rate of change [warming] is so fast that I don't hesitate to call that kind of change potentially catastrophic

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for ecosystems.ⁱⁱⁱ

Public awareness of this about-face occurred with dramatic suddenness. In *Hothouse Earth: the Greenhouse Effect and Gaia* John Gribbin observes that 'during the 1970s climatologists had become used to the idea that the world was in a *cooling* phase, retreating from the high temperatures reached in the early 1940s.' He describes the circumstances in which the scientific turnaround took place.

'In 1981 it was possible to stand back and take a leisurely look at the record from 1880 to 1980. ... In 1987, the figures were updated to 1985, chiefly for the neatness of adding another half-decade to the records. ... But by early 1988, even one more year's worth of data justified another publication in April, just four months after the last 1987 measurements were made, pointing out the record-breaking warmth now being reached. Even there, Hansen [James Hansen, head of the NASA team studying global temperature trends] and Lebedeff were cautious about making the connection with the greenhouse effect, merely saying that this was "a subject beyond the scope of this paper". But in the four months it had taken to get the 1987 data in print, the world had changed again; just a few *weeks* later Hansen was telling the US Senate that the first five months of 1988 had been warmer than any comparable period since 1880, and that the greenhouse effect was upon us.'

Science writer Fred Pearce also captured, and contributed to, the excited atmosphere surrounding the issue in the late 1980s in his book *Turning Up the Heat*. Figure 1, redrawn from the book, shows the data for the first 5 months of 1988 that attracted such intense interest. The graph, ending as it does with the graph heading vertically off the top of the page, and the caption proclaiming 'the greenhouse effect is here', combine to suggest a warming process rocketing out of control. The text accompanying Figure 1 captures the mood of eager anticipation at the time, with scientists racing to be the first with the bad news.

'But however hard the greenhouse watchers peered at their thermometers, none had been sure until 1988 that the planet was heating up as predicted. Richard Gammon of the US government's Pacific Marine Environmental Laboratory at Seattle in Washington state, seems to have been the first off the starting blocks. After seeing the complete data for 1987 and the first results from 1988, he told a conference in March 1988: "Since the mid-1970s, we have been in a period of very, very rapid warming. We are ratcheting ourselves to a new warmer climate".'

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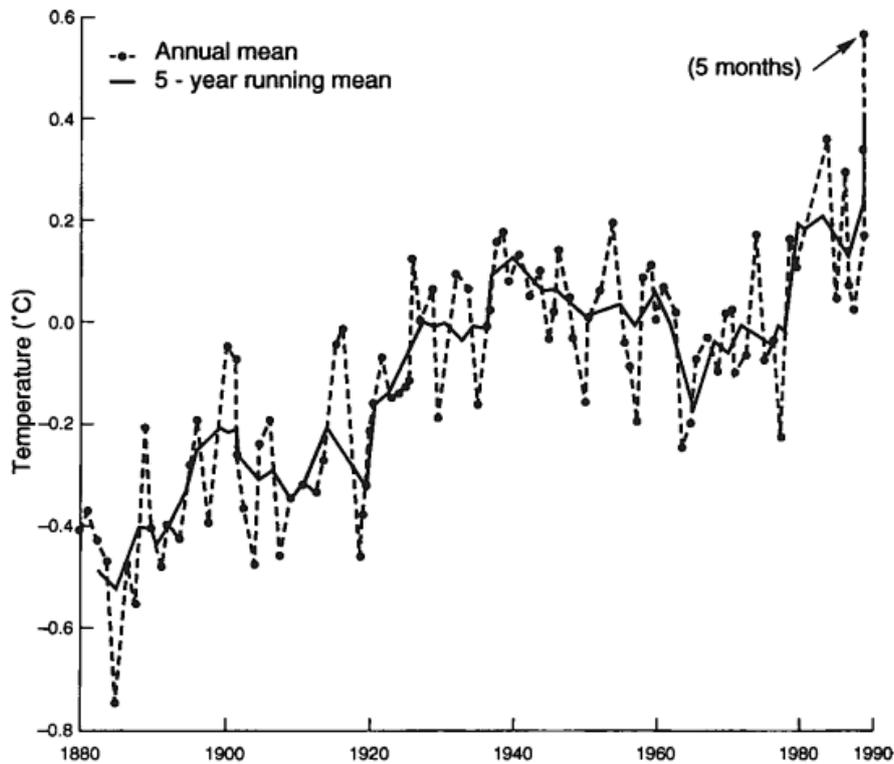


Figure 9.1 Graph from Pearce (1989). The accompanying caption reads: "A century of global warming. The picture in mid-1988, when Hansen declared The greenhouse effect is here".

Since then the world has witnessed a greenhouse-effect-bandwagon-effect. There has been a great rush to climb aboard a rather fragile vehicle. Intriguingly much of the evidence for global cooling is now being recycled as evidence for global warming. Extreme or unstable *weather* conditions are adduced as evidence of changing *climate*. Ponte, in support of his cooling hypothesis, says '... weather gets progressively worse and tends toward extremes: heat waves and cold snaps, floods and droughts, frost and snow in the tropics and bizarre hot weather as far north as Scandinavia.' (Ponte p. 5) Gribbin in support of the greenhouse hypothesis quotes Hansen: 'The greenhouse effect is already large enough to begin to affect the probability of occurrence of extreme events such as summer heat waves ... heatwave/drought occurrences in the Southeast and Midwest United States may be more frequent in the next decade.' (James Hansen, quoted in Gribbin p 3)

Because of the year-to-year and decade-to-decade *natural* variability in global temperature, *climate* change is a process that can only be pronounced upon with any confidence on the basis of trends spanning many decades. Both

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the believers in cooling in the 1970s and the believers in warming in the 1990s projected historic temperature trends into the future. These trends are characterised by great variability, both temporal and geographic, and great uncertainty. The identification of 'trends' in such circumstances is a highly problematical affair.

Figure 2, showing global mean temperatures over the past 850,000 years, is reproduced from *Hothouse Earth*; there is a similar one in *The Cooling*. Gribbin and Ponte both describe the Earth, toward the end of the 20th century, as being in an 'interglacial' period, and note that current temperatures are at or near levels that have not been exceeded within the last 850,000 years. The challenge confronting climatic forecasters is to say where the graph is likely to go from here. It is a problem that they share with other forecasters.

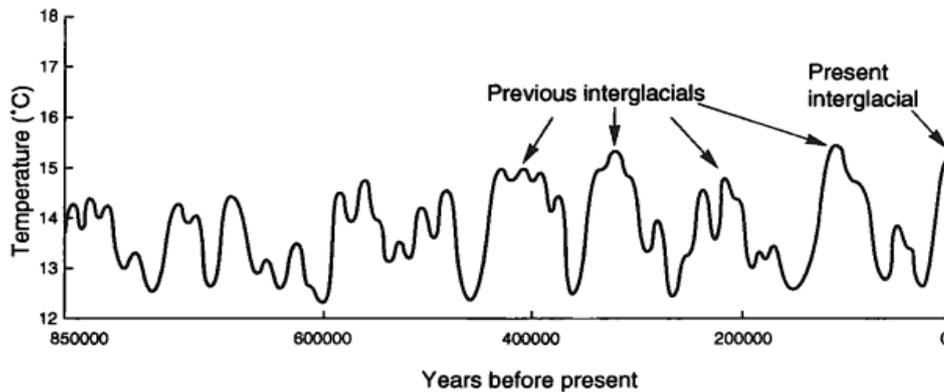


Figure 9.2 Global mean temperatures over the past 850,000 years (source: Gribbin 1989:54).

Alternative futures

Figure 3 illustrates an exponential growth curve of the sort commonly used to describe population growth, traffic growth and economic growth in various countries in recent years. There are, to simplify somewhat, three possible ways of projecting such a trend into the future. One can assume continued exponential growth, one can assume that the process has an upper limit at which it will level off, or one can assume that at some point the graph will turn down. The first assumption is the basis of the forecasts of air traffic growth currently being used for airport planning in Britain; for the foreseeable future growth is assumed to continue as in the past. It is also the assumption on which most economists all around the world base their middle and long term forecasts of Gross Domestic Product. The second assumption, sometimes called a 'saturation model' is the basis of the forecasts of car ownership used for road planning in Britain; growth is expected to stop when

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everyone who is old enough and fit enough to drive owns a car. It is also used by population forecasters who call it the 'demographic transition'. The third assumption, sometimes called a 'depletion curve', is used to describe the expected output of oil fields in the North Sea. It is frequently deployed in limits-to-growth debates to describe the fate of unsustainable growth processes. Each model fits the historical record equally well. The forecast is primarily determined by the choice of model, which in turn is determined by the forecaster's assumptions about the nature of the process he is attempting to predict.

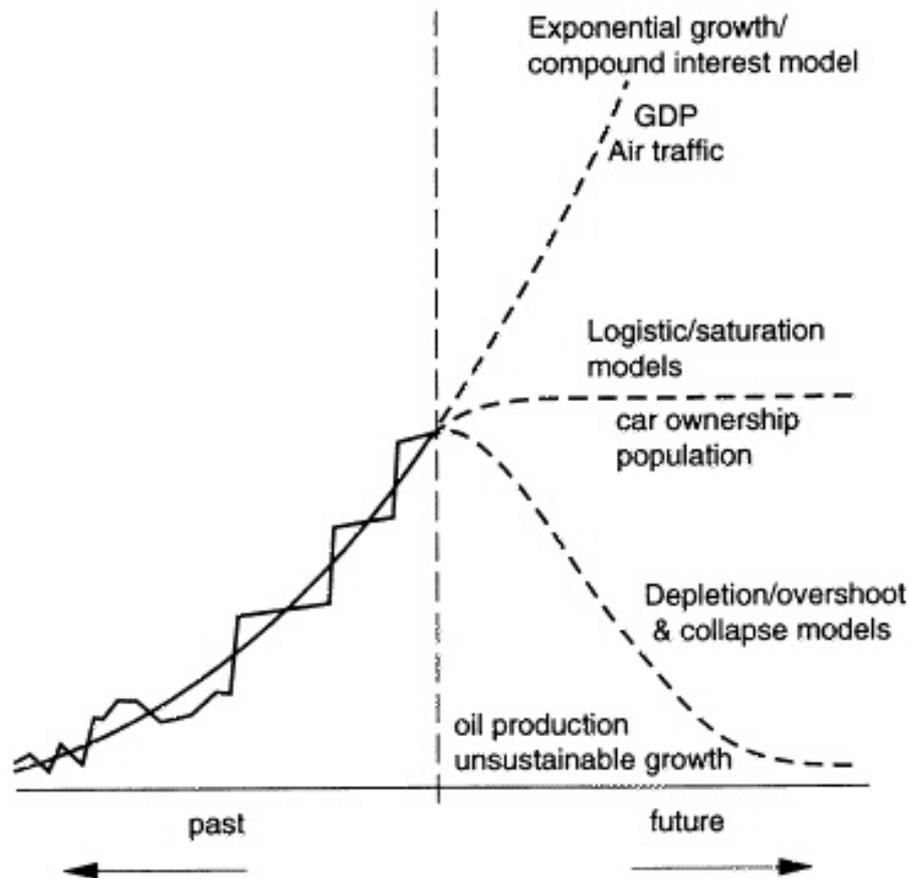


Figure 9.3 Alternative forecasts

The climate forecasters problem is also similar to that of the toxicologists, discussed in Chapter 2, trying to predict human responses to doses of suspect toxins for dose levels far below those tested in animal experiments. In both cases the scientists' predictions are based on

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extrapolation beyond the range of available data. And in both cases the extrapolations are based on assumptions about the nature of the process being predicted for which firm, uncontentious evidence is not available. But without assumptions all such processes are simply unpredictable.

In the 1970s Ponte and a majority of climatologists looked at the record of past temperature changes and concluded that the world was near an interglacial peak. The pattern of ice ages and inter-glacials over the past 850,000 years suggested to scientists at that time that the graph was due to turn down, and the downward trend since 1940 was construed as evidence that it was turning down. By the 1990s Gribbin and Peirce and many climatologists looked at the same record, plus 10 more years of data, and concluded that the graph was rising, and would continue rising unless mankind reduced substantially its production of carbon dioxide. The downward trend that had persuaded the proponents of global cooling in the 1970s that cooling was indeed underway was dismissed as evidence of 'natural variability' about an upward trend.

What changed their minds? The accounts of Gribbin and Pearce quoted above suggest that it was the reversal of the cooling trend from 1940 to the early 1970s. When Ponte was writing his book in the early 1970s temperatures in the northern hemisphere had been falling for three decades. When Gribbin was writing his book they had been rising for over a decade. The data in Figure 2 spanning hundreds of thousands of years have been heavily 'smoothed'. 'Local' deviations spanning a few centuries are averaged out to produce a relatively smooth graph. Figures 1 and 2 ought to demonstrate the futility of attempting to forecast global temperature by projecting 'trends' of a few years, let alone a few months, into the future. But it appears to have been the change in recent 'trends' that was the main cause of the shift in concern from cooling to warming.

There is now some doubt about whether the recent upward trend is a trend at all. The recent development of techniques for measuring temperatures from satellites now permits comprehensive coverage of the Earth's surface, and in particular has permitted much more extensive coverage of the oceans, and the measurement of atmospheric temperature in depth and not just at the surface. The estimates of global mean temperature shown in Figure 1 going back to 1880 and extended up to the present are based on thermometer measurements made at weather stations. Over time the number of these stations has increased, but, for the purpose of estimating global mean temperatures, the measurements produced by them have a number of limitations. The stations are run by large numbers of different people with limited inspection to ensure consistent, comparable standards. Many are located in or near urban areas or airports which are 'heat islands', unrepresentative of the surrounding areas. And the coverage of the stations is

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sparse and uneven, with very limited coverage of the oceans. The message of the combined land-air and sea-surface temperature record published by the IPCC is one of a rapidly rising trend through the 1980s^{iv}. The satellite measurements of global average temperature for the period 1979 to 1993 (Figure 4) reveal no trend at all. In fact the most recent data available from NASA at the time of writing reveal a very slight *downward* trend - a decadal trend over this period of -0.03°C .

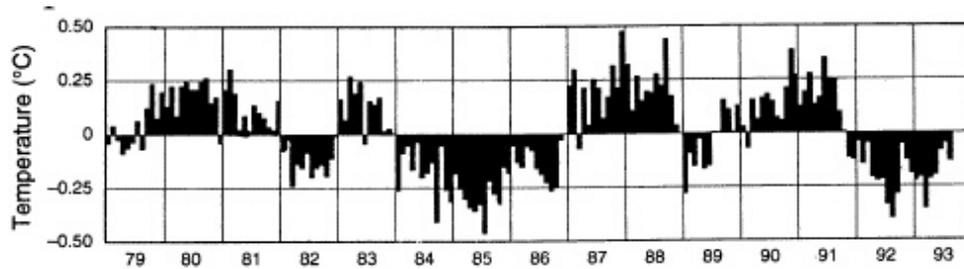


Figure 94 Global temperature variations in Celsius; trend since 1979, -0.03 degrees C per decade. All temperature variations are based on a 10-year average for the month reported. (Source: J. Christy, Earth System Science Laboratory, University of Alabama, Huntsville.

Far greater uncertainty must attach to attempts such as that shown in Figure 2 to reconstruct the temperature record of the distant past. The further one goes back in the past the patchier the sampling becomes and the more speculative become the methods by which past temperatures are deduced. There is wide variability in temperature change over the earth as average global temperatures change - Gribbin notes that during the 1980s when, according to some records, the northern hemisphere warmed by 0.31°C , over Scandinavia mean temperatures fell by about 0.6°C . Thus graphs such as that displayed in Figure 2 of mean global temperature going back hundreds of thousands of years must be treated as speculations with a high degree of probable error.

The issue is further complicated by new arguments about whether anthropogenic CO_2 emissions are contributing to global warming at all. Firstly it is argued that water vapour accounts for about 97% of all greenhouse gases, that CO_2 accounts for less than half the remaining 3%, and that the effect of human contributions to atmospheric CO_2 through the burning of fossil fuels is too small to separate from the 'noise' of natural fluctuations. Second it is argued that because cold water can hold more CO_2 than warm water, as the oceans warm they release CO_2 to the atmosphere, and it is, therefore, warming that has caused increases in atmospheric CO_2 and not the other way around. Further, it is acknowledged that CO_2 can only absorb infra-red radiation at two

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specific narrow wave bands. It is contended by some greenhouse sceptics that these wave bands are already near saturation - that is there is already sufficient CO₂ to absorb almost all the energy available in the relevant wave bands - and that adding further CO₂ to the atmosphere will not cause further warming because there is no more energy to be absorbed.^{vi}

The Debate

On 11 September 1993 the Royal Geographical Society held a mock trial in London. The prosecution framed the charge in legalistic language: 'the proponents of man-made global warming are charged in that they have acted irresponsibly, causing discredit to the integrity of science and ill-advised decision-making by governments without proper justification.' The trial was presided over by an eminent judge, Lord Lloyd, and two Queen's Counsellors presented and cross-examined witnesses who were prominent participants in the greenhouse debate.^{vii} The defence consisted mostly, not of a robust justification of the case for global warming, but of a review of all the caveats that the defendants had attached to their predictions of global warming. Counsel for the defence insisted in his opening statement that 'we do not seek to argue that the case for man made global warming is as yet conclusively demonstrated,' and his principal witness, Dr. David Carson, head of the Hadley Centre for Climate Prediction and Research, conceded that 'it is simply not possible with any confidence to attribute global warming [0.5°C since 1900] to a cause such as an enhanced greenhouse effect.' If the public had formed the impression that global warming was an established fact rather than a mere possibility, the responsibility, according to the defence, should be laid at the door of exaggerated reporting by the media.

The prosecution argued that both the climatic models and the evidence from the historic record are far too primitive and unreliable to form the basis of policy recommendations, *and* that there is reason to suppose that the earth's climate is robust and stabilized by myriad feedback mechanisms, *and* that carbon dioxide should be seen not as a pollutant, but as a fertiliser promoting plant growth. The defence accepted that conclusive proof of their fears is not yet available, *but* that there is reason to suppose that the Earth's climate is precariously balanced, and that business-as-usual is likely to lead to a runaway greenhouse effect.

There was a surprising degree of agreement about the inability of empirical evidence to resolve the issue. The executive summary of the 1990 report of the IPCC (Intergovernmental Panel on Climate Change) acknowledged that the increase in global temperature over the last 100 years was within the range of 'natural climatic variability'. Nor could they find evidence that 'climates have become more variable over the last few years.' And in its 1992 report it stated that 'it is still not possible to attribute any or all of the warming of the last century to greenhouse gas induced climate

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change.' This remains the view of most climatologists. A poll by *Nature* of 1500 climatologists revealed that 71% thought that the climate changes of the past 100 years were 'within the range of natural fluctuation.'

Arguing in the dark

Human risk thermostats manifest a variable sensitivity to the behaviour of the global thermostat. The greenhouse debate turns out to be yet another case of people arguing furiously in the dark. Again the participants in the debate turn out to exhibit the biases characteristic of the stereotypes of cultural theory. The scientific disagreement about the nature of the processes at work and how to model them, and the inability of scientists to settle their arguments by appeal to empirical data, provide a fertile environment; biases, like mushrooms, flourish in the dark.

The *fatalist* shrugs and smiles, amused by the exertions of those trying to make sense of an unpredictable universe. And many scientists studying climate change are rendered fatalistic by their apparent insignificance in the face of the magnitude of the processes under investigation. James Lovelock invokes the Gaia hypothesis to explain the remarkable stability of the Earth's average temperature - between 10°C and 20°C - over 3.5 billion years^{viii}. But this 'stability' has embraced numerous ice ages and greenhouses in which millions of species have evolved and been extinguished. He captures the fatalistic state of mind that this perspective engenders when he observes 'People sometimes have the attitude that "Gaia will look after us". But that's wrong. If the concept means anything at all, Gaia will look after herself. And the best way for her to do that might well be to get rid of us.'^{ix}

The *egalitarian*, transfers his allegiance easily from fear of global cooling to fear of global warming. The ups and downs of the historical and geological record show that both are possible. Earth is either balanced precariously on the peak of an interglacial ready to plunge into another ice age, or on the verge of runaway warming. His myth of nature - fragile and precarious - makes him vigilant for confirming evidence. The following passage from *The Cooling* by Ponte shows that the bond uniting the 'coolers' and the 'warmers' is *instability*.

'Earth's climate has been cooling. This fact seems to contradict theories that say that it should be warming. But the prophets of warming *are* describing real forces that influence climate, and like other scientists are still learning how these forces interact to produce a balance of heating and cooling on our planet. It may well turn out that the growing instability of the Earth's climate is caused by human influences adding both heating *and* cooling forces to the balance, thereby making it more and more "unnatural" and precarious. The prophets of both

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warming and cooling agree on at least one thing: climatic changes can come quickly, within centuries or even decades, and can have devastating consequences for humankind. Climatology has ceased to be a drab science. Its findings have taken on an urgent importance for all of us.¹⁸

The egalitarian precautionary principle transforms uncertainty into cause for urgent action. The Greenpeace report acknowledges that 'the world's climate scientists conclude in their IPCC report that "the unequivocal detection of the enhanced greenhouse effect from observations is not likely for a decade or more".' But those who cannot appreciate the urgency are nevertheless viewed with disdain. The report continues: 'Ten years from now - possibly amid environmental refugees, nations on the verge of conflict over dwindling water supplies, and hosts of agricultural pests surviving increasingly warm winters - we are still likely to see scientists having difficulty putting their hands on their hearts and saying "The impacts of the enhanced greenhouse effect are now definitely being felt".'

An egalitarian response to the threat of global warming is set out in a 10 point agenda in the conclusion to *Global Warming: the Greenpeace Report*. It is called 'Some anti-greenhouse actions for the concerned citizen'; it advocates energy saving lightbulbs and energy efficient appliances, draught proofing, insulating, recycling, reducing dependence on the car, organic farming, vegetarian diets, and campaigning 'for anti-greenhouse changes in society' - in brief, it enjoins us all to *tread more lightly on the earth*.

The ultimate justification for the egalitarian agenda is the possibility of a *runaway greenhouse effect*. George Woodwell, president and director of the Woods Hole Research Centre demonstrates the precautionary principle in action.

'The possibility exists that the warming will proceed to the point where biotic releases [of greenhouse gases] from the warming will exceed in magnitude those controlled directly by human activity. If so, the warming will be beyond control by any steps now considered reasonable. We do not know how far we are from that point because we do not know sufficient detail about the circulation of carbon among the pools of the carbon cycle. We are not going to be able to resolve those questions definitively soon. Meanwhile, the concentration of heat-trapping gases in the atmosphere rises...

If the process [of stabilizing the composition of the atmosphere] is not undertaken, the erosion of the human habitat will proceed rapidly, with the full panoply of ecological and political consequences.¹⁹

He begins with a *possibility* and proceeds by an *if* via doubts about *how soon* to the *imperative for urgent action*.

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Individualists emboldened by their belief in a robust and benign nature, read the record of the past very differently; nature is benevolent and nothing has happened in the last 100 years that cannot be accounted for by 'natural variability'. William Nordhaus, author of the first cost-benefit analysis of the greenhouse effect (discussed below), puts the case against the precautionary principle succinctly: 'To defend against the worst case will quickly bankrupt any imaginative government.'^{xiii} The precautionary principle, they observe, is indiscriminate; it has also been used to justify Star Wars and the arms race - causes to which most of those invoking it in the global warming debate would not subscribe. Human ingenuity and the march of compound interest they say have seen off the Malthusian prophets of doom for the past 200 years. The abrupt switch from alarm about global cooling to alarm about global warming they offer as reason to suppose that the believers in the greenhouse effect are simply alarmist. There are scientists to serve all the established myths of nature. Individualists are reassured by the views of Richard Lindzen, professor of dynamic meteorology at the Massachusetts Institute of Technology and a prominent greenhouse sceptic, who asserts that 'the evidence of billions of years' proclaims the 'immense robustness' of the Earth's atmosphere. He protests that the models of the proponents of global warming embody *substantial positive feedback*, that is they assume global warming to be a self-amplifying process which, once started, will run on to catastrophic heating of the Earth. On the contrary, he insists, *negative feedbacks* are the norm in long surviving stable systems - which he believes the Earth's atmosphere to be. Available empirical evidence cannot resolve the dispute. The disagreement is rooted in opposed myths of nature. Where the egalitarians present uncertainty as grounds for precautionary action, individualists find the severe limits on the present understanding of global climate grounds for optimism, and are reassured by the failure of present climate models to produce backward projections that fit the observed data. Each side points triumphantly to the inability of the other side to *disprove* the other's case. The same climatic record that renders the fatalists fatalistic and the egalitarians fearful renders the individualist cheerful.

Earlier false alarms are revisited. They dig up predictions of global energy shortages made during the 1970s oil crisis, and note that they have been confounded; the price of oil is now back to its pre-crisis level. A robust and benign physical nature is complemented in their outlook by an ingenious and adaptable human nature. If natural resources run short substitutes will be invented. If the atmosphere warms up and sea levels rise air conditioning can be installed and dykes can be built. The wealthier a nation is the more resources it can command in the unlikely event that they might be needed to meet some future climatic challenge. The egalitarians prescription of self-denial and reduced consumption would, they argue, slow, or stop, economic growth - the very process that increases mankind's adaptive capacity.

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The individualist favours business-as-usual.

Hierarchists look at the climatic record and see cause for concern but not panic. They bring the same scientific/managerial approach to the threat of global warming that they bring to all risks. What distinguishes the greenhouse effect from most other risks they seek to manage is the unprecedented scale of the management problems it poses.

During the Cold War climate control was seen as an issue of military significance. Lowell Ponte, the author of *The Cooling*, worked during the 1960s for the US Defense Department on strategies for climate modification. In his book he rehearses some of the ideas that both the Americans and Russians had already contemplated, such as damming the Bering Straits, or using aircraft to dust vast areas of northern Russia to reduce reflectivity and increase heat absorption. The ideas now being discussed in international forums to counteract global warming - from carbon taxes and tradable CO₂ pollution permits to schemes for massive reforestation in the third world - *all assume that the problem being addressed is a manageable one.*

Hierarchists favour more research and a constrained version of the precautionary principle. The British Government established the Hadley Centre for Climate Prediction and Research in 1990 with an annual budget of £12 million to investigate global warming. But meanwhile it has set in train a wide range of precautionary research - on issues ranging from agricultural practices and alternative sources of energy to energy saving forms of transport and land use - that is predicated on the assumption that man-made global warming is an established fact.

Of all the work that has been launched on the back of this assumption the most ambitious by far is that of the economists who are attempting a cost-benefit analysis of global warming. Economists are now being employed by the Intergovernmental Panel on Climate Change. They are insisting that a rational response to climate change requires that all costs and benefits of global warming and the control of global warming be expressed in monetary terms. A global cost-benefit analysis faces all the same problems of monetary evaluation that are encountered in a cost-benefit analysis of village by-pass. The most significant of these problems were discussed in Chapter 5, but the unprecedented scale of the exercise merits further comment. It is the largest example I can offer of the application of the *hierarchist* approach to risk management. I call it 'Vogon Economics'.

Vogon Economics and the hyperspatial bypass

The Hitchhiker's Guide to the Galaxy begins with a tale of two bypasses. Both threaten the house of Arthur Dent, the bemused character at the centre of the story. A bypass presents a classic problem for economists. If built it will produce *benefits*, usually in the form of time savings for motorists,

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and relief from traffic in the locality bypassed. It will also impose *costs*; it will take land and often a few houses, and bring the disturbance of traffic to a previously tranquil area.

Enter the cost-benefit analyst. His job is straightforward. He weighs up the costs and benefits, and if the latter exceed the former he concludes that there is a case for building the bypass. Cost-benefit analysis is the British Treasury's test of value for money. It is, as we have seen in Chapter 5, the quintessential hierarchist management tool. Over the last two decades almost all the new roads built in Britain, including those planned through Twyford Down and Oxleas Wood^{xiii} have passed this test. Despite the apparent simplicity of the method and its application over many years, cost-benefit analysis remains an unsatisfactory way of resolving disputes about bypasses - unsatisfactory in the sense that those who do not want the bypass are rarely persuaded by a cost-benefit analysis that it should be built. The main difficulty is that those who enjoy the benefits of a bypass and those who bear the costs are seldom the same people. The losers are not often content with the knowledge that other people will gain more than they will lose. And attempts to compensate the losers from the gains of the winners routinely founder on disagreements about the valuation of the losses.

How, for example, should the loss of Arthur Dent's home be valued? A real estate agent could be given the job of establishing its current market value. But what if he does not want to move? He could be paid additional compensation for his *consumer surplus* - the economist's term for the extra-market value that he places on his house. How much? According to the rules of cost-benefit analysis the loser's loss must be the sum of money that would leave him feeling as well off after he has lost his home as before.

Unfortunately the only person who can calculate the compensation required to leave a person feeling as well off after the event as before is the loser himself. If one's home is demolished, the geographical centre of one's existence must be relocated. For some this experience will be more upsetting than for others. For many, surveys have repeatedly confirmed, the disruption of their web of friendships and the loss of cherished surroundings cannot be compensated by any sum of money. Many people resist the idea that such losses can be translated into cash at all, however large the sum. They either refuse to play the economist's game and decline to name a sum that would compensate them, or they say it is priceless - an answer that the economist is obliged to either disregard, or enter into his spreadsheet as infinity. It takes only one infinity to blow up a whole cost benefit analysis.

This valuation problem is encountered not just with homes. Other buildings and landscapes with nostalgic associations, endangered species, security, health, and life itself also present intractable obstacles to analysts whose method requires that *everything* relevant to the decision they are trying to make should be reduced to cash.

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Of the two bypasses threatening Arthur Dent's home, one was a common-or-garden local bypass of the kind that Britain's Department of Transport routinely justifies with cost-benefit analysis. The second was a Galactic Hyperspatial Express Route that required the demolition not just of Arthur Dent's home but planet Earth as well. Although the *Hitchhiker's Guide* fails to say whether cost-benefit analysis was used by the Alpha Centauri planners in deciding to route their bypass through Earth it is obvious that it must have been. In all other respects the practices of the Alpha Centauri planners and their earthling counterparts are identical. They differ only in the scale of their activities. Throughout the Galaxy it seems planners (*hierarchists*) react to protesters in the path of their projects with the same dismissive irritation. In his last announcement, before energizing the demolition beams that vaporized earth the head of the Vogon Constructor Fleet explained that 'all the planning charts and demolition orders have been on display in your local planning department in Alpha Centauri for fifty of your Earth years, so you've had plenty of time to lodge any formal complaint and it's too late to start making a fuss about it now.'

The irritability of the planners stems directly from the unresolved valuation problem. The planners are persuaded that the benefits of their schemes outweigh the costs, but those in the path of their schemes rarely agree. Because some potential losers are incapable of assigning finite numbers of dollars or pounds to their losses the planners cannot prove that the benefits of their schemes outweigh the costs. So they bypass the difficulty. Instead of asking people what amount of money would compensate them for their losses, they ask them what they would be willing to pay to prevent these losses. This has the effect of transforming all priceless valuations into finite numbers, and substantially reducing all lesser valuations. This in turn substantially improves the benefit:cost ratios of their projects, strengthening their argument for building what they wish to build.

The Department of Transport has hit upon a particularly effective version of this trick for valuing Sites of Special Scientific Interest, parks and other land subject to protection from development. They ask themselves what a purchaser would be willing to pay for the land if it were offered for sale in the open market *without planning permission for development*. They answer 'virtually nothing'; the greater the 'protection' enjoyed by a piece of land, the lower the value assigned to it by the Department's cost-benefit analysts. They call their version of cost-benefit analysis COBA; it selects routes for their schemes that have the highest benefit:cost ratios; it actively seeks out routes through the *best protected* parts of the country.

Where those standing in the path of a project are poor and powerless, and able to pay little or nothing to fend off the threatened destruction, and

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where the proposers of a project are rich and powerful and willing and able to pay a lot for the benefits, cost-benefit analysis - modified to value the losses of the poor by how much they are willing to pay to prevent them - will invariably demonstrate that the project should go ahead. Throughout the Galaxy proposers of major projects are usually richer and stronger than the objectors, and so find cost-benefit analysis a most congenial decision making tool. Projects whose proposers are weak and poor rarely get off the drawing board.

Tomorrow the World

Flushed with their success in the road building industry, cost-benefit analysts are now turning their attention to a Vogon-scale problem - the threat to the Earth of the greenhouse effect. In 'To slow or not to slow: the economics of the greenhouse effect' William Nordhaus^{sv} explains that an efficient global strategy requires that 'the costs of steps to slow climate change be balanced on the margin by the benefits in reduction of damages from climate change.' More recently Fankhauser and Pearce, in a study for the OECD, have set out the case for global scale cost-benefit analysis as follows.

'A monetary assessment is crucial to design the optimal policy response. A comparison between the costs of greenhouse prevention and the benefits of avoided warming, which forms the backbone of an economically rational greenhouse response, is only feasible if damage can be expressed in monetary terms.'^{sv}

The economists are attempting to attach cash values to physical effects about which there is still great scientific uncertainty and dispute. For the purpose of their analysis they are obliged to make assumptions. Nordhaus *assumes* for his cost-benefit analysis that the 'damage function' increases as greenhouse gases increase. He goes on to say 'I have little confidence in this assumption'^{svi}, but nevertheless proceeds to calculate that the costs of reducing greenhouse gas emissions by half would be four times greater than the benefits. He estimates the total cost of a doubling of CO₂ at a mere 1% of global GDP, considerably less than one year's growth in a good year. He concludes that, like a bypass, 'climate change is likely to produce a combination of gains and losses with no strong presumption of substantial net economic damages.'

Some economists appear to be so anxious to play a significant role in the greenhouse debate, that they are prepared to assume things that they do not believe. The essence of Nordhaus's conclusion is that even if the greenhouse damage function is increasing, it is not very important. Fankhauser and Pearce, compare Nordhaus's estimate (*based on an assumption in which he has little confidence*) with those of two subsequent studies and report a reassuring convergence on Nordhaus's view that a doubling of CO₂ would not make a serious impact on the world economy.

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‘Despite differences in individual damage categories, the three studies roughly agree on the overall result, with a 2xCO₂ damage in the order of 1 per cent to 2 per cent of GNP. This range turns out to be surprisingly robust. Even when picking the most pessimistic figure for each damage category the total only modestly exceeds 2 per cent of GNP. Conversely it does not fall below 3/4 per cent in the most optimistic case.’

In their cost-benefit analyses the *global costs* are the expenditures incurred in slowing warming, and the *global benefits* are the damage avoided. But *if* the IPCC scientists and other proponents of the global warming theory are right in their contention that the principal cause of global warming is the increase in CO₂ emissions caused by deforestation and the burning of fossil fuels, then the potential damage of global warming is a cost directly attributable to the growth of economic activity in industrialised countries. Most of the benefits of this activity have been enjoyed by the wealthy and powerful; most of the costs have been borne by the poor and the weak. And *if* the proponents are also right in their assumption that a substantial rise in sea level will accompany global warming, then a fair cost-benefit analysis of the greenhouse effect would have to ascertain the sum of money that would compensate the inhabitants of large parts of Bangladesh for the loss of their homes and livelihoods, and the inhabitants of small island states for the loss of their countries. The method would encounter the same difficulty discussed in Chapter 5; many of these people would answer that no sum of money could adequately compensate them for their losses, and such answers render cost-benefit analyses inoperable.

Fankhauer and Pearce bypass this problem in the same way as the Department of Transport, and with similar, although potentially much larger, effect. In their formulation of the problem costs become benefits and benefits costs. The mighty juggernaut of economic growth, out of whose tailpipe comes the threat of global warming, is treated as an irresistible force of nature. The costs in their analysis are not the damage that the juggernaut might do to the Bangladeshis and islanders, but the costs of *preventing* this damage. The benefits are ‘the benefits of avoided warming’. In this analysis, the rich nations on board the juggernaut do not ask those whom they are about to obliterate, ‘what sum of money would leave you feeling as well-off after we run over you as before?’ They ask in effect, ‘what would your country fetch if offered for sale in the open market without planning permission for development?’

They provide a fairly specific answer; for land whose existence is threatened by sea-level rise they assume a value ranging from \$2 million per square kilometre to \$5 million. This would value the benefit to the low-lying island state of Tuvalu of not being wiped out at between \$52 million and \$130 million (*in 1989 US dollars*) - or between \$6,000 and \$15,000 per inhabitant.

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Meanwhile, in the 'developed' world a London/New York day return by Concorde costs \$7000 and, as Nordhaus observes, we have air conditioning and can afford to build dikes.

The application of cost-benefit analysis to the greenhouse effect is breaking new ground in one further important respect which merits a brief mention - the Vagon-scale time frame of the analysis. Economist William Cline, whose work on the economics of the greenhouse effect has been fulsomely praised by *The Economist*, insists that the analysis must be extended to embrace effects 250 to 300 years in the future^{viii}. Cost-benefit analysis requires all future effects to be discounted, i.e. reduced to their present value at the time of the analysis. Even at a relatively low discount rate - Cline recommends 2 per cent - effects 300 years into the future become insignificant. But Cline manages to salvage a role for the economist by observing that 'the scale of greenhouse damage is likely to grow with the scale of GNP'; assuming that GNP will continue to grow for the next 300 years, he concludes that 'the scale factor could thus neutralise much of the discounting'. For the neutralisation effect to be complete, global wealth (in 'real' terms) and greenhouse damage 300 years hence would have to be 380 times greater than at present.

300 years ago the US dollar did not exist and most of the North American continent was still owned by the Indians. One way of appreciating the magnitude of the task that the greenhouse economists have set themselves, is to imagine them transported by time machine back to 1693, and set the task of doing a cost-benefit analysis of the European conquest of North America - with the net present value of the conquest calculated in 1693 wampum.

Doubtless the greenhouse economists would argue that the cost-benefit analyses of the greenhouse effect done so far are merely illustrative of their method, and that they require improved inputs from the scientists before they can be truly useful; Nordhaus concedes that his calculations need 'fine tuning'. There are two defects in this defence. First, it is likely to be a long time, if ever, before the scientific evidence is conclusive. Second, the economists will *never* develop a workable cost-benefit analysis that will not discriminate against the losers, because they will never have a fair valuation method that will yield finite estimates of the costs of global warming; *there is no system of valuation that allows the losers to be the valuers of their own losses that is proof against one or more losers declaring their losses to be unassuageable by finite sums of cash*. Cost-benefit analysis can therefore never answer Nordhaus's question 'to slow or not to slow?' It is a method for evading, not answering, a moral question - should the wealthiest grow wealthier at the expense of the poorest?

A failure to build more roads to accommodate traffic growth would, the Department of Transport argues, retard economic growth in Britain. For those who equate rationality with the reduction of all concerns to cash, all

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projects are to be judged ultimately by their effect on Gross Domestic Product. Over zealous attempts to slow the greenhouse effect would, they argue, retard the growth of Gross World Product; they would divert resources from other projects with higher rates of return. Where the costs and benefits of projects are measured in US dollars the concerns of those with the most dollars loom largest. The *project* being appraised by a cost-benefit analysis of the greenhouse effect is the promotion of world economic growth. It is comparable to a bypass through a poor suburb of Alpha Centauri to accommodate the growing traffic of wealthy Vogons travelling in air-conditioned space ships. For Vagon economists the problem is straightforward. The benefits of the project are great. The costs are negligible. The benefit:cost ratio is substantially greater than one. The project should go ahead.

There is one small problem with this comparison. Should their project run into difficulty the Vagon economists have another planet to which they can retreat.

An introspective postscript

For a wide range of debates about risks, of which the greenhouse effect is but one of the largest, there is little or no prospect of science settling the issue. We are *all*, this author included, confronted by the need to make judgements about potential risks on the basis of inadequate evidence. The experience of assembling and discussing the evidence here presented has been accompanied by intensive introspection. Where do *I* stand? At times there appeared a danger of the introspection inducing total paralysis. It is easy to demonstrate that people are arguing from different premises, but if *science* is incapable of forging an agreement about premises, what more can one say? This is a problem to which I return at the end of the book.

What I have done in my discussion of the application of cost-benefit analysis to the greenhouse effect is to offer the reader an example of bias (my bias) in action. My survey of the global warming debate has made me more open-minded about the scientific evidence - I began as a firm believer in the greenhouse effect, and am now much less sure. It has made me more fatalistic - ice ages and greenhouses of the past have occurred without the assistance of mankind and doubtless will again. It has also confirmed my prejudices about cost-benefit analysis. Having vented these prejudices I conclude that I am not a hierarchist - a least not on a global scale. The hierarchist 'rationality' presumes an agreement about objectives - what the economist calls an 'objective function'. The hierarchist inhabits a singular hierarchy, and any hierarchist's attempt, such as that of cost-benefit analysis, to formulate a rationale for action, can only work if there are common values and agreement about the hierarchy's objectives. The method encounters insurmountable problems when attempts are made to use it to resolve disputes

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involving more than one hierarchy and/or other cultural biases.

The attempt by economists from affluent OECD countries to apply cost-benefit analysis to a globe spanning problem such as the greenhouse effect is, I conclude, doomed to fail. Not only will it antagonise adherents to the other three cultural biases, it will also encounter resolute opposition from many non-OECD hierarchists.

Endnotes

- i. L. Ponte, *The Cooling* (1976, Englewood Cliffs N.J.: Prentice-Hall) p xiii.
- ii. J. Leggett (ed), *Global Warming: the Greenpeace Report* (1990, Oxford, Oxford University Press) p 14.
- iii. Stephen H. Schneider, interviewed in *The Greenhouse Conspiracy*, Chanel 4, 12 August 1990.
- iv. Intergovernmental Panel on Climate Change, *Scientific Assessment of Climate Change* (1990, WMO/UNEP, Geneva) graph p. 21.
- v. Gribbin p 12.
- vi. J. Olstead, Global Warming in the Dock, *Geographical Magazine*, September 1993, 12-16.
- vii. The witnesses for the prosecution were Richard Lindzen of the Massachusetts Institute of Technology, John Emsley of Imperial College London, and Nigel Hawkes, science editor of *The Times*. The witnesses for the defence were Bert Bohlin, chairman of the Intergovernmental Panel on Climate Change, Martin Parry from Oxford University and David Carson of the British Meteorological Office's Hadley Centre for Climate Prediction and Research.
- viii. J. E. Lovelock, *Gaia: a New Look at Life on Earth*, (1987, Oxford: Oxford University Press) 21.
- ix. quoted in Gribbin.
- x. Ponte p 31.
- xi. G. M. Woodwell in *Global Warming: the Greenpeace Report*, pp 116-132. The Woods Hole Research Centre is a small private organization created by Woodwell, not to be confused with the well-known Woods Hole Oceanographic Institution and the Woods Hole Marine Biological Laboratories.
- xii. W. D. Nordhaus Lethal Model 2: The Limits to Growth Revisited, *Brookings Papers on Economic Activity*, No. 2, (1992) 1-59.

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xiii. On 7 July 1993 the Government withdrew its proposal to build a road through Oxleas Wood in response to enormous public pressure, not as a result of a new improved cost-benefit analysis. The same method that was used to justify the Oxleas Wood scheme continues to be applied to the rest of Britain's road programme.

xiv. William D. Nordhaus, To slow or not to slow: the economics of the greenhouse effect. There are two papers with this title. The first, dated 5 February 1990, is the longer unpublished version of the paper. It circulated widely in environmental circles and was much discussed prior to publication in *The Economic Journal*, 101, July 1991, 920-937.

xv. The Social Costs of Greenhouse Gas Emissions, paper presented to the International Conference on the Economics of Climate Change, OECD, 14-16 June 1993.

xvi. This statement does not appear in the published version of the Nordhaus paper.

xvii. William R. Cline, Scientific basis for the greenhouse effect, *The Economic Journal*, 101, July 1991, 904-919.