CLIMATE EMERGENCY

We face a global 'Climate Emergency'. The situation is much worse than we are told by politicians and much worse than the day to day discussion in the media would suggest. The measures currently being taken at the national level, and even the best plans, currently being considered at the international level, are quite inadequate to meet the scale of the threat we face.....

Understanding any problem is the first step to solving it.
This is a concise guide to what you need to know
for you and your childrens' future.

Contents:

‘Climate Change’ or ‘Global Warming’ constitutes a massive threat to humanity which many find hard to understand in part because it is, in nature, quite unprecedented.

Of course the climate has changed before and sometimes this has taken the form of the planet warming – but what we mean by ‘climate change’ or ‘global warming’ is climate change, or warming, *caused by humankind* – or, to put it in fancier language, “anthropogenic climate change”. This warming up of the climate, caused by humankind, is happening at a much faster rate than the natural variations in the climate that have occurred before. Or at least whenever the climate has changed at a rate approaching anything like what is happening now, in very distant prehistory, it has had a disastrous impact on life at the time, with mass extinctions of species.

Humankind has had a destructive impact on the environment many times before, and the rate at which we have destroyed forests, polluted rivers, fouled the air in our cities and hunted species to extinction has accelerated phenomenally over the last two hundred years. What is different and new about human-caused climate change is that for the first time humankind is having an impact on the environment not just locally but at the global level – that is to say that rather than just destroying a forest here or polluting a sea or river there (or even many forests and many rivers), we are doing something that effects the whole world all at once by influencing the natural systems that work at the global level. This is something quite unprecedented in human history and the implications are very frightening

1. The Science of Climate Change

We are having an impact on the environment at the global level by changing the composition of the atmosphere. The atmosphere, of course, is everywhere – there is only one atmosphere and that is shared by the whole world.

Humankind has changed the atmosphere in various ways and in fact the first adverse impact we had on the atmosphere, that gained general recognition, was not its warming up but rather the destruction of gases that formed a layer (the "ozone layer") that naturally protected us from the harmful effects of ultraviolet radiation from the sun. Certain gases, produced by industrial processes, were breaking down the ozone and so starting to expose us to harmful radiation, especially in certain regions of the planet. Fortunately countries around the world cooperated, through an agreement called the 'Montreal Protocol' to reduce their production of ozone-destroying gases. As a result this problem of the destruction of the ozone layer is, for the most part, being steadily brought under control. There is a lesson here: international collaboration to combat environmental problems can be made to work.

The adverse impact that humans have had on the composition of the atmosphere that we are most concerned about in this booklet, however, is one that is continuing to get worse – and at an accelerating rate. We are continuing to emit gases into the atmosphere that have the effect of trapping heat, or to put it another way, that are increasing the intensity of the 'greenhouse effect'.

The 'Greenhouse Effect' refers to the way that the atmosphere traps heat that comes from the sun, rather in the way that a greenhouse does, thereby making the planet warmer than it would otherwise be. In fact without the greenhouse effect the planet would be too cold to sustain life as we know it.

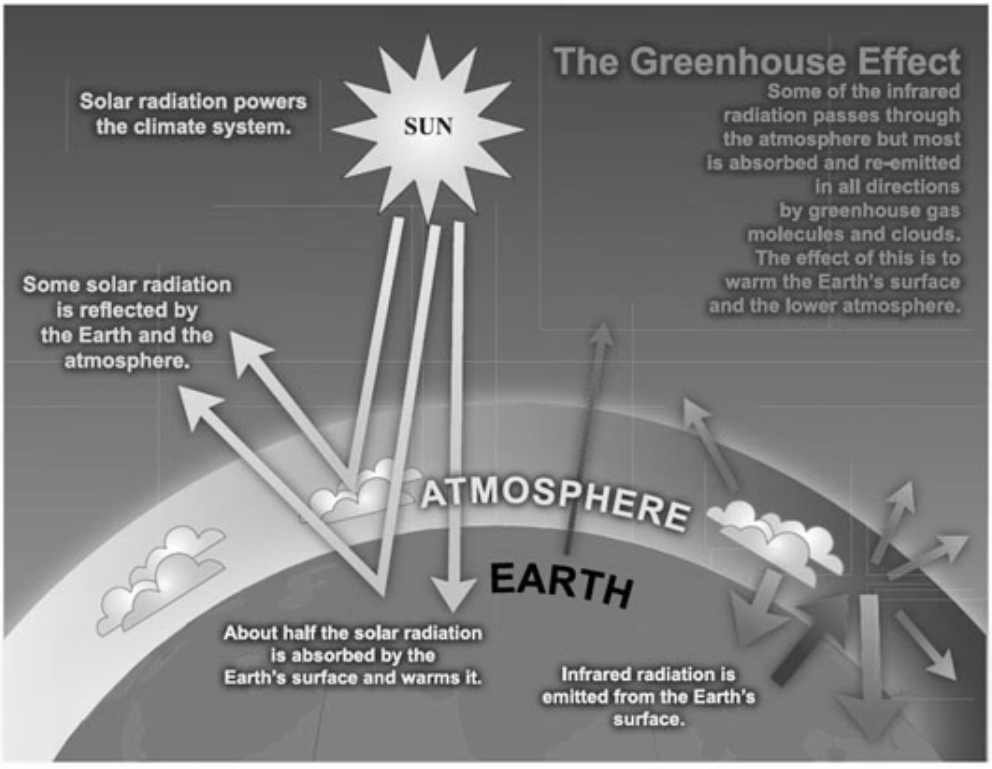


Fig 1

To describe it in a little more detail – energy radiated from the sun enters the atmosphere and warms the surface of the earth. A proportion is radiated back from the surface (in the form of infra red waves) and all of this would escape back into space, were not most of it absorbed or 'trapped' by the atmosphere. In other words, the atmosphere acts like a kind of blanket keeping in the re-radiated energy and making the atmosphere and planet warmer than it would otherwise be. To be more accurate, it is certain gases within the atmosphere – that include water vapour and

Carbon Dioxide but which are known collectively as "greenhouse gases" – that have this effect of absorbing the radiated energy and acting like a 'blanket'. The actual amount of these 'greenhouse gases' that are present in the atmosphere determines how effectively energy is trapped and thereby the temperature of the planet. By comparison to Earth, for instance, Mars has a thin atmosphere with low concentrations of greenhouse gases and therefore temperatures too low for most forms of life. Venus, on the other hand, has a very dense atmosphere with a very pronounced greenhouse effect and is too hot for most life, as we know it, to exist.

The Earth has just the right balance for a wide variety of life forms to exist but recently humankind has begun to upset that fragile balance. Since the start of the Industrial Revolution we have been emitting extra greenhouse gases into the atmosphere, increasing, or 'enhancing', the greenhouse effect and thereby warming up the planet. These gases include methane, nitrous oxide, and CFCs (or 'chlorofluorocarbons') but the most significant of the extra greenhouse gases that we have been emitting into the atmosphere is carbon dioxide (CO2). This exists naturally in the atmosphere but we have been producing *extra* CO2 through our burning of fossil fuels – the coal, oil and natural gas that powered the Industrial Revolution and continue to fuel modern economies. As well as releasing the carbon from these fossil fuels – formed from "fossilised" vegetation buried over millennia underground – we have been destroying forests and thereby releasing huge quantities of carbon from 'living' vegetation, as well.

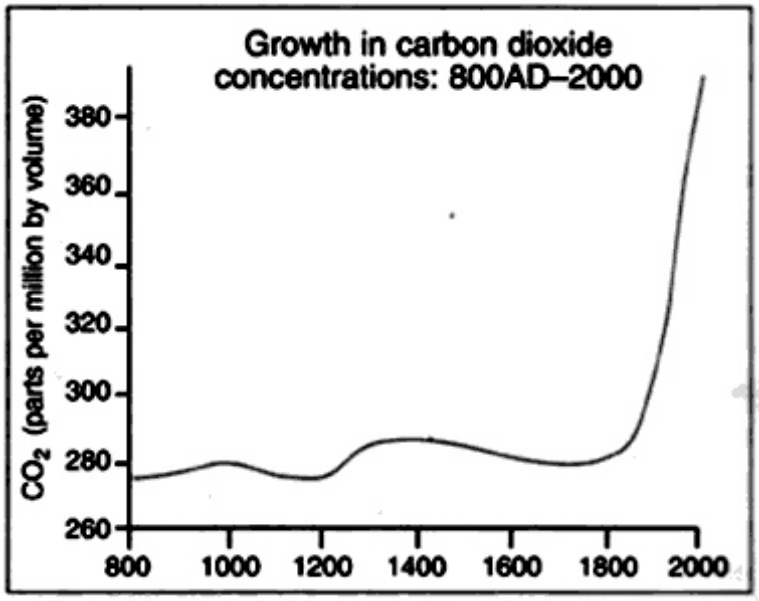


Fig. 2

Over the last 2 hundred years we have increased the amount of carbon in the atmosphere by about ONE THIRD. By analysing the bubbles found in ice cores from Antarctica, we know this is a higher level than has been reached for 800,000 years and scientists think this level may not have been exceeded in the last 20 million years. This is far longer than humankind or even humanoid-type creatures have existed, so for humanity this is something quite unprecedented. The extra carbon, along with extra amounts of other greenhouse gases, have had the effect of enhancing the greenhouse effect and trapping more heat within the atmosphere. As a result the last three decades have each in turn been the warmest on record and global average surface temperature has risen by about

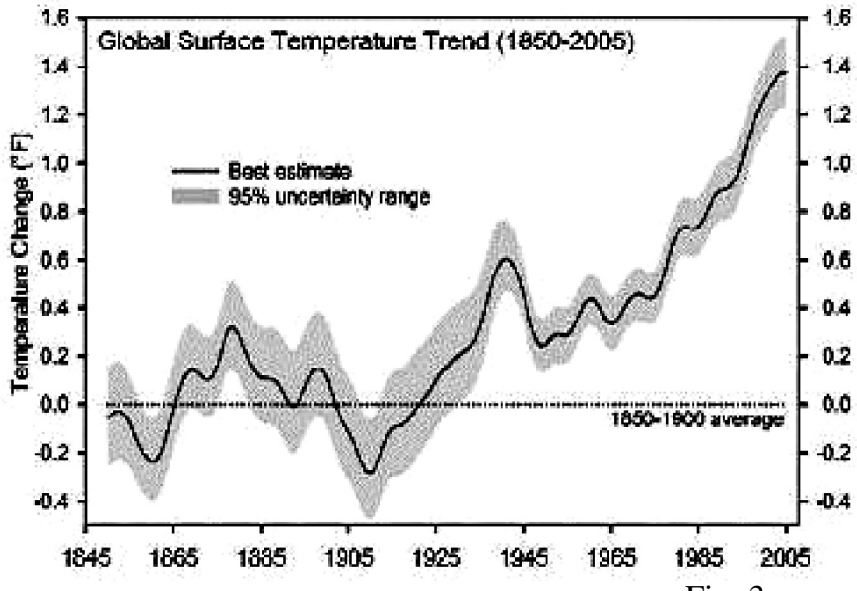


Fig. 3

0.7°C in the last hundred years. This may not sound much, but we need to bear in mind that the temperature difference between now and the ice age – when much of Britain was under ice – was only about 5 degrees. Already (as we shall see below) that 0.7°C rise in temperature is having a considerable impact on the physical world around us. The real problem, though, is that it looks like the effect of the rise in greenhouse gas concentrations is only just beginning to filter through the climate system to affect global temperature - so there is a much bigger rise in temperature 'in the pipeline', as it were.

The close relationship between the concentration of carbon (in the form of carbon dioxide) in the atmosphere and average global temperature becomes very clear when you look at the record from the past. Looking at a graph showing the temperature record for the last 450,000 years, say (see right), then as you would expect there are deep temperature troughs during the ice ages and then big temperature peaks during the 'interglacial' periods in between. If you then superimpose the record for atmospheric carbon concentrations (dark line) then it is really striking how closely they mirror the temperature record. The only place they don't is right at the right hand end of the graph – in other words in the very recent past, when (due to human activity) the carbon concentration shoots up but the temperature doesn't. Or it hasn't yet – because the most obvious conclusion to draw is that the temperature just hasn't yet had time to catch up with the carbon concentration but that when it very shortly does, it will shoot up, too. That's scary and you can begin to see why we talk about a global 'emergency'.

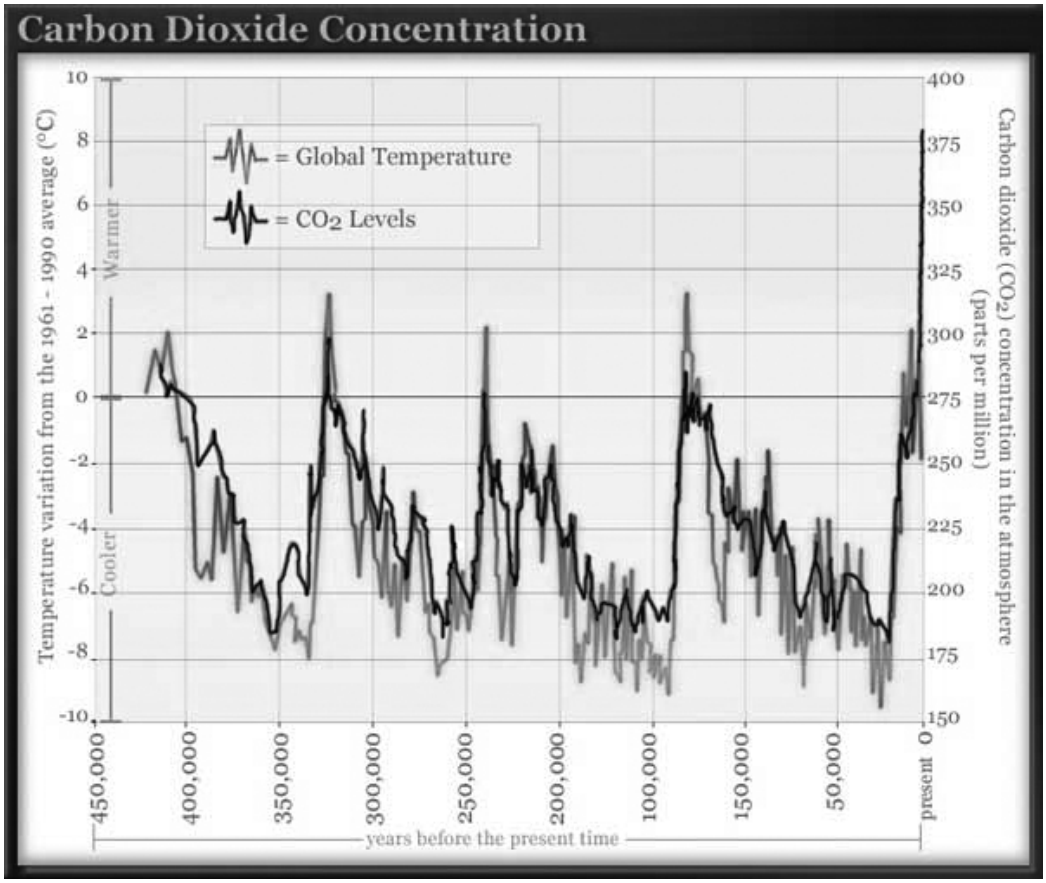


Fig. 4

The graph shows very clearly the close relationship between average global temperature and the concentration of carbon in the atmosphere and more detailed study does indeed broadly confirm what common sense would suggest – that we should now expect average global temperature to 'catch up' with the dramatic increase in atmospheric carbon concentration that we've seen in recent years.

This illustrates one of the biggest problems about man-made global warming. There is a *delayed effect* between the increase in atmospheric carbon concentration and the rise in

average global temperature. That means we don't feel the actual damaging impacts until it's too late to do anything about it. We have to take action in response to the increase in CO2 in the atmosphere *well before* we see a really dramatic rise in temperature and begin to witness the full destructive impact of that on our environment.

What caused the ice ages?

While current climate change is caused by human activity increasing the concentration of carbon in the atmosphere, with temperature then responding to that, that was not the case in the past. The 'trigger' for the changes in temperature that caused the ice ages was very small variations in the earth's tilt towards, and orbit of, the sun (the 'Milankovitch cycles'). But these orbital variations were quite small and nowhere near enough on their own to produce the scale of temperature change that occurred. They just acted as a trigger for other processes that took over.

Rising temperature caused an increase in natural carbon emissions and the resulting increased carbon concentrations trapped more heat and increased temperature further again, in a series of knock on effects, or 'positive feedbacks', that amplified the original small rise. The other major amplifying 'feedback effect' involved was the melting of ice caps because white surfaces reflect away the sun's energy while the darker surfaces exposed when it has melted absorb more of that energy thus increasing temperatures so that more ice is melted and so on. To put it another way there was a decrease in the earth's 'reflectivity' that allowed more heat to be absorbed and temperatures to rise.

Now it's important to realise that the 'trigger' here was very small and it acted over, what for human beings, is a very long time scale. By comparison the impact human beings are having now is very big (the actual amount of energy that our extra greenhouse gases have trapped is *much more* than the change in the amount of energy reaching us from the sun, that was caused by the orbital variations) and it is happening far more quickly. So there is now no possibility, for instance, of "another ice age" because the human impact on climate is already much bigger than, and has completely overrode, the natural processes that have caused ice ages in the last few million years. What we think of as the great immutable processes of nature beyond the power of humans to influence, like the transition in and out of ice ages, were actually triggered by very tiny changes in the amount of energy reaching earth from the sun. By comparison the 1850 billion or so extra tons of CO2 that humankind has added to the atmosphere in the last two or three hundred years represents a very big change happening very quickly. Changes that big, *that fast*, just don't – or very rarely – happen in nature: we are in 'uncharted territory'.

Its also important to note that, whichever way the cause and effect is working, whether it's a temperature increase that triggers a rise in (natural) carbon emissions or whether increased carbon concentrations in the atmosphere cause a rise in temperature there is always a close relationship between average global temperature and the concentration of carbon in the atmosphere. This means that we should indeed now expect that, as we noted above, average global temperature will 'catch up' with the rapid increase in atmospheric carbon concentration that has occurred over the last two hundred years or so.

2. Climate Change Impacts

At first glance, especially for those of us living in less sunny parts of the world, the idea of the climate becoming warmer does not seem at all bad. But when you think about it, that idea doesn't hold up long. The trouble is that the whole natural world and indeed all of human civilisation, is adapted to the climate the way it is now – so any change, especially if it is relatively rapid, spells a whole lot of trouble.

a/ Sea level rise

Some detrimental effects are easy to understand, like already hot places getting yet hotter or rising sea levels. Melting glaciers and ice caps will add more water to the oceans while the volume of the oceans will increase slightly with its temperature. The result will be rising sea levels. Actually they are already rising – only a little bit, but the rate is increasing. The potential for devastating impacts on coastal cities and much of the world's low lying, coastal agricultural land – is obvious.

What is less obvious is that the oceans will absorb a great deal of CO2. This can be seen as a good thing because that CO2 would otherwise have remained in the atmosphere and so absorption by the oceans will slow down the rate at which extra carbon accumulates in the atmosphere and thereby, also, the greenhouse effect. However, increased carbon in the oceans has its own problems: it is causing acidification which will ultimately have a very destructive impact on marine life. This will be a big problem quite independent of the changes in the global climate.

b/ Weather and climate

Not all the impacts of global warming will be straightforward. Because weather systems are complex with many interacting factors, the effects of rising temperatures can be multiple and hard to predict. This very unpredictability is already becoming a problem for farmers all around the world. It is important to recognise, of course, that there will always be a great deal of fluctuation in temperatures, precipitation and other conditions on a day to day, week to week, or month to month basis, including very cold periods - but this is why scientists are keen to differentiate those kind of fluctuations that make our day to day '*weather*' from conditions averaged out over a longer time period that constitute '*climate*'.

It is also important to differentiate localised changes from those that are happening globally. Rising temperatures may upset established patterns in the movements of air masses or ocean currents in unexpected ways so that changing winds and pressure systems might move cold arctic air south, for instance, bringing localised cooling. This is what has happened with the recent exceptionally cold winters experienced in Europe and other Northern mid-latitude regions. In fact if you look at a temperature map of the whole world during these periods of very cold weather in Europe, much of *the rest of the world* was warmer than average. But the unusual weather showed that what we are seeing is the destabilisation and disruption of climate that may manifest itself in various ways: that's why we talk in a general way about "*climate change*". But whatever the various local, or short term, impacts, overall the average *global* temperature will still be increasing, *when measured over any significant period of time*: that's what we mean by "*global warming*".

c/ Weather extremes

Hurricane Dolly 2008

What is not immediately obvious is that this long term trend we call 'Global Warming' does not just mean an increase in (global average) temperatures: it also means an increase in the 'energy' in weather systems generally. The extra energy in the system, in other words, not only makes for an increase in temperatures: it also makes for more extreme and more violent weather. More heat can mean more evaporation which in turn means more rain and potentially floods while in other areas, or at other times, extreme desiccating heat can intensify droughts. More energy in the system means stronger winds and storms. So one thing we can predict is that *overall* there will be a steady increase in the frequency and severity of weather-related 'natural' disasters - floods, droughts, hurricanes, heat-waves, wildfires and so on (but in reality these will no longer be purely 'natural' because *in part* they will reflect the human influence on climate).

d/ Ecosystems and Biodiversity

The warming of the planet will have a big impact on ecosystems. As we've already noted, the problem is that these are adapted to the climate the way it is now, and has been for thousands of years – not to a whole new set of rapidly changing conditions. For instance, higher temperatures and changes in rainfall patterns may have the effect of drying out rainforests and rendering them more vulnerable to forest fires. This could ultimately destroy the rainforest ecosystem as such, changing it into less bio-diverse 'dry' forest or wooded savannah. There have already been some exceptional episodes of the seasonal 'drying out' of the Amazon rainforest with rivers running lower than ever before.

Most life forms are adapted, to various degrees of specialisation, to certain conditions and certain temperatures so, again, changing these will have an adverse effect upon them. Luckily many life forms will be able to move – either towards the poles or upwards in altitude – in order to escape rising temperatures. Naturalists are already observing this happening. If the organism that moves happens to be a disease-carrier like the mosquitoes that spread malaria then that can be bad news, of course, for people in their new extended range: climate change will have some serious impacts on human health.

But at the same time there is a limit to the speed with which plants, for instance, can move. If the temperature changes too quickly they will die, as will, potentially, the creatures that live off them. Overall, global warming will have a very damaging impact on biodiversity, speeding up the rate at which species are becoming extinct. Of course, deforestation and biodiversity

loss would be problems anyway even without global warming – due to the many other destructive impacts of ever growing numbers of ever more resource hungry human beings. So in these cases man-made climate change will combine with other factors to produce the serious negative impacts that we see.

e/ Human impacts

This combination of factors is all the more evident when we come to the impact of global warming on the world's most dominant species – humankind. As with other species human communities are adapted to certain conditions so any change in these are likely to cause hardship in the short term. As well as that, today's highly populated world, with many people crammed into coastal districts and cities, highly dependant on fragile infrastructures, means there is a very high level of vulnerability to the kind of 'natural' disasters we mentioned above.

In fact the impact of global warming on vulnerable communities is already severe and likely to get much worse, but it is not always obvious or easily quantifiable. We may be shocked by terrible hurricanes or floods but see nothing new in these 'natural disasters' because an increase in their severity or frequency is harder to spot, and the resulting increase in victims difficult to quantify.

Meanwhile it is because the impact of global warming is often combined with other factors that it can be hard to see. We see a civil war in Sudan but not the underlying causes that include conflict over diminishing fertile lands caused by desertification, caused in part by global warming. We see uprisings in the Arab world which we attribute to political causes – largely correctly – but we may not see how rising food prices played a part and how those in turn were caused to an extent by the negative impact of global warming on agriculture. So the impact of global warming can feed into already existing sets of problems and amplify them, while often being a factor that is easily overlooked.

f/ Escalating Crises

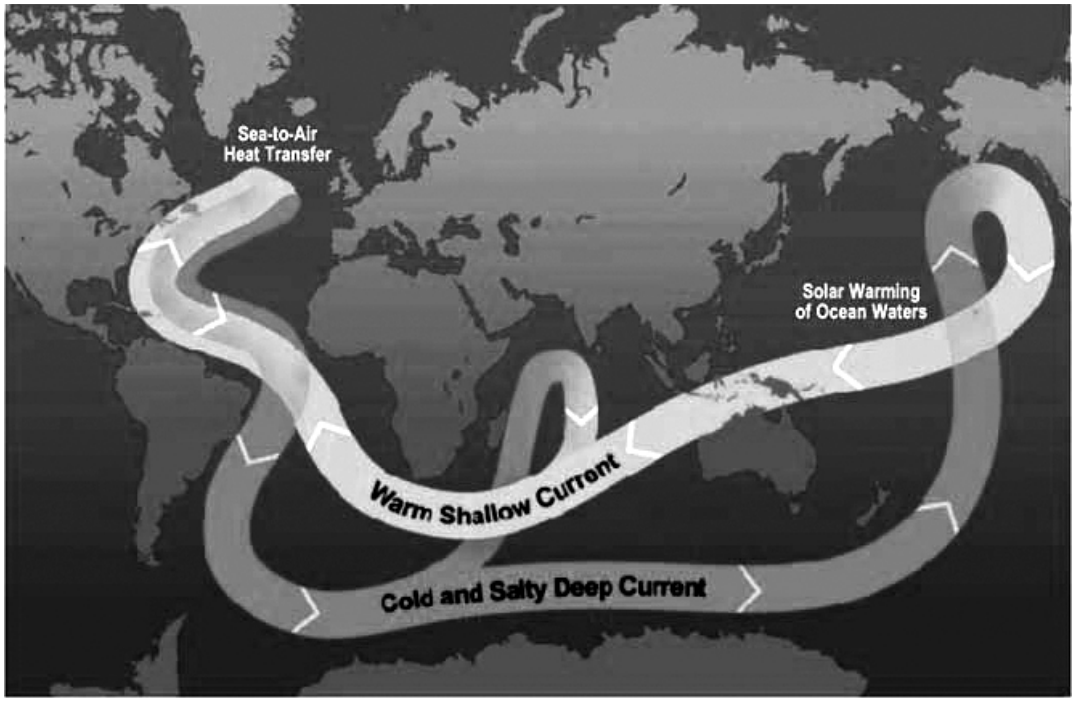
Extrapolating out from the impacts noted above we can see how in the future global warming could have a devastating effect on agriculture through shifting rainfall patterns that might include the failure of the monsoon, for instance, or large areas of land succumbing to desertification. Added to that is the melting of glaciers and mountain ice which could mean that rivers with a steady flow now see torrential spring floods followed by near drying out, later in the year. In the case of the Himalayas this could have big impact on the rivers (Indus, Ganges, Mekong, Yellow River etc) upon which a very large part of the world's population depend for their agriculture and food supply.

Finally, much agricultural land could be lost to rising sea levels. The combined effect of all these factors on agriculture could result, in turn, in famine, economic collapse, high levels of emigration, large numbers of refugees, chronic political instability, civil unrest and escalating conflict. But long before that happens global warming will simply be making many of the problems we are used to much worse. It will be one among many factors but the point is that out of all those factors it is the one that has the potential to grow in scale exponentially until it becomes finally quite clearly the dominant, overwhelming, factor.

g/ Sudden big impacts – abrupt climate change

Finally, a destabilising climate is likely to bring some surprises. For most of the last few thousand years during which human civilisation has evolved the climate has been relatively stable. There is evidence that it has not always been that way and in the distant past there have been some very abrupt changes, even on a human timescale of hundreds or even tens of years, or less. These occur particularly as the climate is shifting from one state to another (e.g. glacial to interglacial) and generally represent changes in the way heat is moved around the planet in normally fairly stable systems of air or ocean currents.

A typical example is a sudden change in the 'thermohaline ocean circulation' whereby the 'North Atlantic Drift', or the 'Gulf Stream', - the current that brings warmer waters to the seas off North West Europe – is shut down. This has happened in the past and could arguably happen again. An essential feature of the thermohaline circulation as it now operates is that salty and therefore heavy surface water off North West Europe sinks and then flows South in a deep ocean cold current that matches the warm surface current – the Gulf stream - flowing North. Factors like increased ice melt, increased river flow, or the (sudden!) bursting of a glacial "dam" that previously held back a lake of fresh melt water, can dilute the saltiness of the surface sea water so that it no longer sinks and the whole circulation system breaks down. This means the Gulf Stream no longer brings warm water north so that in North West Europe there is a sudden *cooling* (though not quite as sudden as depicted in the over-dramatised version of this phenomenon in the film "The Day after Tomorrow").



The "thermohaline circulation" of ocean currents as it works now

This can typically happen when the earth as a whole is (gradually) *warming* and then represents an extreme version of what we discussed above: a localised trend that *goes against* the general global trend. An abrupt change like this could potentially become part of something yet bigger, as a trigger for, or significant accelerator of, a 'runaway' event'. In the next section we will discuss this subject further and find out more about the potential for global warming to get much worse, very quickly

3. **Climate Emergency: Positive Feedbacks and Tipping Points**

We have noted that climate change is especially difficult to deal with due to its "delayed effect" – the delay being that between the build up of extra greenhouse gases in the atmosphere and the actual rise in average global temperature, with its full destructive impact on our environment. In fact, this problem is compounded by the very great uncertainty that surrounds both the actual scale of the impacts and the length of the 'delay'.

For the last two hundred years we have been emitting increasing amounts of greenhouse gases into the atmosphere and global average temperature has been increasing as a result, at an accelerating rate. It would be a mistake however to think that reducing the *rate* that we emit these gases into the atmosphere would stop the temperature increasing because each year we are adding to the **accumulation of extra gases already in the atmosphere**, thereby continually increasing their concentration there and it is that increased concentration which causes the increase in temperature.

a/ Tipping points

The assumption often made, however, is that of a relatively smooth or 'linear' rise in temperature with the steepness of the curve on the graph corresponding to a given rate of increase of the current accumulation of extra greenhouse gases in the atmosphere. So the line on the graph whilst angled upwards, curves relatively smoothly and we have a certain level of predictability that we can plan around.

Unfortunately the geological record suggests that 'non-linear' progression has been closer to the norm, in previous episodes of rapid global temperature change. This means that the line on the graph is not smooth but in fact steepens abruptly when certain thresholds or 'tipping points' are met. These 'tipping points' are essentially the triggering of 'positive feedback' effects. These can best be understood by considering examples.

b/ Burning forests

The drying out and burning of forests will release more carbon into the atmosphere which will in turn cause the temperature to rise yet more quickly again (causing yet more burning of forests and so on). As we have seen, it has been suggested that the Amazon could dry out to a point at which a series of mega-fires could destroy it as a rainforest ecosystem, completely. This could release a very large amount of carbon into the atmosphere within a fairly short time frame with a very considerable effect on global temperature.

c/ Oceans and soils: absorption to release

We have seen that the oceans absorb carbon and so, to a lesser degree, do soils, but when these become saturated their capacity to absorb carbon diminishes, so that more human-emitted carbon goes into the atmosphere and they may reach a point where they actually start to release carbon instead of absorbing it, thereby causing a very marked increase in the rate of warming, once again.

d/ Ice melt and the albedo effect

As polar ice melts and less snow covers the ground for a shorter period then there is a diminution of the 'albedo' effect whereby light, or white, surfaces reflect away heat. The dark waters exposed by melting arctic sea ice, or the dark ground exposed by melted snow, absorb rather than reflect away heat thereby increasing global temperatures, which means, in turn, that more snow and ice is melted and so on... another 'vicious circle', or positive feedback loop, is set up. We have already seen this effect associated with the change from glacial to interglacial periods in prehistory but we also saw that humanity *now* is having a much bigger impact, far more quickly than the factors that triggered the process back then.

e/ Methane from melting permafrost

At the speed it is happening now, the effect of melting arctic sea ice could have another knock-on effect. The land masses surrounding the arctic sea contain huge quantities of frozen subsoil or 'permafrost', which contains around twice the amount of greenhouse gases (in the form of carbon dioxide and methane) currently in the atmosphere. It would therefore triple the level of atmospheric green house gases if it all melted. The positive feedback effect associated with diminishing albedo means that the arctic ocean and surrounding land masses are warming quicker than the rest of the world so that the permafrost in that area is especially vulnerable to melting.

f/ Methane Hydrates

Yet another potential feedback effect is particularly associated with the Arctic. Underneath the oceans are the remains of organic matter from dead plankton or washed into the sea by rivers over the millennia, degraded by bacteria and frozen to form crystalline 'methane hydrates'. These are kept stable by a mixture of temperature and pressure but in the relatively shallow, cold, Arctic sea the former is especially important. An increase in temperature caused by a warming of the waters could release large quantities of methane from the hydrates. Methane is a greenhouse gas twenty times as powerful as Carbon Dioxide. Whilst it does not last nearly so long in the atmosphere as CO2 it does not just go away either, but degrades, partly into CO2.

It is thought the very rapid rises in atmospheric carbon and temperature associated with 'extinction events' such as that of the End-Permian (which wiped out 95% of life on Earth as it then existed) 251 million years ago or of the PETM (Paleocene Eocene Thermal Maximum) 55 million years ago, could only have been caused by massive releases of methane from the ocean beds. So it looks like the melting of methane hydrates has been one of the main causes, if not *the* main cause, of big, relatively sudden rises in temperature – with associated huge destructive impacts – in the earth's past.

You can only get a really big meltdown of methane hydrates when they have had a long time to accumulate (since the last 'meltdown') but unfortunately there is a very high accumulation of methane hydrates beneath the earth's oceans right now. The methane 'gun' is, as it were, 'fully loaded'.

In 2008, for the first time, methane was found escaping – to date in relatively small quantities – from the Arctic Ocean...

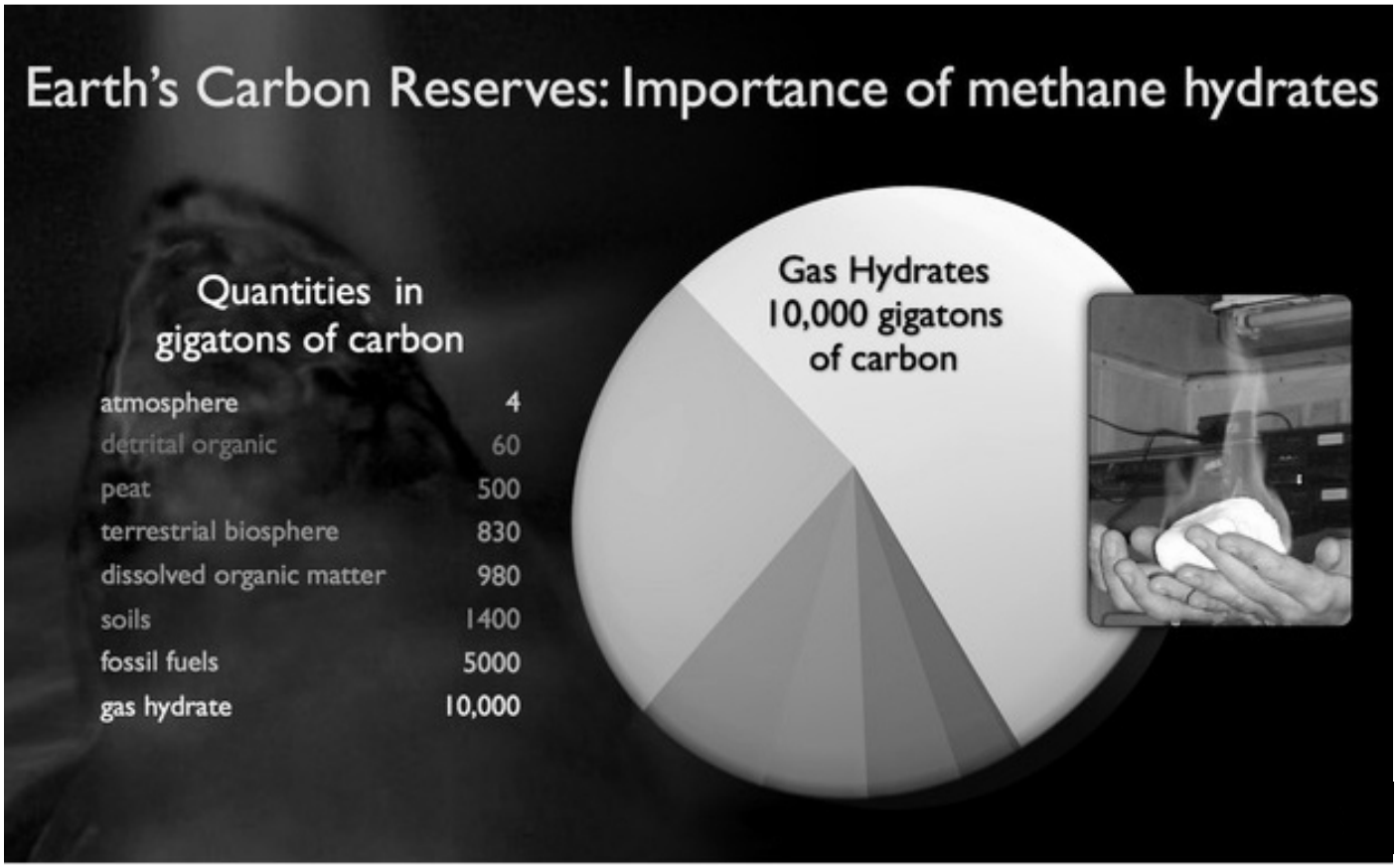


Fig 5

g/ A runaway event

All these 'positive feedback' effects involve the increased emission of greenhouse gases from 'natural' sources. At a certain point these natural processes could become so strong that they would be putting more extra carbon into the atmosphere than humankind itself is, directly. This would be the case, for instance, if we saw massive releases of carbon dioxide and methane from melting permafrost, or ocean-bed methane hydrates. At the point that that happened we would have what has been called 'runaway' global warming and the situation would be completely outside our control – because it would no longer matter how much we managed to reduce our own directly 'man-made' emissions. As a yardstick of comparison, and an indication of how potentially close we are to the situation getting out of control, just 0.1% of the carbon locked up in the world's permafrost is equal to the amount of carbon that the world could prevent from entering the atmosphere by reducing global emissions by 80% by 2050. In other words, everything that we could do through that level of emissions reduction would be cancelled out by the release of that mere 0.1% of the carbon trapped in the permafrost.

Meanwhile all these potential feedback effects, which are not well understood in terms of their precise scale and imminence, make it very hard to plan ahead in a way that could guarantee that we remain safe from the catastrophic impacts of climate change. The task for planners is, as it were, redefined – it is not about how to keep that line on the graph from rising too steeply, it is about not letting it on any account reach a certain level – when it will suddenly shoot upwards. The situation we are in is not so much that of the thrifty householder who simply needs to plan their carbon budget wisely and well ahead – but rather of the man staggering though a minefield in the dark: he does not know when he might make that fateful step that

will obliterate him, he only knows that the more walking he does the more likely he is to make it.

The situation, in other words, is much more uncertain and dangerous than generally portrayed. Whilst we need emission reduction 'targets' to aim for and to organise policy around there is no way any target can be guaranteed to be 'safe', as some in authority might suggest. We do not just have a huge but predictable threat that we need to do perhaps big, but measurable, things to deal with – we are rather already in an irreversibly dangerous situation where there is an overwhelming need simply to do as much as we possibly can as fast we possibly can, to give ourselves the best possible chance of avoiding the very worst catastrophic impacts. It is in other words, not simply a global problem, or even a global crisis, but rather a global *emergency.*

Just how bad could it ultimately get in the *very worst case* scenario ?

Well, it has been pointed out that the planet Venus (which currently has an atmosphere that is 97% carbon with a greenhouse effect strong enough to result in a surface temperature of 450 degrees Celsius) was at one time more like earth with, most likely, a considerable quantity of liquid water on its surface. That water all evaporated in a runaway greenhouse effect (to which the extra water vapour would have contributed) which also caused over time all the carbon in the planet's crust to be 'baked out' into the atmosphere, while finally the water vapour, itself, was broken down and lost to space. The earth is further away from the sun than Venus and so clearly receives less energy from it, but nevertheless it has been suggested that a parallel kind of 'runaway greenhouse effect' could happen on earth if humankind burned *all* the fossil fuel reserves in existence (including the 'unconventional' fossil fuels like tar sands, etc.) and triggered a massive melt down of the methane hydrates (about which see above).

This is because the rate at which the planet reacts to temperature change (its 'sensitivity') increases as it gets warmer and given that the speed at which humankind is affecting the planet might not allow the kind of 'negative feedback processes' (which have stopped this kind of thing happening so far in earth's history) the time to actually 'kick in'. This process would necessarily involve the total melting of the ice caps and so would most likely take some hundreds of years at least.

Given the uncharted territory into which the scale and speed of such a burning by humanity of *all* fossil fuels would be taking us and the difficulty of quantifying so many of the factors involved, there is not a strong or broad scientific consensus around this scenario but it represents the view of at least one eminent scientist. So if you are asking what is the *very worst* that is conceivably possible – then that's it: a planet on which any kind of life would not be possible. Of course we would have passed the stage that we might reasonably label a 'global catastrophe', in human terms, a very, very, long time before we got to that.

4. Climate Change 'Denial' and 'Scepticism'

a/ Nobody likes bad news

The catastrophic destabilisation of global climate presents a threat to humanity of unprecedented gravity. Climate change is bad news. Nobody likes bad news. And as with all bad news there is a tendency to shoot the messenger.

Nobody in their right mind would *want* to believe it. And many people simply refuse to believe what they don't want to believe. People have always had all manner of stratagems for avoiding unpleasant (or 'inconvenient' as Al Gore would have it) truths. This is certainly the case with climate change. For some people it goes deeper. The implications of the climate crisis are profound – it is a 'game-changer' at a global level. Some people just bitterly resist anything that undermines or threatens their established world-view and outlook. Ironically, the more we discover about the profoundly grave implications of global warming the more people want *not* to believe it and even begin to actively look for reasons not to believe it.

b/ A difficult thing to understand

To be fair, the very unprecedented nature of man-made global warming makes it difficult for many to grasp – and for even more to grasp the full gravity of its implications *completely*. It has no real reference point in either our individual experience, or even in our historical experience as a community or a nation. We can come to terms with the massive threat posed by invasion from a foreign foe because this is something that has a place in our historical experience (although on the last occasion in the 1930s we were very reluctant to face up to even that). But with climate change there are no spectacularly visible, serried ranks of invaders massed on the other side of the channel to goad us into action. As we have seen, with climate change there is a delayed effect so that by the time it manifests itself in any really obvious way it will be too late.

Meanwhile as a scientific concept it remains, to most, remote, highly abstract and even counter-intuitive. One can see with ones own eyes the destruction of a forest, or the dead fish washed up from a poisoned river but one cannot see the accumulation of extra CO2 in the atmosphere. And it is not at all obvious why that should have any detrimental effects in the way that, say, logging will obviously destroy forests or toxic chemicals poison a river.

Finally, the seriousness of an increase in 'global average temperature' is hard to understand when the temperature increase involved is dwarfed by those we see in the daily fluctuations of the weather. It is hardest of all when the disruption caused to weather systems by global warming results in actual localised cooling – or periods of unusually *cold* weather – in certain parts of the globe.

c/ Short term self-interest and wishful thinking

However, the reasons for not believing in the reality of man-made climate change are not only an inability to fully understand it or an unwillingness to face up to its frightening implications. There are more material and self-interested reasons for either not believing in it, or not admitting to believing in it. People don't like paying taxes for instance (shock revelation!) so if they think that dealing with climate change may mean they have to pay more taxes then that

may incline them not to want to think climate change is real. Then again, people may believe, perhaps correctly, that dealing with climate change may require that they change their behaviour or lifestyle and that may incline them not to want to believe it is real, too. Arguably it is significant that the recent 'sceptic backlash' against climate change science occurred just at the point when it looked like we might finally be about to *actually do* something about it.

d/ 'Special interests' and the fossil fuel lobby

However, the self-interested reasons for not believing, or not admitting to believing, in man-made climate change become most significant when they apply to a relatively small number of people who are extremely rich and (therefore) powerful. Most of all, that means the people who run big corporate concerns, who feel that their bottom line is threatened by the action we will need to take to tackle climate change. Primarily this means the people who run the fossil fuel industries – because it is the burning of fossil fuels which is the biggest source of man-made greenhouse gases (in the form of CO2) and therefore what we have to reduce. As a result, these people feel that their industry, their main source of profits, is threatened – and some of them will go to very great lengths to eliminate this perceived threat. Not only do they use their money to lobby politicians to oppose the measures we need to deal with climate change – and effectively run a full blown political campaign against them – but they have also used it to undermine and discredit the science that shows that global warming is a real and imminent threat to humanity. In fact, a precedent had already been set by the tobacco industry in seeking to discredit the science that proved that smoking caused cancer – and some of the very same individuals and companies employed by the tobacco industry have subsequently been employed by the fossil fuel industries.

Of course not all fossil fuel industries have been involved in this, or not to the same degree, or so overtly, but some companies have become notorious for what amounted to a cynical and sustained campaign of disinformation on the science of climate change. These include the world's largest oil company, ExxonMobil, the world's largest coal company, Peabody Energy, and the world's second biggest privately owned company – Koch Industries. Needless to say these are extremely powerful – unfortunately the great green renewable industry of the future does not yet exist (on a comparable scale) as a counter-force.

Meanwhile, it was not only the fossil fuel industries which felt their profits threatened by the actions we would need to take to reduce greenhouse gas emissions, but also allied industries like the electrical, utility and car manufacturing industries. Beyond those again, there was a wider group of businessmen and industrialists who all felt they could make more money if there was less government regulation and less taxes to restrict their activities. These were at the core of what amounted to a political movement, with its own political and economic philosophy (often called 'neoliberal') focused on the elimination of all barriers to the free market and the removal of as many government regulations on trade and industry as possible. Of course, there has long been a legitimate argument about the proper balance between state and private enterprise, where the limits of the free market should be and so on – but clearly once you admit the existence of a huge and imminent threat to humanity then the nature of the argument changes and there is a very pressing case for more government regulation and control in order to meet that threat (just as there would be, for instance, to meet the threat of an enemy in wartime). Now some in trade and industry are to varying degrees appreciative of that fact (even if the response they recommend is not *always*, necessarily the best one) but others –

often those who adhere to a more extreme version of the 'neoliberal' economic philosophy – would rather just try to claim that there was no big threat we have to face and that man-made global warming either does not exist or is not serious.

'Tea Party' supporters demonstrate against Climate Change legislation in New Mexico (left) and Arizona (right), 2009.

e/ The 'Climate Denial Machine'

Altogether then, there is a quite broad and powerful lobby, with the fossil fuel corporations at its core, which has both opposed action by governments to deal with the climate threat and sought to discredit the science that demonstrates that threat is real. Using their considerable financial resources they have created an extensive network of lobby groups, pseudo-grassroots campaigns, so called 'think-tanks' and more or less bogus scientific institutes - with names like the Competitive Enterprise Institute, the Committee for a Constructive Tomorrow , the Global Warming Policy Foundation – and so on. These are especially plentiful in America but they have their counterparts in the UK and other countries. All together they create an 'echo-chamber' of voices all reinforcing the message that climate science is doubtful and that action to curb it is unnecessary or economically harmful. Many of them are actively involved in lobbying politicians whilst many, also, are involved in undermining the science of climate change in a number of ways. They ensure maximum publicity for any studies or literature that support their view even if the overwhelming majority of scientists reject it, give lavish support to any scientists (usually not climate scientists) whose views suit them and even devise bogus petitions and pay for TV ads claiming that man-made global warming is not real. There is, in effect, what has been called a 'climate denial machine' which has had a powerful influence on the public debate especially because this cynical and paid-for campaign of disinformation has merged with, and reinforced what we described above – peoples' natural disinclination to want to believe bad news and difficulty in fully understanding an abstract scientific subject. The "climate sceptic" movement includes, therefore, everything from cynical and deliberate disinformation to naïve wishful thinking – and a whole spectrum in-between.

f/ Leaked emails from the University of East Anglia

The 'climate denial machine' was spectacularly successful in the campaign it conducted over the leaked emails from the University of East Anglia. Many expected real progress at the crucial UN Climate talks in Copenhagen in late 2009 and an attempt was made to prevent this by undermining the science on the basis of which the calls for progress were being made. The computers at the large and prestigious climate change research department at the University of East Anglia were hacked into and a huge amount of email correspondence stolen. Now if you

are in possession of a huge volume of anyone's personal correspondence you are almost bound to find some things that can be used to put that person in a bad light, and some of the scientists involved had been under a sustained attack from 'sceptics' for some time and had reacted by becoming defensive or even, arguably, manipulative. Meanwhile it was easy to misrepresent the efforts that any serious scientist must make, through the review process for instance, to maintain high academic standards, as a form of "censorship" or undue bias. The fact is that had the research department at UEA been shown to be genuinely flawed in some way then there was in any case a host of other institutions, and indeed a huge worldwide scientific consensus, that supported the science of climate change. But in actual fact not one single significant finding, by one single scientist at UEA was put into serious question, let alone the scientific standing of the department as a whole. Yet the public received a very different impression and the fact that it did vouched for the extraordinary effectiveness of the 'climate denial machine', as well as – perhaps – showing what kind of message large sections of the public 'wanted' to hear.

g/ The media

The media meanwhile, played a large role in this because their interests were, for the most part, better served by blowing up the whole affair into a notorious "scandal" than giving a balanced view that might risk making it less newsworthy. The rich and powerful 'sceptic' lobby in any case either owns, or uses its money to influence, large sections of the media, especially in the US. Other parts of the media, usually the more down-market end of the spectrum, simply find they can sell more newspapers, or attract larger audiences, by promoting a populist message that many people want to hear. So often it is much easier for them to ridicule than to explain the unfamiliar and quite complicated science behind global warming.

h/ Sceptic Arguments

The misleading, or downright bogus, arguments that the 'deniers' or 'sceptics' typically use are too many to list and refute here but one ploy (i) is to point out that CO2 is natural and beneficial to life. This is true but it is the actual amount, the excess quantity, in the atmosphere that matters – and which is detrimental. Another example (ii) is the claim that the increase in temperatures we now see is nothing unusual because there were many previous changes in climate that were not caused by human activity, like the so called 'Medieval warm phase'. This latter was in fact really a localised (mainly North Atlantic) rather than global phenomenon. In any case, it ignores the real point, which as we saw above, is the totally exceptional rise in the concentration of carbon in the atmosphere that we are seeing now – certainly unprecedented for 800,000 years and probably for as much as 20 million years.

Yet another sceptic gambit (iii) is the claim that global warming has 'ceased' since 1998. This is because 1998 was an exceptionally warm year – actually 2005 and 2010 have been warmer still but it could be made to look like the global warming trend has flattened out since 1998. In fact scientists are always looking beyond the exceptions to identify the underlying trend – and when they average it all out the trend is seen to be maintained. There was a reason that 1998 was exceptionally warm and that is because it was a strong 'El Niño' year. This refers to a cyclical oscillation of the ocean currents in the tropical Eastern Pacific that bring warm ("El Niño") or cold ("La Niña") water to the surface – with a sometimes significant warming or cooling effect on global temperatures. This cyclical oscillation is the most significant

temporary fluctuation in *yearly* global average temperatures: as such, its effect is precisely what scientists seek to exclude when establishing the long term underlying trend.

One thing that consistently exposes the sceptics is the opportunistic way that so many tend to change their argument according to what they think they can get away with. At first, or when they think their audience is particularly easy to persuade, they argue that global warming 'is not happening'. It is a 'myth' or a 'hoax'. Next, when under a bit more pressure, they may admit that the figures prove that average global temperatures are rising, but will claim that this is not caused by human activity, but has 'natural' causes. Finally, in contexts where they are under real pressure and desperate to retain some kind of scientific credibility they may admit it is happening but claim that it is not serious and that to do anything about it will be too expensive and not worth it. Some commentators, like Bjørn Lomborg, have gone through most of these stages in a kind of 'strategic retreat'.

The fact that so many "sceptics" are opportunistic in this way and use simply whatever argument they can find for a conclusion that they have already decided upon shows that these 'sceptics' are not showing true scientific 'scepticism' at all – otherwise they would be equally critical of all the different arguments, but it is quite clear they are not.

More on the science – "global dimming"

One of the 'sceptic' arguments (iv) involves the fact that there appears to have been a cessation in the trend towards increased average global temperatures beginning around the time of the second world war, and continuing for some three decades or so after, before temperatures began to rise remorselessly once again (see Fig 3). Since this was a period of accelerated industrialisation and therefore CO2 emissions, one might have expected an increase in the rate of temperature rise, if the latter is indeed linked to rising CO2 emissions.

The answer here lies in an aspect of the science we have not yet taken into account, but which we might take the opportunity to explain here. Whilst humanity has been warming the planet through increased greenhouse gas emissions – odourless and invisible gases like CO2 – we have also been cooling the planet through other kinds of pollutants: the dirtier, more obvious kind of pollutants like sulphates that are also produced from burning fossil fuels. The second kind of pollution forms 'aerosols' in the atmosphere that actually block incoming sunlight and therefore cool the planet down – like a 'sun shade', as it were – in a process sometimes called 'global dimming'.

The reality is quite complex because some kinds of 'dirty' pollution like 'black carbon' soot actually increase global warming but the balance is clearly towards a 'cooling effect'. So humanity is actually warming up the planet and cooling it down *at the same time*. The rise in temperatures we have seen shows that, on balance, the warming effect (through extra CO2 enhancing the 'greenhouse effect') has been stronger.

But the way the two processes have balanced each other and interacted is quite complex. It seems that during the war, when increased industrial production meant increased 'dirty

pollution' and sulphate aerosols, this had the effect of cooling the planet, or at least 'flattening out' for a while the trend towards increased global average temperatures. The largely successful effort to reduce 'dirty pollution' in Europe and the US in the sixties and seventies are a part of the reason the balance shifted back towards a warming trend.

But in fact the warming trend was always going to be more significant in the long term This is because greenhouse gases like CO2, once emitted, remain in the atmosphere for hundreds of years – so as humanity continually emits CO2 so it accumulates in the atmosphere, where it becomes more and more concentrated, enhancing ever further the 'greenhouse' warming effect. By contrast dirty pollution, like sulphate aerosols, do not stay in the atmosphere for very long – they do not therefore accumulate in the same way and depend on a constant level of emission to maintain their 'global dimming' effect.

The bad news is that this pollution – now mainly as a result of the 'dirty industry' in China, South Asia and newly industrialising countries – is **'masking' the underlying warming trend**, which is therefore *worse than we think it is*. If we clean up the industries responsible, as we obviously want to, to control visible dirty pollution with its many damaging impacts on health and so on, then this will have the effect of reducing the 'dimming' effect and so *increasing* the warming trend. If we managed to just stop all kinds of emissions now – instantaneously – (something we obviously want to do) then unfortunately the *immediate* effect will be more warming – a relatively sudden 'spike' in average global temperatures. This is because the sulphates that produce the 'dimming effect' will rapidly fall out of the atmosphere, once they are not being constantly replenished but the warming greenhouse gases like CO2 will stay there – so you will cancel out the cooling, dimming effect but the warming 'greenhouse' effect will remain. Of course stopping the emission of greenhouse gases will slow down the rate of warming *over the long term* and is something we desperately need to do (whilst reducing dirty pollution and aerosols is also something we want to do for other, obvious, reasons) but there is a sense in which humanity is building a 'trap' for itself – because we can only achieve what we want and need to do by **making things temporarily worse before they get better**. The actual 'dimming' or 'cooling' effect of sulphate aerosols is difficult to quantify, and so the warming 'spike' that would result from eliminating them is difficult to quantify too but the *worst case* scenario is that it would be just enough to tip us into some kind of irreversible 'runaway' warming situation. What we *definitely don't want to do*, in any case, is, as it were, get sucked further into the trap.

i/ The Scientific Consensus

The scientific consensus on climate change is very impressive. Despite the continuous attempts made by the 'sceptics' to pretend there is a significant scientific debate on the question, anyone who looks into it at all seriously will soon discover that this is quite bogus. All the major scientific institutions, in all the countries of the world with a significant scientific establishment, confirm the reality of man-made climate change and its potentially grave implications for humanity. You may find an institution with an impressive sounding name that disputes this, but on closer inspection you will find that this institution does not have any significant standing with the broader scientific community.

One study examined every article on climate change published in peer-reviewed scientific

journals over a 10-year period (between 1993 and 2003, and listed in the ISI database with the keywords "climate change"). Of the 928 articles on climate change the authors found, not one of them disagreed with the consensus position that climate change is happening and is human-induced (75% of the papers agreed with the consensus position while 25% made no comment either way).

Not only that, but when you look closely there is clearly a correlation between how much any given group of people knows about the subject and the degree of unanimity with which they support the consensus. When a survey asked 3146 earth scientists the question, *"Do you think human activity is a significant contributing factor in changing mean global temperatures?" 82%* of all the scientists answered yes. Of the scientists amongst these who were non-climatologists and didn't publish research, a lower percentage – *77%* – answered yes. However, looking at those scientists out of the 3146 who were climatologists, who actively publish research on climate change, *97.5%* responded yes. So in other words, as the level of active research and specialisation in climate science increases, so does agreement that humans are significantly changing global temperatures.

Of course, more striking still is the divide between expert climate scientists and the general public. As we have seen 97.5 % of the former support the consensus while surveys have found that something like 60% of the latter do.

The problem is that, all too often, the issue is presented in the media through a debate with one person arguing for and one against the reality of human induced climate change. So the impression the public gets is, therefore, of a fifty-fifty argument, when in fact, amongst the real climate experts, it is more like 97 'for' to 3 'against'. The gap between the (average) perception of the public and that of the experts is thereby perpetuated and reinforced.

The fact that the scientific consensus is so strong is why we feel justified in using the word '*deniers*' for those who wilfully chose to ignore it, and often disguise or misrepresent it to others. When confronted with it there are some who resort to elaborate conspiracy theories as to why such a strong consensus exists – then they really do begin to expose themselves as the eccentric fringe group they really are.

Greenpeace US expose the billionaire Koch brothers as funders of climate disinformation

5. The real debate: how much are we underestimating the problem?

a/ The real uncertainty and the direction the debate is going

The 'deniers' are prone to making a very big thing about the "**uncertainty" in the science** about climate change. Now in one sense they are right, because as we saw earlier, there are indeed very real, and very big, uncertainties about the climate science. However, these are not about whether global warming is happening, they are not about whether it is caused by human activity and they are not about whether it is serious and a grave threat to humanity. (On these things there is a very strong consensus.) They are rather about **just *how* serious, how big the impacts will be and how soon they will happen**. This is where the real debate, the debate held by the vast majority of scientists, lies. And it is quite clear where the direction of movement in that debate lies. Study after study has tended to revise in an upward direction not only the degree of certainty around the reality of human induced climate change, but the rate at which it is happening and the scale of its likely impacts. It's not true to say that every single study does this but the clear majority do. There is little doubt that the average perception amongst scientists now is of a much more serious crisis than the perception would have been, say ten or twenty years ago. (Extrapolating on this basis, one doesn't like to think what the perception will be in, say, 20 years time.).

The fact is that while it may be possible to find at least one scientist to say more or less anything, most of them do not prosper in their careers or gain respect from their colleagues by sticking their necks out and making statements that risk sounding outrageous. There is an **inbuilt bias towards conservatism** in the scientific/academic establishment: the already frightening conclusions that scientists have arrived at about climate change would never have surfaced in the way they have without something very, very, real behind them. But more than that, the predictions of scientists are, for the most part, much more likely to err on the side of a cautious underestimate, than they are to overestimate, the scale of the climate change crisis. That is why they have had to constantly revise upwards their estimation of the scale of the crisis, and the gravity of the threat, as more and more evidence has been amassed and indeed as the physical world itself has changed around them (as we'll see below).

b/ A consistently overoptimistic assessment

Meanwhile as the scientists struggle to keep up with the changing physical world around them – those who need to take the decisions on actually what to do about all this – the politicians – are struggling to keep up with the scientists. They are reluctant to be the ones to convey the bad news about the true scale of the crisis to the public and to take what are necessarily quite drastic, and so – they fear – potentially unpopular, measures to deal with it. As a result, all along there has been strong political pressure to minimise the scale of the threat and what needs to be done. The scientists generally present their conclusions in terms of a range of probability, and the pressure to keep within the bounds of 'political pragmatism' tends to mean it is the more optimistic end of the range which is quoted as a basis for policy again and again until the less optimistic end of the range, and the scenarios based on less optimistic assumptions, are almost forgotten about completely. The result is that we have a **consistently overoptimistic assessment** even as the evolving science is heading in the opposite direction and unfortunately, all too often, it seems to be the more pessimistic assumptions that are

proving true.

This means that we can often have a situation where, even where the plans for addressing the threat of catastrophic climate change are proving fantastically difficult or impossible to implement due to a failure to secure the necessary political support at national or international level, those plans themselves, still fall a long way short of what really needs to be done.

c/ The IPCC

The scientific consensus that we examined above is most clearly expressed at the international level through the reports of the '**Intergovernmental Panel on Climate Change**' or IPCC. This was created by the UN (through the World Meteorological Organization and the United Nations Environmental Programme) in 1988 when global warming first became recognised as a major problem. Its purpose was to evaluate the state of climate science, primarily on the basis of peer-reviewed and published scientific literature, to form a basis for informed policy action.

Its reports became especially important to give a sound scientific base to the international negotiations that have been conducted under the aegis of the **UNFCCC or United Nations Framework Convention on Climate Change**. which was set up at the Rio 'Earth Summit' of 1992 with a mission to coordinate international action on climate through international agreements like the Kyoto Protocol.

The IPCC is one of the largest bodies of international scientists ever assembled to study a scientific issue, involving more than 2,500 scientists from more than 130 countries. Despite this, its credibility is constantly challenged by the sceptics: in reality what they don't like is the fact that it not only supports the scientific consensus on human-induced climate change but also transmits that consensus to those who might potentially shape actual policy at the international level.

However this does not mean that the IPCC is always right in every possible way: it's just that its failings are far from those that are claimed by the sceptics. As we have seen, it represents the consensus of a huge body of experts, but establishing that consensus is a process that not only tends to favour the cautious and conservative but necessarily takes a very long time. There are long periods between new reports and the science used in the reports may already be somewhat dated even when the IPCC report first appears.

That means that in a situation where the science is evolving and changing very rapidly, the IPCC reports – the primary scientific report on which policy is based – can often be out of date. And out of date, given the general direction of movement of the science, more often than not means that **the threat posed by human-induced climate change is underestimated** rather than overestimated. In fact a number of leading scientists have now suggested that this is the case.

d/ Ice loss from the Arctic

A striking example of the projections of the IPCC proving overoptimistic is provided by the rate of the **disappearance of summer ice from the Arctic**, shown in the graph below. The dotted line shows the predictions of IPCC models while the solid line shows what actually

happened– ice disappeared much more quickly than expected. Although the area (though not actually the volume) has picked up a bit since the stunning record low of 2007 it is still well below IPCC projections. An average prediction for the total disappearance of arctic summer ice ten or so years ago hovered around the 80-years-from-now mark. It is not now unusual to hear predictions of the complete disappearance of summer arctic ice in around 30 years or even less.

Scientists are finding that the very physical world around them is moving much more quickly than they have predicted.

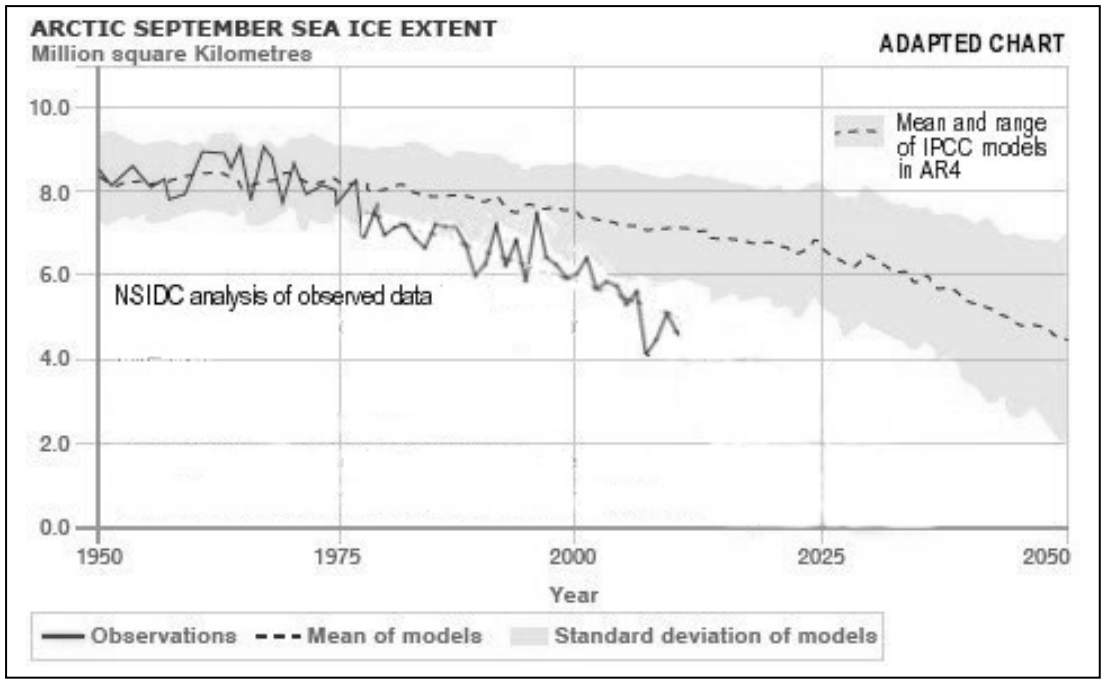
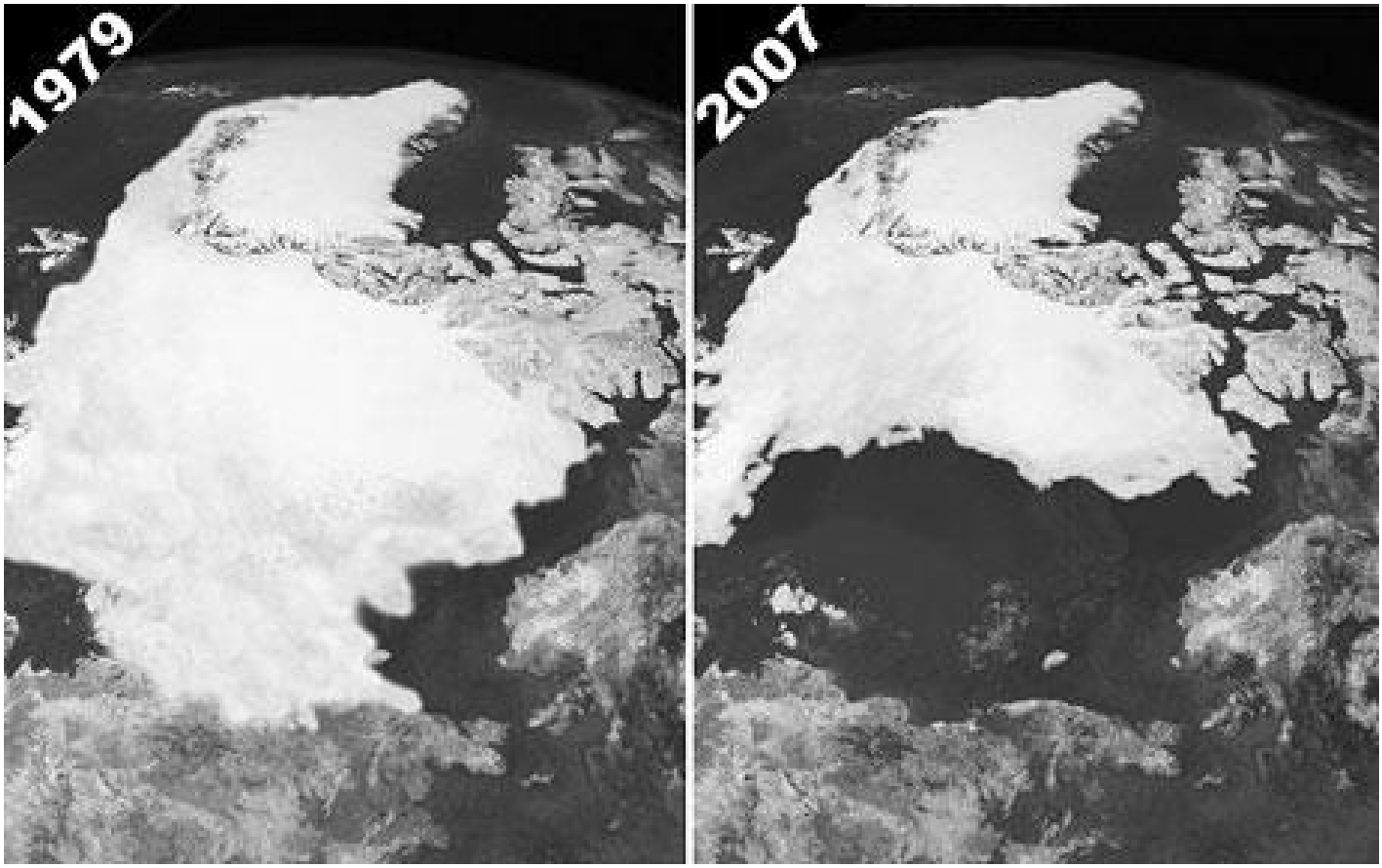


Fig 6



Summer minimum Arctic Ocean ice: 2007 compared to 1979.

e/ "350"

One of the leading scientists – perhaps the most prominent – to paint a more grave and urgent picture than even the IPCC does is **Doctor James Hansen** from the NASA Goddard Institute in the US. His name has become particularly associated with **the number '350'** which has even become the name of an international climate change campaign. What the number refers to is 'parts per million' of carbon dioxide in the atmosphere – in other words a certain level of concentration of this greenhouse gas in the atmosphere. As we have seen this has increased rapidly in recent times since the advent of the Industrial Revolution and the burning of fossil fuels on a large scale. Before the Industrial Revolution the level of CO2 in the atmosphere was around 275 ppm or 'parts per million'. It is currently (2011) around 390 ppm. What Hansen and other are saying is that **a safe level would be 350 ppm** – *at most*.

So in other words, we have already gone beyond the safe level. Even if we were to reduce our emissions to zero tomorrow, the excess greenhouse gases in the atmosphere would mean warming would continue. The planet would still be in an 'unsafe state' with the climate gradually destabilizing, or slipping relentlessly towards a rate and degree of climatic change that would be catastrophic for humans. This would be happening much more slowly than if we continue to pump out huge quantities of greenhouse gases but it would still be happening. However, because that slippage towards catastrophic climate change happens relatively slowly we have a window of opportunity to do something about it before it becomes irreversible. (It will certainly become irreversible, for instance, when melting of the land-based ice caps is well underway since these can only restore themselves by an accumulation of snowfall turning to ice which only occurs over a time scale that is vast by human standards). What Hansen is saying is that what we need to do – within that window – is not only reduce our greenhouse gas emissions to net zero as fast as we can, but also, at some stage, to **actually take some of the CO2 *out of* the atmosphere**. We have already seen how urgent our task is in terms of acting before we reach some unseen and potentially irreversible 'tipping point': the '350' concept gives us an idea of the sheer magnitude of our task as well.

Cartoon by Justin Bilicki

6. Climate Justice

a/ Unequal Responsibilities

Human-induced global warming has serious moral implications. This is, in part, because not every human, or group of humans, has had an equal role in causing it and not all humans will suffer equally from its impacts. In brief, it is the richer long industrialised countries that have overwhelmingly the greatest responsibility for the level of greenhouse gases, especially CO2, currently in the atmosphere whilst it is the poorest communities in the world with very low emissions who have done the least to cause the problem but who will tend to suffer most and soonest - because they have the least resources to deal with the impacts, often inhabit zones of high impact like the floodplain of Bangladesh or the African Sahel and are already, as it were, living 'on the edge' so that any further deterioration in their circumstances would be disastrous. Given the colossal scale on which it is likely to unfold this makes climate change the greatest issue of global justice of our times.

The richer developed countries (let's call them the rich 'North') are responsible in two ways. First, there is the fact that they have been industrialised the longest and therefore have the greatest historical responsibility for the current excessive build up of CO2 in the atmosphere. (The graph opposite represents the total historical emissions of various countries divided by their population: the UK has the greatest *cumulative* emissions, *per person*, because it has been industrialised the longest).

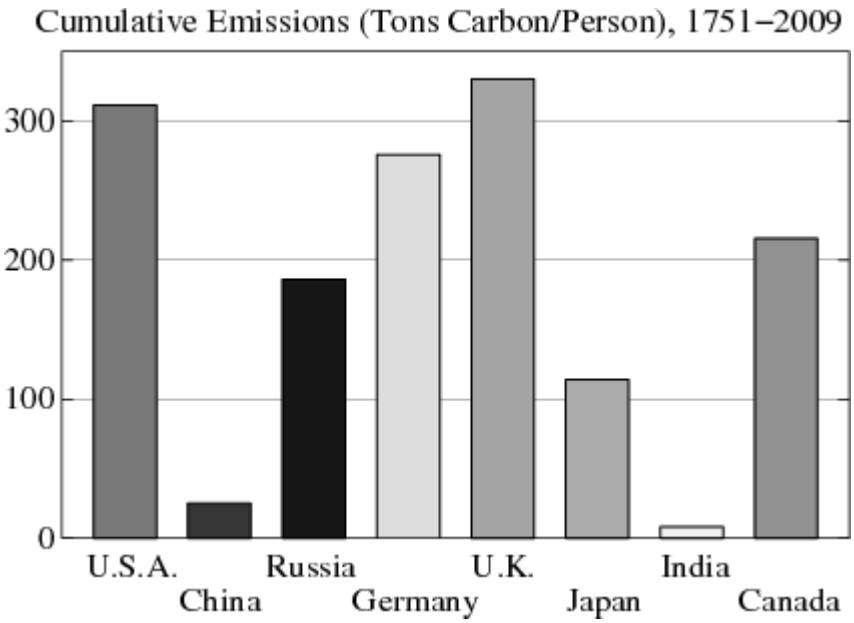


Fig 7

Second, the richer developed countries are for the most part the countries with the highest current rate of emissions per head of population so they are also doing the most to make the problem yet worse – in proportion to their population.

In fact in some ways the inequality in the level of responsibility is even greater than it seems because if we measure the total quantity of emissions from the UK, for instance, (and divide it by the population) we fail to take into account the fact that through importing large quantities of goods from places like China we are in a sense responsible for all the emissions associated with the manufacture of those goods (although by the normal way of reckoning they would be apportioned to China). Of course we in the UK do not produce anything like the number of goods, here, for export to the Chinese, so there is no balance, in that sense. By and large emissions are proportionate to consumption because most goods require energy in their manufacture and transport and - at least until we find a way of producing energy, on a much larger scale than now, without burning fossil fuels - high energy use means high emissions. It is therefore precisely **the high-consuming lifestyles of the rich that are making life even worse for those who already have the least**. We can see how this might, in due course,

provoke a veritable tidal wave of anger from the poor South towards the rich North – especially when the impacts on the former become much more severe and obvious than they are now.

Of course those in the richer countries of the North have not deliberately set out to create this state of affairs but as we have seen, there is now a clear consensus amongst scientists about what is happening so it is **not now possible to claim the excuse of ignorance**. There is an overwhelming moral responsibility for richer countries to act to reduce damaging emissions – something that is, of course, in their own long to medium term interest anyway. At the same time one can see, in this context, just how damaging are the activities of the 'deniers' and just how damning the moral verdict should be on those who deliberately spread disinformation on climate change.

Floods in Pakistan, 2010

b/International negotiations

The issues around the unequal levels of responsibility, and conversely vulnerability, between rich and poor countries bulk large in the **international negotiations** that have been ongoing under the aegis of the UNFCCC with the aim of coordinating international action on climate through international agreements like the Kyoto Protocol. Developing countries have demanded that the long industrialised, developed countries take the greater responsibility and act first, as well as giving assistance to poorer countries to adapt to those impacts of climate change that it is already impossible for us to prevent. Given that these impacts, and climate change in general, are caused overwhelmingly by the richer countries (now and in the past) and very little by the poorer countries then this is clearly an argument with considerable moral force.

Developing countries further argue that they have a right to achieve the same level of development as richer countries – something those richer countries only achieved by putting vast amounts of greenhouse gases in the atmosphere (that now threaten everybody's prosperity – if not, indeed, survival.). Developing countries argue that in any international agreement to reduce greenhouse gas emissions they should either not have to cut their emissions (or cut a

smaller percentage than rich countries) and be allowed to continue emitting sufficient to allow them to develop *and/or* they should receive financial and other assistance to allow them to develop in a different 'green' way - not the carbon-intensive model of development pursued in the past by today's 'developed' countries.

c/ Russian heat wave, crop failure, grain shortage - and riots in Mozambique

Of course there are already great inequalities and arguably injustices in the world but climate change has the potential to exacerbate and profoundly deepen these. As we noted in Section 2 on climate change impacts, climate change will initially act in combination with other factors, but it has the potential to grow, to become in due course the overwhelmingly important one. The way in which climate change is already acting to hit the poorest hardest was well illustrated in 2010 when all-time record temperatures caused a quite exceptional heat wave and widespread forest fires around Russia. Quite a few people died from these in Russia itself but the high temperatures also destroyed around 20% of Russia's grain harvest with the indirect effect of forcing up food prices.

Through this indirect effect, **the impact of this climate disaster was passed on to the world's poorest** and we saw, for instance, food riots in Mozambique, as a result. The point is that even though the immediate impacts were felt in a medium income country, the effects were nevertheless passed down the line, as it were, to the world's poorest through rising food prices. It is through indirect effects like these and in particular **rising food prices** (caused by a combination of factors but amongst which climate change is becoming increasingly important) that we can expect to see the poorest in the world suffering more and more. And that is before we see the potentially massive devastation – and millions of refugees – that are likely to result from the flooding of large parts of Bangladesh, say, or the drying out of huge areas of the Sahel region and other really large-scale and devastating impacts of global warming. This will all be happening – very largely – as a result of the **high consuming lifestyles of the world's richer people.**

Food riots in Mozambique, 2010.

7. A Global Solution

a/ The solution must be global

Climate Change is a global problem *par excellence*. It can only be tackled ultimately at the global level.

For a farmer in Bangladesh, for instance it does not matter whether the greenhouse gas emissions are coming from a power station down the road in Dhaka, or from one in far away London or in Beijing or in Washington DC: he will suffer from their effects equally in terms of how more likely they will make it that his land is flooded or he is hit by a strong cyclone. The "domestic" policy of any state in terms of its energy policy or indeed anything that affects its rate of consumption is no longer just its own business: it can affect people in other countries to a degree, potentially, that in a previous age you could only match by actually marching in with a plundering army and laying waste to the land.

At the same time it is no use reducing emissions of greenhouse gases in one place if you fail to stop them rising somewhere else – and in fact the likelihood is that no-one will reduce their emissions to any very significant degree at all if they suspect that other people in another country will simply seek to benefit from their effort while doing nothing to stop their own spiralling emissions from inflicting damage on everyone.

For these reasons it was realised as long as twenty years ago that the only way to deal with the threat from global warming was by all countries acting together in a collaborative and coordinated way through an international agreement. A cursory glance at the relevant news reports, however, will reveal that current negotiations around an international emissions reductions agreement appear to be bogged down. This is due, in part, to disagreements about how to 'share out' those reductions - particularly between the developed North and the developing South, as we saw above.

b/ The History: attempts to forge a global agreement

The history is that most countries agreed to the '**Kyoto Protocol'** which obliged the richer countries to reduce emissions (although by a very inadequate amount, using many unsound methods and inadequately enforced) but it was never supported by the world's most powerful country, the United States, having been rejected by President George W Bush in 2001. The period covered by the Kyoto protocol is now (2011) running out. Whilst some countries led by the US support the '**Copenhagen Accord'** whereby all countries make voluntary pledges, many developing countries support a continuation of the Kyoto regime

The "Statue of Taking Liberties" burning the Kyoto treaty in her torch.
A protest against the US blocking progress at the international climate talks. London 2003.

whereby the richer countries make legally binding reductions. The reality is that there is a lack of political will all around but particularly in the United States, where there are powerful political forces, including special interest groups (above all fossil fuel companies) opposed to *any agreement* and any action to limit emissions and the burning of fossil fuels. The result is that at the moment, not only is there a failure to reach a working agreement, but any agreement that looks likely to be reached falls far short of what we really need.

c/ Shortcomings and failures: where the international negotiating process has taken us so far

Some essential requisites of any effective agreement are not being met or are in serious doubt. A**ny effective agreement must have targets for how much we need to reduce emissions and how fast.** Whilst we have said that no targets can now be said to be 100% safe there must be emissions reductions targets to shape policy (and make sure, for instance, we do not just have a showy initiative to reduce emissions in one sector while they increase outrageously in another) **and those targets must be legally 'binding'** or 'compulsory' in other words. Mere voluntary targets or 'pledges' will never be sufficient given the urgency of the situation. No one country will be able to be confident than any other country is really serious unless the targets are binding – and indeed unless they are effectively enforced. .This latter is a very considerable challenge in its own right.

The targets must also be sufficiently in line with the science to give us a reasonable chance of avoiding the most catastrophic impacts of climate change. What that means is hotly disputed, but it is quite clear that the targets currently on offer fall well short of what we need – especially in the light of the evolving science that highlights the need to avoid 'tipping points' and the suggestion from Hansen and others that we need to reduce the concentration of CO2 in the atmosphere to 350 parts per million at the most.

But these are not the only ways that **the kind of agreement currently on offer is both inadequate and in many ways, unjust.** This is because the political forces and special interests we referred to above have essentially worked on two fronts, trying not only to block the UN talks completely but also to weaken them from within – using their presence at the talks, and influence on politicians, to ensure that their financial interests come before the effectiveness of any solutions adopted so that the agreements reached are often watered down and full of loopholes - and also, in many cases, favour the rich at the expense of the poor.

A typical case is "**offsetting**" whereby countries are allowed to pay other countries to reduce their emissions rather than reducing their own. This is supposed to add flexibility and be more economically efficient but actually it means that the high emitting, richer, countries can put off making the deeper systemic changes they really need to and offload the burden of cutting emissions onto poorer countries.

In practice, the system is full of abuses, especially when offsetting is done via CDMs or '**Clean Development Mechanisms**' which mean that rather than simply burning less fossil fuels rich countries organise some project in a poorer country supposed to compensate – like for instance the planting of a forest as a 'sink' to soak up an equivalent amount of CO2 as the rich country has emitted through the continued burning of fossil fuels. The problem is that

even if, say, this not a forest that might have been planted anyway, who knows whether the trees may not burn down, or decay from disease in the future thus releasing their carbon into the atmosphere? If temperatures continue to increase due to climate change then those trees *may well* end up being consumed in a forest fire. Trees, like all plants, exist as part of a cycle whereby they absorb carbon from the atmosphere and then release it back into the atmosphere when they burn or ultimately decay. The carbon in living vegetation is always *never far* from being converted into atmospheric CO2: it is no equivalent to the carbon that exists as coal or oil safely locked away in the earth for potentially millions of years.

There can be **all sorts of false accounting and perverse incentives involved in offsets and CDMs**: old forest is actually cleared to plant new plantations or *more* factories to produce chlorofluorocarbons (gases that both destroy the ozone layer *and* cause global warming) are created in order to reap the subsidies available for destroying the chlorofluorocarbons they produce, and so on.

The basic inescapable fact is that any treaty, or coordinated worldwide effort, to avoid catastrophic climate change must ensure that **the vast majority of the remaining reserves of fossil fuels are *left in the ground***. Simple mathematics shows that if we burn the remaining reserves it will result in a concentration of atmospheric carbon dioxide that amounts to global suicide. So no amount of clever measures will really be effective unless they result in keeping the vast majority of those remaining reserves – mainly in fact coal - in the ground. (There is one minor caveat to this since fossil fuels *could* be burnt safely *if* the CO2 produced was reliably 'captured' and then buried, itself – it is arguable if this is really possible on a large scale but we will return to this below).

Another set of problems and abuses is associated with **carbon trading** as introduced through the international negotiations. The way that the system works means that any company burning large quantities of fossil fuel is essentially rewarded with a right to emit CO2 that they can sell to other companies – rather than being penalised relative to other, cleaner, companies from the start. In the **EU carbon trading system** the price for carbon has often been too low to seriously encourage anyone to burn less and there have been cases of downright fraud. There are those who would argue that any kind of carbon trading, involving in a sense the privatisation of the common good that is the atmosphere, is unacceptable and not the best way to reduce emissions: it is certainly the case that in the way it has been done so far there have been manifold abuses with a distinctly limited success in actually reducing emissions.

Finally, about **a quarter of all man-made emissions are a result of deforestation or other land use change**. Forests are a huge repository of carbon and destroying them results in that carbon being released into the atmosphere. In many parts of Indonesia, not only are the forests burnt but also the peaty soil beneath them, releasing more carbon still. Indonesia ranks as the world's third biggest CO2 emitter, mainly as a result of rampant deforestation. Deforestation in the Amazon exacerbates the drying out and increased incidence of fires anyway caused by climate change and a vicious circle is set up which, as we saw above, could lead to a 'climate-tipping point' if the forest dries out sufficiently for huge fires to take a hold.

Consequently it has been recognised in the international negotiations that deforestation is a big

problem that needs to be addressed but many of the proposed solutions (as outlined in the **REDD – Reducing Emissions from Deforestation and forest Degradation –** policies) are hotly debated. The basic premise of REDD is to give standing forests a value and so reward their conservation **–** thereby ending the situation where only their exploitation (for timber, clearance for agriculture etc) yields a financial return. The problem is that those who legally own the forests – and who would be rewarded **–** are often not those who actually live in them and who are best placed therefore to protect them in practice. Also the whole system is highly vulnerable to the corruption often endemic in the forest sector. A better approach might be to do more to empower those who live in forests to protect them **–** and to reduce the demand and therefore patterns of consumption, in the richer developed countries, that are the real drivers of deforestation and destructive land use change. We will see below what this might mean in a UK context.

d/ The global solution – a way forward

None of the problems and abuses we have listed here, however, are inherent or unavoidable in an international agreement to reduce global emissions. They simply show how too many politicians have been looking for 'easy ways out' rather than really facing up to the problem and quite often how 'special' or commercial interests have dominated the negotiations.

For instance the problem of how to 'share out' the emission reductions that have to be made, in an equitable manner, has been addressed very effectively by the '**Contraction and Convergence' (C&C)** model devised by Aubrey Meyer at the Global Commons Institute. The basic assumption is that everyone in the world has the same right to emit CO2 but since people in richer countries currently emit much more, then as overall emissions are reduced (which is the key objective of course) then the richer nations have to reduce emissions much more quickly than the poorer until at some point in the future we reach a point where everyone is effectively emitting the same amount.

Another more recent model, called "**Kyoto2**" devised by Oliver Tickell, incorporates many of the elements of C&C but involves the taxing of fossil fuels at source in a regime that is arguably more practically enforceable. Neither of these models (or other models that are close variants of these) has gained sufficient political acceptability to make them very significant within the actual negotiations but they show that it is possible to devise **an international governance structure to reduce global emissions that is both effective and equitable**. What is needed is the political will to make them a reality.

Any agreement needs to be fair enough to command widespread acceptance and strong enough to be effective, but the fact remains that the obviously best, fastest and most logical way to deal with a huge global threat like climate change is top-down from the highest level. That remains the case, however distant the prospect of an international agreement looks politically, however flawed the agreement currently on offer appears to be and however deeply bogged down the current negotiating situation seems to be. A collaborative international agreement is the best, most practical and will ultimately be *the only* possible way forward. However dauntingly distant the prospect of an effective international agreement seems to be we cannot afford to lose sight of it as a goal or give up the struggle to achieve it. As we have seen there are powerful models of how a fair and effective agreement might work.

The Campaign against Climate Change is actively involved in working with others around the world to put pressure on politicians to reach such an agreement - in particular we are involved in organising a Global Day of Action (that includes a mass event in the UK) each year to demonstrate in as loud and visible a way as possible the global will for just and effective action to prevent catastrophic climate change. See www.globalclimatecampaign.org

Demonstrating for international action on climate change, Petite Mbau, Dakar, Senegal on the Global Day of Action, 6th December 2008

e/ A route to a global solution - progress at the national level

However, all this said, we should not restrict our efforts solely to securing an international agreement, and certainly not use the lack of such an agreement as an excuse not to make progress in reducing greenhouse gas emissions at whatever level (national, local, individual) possible. Clearly, securing progress at say, the national level is one of the things that might make an international agreement more possible: indeed when the negotiating process for an international agreement is deeply bogged down, then probably the best thing any single country can do is to set a an example of radically bold action at home, and thereby encourage others to make the commitments necessary for an effective international agreement. When it comes to progress at the national level then once again top-down action coordinated at the highest level is best and most effective – where possible. We will now take a closer look at the various solutions we might pursue at the national level

8. Addressing the Climate Emergency: A way forward for the UK

a/ Reducing emissions – the spectrum of technical solutions

There are a variety of things we can do to reduce the emissions of a whole range of greenhouse gases including methane, nitrous oxide and CFCs, as well as particle emissions like 'black carbon', but reducing these, while helpful, cannot substitute for addressing the most important greenhouse gas – carbon dioxide. As we have seen, this is the gas that is very closely linked with temperature change in the prehistoric past (and it is worth noting that through prehistory, the emission of other greenhouse gases for the most part rose or fell in response to, and together with, changing carbon dioxide levels). CO2 is now the hardest greenhouse gas to deal with because modern economies are largely dependent for their energy on the burning of fossil fuels which produces carbon dioxide (and we have seen, for instance, how special interests associated with those economies frequently try to block progress to reduce CO2 emissions). The other big source of CO2, as we have seen above, is land use change and especially deforestation so this needs to be brought under control and reduced (we'll explore more about just how in a UK context below).

To reduce CO2 emissions from energy production we can **(1)** use less energy, by reducing consumption and altering high consumption lifestyles, or we can **(2)** improve the efficiency with which we produce and use it – or **(3)** we can produce energy in new, different, ways that do not involve the release of CO2 either by **(a)** 'capturing it' as part of the process of burning fossil fuels or **(b)** by producing it in ways that do not involve the use of fossil fuels at all (or only a little and indirectly). The latter includes **(i)** nuclear power and **(ii)** what is known as 'renewable energy', like wind power, solar power, tidal power, geothermal power and so on.

Reducing consumption and altering lifestyles is likely to be unpopular and politically difficult but it has been shown how – with admittedly a big effort and some pretty sweeping changes – we could, in the UK, increase efficiency and convert to the use of renewable energy, to achieve net zero emissions by 2030, whilst preserving current living standards largely intact with only *relatively* limited lifestyle changes. The **Zero Carbon Britain 2030 report**, produced by the Centre for Alternative Technology in the summer of 2010, outlines in some detail one possible way (with variants) of doing this.

Their proposals do not include the capture and storage of carbon dioxide at power stations that use fossil fuels (**CCS – Carbon Capture and Storage**) which is difficult, energy inefficient and expensive. It is in, fact, hotly debated whether CCS can work economically on any large, significant scale, and there is certainly the danger that the prospect of it will simply be used by the coal mining industry as an excuse to carry on producing.

One important method of producing energy *without* burning fossil fuels is, again, not included in the ZCB report, and that is **nuclear power.** This very clearly has its own set of problems and dangers, of which we are periodically reminded (Three Mile Island, Chernobyl, Fukushima) and the problem, above all, of contaminated waste undoubtedly places a very significant burden on succeeding generations. However this has to balanced against the imminent possibility of a climate catastrophe that might kill billions and one has to make a

judgement about the practical *and political* feasibility of reducing emissions using **efficiency measures** and **renewables** alone (both at the national UK and international level).

One limitation of the ZCB report is that, for the most part, it deals with the UK, as it were, 'in isolation'. In fact one, even arguably the biggest, potential source of renewable energy might be '**concentrating solar power**' (using mirrors to concentrate sunlight to create heat) that could be imported from the hot, sunny, often 'desert' regions, where it could potentially be developed on a scale sufficient to generate very large amounts of electricity. This would also require the development of a special electricity 'super-grid' that uses high-voltage direct-current so as not to lose too much of the electrical power when transmitting it over long distances. There is a plan for just that, called '**Desertec**'. It has the added advantage that it can overcome the problem of 'intermittence' in, for example, wind power because as the wind slackens in one place electricity could be transmitted from some other place where the wind was still strong - and effectively all the intermittent sources in a very large area could be 'pooled' to make the very best use of them by a large number of users.

There is considerable debate around which are the best, most economic or most practicable of the new sources of energy that avoid or reduce the emission of CO2. But some new technologies proposed as 'solutions' are clearly counter-productive or '**false solutions**'. Not only that, but they can also be unjust - that is favour the rich against the poor - and '**unjust solutions**' are another aspect of the 'climate justice' issue, discussed above.

The world's first commercial tidal stream generator 'Sea Gen' at the Narrows of Strangford Lough, Northern Ireland. Sea Gen was developed by Marine Current Systems, Bristol.

b/ 'Agrofuels' and bioenergy: a false solution

One proposed 'solution' that is clearly both counter-productive and unjust is the use of 'agrofuels' as an energy source both for transport and electricity generation. '**Agrofuels' are 'biofuels' produced using intensive agriculture.** The theory about 'biofuels', or any form of 'bioenergy', is that because they are made from living plants (rather than the "fossilised" ones that make up oil and coal) they absorb as much CO_2 when they grow, as they emit when they are burnt and so they are basically 'carbon neutral'. Now, 'biofuels' made from waste materials like used chip fat are fine, but these could only ever supply a fraction of the demand if we use biofuels to replace any significant proportion of the transport fuel (let alone the electricity) that now comes from fossil fuels. To do this requires growing crops – such as

rapeseed, palm oil, soy, sugar cane or jatropha – for fuel on a massive scale. This is why we use the term "agrofuels".

The fact is that even when biofuels are produced from home-grown crops new 'full cycle' studies suggest that in many cases more emissions are associated with their production than are produced by fossil fuels, due mainly to the nitrous oxide emissions from the fertilisers used in intensive agriculture. But this is far from being the biggest problem. Most 'agrofuels' use imported raw materials and this has accelerated the expansion of intensive agriculture in many tropical regions which in turn has **increased the rate of deforestation**. Clearance for palm oil plantations is now the biggest driver behind deforestation in South East Asia and the rate of deforestation in the Amazon Basin has been shown to correlate directly with the price of soya. Demand for both palm oil and soya has rocketed due to their use as a 'biofuel'. Even if agrofuels are produced from, say, "certifiably sustainable" rapeseed in Europe this can have knock-on effects – it means there is less rapeseed available to produce cooking oils and foodstuffs and this results in a massively increased demand for Indonesian palm oil to fill the gap. The impact of biofuel production on deforestation, and other detrimental land use change, makes them **fantastically counter-productive as a climate change "solution".**

But not only are they counter-productive, they are also **socially unjust**. One could talk about the forced evacuations and other social ills that come with land clearance for intensive agriculture but the main problem is the fact that using crops for fuels means there are less available for food. The huge demand of rich countries for fuel to drive their cars around is put in direct competition with the need of people in poorer countries just to eat. Within five years half of the US maize harvest is expected to be burned in cars, further pushing up the global price of what is a staple food for hundreds of millions of people. We have seen already how direct climate change impacts, like floods and droughts, are effecting food production and pushing up prices – now we can see how a 'false solution' to climate change is making matters yet worse again.

The basic problem with 'agrofuels' and indeed with all forms of bio-energy (including '**biomass**' – the burning of wood or other vegetation in solid form to create energy) is that to produce them on any significant scale you need a lot of land. And increased pressure on land is at the root of so many environmental problems. As we have seen land use change and deforestation are at the cause of perhaps a quarter of all carbon emissions. To a lesser or greater degree **all forms of large-scale bio-energy are likely to feed into the pressures that are causing increased deforestation** and other forms of land use change that release extra carbon from vegetation or soils. The large scale development of bioenergy– that is production on anything more than a local level – risks becoming a dangerous diversion of resources towards the creation of a commercial-industrial bandwagon that will end up creating more emissions than it saves due to its snowballing impact on ecosystems around the world..

c/ Patterns of consumption in the UK and their impact on ecosystems and emissions worldwide

But 'agrofuels', and other forms of bio-energy, are not the only source of increased pressure on land associated with the high consumption lifestyles of the richer Northern countries. This brings us back to the subject of **food,** once again. There are some who will say that to fight climate change we should become vegetarian – and it is true that, all other things being equal,

a vegetarian diet does cause less greenhouse gas emissions than a diet with a lot of meat. However, the factors that surround the emissions associated with food production are quite complex and varied – including for instance how far the foodstuffs have been transported before they are consumed. What really stands out as **a big factor in causing climate change is our system of 'industrial agriculture'**.

The main factor here is not the methane emissions associated with livestock but rather the fact that we need to import large quantities of feedstock for the large quantities of livestock we are rearing intensively for meat production. This is what increases the pressure on land in other, mainly poorer, countries. It means increased importation of products like soy which is a big driver of deforestation in tropical countries. Changing one's personal eating habits may help a little but far more effective would be **a basic change to our systems of agriculture coordinated at a national level** by government. If we all end up eating less of the kind of products that are likely to cause environmental damage, compared to those that don't, then maybe that would only be fair enough. (and would effectively mean, amongst other things, that less meat would be being consumed).

There are of course **other products that we consume that have an impact on land use and deforestation** around the world – the many food products that use palm oil, for instance, or timber and wood-based products. These need to be controlled and regulated, even if we need to change the rules of international trade to do it (although this takes us back to the international level). Part of the problem is that to do this requires confronting the commercial interests involved. 'Agrofuels' are not the only example of a 'false' and/or 'unjust' "solution": we have already noted the counterproductive and unfair elements in the current negotiations for an international treaty. It is not surprising that in attempting to deal with the new, vast and unprecedented problem that is climate change people are scrabbling about to find anything that will work and often look for the easiest answers that may not, however, be the best ones. Added to that is the fact that all too often commercial interests, of the kind that often try to block *any* kind of action on climate change because they fear it might damage their profits, also tend to have an undue influence on the *kind of* solutions adopted. As a result those "solutions" risk ending up being the ones that allow some interest group to make a lot of money rather than actually dealing with the problem in the most efficient way. The commercial bandwagon that has built up behind agrofuels is a typical example

Geoengineering

Perhaps the ultimate 'hotly debated' solution to climate change is "geo-engineering". This means large scale artificial changes to our global environment to cool the planet down. These can take the form of projects designed to actually remove CO2 from the atmosphere but there are huge problems in doing this on a sufficient scale to be significant. More often geoengineering involves compensating for the warming effect of greenhouse gases by devising other, artificial, means of cooling the planet. Less feasible ideas include putting giant reflectors in space to reflect away a proportion of the sun's incoming energy while more feasible examples include generating extra clouds – to increase 'albedo' and again reflect away the sun's energy – by spraying seawater into the atmosphere on a large scale. The *most* feasible method is probably to simply increase (in a more controlled and strategic way) what we are doing anyway, inadvertently, that is emitting 'sulphates' into

the atmosphere and thereby causing 'global dimming' - as we noted above.

The problem with almost all of these is that, even if achievable, they are likely to have unpredictable and quite possibly dire, side-effects. The inadvertent production of sulphate aerosols, for instance, has already been implicated in causing the changes in rainfall patterns responsible for the Ethiopian famine of the 1980s. Unfortunately we have only one planet to experiment on. What is almost certain is that the prospect of a geoengineering 'solution' is likely to be used as an excuse, by those who want to carry on (making money out of) emitting CO2, to do so. What is also highly probable is that – as with 'agrofuels' – a commercial bandwagon will build up behind whatever geoengineering solution, or solutions, are chosen so that the decision making process will be dominated by the commercial interests involved rather than the dispassionate pursuit of a rational solution to the problem in hand. Given that, as we have seen, we are dealing with something likely to have huge and dire side effects then that is a frightening prospect.

The strongest argument for at least researching 'geoengineering' is that we should try to make sure we have at least one weapon in our arsenal as a last resort if there is a complete failure to reduce emissions sufficiently and in time. In particular we might regard it as a 'stopgap' to allow us to clear the 'hurdle' of the warming spike that we might need to, to escape the "global dimming trap" (see above). What is certain, here, is that any intelligent use of 'geoengineering' would be combined with – and not instead of – reducing emissions of greenhouse gases. It might conceivably be a stopgap to give us time to get to the root of the problem, namely the excessive concentration of greenhouse gases in the atmosphere. Some techniques might actually help us reduce that concentration but it would be insane not to apply the obvious solution of ceasing to put carbon into the atmosphere before devising difficult and costly methods to take it out again. What is certain, again, is that *the more* we can do to get to the root of the problem directly, applying the obvious and sensible solution of reducing greenhouse gases, and *the less* we are forced to do by the more dangerous, uncertain, and indirect methods of geoengineering then the better.

d/ Avoiding false solutions – standing up to commercial pressures

So, avoiding the pitfalls of counterproductive 'pseudo-solutions' is critical – something that may be only possible if governments are rigorous and dispassionate in their pursuit of scientifically determined goals, capable of standing up against commercial interests and resisting various temptations of financial and political advantage.

e/ Not enough is being done – the government is letting us down

You don't need to be cynical about politicians, or a political opponent of the current government, or an enemy of "the system" (although you may be any or all three of those) to appreciate that the government is not doing enough. Given the absolutely unprecedented nature and huge scale of the crisis we face, it's hardly surprising. In fact what the government (the Labour government, with cross party support, in 2008) has done is to pass a **Climate Act** which commits the UK to a legally binding target of 80% cuts in greenhouse gas emissions by 2050. This is a very progressive step, certainly measured against a general worldwide failure to take effective action on climate.

It is however no more than a promise written into legislation and it needs the right policies to secure the emission cuts it promises. Many would argue we do not yet have those – just a recession, the fortuitous and temporary by-product of which has been a decrease in the rate of emissions. *Second,* it does not cover what we have just noted above in terms of the UK's impact on other countries through increasing the demand for products that cause deforestation or other emissions-increasing land use change. It has not, for instance, stopped us pursuing the seriously counterproductive "solution" of agrofuels, whilst our use of biomass for power generation is set to increase dramatically. *Third,* (something we discussed above in the 'Climate Justice' section) it does not take into account the emissions that go into making, and transporting, the vast quantity of consumer goods that we import (not balanced by our exports). Taking these into account dramatically increases the carbon footprint of UK consumers and the nation as a whole. They have increased dramatically in recent years, *more* than cancelling out any *apparent* decline in emissions. *Fourth*, in the light of the latest science **the target itself is not sufficient** – in particular it is too distant a target when we need to reduce emissions very rapidly straight away. One might add '*fifth*', that ultimately what we do is only really effective in so far as it affects others and gives a lead. To do that, to have an impact on the wider global community, we need to be taking really bold, conspicuous action on a scale that we are not, now.

f/ Doing very big things very quickly – the whole of society acting together

It is clear, then, that whatever the precise methods adopted, given the scale of the threat we face we need to do very big things very quickly. At this point we can refer back to the section on 'positive feedbacks and tipping points' and remind ourselves of the extreme uncertainty and urgency of our current situation. All this means there is an overwhelming need to do as much as we can NOW. This is why a target set for 2050 is inadequate and we need to be thinking of short term targets of, say, 10% cuts per year. **Anything we do this year is worth twice as much as doing the same thing next year**. An emission cut in ten years means ten years worth more emissions into the atmosphere *more* than if we make that cut this year. Of course this is true at every level – global, national, local and all. Securing real effective action in the short term – ideally crash programs of emissions reductions or 'decarbonisation' – are more important than ambitious programs for the more distant future. The fact is that by the time that future arrives the situation may have changed dramatically and we will have to adapt to a whole new set of circumstances. The only thing we can be sure of is that the adaptations we have to make *then* will be all the more drastic and traumatic in proportion to how little we manage to achieve now.

The best way to achieve the great transformations necessary to create a low or zero carbon economy within a very short period of time is by **the whole of society acting together through government**. Just *encouraging* people to drive their cars less, fly less, insulate their homes more, use less energy, and so on – is not enough. Asking people not to fly, or fly less, will not work: an air-passenger tax, for instance, or a ban on domestic flights, might. Whilst we should welcome every spontaneous effort we should not expect, and it is not fair to expect, the virtuous who are prepared to alter their lifestyles, to bail out the rest of us who are not. We should have the courage to take collective decisions as a society acting together.

When enemy submarines were sinking British ships and threatening food shortages in the 1940s, the government did not say to people "please don't eat too much": rather there was rationing which was quite tough but effective and fair to everyone. We are in at least as much peril now and our best way out of that peril is for the government and all those in positions of power and influence to take a bold lead and coordinate collective action. At the national level this means crash programs, ambitious and radical forward thinking with the goal of achieving a low carbon economy quickly clearly established as the first priority for government across all departments. Half hearted measures, muddled policy, short term thinking and tinkering at the edges will not do.

An example of *the kind of* thinking we should be adopting is provided by the "**Zero Carbon 2030" report** that we have already mentioned. It combines an ambitious target with a willingness to 'think outside the box', and well ahead, with solutions that are thoughtfully integrated together to give a coherent plan to achieve the desired result (in this case a 'zero carbon' economy for the UK by 2030). As a revolutionary research enterprise it's unlikely it gets *everything* right but it's the kind of bold, comprehensive and integrated plan that we need.

It will be *far more effective and quicker* to progress through policies coordinated at the national level than to expect communities or companies to 'power down', one by one, or for individuals to change their lifestyles, one by one, converting others to do the same by their example. Top-down and coordinated from the highest level possible – ideally the highest possible, the international level – is much *the best* way to deal with the imminent *global* threat of global warming. But having said, that we know that the international negotiations for a climate treaty are currently deeply bogged down and that politicians, for example, can all too often be corrupt at worse, or otherwise short sighted and selfishly concerned with their own electoral fortunes. In any case, right now they are just not offering the kind of leadership we really need. Given that is the case then clearly **every little thing that we can achieve at community, or individual level, in this desperate struggle to avert a global catastrophe, is well worth it** and may help to create an atmosphere in which progress coordinated at a higher level is more likely to be achieved. But we cannot afford to ignore the political process. However much we may despise politicians (rightly or wrongly) we must hold them to account and make the political process, or at least make *a* political process, work for us so that we can get the kind of action coordinated at the national – and ultimately international level – that we really need.

g/ A Green New Deal – Climate Jobs

To take action on the scale, and with the speed, that we need to, will clearly require a massive investment of time and effort, and of course, **money**. Given that we are in economically difficult times it is often argued that we cannot afford to do it. But for one thing it would be unwise to wait for economically better times because it could be too late by then and anyway those better times *may* never come. This might be for a variety of reasons but will include climate change which will, without a doubt, ultimately become the overriding one. It is quite clear that escalating climate impacts will have an escalating, and in due course devastating, impact on the (world and UK) economy.

But in any case, the history suggests that recovery from economically difficult periods – from the Great Recession of the 30s for instance – has almost always been achieved through high

levels of investment, even at the cost of high short term debt. It has often involved a concerted effort by society acting together through government, as was the case with the famous 'New Deal' of President F D Roosevelt, in the US. In part this works because a high level of unemployed people is always a big drag on any economy and ensuring higher levels of employment can both help to kick start a sluggish economy as well as, potentially in due course, repay the debt incurred in measures to achieve it. This is to just touch on a big economic discussion but whilst many of the implications of a concerted effort to reduce emissions may be regarded by many as 'negative' (with constraints upon high-energy, high-consuming lifestyles) there is no doubt that the massive effort required to effect a 'green revolution' of the economy would require a very large number of people to bring it about: it would mean a large number of new jobs in what has been called a "**Green New Deal**". *Just how these 'green' or '**Climate Jobs**' (that is jobs that genuinely have the effect of reducing emissions) might be created has been outlined in the CCC pamphlet "One Million Climate Jobs Now!". See www.climate-change-jobs.org/*

Installing solar panels

Historical parallels are never perfect but, for inspiration, we can look at the way countries like the US transformed their economies at very great speed, turning truck factories into tank factories in months, during the Second World War. (One need not even think how the Soviet Union did the same kind of thing while moving much of its industry East of the Urals!). The concerted national effort that was made by the UK at that time shows how little real action there has been in recent years, when measured against politicians' rhetoric about climate change being the greatest threat that we (and the whole world) face. Reaching the targets established by the Climate Act is predicted to cost about **1% of GDP**. During the last two great national emergencies, the world wars of the last century, the government increased its spending from around ten to 40 or 50 per cent of GDP, implying that as a nation we spent roughly **30 or 40 per cent of GDP** on fighting those wars. That is the kind of response a real national emergency requires and it is not what we are seeing now.

It was in fact the response to an external threat that finally galvanized the economies of nations like the UK and US and finally, definitively, pulled them out of the 1930s recession. We can expect the same kind of thing to happen once there is a really concerted response to the threat of the catastrophic destabilisation of global climate. The 'quasi-science' of economics is merely a set of generalisations which if they are meaningful at all are rooted in human behaviour: the infusion of urgency and determination into any group of people to rally towards a common goal has an economic dimension and an economic impact.

h/ Climate Emergency

Of course to achieve this we need a real sense of urgency about the reality of the climate threat to be diffused through society through accurate readily available information and through those in positions of power and influence, in politics or the media for instance, giving the kind

of clear bold lead that they are not giving now. We should have a **leaflet about the climate threat in every home**, regular features on TV that explain it, and billboards that remind us about it. We should be doing all the easy things we can do *straight away* to reduce emissions like **reducing the speed limit to 55 mph** and **banning domestic flights**. These would have the added benefit of demonstrating with concrete measures, rather than words, that the government is treating the climate threat as an emergency and that *we are in* a situation of emergency, a **global emergency**.

Climate Emergency protest outside Parliament, July 2009

i/ Cynicism, ignorance, apathy and despair

…are the enemy! This pamphlet has attempted to tell the simple unalloyed truth as we see it. There are many who will warn …don't say that, that's far too depressing, that will only alienate, depress and disempower people. But we don't think there will ever be action *on a scale sufficient to meet the threat* until the true scale of the threat, and the real urgency of the situation, are understood by all - or at least as many as we can possibly make understand it. The fact is the situation looks bleak in many ways and we have not tried to hide that. It now looks like we are already too late be able to avoid seriously destructive impacts. People are already dying from climate change and there will without doubt be a far greater number who will in the future. It's a question of doing all we can to save as many lives, and as much of the world that is dear to us as we can. Put it this way: even if we were to fail to prevent an environmental holocaust, the last human life, and indeed the last tree, on earth, would still be worth making the effort to save.

j/ A clear way forward

But there is no sense in which all is hopelessly lost, we have no way out, or its impossible to know what to do. The future is profoundly uncertain, as we have shown, in terms of the likely scale and speed of the destabilisation of global climate. **But there is a clear way forward**, as we have also tried to show. And it will have many benefits – like jobs, like saving forests and wildlife, like a cleaner, less noisy, world. **Its time we took this way forward, full-heartedly with vigour and determination, for the sake of the poorest and most vulnerable in the world and all those who will come after us.**

The Campaign against Climate Change brings people together to push for the urgent and resolute action we need to prevent the catastrophic destabilisation of global climate. Help us campaign for stronger action on climate change within the UK and worldwide. Join us, volunteer your time or donate much needed money at:
www.campaigncc.org *info@campaigncc.org* **02078339311**

Find out more …

Recommended Reading (these works also form a constant thread through the references below)
"Storms of my Grandchildren" (**SOMG**), Dr. James Hansen, Bloomsbury 2009
http://www.stormsofmygrandchildren.com/
"Climate Code Red" (**CCR**) David Spratt & Philip Sutton, Scribe 2008 *http://www.climatecodered.net/*
Climate Safety Report (**CSR**), Public Interest Research Centre (PIRC), *http://climatesafety.org/downloads/*

Recommended websites :
Real Climate (**RC**) *http://www.realclimate.org/*
James Hansen / Columbia University *http://www.columbia.edu/~jeh1/*
Skeptical Science (**SkS**) *http://www.skepticalscience.com/*
Climate Safety (blog) (**CS**) *http://climatesafety.org/*
SourceWatch (**SW**) *http://www.sourcewatch.org/*
Desmogblog *http://www.desmogblog.com/*

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You should be able to find below not only references to support the statements made in the text but also an introduction to further reading around each topic – most of it instantly accessible on the internet. To check for references that support specific statements in the text find the reference section that corresponds with the relevant section of the text and then look for a topic heading (in bold) that most closely matches the topic of the relevant statement (eg **2. f/ Himlayan glacier melt**). Altogether it may seem like a lot of reading, and some of may duplicate or cover the same ground from different angles - but at the same time it's a small selection of what's out there and much good and important work has undoubtably been overlooked.

Abbreviations:
AAAS American Association for the Advancement of Science | **BG** Business Green |**CCR** Climate Code Red – see recommended reading | **CI** Climate Institute | **CP** Climate Progress | **CSR** Climate Safety Report | **ERW** EnvironmentResearchWeb | **G** The Guardian | **Indy** The Independent | **NASA** National Aeronautics and Space Administration | **NOAA** National Oceanic and Atmospheric Administration | **OSS** OSS Foundation | **PLA** Parliamentary Library, Australia | **PC** Pew Centre on Global Climate Change | **PIRC** Public Interest Research Centre | **PIRIC** Potsdam Institute for Climate Impact Research | **RC** Real Climate | **SA** Scientific American | **SC** Solve Climate News | **SD** Science Daily | **SkS** Skeptical Science | **SM, NAS** Science Museum, National Academy of Sciences | **SOMG** – see recommended reading | **SW** Source Watch |

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Figure 3. Average global surface temperature based on instrumental measurements (Adapted from Brohan et al. 2006) *http://www.finfacts.com/irelandbusinessnews/publish/printer_1000article_10008928.shtml*
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Figure 6. (adapted) *http://geo-engineering.blogspot.com/2011/01/2011-starts-with-lowest-arctic-sea-ice.html*
Figure 7. Figure 24: Cumulative per capita carbon dioxide emissions, with countries listed in the order of national cumulative emissions, Updated Figures. Makiko Sato & James Hansen, Updating the Climate Science: What Path is the Real World Following? *http://www.columbia.edu/~mhs119/UpdatedFigures/*

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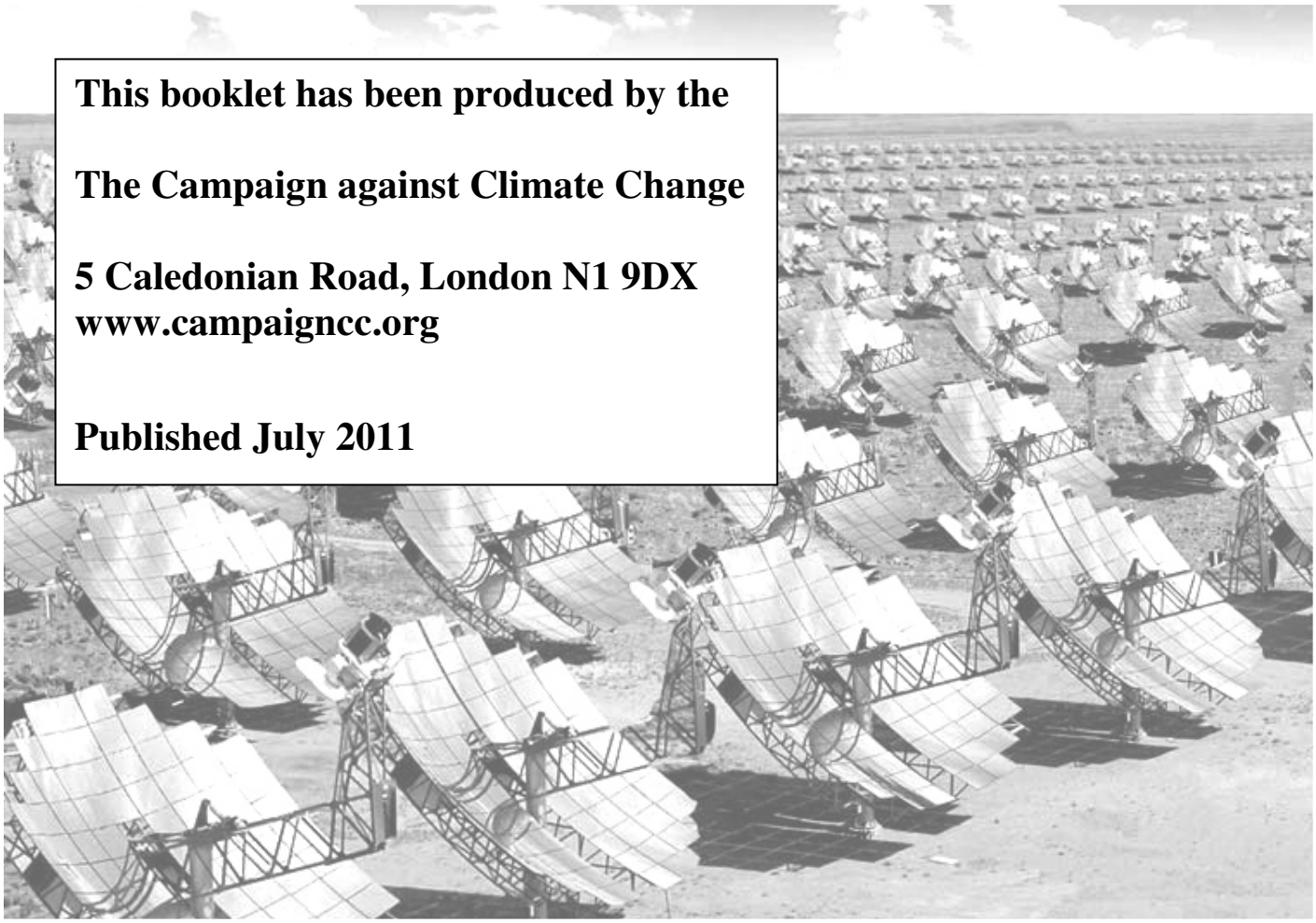

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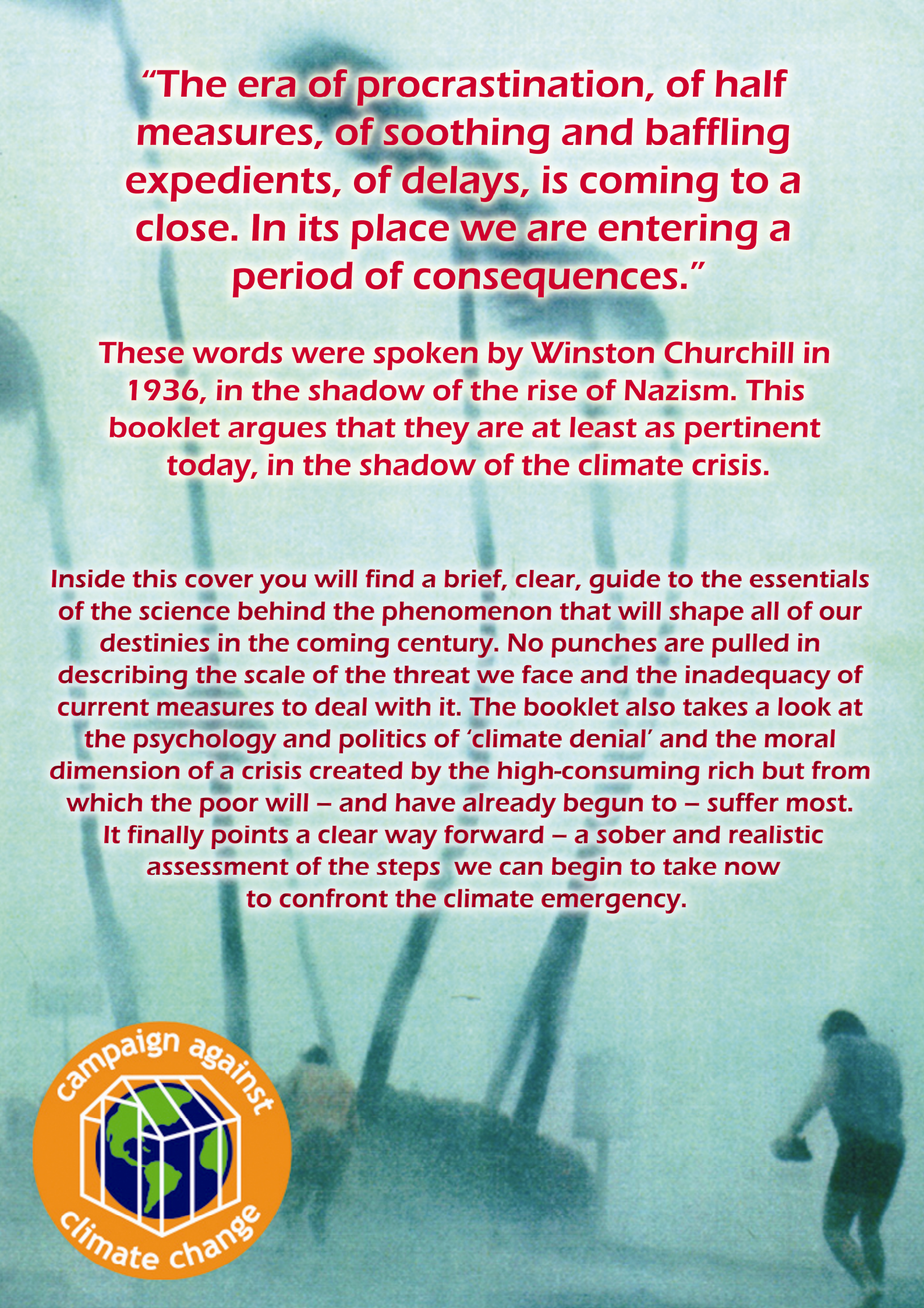

"The era of procrastination, of half measures, of soothing and baffling expedients, of delays, is coming to a close. In its place we are entering a period of consequences."

These words were spoken by Winston Churchill in 1936, in the shadow of the rise of Nazism. This booklet argues that they are at least as pertinent today, in the shadow of the climate crisis.

Inside this cover you will find a brief, clear, guide to the essentials of the science behind the phenomenon that will shape all of our destinies in the coming century. No punches are pulled in describing the scale of the threat we face and the inadequacy of current measures to deal with it. The booklet also takes a look at the psychology and politics of 'climate denial' and the moral dimension of a crisis created by the high-consuming rich but from which the poor will – and have already begun to – suffer most. It finally points a clear way forward – a sober and realistic assessment of the steps we can begin to take now to confront the climate emergency.

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