

Unpacking Climate Change

Background notes to the
catastrophe

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Unpacking Climate Change: **Background notes to the catastrophe**

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Introduction

Reading about climate change can be confusing because there is a lot of jargon and it is not always clear what people are saying. This short guide is intended to let people know what is happening and to make the debate more accessible. It is written in response to questions that people have asked me and also to my own puzzlement as I have tried to make sense of things. So 'Unpacking Climate Change' tries to give some of the background information that the climate gurus often take for granted but which helps people understand what is happening and the implications of what is being said. What is said is often said in numbers, so some sections do have a lot of numbers in them and I try to make the meaning of these numbers clear.

The booklet comes in both a web version and hard copy. The web version can be downloaded as a single document or section by section. Similarly, the hard copy is arranged so that each section can be pulled out. As far as possible, each section is written so that it can stand alone. Some information is repeated in different sections to make it easier to read but that is not always possible so readers may sometimes need to refer back. Readers are welcome to comment and ask more questions. You can post comments on the web, email groundWork or write a letter.

The first section looks at the pattern of climate change over the last million years or so and shows why it is different this time. It also introduces the greenhouse gases which cause global warming. The second section introduces the international climate institutions – the International Panel on Climate



Change (IPCC) which coordinates the science and the climate negotiations process under the United Nations Framework Convention on Climate Change (UNFCCC). The negotiations have failed to deliver on the stated purpose of the treaty – to prevent dangerous climate change – and the third section looks at how badly off-target they are: climate change is already dangerous, the targets are inadequate and the world’s governments are not acting to meet them. Instead, they promote a range of false solutions which are discussed in the fourth section. The fifth section has a lot of numbers in it. It looks at who is emitting what and at different takes on responsibility for emissions. Reducing fossil fuel use and hence emissions on the scale needed requires an economic transformation. It would be really tough to pull it off but doing so would bring very large benefits, as discussed in the sixth and last section.

This booklet makes a companion piece to groundWork’s ‘Position paper on Climate and Energy Justice’. The position paper was produced just ahead of the 2011 Conference of the Parties (CoP 17) negotiating session in Durban. It goes into more detail on the politics of climate change and includes a critique of South Africa’s policy. The position paper is also available on the web here.



1. Changing earth

Climate change is just one dimension of global ecological change forced by the massive scale of industrialisation powered by the fossil fuels: coal, oil and gas. The scale of change is such that scientists are calling this the beginning of a new geological epoch – the *Anthropocene*.¹ *Anthropos* means human (in Greek) and the Anthropocene is an epoch in which the basic functioning of earth’s ecological systems is decisively influenced by human actions. There are several dimensions to this change including climate change, air pollution, the transformation and erosion of land, interruption of fresh water cycles and extinction of species. These processes are taking place on a very large scale and each interacts with the others.

Climate – the long view

Earth’s climate has never been stable. Over the last two million-odd years, it has fluctuated between cold ice ages and warmer temperate periods. The cycle generally takes about 100,000 years and is largely driven by variations in the earth’s orbit around the sun and how much of the sun’s heat is absorbed by the earth. Generally speaking, the ice ages end with rapid warming followed by a slow cooling towards the next ice age. But the cycles are also influenced by events on earth, particularly by how much carbon dioxide (CO₂) is in the air, and there is a great deal of variation from one ice age to the next and from one temperate age to the

1 Will Steffen et al, 2004. Global Change and the Earth System: A planet under pressure, The IGBP Series, Springer Press. p.6.



next. The difference in average global temperatures between an ice age and a temperate age has been around 5°C. This average temperature difference is not evenly distributed, so the change in one place is much greater than in other places.

Carbon dioxide is critical to regulating earth's temperature: if CO₂ were eliminated from the atmosphere, earth would freeze. At different times in earth's history, increased CO₂ concentration has followed from warming or led to warming. It goes both ways. Figure 1.1 opposite shows what we might call earth's normal operating range. The fluctuations in temperature have been accompanied by the fluctuations of CO₂ concentrations in the atmosphere ranging from 180 parts per million (ppm) during the cold periods to about 280 ppm in the warm periods.

The previous temperate period is called the Eemian. It began about 130,000 years ago and at its hottest was about 1°C warmer than now and sea levels were 25 metres higher than now. The Eemian ended in the last ice age which began about 110,000 years ago. The ice cover reached a maximum about 20,000 years ago, covering much of the northern parts of America, Europe and Asia. So much water was frozen as ice on land that the world's oceans were then 120 metres lower than they are now. The ice finally started to retreat about 11,500 years ago. That marked the beginning of a new temperate epoch – the Holocene. Over the next two or three thousand years, the rising seas flooded into low lying areas. The Baltic Sea between Sweden and northern Europe formed at this time.



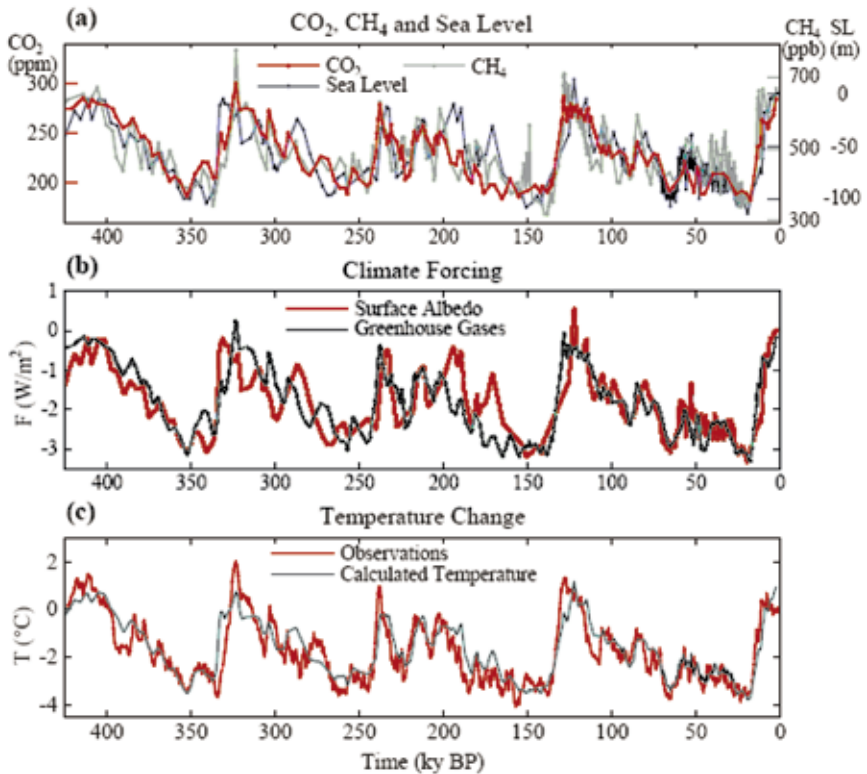


Figure 1.1: These figures show climate change over the last 400,000 years: (a) shows concentrations of carbon dioxide and methane and sea level rise; (b) shows the effect of greenhouse gases and albedo (heat reflected by ice) on ‘climate forcing’ – how much extra warmth is absorbed; (c) shows changes in temperature (observations are from ice cores). Source: Hansen et al.²

2 James Hansen, Makiko Sato, Pushker Kharecha, David Beerling, Robert Berner, Valerie Masson-Delmotte, Mark Pagani, Maureen Raymo, Dana Royer and James Zachos, 2008, Target Atmospheric CO₂: Where Should Humanity Aim? Submitted at arXiv.org, April 7, 2008 and revised June 18, 2008 (ref: arXiv:0804.1126v2).



'Anatomically modern' humans evolved about 200,000 years ago in Africa. By 50,000 years ago, it seems they were using abstract language, using more complex tools and making art and music. About the same time, people also migrated out of Africa and, in time, came to populate the rest of the world. People started domesticating plants and animals about 10,000 years ago and then went on to build and settle in permanent villages and towns. What we think of as human civilisation thus starts with the Holocene and our history is pretty much co-extensive with this hospitably temperate age.

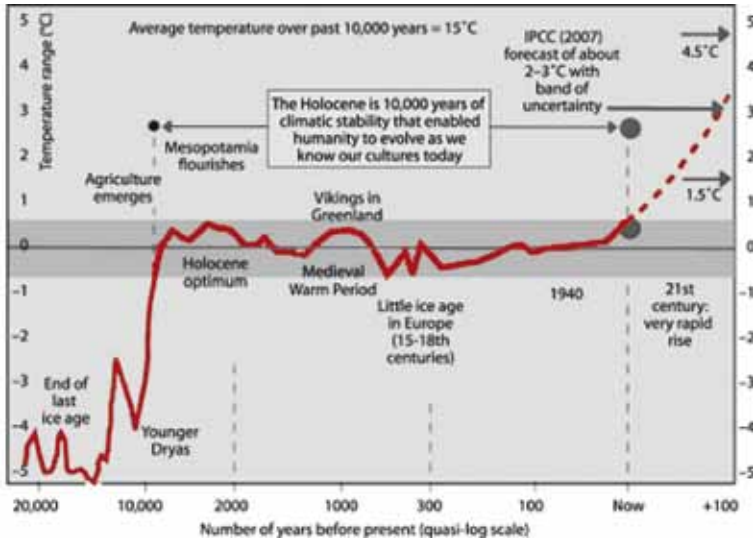


Figure 1.2: Temperature stability during the Holocene

The Holocene, however, now looks like the shortest of all epochs, having been terminated by the Anthropocene. And although this new age has been brought on by human actions, it will not prove hospitable to people. Climate change is the most significant of the impacts of industrial expansion because it will accelerate most



of the other impacts: threatened water cycles will be further stressed, the mass extinction of species resulting from habitat destruction will be exacerbated, and land erosion will accelerate even as it amplifies the impacts of bad weather.

Greenhouse gases

Global warming and climate change are driven by the increasing concentration of greenhouse gases in the atmosphere. The most important of these gases is CO₂ both because there is much more of it and because a large proportion of it lasts a long time in the atmosphere and so accumulates – CO₂ emitted this year is added to what was emitted a century ago. About half the CO₂ emitted each year is absorbed within 30 to 100 years by the sea, by soil and by plants. More is absorbed over a period of several centuries but about 20% stays for many thousands of years.

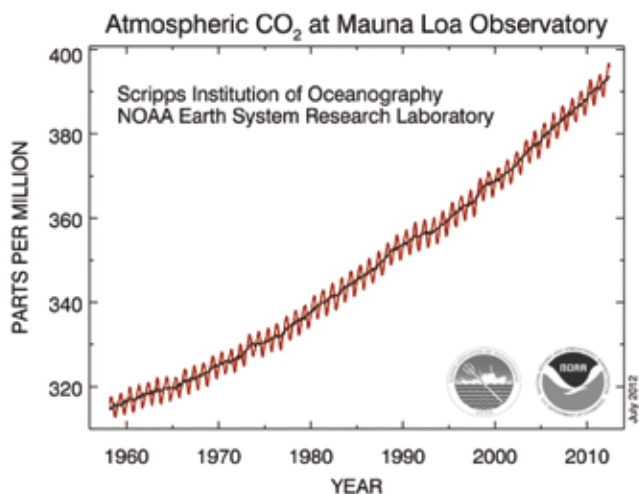


Figure 1.3: Monthly data for the atmospheric CO₂ since 1958. Source: National Oceanic and Atmospheric Administration (NOAA).



The increasing quantity of CO₂ in the atmosphere comes from burning ever more fossil fuels. In 2010, 33.4 billion tonnes (Gt) were emitted from burning fossil fuel – mainly for energy, cement making, industry and transport – and another 3.3 Gt were emitted from land use change – including the destruction of forests to grow palm oil plantations for bio-fuels. The total of 36.8 Gt compares with 34.1 Gt in 2009, the year following the global economic bust, and 34.7 Gt in 2008, the last year of the boom. The jump in emissions from 2009 to 2010 was the biggest ever annual increase. It more than made up for the 2009 dip in emissions and confirmed two trends of the 2000s: first, emissions are rising faster than ever and second, the carbon intensity of the global economy (emissions per unit of economic output or GDP) is rising. This reverses the long term trend, evident since the dawn of the industrial era, of declining energy and carbon intensity.

CO₂ concentrations in the atmosphere topped 390 ppm in 2010 and are now just short of 395 ppm, well outside earth's normal operating range of 180 to 280 ppm. The rate of increase is around 2 ppm a year and was higher than that in the boom years before the 2008 economic meltdown. Temperature rise lags behind the rise in carbon dioxide concentrations. The earth is now 0.8°C warmer than in 1900 and the pace of warming is accelerating. It now averages about 0.2°C every decade. Because of the time lag, 0.8°C probably reflects CO₂ concentrations in the 1980s or earlier and a further 0.6°C rise is still to come in response to past industrial carbon emissions.



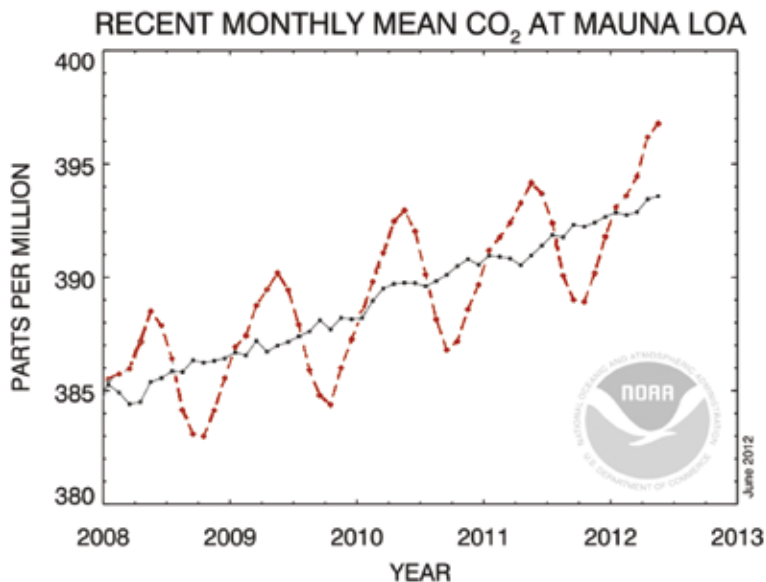


Figure 1.4: Seasonal fluctuation in atmospheric carbon dioxide (CO₂) at the Mauna Loa Observatory since 2008. The black line shows the overall trend. The red line shows carbon levels month by month. Carbon levels drop during the northern summer because plants absorb more carbon in the growing season and there is much more land for plants to grow on in the north than in the south. Source: National Oceanic and Atmospheric Administration (NOAA).

Table 1.1 lists the main greenhouse gases in the order of their significance. Methane is the next most important despite its relatively short life in the atmosphere because, after carbon dioxide, it is the most abundant. The table also shows the warming potential of each gas over different time periods. The 100-year time horizon is used to calculate ‘carbon dioxide equivalents’ (CO₂e) to create a common arithmetic for adding up the combined effects of all greenhouse gases. Thus 1 tonne of methane is said to be 25 tonnes CO₂e and 1 tonne of nitrous oxide comes in at 298 CO₂e. For methane, however, the shorter time



frame may become critical as the earth heats up [see ‘feedback loops’ below]. Over a 20-year period, 1 tonne of methane would be equivalent to 72 tonnes CO₂. Down the list, each particle of sulphur hexafluoride has a huge impact but there is very little of it in the atmosphere.

Table 1.1: Greenhouse gases that last in the atmosphere.

Gas name	Chemical formula	Lifetime (years)	Global warming potential (GWP) for given time horizon		
			20-yr	100-yr	500-yr
Carbon dioxide	CO ₂	Variable	1	1	1
Methane	CH ₄	12	72	25	7.6
Nitrous Oxide	N ₂ O	114	289	298	153
CFC-12*	CCl ₂ F ₂	100	11 000	10 900	5 200
HCFC-22*	CHClF ₂	12	5 160	1 810	549
Tetrafluoromethane	CF ₄	50 000	5 210	7 390	11 200
Hexafluoromethane	C ₂ F ₆	10 000	8 630	12 200	18 200
Sulphur hexafluoride	SF ₆	3 200	16 300	22 800	32 600
Nitrogen trifluoride*	NF ₃	740	12 300	17 200	20 700

[Source: IPCC]

* These gases are regulated under the Montreal Protocol on ozone-depleting substances and are not mentioned in the Kyoto Protocol. Water vapour, ozone and soot (also called ‘black carbon’ or PM₁₀ particulates) have a short-lived warming effect and are not included in the list of long-lasting gases. Sulphur dioxide emissions, by contrast, have a cooling effect.

Officials may mean one of three quite different things when they talk about the concentration of CO₂e in the atmosphere. First, they may mean the concentration of all the long-lived greenhouse gases. According to the IPCC, this was 455 ppm CO₂e in 2005. Figures for 2012 are not available but it is probably about 475 ppm. Second, they may mean the concentration of only those gases named in the Kyoto Protocol.³ According to the European

3 The ‘Kyoto gases’ are: Carbon dioxide, methane, nitrous oxide, hydrofluorocarbon, perfluorocarbons, and Sulphur hexafluoride.



Environment Agency, this was about 433 ppm CO₂e in 2006 and 439 in 2009. In 2012, it is probably over 446 ppm.

Third, the common industrial pollutants also influence global temperatures. Sulphur dioxide (SO₂) and nitrogen oxide aerosols (or particulates) have a cooling effect because they are a bright silvery colour and reflect heat. Black carbon or soot, which is visible as smoke, absorbs heat and so contributes to warming. Taken together, the cooling effect of the bright aerosols is much greater than the warming effect of black carbon aerosols. At present, the overall cooling from polluting aerosols more or less cancels the warming effect of the lesser (non-CO₂) greenhouse gases. For this reason, some scientists consider only CO₂ when calculating warming effects.

However, what is true of the past will not necessarily be true of the future. Researchers argue that, in the 21st Century, the warming effect of the lesser greenhouse gases will become more significant than the cooling effect of aerosols. This is because they believe that policy to reduce industrial pollution will be implemented in the 'emerging economies' of the global South just as they were during the 1960s and 70s in the North. Further, these aerosols have a very short lifespan in the atmosphere – mere days or weeks as compared with decades, centuries or millennia for the greenhouse gases. So they do not accumulate in the atmosphere and the cooling effect depends on constant replenishment. They are therefore said to suppress or mask warming – without them, the temperature will rise rapidly to match the concentration of greenhouse gases (see Table 1.2). It is nevertheless a bad idea to rely on seriously toxic pollutants like SO₂ to counteract warming.



The IPCC says that the overall effect of all warming and cooling emissions in 2005 was 375 ppm CO₂e, just less than the 2005 figure of 379 ppm for CO₂ only. In 2009, according to the European Environment Agency, the comparable figures were 399 ppm CO₂e and 389 ppm for CO₂ only. This was the recession year when carbon emissions declined so it is probable that sulphur dioxide pollution also declined. But it is notable that the combined effect of all warming and cooling gases is now 10 ppm more than the figure for CO₂ alone.

Table 1.2: Overall warming from all greenhouse gases and aerosols in 2005.⁴

CO2	+ 1.3°C	GHGs	+2.4°C	+1.3°C
Non-CO2	+1.1°C			
Black carbon	+0.9°C	Aerosols	-1.1°C	
Bright aerosols	-2.0°C			

Note: In 2005, the observed warming was 0.76 °C. Most of the difference between 1.3 and 0.76 is because of the lag between rising GHG concentrations and the response of temperature rise.

Many officials and politicians are no doubt as confused as the rest of us about the difference between CO₂ or CO₂e, and the difference between the three versions of CO₂e. But this is a convenient confusion for those who need to fudge the numbers in order to fit their climate policies to their economic priorities.

Comment on this section

⁴ Adapted from V.Ramanathan and Y.Feng, 2008. On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead. Proceedings of the National Academy of Sciences, Vol.105, No.38.



2. Climate institutions

The international process is way off target – assuming that the target is about the climate – and we’ll look at that in the sections below. This section provides a very brief introduction to the key international institutions and process.

Boffins

The possibility that carbon emissions would lead to serious climate change was first discussed in the early 1970s. By 1988, there was sufficient concern for the United Nations Environment Programme and the World Meteorological Organisation (that’s the weather people) to establish the Intergovernmental Panel on Climate Change (IPCC) as a scientific body to review the evidence.

The UN General Assembly then mandated the IPCC to assess the state of knowledge about climate change and its possible social and economic impacts. Since then, the IPCC has produced four Assessment Reports. The First Assessment Report (AR1) in 1990 produced compelling evidence of climate change and so led to the creation of the United Nations Framework Convention on Climate Change (UNFCCC) at the Rio de Janeiro Earth Summit in 1992. Each subsequent report has shown greater certainty that climate change is happening, that the primary cause is greenhouse gas emissions, that the impacts will be severe and that they are coming earlier than previously anticipated. The Fourth Assessment Report (AR4) in 2007 barely concealed the



alarm of the scientific community under the spare scientific language.

Governmental members of the UN and WMO are also members of the IPCC. They participate in decisions on its work plan and on the approval of reports. This gives the work a generally conservative bias as governments contest findings that impinge on their interests. Nevertheless, the voluntary participation of thousands of scientists around the world makes it possible for the IPCC to carry out the actual work and gives a high degree of credibility to the assessments, particularly in respect of the physical science. The IPCC's approach to social and development studies seems less convincing and more confined ideologically as questions concerning relations of power appear to be off limits.

Convention and protocol – not observed

The UNFCCC's purpose is to “stabilise greenhouse gas concentrations in the atmosphere at a level that will prevent dangerous human interference with the climate system”. The treaty has been ratified by 194 countries (pretty much all of them) and these countries are therefore ‘parties’ to the Convention. The Conference of the Parties (COP) is the “supreme body” or highest authority. The first conference – COP 1 – was in 1995 in Berlin. Since then the COP has met every year.

The Convention recognises that developed and developing countries have ‘common but differentiated responsibilities’ and it lists developed countries in Annex 1. This principle is meant to secure developmental equity between North and South recognising that:



- Northern (or Annex 1) countries are responsible for the bulk of emissions to date and are better resourced to implement the agreement; and
- Southern (or non-Annex 1) countries have a priority for 'sustained economic growth and the eradication of poverty'.
- Northern countries should therefore cut emissions first, share appropriate low carbon technologies with the South and help fund low carbon development in the South.

The UNFCCC initially relied on Annex 1 countries taking voluntary actions to reduce emissions. No-one volunteered. A binding agreement was therefore called for and the Kyoto Protocol (KP) was adopted at COP 3 in 1997. The KP is a cap-and-trade scheme proposed by the US which said it would participate only in a system based on 'the market'. Having imposed its preferred system, however, the US refused to ratify the KP and so exempted itself from abiding by it. At COP 6 (2001) in Bonn, the European Union pushed through acceptance of Kyoto without the US. The KP came into force three years later when enough countries had ratified it. At Montreal (2005), COP 11 was held in parallel with the first meeting of the parties (MOP 1) to the KP.

Under KP, Annex 1 countries agreed to meet binding emission targets (the cap) during the 'first commitment period' (2008 to 2012). It specified targets for each Annex 1 country which added up to a 5% reduction in Annex 1 emissions as compared with what they emitted in 1990. This target was not adequate to prevent dangerous climate change but they said they would do better in each successive commitment period. In the 'second commitment period' beginning in 2012, it was expected that



Annex 1 countries would take on tougher targets while 'non-Annex 1' countries would also take on mandatory reduction targets.

The principle of binding emission targets was welcomed but KP targets were founded on 'grandfathering': those countries with the highest emissions in 1990 would have the largest rights to future emissions. The targets thus enshrined historic inequalities and projected them into the future.

Kyoto set up carbon trading through three 'flexible mechanisms':

- Emissions trading allows Annex 1 countries and corporations that exceed their reduction targets to trade their surplus allocation with other Annex 1 countries that do not meet the targets;
- Joint Implementation (JI) projects enable investors in one Annex 1 country to invest in projects that produce less emissions than a business-as-usual project in another Annex 1 country and to claim 'carbon credits' for the reductions;
- The Clean Development Mechanism (CDM) works in the same way except that the investors must be from Annex 1 countries and CDM projects must be located in non-Annex 1 countries [[See Section 4 on 'False Solutions'](#)].

The stated objective of CDM was to support sustainable development in Southern countries while reducing the costs to Annex 1 countries of meeting their reduction targets. Thus, Northern polluters could invest in 'clean development' projects in the South and claim carbon credits known as 'certified emissions reductions' (CERs). Alternatively, they could buy



CERs produced from CDM projects on the market. The explicit reasoning behind this was first that the costs of meeting targets would be unaffordable to Northern economies and second that reductions would be cheaper in the South. It is thus founded on unequal development – that is, on economic, social and environmental injustice – and so negates the rationale of ‘common but differentiated responsibility’.

The US position inside the UNFCCC but outside Kyoto led to a dual climate regime.

COP 13 in Bali (2007) agreed the Bali Action Plan which outlined a ‘two track’ negotiating process. The Kyoto Protocol track was to negotiate the terms of the second commitment period. The Long-term Cooperative Action (LCA) track was to accommodate the US outside Kyoto and intended to ensure ‘comparability of effort’ with other developed countries. In other words, the US would commit to cut its emissions on the same scale as other Annex 1 countries bound by the KP.

The Bali plan envisaged a two year process to reach agreement at COP 15 in Copenhagen in 2009 and so allow time for countries to prepare for implementation in 2012. This process fell apart in Copenhagen. A so-called ‘political’ agreement, the Copenhagen Accord, came out of a back room negotiation involving the US and the ‘BASIC’ group of countries – Brazil, South Africa, India and China. Back in the COP plenary, the Danish chair then tried to impose formal adoption of the Accord but this was resisted by a number of countries who had not even been given sight of the document. Finally, the COP merely noted the Copenhagen Accord as the meeting ended in disarray. Canada, meanwhile, tore up its supposedly binding Kyoto commitment.



The Copenhagen Accord met with derision in Copenhagen but was turned into the Cancun Agreement at COP 16 in Cancun (2010) following a year of unembarrassed diplomatic bribery and coercion from the US. Japan and Russia refused any second-period binding commitments and a last ditch effort to 'save Kyoto' at COP 17 in Durban (2011) succeeded only in so far as the KP was not formally declared dead. The 'Durban Platform' says that the parties agree that they will agree a new treaty (including the US) by COP 21 in 2015. So it opened another negotiating track while the LCA track was closed at COP 18 in Doha. Also in Doha, the European Union finally signed on for the second KP commitment period but without any actual commitment – the terms make it meaningless: an undead agreement.

Effectively, the US has steamrolled the replacement of the Kyoto cap-and-trade regime with a non-binding pledge-and-review regime. This means that each country, North and South, will pledge emission cuts and countries which receive international climate funding (i.e. Southern countries) will be subject to international review. Thus far, the combination of all country pledges makes for a 4°C temperature rise before 2100. Since the pledges are voluntary, there is no reason to believe that countries will abide by them. The agreement was sold to Southern countries with promises of money and technology which look like being honoured only in so far as they return a profit.

[Comment on this section](#)



3. Off target

At the 2010 climate negotiations in Cancun, Mexico, global leaders agreed that they should aim to keep global warming to less than 2°C above pre-industrial temperatures. They have not formally agreed a target for the maximum carbon concentration in the atmosphere, but have widely advertised the figure of 450 parts per million (ppm) CO₂e as the ‘stabilisation’ target. Stabilisation means that this is where they intend that the concentration of CO₂e ends up.

There are three big problems here. First, 2°C is not a safe target. It is, as climate scientist James Hansen says, a recipe for disaster. Second, stabilisation at 450 ppm CO₂e is unlikely to result in the temperature stabilising at 2°C. Third, global leaders have not taken any credible action to stabilise the temperature at less than 2°C or to stabilise CO₂e at 450 ppm. Let’s take these problems in order.

First: Impacts are now

Global temperature rise is now about 0.85° Celsius above pre-industrial levels and, by 2020, will have exceeded 1°C. Carbon emissions to date mean that the world is already committed to a further rise in temperature of at least 0.6°C. So 1.5°C is already in the bag and we are closer to 2°C than we think. If sulphur aerosols are eliminated, then the committed warming is over



2.4°C. That committed warming can be reduced only by reducing the concentration of greenhouse gases in the atmosphere.

Much of the increased warmth has been absorbed by the oceans, moderating the effects of temperature rise on land but locking in the increased temperature for the next thousand years or so. There is no return. We are stuck with the temperature at 'stabilisation'.⁵

There is no 'safe' level for rising temperatures. Impacts are already ahead of schedule with several natural positive feedbacks kicking in, such as the loss of the albedo effect from arctic sea ice, accelerating rates of methane release from permafrost peat bogs and ocean methane hydrates, the conversion of land carbon sinks to carbon sources documented for some areas as well as the saturation of ocean sinks. We'll look at these feedbacks in more detail _____.

0.8°C is already catastrophic for millions of people around the world. In 2010, millions of people lost their homes to the floods in Pakistan and China, while fires induced by an unprecedented heat wave swept across large areas of Russia. 2011 opened with unprecedented flooding in Australia and Brazil. The USA was hit by a series of deadly tornados, killing over 520 people, floods in the Mississippi basin and a severe drought with record temperatures in Texas and northern Mexico. In 2012 the Mississippi basin suffered unusual drought and Hurricane Sandy swept across the Caribbean and up the east coast of the USA to flood New York. Across the world, Typhoon Bopha struck

5 Solomon, S., G-K. Plattner, R. Knutti and P. Friedlingstein. 2009. *Irreversible Climate Change Due to Carbon Dioxide Emissions*. Proceedings of the National Academy of Sciences available at www.pnas.org.



the Philippines island of Mindanao and left 600 dead and many thousands homeless.

In much of Africa the temperature rises at 1.5 times the global average and already exceeds 1°C. In Niger, several years of drought were followed by heavy flooding in August 2010. People already vulnerable to malnutrition saw their crops destroyed and 200,000 people were flooded out of their homes. The ‘international community’ barely registered this disaster and emergency aid was not forthcoming. In 2011, the East African drought was unusually severe and affected 13 million people already vulnerable because of the Somali war. In 2012, drought returned to the West African Sahel putting some six million people at risk. The people there were more vulnerable because they had not yet recovered from the misfortunes of 2010. In the southern Cape in South Africa, successive years of heavy flooding were followed by drought in 2010 while the normally dry Northern Cape was inundated with flood waters in early 2011. This was followed by winter floods in summer rainfall areas in the eastern half of the country. In 2012, the Eastern Cape was visited by extreme floods.

A warm atmosphere holds more water than a cool atmosphere. This is one reason for more flooding. However, even as some regions get wetter overall, others get dryer. Much of Africa is predicted to get dryer. By 2020, when global temperatures will have topped 1°C above pre-industrial levels, between 75 and 250 million Africans are likely to face increased water stress and this will in turn affect farming and food security, according to the IPCC. By the end of the 21st Century, it is expected that around



200 million Africans will have died because of climate change. This will turn out to be a conservative projection if carbon emissions are not cut dramatically, as average temperatures in many areas will rise by between 6 and 10°C by 2100. This will not be a liveable climate.

For many years scientists have avoided saying that any particular weather event is caused by climate change. Rather they have said that extreme weather is 'consistent' with climate change. This is now changing. First, researchers have shown that extreme weather events are more frequent and more severe. What used to be classified as a one-in-a-hundred-year event is now a one-in-fifty-year event. Second, scientists are now showing that the severity of particular weather events can be attributed to climate change.⁶

Sea level rise is just beginning. Water expands as it gets hotter and the oceans absorbed enough heat over the 20th Century to raise the average level of the sea by 18 centimetres. This is 'thermal expansion' and it is expected to add another 19 to 59 centimetres in the 21st Century. The lower estimate suggests the seas will rise at the same pace as in the last century. This is highly unlikely as there is strong evidence that sea level rise is accelerating.

The second source of sea level rise is from melting of glaciers and polar ice-sheets. Huge quantities of water are frozen in ice. Melting sea ice makes no difference to sea level but ice melting off the land does. Greenland and the Antarctic hold the most ice and, if it were all to melt, Greenland's ice would raise sea levels by 7

6 John Carey, *Storm Warnings: Extreme Weather Is a Product of Climate Change*, Scientific American, June 28, 2011.



metres and the Antarctic ice would raise it by 70 metres. Not all of it will melt but they are now contributing about 0.5 millimetres a year to sea level rise and the loss of ice is accelerating fast. Once it really gets going, ice melt can raise sea levels by 50 millimetres a year or one metre every twenty years.

Several scientists have noted that sea levels were 24 metres higher in the Eemian when temperatures were 1°C hotter than now, or nearly 2°C hotter than pre-industrial temperatures which is, of course, the international ‘stabilisation’ target. In Hansen and Sato’s reading of the evidence, the Eemian big melt started when the temperatures were around present levels and there is plenty of evidence that suggests the Anthropocene big melt is now starting up. Ice sheets are breaking up at a rate that scientists find alarming and, in the last decade, the pace at which the massive Greenland glaciers push ice into the sea has accelerated dramatically. Hansen and Sato think it probable that the rate of loss is now doubling every ten years. If that carries on, it implies sea level rise up to 5 metres by 2100.⁷

With the sea level up just 18 centimetres, the 2,500 people of the Carteret Islands off Papua New Guinea were evacuated in 2010. The islands are still above water – although shrinking – but spring tides are lifting salt water into their gardens and storm surges are eroding the coast. In low lying deltas the impact is even more dramatic. In the Ganges Delta, two islands formed from the sediment flow of the Ganges have been lost, creating 6,000 refugees.⁸ They are affected not only by the rising sea but

7 James Hansen and Makiko Sato, 2011. Paleoclimate Implications for Human-Made Climate Change, Goddard Institute for Space Studies, Nasa. Posted at <http://pubs.giss.nasa.gov> (paper revised in 2012).

8 Roger Harrabin, *How climate change hits India’s poor*, BBC, February 1, 2007.



also by inland dams that interrupt the flow of sediments to the delta.

The great mountain ranges store much less ice than the poles, equivalent to about half a metre sea level rise. Mountain glaciers are shrinking all over the world and some have melted completely away with serious implications for people downstream. In Peru, the Rio Santa is the biggest river draining from the Andes to the dry Pacific coast and its water is used for municipal supply, irrigation and hydro-electric power. It is unlikely to run dry because it is fed by groundwater as well as shrinking glaciers but the flow of water is already diminished and this is contributing to conflict over water rights.

All this is with the temperature still at 0.8°C. It is therefore imperative to keep warming as little above 1°C as is now physically possible. That probably means 1.5°C, the target demanded by small island states, which face the prospect of being wiped off the map in the next few decades, and African countries, which face the prospect of unprecedented famines.

1.5°C is not a 'safe' target. It can only be justified as the lowest temperature rise that is physically possible. But the lowest temperature rise physically possible is a moving target as it is forced higher every year that emissions are not cut. It is forced higher by the usual business of policy making in support of market growth and corporate profit and the consequent refusal to seriously address climate change.

The 2010 People's Conference on Climate Change meeting in Cochabamba called for a 1°C target. This was perhaps the lowest that was physically feasible in 1992 when the UNFCCC was agreed. It creates a symbolic and moral standard against which



to measure the irresponsible collusion of governments with corporate capital. But it is no longer possible.

The oceans are not only getting warmer but are also more acidic because they have absorbed so much of the CO₂ emitted by burning fossil fuels. The combination of greater warmth and acidity impairs the reproductive capacity of all species that make shells and corals. That includes several forms of plankton at the base of the ocean food chain. Fish populations are already threatened by over-fishing and loss of habitat and particularly of breeding grounds. The additional stress of climate change threatens the final collapse of whole populations and, with it, the collapse of fisheries and an important element of the global diet.

Second: 450 ppm CO₂e does not equal 2°C

Climate science does not deal in clear cut certainties but in probabilities. In considering how the climate will respond, scientists correlate a range of greenhouse gas concentrations with a range of temperature increases. Table 3.1 is from the IPCC AR4 mitigation report. The first row shows that a long-term concentration of CO₂ (only) in the range between 350 and 400 ppm, and of CO₂e between 445 and 490 ppm, correlates to a rise in temperature of between 2 and 2.4°C 'at stabilisation'. For greenhouse gas concentrations to remain constant at these levels and not rise further, emissions would need to peak during the period 2000 to 2015 and, by 2050, they would need to have declined to between 80% and 50% below the emissions level in 2000. That was 30 GtCO₂ (only), so this table implies 2050 emissions at between 6 and 15 GtCO₂. However bad the news in the top row, the next five rows show that things can carry on



getting worse. At present we are heading for one of the bottom two rows with the temperature rising between 4°C and 6°C.

Table 3.1: Stabilisation scenarios.

Atmospheric concentration		Best estimate temperature at equilibrium	Peak year for CO ₂ emissions	Change in global CO ₂ emissions in 2050 (% of 2000 emissions)
Ppm CO ₂ only	Ppm CO ₂ e (All GHGs and aerosols)			
350 – 400	445 – 490	2.0 – 2.4	2000 - 2015	-85 to -50
400 – 440	490 – 535	2.4 – 2.8	2000 - 2020	-60 to -30
440 – 485	535 – 590	2.8 – 3.2	2010 - 2030	-30 to +5
485 – 570	590 – 710	3.2 – 4.0	2020 - 2060	+10 to +60
570 – 660	710 – 855	4.0 – 4.9	2050 - 2080	+25 to +85
660 – 790	855 – 1130	4.9 – 6.1	2060 - 2090	+90 to +140

Source: IPCC AR4 Mitigation Report

The stabilisation target of 450 ppm CO₂e is taken from the top row but, according to the IPCC, there is only a 50% probability that this will restrict warming to 2°C. So it is as likely as not that temperatures will exceed 2°C.

But which of the three versions of CO₂e are we talking about? [See Section 1 on 'Greenhouse Gases'] If the 450 target includes all greenhouse gases and cooling aerosols, then concentrations can increase by 50 ppm from the 2009 level of 399 ppm before reaching the target. At present rates of increase, this will take about 20 years. If CO₂e means the Kyoto gases only, concentrations are just 4 or 5 ppm short of the 450 target and will exceed that target in the next couple of years.



If CO₂e means all long-lived greenhouse gases, the 450 CO₂e target is long since over-shot. At first sight, the figures in the table seem to suggest this and the first row looks very much like a picture of where we are now – except that the greenhouse gas concentrations are not stabilised but still rising. With CO₂ at about 395 ppm and CO₂e probably at 475 ppm or more, both are approaching the top end of the range given in the first row and will soon exceed this range.

However, Table 3.1 in fact represents the version of CO₂e that includes all greenhouse gases and cooling aerosols. This is confusing because CO₂ (only) is already at the top of the range given in the first row of the table while CO₂e is not yet close to the bottom of its corresponding range of 445 – 490 ppm. And whereas the present concentrations of CO₂ and CO₂e (with aerosols) are very close, the table shows a 90 ppm gap between them. It is almost as if the table mistakes CO₂e with aerosols for CO₂e as all greenhouse gases. So what is happening here?

Each row in the table is a ‘scenario’: it represents some time in the future when the concentration of greenhouse gases has remained constant for several decades and the warming associated with that concentration is fully realised. By that time, it is assumed that air pollution control measures will have greatly reduced aerosol emissions. The cooling effect then fades out fast because aerosols are short-lived in the atmosphere so the figure given for greenhouse gases with aerosols increasingly resembles the concentration of all greenhouse gases without aerosols.



It then follows that the combination of increasing greenhouse gas emissions and successful pollution control would mean a very rapid increase in CO₂e. This suggests that aerosols are merely ‘masking’ the underlying warming, that the concentration for all greenhouse gases is the figure to watch and that the 450 target is indeed overshoot.

This makes sense because each new scientific report confirms that the concentration of CO₂ only has also long since passed any reasonable target. To take just two examples: In 2008, James Hansen and colleagues argued that 350 ppm CO₂ is the maximum ‘safe’ target for stabilisation and even this might need to be revised downward.⁹ In 2009, Aradhna Tripathi and her colleagues reported that the last time CO₂ stabilised at 400 ppm was 15 million years ago and that the temperature was then between 3 and 6°C warmer than now and the sea level 25 to 40 metres higher.¹⁰ The 2010 Cochabamba People’s Conference called for a return to 300 ppm CO₂e (all greenhouse gases) which is pretty much the pre-industrial and pre-Anthropocene concentration.

Whereas the global temperature will take thousands of years to cool from the temperature at ‘stabilisation’, it is physically possible to reverse the increase in CO₂ concentrations in this century and urgently necessary to do so. It can be done by cutting emissions to near zero and by restoring the capacity of land-based ‘sinks’ – soil and forests – to absorb carbon.

9 Hansen et al, 2008, *Target Atmospheric CO₂*, (reference above).

10 Aradhna Tripathi, Christopher Roberts and Robert Eagle, 2009, *Coupling of CO₂ and Ice Sheet Stability Over Major Climate Transitions of the Last 20 Million Years*, Science, Published Online October 8 2009.



Feedback loops

Table 3.1 is concerned with the warming induced by the greenhouse gases. It does not take account of ‘feedback loops’ which result from the way the earth system starts responding to the additional warming. Some of these responses amplify the warming effects and so create a vicious cycle. The risk of runaway climate change – the point at which feedbacks from the natural system becomes more significant than industrial emissions – is already evident and becomes a near certainty at 2°C.

Some feedback loops will cut in progressively, adding a little more to the warming effect each year. Others will cut in abruptly. This follows from the strong probability that environmental systems will ‘flip’: the environment absorbs a variety of pressures until a threshold is reached at which point very abrupt change takes place.

The first feedback loop concerns CO₂ itself. CO₂ is naturally exchanged between the air and the oceans and between the air and soils and plants. In the pre-industrial Holocene, these ‘fluxes’ from one to the other would be more or less in balance. Plants and soils would absorb more CO₂ during the northern summer and release as much back to the atmosphere in the northern winter. This is because there is more land in the northern hemisphere and therefore more plants absorbing carbon in the growing season. We can call this the ‘above ground’ carbon cycle.

Fossil fuels release carbon that was buried millions of years ago. As this ‘below ground’ carbon is released into the atmosphere, it puts pressure on the above ground carbon cycle. Oceans, plants and soils at first absorb more CO₂ from the atmosphere. As the oceans warm, however, they absorb less CO₂ so more CO₂ will stay



longer in the atmosphere. Meanwhile, the carbon absorption of some soils has already gone into reverse so that they become a source instead of a sink for CO₂.

The world's forests absorb and store vast quantities of CO₂. Only remnants remain of the temperate forests that once covered much of Europe and North America. The European forests were felled as much for naval timber as for clearing land for agriculture. The navies carried the imperial troops and colonisers who then started the business of deforesting the colonies. That business expanded dramatically as the US displaced the European empires and the colonies turned into the Third World.

The great tropical forests of Latin America, Africa and South East Asia still absorb huge volumes of carbon but the extent of deforestation makes them ever more vulnerable to climate change. In 1997, Indonesia experienced an unusual drought and fires burnt through nearly 100,000 square kilometres. The carbon in the trees went up in smoke and so did carbon from deep peat soils. Under normal conditions, these soils are too damp to burn but the severity of the drought was such that they had dried out and some burnt deep below the surface for months. Uncontrolled fires are now an annual feature of Indonesian life and the incidence of fire will increase as earth heats up. A peculiar irony is that many fires are set by corporations wanting to convert forest to palm oil plantations to cash in on the bio-diesel market created by Europe's climate and fuel security policies.

The Amazon remains the greatest tropical rainforest but it seems that climate change will take the rain out of rainforest. Two papers from 2004 show that there is a strong probability



that the Amazon will dry out. The first paper projects that forest cover will shrink from 80% to 24% of its original extent, and the second that it will shrink from 80% to 10%, by the end of this century.¹¹ The drying process will be accompanied by a massive loss of carbon, whether or not the forests burn. It will also reduce the biosphere's capacity to absorb carbon so more of the CO₂ that is emitted will remain in the atmosphere.

Peat bogs (or wetlands) are common to many areas. Peat is produced from rotting vegetation which is why it is rich in carbon. Peat bogs also produce methane when the rotting matter is buried deep and oxygen can't get to it. Across the far north of Canada, Alaska and Russia, old and deep peat bogs are permanently frozen. This is known as 'permafrost' and it covers millions of square kilometres and extends under the shallow seas off Russia's Arctic coast. It was noticed in the early 2000s that the permafrost was beginning to melt and emit both methane and CO₂. Since then, the pace of the melt has accelerated dramatically. In 2011, Russian researchers who have monitored the seas off Siberia for the past 20 years said they were astonished at the scale of methane bubbling up. The number of methane 'fountains' had increased dramatically and, where previously they had seen fountains which measured tens of metres across, they now saw some of a kilometre in diameter.¹²

As yet, Arctic CO₂ and methane emissions are relatively minor compared with emissions from tropical wetlands and agriculture.

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- 11 The probable drying of the Amazon was reported in the IPCC's AR4 and became a matter of controversy when right wing propagandists claimed there was no basis for the assertion. They were wrong. See George Monbiot, *The IPCC messed up over 'Amazongate' – the threat to the Amazon is far worse*, The Guardian, July 2, 2010.
 - 12 Steve Connor, *Shock As Retreat of Arctic Sea Ice Releases Deadly Methane Gas Levels*, The Independent (London), December 15, 2011.



But within the next 20 years, and possibly sooner, permafrost melt will cross a tipping point to create a major source, according to researchers at the National Snow and Ice Data Centre in the US. The melting permafrost is likely to release 697 billion tonnes of straight CO₂ over the next two centuries – which is worth 3°C on top of warming from industrial emissions.¹³ Potential Arctic methane emissions are still to be quantified but are thought to be around 70 billion tonnes – equivalent to 1.6 trillion tonnes of CO₂ on the 100 year time horizon. A very large spike in methane emissions would have a greater short term effect on temperatures. The scientists at RealClimate think this unlikely, however. They argue that the carbon component in methane will be more significant because methane degrades to CO₂ and CO₂ accumulates.¹⁴

Even greater quantities of methane are stored in methane-hydrates. Hydrates are a bit like ice crystals but form in the oceans under pressure at some depth.¹⁵ These formations are regarded as unstable and it is somewhat alarming that the US, Japan and others are experimenting with ‘drilling’ them as a source of ‘unconventional gas’. In January 2013, Japan announced a successful test drill.

Ice creates an ‘albedo effect’: Because it is white, it reflects heat from the sun back into space, beyond the earth’s atmosphere. The melting of the ice means the loss of this cooling effect. The Arctic Sea has been frozen over all year at least since the start

13 Stephen Leahy, *Permafrost Melt Soon Irreversible Without Major Fossil Fuel Cuts*, Inter Press Service, February 20, 2011.

14 David Archer, *Much ado about methane*, posted at www.realclimate.com, January 4, 2012.

15 See Jeremy Leggett, 2005. *Half Gone: Oil, Gas, Hot Air and the Global Energy Crisis*. London: Portobello Books, p. 76; 118.



of the last ice age 110,000 years ago. The pace of sea-ice melt accelerated dramatically in the last decade and, in 2008, it was possible to sail right around the North Pole as both the north-east passage along the Russian coast and the north-west passage on the coast of Canada and Alaska opened during the summer. It is now expected that the Arctic Sea may be free of ice in summer as early as 2013 and not later than 2018. Instead of the ice reflecting heat, the dark water will absorb heat.

As well as the loss of albedo, this will accelerate the release of carbon and methane from the melting permafrost both on the sea bed and for many kilometres inland. The additional warming will also accelerate the melt of ice on land and, without the sea ice to buttress it, land ice will fall faster into the sea and so accelerate sea level rise. It is also likely that an ice-free Arctic Sea will change summer weather patterns in the northern regions as air pressures change over warm water in the place of cold ice.

Change will not always go in one direction everywhere. It is possible that melting ice will result in the Gulf Stream – the Atlantic Ocean current that flows from the tropical Caribbean to northern Europe – shutting down before 2100.^{16 17} This current carries heat northwards and without it Europe may get colder even as the world as a whole gets hotter. The energy that is no longer carried north is then likely to be released in more extreme heat and weather at the tropical end. A shut down is also likely to

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- 16 Timothy Lenton, Hermann Held, Elmar Kriegler, Jim Hall, Wolfgang Lucht, Stefan Rahmstorf, and Hans Schellnhuber, 2008, *Tipping elements in the earth's climate system*, Proceedings of the National Academy of Sciences, February 12, 2008, vol.105, no.6.
- 17 The current is pulled by dense salty water sinking at the northern end and it then returns south as a submarine current. If the water is diluted so that it is no longer heavy with salt, it will not sink and will not draw the Gulf Stream northward.



affect weather everywhere else because the Gulf Stream is part of the global system of currents known as the Thermohaline Circulation which connects all the world's oceans.

Third: Climate inaction now

Meeting any credible target requires a radical programme for reducing carbon emissions in absolute terms starting now. Any delay in reducing emissions creates the need for ever-sharper reductions in the future. This is because the accumulation of CO₂ is what matters. It is not enough to say, 'We will cut our emissions to 4 billion tonnes in 2050.' We have to say how much we can emit from now to 2050. This is the carbon budget. How big it is depends on the temperature target and the probability of meeting it.

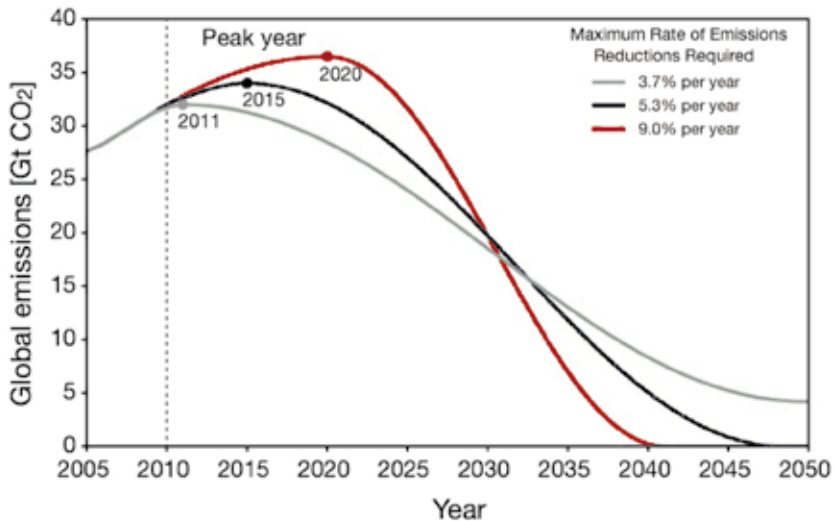


Figure 3.1: Reduction pathways for a 750 Gt CO₂ budget from 2010 to 2050. Source: WBGU 2009.



Assuming a 2°C target and a 75% chance of meeting it, the budget for the period 1990 to 2050 is around 1,100 Gt CO₂.¹⁸ From 1990 to 2009, about 500 Gt was emitted so that left just 600 Gt for 2010 to 2050. In 2010 and 2011 emissions kept rising and added 33 and 34 Gt respectively from burning fossil fuels but not counting emissions from land use change. From the end of 2012 there is less than 500 Gt left. At 34 Gt per year, the budget will be consumed by 2028. If emissions keep on rising, it will be consumed before 2025.

If the chances of avoiding 2°C are reduced to 67% (a one in three chance), then the 2010 to 2050 budget increases to 750 Gt. Figure 3.1 shows emission pathways to 2050 with different peak years based on this budget: the area below each of the three lines is the same and adds up to 750 Gt CO₂. To stay in this budget, it shows that peaking later means sharper cuts in the following years.

That is a reasonably generous calculation of the carbon budget. Later research makes it look optimistic as it suggests that the 2°C carbon budget for 1850 to 2100 is already used up “so emissions must ramp down to zero immediately” and go negative after 2050.¹⁹ Even if this is shown to be overly pessimistic, it is obvious that aiming for 1.5°C and 350 ppm CO₂ requires immediate ‘ramping’ down: there is no ‘carbon space’ left.

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- 18 German Advisory Council on Global Change (WBGU). 2009. *Solving the Climate Dilemma: The Carbon Budget Approach*. Berlin: WBGU. Note that carbon reductions following a 2015 peak are less demanding than that calculated by Anderson & Bowes. See also Meinshausen et al, 30th April 2009. *Greenhouse-gas emission targets for limiting global warming to 2 °C*. Nature 458, April 2009,
- 19 Arora, V., J. Scinocca, G. Boer, J. Christian, K. Denman, G. Flato, V. Kharin, W. Lee, and W. Merryfield, 2011. *Carbon emission limits required to satisfy future representative concentration pathways of greenhouse gases*, Geophysical research letters, Vol. 38, published 10 March 2011.



However, if we stay with the more generous 2°C budget, the remaining 500 Gt CO₂ compares with 2,795 Gt in existing fossil fuel reserves as calculated by the Carbon Tracker Initiative.²⁰ This is the stuff that is already found, available for extraction at current prices and underpinning the value of coal, oil and gas corporations. In short, it is ready to burn. This is five times what can be burnt in the next 50 years and one and a half times what can be burnt in the next 500 years.²¹

There are three evident implications: first, all oil, gas and coal exploration should stop now; second, unconventional resources (tar sands, deep water, shale gas, coal-to-liquids, etc.) must be abandoned; third, fossil fuel use must be phased out as rapidly as possible so that the better part of the conventional reserves, starting with coal, are also abandoned. As Bill McKibben points out, doing this would crash the value of the fossil energy corporates – whether private or state owned – and they would certainly prefer to crash the planet.²²

As noted above, the Cancun agreement adopts the voluntary greenhouse gas reduction ‘pledges’ made under the Copenhagen Accord. If each country actually meets its pledge, it will result in a 4°C rise in average global temperatures from emissions alone – climate feedbacks will push it higher. The agreed 2°C target is thus meaningless. Cancun even agreed to open discussion on a

20 Carbon Tracker Initiative, (undated) *Unburnable carbon – Are the world’s financial markets carrying a carbon bubble?* written by James Leaton. Note that their figures are from 2011.

21 For comment on fossil fuel reserves relative to the 1750-2500 carbon budget, see Allen et al, *The exit strategy*, published in *Nature*, 30th April 2009.

22 Bill McKibben, *Global Warming’s Terrifying New Math: Three simple numbers that add up to global catastrophe - and that make clear who the real enemy is*, Rolling Stone, August 2nd, 2012.



1.5°C target. This is certainly better than 2°C but, in the context of the multilateral negotiations, it too will be meaningless because the negotiators have purposely disconnected temperature from the carbon budget.

The mismatch of temperature target and reduction pledges led the United Nations Environment Programme (UNEP) to publish the 'Emissions Gap Report' in 2010 and 'Bridging the emissions gap' in 2011. In 2010, greenhouse gas (the six Kyoto gasses) emissions were about 48 Gt CO₂e for the year. That had to be reduced to 44 Gt CO₂e in 2020 if there is to be any chance of keeping to an emissions pathway that makes 2°C at all possible. Assuming 'business-as-usual' (i.e. no action), emission would rise to 56 Gt CO₂e in 2020. So that would make for a 12 Giga-tonne gap.²³

UNEP then looked at the country pledges and noted that they contained all sorts of vagaries and various conditions – 'we will do this only if ...'. So it developed four different interpretations of what the pledges would mean in terms of actual emissions in 2020. In the best case it found that there would be a 6 giga-tonne gap and in the worst case it would be an 11 giga-tonne gap – just one giga-tonne less than taking no action whatever.

In Durban, the parties agreed that they would agree an 'inclusive' new agreement -- in 2015 for implementation by 2020. 'Inclusive' means including the US. This adds a third negotiating track to the existing KP track and the Long-term Common Agreement track. Or it may be that the LCA track is merged with the Durban Platform track while the KP runs out of track when

23 The gap is bigger in the 2011 than in the 2010 report. These figures are from 2011.



the new agreement kicks in. Either way, implementation in 2020 will be rather late to close the 2020 giga-tonne gap.

It cannot be assumed, however, that the new agreement will in fact be agreed or, if it is, that it will meet the challenge. The record of negotiations to date rather suggests that agreement is conditional on it being ineffective in addressing the climate crisis. The reason is this: Capitalism requires economic growth of about 3% a year forever, which means that the sheer volume of materials must double every 30 years or 40 years if we assume greater efficiency in production. This is not compatible with the steep carbon reductions required.

The priorities of governments are very evident. In the period to 2008, global economic growth was sustained by allowing the major banks to inflate a massive bubble. When the bubble burst, governments conjured up some US\$13 trillion to save the banks. That was just for 2008 and 2009. To save the climate, the Copenhagen Accord promised that rich countries would 'mobilise' \$30 billion in 'fast start' funding for the first three years (2010, 2011 and 2012) and would 'mobilise' \$100 billion annually by 2020. They have not delivered the \$30 billion and are unlikely to deliver the \$100 billion.

Rich country emissions dropped dramatically following the banking bust. In consequence, some of them inadvertently met their Kyoto emissions targets. Global emissions fell by just 1.3% largely because China spent huge sums of money on infrastructure to off-set the collapse in exports to the North. So it imported more oil and coal as well as iron ore, copper and everything else and that kept African mines busy. Everyone was



very pleased that China had rescued the global economy from collapse. Whether it can do it again in 2012 or 2013 is doubtful.

Deepening global depression is now the best hope for avoiding catastrophic climate change. This is the starkest indicator that the economy founded on never-ending growth is not sustainable. The world's governments, however, have tied their legitimacy and expertise to the management of growth. This brings us to the point where survival depends on their political and economic failure. It is not a pretty prospect. It will change only if people are able to assert an economic logic based on ecological sustainability and people's well-being.

[Comment on this section](#)



4. False solutions

Governments cannot ignore climate change but, as long as they are tied to the interests of corporate capital, they cannot seriously address it. They have therefore put forward various false solutions.

Carbon market

Carbon trading is the heart of the Kyoto Protocol and it has proved to be a false heart. The idea is that a limit (or cap) is placed on how much carbon can be emitted, emission rights are then allocated and those who emit less can sell their surplus rights to those who emit more. The 'market' would then automatically find the most efficient solutions without the need to create a big bureaucracy. Only governments can create the rights, however, so the idea that the process could run without them was nonsense. Trading not only created a new governmental bureaucracy but bloated private consultancies as well.

In the absence of the US, Europe set up its own internal emissions trading scheme (ETS). The ETS delivered profits to polluters and traders without reducing emissions. At the start, big business, particularly the energy corporations, lobbied for generous emissions rights. European governments were duly generous and gave away rights to emit more than corporate Europe was already emitting. So the cap was lifted off the corporate head. Nevertheless, the price of emissions rights was pulled up by the boom in coal, oil and gas up to 2008.



The 2008 crash in oil prices similarly crashed the carbon price. European industry slumped, energy consumption shrivelled, corporate revenues dwindled and the creditors came knocking at their doors. What they had in surplus was carbon credits which were sold off to plug the holes in their balance sheets. Got free, these credits produced pure profit at whatever price. The carbon price did not recover with commodities in 2010/11 and a series of scandals have shown that the market creates open season for scams of all sorts.

The Cleaner Development Mechanism (CDM) has an equally inglorious record. It allows polluting industries from the North to invest in projects in the South which are calculated to produce fewer emissions than a business-as-usual project and to claim 'carbon credits' for the reductions. It invites players to 'game the system' and they have embraced the invitation. Even if the rules are followed, the carbon accounting is based on a series of fictions and false assumptions. For Southern countries, CDM has simply created a new arena of competition for foreign direct investment. Real or not, the carbon credits are subtracted from the Northern country's total carbon count and must logically be added to the Southern country's count. This is fudged. Thus, Sasol includes its CDM projects in its strategy for reducing its greenhouse gas emissions. So it takes the money from selling 'certified emission reductions' (CERs) but still reports the carbon reductions as their own, even as they are claimed by the buyers.

Northern countries, meanwhile, bank on trading to meet impressive-sounding targets with minimal cuts in real emissions. Thus, the UK's 2008 climate policy requires that the country's CO₂ emissions are cut by 60% by 2050. Journalist George Monbiot



observed that this was at odds with the UK's energy plans. The contradiction was resolved by deleting a clause limiting the use of internationally traded credits in meeting the 60% target: "In other words we could buy the entire cut from other countries."²⁴ Limits may be restored but the political intention of Northern countries is clear.

Carbon capture and storage (CCS)

Coal is the dirtiest of the fossil fuels and has the highest carbon density. 'Clean coal technologies' are now being promoted to justify the continuation of the industry in the context of climate change. Carbon capture and sequestration (CCS) is the main hope. This involves separating CO₂ from the emissions stream – leaving other pollutants to go their way unless separately scrubbed – compressing it to a liquid and injecting it into deep geological strata or the ocean.

If CCS is to make a meaningful difference, it has to be done on such a large scale as to make it improbable. Technology and environment academic Vaclav Smil comments, "... to sequester just 25% of CO₂ emitted in 2005 by large stationary sources ... we would have to create a system whose annual throughput (by volume) would be slightly more than twice that of the world's crude-oil industry ..."²⁵

The ocean has already absorbed an overload of CO₂ and is consequently becoming more acid. This is already affecting the reproduction of krill, the foundation of the ocean food chain,

24 George Monbiot, *Traded Away*, The Guardian (London), July 24, 2008.

25 Vaclav Smil, *Long-range energy forecasts are no more than fairy tales*, Letter to Nature, Vol. 453, May 8, 2008.



and so threatens to collapse fisheries. Risking accelerated acidification through ocean sequestration seems like a really bad idea. As a liquid, it may also spread across the ocean floor creating dead zones.

That CO₂, injected on the scale required, will stay where it's put in geological strata is also uncertain and is possible only in particular geological formations. Such formations do not necessarily coincide with the location of power plants and other big industrial emitters. South Africa, for example, has recently mapped potential storage sites and the best prospects are offshore and remote from Eskom's carbon intensive power plants and Sasol's coal-to-liquid plants.

A peculiarity of the coal-to-liquid process is that it already separates out a portion of carbon dioxide and so makes capture relatively easy. Adopting CCS, whether or not it actually works, therefore requires the additional costs of compressing and injecting it. Power stations would, in addition, have to separate the carbon dioxide which is very costly and consumes around 30% of the energy produced by the power station – so producing even more carbon to be stored.

In Durban, governments agreed to recognise CCS under the Kyoto Protocol. So CCS projects can now get CDM carbon credits – allowing two false solutions for the price of one. Civil society has long resisted recognition of CCS as a wasteful distraction: the money invested in it should rather be put into building the renewable energy system. On the other side, CCS has been pushed by the US, the World Bank and energy corporations to avoid cutting fossil fuel use. Europe joined the clamour when it announced more ambitious reduction targets in 2007 while



the big coal countries were all looking for a technical fix to get coal off the climate hook. South Africa now wants to host an internationally funded demonstration project.

The cost of CCS puts the coal industry in a quandary. On the one hand, it promotes CCS as a response to climate change. On the other, it is concerned that the cost will wipe out coal's price advantage and generators will turn to nuclear instead.²⁶ But the real point of CCS is to justify building new coal fired plants now, whether or not CCS is eventually made to work. New power stations like Kusile in South Africa are advertised as 'CCS ready' but, as Eskom's technical supremo, Steve Lennon, admits, "no one really knows what that is at the moment".²⁷

Nukes

Nuclear power remains fabulously expensive. Proponents claim it will enhance energy security and reduce carbon emissions. The claim of carbon savings is widely disputed. Nuclear energy does not emit carbon from the generating plant but the full cycle of production is both energy and carbon intensive. This includes uranium mining and processing into 'yellow cake', enrichment and fuel fabrication, and long term storage or disposal of spent fuel. In addition to fuel production, nuclear construction is enormously costly in energy, carbon and money and similar costs are incurred in the final decommissioning and demolition.

Taking account of the full cycle, the Eco-Institute in Darmstadt, Germany, calculates that a 1,250 MW nuclear power station in

26 See Creamer's Mining Weekly, March 16-22, 2007.

27 Quoted in Earthlife Africa's submission to Nersa on Eskom's MYPD2 application, November 30, 2009.



Germany emits 33 grams of CO₂e per kWh, amounting to 250,000 tonnes per year. Carbon emissions are higher for lower grades of uranium ore: for grades between 0.1% and 1%, CO₂e emissions are 120 grams/kWh.²⁸ That would bring the German plant's emissions to 900,000 tonnes a year. This is a lot less than coal, at over 750 grams/kWh, but a lot more than most renewables, at between 10 and 30 grams/kWh.²⁹

The International Energy Agency (IEA) says uranium deposits are plentiful but a worldwide turn to nuclear would soon test the limits of supply and production. This is not just about whether or not there is uranium in the ground, but how fast it can be extracted and processed to supply a greatly expanded industry as the high grade easily reached uranium is mined out and only the low grade ores are left. At present, the world's 443 nuclear power stations consume 68,000 tonnes. Only 40,000 tonnes comes from mining. The rest is supplied from decommissioned Russian warheads which will be used up soon. Like oil, uranium prices are volatile and presently depressed. Some major mine investments have been delayed, putting future supplies in jeopardy.

The mining industry has been prone to disaster. In October 2006, the Cigar Lake mine in Canada flooded with groundwater. This is a new mine still under construction by Cameco, the world's leading uranium producer. The scale of groundwater contamination is unknown but remediation plans involved pumping it out to the surface. Short of disaster, miners are routinely exposed to

28 http://www.precaution.org/lib/nuke_ghg_emissions.060224.pdf

29 There are large variations in estimates for both nuclear and renewables, depending on methodological assumptions, specific plant characteristics and, for renewables, different technologies.



radiation while mine tailings leave a radioactive legacy for tens of thousands of years. Niger supplies most of the uranium for France's nuclear power stations from mines operated by French nuclear corporation Areva. Radiation levels on the streets of local towns are up to 500 times higher than normal and drinking water in some areas is also contaminated according to a report by Greenpeace.³⁰ In South Africa, uranium is found with gold on the West Rand and local streams are heavily contaminated with radiation.

Decommissioning and disposing of high level nuclear wastes has a particular significance. First, no satisfactory solution has been found for either. Second, in a post-peak oil context, decommissioning will compete with other resource demands and may simply be beyond the capacity of a declining energy system. Nuclear power will then leave an irredeemable toxic legacy to future generations.

Nuclear power claims an above average safety record because it is tightly regulated. This is partly achieved simply by secrecy. Many incidents at nuclear plants have come to light years after the fact. Even if it were true, the claim does not address the real issue that a single incident can be catastrophic. The 1986 melt down of the reactor at Chernobyl in Ukraine spread radioactive fallout across Europe. Recently published research puts the death toll at close to a million people.³¹ The area surrounding the

30 Julio Godoy, *Niger: French State-Owned Company 'Poisoning' Poor*, IPS, April 12, 2010.

31 *Chernobyl Radiation Killed Nearly One Million People: New Book*, Environmental News Service, April 26, 2010. The book draws on East European scholarship not previously published in the West: Alexey Yablokov, Vassily Nesterenko and Alexey Nesterenko, 2010. *Chernobyl: Consequences of the Catastrophe for People and the Environment*, New York Academy of Sciences.



plant is effectively sacrificed for ever. The 2011 Fukushima melt down in Japan has spread radiation by sea and air all the way to America. The multiplication of plants around the world clearly increases the risks of catastrophic failures.

The proliferation of nuclear power cannot be dissociated from the proliferation of weapons. The Non-Proliferation Treaty (NPT) has been discredited and now appears as a tool for maintaining the military advantage of the great powers and their allies. The US has abrogated its own obligations under the treaty, supported Israel's nuclear capacity in defiance of the treaty, and used the treaty as a diplomatic weapon against Iran.³² In this context, it proposed a Global Nuclear Energy Partnership which is little more than a move to take control of the world's nuclear supply chain. At national level, meanwhile, nukes play to the ambitions of the securocrats and consolidate anti-democratic tendencies.

Geo-engineering

In the US, the right wing movement simultaneously denies that climate change is happening and promotes geo-engineering as a solution to climate change. What they really object to is the idea that they should restrain their use of energy in general and fossil fuels in particular.

Unsurprisingly, the funding for this comes from industrial lobbies and big oil in particular. ExxonMobil, for example, has long been a funder of think tanks that dispute that climate change is happening. However, CEO Rex Tillerson now says that climate change is real but that it is 'an engineering problem'. Neoliberal

³² See The groundWork Report 2006: 159 ff.



economists chime in with the claim that geo-engineering is cheaper than cutting CO₂ and is therefore the moral response.

So climate change is denied until it is too obvious to ignore and, by that time, geo-engineering is primed as the evident and necessary solution. It is likely that the US government will soon adopt this line. It fully understands that the world is heading for 4°C or more but has knowingly wrecked any common framework for reducing carbon emissions. Geo-engineering will be the last refuge of a rogue state.

Proposals for geo-engineering come in two basic forms. The first creates artificial ways of enhancing the capacity of the oceans to absorb CO₂. For example, it is proposed that spreading iron dust will create a bloom of phytoplankton which will absorb CO₂ before dying and sinking to the deep ocean. Trials haven't worked very well and, along with all such other proposals, doing it at a scale large enough to make a difference will take massive resources and create new problems on an equal scale.

The second is 'solar radiation management' – that is, managing how much of the sun's heat comes through to the earth. The two main proposals are: to sail 1,500 or more ships constantly across the oceans with each ship spraying water droplets into the air to create white clouds and a large albedo effect; and to pump sulphur dioxide (SO₂) aerosols into the upper atmosphere and so reflect heat outwards – placing the albedo effect at high altitude.

These responses do nothing about CO₂ emissions so, even if the earth is cooled, the oceans will carry on getting more acidic. SO₂ pumping will accelerate acidification – of land as well as sea – because much of it falls to earth. It would thus add to the impact



of ground level industrial pollution and the acidification of soils cannot be reversed.

These interventions are also likely to change weather patterns. Thus, high SO₂ emissions in Europe and North America during the 1960s and 70s produced regional cooling sufficient to change atmospheric circulation patterns. This is likely to have contributed to drought in the African Sahel during those decades with severe consequences for peasant agriculture.³³ With a little practice, those who 'manage' radiation will probably try to manage the climate in their own geo-political interests.

These are extravagant examples of treating the symptom but not the cause. Whereas CO₂ lasts in the atmosphere for millennia and methane lasts for a decade, SO₂ lasts only for a week or two and artificial clouds last a few days. So to sustain the cooling effect, sulphur aerosols must be constantly pumped into the atmosphere. Should this be interrupted for whatever reason, the temperature will rise very rapidly to where it would have been without the additional SO₂ aerosols. The pace of warming is already too fast for many species to adapt and, without a rapid reduction in CO₂ emissions, will prove too fast for societies to adapt. Accelerated warming following the removal of a heat shield would be devastating.

Geo-engineering is advocated either from despair or from hubris. From despair: many scientists who put their faith in the international negotiations have now concluded that the negotiators will not agree to reduce CO₂ emissions. They are also agonisingly aware that time is running out. So they argue

33 Ulrike Lohmann in Will Steffen et al, 2004. Global Change and the Earth System: A planet under pressure. The IGBP Series, Springer Press. p.169.



that global cooling technologies would give the world leaders the time to get serious about carbon emission reductions. The problem is that geo-engineering is more likely to substitute for cutting emissions.

From hubris: Dr Strangelove is the mad and fascist scientist in the 1964 film of that name. This figure was inspired by Edward Teller who presided over US weapons research at the underground Lawrence Livermore National Laboratory. He was the ‘father’ of the hydrogen bomb and a charismatic figure on the US right. Clive Hamilton observes that he and his protégés believed that humanity has “a duty to exert supremacy over nature”.³⁴ That fits well with the US imperial ideology of ‘manifest destiny’ and with corporate America’s authoritarian instincts. Little surprise then that Teller was an influential proponent of geo-engineering. It is perhaps the ultimate fantasy of this world view. And it would prove most profitable to the corporations of the military industrial complex.

Comment on this section

34 Clive Hamilton, *The frightening politics of geo-engineering*, posted at OurWorld 2.0 on September 13, 2010: <http://ourworld.unu.edu/en>



5. Responsibility – allocating the budget

All governments are complicit in climate inaction because they are protecting their interests in global capital, but countries are not all equally responsible for carbon emissions. So it's one thing to get a global carbon budget and another to allocate it between countries. This section looks at who emits what and at different takes on responsibility. We start by reading Table 5.1 column by column. Note that this table does not include emissions from land use change.

Absolute emissions

Table 5.1 shows the top 15 CO₂ emitters and five African countries from the lower end of emissions ranking. Column 3 shows total emissions for each country.

Column 4 shows substantial emissions reductions in the year 2008-2009 in several countries. This was the result of recession, not of policy. The reduction from about mid-2007 to 2010 would be much larger so most rich countries will inadvertently meet their Kyoto commitments. They are, of course, doing everything they can to 'restore' growth. They won't succeed but would miss their targets if they did. Meeting their commitments does not displace them from the top rankings because Kyoto is based on 'grandfathering'. The targets are for a reduction from what each country emitted in 1990, so countries with the biggest emissions in that year would be entitled to emit most in the



Table 5.1: CO₂ emissions from fossil fuel combustion and cement making.

1	2	3	4	5	6	7	8
	Country	2009 emissions Gt CO ₂	2008-2009 % change	2008 GDP US\$/ CO ₂ t	2009 CO ₂ t / per person	2009 Consumption emissions Gt CO ₂	2004 net import / exports Gt CO ₂
	World	30.389	-0.3				
1	China	7.711	+13.3	435	5.7	5.187	-1.147
2	USA	5.425	-7.0	2,291	17.2	5.699	+0.699
	EU	4.310		3,712	8.1	4.822	
3	India	1.602	+8.7	579	1.6	1.563	-0.100
4	Russia	1.572	-7.4	632	11.0	1.240	-0.286
5	Japan	1.098	-9.7	3,374	8.7	1.291	+0.284
6	Germany	0.766	-7.0	3,621	8.9	1.008	+0.233
7	Canada	0.541	-9.6	2,348	15.2	0.559	
8	S. Korea	0.528	+1.2	2,003	10.6	0.517	
9	Iran	0.527	+3.2	476	8.2		
10	UK	0.520	-7.8	4,284	7.7	0.672	+0.253
11	Saudi Arabia	0.470	+3.2	935	16.1		
12	South Africa	0.450	-6.7	622	10.0		-0.140
13	Mexico	0.444	-1.9	2,184	3.9		
14	Brazil	0.420	-0.3	3,090	1.9	0.376	
15	Australia	0.418	-1.8	2,030	18.2	0.453	
114	Tanzania	0.0067	+7.1	2,671	0.16		
131	Namibia	0.0041	+3.7	2,819	1.6		
148	Mozambique	0.0023	+4.6	3,538	0.11		
165	Malawi	0.0013	+4.6	2,998	0.07		
177	Mali	0.0007	+6.4	10,789	0.04		

Note 1: Gt is Giga tonnes which is billion metric tons.

Note 2: Sources for this table: Columns 1-4 – Guardian CO₂ atlas; Column 5 – Wikipedia; Column 6 – UN Statistics; Column 7 – Boitier 2012, Column 8 – Davis & Caldeira 2009. Blanks in Columns 7 & 8 are because there is no data.



future. Grandfathering therefore favours the rich countries with the highest historical emissions.

Up to 2007, the UK was the only rich country on track to meet its target. This was not because of climate policy but because it replaced old coal power plants with cheaper gas plants in the 1990s. Canada will not meet its target despite recession because of the growth in tar sands production and its Prime Minister tore up its supposedly binding Kyoto commitment in a show of macho bravado. There is no penalty for that. China's massive counter-recessionary spending off-set both the recession and the cut in carbon emissions so that the global reduction from 2007 to 2010 was only 1.4%. Emissions bounced back in 2010 to post a record annual increase of 5.9%.

Columns 5 and 6 show the emissions 'intensity' of economic production and per person emissions in each country. These are the conventional measures used to show how well or badly countries are doing and to compare their performance. Rich countries (particularly the US) tend to favour emissions intensity as a measure. Economic intensity is calculated by dividing gross domestic product (GDP) by total emissions. This shows the dollar value of all goods and services produced for each tonne of CO₂ emitted, so the more dollars to the tonne, the lower the intensity. The US is bottom of the range for a developed country. The South African, Indian and Chinese economies are all very carbon intensive.

Globally, energy and carbon intensity declined over the 20th Century as technologies got more efficient but, in the 2000s, this long term trend was reversed. The reasons include that production was relocated to countries where it was cheapest



but not necessarily energy efficient; goods are produced from components made in many countries so transport emissions have grown rapidly; it takes more energy to extract energy because the easy-to-reach gas, oil and coal has been taken.

Emissions per person – total emissions divided by population – is obviously a more egalitarian measure than economic intensity but is misleading in two respects: First, national figures conceal inequality within each country. South Africa's middle classes, for example, would compare with the US or Australia while its poor would compare with Mozambique or Malawi. Second, South Africa's emissions are less about what people do than the extraordinary intensity of industrial energy use. In effect, when South Africa exports minerals it exports the energy and carbon used to mine and smelt them and does so to the benefit of corporate capital but at the cost of the majority of people.

This brings us to the last two columns in the table. Column 7 shows the carbon embedded in the goods and services consumed in each country in 2009. In contrast to the 7.711 Gt CO₂ that China produces, it consumes 5.187 Gt and the remaining 2.524 Gt is exported. The US takes top spot for consumption emissions at 5.699 Gt of which 0.274 Gt were imported. 2009 was the big recession year and US imports in the boom years were much higher. The last column shows the balance of imports minus exports in 2004 when the US imported 0.699 Gt.

This is not just about who is top of the carbon dog house. Since 1990 – the Kyoto base year – the rich countries have outsourced production and the associated emissions to developing countries. The UK is on track to meet its Kyoto target only because the target is defined by emissions produced within the



country. Taking account of carbon embedded in imports (minus exports), the UK's emission cuts are illusory. Measured by what it consumes – or by its carbon 'footprint' – its emissions have increased since 1990. The same applies to other rich countries that claim reductions.

This reflects the global restructuring of production that has been under way since the late 1970s and is associated with growing inequality globally and in all countries. Under the 'Washington consensus', Northern transnational corporations relocated production to low-cost Southern countries which competed for this foreign direct investment by lowering labour and environmental standards in a 'race for the bottom'. This has given rise to a triangular ordering of the global economy and flow of resources. Raw materials from Africa and Latin America are taken to the Asian factory to produce goods consumed in the North. This flow of resources is largely managed by Northern transnational corporations which also take most of the profits.

Thus, the carbon intensity per unit of production in South Africa indicates its structural location at the dirty end of the global economic order. This is where it always was except that it now exports more to the East and less directly to the North. Up the production chain, China's cheap and dirty production is on the back of the dispossession of the peasantry and pitifully low wages. On the other side of the world, cheap goods are essential to the low inflation rates that were supposedly achieved through the wisdom of Northern central bankers. The 'Walmart economy' was sold on cheap goods and cheap credit even as Northern workers' wages declined in real terms. In almost all countries,



North and South, labour's share of national product was cut to the benefit of capital.

Economic growth was thus accompanied by:

- growing inequality of incomes globally and in most countries, North and South;
- intensified pollution and carbon emissions; and
- large scale dispossession of those who stood in the way of 'development'.

In this context, Northern demands for reduced emissions from production in the South, and Southern demands for reduced emissions from consumption in the North, look like a shadow play. The elite interest, North and South, is for a dysfunctional climate regime.

Carbon budgets and historical emissions

China may be the top emitter now but the US has emitted four times more over the last century. Carbon dioxide lasts a long time in the atmosphere. It therefore accumulates year after year and emissions from a century ago still contribute to present concentrations in the atmosphere. It is the total emissions that count and recognition of this has given rise to the notion of a global carbon budget: if we want a good chance of limiting the rise in temperature to $x^{\circ}\text{C}$, then only y tonnes of CO_2 can be emitted over a period of z decades. If more is emitted now, then less can be emitted later. These budgets generally account for warming from CO_2 or CO_2e and do not take account of natural feed-backs described [above](#).



Having calculated the global budget, the next issue is how it is to be distributed. The two budgets below (in Tables 5.2 and 5.3) allocate a budget to each country based on every person having an equal entitlement. So the total carbon budget is divided by the number of people in the world and then allocated to each country according to its share of the population. This makes a big difference from the Kyoto Protocol's allocation based on 'grandfathering' – what a country emitted in 1990 is irrelevant to its budget.

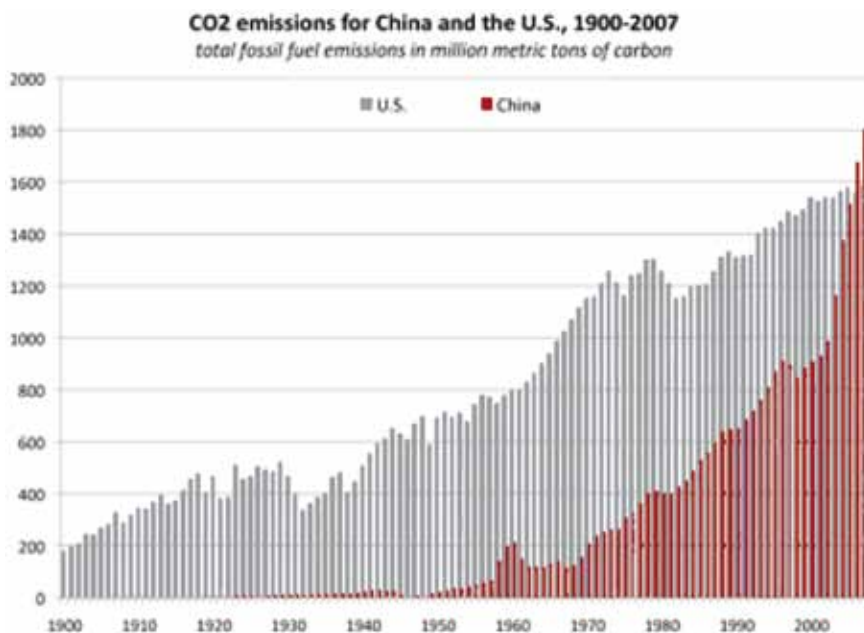


Figure 5.1: Source: Mongabay.com based on CDIAC data.



Table 5.2: Carbon budgets 1990-2050 with 75% chance of avoiding 2°C or more.

Country	Population: % of world	1990- 2009 emissions Gt CO ₂	1990- 2050 budget Gt CO ₂	2008 emissions Gt CO ₂	2010- 2050 What's left Gt CO ₂
USA	4.7	108	52	6.1	-56
EU	8.9	81	98	4.5	18
Germany	1.5	17	17	0.91	0
China	22.0	75	239	6.2	164
Russia	2.8	31	31	1.6	0
India	16	19	175	1.5	156
Burkina Faso	0.16	0.009	1.7	0.00062	1.7
World	100	500	1,100	30	600

Source: WBGU (German Advisory Council) 2009.

The time period chosen also makes a large difference. Table 5.2 is taken from a paper by the German Advisory Council on Global Change.³⁵ It argues that the evidence for climate change was not widely recognised before 1990 so no-one could be held responsible for emissions before then. It therefore gives this as the starting date for a calculation based on ‘historical emissions’. For a 75% chance of avoiding 2°C, it calculates the budget from 1990 to 2050 as 1,100 Gt CO₂. Since 500 Gt were emitted in the first 20 years, that left just 600 Gt for 2010 to 2050. By the end of 2012, there will be just 500 Gt left and 15 years before we bust the budget. [See ‘Climate inaction now’]

35 German Advisory Council on Global Change (WBGU). 2009. *Solving the Climate Dilemma: The Carbon Budget Approach*. Berlin: WBGU.



Each country's share of the 1,100 Gt CO₂ global budget is then calculated based on population. The results show that the US has already bust its budget, Germany has nothing left (in 2010) and the EU will break its budget around 2014. China looks comfortable but in fact only has 26 years to go if its emissions level off at 6.2 Gt per year – the 2008 rate. In fact, of course, its emissions are still rising fast and China will break its budget well before then. India has 100 years at 2008 emission rates.

If the chances of avoiding 2°C are reduced to 67%, then the 1990-2050 budget increases to 1,250 Gt and what was left for 2010-2050 is 750 Gt. The figure below is based on this: the total area below each line adds up to 750 Gt CO₂. It shows that peaking later means sharper cuts in the following years and the budget is down to zero before 2050.

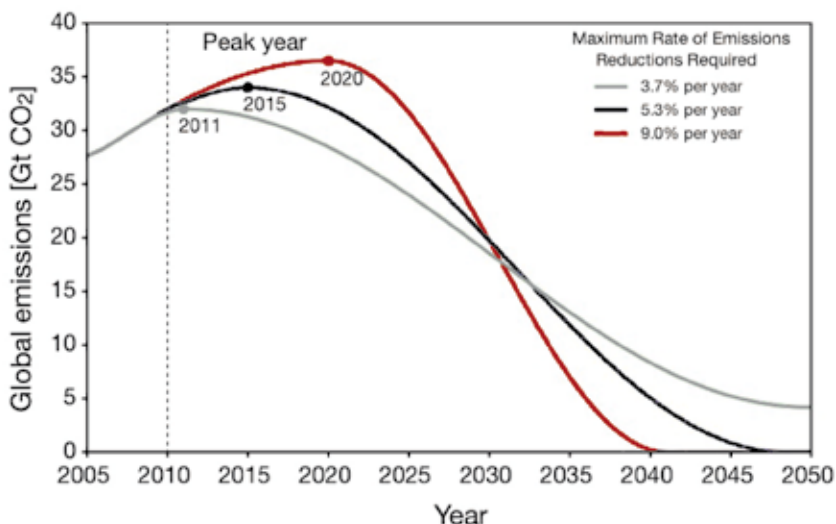


Figure 5.2: Reduction pathways for a 750 Gt CO₂ budget from 2010 to 2050 (repeats Fig 3.1): Source: WBGU.



The second budget shown in Table 5.3 is from a group of experts from the BASIC countries – Brazil, South Africa, India and China – who take a longer view of history.³⁶ From the start of the UNFCCC process, Southern countries said that Northern commitments must reflect their responsibility for causing climate change. Historic emissions must therefore be central to the carbon calculation and the BASIC experts make their budget for 1850 to 2050. (They make an alternative budget starting from 1970 – about the time when the issue of global warming was raised.)

This budget is based on only a 50% chance of avoiding 2°C so it allows a generous 2,413 Gt CO₂ for the full period. That leaves 1,438 Gt for 2000 to 2050 – considerably more than the German group’s 1990 to 2050 budget with a 75% chance. This budget for the next 50 years is also nearly one and half times what was actually emitted in the previous 150 years. And since it does not include feed-backs, the chances are probably a lot less than 50%. This is therefore the largest possible budget with some shred of intellectual credibility and choosing it no doubt reflects the reluctance of the BASIC countries to face up to what they really need to do. It is worth noting that the budget for the whole of the 21st Century with a 50% chance of avoiding 2°C is 1,578 Gt CO₂³⁷ so the BASIC experts are leaving just 140 Gt for the second half of the century.

The table shows the US and Europe deep in carbon debt while the big Southern countries have ample entitlements. South

36 BASIC experts, 2011. *Equitable access to sustainable development*, BASIC expert group, Beijing, Brasilia, Cape Town and Mumbai.

37 Kevin Anderson and Alice Bows, 2011. *Beyond dangerous climate change: Emission scenarios for a new world*, Philosophical Transactions of the Royal Society, doi: 10.1098/rsta.2010.0290.



Africa, however, will break its 7 Gt budget in the next few years.³⁸ Since it is physically impossible for Northern countries to repay their debt in carbon (i.e. to absorb rather than emit billions of tonnes of CO₂), the Southern countries cannot use their full entitlement without breaking the global budget. They argue that the difference must be made up in funding and technology support.

Table 5.3: Carbon budgets 1850-2050 with a 50% chance of avoiding 2°C or more.

Country	Population in 2000: millions	1850-2000 emissions Gt CO ₂	1850-2050 budget Gt CO ₂	2000-2050 Remainder
USA	288	300	114	-186
EU	481	281	190	-92
China	1,267	71	500	429
Russia	147	84	58	-26
India	1,043	20	411	391
Brazil	174	7	69	61
South Africa	45	11	18	7
Annex 1		756	491	-269
Non-Annex 1		204	1,910	1,706
World	6,116	973	2,415	1,438

³⁸ The South African approach takes account of a country's 'capability' and need for 'sustainable development' as well as its 'responsibility'. This makes the maths a lot more complex and rather less convincing. At the end of it, South Africa gets 29 Gt CO₂ for 2000 to 2050 in contrast to the 7 Gt it gets in the Indian version.



Adapted from BASIC experts: Indian approach [65]; A1 & NA1 from Chinese approach [43].

The over-use of the carbon budget is one aspect of the climate debt owed by the North to the South. Arguably, the BASIC countries themselves owe a debt to the countries at the bottom of Table 5.1. Poor countries and poor people have least responsibility for causing climate change but are most vulnerable to its impacts. A second aspect of climate debt therefore relates to adaptation – the costs of avoiding harm as well as the costs of actual harm. Since this debt is not acknowledged, and since funding the poor will not return a profit, funding for adaptation will not go where it is needed unless power relations shift to enable poor people to claim their right.

If global temperatures rise by 4-6°C in the second half of this century, then temperatures in most of Africa, including the inland areas of South Africa, will rise by an average of 6-10°C. This would be accompanied by terrible droughts, floods and epidemics of diseases such as malaria and will overwhelm all attempts at adaptation. That said, the division of the climate response into mitigation and adaptation is artificial. Restoring the resilience of ecosystems, and of agriculture within ecosystems, is an adaptation measure which would simultaneously restore the capacity to absorb carbon – an essential mitigation measure.

[Comment on this section](#)



6. Restoring earth

Considering that carbon dioxide emissions must be cut by 6 to 9% per year, climate scientists Kevin Anderson and Alice Bows conclude that “it is difficult to envisage anything other than a planned economic recession being compatible with stabilisation at below 650 parts per million (ppm) CO₂e”. (Note that 650 ppm implies temperature rise on the way to 4°C). This implies “an unprecedented step change in the global economic model”.³⁹ They were writing just ahead of the 2008 crash which did indeed result in dramatic reductions in CO₂ emissions in most rich countries and some not-so-rich countries like South Africa.

Recession is a tough call, particularly since the actual recession is being managed in the interests of the elites: Northern governments bailed out those responsible for the crash and imposed the costs on the rest of the people through austerity measures and swelling national debt to be paid for in taxes for generations to come. The costs were also transmitted to the rest of the world through currency manipulations. The pattern is strikingly similar to the way in which the rich avoid taking responsibility for climate change while the poor are most vulnerable to it. We will come back to the economy but first let’s look at some material benefits of a radical reduction in CO₂ emissions.

39 Anderson, K. and A. Bows, 2008. Reframing the climate change challenge in light of post-2000 emission trends, *Philosophical Transactions of the Royal Society*. doi:10.1098/rsta.2008.0138, p. 18 & 15.



Toxic world

The world fired by fossil fuels is made ever more toxic. First, most industrial production is polluting and the production of fossil fuels themselves is particularly toxic. Second, there are already some 144,000 chemicals in commercial use globally and the United Nations Environment Programme observes a process of ‘chemical intensification’. Very few of these chemicals have been tested for their impact on people or the environment.⁴⁰

In consequence, people live with an ever higher toxic ‘body burden’. In 2003, a pioneering study in the US “found an average of 91 industrial compounds, pollutants, and other chemicals in the blood and urine of nine volunteers”. It found a total of 167 chemicals in the group, of which “76 cause cancer in humans or animals, 94 are toxic to the brain and nervous system, and 79 cause birth defects or abnormal development. The danger of exposure to these chemicals in combination has never been studied”.⁴¹ The people tested did not work with chemicals or live near industrial plants.

In the US and in South Africa, polluting factories and toxic waste sites are most often located in poor neighbourhoods and the body burden of people living on the fenceline will be heavy. After long years of campaigning, the people of south Durban in South Africa forced official recognition of the health impacts of living in the neighbourhood of Sapref and Engen – two of South Africa’s largest oil refineries – and of several hundred smaller

40 United Nations Environment Programme, 2012. *Global Chemicals Outlook*. Synthesis Report for Decision Makers.

41 Environmental Working Group (EWG), 2003. *BodyBurden, the pollution in people*, report by Environmental Working Group, Mount Sinai School of Medicine and Commonweal, released January 2003 at: www.ewg.org



smoke stack industries. A major health study found high levels of respiratory ailments in south Durban compared with other sites and it conservatively estimated the risk of cancer at 250 times the accepted norm.⁴² It confirmed that the transgression of people's Constitutional right "to an environment that is not harmful to their health or well-being" is systemic: it is built into the economic fabric.

Sasol's coal-to-liquids process is even more polluting. Sasolburg's Zamdela township is located immediately downwind of the plant. People say that those born in the area are less likely to get work at the plant than newcomers because, having grown up in the bad air of the Vaal Triangle, locals tend to fail the medical test. So it seems that Sasol and its big corporate neighbours rely on the fresh blood of people they have not yet contaminated.

The Mpumalanga Highveld is another sacrifice zone with Sasol's second and third plants at Secunda and most of Eskom's power stations. For most of its history, Eskom did no more than build high stacks to disperse its pollution over a wider area. It has subsequently installed filter bags for particulates on some plants. It has not installed sulphur scrubbers on any. Together, these two corporations push out about two million tonnes of sulphur dioxide and one million tonnes of nitrogen oxides as well as a cocktail of volatile organic compounds.

Oil and coal also contain traces of various metals. Coal burning is the largest source of mercury pollution. Mercury is very persistent in the environment so two centuries of coal burning

42 Naidoo, R., N. Gqaleni, S. Batterman and T. Robins, 2006. South Durban Health Study, Centre for Occupational Health, University of KwaZulu Natal; Department of Environmental Health Sciences, University of Michigan; Department of Environmental Health Sciences, Durban Institute of Technology.



have raised levels of mercury in the atmosphere and in living organisms. Minute particulates (or aerosols) are very toxic when breathed in. It is also found in fish in places that are remote from any source of pollution which shows it can be carried great distances before it comes back to earth. Because it 'bio-accumulates' up the food chain, those who regularly eat the fish are more contaminated than the fish.

Upstream from the refineries and power plants, are the oil wells and coal mines. In the Niger Delta, a most marvellously fertile ecosystem has been trashed. The water, the fish, the fields and the air are poisoned and the people are impoverished. Ken Saro Wiwa called it ecocide and Shell collaborated with the Nigerian regime to have him eliminated for organising against it. Oil extraction has been filthy and bloody across the world but it gets ever dirtier as the easy-to-reach oil has been taken. The massive blow out of BP's Deepwater Horizon in the Gulf of Mexico is symptomatic of an industry that is going to ever greater extremes to find oil. That big oil sees the summer melting of Arctic ice as opening up a new oil region is nothing short of lunacy – and this lunacy is supported by the Arctic governments.

On the coal mines of South Africa, fires started by 'spontaneous combustion' are thought to burn as much coal as Eskom does. Underground fires at what are called 'ownerless and abandoned' mines have burnt for 50 years or more. These emissions are not mitigated in any way and nor are they counted. On the ground, South Africa's mining and industrial corporations produce mountains of solid waste and rivers of liquid waste, much of it



toxic. In addition to the pollution of water used in production, mining turns groundwater into toxic 'acid mine drainage' (AMD). This is so whether it is coal, gold, platinum or anything else being mined.

Acid mine drainage results when sulphates in rock are exposed to oxygen, on mine dumps or underground, to produce sulphuric acid. The acid then dissolves and mobilises heavy metal toxins. Millions of litres are pumped from South Africa's mines daily and 'partially treated' with chemicals to neutralise the acid, but not the metal toxins, before being released into the surface water. If it is not pumped, the poisoned water fills to the surface and decants untreated into streams and rivers. The Olifants River and its catchment in the Mpumalanga coal fields is dying. Researchers from the University of the Witwatersrand warn that 'the region could become a total wasteland'. There is no plan to prevent it.⁴³

The coalfields of the Highveld are now being depleted and the Waterberg, said to hold 50% of South Africa's remaining reserves, is the next sacrifice zone. Eskom's massive new Medupi power plant is being built here, next door to its existing Matimba plant. The big coal corporations want to open new mines both for power production and for export and Sasol is contemplating building a fourth coal-to-liquids plant in the area.

To be 'developed', this arid region near the border with Botswana will need a massive transfer of water from elsewhere. Phase 2 of the Lesotho Highlands Water scheme is therefore being developed to feed water across two catchments, leaving

43 T. McCarthy and K. Pretorius. undated. *'Coal mining on the Highveld and its implications for future water quality in the Vaal River system'*. Paper for South African Environmental Observation Network (SAEON).



Lesotho's rivers as little more than drains while the Limpopo River in the north is connected through the Vaal River into a national plumbing system that stretches across South Africa. These water transfers are as much to dilute polluted water with clean water as to provide extra water in dry areas.

South Africa is an arid country so the abuse of water is particularly stupid. Taking account of the combined impacts of climate change and water pollution, a report for the Africa Earth Observatory Network concludes that "continued investment in coal-based energy supplies will bankrupt the country".⁴⁴

Toxic matter in food and consumer products is a major source of the chemicals that make up most people's body burden. Thousands of chemicals and plastic products are brought to market every year and few are tested for their potential to pollute people or the environment. Most are derived from oil and coal or can be produced only with a large input of energy from fossil fuels. Food is contaminated both by plastic packaging and by the chemicals used in production. Consumer goods, including plastic toys and electronic goods such as cell phones, carry toxins across the world, into people's homes and then onto the waste dumps of the world.

Industrial agriculture and plantation forestry are also pushing up against global ecological limits. Land change has a long history throughout the world. By the sixteenth century, Europe was largely deforested for naval timber as well as clearance for cultivation. Imperial expansion drove deforestation throughout the colonies. It also replaced indigenous environmental

44 Stephanie de Villiers and Maarten de Wit, 2010, *H₂O-CO₂ – Energy equations for South Africa*, AEON Report Series No.2. Africa Earth Observatory Network, University of Cape Town.



management and production systems that relied on a diversity of biological resources with capitalist production regimes and food crops favoured in European markets.

The scale of change increased dramatically in the twentieth century: 'in little more than a century the amount of forest that fell was equivalent to the entire previous historical conversion of forests over thousands of years'⁴⁵. Grasslands were ploughed up even faster, soils were de-structured through mechanisation and massive chemical inputs, and water resources were sucked out for irrigation while being polluted by chemical run-off. Nitrogen and phosphates are now carried down rivers on such a scale that large areas of the sea are turned into 'dead zones' because over-fertilisation results in oxygen depletion. At the same time, trillions of tonnes of CO₂ have been lost to the atmosphere from soils and forests.

During the twentieth century cities began to sprawl across ever more land, particularly in coastal areas, and the process is now accelerating with the development of mega-cities. The scale of land disturbance by the extractive industries – mining and oil – is locally devastating and increasingly significant globally.

The fresh water cycle has been modified on an equal scale. Land conversion affects the rate of evaporation sufficiently to affect local climates and rainfall. Groundwater aquifers have been depleted and wetlands, together with the 'eco-service' they provide in filtering and cleaning water, are everywhere threatened. Up to 45,000 large dams interrupt the flow of rivers

45 Will Steffen et al, 2004. Global Change and the Earth System: A planet under pressure. The IGBP Series, Springer Press. p. 96.



and of sediments and nutrients formerly deposited in estuaries, deltas and coasts.

Species extinction has accelerated rapidly during the industrial period, to the point that 'the earth is now in the middle of the sixth major extinction event in its history'⁴⁶. The previous five extinctions were caused by natural events such as major volcanic eruptions and ice ages. This is the first to be caused by the actions of a living species. Historically, the main cause was loss of habitat as people turned more land over to cultivation. More recently, industrial fishing has driven a number of marine species to the edge of extinction.

Climate change is now the most serious threat to species. On land, species are migrating towards the poles to keep ahead of rising temperatures, but the pace of change is so rapid that plants in particular cannot keep up. Others are running out of space. The Western Cape fynbos, an entire floral kingdom, has nowhere to go. At sea, the warming of the oceans is compounded by the fact that the oceans have absorbed a large proportion of CO₂ emissions, making them more acid. Corals which act as marine nurseries are gravely threatened and some populations of plankton species at the bottom of the food chain are in sharp decline. Consequently, whole ocean food chains may collapse, thus wiping out fisheries.

Detoxing

Taking the economic foot off the fossil fuel pedal would start a process of detoxing the world. In the first place, it would stop

46 Steffen et al, p. 118.



things getting worse. The acidity of soils and oceans cannot be reversed except over thousands of years. Mercury and the whole range of persistent organic pollutants (POPs) will remain in the environment. Accumulated plastic waste in the oceans cannot be swept up. The best result here is only that these problems are not intensified.

On land, there would be a lot of cleaning up to do. Toxic spots are splattered across the industrial landscape and will not disappear with the industry that made them. In the 1980s, Thor Chemicals traded in mercury waste from Northern countries for reprocessing at its plant at Cato Ridge outside Durban. Four workers are known to have died from mercury poisoning, many more suffered chronic poisoning, the site itself was saturated with mercury, a stream used by local people was heavily contaminated, and mercury emissions to air are unknown because not measured. The mercury process was finally closed in the mid-1990s but a plan to clean the site was finalised only in 2009. The most toxic waste will be sent to Switzerland for treatment and disposal there. Contaminated soil has been put into drums for disposal at the Holfontein high hazard waste site in Gauteng. Thus, most of the poison is confined but not eliminated. Holfontein will remain forever toxic. A ribbon of contamination leads downstream from Thor to the Mgeni River. Mercury is found in fish caught in the Inanda Dam but it is not certain if it was washed down from Thor or is carried on the air from the Highveld power stations – or both.

A host of other problems evaporate when fossil carbon is not burnt. The big ticket air pollutants – sulphur dioxide, nitrogen oxides, volatile organic compounds (including methane) – are



all emitted along with CO₂. Because they are short-lived in the atmosphere, the air would clean up pretty quickly and allow people and other species to breath freely again. Rivers polluted with industrial effluent would clean up more slowly and special measures would have to be taken to deal with acid mine drainage and with land saturated with toxic substances.

Contamination from badly managed sewage plants would remain a problem. However, a high premium would be placed on the energy content in sewage and other organic wastes and it may be hoped that this would impel better management. Clean air and clean water would enhance eco-system resilience which is central to climate change adaptation.

High input industrial agriculture would no longer be possible in a world where CO₂ emissions are in steep decline. Organic agriculture is all about returning carbon to the soil in compost and dung. This is critical to creating ecological resilience for adaptation but is also essential for mitigation because it will not be possible to reduce the concentration of CO₂ in the atmosphere without restoring the capacity of soils to absorb carbon.

The global elite has long claimed that industrial farming is necessary to feed the growing population of the world. University of Michigan researchers Ivette Perfecto and Catherine Badgley have refuted the elite claim. They calculate that organic farming in developed countries would produce 92% of what industrial farming produces but, in developing countries, it would produce 80% more than industrial farming.⁴⁷ A 2007 report from the UN Food and Agricultural Organisation (FAO) found organic

47 Catherine Brahic, 'Organic Farming Could Feed the World', *New Scientist*, 12 July 2007.



farming superior in terms of food security, productivity and local economic returns while it reverses the ill effects on the health of workers and consumers and on the environment.⁴⁸

Industrial agriculture is associated with the concentration of land into larger and larger estates. Ecological agriculture in contrast requires an intense relationship of people with the land they work. This creates a bias to small scale peasant production which is generally more efficient than industrial agriculture in terms of production per hectare. It is less efficient only in terms of delivery to market but that is a reflection of market power rather than of productivity.

Living well

A great price is paid for economic growth. Over the last three decades, economic growth has been associated with growing inequality in all countries. In the 1990s, it took US\$ 166 worth of growth per person to produce \$1 going to poverty alleviation and things have got worse since. The implication is “that ever smaller amounts of poverty reduction amongst the poorest people of the world required ever larger amounts of conspicuous consumption by the rich”.⁴⁹

In fact, it is doubtful that poverty has been reduced at all. Even where people’s money income improves – rising above the World Bank’s benchmark of \$2 a day – the gains are lost to health costs imposed by pollution and appalling working conditions,

48 Institute of Science in Society (ISIS) press release, 10 September 2007. The report is titled ‘Organic Agriculture and Food Security’. It does not represent the dominant view within FAO but rather a challenge to that view.

49 Andrew Simms, Victoria Johnson and Peter Chowla, 2010. *Growth isn’t possible*, New Economics Foundation.



to the loss of resources starting with land and water, and to the increased cost of access to services and amenities previously provided as public goods. And increasing numbers of poor people are already feeling the harsh impacts of climate change.

We are told that fast economic growth in China has drawn hundreds of millions of people out of poverty. Yet the rural migrants who stream into China's coastal cities looking for work at miserly wages are driven to it because local elites have grabbed their land and extracted multiple rents, fines and taxes,⁵⁰ while the national elite enacts policies that have the effect of transferring wealth from country to city.⁵¹ The poor journey in desperation, not in hope, and most are left worse off. Elsewhere in the world, millions of people are thrown out of work as local industries crumple under the pressure of cheap Chinese imports. Around the world, profit and growth are increasingly dependent on dispossession.

Growing inequality is accompanied by growing concentration of ownership and control. Much of what is made in China is made under supervision by northern transnational corporations who own the brand and associated intellectual property rights. But power is not only about direct control of production. 'The market' – meaning global capital – works through network power and is effectively shaped by just 147 corporations, most of them in the financial sector.⁵²

50 Yang Lian, 2005. *Dark Side of the Chinese Moon*, New Left Review No.32, March/April 2005.

51 Hung Ho-fung, 2009, *America's Head Servant? The PRC's dilemma in the global crisis*, New Left Review No.60, November/December 2009.

52 S. Vitali, J.B. Glattfelder, and S. Battiston, *The network of global corporate control*, arXiv:1107.5728v2 [q-fin.GN] 19 Sep 2011



In the market system, economic growth constitutes the central organising principle of development. This is not because growth is needed to alleviate poverty but because it is needed to reproduce capital. To sustain economic growth through the 1990s and 2000s, 'the market' created the illusion of value in the incomprehensible array of derivatives that came to be known as 'toxic assets'.

These assets blew into the bubble which burst in 2008. In effect, the market made itself into a giant Ponzi (or pyramid) scheme. Unless they are writing the rules, people go to jail for that sort of thing. Instead, in an extraordinary display of market power, the toxic debt was passed to governments, and hence to people, even as the market blows more bubbles in an ever more desperate attempt to save the economy of growth. This cannot be sustained even on the most reductive economic terms.

In 2008, the world entered the opening phase of a major depression. In contrast to the recession of the 1980s, which was induced to restore the political power of the US, the managers of global capital have lost control. Investors run from pillar to post to find a safe place to put their money – now in US bonds, now in emerging markets, now in commodities. The result is increased economic volatility. Peak oil plays into the crisis. At the first sign of 'green shoots' of economic recovery, the oil price spikes as investors rush in, only to strangle the shoots.

There may be more booms and even bigger busts to come but the global political and economic order will not survive the next few decades. Sociologist Immanuel Wallerstein sees "a new order" emerging from the turbulence over the next 20 to 50 years.



This will not be a capitalist system but it may be far worse (even more polarizing and hierarchical) or much better (relatively democratic and relatively egalitarian) than such a system. The choice of a new system is the major worldwide political struggle of our times.⁵³

Capitalism in chaotic decline is unlikely to be less vicious than capitalism booming. Yet economic contraction will bring relief to millions of people who will not be dispossessed by the next expansion project. At the same time, it poses the threat of the large scale loss of jobs. It is in this context that workers' and social movements are challenged to join together to respond to the question of the future. If capital is terminated in the struggles that intensify over the next decades, what will be the base, to succeed the corporation, for organising production and doing so democratically and without laying waste to the planet?

How that question is answered will emerge from people's struggles and debates. Here we propose some starting points.

First, sustainable development founded on economic, social and environmental justice should replace growth as the central organising principle of economy. This means a commitment to growing human solidarity and equality as well as a relationship to the environment which enhances rather than degrades the functioning of ecosystems both for their intrinsic value and for the eco 'services' they provide. Put differently, it implies that people recognise themselves as a living part of earth's ecology. This does not imply that economy and production are

53 Immanuel Wallerstein, 2008. *The Depression: A Long-Term View*, Commentary No. 243, Oct. 15, 2008, Fernand Braudel Center, Binghamton University.



unimportant, but that the economy must serve people rather than people serving the economy.

Second, peak oil implies either a compelled shift to economic localisation or the exclusion of ever more people from the shrinking enclaves of elite development. The choice for localisation follows from the choice for justice and is essential to any serious programme to avoid catastrophic climate change. This implies that national resources should be focused on supporting people's capacities to direct local development.

Third, if we are to address climate change, the energy system must be transformed as a matter of urgency. In South Africa, the big mining and energy corporations have shaped development in their own interest and created the world's most unequal society. This 'minerals-energy complex' requires big fossil fuel power plants to supply big energy-intensive industries. That is why Eskom's 'new build' programme centres on building what will become the fourth and fifth biggest power plants in the world. Shell, Anglo American and others meanwhile anticipate opening a new energy frontier by forcing gas from shale rock through 'fracking'.

Resistance to this energy agenda is growing and creates the beginnings of a movement for transformation. Overall, energy systems including power generation should be localised and placed under people's common control. Maintaining a level of national and regional grid capacity will remain important and this capacity should be provided by renewables. An aggressive programme of renewable energy should therefore be prioritised. Supporting the capacity for local production of renewable energy



components should be made central to industrial development policy.

Fourth, the transition to a different energy and development order will require energy inputs from the declining fossil fuel system. If these investments go into the declining system, they will represent a permanent loss. Thus, Eskom's new coal fired plants are intended to last to 2070 or so but will likely be forced to close before then and be left as 'stranded assets'.

Fifth, food is the most basic form of energy for people and the food system must be thoroughly transformed to enable people to define and take control of production and consumption and hence of their own futures.

Cuba suffered a severe contraction of its energy system and its economy following the sudden collapse of the Soviet Union in 1991. Until then, it grew sugar to exchange for cheap Soviet oil. The deal subsidised the Cuban economy as a whole and allowed it to import most of its food. In the 'special period' that followed, the country could not afford to import food and the fertiliser factories closed for want of oil. Cuban people then took to growing their own food, first in urban areas and then in the country, using organic methods and the government was wise enough to support their initiative.

At the start of the crisis, the Cuban state imposed equal rations on everyone irrespective of status. People did go hungry but no-one starved and Cubans felt they were facing a common crisis together. And in just four years they transformed agricultural production and restored adequate levels of nutrition. The experience changed people's imagination of the world. It ended the regime of the 'passive consumer' for food and for energy and



created a new social identity in which people see themselves making their own future and remaking a sense of social solidarity. It also changed their diets from an emphasis on meat to an emphasis on a diversity of vegetables and fruit so people actually got healthier.

Reflecting on the experience, Cuban lawyer Rita Pereira commented that ‘we can be happy with less’. She saw the potential of a declining energy system ushering in ‘a time for sharing, for cooperation, for solidarity. Maybe we’ll have a better world.’⁵⁴ This emphasis on relationships was taken up at the 2010 People’s Conference on Climate Change in Cochabamba. Rather than ‘living better’ as consumers of more things got ‘at the cost of others and of nature’, the conference declaration holds that everyone should be able to ‘live well’ with each other and with the earth. It declares that “we are all part of Mother Earth, an indivisible, living community of interrelated and interdependent beings with a common destiny”.

Comment on this section

54 Faith Morgan, (director). 2006. *The Power of Community: How Cuba Survived Peak Oil*, Video: The Community Solution.



