Chapter 2 - Dreams and realities

> *"Upon the sightless couriers of the air,*
> *Shall blow the horrid deed in every eye,*
> *That tears shall drown the wind. I have no spur*
> *To prick the sides of my intent, but only*
> *Vaulting ambition, which o'erleaps itself*
> *And falls on the other."*

Over the years, much has been written on climate change and much of it ignored.

It is easy for many to still believe that this is a subject that has just come into the consciousness of the scientific community over the last ten years, that governments have taken action and solutions are either in hand and or that mankind's ingenuity will allow solutions to magically appear in the near future. After all, the extraordinary explosion of solar panels, renewables energy systems, economical cars and planes have done much to give the impression that action is taking place and there is no need to worry, or at least less need to worry. These developments are certainly having an effect. Carbon emissions in the US have reduced as renewable energy gains increasing traction in the economy and China's carbon intensity measured as the amount of CO2 per unit of economic activity is also falling.

However the facts brutally and clearly tell otherwise, irrespective of what scenario is chosen, because today despite these gains atmospheric CO2 continues to rise. But the significance of this is shrouded in deep mystery and obfuscation as the debate on climate change is smothered by plans to escape the imprisonment of recession and austerity that has trapped world's most powerful economies while vested interests seek to suppress discussion and maintain the status quo.

Today is not the first time that climate change has been relegated from the front pages, it is just another step in a consistent pattern of denial and avoidance. Initial warnings from the science community as far back as the 1950s and 60s about the potential danger of a rise in atmospheric CO2 were dismissed as either being an interesting experiment or a benign effect that could improve living conditions on the planet. This was superseded in the 1970s with confusion as to whether the planet was actually warming or cooling. We now know that the planet continued warming but atmospheric dust from coal burning and nuclear weapons tests caused sufficient cooling to mask it.

When the evidence of warming became incontrovertible new hypotheses were cast around; the warming was part of a natural cycle and we were innocent of the destruction being caused. This was despite the chance being minuscule that today's unprecedented global heating should be occurring in the tiny sliver of geological time we occupy by chance. It was however, also a particularly easy message to sell to a population whose energy intensive lifestyles are inextricably coupled with environmental destruction. Finally it has been replaced with ambivalence. The shrill scream of the world's top climate scientists and the increasing physical evidence on the ground is all but ignored by policy makers and populations desperate to survive in a world that is becoming increasingly hostile both economically and politically. Instead of cutting back on fossil fuel consumption, tax breaks and government subsidies are supporting unconventional energy sources such as shale gas and deep water offshore drilling allowing the well documented pattern of ignoring climate change to continue[1]. Even recent global warming disasters such as the flooding in the UK and has done little to dent to the race to exploit fossil fuel - within weeks of this David Cameron was offshore on an oil platform warning that Scottish independence would reduce investment and production from the North Sea.

The result - an inexorable increase in atmospheric CO2; today we are at 397 ppm and the rate of increase is increasing. What needs to be done now is to understand the folly of ignoring the warnings and establish the time-scales that will be forced upon us and to which we must work. Without these, rational debate is impossible.

We turn our attention first to the consequences of this folly.

The lexicon of tipping points has now become well established in discussions of climate change. These are the levels reached, usually determined in CO2 levels or temperature, when events subsequently create their own momentum and force a change from a stable equilibrium that supports life to a new equilibrium that may be so extreme as to prohibit life surviving on the planet.

One of the early attempts at demonstrating tipping points came from the work of James Loverlock with his simplified model of an ecosystem consisting of a planet orbiting a steadily warming sun and upon which grew only black and white daisies, called rather conveniently Daisy World. In this simple sense, it represents our earth which is an ecosystem orbiting a star which over billions of years has become steadily warmer as its nuclear furnace moves from burning hydrogen to helium. In the early days of Daisy World it was advantageous to be a black daisy as black absorbs the sun's weak rays. The result was the entire planet became black and warmed as a result. In the latter days, it was advantageous to be a white daisy to reflect the sun's burning rays. As a result the whole planet became white and kept cool despite the steadily increasing temperature of the sun. The balance between black and white daisies maintained the temperature of Daisy World in equilibrium and kept its environment viable for daisies, which were the only form of life on the planet. The problem comes when the sun's temperature becomes too hot even for white daises. At this point, as soon as one white daisy succumbs to the heat and dies it exposes the brown soil beneath it which warms up killing the adjoining daisies which are only just able to survive the increasingly intense rays. They too quickly succumb exposing more brown earth. The localised warming rapidly expands the hole instantly consuming all surviving white daises on the planet. With the disappearance of white daisies the planet's surface transforms from a reflective white to an absorbing brown

[1] See The Discovery of Global Warming by Spencer Weart,
http://www.aip.org/history/climate/summary.htm

forcing the planet's temperature to step change upwards to a level that is now prohibitive to any life.

It is a beautiful but brutal illustration of how life maintains a stable and habitable environment but how this can be easily thrown off balance resulting in non-linear changes to the temperature. On planet Earth, atmospheric CO2 does the job of the daisies by holding the environment in a state that is suitable for life. In the past if the temperature increased plant life would increase in response reducing the CO2 levels and the temperature would then fall back to normal. Likewise, if the temperature fell then plant life would die and CO2 levels would increase through the normal action of volcanic activity bringing the temperature back up to optimum levels again.

Simple though the daisy world model is, it captures the key dynamics of the much more complicated planet Earth in an intuitive way and can be calibrated to capture all the main thermodynamic constants governing our planet. It was further extended to look at the stability of ocean circulation and this is discussed in James Lovelock's book, The Revenge of Gaia. This concluded that when atmospheric CO2 reaches 450ppm the ocean surface warms sufficiently to lower its density preventing it sinking at the poles. The normal mechanism that drives this is surface evaporation as the Gulf Stream moves waters from the equatorial regions to the higher latitudes which increases the salinity and hence the density of water at the same time. The sinking water at the poles then works its way along the seabed to eventually rise up again at the equators carrying nutrients and maintaining the health of the ocean. Lowering the density of the surface water by global warming stops the ocean circulation as effectively as stiking a spike in the wheels of bike. The consequences are drastic. The ocean food chain collapses and the oceans become stagnant. The stagnant ocean becomes fit only for massive algae blooms. These will belch poisonous hydrogen sulphide gases into the atmosphere and turn the sky green. As this rises into the high atmosphere it will strip the protective ozone layer from the sky and what life has survived the searing temperatures will be scorched to death by ultra violet radiation or suffocated. Little life will survive and that which does will do so by good luck. In this doomsday environment our complex civilisation will stand little change and will be wiped off the planet along with most life forms. It was this mechanism that led to the mass extinction 250 million years ago when 95% of all life on the planet was wiped out following a major runaway global warming event. The build up of CO2 to trigger this happened over a 10,000 year time period from the Siberian Traps; today we are doing the same but on a time-scale measured in tens of years. The crisis that we are creating is orders of magnitude more serious than anything the planet has seen before.

If 450ppm is the upper tipping point of environmental Armageddon, then the lower tipping point is 350ppm based on the work of James Hanson[2]. His rational is that once emissions rise above this level for any length of time the accumulated warming of the planet allows the frozen methane hydrates in the

[2]Where should humanity aim? James Hansen et al 2008
http://pubs.giss.nasa.gov/abs/ha00410c.html

Arctic Ocean and permafrost to melt, a factor missing in the analysis of James Lovelock. These hydrates have built up over a fifty million year period of climatic stability and are a bullet in the breach. Ironically it was this stable climate that allowed homo sapiens to evolve, colonise the planet and develop an industrialised civilisation. Once a tipping point is reached which triggers the methane bullet, there is the potential that the release will be so rapid as to fill the atmosphere in the northern hemisphere with methane levels at a concentration high enough to cause continental sized fire-storms[3]. These will dwarf even the biggest nuclear explosions. If this sounds extreme, then it can be put in perspective by comparing the 350ppm target of James Hanson with past atmospheric records from ice cores. These show that at no time in the past one million years had atmospheric CO2 been above 300ppm and these ancient atmospheres were not polluted with other greenhouse gases such as fluoride gases which have greenhouse effects tens of thousands of times greater than CO2, thus what we are doing to the atmosphere is extreme.

It is only time that stands between the increase of CO2 that we have caused and runaway climate change. In 1979 the Woods Hole report[4] was written to be followed shortly after by the Jason report and these were finally made available to the public in 1982[5] Both were unequivocal in their prognosis for a 3 deg C global average temperature increase if atmospheric CO2 doubled. It predicted with remarkable accuracy a 40 year time frame for the collapse of the planet's ecosystem if the CO2 build up was not stopped. In common with all science on climate change its warning was ignored. Both reports also highlighted the time lag between increasing CO2 concentration and actual atmospheric warming due the thermal inertia of the oceans. They both unequivocally explained the time lag meant responses to tackle climate change taken on the basis of the actual atmospheric warming observed would be futile as by that time too much warming momentum would have built up to allow effective action to be taken. They warned that that once the the earth warms 2 deg C it will be too late to do anything to stop the situation running out of control.

Yet global policy is to do exactly what they warned against by working to a target of 2 deg C for global warming. It is akin to monitoring a boiling kettle by measuring the temperature of the heating element rather than the water level. Common sense alone is enough to tell that if the temperature of the elements starts increasing it is too late as the water will have boiled dry. The slightest delay to switching off the power will burn out the elements and destroy the kettle. A far more sensible thing to do is to measure the water level and switch the power off before the heating elements are exposed. This is what rational people do. What is true for a kettle is also true for our planet,

[3]Global Extinction within one Human Lifetime as a Result of a Spreading Atmospheric Arctic Methane Heat wave and Surface Firestorm
http://arctic-news.blogspot.co.uk/p/global-extinction-within-one-human.html

[4]Carbon Dioxide and Climate: A Scientific Assessment
http://www.nap.edu/catalog.php?record_id=12181

[5]The Long Term impact of Carbon Dioxide on Climate
https://play.google.com/store/books/details?id=oYgJAQAAIAAJ&rdid=book-oYgJAQAAIAAJ&rdot=1

once the global temperatures has increased by 2 deg then the ecosystem that maintains our environment will be burning out. Rather than deciding our course of action on temperature, we should choose predictive measurements such as sea ice thickness which will change long before the global temperature changes in response to their loss. This would have seen us closing down our industrial bases in the mid 80s with enormous economic consequences, but at least the planet would have had a chance of surviving.

Since the Woods Hole report, we have learnt that the risks are far greater. Many new positive feedback mechanisms have been discovered such as a warmer atmosphere holds more water vapour which acts as a greenhouse gas or the action of biological agents in the arctic tundra release additional CO2 once warmed. As our understanding of the dynamics improves, we continue to find more; by contrast we find hardly any significant negative feedback mechanisms that act to minimise or reverse warming. At best those that we do find merely delay the inevitable by a couple of years and their mitigating effects are dwarfed by the increasing CO2 levels.

The risk levels our planet faces today are greatly amplified by the industrial complexes to levels far above those during the last great extinction of 250 million years ago. Even a partial methane fire-storm could be rapidly magnified into a far worse disaster than just the fire-storm itself. Our highly interconnected economy requires continuous inputs of energy and mineral resources from around the world to be available at all times. So a large ecological crisis in one part could destroy the critical flows of material from oil fields, mines or argicultural centres undermining what is left of the economy. Those survivors now struggling for food and energy will also have to cope with the consequences of nuclear power plant failures, destroyed oil platforms and chemical factories.

Even if the worst that climate change throws at us is just a 6 deg C temperature rise as predicted by the IPCC reports, then the collapse in society combined with rising sea levels will still put unbearable pressures on critical infrastructure. Virtually all oil refineries are at sea level to allow for easy oil import and export. They will destroyed. Many nuclear power plants are in coastal locations to enable access to cooling water and these will be a deadly liability. Many cities are in coastal locations and entire populations will have to be relocated.

With our current approach to climate change, nations will find themselves in the impossible position of having to move whole populations while simultaneously coping with large influxes of immigrants. They will have to do this when the economic network that supports the relocation of people and infrastructure suffers collapse as the interconnections between all the different nodes that economies rely on start breaking down. The failure of one node or one connection will deprive the economy of critical inputs such as energy, mineral resources or management ability at the time when it is needed the most. This will cause further knock on effects breaking other connections. For example, it is not possible to shift an oil refinery without a large and well fed population near by to provide the necessary engineering skills, management skills and general manpower. Likewise it is not possible to relocate the population from a large city area without fuel produced by refineries or the electrical energy from nuclear power stations. Yet not to relocate any of these pieces of critical infrastructure in the face of rising sea levels is to invite unimaginable ecological and humanitarian catastrophe which will place intolerable burderns on the rest of the economy. The irony is that much of the infrastructure that has enabled civilisation and human progress is dirty and dangerous and set to become our biggest liabilities in a collapsing world.

Not only is the infrastructure risk profile already high, but it is increasing further as we continue to strive to meet the exponentially increasing demand for energy. This needs more facilities to cope with demand, but as the easily available and low risk energy sources have been exhausted we are now forced to turn to increasingly high risk energy sources such as deep sea oil wells or nuclear power stations. In the 1930s oil exploration boom in the US a leaking oil well in Texas could be capped relatively easily and damage could be limited by its accessibility and the relatively low production rates and pressures that the well operated at. By comparison, oil is now produced from inaccessible deep sea reservoirs thousands of feet below the sea bed at super high temperatures and pressure. The consequences of error is orders of magnitude greater than in the past. The BP Gulf of Mexico disaster illustrates how today an entire ecosystem can be easily destroyed even when the world's largest economy is on the door step and mobilised to stop the leak and attempt the clean up operation. If this same incident were to happen simultaneously with several other major climate change disasters or when society is collapsing due to climate change it is possible that no intervention could be made and the entire contents of the reservoir would spill into the Gulf of Mexico and on into the Atlantic destroying both. Our search for increasing energy has added into the risk portfolio tar sands with their enormously dangerous tailing ponds, dangerous mining operations and expansions of the chemical and nuclear industries.

As well as the Gulf of Mexico disaster we have had other foretastes of this increasing risk profile that we are subjecting ourselves and the planet to; the most prominent being the Fukishima nuclear disaster. This still knows no end and continues to spill radiological waste into the Pacific. The scale of this disaster is beyond even the massive Japanese economy and it is increasingly impossible to envisage how it can be resolved in anything less than 50 years with the real potential that it may never be resolved.

To date, no consideration has been made of the risk management strategy necessary to cope with large scale common mode failures in our industrial complex caused by rapid climate change and how our response will be limited in the zero carbon economy that we must migrate towards. Instead we take the same attitude to this that we have taken to the science of climate change; it is to ignore it, hope for the best and believe against all knowledge and rational judgement that it will go away. Regrettably history has already provided us with too many examples to show that this is not a viable risk management strategy.

In the face of these catastrophic risks, the big question now is how fast we should expect the increase of CO2 to be. We turn to the results of the

Keeling experiment which started measuring atmospheric CO2 in the Manu Loa observatory in Hawaii in 1958 and publishes monthly averages. This shows an annual cycle as vegetation grows over the summer months pulling atmospheric CO2 down and rising in the winter as vegetation dies, but its distinguishing feature is its upwards climb. The relentlessness of this makes a mockery of the platitudes on climate change that have spouted from governments claiming credit on the Kyoto agreement and from corporate marketing departments busily developing their latest green-wash campaigns. What is most concerning about the data is not just that CO2 is increasing, but that the rate of increase is increasing. Thus, not only are things bad, but they are getting worse quicker. The extent of this can be seen more apparently once a line of best fit is drawn through the data which illustrates the gradient of the curve is evidently steeper in the last five years that it was in the first five.

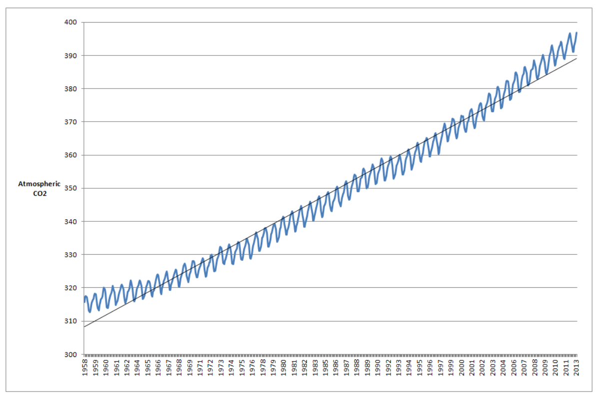


Figure 1: Keeling Curve with line of best fit drawn through

This curve needs to be considered from the perspective of what needs to be done to avoid runaway climate change. At best we need to ensure that we do not exceed 450 ppm. This is going to be a difficult enough challenge which entails slowing the rate of growth to zero and stabilising atmospheric CO2 at today's levels. More credibly, for life to survive we need to reverse the trend and get the atmospheric CO2 levels back down to below 350 ppm. This challenge will be orders of magnitude harder; common sense tells us that the because the curve is relentlessly increasing then reversing its direction and driving it down to 350ppm is going to be significantly more difficult. It is akin to the trying to slow down a car - if it is coasting along the road it can be done relatively easily with a simple application of the brakes. However if the car is accelerating with the throttle jammed open then slowing it down is a far more complex problem and merely applying the brakes is not enough, they will simply burn out. This is the problem we face, the atmospheric CO2 increase is accelerating as if the throttle controlling it is jammed open.

This upward trend is driven by three factors, the amount of fossil fuel that we burn, the amount of CO2 emitted by the ecosystem into the atmosphere and the amount of CO_2 that the ecosystem sequestrates. Before the industrial revolution, the last two of these things were roughly in balance; the amount of CO_2 emitted by the ecosystem was roughly equal to that which was absorbed by the ecosystem and atmospheric CO_2 never rose above 300 ppm. This is the upper limit at which we know the control system that is our ecosystem will return the planet's CO_2 levels back to equilibrium.

Above this, the balancing act that has sustained life runs in to problems and destablises. The higher level of CO_2 that our fossil fuel burning has caused heats the planet up causing plant life to die thus adding more CO_2 to the atmosphere. This warms the planet further exacerbating other feedback mechanisms such as melting the reflective sea ice and releasing methane hydrates. Simultaneously the sequestration ability of the ecosystem is being destroyed through pollution, industrialisation and war. Major problems are now being observed in every major ecosystem. CO_2 saturation of the oceans is causing acidification and collapse of carbon sequestrating food chains. Tropical rain forests are on the point of collapse with the recent droughts in the Amazon causing as much damage as deliberate forest fires. Warmer oceans absorb less CO_2 than the colder ones of the past contributing to the build up of atmospheric CO_2. The situation has turned so serious that many carbon sinks have now become carbon sources at the worst possible time. All these cause further warming and combined together are triggering runaway climate change.

The evidence suggests that we have entered this phase.

With this in mind we need to extrapolate forwards to establish the time frame that we have to avoid the 450 ppm trigger point, but mindful that the true test of what we must achieve is to reverse the trend and target 350 ppm. This is the optimistic hope for the future - that if we can avoid the 450 ppm there might just about be time to get atmospheric CO_2 down to the 350 ppm before the planet starts heating up and making runaway climate change unavoidable.

We can consider three scenarios for extrapolation starting from the blindingly optimistic to the most likely based on the build of CO_2 in the atmosphere. The first scenario simply takes a best fit line through the existing data and projects forward, the second finds the function through the data with the best fit and extrapolates this forward, the final scenario reconciles the growth in CO_2 with the exponential growth in fossil fuel consumption. These three scenarios are shown in Figure 2 and we take each in turn.

Scenario 1: Drawing a line of best fit through the data and extrapolating forwards gives us a date of 2055 when we exceed the 450 ppm threshold. This is both blindly optimistic and mathematically naive. The raw data is showing a consistent trend where the rate of increase is increasing year on year. Implicit in the straight line extrapolation is the assumption that this trend of an increasing rate of increase miraculously ceases. An assumption that is hardly likely with the business as usual.

Scenario 2: The second approach uses standard curve fitting techniques to find a quadratic function to model the 12 month moving average. The data can modelled with the following function:

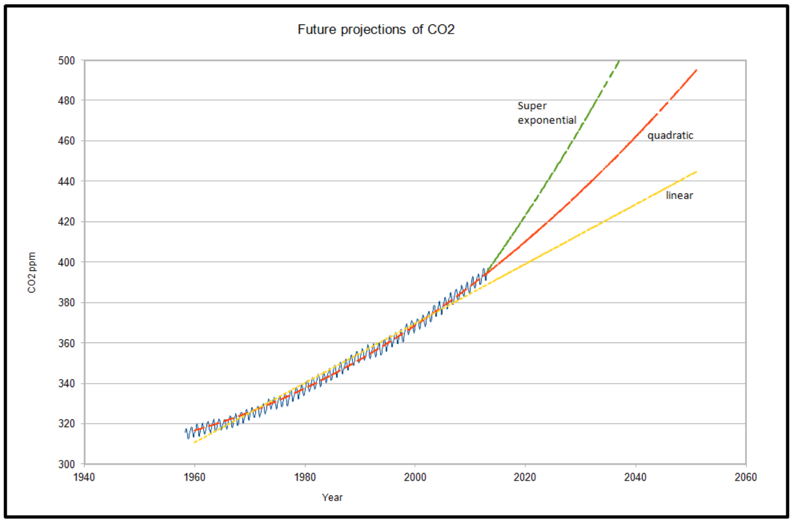


Figure 2: CO2 growth scenarios

$$Atmospheric\ CO2 \quad = \quad 0.0129 \times date^2 - 49.93 \times date + 48484 \qquad (1)$$

This equation gives an excellent fit of the data over the range from 1957 to 2013. We equate the left hand side of the equation to 450ppm and solve to give the critical date of 2035 when we exceed 450ppm. Despite the extremely good correlation that this gives with past data, there is absolutely nothing to prove that this quadratic function represents a suitable model for future atmospheric CO2 projections, especially as fossil fuel consumption continues to grow exponentially while the ecosystem is being simultaneously destroyed.

Scenario 3: It is far more realistic to expect that the growth in CO2 should be modelled by an exponential equation which would take the general form:

$$Atmospheric\ CO2 = Ae^{kt} \qquad (2)$$

where A and k are constants to be found using the existing data.

Using an equation of this form reflects the exponential growth in the fossil fuel consumption; for example coal consumption continues to grow at 5.5% per annum[6] doubling the amount of coal burnt every 13 years[7]. This reflects the growth in total energy demand across the planet and when other forms of fossil fuel are taken into consideration such as oil and gas which are showing the same rates of growth, it translates into an exponential build up of atmospheric CO2.

[6] International Energy Agency
http://www.iea.org/aboutus/faqs/coal/

[7] $Doublingtime = \frac{ln(2)}{ln(1.055)}$

It also reflects the many other factors that contribute to CO2 growth that are also growing exponentially such as population growth, economic growth and ecosystem collapse and which are coupled together. However, when we apply standard curve fitting techniques we find that the exponential equation we derive $Atmospheric\ CO2 = 0.0829554e^{0.0042003t}$ does not fit the data[8]. Figure 3 shows this exponenital curve against the actual data overestimates the measurements in the early parts of the data range and underestimating the later parts.

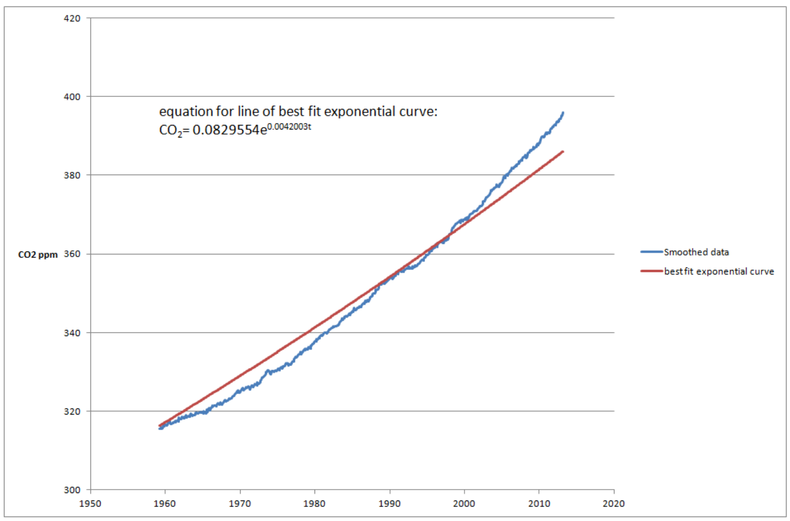


Figure 3: smoothed data and best fit exponential curve

This leads to the proposition that the constant k in the general exponential equation above is not constant, but is in fact a time dependent increasing function which is ultimately a function of the atmospheric CO2. It means that as atmospheric CO2 increases then the constant k increases with the result that a much faster build up of CO2 in the atmosphere occurs, further amplifying k. It is a deadly feedback mechanism where the growth in CO2 can become explosive. This is known as super exponenital growth.

Though many of the sources contributing to the CO2 emissions may be increasing at a lower rate than that being observed in the atmosphere, when they are taken together with one on top of the other and all having a reinforcing effect on each other; the result is that the cumulative increase becomes super exponential. There are many factors combining to cause this. The fossil fuels that we use today to maintain our global economy are increasingly energy intensive to extract, process, transport and defend as the economy becomes increasingly reliant of extreme forms of energy such as shale gas, tar sands and deep sea drilling. This means that as global energy demand continues to increase the environmental cost of that increase is amplified, as not only must an exponen-

[8]To find the k for the best fit curve: $k = average\ of\ \frac{dy}{dx}\frac{1}{y}$

tially increasing amount of energy be extracted from the planet to maintain demand, but the increasing inefficiency of this must all be factored on top of the exponential curve. Also as greenhouse gas emissions increase and the climate is destabilised at the same times as critical resources such as oil become scarce, wars and hostilities are breaking out with enormous environmental impacts. The ecological overload this adds to the planet further destabilises the existing carbon sinks leading to additional carbon releases to the atmosphere.

We can see how these changes impact the environment by calculating the variable k in the exponential formula on a month by month basis from 1958 to the present day. We do this by imagining two points on the CO2 curve, one at fixed at 1958 and the other that will slide along the curve. From these two points we can calculate the two parameters of the general exponential equation, the most important of which is the variable k in equation 2. As we slide moving point along the CO2 trend line towards today we can contunally calculate the value k and we plot this in figure 4. This shows that k was relatively stable up until 2009 with a only a gradual increase. However since this time, the growth of k has been explosive[9]. This lays out the nightmare of super exponential growth.[10]

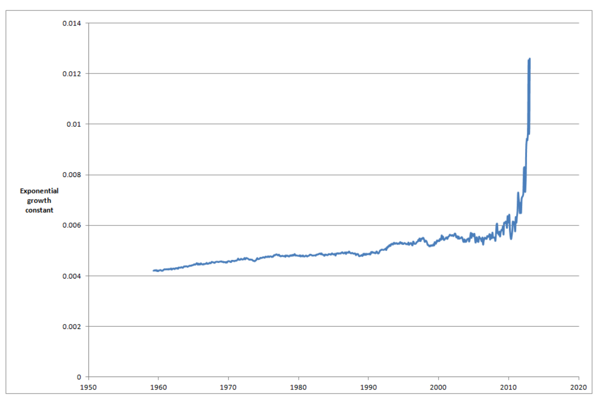


Figure 4: Exponential increase in growth constant, k

The effect of this on the predicted date atmospheric CO2 reaches 450 ppm can now be calculated. This is shown in the figure 5. The y-axis shows the anticipated date when the atmospheric CO2 can be expected to reach 450 ppm. Thus in 1970 it could be assumed from the data that the 450 ppm threshold would occur around about 2040. However because k is increasing exponentially with time, we can now expect to cross this threshold as early as 2020.

[9] $k = ln\left(\frac{Current\ CO_2}{CO_2\ for\ month\ being\ assessed}\right)/time\ from\ month\ being\ assesed\ to\ present$

[10] Evidence for super-exponentially accelerating atmospheric carbon dioxide growth, A.D. Husler and D. Sornette

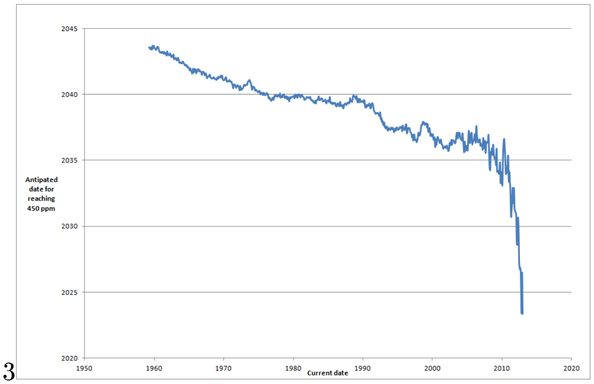
3 

Figure 5: Projection date for exceeding 450 ppm

In terms of these three models for CO2 growth, we can dismiss the straight line extrapolation. This leaves us on track to reach the 450 ppm level between the dates predicted by the quadratic model from equation 1 and the super exponential model, thus 450 ppm will most likely be achieved somewhere between 2020 and 2035, with the balance of probabilities being towards the earlier date.

This is a desperately short time period to make the biggest change in human history which is the transition from a fossil fuel dependant society to a zero carbon society while catering for the needs of ten billion people in a world destabilised by high risk infrastructure that will amplify the problems of climate change. Few published reports on climate change give any sense to the size of this challenge.

The most blatant failure to do this was the IPCC report published in 2007. This was the global consensual statement on climate change. It was based around a series of different scenarios of CO2 build up, ranging from the hypothetical best case of cutting all emissions to zero to the worst case of the A1F1 scenario, which assumed maximum fossil fuel driven economic growth. Though in the long term, the IPCC's A2 scenario of a heterogeneous world with high population growth, slow economic growth and slow technological change increased CO2 emission more, it did not exceed A1F1 case until 2090. This is entirely academic because the planet's ecosystem and society will have long since collapsed before this irrespective of which scenario mankind chooses to follow. In an abrogation of responsibility, the IPCC specifically made no mention of which scenario they considered to be the most likely scenario. Instead the report is caveated with the statement[11] *"No likelihood has been attached to any of the scenarios."* It was as if all scenarios were equally feasible and it was simply a matter of choice as to which one humanity opted for with no more challenge than being in a restaurant and having to choose from a menu of healthy or non-healthy foods. Politicians made statements to support this prognosis of easy decision-making. Britain's prime minister at the time, Gordon Brown,

[11] Climate Change 2007 Synthesis Report (AR4)

praised[12] the "*IPCC's measured assessment of an urgent challenge*," and went on to say that *"It is vital that we launch negotiations on a comprehensive global agreement on tackling climate change."* He then immediately went on to support a series of airport expansions across the country without a hint of cynicism.

The brutal reality was that none of IPCC scenarios were even feasible and the atmospheric CO2 was already building up quicker than that assumed by the worst-case scenario at the time of its publication. To be worthy of the Noble prize that was awarded for the work, the IPCC authors should either have excluded all of the fictitious and totally improbable alternative scenarios or made a much stronger and clearer statement that it should be considered impossible within the current political frameworks to achieve anything other than the worst case scenario.

To make matters worse, major elements of the science were omitted from the models.

Amongst many omissions the climate models excluded was the impact of methane releases from the Arctic. The ostensible reason is that for the models to be as dependable as possible, inputs were to be limited to factors were the strength of the science was certain. The obvious flip side to this is that many of the critical factors that drive climate change and global heating can be easily edited out of the models, even if they are known about, simply by arguing that their full impact is not adequately understood. This approach allowed easy censorship of the models to support the wishes of governments such as the US and Saudi who were actively fighting climate change legislation at the time. Thus by merely claiming elements of science were not strong enough to justify inclusion, the models would always underestimate the true severity of the heating that the world faced and provided the results sought by the most powerful nations.

The result was that world would be doomed to cook and the US and Saudi governments, along with other similar governments would be able to continue business as usual and avoid signing up to any agreements to make emission cuts right up to the day of disaster. Tucked away under a table in one of the IPCC reports[13] is the ominous disclaimer *"The emission reductions to meet a particular stabilisation level reported in the mitigation studies assessed here might be underestimated due to missing carbon cycle feedbacks."* Amen.

The truth of this statement was to be made brutally obvious only 2 years after the reports publication with the Copenhagen Diagnosis report showing that Arctic sea ice volume was catastrophically collapsing. The rapid warming of the Arctic's ice cap was causing further warming in this region by exposing the darker sea. Instead of having an ice free Arctic Ocean in 2100 as predicted in the worst case scenarios in the IPCC report, we are now heading towards an ice free Arctic ocean in 2015 and one of the major triggers to runaway climate change is being pulled. The dangerous feedback mechanisms that the models

[12] Response to IPCC warnings,
http://afp.google.com/article/ALeqM5hbs7ndJeJUTPYlzLanTVWnbCyTuA
[13] IPCC AR4, Table SPM 6

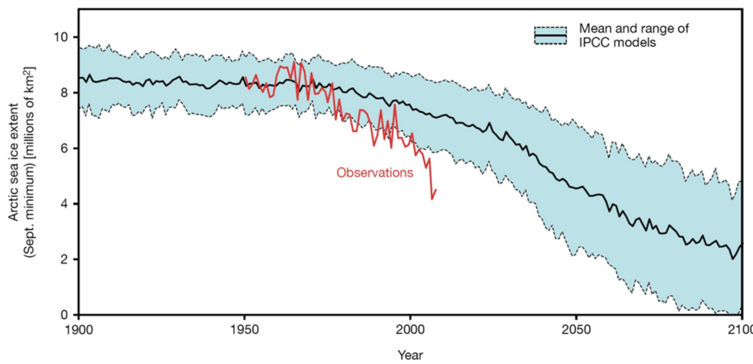


Figure 6: Sea Ice Collapse

had underestimated were taking hold as the report was coming off the printing press

Despite all the computing power at the disposal of the scientific community, despite all scientific advancement painfully accrued over hundreds of years, despite billions being spent on information gathering from thermometers to satellite measurements, the best assessment mankind could manage of its most critical future issue was so hopelessly useless it could not predict more than 2 years into the future. The mainstream media did their usual job of staying silent. There was no collective outrage splashed across the headlines of gross incompetence, wilful disinformation or systemic failure. Yet it had to be one of these. A gross underestimation such as this supports the argument that perhaps other critical aspects of the report are also underestimated and that is prudent to plan for much more rapid change than is normally assumed. The Manua Loa data certainly bears out this assessment.

It is now safe to say that we sit on the precipice of a carbon dioxide explosion were its super exponential growth will take us far above the critical safe limits in a very short time period. At time of publication in 2007 the worst-case scenario of the IPCC reports was already being exceeded; in the near future it will be exceeded by far. Our future will not be like our past or our present. With no risk management procedures in place to cope with our inherently dangerous and fragile infrastructure, we are now critically exposed.

We know we must start planning for a future where the global average temperature increase is far in excess of 6 deg C. This will be incompatible with maintaining our society in its present form. It means that today's children face a future racked with rising sea levels, food shortages, energy shortages and conflict, yet at the same time they will be expected to decommission dangerous infrastructure, remove environmental pollutants and live in a zero carbon economy. It is an unimaginably difficult set of conflicts that we will hand them.

It is now too late to stop climate change, a fact that almost all thinking people realise now. The focus on society now must be to reduce the risks for the future, to start the reconstruction of our society for survival while some degree of stability still exists and to do all that we can to minimise the explosive build up of CO_2 while acknowledging we have little time to prepare for this.

This is no happy prognosis, but the warnings from science have been clear for years. Those warnings were either ignored by those who held power or were deliberately discredited. Populations that were either too self-interested, too ignorant or too busy in their own struggles for survival failed to hold those in power to account. The consequences of inaction now have to be faced. Mankind's vaulting ambition has over-leaped itself.