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."

Much has been written on climate change, and much of it ignored.

It is easy to 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. However the facts brutally and clearly tell otherwise, irrespective of what scenario is chosen. But the facts have been shrouded in deep mystery and obfuscation as the debate on climate change is further smothered by the planning to escape the imprisonment of recession and austerity that has trapped world's most largest economies while powerful vested interests seek to suppress discussion and maintain the status quo.

But 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 CO2 were dismissed as either being an interesting experiment or having 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 This was superseded in the 1970s with confusion as to whether the planet was actually warming or cooling, the evidence now demonstrates that atmospheric dust from coal burning and nuclear weapons tests caused cooling that masked the warming that was happening.

When the evidence of warming was incontrovertible a new hypothesis was cast around; the warming was part of a natural cycle and we were innocent of the destruction being caused, despite the chance being minuscule that today's unprecedented global heating should be occurring in the tiny sliver of geological time we occupy. This was 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 drilling. The well documented pattern of ignoring climate change continues [1]. The result - an inexorable increase in atmospheric CO2. Today we are at 398 ppm and more worryingly the rate of increase is increasing. We must project forward to understand the folly of ignoring the warnings for so long and the consequences that we are now left with. To do this we need two things, the consequences that we will suffer and the timescales that will be forced upon us and to which we must work. Without these rational debate on the profound actions that we must take is impossible.

We turn our attention first to the consequences.

The lexicon of tipping points has now become well established in discussions of climate change. These are the levels that are reached, usually determined in CO2 levels or temperature, when events subsequently take on their own momentum and accelerate the change towards a new stable equilibrium that will potentially be so extreme as to prohibit any life.

One of the first attempts at determining where a tipping point lay was done by James Lovelock when he extended his Daisy World models to look at the stability of ocean circulation and it is discussed in the Revenge of Gaia. The conclusions from this was when atmospheric CO2 reaches 450 ppm the ocean surface warms sufficiently and its lower density prevents the surface water sinking at the poles. This normally happens because surface evaporation increases the salinity and hence the density of water as the Gulf Stream flows towards the high latitudes. The sinking water at the poles then works its way along the seabed to rise up again at the equators carrying nutrients and maintaining the health of the ocean. The low density surface water brought about by rising surface temperatures stops this dead. The consequences are drastic. The ocean food chain collapses forcing them to become giant stagnant ponds. The stagnant ocean becomes fit only for massive algae blooms. These will belch poisonous hydrogen sulphide gases into the atmosphere and turning the sky from blue to 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. This is the mechanism that led to the mass extinction 250 million years ago when 95% of all life on the planet was wiped out following a runaway global warming event. However, this occurred over a 10,000 year time period; today we are doing the same on a time period measured in tens of years. Today's ecological crisis is orders of magnitude more serious. Little life will survive and any which does will do so by good luck and suffer appalling living conditions. In this doomsday environment any last remnants of civilisation will be wiped off the planet.

If 450 ppm is the upper tipping point of environmental destruction, then the lower tipping point is 350 ppm 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 Arctic Ocean and permafrost to melt, a factor which Jame Lovelock was unaware

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

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

of in his initial analysis. These hydrates have built up over a fifty million year period of relatively stable climate and are a bullet in the breach. Ironically it was also a relatively stable climate that allowed homo sapians 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 that could cause continental sized fire-storms[3].

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 published and followed shortly after by the Jason report which was finally made available to the public in 1982.[5] Both were unequivocal in their prognosis for a 3 deg C global average increase if atmospheric CO2 doubled. Remarkably, it predicted a 40 year time frame for the collapse of the planet 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.

Ironically, this is exactly the strategy policy makers adopted and continue to work towards. Ever since political debate on climate change started, they have pursued and continue to pursue the naive and failed strategy of limiting global warming to 2 deg C. The Jason and Wood Hole reports were unequivocal; once the earth warms 2 deg C it will be too late to do anything else. This 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 has 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. So it is on the planet, once the temperatures has increased by 2 deg, then the ecosystem that maintains our environment will start burning out.

Since the Woods Hole report, we have learnt that the risks are far greater. We have found many new positive feedback mechanisms, such as a warmer atmosphere holds more water vapour which acts as a greenhouse gas or the action of biological agents in the tundra release additional CO2 once warmed.

[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

We continue to find more; by contrast we find hardly any negative feedback mechanisms that act to minimise or reverse warming.

The risks levels our planet today faces 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 oil fields, mines and food resources undermining what is left of the economy. Those survivors who are struggling for food will could also have to cope with the consequences of nuclear power planet failures, destroyed oil platforms and chemical factories.

In recent years we have already had foretastes of these. The Fukishima disaster still knows no end and continues to spill radiological waste into the Pacific. Even with the Japanese economy reasonably intact it is currently estimated that it will take 50 years to clean up. The BP Deep water Horizon disaster destroyed much of the Gulf of Mexico and the Bhopal disaster continues to poison India 30 years after the event.

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 our critical infrastructure. Virtually all oil refineries are at sea level to allow for easy oil import and export. They will destroyed. Very many nuclear power plants are in coastal locations to enable access to cooling water. Fukishima has already provided a warning. Many cities are in coastal locations and entire populations will have to be relocated.

With our current approach to climate change, we will find ourselves in the impossible position of having to move whole populations and cope with large influxes of immigrants simultaneously. Doing this will not happen when the economic network that supports the move is dependent on all nodes operating effectively and where the failure of one will deprive the economy of critical inputs such as energy, mineral resources or management ability at the time when it is needed the most. 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. The irony is that much of the infrastructure that has enabled civilisation and human progress has now become one of the 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 drives the need for 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 the plains of Texas could be capped relatively easily and damage could be limited by easy accessibility to resolve the problem and the relatively low production rates from the wells. By comparison, oil is now produced from deep sea reservoirs thousands of feet below the sea bed which are 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 onto the Atlantic destroying both. Our search for increasing energy has added into the risk portfolio tar sands with their enormous tailing ponds, additional mining operations and expansion of the chemical industry.

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. 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 provides us with too many examples to show that this is not a viable strategy.

In the face of these catastrophic risks, the big question now is how fast should we 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. The curve shows the annual cycle as vegetation grows over the summer months pulling atmospheric CO2 down, but its distinguishing feature is its climb upwards. 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.

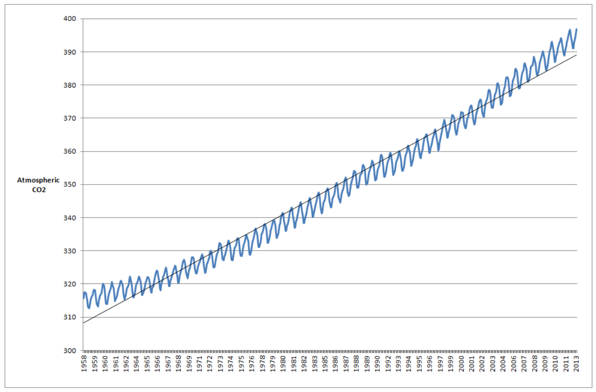

Figure 1: Keeling Curve with line of best fit drawn through

This curve needs to be considered in 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 it. More credibly we need to reverse this trend and get the atmospheric levels back down to 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 completely different and more complex problem, merely applying the brakes is not enough.

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 CO2 that the ecosystem sequestrates. Before the industrial revolution, the last two of these things were roughly in balance; the amount of CO2 emitted by the ecosystem was roughly equal to that which was absorbed by the ecosystem. If for some reason the system was perturbed, and the amount of CO2 increased, then the planet would warm up and plant growth would increase pulling the CO2 back to its equilibrium level. Likewise, if the amount of CO2 decreased too much, the planet would cool, killing plants and allowing the CO2 to build up back to its equilibrium state. The Vostok Ice cores taken from the Antarctic show this oscillation over a period of 600,000 years where the CO2 rises and fall but always about an equilibrium line and never rises above 300 ppm. This is the upper limit at which we know the control system will return the planet's CO2 levels back to equilibrium.

Above this, the balancing act that has sustained life runs into problems. The higher level of CO2 heats the planet up causing planet life to die and adding more CO2 to the atmosphere, warming up the planet still further and 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. CO2 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 CO2 than the colder ones of the past. The situation has turned so serious that many carbon sinks are now posed to become major carbon emitters

Other factors such as a warmer sea surface reducing the amount of CO2 can be absorbed be ocean act to further speed up the CO2 accumulation in the atmosphere. All these cause further warming and this is runaway climate change.

The evidence suggests that we have entered this phase. The CO2 increase in the atmosphere is now being driven by the burning of fossil fuels and the release of greenhouse gases into the atmosphere from the ecosystem from forest fires and methane releases, while the planets ability to sequestrate CO2 falls.

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 emissions 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. 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 CO2 with the exponential growth in fossil fuel consumption. We take each in turn.

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. However this is extremely 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 miraculously ceases. A assumption that is hardly likely.

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:

$$Atmospheric\, CO2 \quad = \quad 0.0129 \times date^2 - 49.93 \times date + 48484$$

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, giving the critical data of 2035. Despite the extremely good correlation that this gives with past data, there is absolutely nothing to suggest that it can be modelled in the future by a quadratic function, especially when the increase in

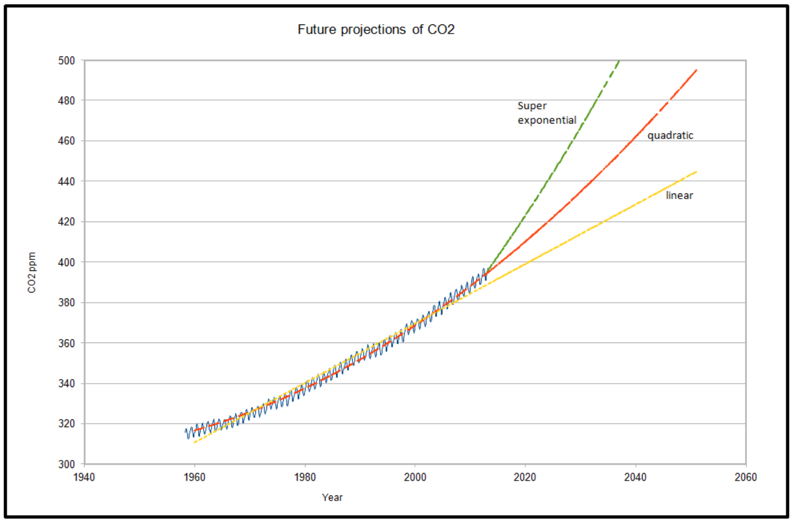

Figure 2: CO2 growth scenarios

fossil fuel consumption has been growing exponentially while the ecosystem is being simultaneously destroyed.

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:

$$Atmospheric\,CO2 = Ae^{kt}$$

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 when other forms of fossil fuel are taken into consideration such as oil and gas translating into an exponential build up of CO2 in the atmosphere. The problem is that the best fit exponential curve, $Atmospheric\ CO2 = 0.0829554e^{0.0042003t}$ does not fit the data[8]. The graph below shows this curve overestimating the measurements in the early parts of the data range and underestimating the later parts.

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

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

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

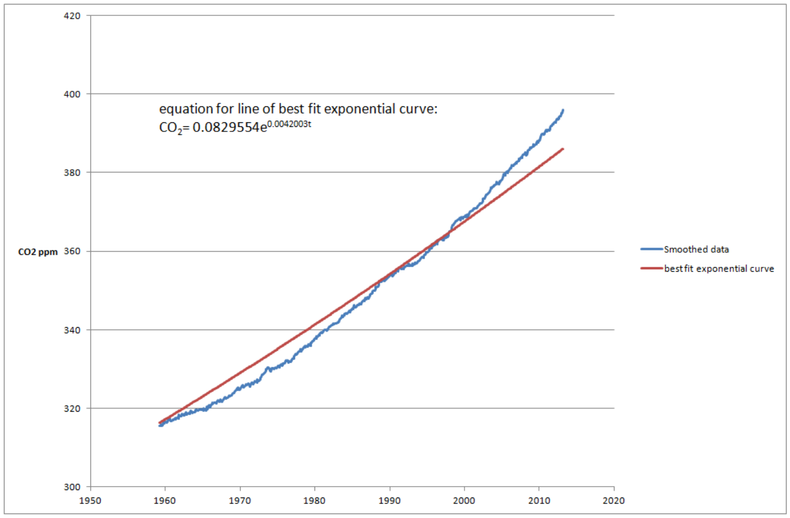

Figure 3: smoothed data and best fit exponential curve

This leads to the proposition that k is not constant, but is in fact a time dependent increasing function which is ultimately a function of the atmospheric CO2. This is the nightmare scenario. It means that as atmospheric CO2 increases, then the constant k increases. The result will be an explosive increase in atmospheric CO2.

Various factors are combining to cause this. The fossil fuels that we are using to maintain our global economy are increasingly energy intensive to extract, process, transport and defend. Wars and hostilities to secure energy such as the Iraq war, energy intensive developments such as tar sands, shale gas and deep sea drilling projects all result in a much lower return on energy invested to energy gained with a correspondingly higher level CO2 emissions per joule of energy used.

The ratio of CO2 emitted per joule of energy used increases further as a result of an increasing risk profile of the energy resources that we now rely on. It is estimated that coal mine fires in China now produce as much CO2 as all the auto-mobiles in the United States.

At the same time as the emissions per joule of energy used are increasing, then the energy used is also increasing exponentially as a function of the exponentially expanding global economy and population.

The final aggravating factor is that the exponentially increasing greenhouse gas emissions are occurring at the same time as the sequestration ability is being destroyed as discussed above.

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. This is done using standard mathematical methods where we assume that an exponential relationship exists between each month and the reference month which is the most recent data (at time of writing this was March 2013)[9]. If a normal exponential relationship did exist between time and CO2 levels, then the value of k would remain constant. However the graph below clearly shows that not only is k increasing, but that it is increasing exponentially. This is the nightmare scenario of super exponential growth. [10]

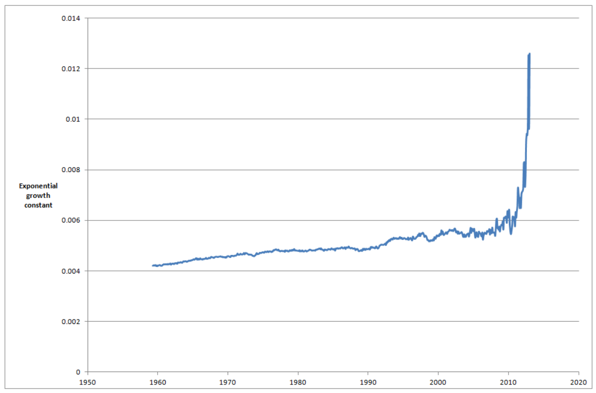

Figure 4: Exponential increase in growth constant, k

The effect of this on the predicted date atmospheric CO2 reaches 450 ppm can now be calculated. This is shown in the next graph. 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.

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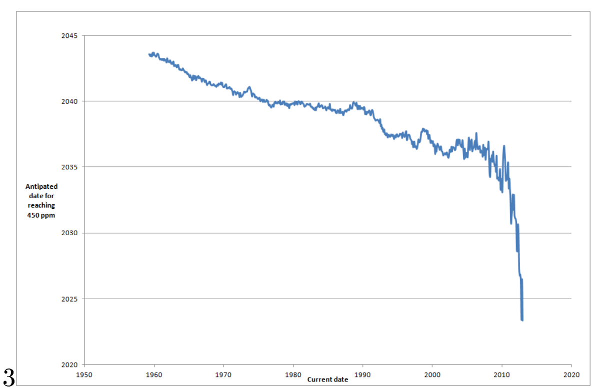

Figure 5: Projection date for exceeding 450 ppm

[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

In terms of these scenarios, we can dismiss the straight line extrapolation. It leaves us on track to reach the 450 ppm level between the dates predicted by the quadratic model 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.

Does this tie-in with published research on climate change? The answer is an emphatic no. The main publication is the 2007 IPCC report which it is not an exaggeration to say was deliberately manipulated to add more obfuscation to the debate and to further delay critically urgent action.

The reports were based around a series of different scenarios, 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 caveatted 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 we opted for with no more challenge than being in a restaurant and being forced to choose from a menu of healthy or non-healthy foods. Politicians made statements to support this prognosis of easy decision-making. Gordon Brown 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 and hiding the fact that making significant carbon cut backs will be most difficult decision ever faced by mankind entailing mutual sacrifices with other nations and changing our entire economic system.

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.

[11] Climate Change 2007 Synthesis Report (AR4)

[12] Response to IPCC warnings, http://afp.google.com/article/ALeqM5hbs7ndJeJUTPYlzLanTVWnbCyTuA

Amongst many omissions the climate models excluded 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 the model 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. By merely claiming the science was not strong enough 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 soon to be made brutally obvious only 2 years after publication with the Copenhagen Diagnosis report showing that Arctic sea ice volume catastrophically collapsing. The dangerous feedback mechanism ignored in the models took hold where the Arctic's warming melted the ice cap causing further warming by exposing the darker sea. Instead of having an ice free Arctic Ocean in 2050 as predicted, 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.

This is sea ice melting is the water boiling dry in the kettle. This is what that global economic and environmental policy should be based around.

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 underestimates and that is is prudent to plan for much more rapid change.

We 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

[13] IPCC AR4, Table SPM 6

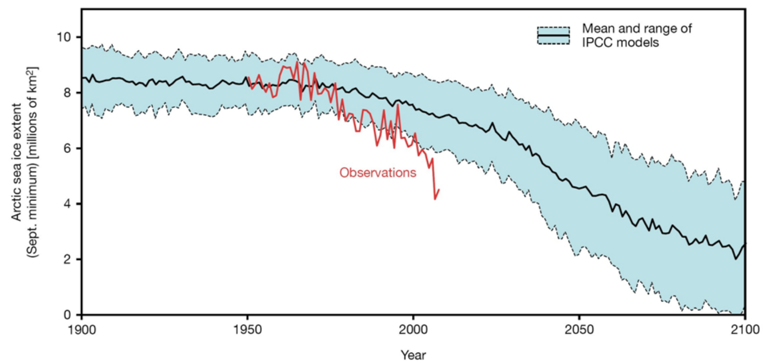

Figure 6: Sea Ice Collapse

exceeded by far. When this is combined with the hopeless under estimate of the effect that increasing atmospheric CO2 is having on the environment our future now is totally unknown. With no risk management procedures in place to cope with our inherently dangerous infrastructure we are critically exposed.

All that is know is that 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 today's society. Today's children will face a future racked with rising sea levels, food shortages, energy shortages and conflict, yet at the same time incredible demands will be placed on them to decommission dangerous infrastructure and remove environmental pollutants. That is all we can be certain for 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 CO2. It is likely that we will have very little time to prepare for this.

This is no happy prognosis, but the warnings from science had 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.