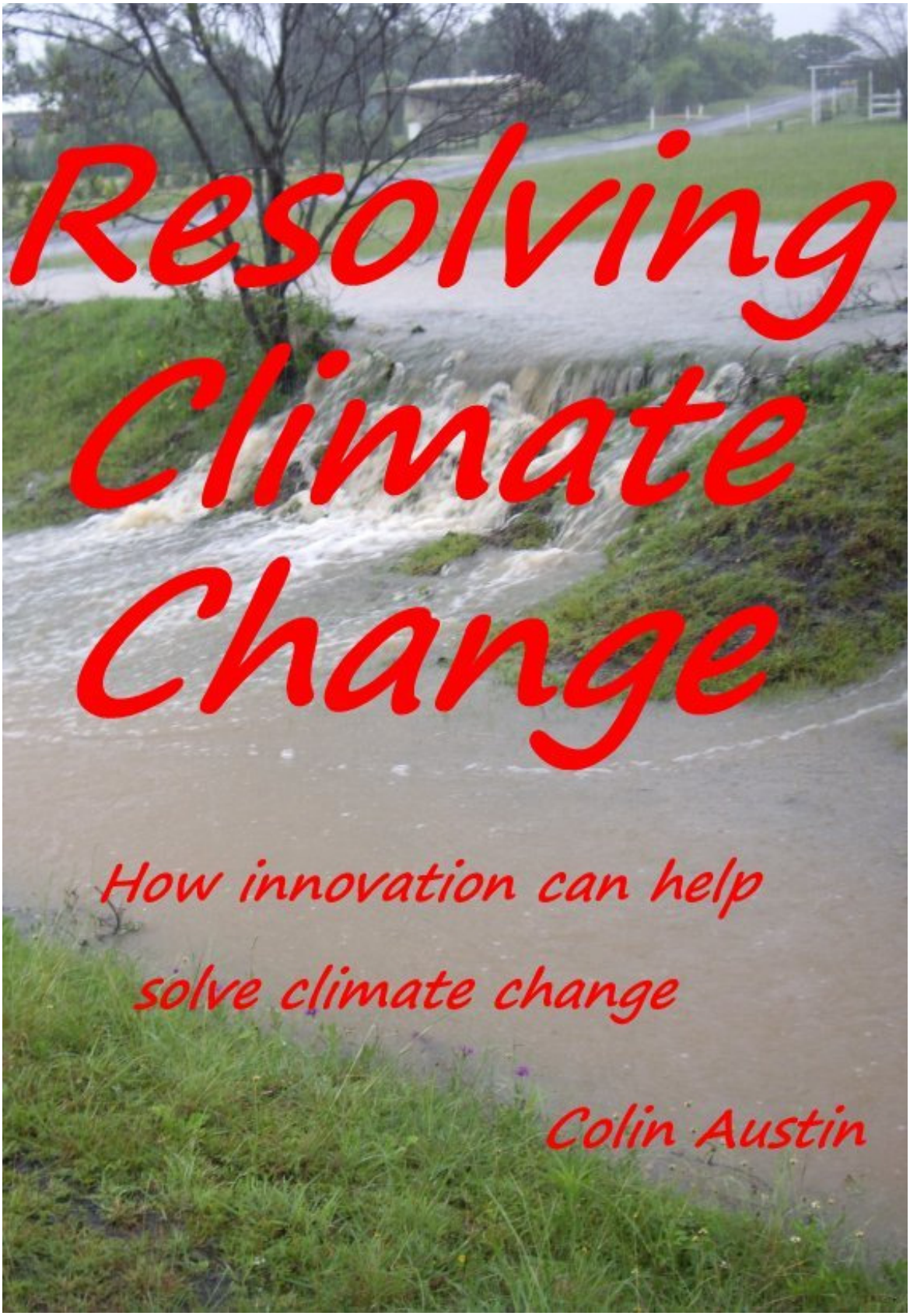
Resolving
Climate
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How innovation can help
solve climate change
Colin Austin

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9/25/2012

We are not winning the climate change war. We look at how innovation can lead to ways of removing large volumes of carbon dioxide from the atmosphere

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About The Author

Colin Austin has had a varied career after graduating in engineering in from Sheffield University in 1963. He started his career in process control, gradually building up expertise in the control of plastics processing equipment, working as R & D Manager before taking a spell in academia lecturing at RMIT in Melbourne.

Some years ago, Colin wrote a piece of software that transformed the international design of plastics moulds using scientific principles rather than 'gut feel'. So successful was this software that the company that Colin founded (Moldflow) became the largest exporter of technical software in Australia, a multi-million dollar company selling in over 48 countries throughout the world. He attribute the success to the system of speculative research he used to create innovations.

He became increasingly concerned about environmental issues, particularly the management of what he sees as the world's most critical resource soil and fresh water. Just as he had changed the plastics industry from a 'hunch based' to a science based process, he saw that soil and water technology could be transformed by the application of the scientific approach.

He realized that the work he had being doing on improving soil by increasing the organic content could have profound impact on resolving climate change.

Prologue

I, like many people was concerned about climate change - but in a rather abstract way, it was something that was going to happen way into the future. But when the Queensland floods struck with water running under my house (fortunately a high set Queenslander) I realized that the increase in temperatures - way into the future - was not the real issue, it was the increase in extreme weather, floods and droughts, which are a here and now issue, which are the real danger. Action is needed now – but what did I find when I investigated further?

We are simply not winning the climate change war. The Kyoto targets for the developed countries were based on what was politically acceptable rather than what is needed. But even if they did achieve these targets emission from the developing countries would more than offset any saving. We are putting tens of billions of tonnes of greenhouse gases into the atmosphere every year, and despite all the efforts to reduce our emissions they grow every year.

Sustainable technologies like wind and rain could potentially supply enough energy to meet all our needs but until someone invents a way of storing the energy they cannot provide a viable alternative to fossil fuels. It all looked totally depressing until I came across a startling piece of information. Vegetation is absorbing some thirty times all man made emissions.

So why is there a problem? Simple, virtually all of that carbon goes back into the atmosphere by oxidation and decomposition. The largest emitter of carbon is not electricity generation or transport as we are told - it is simply rotting vegetation.

So why cannot we divert that carbon so it goes back into the soil, and stays there?

I am an innovator. My most socially important innovation is a system which has the potential to remove large, e.g. gigatonnes of carbon dioxide from the atmosphere. It also improves soil quality to make food production more resilient in a changing climate.

This innovation would enable the wealthy countries to continue to enjoy the modern life style and the developing countries to expand their economies so they too can enjoy this life style without inducing catastrophic climate change.

Does that all seem too simple? Removing gigatonnes of carbon from the atmosphere is hardly a trivial technology and requires logistic as well as technical solutions. That is what this book is all about.

Process not gizmos

For the last twenty years some of the best brains on the globe have been dedicated to resolving climate change, we have been through Rio, Kyoto, Copenhagen etc. but we are emitting greenhouses gases faster than ever.

We are not winning the war against climate change. I want to present a solution; - the technology of removing carbon from the atmosphere.

Our current failures do not stem from a lack of technology but limitation of the process. We live in an era where reductionism dominates the process. This is particularly true of science but equally true of the political and administrative processes. Each aspect is broken down into smaller aspects often losing sight of the overall process.

Australia could absorb its entire carbon emissions if it were to use the Murray Darling Basin to absorb carbon. The technology I describe is singularly efficient in its use of water for crop production so this would elevate many of the problems that the Murray Darling Basin Commission is facing. This would require a major change in agriculture to absorb the carbon.

The reductionist approach, which considers these as separate problem to be managed by separate departments has little chance of success, it requires an integrated approach.

Resolving climate change requires a change in how humanity reacts with the environment, a life style change. This requires an integrated rather than a reductionist approach to problem solving.

The good life

Let us face it, modern life in an affluent society is very pleasant. Just hop in the car, decide whether to go Thai, Chinese or Italian restraint, have a nice meal with foods from different parts of the world, come back home, adjust the air conditioning, flick on the recorder so you can watch the good program you recorded while at the restaurant, decide whether to watch on the big screen in the living room or just snuggle down and watch on the smaller screen in the bedroom. Next day decide whether to take the 4WD to the beach of out to the bush.

Modern life for a couple of billion or so people around the world is very pleasant. If things get a bit rough, say a bit of an accident on the drive on mower so you need a knee replacement there is a sophisticated medical service.

People are very reluctant to give up the good life to resolve climate change. Even if we wanted to we cannot go back, there are simply too many people, we are dependent on technology; - we have to develop new technologies and life styles.

Another 4 billion more people aspire to the good life. Some struggle through with a pretty basic life others just survive without any modern conveniences, no electricity and not enough food. While they see the affluent enjoying the good life they too will pressurize their Governments for a better life so increasing carbon emissions.

It will not be that long before we have 9 billion affluent people all contributing to carbon emissions.

My role in creating the modern life style

I helped create this modern life style. As an engineer I was lucky enough to realize the potential of computers in engineering when they first appeared. I taught myself to program, wrote up computer aided engineering software which helped solve serious engineering problems. This technology was sold around the world, changed the way an industry operated and generated millions of dollars.

But way back, some thirty five years ago, Australia suffered huge dust storm with the loss of millions of tonnes of valuable top soil. I realized that the desirable life style we were enjoying was delicately balanced on a vulnerable environment and I had better put what innovative skills and money I had to help make our society more environmentally sustainable.

Environmental innovation

Initially I focused on soil regeneration and water conservation which seemed at that time to be the critical issues, but later I became aware of climate change from manmade greenhouse gases. I realized the importance of all the efforts to develop alternative green energy sources but with the ever increasing adoption of modern technology throughout the world but could see that these green energy sources would never, by themselves, resolve the climate change challenge. What was really needed was a way of extracting large, billions of tones, of carbon from the atmosphere.

This has been my project for some thirty five years. I have now developed such a technology and it may be reasonable to expect that with the global threat of climate change that this technology would receive immediate acclaim.

This is not the case, innovation is only of value when adopted on a large enough scale to bring the global carbon balance into equilibrium.

Adoption

Developing technology is the easiest part of innovation, getting adoption is a far greater challenge.

The public is not stupid; they fully realize that the possibility of reducing emission by the targeted 5% below 2000 levels is remote. Even if that were achieved, the reduction is nowhere near enough to bring our emissions into balance. To achieve carbon balance would require a much higher reduction in emissions. But if by some stoke of magic we could find some way of achieving balance it still offers Australia no protection from the hazards of climate change. The emission which no doubt played some role in our recent droughts and floods originated from overseas, particularly China.

This is an argument which will undoubtedly be aggressively exploited by the skeptics. It's easy to argue all pain no gain.

China would be very receptive to this technology. It is not only the largest emitter of greenhouse gases it is incredibly vulnerable to climate change. It has already experienced major floods while the Northern regions are suffering extreme drought which is affecting food production. China, with 1,400 million people to feed is particularly threatened by climate change. It also has a track record of making major social and economic changes.

China is a lead country for the developing world, once adopted by China we could expect many other countries such as India, Brazil, Russia etc. to follow their lead.

You cannot bring emissions into balance without some pain, but this way gives us the gain.

Part 1 Defining the problem

The growing affluent population

Currently we have some 2 billion people enjoying the luxury of modern technology (and some 4 billion people still living in poverty). This small minority of the population has already increased the levels of greenhouse gases which is changing the climate. Despite all our current efforts since Kyoto we are still pushing greenhouses gases into the atmosphere at a faster rate than ever.

However much we would like to fool ourselves, we have totally lost the climate change battle. (At least up until now.)

But the future looks even bleaker. We will shortly face the situation of some 9 billion affluent people all wanting to enjoying the benefits of modern technology. The challenge is not diminishing but dramatically worsening.

How do we develop technology so we can all live on this earth in a sustainable way without the environmental problems of climate change, destroying our top soil and the social and political tensions creating conflicts between the rich and the poor?

There is no way in the near future, with the rapid growth in the developing countries that we could globally reduce our emissions to the required level to achieve carbon balance.

Of course I support the development of the green technologies, wind, solar electric, solar thermal, geothermal etc. but they are just too slow to come on line and make an impact.

Excessive greenhouse gasses present a real threat to our ability to feed the increasing population by increasing the severity of the natural flood and drought cycle, removing top soil.

There is no technology immediately available (except the high contentious nuclear) which will reduce greenhouse gases to the required extend to avoid the increasing severity of the flood and drought cycle.

Greenhouse gasses will increase as the developing countries inevitably modernize. This will far out way any possible savings from the developed countries.

The only way to resolve climate change is to remove large quantities of carbon dioxide from the atmosphere. My innovation has the potential to do precisely this. To have any effect it needs to be widely adopted.

As this is the key point in this proposal I will say again in bold and italics.

The only way to resolve climate change is to remove large quantities of carbon dioxide from the atmosphere. My innovation has the potential to do precisely this. To have any effect it needs to be widely adopted.

Part 2 Proxy technology

I have learned that talking too early about a subtle technology for removing billions of tonnes of carbon from the air can quickly leads to a technical discussion which end up with the missing the whole point of the debate, which is to extract large quantities of carbon from the atmosphere. So for the moment I am going to use a proxy so we can focus on the critical issue of adoption.

Imagine a unit which looks just like a normal air conditioning unit with a fan at the back and at the front is a screen and card reader, just like an ATM machine. To operate, a credit card is placed in the card reader and the amount of carbon to be extract is entered. Money at the rate of $25 per tonne is then deducted from the card.

A little water is needed so the captured carbon is emitted in the form of a soup containing complex organic molecules which provides nutrient rich irrigation for crop production. It also enhances soil properties, increasing the water holding capacity, nutrients and mechanical properties to resist wind and water erosion. This provides a major benefit for long term food security but does not necessarily have an immediate commercial benefit.

(This proxy operates pretty much as the actual technology.)

Costs and logistics

Sounds great? Now look at the snags.

First the units cost $1,000 each and can only extract 100 tonnes of carbon per year. To work effectively they must be placed at least 100 meters apart and they require regular maintenance. This is not difficult but does require training a large number of people.

Now the problem becomes clearer. To offset our current emissions means we need to extract carbon at a scale of at least 10 billion tonnes per annum. There are no technical problems but serious logistic problems.

100 million units would have to be manufactured, distributed and installed. There is no major manufacturer who even knows how they work, let alone with the tooling, manufacturing and distribution expertise.

The units themselves would cost $100 billion dollars to manufacture and install.

Then there is an annual payment of $250 billion.

A land area of a million square kilometers is needed.

The only practical way is to install the units over a significant proportion of current farmland in both developed and developing countries with the local people, probably farmers, trained to maintain the machines.

While this does present a major logistical operation it is perfectly doable. But the question is ‘Who is going to do it?’

Why should anyone spend $1,000 up front, then a further $2,500 per year thereafter, plus undertake all the maintenance work for the benefit of the community? No doubt there would be a few people, highly concerned about climate change, who would participate; - but nowhere near on the scale to offset our current emissions, it simply would not happen on a large enough scale.

With due respect to the lovers of economic rationalism and market forces; - when it comes to protecting our long term wellbeing Governments have to act. They have done this successfully with full community support on a number of cases, smog, acid rain, the ozone layer etc.

Ultimately the community pays as a result of Government action. It makes no difference whether the Governments introduces a carbon tax, cap and trade carbon scheme, direct action or whatever scheme the Government prefers, the community end up paying. The challenge for the Governments is to convince the community it is worth the cost.

This needs a value proposition.

Part 3 The Value proposition

Know your enemy!

How do I know what is happening in the climate change debate? I have set up a system of Google alerts and search engines like Environews to follow the debate. Every morning I log on to read the latest newspaper articles, fresh webs, blogs etc. I have three recorders setup to follow the various news items on TV which I can play back at my leisure. There are of course the old fashioned books; there is simply a huge library on climate change. I must have read thousands of articles, books and blogs on climate change.

Some of these, particularly the blogs, are nothing more than emotional rants; others, particularly the scientific articles, are written in the most obscure language so their meaning is hidden behind a wall of qualifications; some actually are an intelligent attempt to communicate. From all this barrage of information I try and interpret what is really being said and probably more important how it is being received and understood by the wider population.

The articles can be classified into four main types. The most prolific are from the climate change skeptics, there is a steady stream from professional commentators, typically scientists or economists, then there is the contribution from the environmentalist, finally they are the nutters who have really nothing intelligent to contribute but are required reading as they represent a significant section of this vocal community.

The value proposition

The first step any advertising or PR company will take is to develop the value proposition. This is not just marketing it is the basis of business and Government.

The value proposition is usually a simple sentence which sums up what you get and what the cost is e.g. if I buy ***ponggood*** I will become rich and famous and beautiful people of the opposite sex will want to press their bodies against mine - and it only cost $5.95 for a jumbo bottle.

We might not like such a commercial concept to be used with climate change but the fact is that the skeptics who are opposed to any action on climate change have proved masters of the value proposition.

The skeptics

The skeptics have been well described in Naomi Oreskes book ‘Merchants of doubt’, although much of the material was contained in Bob Reisss’es book ‘The coming storm’ a decade earlier.

They skeptics originate from two main sources. Those with a financial interest in debunking climate change and the political extremists who are conducting a battle against big Government and what they perceive as left wing plots. The chains of influence are usually well concealed and end up as respectable looking sources, with respectable looking web addresses.

While I find the tactics they use are often despicable I have to admire the shear professionalism of their approach. The can obviously afford the best PR operations in the business, and it shows. I have to admit reading one particularly slick presentation and almost deciding not to

write this document as I was temporally convinced that they were right. It was only after carefully going through each step of their arguments that the fallacies became clear.

The most obvious and therefore least effective is character assignation. I am sure they lose points to the more rational community with this tactic.

A most successful technique is manipulating data from respected sources. For example real data never follows the nice neat curves given in simplified publications. Climate change deniers are not restricted by the truth. Temperatures go up and down for a variety of reasons. All climate scientists recognize that climate is affected by a number of causes, the Milankovitch cycles, sunspots, volcanoes etc. Volcanic eruptions have had a measurable cooling effect on recent data.

This is well documented and has been incorporated into the models and analysis yet the deniers are happy to ignore these qualifications and select a portion of the graph which shows the world is actually cooling.

This is simply scientific dishonesty.

However the most common and effective is the 'black cat' technique, my cat is black, my dog is black therefore my dog is a cat. The argument goes that climate is always changing from natural causes so man cannot have any effect on climate change. This ignores that the final climate change is the combination of both natural and manmade effects.

Confusing climate and weather events is another trick. The sad fact is that we are not very good at predicting weather, particularly the severity. In the recent Queensland rains I carefully followed the rainfall on the BOM radar. We can reliably predicted rainfall but have really no idea how severe it will be. The rain that caused the Bundaberg floods was predicted but there was no indication it would be so severe. I live near Bundaberg and when I went to bed I was expecting just another wet night.

In the morning I was marooned with water flowing under the house. The extent of the rain was phenomenal, often floods are caused by a restriction so the water cannot escape, yet Bundaberg is open to the sea with no such restriction; - simply there was so much water that it essentially formed a dynamic wave like a Tsunami flooding the city.

A few days later we had the Toowoomba floods. Again I followed that on the radar and when the rain front crossed the coast at Gympie is was obvious that there was a major storm. I contacted a friend in Gympie who confirmed the dramatic rain. Following the radar I could clearly see the rain front moving towards Toowoomba. Neither I nor apparently the BOM had any idea that the effect of the rain would be so dramatic.

But how did the skeptics treat this? They produced a whole series of web sites and newspaper articles showing the previous major floods for the last hundred years or so. Their argument was that there had been similar floods in the past and that the increase in damage was nothing to do with climate change but simply due to the increased population and building density.

I looked through all the pronouncements by the climate experts. Not one I could find was saying that the floods were caused by climate change. Of course the floods were caused by natural weather variations over which we have limited predictive skills. These have happened before and will happen again.

The issue is whether climate change is amplifying these natural and unpredictable events.

The skeptics argued that major floods had happened before so the recent floods were natural events and was nothing to do with climate change. They were either not understanding the arguments that climate change was amplifying the natural weather variability or more likely were deliberately trying to confuse the issue.

This is the black cat syndrome. It is faulty, persuasive but highly deceptive logic.

The scientists

The popular image of science as a happy throng of researches all cooperating together to find the truth is not the way of the real world. Science is a blood bath with each scientist trying to prove the others all wrong. Even the concept of truth is fictitious; the last scientist to have a good run with what looked like an absolute truth was Newton with his laws of motion; - until Einstein upset the apple cart.

There is no such thing as absolute truth so every scientific statement has to be qualified in one way or another.

Nowhere is this more evident than in the field of climate science, there is really no way that you can conduct controlled experiments on the earth, other than the one we are conducting right now.

Naturally this certainly gives the impression to the public of significant controversy, disagreement and vagueness and a lack of conviction.

This also lead to a particular style of language in which meaning is shrouded in a wall of qualification, double or more negatives, conditional and subjunctive clauses which make the meaning, at least to those outside the club undecipherable.

For example; - *Given due consideration it is not beyond the probability of reasonable doubt that the benefits of retrieving the papyrus based information and entertainment package routinely delivered to the ingress and egress points on my boundary out way the probability of the kinetic energy of an intergalactic projectile resulting in mortality; - on this basis positive action on the former proposition is proposed.*

Let's rewrite the above proposition into the vernacular (sorry, try again). Let's put that into plain English; - I am going to pick up the paper from the front gate, if I get hit by an asteroid that is just stiff luck.

This is not atypical (a double negative which avoid directness let's have another go).

This style of English is typical of modern scientific language being presented to the public. It is totally ineffective at promoting the value proposition to the public.

We have to learn to be direct; -

Climate change is real and we are causing it

No one wants to give up the benefits of living in a modern technology based society

In the short term there is no way of reducing our emissions sufficiently to prevent climate change

The only viable solution is to remove carbon from the atmosphere

The technology already exists to do this but we have to change our land use policy.

That wasn't so hard was it? Better than going to the dentist.

The extreme environmentalist

It may be reasonable to hope that the environmental movement may counter the aggressive and dishonest promotions of the skeptics and the lack of directness of the scientific community to generate a convincing value proposition to win the public debate.

Unfortunately this is not true, so many of the claims made are so obviously exaggerated and without any scientific basis that they are discounted by the public. We are not all going to fry up into little black cinders.

While there intentions are exemplary the net result is to reinforce the image created by the skeptics.

I will explore this later in developing the value proposition but first I want to look at the arguments for denial.

Two levels of denial

The skeptics have developed two levels of denial. The first is to deny that climate change is happening at all. This is a progressively failing argument as the scientific evidence for climate change increases so the extreme deniers are branded as ignorant.

The smarter skeptics have adopted the strategy of saying that they admit that the climate is changing, that there is a possibility that if may be induced by man, but that the actions taken to resolve this are both damaging and counterproductive. The costs out way the benefits! This is much more convincing.

Based on wide reading of the climate change literature let me develop that one sentence 'value proposition' which can be offered to the public. First I have to review what we know then condense this into the value proposition.

Snowball earth

Some 800 million years ago the earth was in the grips on a major freeze, ice extended from the poles to the equator and the only life was a few simple single celled creatures. There was virtually no carbon dioxide or oxygen in the atmosphere.

Scientists explain this from what we now call a positive feedback. Ice at the poles reflected much of the incoming heat so the earth temperature dropped, it became colder so more ice was formed, the ice cap spread until the whole earth was a frozen wilderness. This is snowball earth.

Volcanoes erupted pushing volumes of carbon dioxide into the atmosphere. This resulted in a little warming, the ice caps retreated; - the open ocean absorbed more heat - so again the positive feedback melted more ice until the entire earth was warm; - some 10℃ warmer than today, even the poles were tropical.

Far from being a disaster for life, this was a period with the most rapid development of the widest variety of life forms ever seen on the earth. (Although some scientists believe that this era experienced violent storms.)

Extremists often refer to carbon dioxide as a pollutant. Far from being a pollutant carbon dioxide is essential to life, without it no life could exist. The concentration is the critical factor. Following the snow ball, concentrations of atmospheric carbon were many times current levels – and nature flourished.

Extremists also say the 2℃ is the maximum allowable temperature rise. Global warming has most impact nearer the poles, in winter and at night. The average person would simply not be impressed by a 2℃ rise (in itself). The elderly Swede, Canadian or Russian stumbling out of bed to relieve himself on a cold winter night is probably going to be quite happy that it is not so cold.

Portraying 2℃ as the critical issue does not help convince the lay person. The critical issue is the side effects.

At first the simple algae and later the plants started to extract carbon from the atmosphere, there was little oxygen so the dead plants were not easily decomposed and huge deposits of coal and oil were formed.

As more oxygen entered the air more life forms developed, the weirdest array of creatures the world have ever seen plus more simple organisms like the bacteria which are capable of readily decomposing dead plant material.

Stability with oscillations

Temperature and atmospheric concentrations oscillated wildly but gradually honing in an equilibrium state.

We have a good understanding of these oscillations but there were random calamitous events. For example the asteroid which put so much rubbish into the atmosphere that it caused global cooling and the extinction of many species, such as the highly successful dinosaurs. Today we have regular volcanic eruptions which cool the earth.

There were a regular series of ice ages and warm periods which no doubt inflicted great harm too many species; - many died. Those able to move escaped mass extinction.

Man the wonderer

Early man had to endure climate change on a grand scale, far beyond what is envisaged to occur due to current manmade climate change. The population was small and used very little of earth's resources and survived the ice ages and weather variability by simply moving.

We have no idea whether they understood which way to travel or if it was a random movement in different directions by small groups, with the groups moving in the wrong direction simply disappearing. All we know for sure is that enough breeding pairs survived to maintain the species.

Agriculture and civilization

However all that was about to change with the development of agriculture.

The first sign of civilization based on agriculture was in Syria around 9,000 BC as the earth moved out of the Younger Dryas era and into a warmer period. This was put on hold by an extended cold spell around 6,000 BC.

Then about 5,000 years ago it became warmer and agriculture really developed on a wide scale. This happened on a global scale based around the major river systems, the Yellow River, the Indus, the Tigress and Euphrates and somewhat later the civilizations of North and South America.

This had far greater impact than simply providing food. It took much less effort to produce food giving free time. A steep pyramid social structure developed in which the benefits were not equally spread, with the wealthy at the top enjoying unprecedented luxury and privileges, while those at the bottom, responsible for working this new miracle of agriculture were basically serfs; - a situation that has not changed that much in many parts of the world.

This pyramid structure, with the leaders isolated from the source of production left these civilizations particularly prone to collapse from the failure of the underlying agriculture.

Brian Fagan in his book 'Floods, Famines and Emperors – El Nino and the Fate of Civilizations' examines how these once powerful civilizations collapsed. Of course there was pretty continuous conflict and some of these civilizations were simply conquered. But they didn't disappear, it was a bit like a modern take over in the corporate world, the name plate changes but business goes on as usual.

As far as we know there was no major change in climate, e.g. global warming or ice ages for some 4,000 years from 3,000 years BC until the start of the medieval warm period followed by the little ice age.

Yet during this period virtually all of these civilizations went through major or minor collapses. The prime cause was the effects of El Nino or more precisely the Southern Oscillation Index in the Pacific and the Atlantic Oscillation in the Atlantic.

The disaster was caused by a combination of floods and droughts. The most well-known was the drought of 2180 BC in Egypt which decimated the lower Nile Kingdom; - the civilization was only saved by some food still being available in the upper Nile which could be transported to the starving people in the lower Nile.

But excessive rains also caused widespread destruction; - decimating current crops, removing fertile top soil, leaving what soil remained vulnerable to any following drought.

Collapse does not seem to be directly related to temperature change but failure of the agricultural system caused by extreme weather resulting from El Nino or La Nina.

The populations did not die out completely they simply reverted back to their peasant state, unable to support the top heavy burden of civilization.

Modern times

Much more potent information is available from recent history were we have records and the occurrence of two major climatic shifts, the Medieval warm period and the little ice age which extended right up until the start of the industrial era in the 1850's.

The Medieval warm period lased for some 500 years ending with the little ice age in the 1300's. It was a benign period, warmer that today's climate but above all settled weather. During this period population expanded dramatically as did agriculture until most of the best fertile land had been cleared. There were of course good and bad seasons but grain, sufficient to tide over a bad season, was stored in the 'long houses' of that era.

Grapes were grown in England virtually up to the Scottish border. No doubt some people went hungry, that is a feature of the world, but there are no signs of major famines throughout this period.

It would appear that if the climate is stable that a little extra warmth is probably beneficial.

However that all came to an end in dramatic fashion.

Graphs of temperature changes over the centuries tend to show nice smooth curves as though changes were gentle with smooth transitions. It appears however that this is not really what happens; changes are dramatic occurring over a time scale of decades rather than centuries.

This is certainly the case with the start of the little ice age. It may not be clearly reflected in simple temperature graphs but the records show a tempestuous time.

The medieval warm period came to an end with violent storms; the descriptions of water flooding in from the sea with high tides increased by storms are reminiscent of modern catastrophes. But this was just the coastal areas, inland floods and the drenching of the soil destroyed crops and which was the foreteller of widespread famine and starvation.

The effect on society was dramatic. Countries varied in their ability to handle this dramatically changed situation.

The Dutch were the first to recognize the changed situation. They revised their agricultural system, reducing reliance on wheat and grains which only grow under a limited range of climatic conditions. They replaced the traditional fallow season by growing fodder crops such as clover to improve the soil, made wider use of animals to provide nutrients to the land and introduced the humble turnip as a fodder crop for animals (and humans when things got bad).

The English soon realized the benefits of the Dutch system and widely adopted the concepts. But they also changed the entire structure of farming merging the many small plots worked by individual peasant labour from the local village into much large fields which were more effective producers of food. This may have caused great political unrest but it kept the population largely fed under adverse conditions.

The French failed to notice, or at least act, on these agricultural revolutions, resulting in mass starvation and political unrest. Destitute villagers formed gangs, roaming the countryside, searching for food and taking it by force when needed, terrorizing the local residents.

This ultimately led to the French revolution and the overthrow of the Government. Nowhere was this climate induced overthrow of the established Government more spectacular than in China. Millions of Chinese had starved to death when the social pressure became too much and the Ming dynasty was replaced using violent force and replaced by the Manchu dynasty.

During the medieval warm period the Vikings had established a viable community in Greenland. There traditional farming system was largely based around dairy farming. They gradually ate their herds to stay alive. With their cattle gone many simply died of cold and starvation. They failed to adopt the technology of the Inuit's who had survived for generations in the cold climate and continued to survive throughout the little ice age. A lesson in adaptation!

The only obstacle to the Viking learning from their neighbors was the obstinacy in adopting a different technology; - just like the French.

The effects were not just confined to the land. The abundant fish shoals moved away from the shore as they became ice locked. The open fishing boats were not capable of extended open sea voyages which removed a valuable source of food for those societies relying on open boats. The English developed the dogger, an enclosed boat which could stay at sea for long periods in the roughest weathers.

They would venture out as far as the Newfoundland coast to harvest the huge cods stocks and return in the winter. As the ice age developed the seas became too rough and cold for even these hardy boats. This was one factor which sponsored the Pilgrim Fathers, to have a land based community which could outride the winter.

It is somewhat ironic that the country most recalcitrant on climate change, the US should have been partly founded to mitigate climate change.

History teaches us that mankind has repeatedly failed to take action in the face of an obvious threat; - a trait which is painfully obvious today as we see with the lack of action on climate change.

Temperature rise, floods and drought.

I have tried to show that the excessive focus on temperature rise, as a means of persuading the public, is simply not working. The public has to regularly to cope with temperatures from below freezing to above 40C. They view a couple of degrees rise in temperature as insignificant.

And of course the skeptics who promote any idea to help their cause are correct. (I admit with reluctance). History over the last 600 million years shows that life has flourished with much higher (and lower) temperatures.

The recent history going back 5,000 years has shown again that people can flourish at higher temperatures. The greatest threat today is not a small increase in temperature but the extreme weather, excessive rain, floods and droughts. This results in the immediate loss of food production but more important the destruction of the top soil which provides the basis for reliable food production.

Greenhouses gases are intimately connected with the flood and drought cycles. Green houses gases mean an increase in energy input to the earth. But this energy is not distributed uniformly over the earth: - more energy is received at the equator. This unequal distribution of energy causes the winds and ocean currents which circulate around the globe.

But these winds and ocean currents are not steady, with nice uniform laminar flow; they are turbulent which results in the great variability of our day to day weather. Recent studies have shown that wind velocity and wave heights are increasing.

The greater water holding capacity of warmed air naturally mean rain is less likely in dry areas. The minor weather events which would previously have resulted in rain no longer produce rain. The air can hold onto the extra water. But a more significant weather event will results in rain, but now the air contains much more water so the rain is much heavier. Dry areas will tend to be drier and the wetter areas more likely to be heavy, and as we have seen destructive rain.

Climate change scientists may express this in different words but the meaning is clear. Climate change by itself does not cause the flood and drought cycle, that is a natural weather event, but climate change will amplify these natural events making them much more severe.

This flood and drought cycle causes great damage to our infra-structure, as seen in the recent Queensland floods, but the greatest damage is to our agriculture. There is of course the short term loss of crops, but much greater damage is caused to the soil.

The brown mud which devastated many people homes in Brisbane was our prime top soil swept away by the floods. Soil deprived of organic contents has little mechanical strength and is easily swept away by either floods or winds following drought.

Modern agriculture

Of course just because the ancient civilizations collapsed because of failure of the agricultural system does not mean that ours will also collapse. We have far greater knowledge of fertilizers, soils, plant species and genetics. However knowledge does not automatically mean wise application. Modern farming is not balanced, it is fragmented and under great pressure from the powerful and consolidated distribution system. These short term pressures have led to the adoption of short term practices which reduce the capacity of the soil to resist pressures from extreme weather condition, such as floods and droughts.

The largest threat from climate change is the loss of top soil from freak weather events and the inability to produce enough food.

Summary of key points

Let see what we can do to improve the value proposition considering the proxy innovation.

First we must stop talking about global warming or temperature increases. There is no doubt that human activity is raising temperature but a simple rise in temperature of itself is not a serious problem. We have to look at the follow on effects.

Warm air can hold more water than cool air. Global warming means that an average evaporation will be higher and what goes up must come down so rainfall will increase. But rain only occurs when the air cools so warmer air with its higher water holding capacity will not

cause rain under marginal conditions, e.g. dry regions may end up by becoming drier but when it does rain the volumes of water falling will be much higher. Drier regions will get drier while the wetter regions will get wetter.

The sheer volume of water falling in the recent Queensland floods was truly awe inspiring.

Those doubting this simple logic should compare the climate of say the North of England where it is cold and rain falls as drizzle 1,456 days a year (People only survive in that climate by developing a peculiar sense of humor) with say hot tropical Queensland where rain is torrential.

Energy from the sun does not give uniform heating across the globe, the equatorial areas heat up most raising the temperature of the air which therefore causes wind and also sea currents.

Increased greenhouse gases will increase the disparity between hot and cold regions and hence increase these atmospheric winds and sea currents. These currents are complex but are likely to increase the El Nino La Nina cycle. (This is an area where we desperately need the climate scientist to come out with clear publicly meaningful statements.)

Climate scientist have no hesitation in linking La Nina, which caused the highest recorded sea temperatures of the Queensland coast with the devastating floods.

Climate scientists have already made it clear that they are not saying that climate change caused the flood (or drought cycle) but that they will make the cycles more extreme.

The biggest threat is to agriculture. The brown mud which invaded much of Brisbane is our prime top soil, it will takes years (left to nature) to replace that soil.

No one would want to overplay history but agricultural failure, following El Nino's caused the collapse of early civilizations.

In preparing a value proposition for the public it is best to focus on the critical issue which is the worldwide damage to food production. Other factors such as the damage to infrastructure, rising sea levels etc. are important but must not direct the focus from the global threat to food production.

Any value proposition must clearly state the costs. Using the technology of absorbing carbon from the atmosphere would cost Australia $4 billion per year, assuming the cost were apportioned on the basis of our emissions. This is real money but trivial in relation to other expenditure representing some $200 per person.

However climate change is a global problem and we should not just think about Australia but take a global perspective. Without any shadow of doubt the most effective action the Australian Government could make is to help introduce this technology to China. China with its 1.4 billion populations is far more exposed to climate change than Australia, it has already suffered devastating droughts and floods which has threatened the ability to produce enough food for large population.

The Chinese Government has already demonstrated that is committed to action on climate change and has specifically asked the developed countries to provide technology to adapt to climate change.

China is a lead country for the developing nations. Adoption by China would lead to virtually automatic adoption through the developing world.

This (if carried out on a global scale) would bring carbon into balance. Extracting carbon from the atmosphere removes the big fear that prevents people accepting action on climate change; - the fear that it would mean giving up all the benefits of living in a modern technology based society.

The simple fact is whether it is driving your car to the supermarket or having a sophisticated hospital service available if you run over your foot with the lawnmower, no one wants to give up the benefits of modern technology.

The final value proposition

The final value statement reads like this; - we need to take action on climate change to prevent destruction of our soils from increased severity of the flood and drought cycle.

We will do this within Australia by removing carbon from the atmosphere and embedding into the soil. We should also work with the developing countries, particularly China, by providing them with the technology to absorb carbon, so they can still grow their economies without increasing their emissions.

Putting the value proposition in its simplest form ‘for 60 cents per day you can stop worrying about climate change and get on with enjoying all the benefits of modern living with a globally assured food supply’.

Not a bad deal!

Part 4 The real technology

I deliberately used the concept of a proxy technology to emphasize the problems of adoption. Now it is time to look at the real technology.

The solution is to find a way of removing carbon dioxide from the atmosphere. The solution has been given to us just by looking over the last billion years ago when the earth was recovering from planet snowball. Since then there has been a continuous battle between the plants and the plant eaters.

At first the plants were busy extracting carbon from the atmosphere but there was little oxygen in the atmosphere. Without oxygen there is no decomposition so the plant material started to form coal.

As oxygen levels increased, aerobic bacteria developed and so decomposition started returning carbon dioxide back to the atmosphere. But this was a time of high humidity and swamps so much of the carbon extracted was retained; - may be at a slower rate but still vast quantities of carbon were removed from the atmosphere.

Then the battle turned; - with the air full of oxygen the plant eaters began to gain the advantage, with increasing levels of atmospheric carbon dioxide. But the plants struck back developing lignin which animals and bacteria could not attack. Carbon levels dropped.

But then the battle turned again, dinosaurs and termites developed ways of attacking the hard lignin; - it is reported. We know that termites can attack lignin but they are not able to digest it themselves. They dedicate this to fungi which they nurture in their hills which digest the lignin making the food available to the termites. Termites were the first carbon harvesters.

I am not so sure about dinosaurs. Even Mr. Google could not tell me how dinosaurs managed to digest lignin; other than they had gizzards filled with grinding stones and could store the lignin for a very long time.

But the battle never stops. Plants developed a whole range of defenses, particularly thorns and chemicals. The chemicals in particular I know to be are highly effective. Tree roots live in the midst of a highly aggressive environment yet survive without being attacked. Anyone who has tried to chop a fresh root system appreciates it toughness. Yet after just a few months the fungi, without the chemical protection, have got to work destroying the roots.

Plants are extremely sophisticated chemical factories, putting out a range of toxins to protect themselves from animals, insects and other plants.

Vegetation is highly effective at removing carbon from the atmosphere. It does not appear to be generally recognized that vegetation absorbs some thirty times all manmade emissions.

The power of vegetation to remove carbon from the atmosphere may be high, but the rate of absorption is virtually balanced by an equally dramatic return of carbon to the atmosphere.

Rotting vegetation is the largest source of carbon dioxide entering the atmosphere dwarfing our current emissions.

This is an incredibly important but little published statement and it is pays to make sure the full implications are recognized.

With an understandable logic, the conventional focus has been on increasing absorption e.g. planting more trees. The preferred option is for the carbon to be captured permanently, for example, wood used in building or furniture.

The question 'what can we do to slow or stop the flow of carbon dioxide back to the atmosphere?' is rarely asked, yet this is the by far the largest flow of carbon into the atmosphere.

It is often reported that the largest emitter of carbon is coal fired electricity generation. This is not true; the largest emitter by far is decomposing vegetation. The reason why it is not generally considered is that this is carbon that has already been extracted from the atmosphere, therefore there is no net gain; - it does not count. But it counts just as much as any other carbon molecule.

Carbon is carbon; it makes no difference where it came from. Slowing the rate of return of carbon to the atmosphere is just as effective as taking more out by, for example planting more trees.

Plants are already extracting large quantities of carbon dioxide converting this to complex organic molecules and storing energy. This is happening right now at no cost or inconvenience to us.

The problem is that photosynthesis produces complex organic molecules which contain large amount of energy. This is after all what makes coal and oil so valuable. However because they contain so much energy there is a tendency for them to release their energy and breakdown into simpler but more stable molecules like carbon dioxide and methane.

This follows naturally from the laws of thermodynamics which says that a system will always tend to the most stable state (increasing entropy). Just as water always runs downhill - carbon systems always tend to the most stable state, usually carbon dioxide, with the release of energy.

We quite rightly worry about the amount of greenhouse gases we release to the atmosphere by burning fossil fuels. Of course we should make major efforts to reduce our emissions. But we pay very little attention to the simple fact that the release of carbon dioxide from the decay of organic waste far exceeds man made emissions and is by far the largest contributor to greenhouse gases.

The simple fact remains that we could resolve global warming by simply slowing the rate at which organic wastes breakdown which returns carbon dioxide to the atmosphere.

This simple statement receives virtually no attention in the global warming debate for reasons which are difficult to identify. It may be that the importance of this concept has not been fully appreciated or it may have been written off as an idea which is just too complex and difficult to resolve.

The study of how things decompose, which I assume would be called rotology, is not the most fashionable. Announcing that you are a rotologist is not the best pick up line at a party.

There is a mistaken argument that it does not matter that organic waste is being returned to the atmosphere as it simply returning carbon that has already been extracted.

The level of atmospheric carbon is not a static problem, like water in a water tank which simply fills with water.

It is dynamic, with large amounts of carbon entering and leaving the atmosphere. It is like a river which will rise if extra water is added, by say a tributary receiving local rainfall.

This is what has happened with manmade emissions; a small extra input upsets the dynamic balance thereby raising the level. Reducing the rate of return of atmospheric carbon will lower the level.

The decomposition of organic waste

Vegetation contains complex organic molecules which contain high levels of energy which is easily released.

This is precisely what happens when vegetation is burned, with almost all the carbon being converted to carbon dioxide. Similar results can happen with the deadly combination of oxygen and UV light. It may be slower and less spectacular (and indeed unnoticed) but organic waste left on the surface will decompose by UV initiated molecular decomposition converting almost all the organic material to carbon dioxide.

Organic material under the ground where it is protected from UV light will be attacked by micro-organisms, particularly aerobic bacteria. The conventional high temperature composting process, powered by high temperature aerobic bacteria, is effective at releasing the energy and hence carbon dioxide.

There is however some residues, complex but stable molecules, generally referred to as humus, which are thermodynamically stable and improve soil quality. Low temperature aerobic composting will retain a higher percentage of carbon.

Immersion in water leads to anaerobic decomposition, typically by bacteria or algae with the release of methane, a more potent greenhouse gas than carbon dioxide but a potential source of alternative energy in bio digestion.

Fungi are particularly effective decomposers which, while still releasing some carbon dioxide to provide their energy source, are particularly effective at improving soil quality.

They form large underground structures and the tips of their hyphae excrete enzymes which penetrate rocks and soil particles, bonding organic matter and the soil together. The result is a strong open soil structure highly beneficial for plant growth and with the organic material locked into the soil particles.

Macro soil organisms are also effective decomposers which again may leave stable residues.

The humble earth worm, for example has bacteria in its gut for decomposition, which again releases carbon dioxide but it also releases a chemically stable glue which lines the outside of its burrows which stabilizes and aerates the soil.

Deep feeding worm will take organic material which will readily decompose under UV light and takes this material deep into the ground where it is protected.

Microorganisms (with the exception of some algae) cannot use photosynthesis to produce energy and depend on the breakdown of the complex molecules to provide their energy source.

It is impossible to stop all carbon being released back to the atmosphere but it is possible to capture a significant proportion. Clearly this proportion is critical. The chemically stable residuals after the energy has been extracted are what really matters.

It only requires 3% of the carbon in vegetation to be permanently captured to balance human emissions. Atmospheric carbon is dynamic, with large flows into and out of the atmosphere. The carbon captured does not even have to be permanently retained; all that is required is for a floating balance to be achieved.

Mycorrhizal fungi are particularly beneficial. They form a synergistic relationship with the plant in which the plant provides sugars for energy while the fungi send out their hyphae which have a far larger area then the roots. They are extremely fine and able to collect nutrients and water which they trade with the roots in return for sugars.

The plants extract carbon dioxide from the atmosphere, with the aid of sunlight convert to sugars and starches which feed the mycorrhizal fungi which in turn exude chemically stables compounds which form the basis of stable humus.

To summarize: - all methods of decomposition release energy and carbon dioxide, this is inevitable, but some methods such as burning, release virtually all the carbon while other methods, such as fungi, will only release a small amount of energy and leave a remainder of stable organic material.

This stable organic material can be embedded in the soil creating a highly productive organic rich top soil.

Examining the soil carbon debate

Soil is second only to the oceans as a carbon sink. The amount of carbon in the soil far exceeds atmospheric carbon. We only have to look at the Savannah belt stretching around the world in both hemispheres to see soil many meters deep holding large amounts of carbon. This has been building up over many years.

Look at all the coal and oil we use and is causing global warming; - this has all originated from vegetation which has extracted carbon from the atmosphere and then resisted degradation so the carbon has been conserved.

It may be true that conventional methods of soil carbon capture may only have limited effectiveness, but we should not look at the current state, but what could be achieved with innovative technology. Modern farming techniques, such as no till farming, were developed to improve farming productivity, particularly by avoiding loss of water with conventional ploughing.

They were not developed specifically to capture carbon; - that is just a fortunate bye product. We have to look at what can be achieved by modifying farming specifically to capture carbon. In the short term this will cost the farmer more money so we have to pay the farmer to capture carbon. The improved soil is a longer term benefit for the farmer.

Carbon can also be sequestered by growing carbon crops or incorporating external sources of organic waste. This greatly increases the soils capacity to capture carbon.

When organic material is added to the soil the natural microbiology will use this as an energy source and release either carbon dioxide or methane to the atmosphere; - this is inevitable. But a certain amount of the organic material will end up as chemically stable residues which can become locked into the soil. These residues are what we need to focus on, not the component which is readily broken down and re-enters the atmosphere.

These residues can build up very large volumes. Every mm. of carbon stored over the farm area of China equates to a gigatonne of carbon stored.

It is time to rethink soil carbon afresh.

Bacteria and Fungi

Bacteria and fungi both decompose organic material, but they do so in very different ways. Bacteria are microscopic and (generally), they obtain their energy by decomposing organic material using oxygen and nitrogen and releasing carbon dioxide. They have relatively short lives when their bodies are attacked by further bacteria, so very little of the atmospheric carbon is retained in their bodies. They are most active at higher temperatures with ready access to air.

Fungi are fundamentally different, like bacteria they obtain their energy by decomposing organic material, they need less oxygen and nitrogen but they are very long lived with much of the carbon being retained in their structure. They can form very large structures, the largest living organism is a fungi spreading over several hectares.

The mycorrhizal fungi form synergist relationship with plants, they plants provide them with energy in the form of sugars while the hyphae of the fungi extend over a much larger area and are finer than roots and more efficient at extracting nutrients and water from the soil. They increase plant growth significantly.

The key to absorbing carbon from the atmosphere is to manage the conditions to favour fungal rather than bacterial growth.

Land management and new agriculture

In my introduction I conjured up a proxy technology which can remove carbon from the atmosphere. Hopefully I have shown that by changing our agriculture system we can use the plants to absorb carbon which by controlling the decomposition process embeds the carbon into the soil. This is a process which has to be managed by the farmer.

First we need decomposition chambers. These are very simple. A trench is formed and lined with a waterproof liner such as a polythene film. Certain leaves, such as eucalyptus leaves, are effective at sealing the soil and provide an effective alternative to plastics film.

Organic material is buried in the soil into these lined channels (which also act as means of irrigation), which are periodically filled with water. These damp conditions favour fungi decomposition over bacteria.

Inoculants in the form of worm eggs and mycorrhizal fungi are added so bacterial decomposition is largely replaced by fungal decomposition.

The mycorrhizal fungi will attack the organic material to extract nutrients and water which they supply to the crops, this if a very productive system which enables us to grow more food from smaller areas.

Second we must have a large supply of organic material. This has to be on the scale of billions of tones. It is the scale that presents the challenge.

The first and simplest source is agricultural waste which is already available on farm.

The amount of agricultural waste is insufficient to balance all the carbon we are likely to be emitting in the future.

But we can increase the amount of organic material in a number of ways.

The growing system is highly productive so the farmer can devote some of his farm to grow carbon crops. These may be fast growing plants which can be pruned or with the ability to copse. These can be repeatedly chopped or pruned to provide a regular source of organic material. They may be productive trees in their own right, for example fruit or timber trees. Again these can be supplied with water and nutrients from the lined channels so they are highly productive.

As these are nonfood plants sewage can be safely used to provide both water and nutrients. In the lined channels there is no danger of sewage entering the water table.

The farmer can select deep rooted plants which mine nutrient from deep in the earth.

Forests are an additional source of organic waste. Forest waste, trimmings and undergrowth can be granulated to form the organic material. This minimizes the risk of forest fires and avoids the need for controlled burnings to remove excess fuel.

Our cities provide an additional source of organic material. The design of cities is undergoing a major rethink, with a tendency to high rise buildings and parks. The parks can be designed for a combination of recreation and carbon capture.

Even the traditional suburban layout can generate organic material by setting up green waste recycling schemes.

Cities produce millions of tonnes or organic waste, often this is disposed of in land fill which is particularly harmful as it generates methane. Again this can be separated and recycled on farm. Urban waste is a major source of carbon.

But we should not be totally focused on climate change; we should look at the wider problem of ensuring a sustainable system which will not damage the environment when we have a population of some 9 billion affluent consumers to feed.

This increased population will create major problems in ensuring sufficient nutrients (and water). Fertilizers, particularly nitrogen are highly energy intensive while phosphorous is becoming in short supply.

There is a general reluctance to use human sewage directly on food crops. This can be used on farm to provide nutrients and water for fast growing plants, particularly varieties that copse.

This would mean that some farm area would have to be sacrificed for carbon capture but this loss would be more than compensated for by the increased productivity in the decomposition beds. The safety hazards of using sewage are avoided as there is no connection between the sewage and food crops.

We need to be looking at our total land area to seek additional sources of organic waste.

Conclusion and requests

This is not Libya, this is democratic Australia

I was trained to approach problems in a logical and systematic way. But at times it's appropriate to show emotion. I live in rural Queensland; I talk and listen to people, in the pub, in the doctor's surgery and the supermarket. Let me tell you how common talk has changed.

This time last year, ask the average Queenslander about climate change and you would have got some earthy reply such as 'a load of bloody greeny crap'. The floods came; the reaction of the Queenslander was the tough fighting spirit, climate change - still nonsense. They were almost proud of their eccentric weather.

Now the floods have gone, the high flying politicians and celebrities have come and gone, but life has not returned back to normal. It still rains, not the dramatic rains of the flood but virtually every day we get a heavy shower or heavy rainstorm. Much of the land is not drying out as you would expect this time of the year, this is supposed to be the start of the dry but it still rains.

Everywhere is mud; the soil is still saturated with no sign of drying out. Under my house which was flooded out in grand style there is still stagnant water, despite all the drains I have made.

I have an experimental plot I use for my research into new farming methods. This was flooded out in the rains and my experiments bought to a temporary halt. I, like the other local people, thought it would soon dry out. Bu the rains keep on coming. The conversion of the skeptics is not coming from some great theoretical argument or natural disaster. It's coming from mud, day after day after day. It is just wearing peoples resistant's down.

People talk has changed; - they are no longer the hard line skeptics, they are now saying the weather has changed. They are in fear that we are going to get some other punch in the belly from the weather, another drought another flood, no one knows but now their confidence that life will go on as before is crumbling.

They look to the Government to protect them from the next disaster.

Now these are rural folk, practical people. Digging trenches, filling with ground up wood chips, sugar cane waste etc. throw in some manure, fungi spores and worm eggs, cover back up and keep moist. This is something they can understand and see how this would cut back atmospheric carbon, which they now see as a real threat. This is something practical they can relate to.

Much as I hate admitting it, the skeptics are right when they say that a carbon tax provides us no protection against climate change. It is unlikely to significantly reduce our emissions but even if it did the greenhouse gases that threaten us originate from the major emitters overseas.

On a global scale, with the increased emissions from the developing countries, we are just not winning the climate change battle. Our traditional approaches of reducing emissions have failed miserably.

We need an alternative approach and that is by removing carbon from the atmosphere by a worldwide revision of farming practices.

So what do we do?

All we can do is to put proposals to our Government, who believe in action on climate change, point out as respectively as we can the dangers in their current policies and promotions.

So here is the proposed action plan.

The proposed action plan

First is to promote that Climate change is real; - the major threat is damage to global food production from the amplified flood and drought cycle. This can be resolved, at reasonable cost, by embedding carbon into the soil.

Second we cooperate with China.

From the point of view of climate and geography the main agricultural regions of China along the Yellow and Yangtze have much in common with our Murray Darling Basin benefiting technical cooperation. The organization structure of Chinese farming, with its myriad of small farmers will lead to the development of simple, easy to apply systems, which will benefit Australia.

Thirdly, within Australia we can set up major carbon farming schemes. In particular the Murray Darling Basin makes a good starting point for carbon farming. The new technology is highly water efficient, eliminating both evaporation and water passing beyond the root zone. Less water is needed which immediately helps resolve the tension over water within the basin and would release more water for environmental flows. The irrigation licenses that remain will be partially used for carbon farming which has immediate environmental benefits.

Significant funding has already been allocated to rectify the environmental problems of the Basin so there will be little if any extra cost. This would resolve one of the major problems within the basin by providing extra revenue to the farming communities which are threatened by the reduction in water licenses.

The current carbon capture schemes initiated by the Government certainly make giant steps forward but are not exactly clear or easy to understand. For the needed widespread adoption a proper support structure for farmers need to be set up with local advisory services.

There are already a well-established carbon farmers, the Government can set up schemes with selected farmers to establish experimental and demonstration farms. These would need to be assisted by research and technical support from the Universities and CSIRO. For example the required mycorrhizal fungi are available commercially on a finite scale, but there does not seem to be any research on optimizing varieties for different climatic conditions. Selection of plants for optimizing carbon capture would also benefit from further research.

There is ample potential to refine the technology; another example is by improved machinery for automating the laying of beds.

A critical issue is the monitoring of carbon captured. Simplified, more practical methods which take into account the large numbers of individual farmers and the variety of soils and growing conditions are needed. While such systems have been concepted there is a need for detailed scientific research.

Monitoring should recognize that soil carbon is dynamic; the concept of permanent soil carbon should be replaced by a system which monitors both gains and losses. (Put so briefly this may sound complex but is actually much simpler than trying to estimate permanent soil carbon).

Research grants to the various scientific organizations would lead to rapid improvement.

The scale required to absorb the sheer volume of carbon present major logistical problems. This requires the cooperation of land managers, local authorities, water and sewage operations etc. This is simply not going to happen by creating the so called right conditions and hoping that market forces and economic rationalism will automatically make it happen. A centralized Government controlled and financed operation is required to establish the system.

May be when this is established and the expertise of the large scale operation developed the market may be able to take over many of these functions.

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Note, these are some of the web sites reviewed during the search. They are not recommended as a source of information, only as an indication of what people are saying.

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