The next great change

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Preface

Imagine if thirty years ago someone had predicted that in thirty years time (e.g. now) the largest most successful companies would not be the auto makers or the oil industry but companies with odd names like Apple, Google and Face Book who made their serious money not from physical products but from providing services These services would seem totally unbelievable at that time but would include ways in which people could locate, communicate and share massive amounts of information with other people anywhere in the world by something called the internet. Friends would be looking up the local mental institution.

Now I want to make predictions for the next thirty years. The internet age will have matured and stabilised and the next burst of new companies becoming the largest and most successful companies would earn their living by services to manage the environment. People would be concerned for my mental state or put it down to the powerful painkillers I am taking to make live liveable while I recover from the current attack of Shingles.

It is common to look at the environment issues with a long face and a feeling of gloom. Just look at this scenario.

Thirty years ago there were some 2 billion people, largely in America and Europe living an industrial life style putting pressure on the environment. There were some 3 billion people in developing countries living essentially a peasant existence and providing environment services to the rich nations. The industrialisation of the developing world has increased the number of people living an industrial life style from 2 billion to 5 billion people living an industrial life style and the number living a peasant existence has dropped to 2 billion.

In the next thirty years we can expect that the number of people living an industrial life style will rise to 8 billion with only a billion living a peasant life style. That is the astonishing figure of a fourfold increase in a generation.

The pressure on the environment has never been experienced before but man is an intelligent creature and we need the confidence that he will learn to live within the environmental resources, even if not this generation with their set views but the next generation.

We know that the green revolution, basically genetics, irrigation and fertilisers has given us a temporary surplus of food. However there is a toll on the soil in the destruction of the soil biology which reduces the capacity of the soil to regenerate and be able to recycle nutrients. We are essentially mining our soil in a non-sustainable way. But again this is soluble with known technology.

But technology can resolve the food problem if we stop wailing about Armageddon and get on with the job of applying technology. Agricultural technology, if applied correctly, can easily feed the increased population. There will still be hungry people but that will be because the lack of access to technology, capital and education to take advantage of technology, that is a social not a technical problem.

We can add to these problems and consider the current failure to make any impact on the ever increasing carbon dioxide emissions and the wider spread health problems of obesity, diabetes etc. the almost automatic response is to anticipate a sense of Armageddon with a deep sense of gloom and impending disaster.

Now if, like me, you are confined to a room, unable to do much but think and dosed up with painkillers you may take a totally different view and see the apparent impeding disaster as a major opportunity for a new breed of organisations to develop which in resolving these problems become major and profitable players on the world economy.

If this seems farfetched then hopefully the following analysis will show that this is a realistic view and that there are major opportunities for the willing.

Let me put the arguments.

How real is the crisis

We may worry about the predicted coming food crisis from conventional wisdom but let's break the paradigm and take a different view.

When we think about food we tend to think about quantity, will we have enough food to eat. Let us think not just about quantity but quality. I spend time living in China – a totally food oriented society. The quality, variety and freshness of food are virtually a national entertainment. Now while western food is making a minor impact bringing the western health problems the vast majority of Chinese eat well and a free from the problems of obesity and diabetes.

This should give us the clue that when thinking about future food we should focus on quality as much as quantity, and good food comes from good soil, and the way to make good soil is to increase the soil biology which means increasing the carbon content. But where do new get the carbon.

The air is full of carbon which now is seen as a major problem. Burning fossil fuel to produce electricity is the largest source of manmade emissions. Multibillion research programmes have been conducted to sequester the carbon dioxide from power stations deep into the ground; - without a great deal of success. Yet the much easier approach of storing carbon in the soil, which also improves food quality and quantity, has received remarkably little research.

The question which needs answering is how much carbon could be stored in the soil? It is easy to do some quick calculations, assuming a depth of only 500mm and a carbon content of 10% shows that the soil could potentially absorb 500 tonnes per hectare or 50,000 tonnes per hectare. Land areas are shown in http://en.wikipedia.org/wiki/List_of_countries_and_dependencies_by_area.

The total land area is some 150 million square kilometres, it is also interesting to look at land areas of specific countries , China, U.S., Australia, and Brazil all have areas have areas just under 10 million while there are numerous African countries like Ethiopia with areas around a million hectares.

Based on looking at available land in selected countries we can estimate that 20% of this land area will be available for storing carbon. That gives a total storage of 1,500 gigatonnes.

This upper limit could be raised by simply increasing the depth of soil in which carbon is stored. Increasing the depth to 2 metres has soil benefits which involves a little extra work but increases the capacity four fold to 6,000 gigatonnes.

This has to be compared with carbon emissions; -available at
http://en.wikipedia.org/wiki/List_of_countries_by_carbon_dioxide_emissions

The total global emissions is some 30 billion tonnes with the top three China, the U.S. and Europe emitting 7.5, 5.5 and 4.2 giga tonnes.

What does all this mean in reality? First 30 gigatonnes per year is an awful lot of carbon dioxide; we cannot continue to pour this amount into the atmosphere year after year without dire consequences. But storing carbon in the soil gives us a potential window of time to come up with alternative technologies. When you look back on the dramatic changes in technology over the last 50 years this seems eminently doable.

In the late 1800's a major environmental problem was the fouling of the streets with horse manure. At that time this seemed insoluble, yet out of the blue a new technology, the car, emerged resolving that problem (but creating new problems). This should teach us the unpredictable nature of technological development.

However this figure for global carbon storage is purely an upper estimate of how much the soil can hold and does not mean that it can actually be achieved, for that we have to resolve two problems first getting the carbon in the soil and then getting it to stay there.

Trees work

I feel like making inane remarks about not seeing the wood for the trees, but it is absolutely true. Trees really do work; they absorb some thirty times all man made emissions. In summer when trees are 'working' the atmospheric carbon dioxide plummet. So why all the fuss, if thirty times man made emissions is not enough then just plant a few more trees and make it forty or fifty times man made emission. 'Plant more trees' is a slogan promoted by environmental groups and is embedded in various legislations around the world, and let's face it, if it weren't for trees we would have been in a serious mess with climate change long ago.

But when there are some 5 billion people all with cars and air conditioners and fridges etc. the trees we have to day just cannot cope. Planting more trees is not going to solve the problem even if we could find the extra room to plant all those new trees. So we have to go back to the corny phrase about not seeing the wood for the trees and see if we are missing something very important.

And we are!

The clue lies in the statement that vegetation absorbs some thirty times all man made emissions. Now if that statement was true without qualifications, then there would be no talk about having to reduce our emissions, in fact they would be looked upon as a good thing, stopping the world from freezing.

So what is the qualifying statement that we are missing? It is simple; - the vast bulk of the carbon absorbed goes back into the atmosphere from decaying vegetation. All those charts which list the various sources of carbon emission, putting coal fired electricity generation at the top are all wrong! The biggest source of carbon emissions, by far, is decaying vegetation.

So why is it that stopping this return of carbon dioxide is not number one on the scientific agenda. Well that is a question for the scientific historians and is probably the same as why companies like Apple, Google, Face Book did not come from the established scientific establishments but were pioneered by individuals with a great idea and passion.

But stopping carbon re-entering the atmosphere and instead imbedding the carbon in the soil is precisely what wicking beds do.

Wicking beds

Wicking beds were designed to regenerate soil. Soil is created by biology - the myriad of fungi, bacteria, worms and the host of other creatures that make soil their home. It is largely the fungi that give the soil structure but bacteria can quickly release nutrients from the softer, more easily decomposed organic matter. These creatures need energy and as they are incapable of photosynthesis they depend on plants for this energy. Fresh vegetation provides the most energy and will rapidly decompose from bacterial and fungal attack.

There are myriads of types of bacteria capable of surviving in a staggering range of conditions. They reproduce explosively but have short lives and their dead bodies are attacked by other bacteria releasing further nutrients. The negative side of bacteria is that they emit large quantities of carbon dioxide back to the atmosphere and do little to give the soil structure – this is the role of fungi.

Fungi are much more sensitive to their environment and only survive in a limited range of conditions; they must be maintained damp - which is what wicking beds do. (Their spores however are incredibly tough and will remain dormant until the conditions are right again. This is their survival mechanism.)

From the point of view of improving the soil the aim of the wicking beds is to maintain the soil moist and encourage the growth of the fungi, particularly the mycorrhizal fungi. These form symbiotic relations with plants with the plants providing energy in the form of nutrients and the fungi supplying the plants with nutrients. Fungi with their enzyme exuding ultra-fine hyphae are extremely efficient at extracting nutrients from rocks and hard material which the roots of plants cannot attack.

Fungi can be extremely long lived; talking in time scales of hundreds of years and contain large amounts of carbon. They are an extremely efficient mechanism for sequestering carbon into the soil.

Wicking beds are best filled with fresh material so they become, in effect, an in ground composting system. While their prime purpose is in regenerating soil they are also a viable method of sequestering large amounts of carbon. Both aspects are interlinked by the potential revenues that can be generated from carbon sequestration.

The rate at which wicking beds sequester carbon shows they cannot immediately fill the soil profile - that takes some years or decades. The numbers at this stage can only be estimates and depend on the type of agriculture. Continuous working of the soil will release large amounts of carbon while no till technology will only have small emissions, even so we are estimating some 40 tonnes per

hectare per year in the first year then dropping over each subsequent year to may between 10 and 5 tonnes per hectare per year. It obviously takes a significant number of years or even decades to fill the soil to its maximum holding capacity.

From the viewpoint of solving atmospheric carbon wicking beds are not a one big hit approach, they provide a steady capture of carbon which will increase over time as the number of farmers using wicking beds increase.

There are some really important points here so let me summarise.

The largest single source of carbon dioxide entering the atmosphere is decaying vegetation. Bacteria decompose organic material under almost any condition and release large amounts of carbon dioxide. Fungi release much less carbon dioxide and permanently store the carbon in the ground, but fungi only survive in moist conditions. Wicking beds maintain the soil moist, the right conditions for fungi, so improving the soil and sequestering carbon.

However the exploitation of the wicking beds is not a simple issue but provides the opportunity for the creation of the next generation of significant companies.

The exploitation of wicking beds technology

There are two main problems to overcome in the widespread adoption of wicking beds, the first is the political scene the second is the industrial structure.

It is impossible to avoid politics, even if the system is dysfunctional as is the case with carbon. The original Kyoto protocol did not even consider soil carbon but laid down rules for carbon capture which were based around forestry. They developed two rules which are totally inappropriate for the new technology of soil carbon capture, namely the rules of additionality and permanence. These are blatantly absurd for individual farmers who want to improve their soil.

Farmers are automatically excluded from receiving revenue from soil carbon if they were going to improve their soil anyway. How ridiculous, what it the difference between carbon that is sequestered by a farmer who wants to earn revenue from carbon sequestration and a farmer who want to improve his soil. Sequestered carbon is still sequestered carbon whatever the motives of the farmer. How do the regulators determine whether an individual farmer is sequestering carbon to improve his soil or to reduce atmospheric carbon? And does it matter as long as he is sequestering carbon?

Permanence is the second major problem. The farmer has to ensure that the carbon in a particular field will remain in the soil permanently, which is generally taken as a hundred years. Very few individual farmers can guarantee that a particular field will still be sequestering carbon in a hundred years' time.

At this moment the only country I know of that has a carbon trading schemes incorporating soil carbon is Australia. The bureaucrats well understand the situation but feel they have to follow the Kyoto protocol and Australia is a small country with little clout at the various conferences. This may all change when it is realised that the current system is not working, that emission continue to grow and soil carbon is the easiest way of holding atmospheric carbon levels in check.

But in the short term we are lumbered with these stupid regulations but like all stupid regulations there is a way around them. And that is having an integrator covering many farms. This is an obvious way to go anyway as individual farmers don't want the bother of all the paper work and

regulation of carbon farming. (An integrator provides a wider service that an aggregator in conventional carbon capture.)

An integrator basically pays the farmer money, according to a scale for following carbon farming practices such as wicking beds based on a reasonable estimate of the amount of carbon the farmer will sequester. The integrator then applies for a single payment covering many farms and has the responsibility of showing that on balance that the total amount of carbon sequestered is real.

While it is impossible to prove that one individual farmer was not going to improve his soil anyway it is extremely unlikely that a large number of farmers are simultaneously going to adopt a technology like wicking beds to improve soil. This circumnavigates the additionality problem.

The integrator holds a certain amount of carbon back in reserve to cover farmers who opt out of the scheme, for example their land is bought for a housing estate. This circumnavigates the permanence problem and acts a bit like an insurance scheme.

This avoids the two main legal problems,

Both these principles have been accepted in Australia.

But the role of the integrator is much more than managing the administrative process for carbon capture, they offer a service extending right the way through from managing organic and water waste through the sequestration of carbon and through to the marketing of food.

Like Google they don't manufacture any product, they are purely a service organisation, and their value proposition e.g. how they make money is subtle. But as they are managing how we dispose of waste to the provision of healthy food in an environmentally sustainable the potential is great.

Inputs

Wicking beds require a large volume of organic material; I am going to use the term 'green fertiliser' rather than green waste. Some of this can be grown on farm. Strip farming is now an accepted technology in farming giving access to nutrients deeper in the ground than is accessible to crops and reducing erosion and wind damage.

But to have on impact on atmospheric carbon we need very large volumes of green fertiliser and so much look for additional sources. Now I am looking thirty years ahead and it is certain that the way we live then will be very different. There has been a mass migration from the rural areas to the cities, so we have to think about what the city of the future will look like.

Now I spend several months every year living in Shenzhen in Southern China. Thirty years ago this was only a fishing village but now is a major city of some 12million people, bigger than most Western cities. But the scene is similar all along the Pearl River strip to Guangzhou with a total population of some 100 million, bigger than most countries.

The cities have basically been designed from the ground up and so reflect what the city of the future may look like.

Most people live in high rise apartments which if there were nothing else would be like living in a mega rabbit hutch and would certainly lead to major social unrest and vandalism as occurred in the 'new towns' built in England after the war.

But wherever you look there is vegetation, the road are lined with trees, every building has a recreational area with trees and shaded areas for resting, little enclaves with exercise machines again surrounded by bushes and vegetation and more open areas for exercise. There are parks scattered all over the city, some small some large areas adjacent to the city centre.

These were clearly designed to ensure a liveable environment and to create a social environment but they are also sequestering a large amount of carbon but as yet there seems to be little action in exploiting this sequestering potential by harvesting green fertiliser.

A metropolis of some 100 million people produces an awful lot of waste - solids, waste water and sewage. At the moment this is considered a liability and is disposed of in a way which is damaging to the environment.

People are not rabbits, they need entertainment and recreation, and contact with each other and the natural world. It is built into us and is an essential feature of stable and peaceful societies. Crime and vandalism are always potentially present but simply explode if people are deprived of these basic human requirements.

But these metropolises produce mountains of so called waste material which are the source of materials for an integrator with his multiple farms. The reality is that the use of sewage, waste water and garbage on farms has been strongly resisted for health and pollution reasons. This is unlikely to change. Yet all this waste can be used in wicking beds to grow trees or plants; - not directly for food but to produce green fertiliser which can be used on farm for food production.

This separates the waste and sewage from food production. It is a way of transforming contaminated wastes into a useful product for farm use - green fertiliser. This does require land but this would not be like the traditional tree plantations, which are not much use for anything else but the land would be designed for recreational activities, which will be an essential feature of the cities of the future.

It is multi use of land, recreation, waste disposal and green fertiliser production.

The job of managing solid waste and water is normally the role for local Governments and this is likely to continue. But there is significant expertise in the management of waste solids and water and reusing them to provide recreational facilities which are safe for the public to use, protected from pathogens and toxic materials.

Of course this is more expensive than simply dumping the waste into the sea (often via river) but it will become gradually accepted that this is no longer acceptable and they must be reprocessed to provide useful products such as green fertiliser.

This is the expertise that the integrator will provide to the local Governments - for a fee. This is one of the revenue streams for the integrator and has the advantage of being an immediately accessible source of revenue.

The integrator can then extend his interest down steam and becomes a manager of the supply chain for the farmer by providing green fertiliser.

Not long ago the price of synthetic fertiliser was so low, and in the short term effective, that farmers operating in a competitive environment had little option to use them, which they did by the truck load. There was really no organised distribution system for green fertiliser and no simple technology, like the wicking bed, for using them and no service structure as provided by the manufacturers of synthetic fertilisers.

Providing green fertiliser to the farmer provides another revenue stream for the integrator; -from the sale of carbon credits.

This is unfortunately delayed by the action of climate change deniers who simply cannot believe the scientific evidence that dumping thirty billion tonnes of carbon dioxide into the atmosphere is sustainable. But what they think is probably not so important in the long term, a few fires, floods storms and droughts will create public pressure for action, particularly when it becomes clear that technologies, of which the wicking bed is just one, are available to manage atmospheric carbon.

But the integrator can also look upstream to assist in the marketing of his farmers products, fresh product produced from nutrient rich soil.

Food is more than just bulk quantities to provide us with the basic calories. Food is now almost an entertainment as people try different types of food, new vegetables and herbs that they have never tried before. The most popular shows on television are food shows. What an opportunity for an integrator having access to food grown from rich soil to generate another revenue stream.

Doom and gloom

The environmental movement, which I strongly support, at least in principle, has created a picture of the future of doom and gloom and we should all adopt an Ashram like life style wearing goat skins and eating beetles.

This is nonsense; we have never enjoyed a better life style. In my life time as an engineer I have seen productivity increase almost beyond believe, we can produce all the goods we need at very low financial cost. Similar improvements have been made in agriculture so we can produce all the products and food needed. I am not a naive optimist, I know that there are, and will continue to be poor people with not enough food, but this is because they do not have access to the technology and resources, which is a social rather than technical problem.

We will have the capacity to produce all the products and food we want, the challenge of the future is to do this within environmental constraints rather than financial constraints.

Economist have yet to revise their theories to the conditions of affluence where we can produce virtually everything we want at minimal cost. They are still thinking of the input cost of material, labour and capital. With the advent of computer controlled manufacturing we can simply churn out products which far exceed demand.

The future economic theory will have to adjust to the idea that the constraint to production is the restrictions caused by the environment, not money.

But history can be encouraging, environmental problems are not new. Around two hundred years ago London had exploded with people pouring into the city; (just like now with our modern cities). But there was no sewage system, yuck flowed down the streets. This was just accepted as the norm, just make sure you had good strong high boots and everything is sort of OK.

But then there was a cholera outbreak which was traced back to drinking water polluted with sewage. This lead to the construction of the London sewage system, which for its time, was a wonder of engineering. The Government just did it, that was the era of getting things done without asking, a bit like China today. But let us say that this had been put to the population as a value proposition; - you have the choice, we can build you a sewer system which will cost you two pounds per head or you can die of cholera. People would have pulled out there wallets faster than Wyatt Herp in the westerns.

Let's look at the value propositions that an integrator can and cannot offer.

For a start we cannot offer going back to some Ashram type of existence in which we all give up the benefits of modern civilisation and live some pre-industrial type of existence. Apart from the fact people do not want to give up modern conveniences they are essential to supporting seven billion people, without mechanisation, transport systems, even items like the humble fridge people would not survive.

But he can say; - Ok you have two options.

Options 1 - can you can keep you cars, televisions, fridges etc. and you can ignore climate change but you are going to have to learn to live with storms, wild fires, floods, droughts and all the consequence of climate change

or

Option 2 - we can (for many decades at least) balance all the carbon emissions creating parks and recreational areas for you to enjoy. Trees and greener will be used to provide you with recreational area from small local parks near home or bigger recreational parks for more outdoor activities like camping hiking or even just a family picnic.

All your waste products and waste water and sewage will be used to water and fertilise the vegetation in the parks which will be used to produce green fertiliser for the farmer which will be used on farm to improve soil quality and provide you with a wide variety of nutritious food, fruit and vegetables grown from naturally improved soil which won't make you fat or give you diabetes.

All this cost more money than just dumping wastes into the sea and using chemical fertilisers so you will have to pay a little more on your rates and a little more for the better food.

Is there really a choice?