Questions and Answers to Ken Bellamy

Reef Carbon
Question: Will soil carbon assist or harm the reef?

Answer: If soil carbon is built into agricultural lands in behind the reef the result is:
a. There is less fertiliser used which means less run-off b. There is a greater storage of nutrient and a better soi structure in place, which helps to keep nutrients in the soil and taken up by plants -- and hence less of it runs off too c. There is less volatilisation of the nutrient -- by virtue of there being less put on and by the increased microbial activity which 'processes' and holds nutrient into the plant/soil ecosystem .... This means, less nutrient concentrations in the air -- a factor which does effect the reef, but is not much talked about. Less nutrient concentrations (particularly heavier-than-air nitrogen compounds) mean less of these are sequestered by water-borne organisms into the waters off the coast.
Additionally, the process to manufacture the products which replace fertliser input and build soil carbon is essentially a re-cycling of organic matter process.
This means that stuff which would otherwise end up in the reef -- including sewerage and compost materials and some leachate material (from dumps and waste facitlities) does not end up in the waters behind the reef.
the whole process is also an energy recycling process -- re-using energy storage compounds (recycled organics and microbes which capture sunlight) -- so that in total, in the region, there is less energy required and thus, in time less of all the inputs of energy which create pollutants in the area.

Soil Carbon Hi Jinks

Question: As you know, there are ideas in press that elevated CO2 will increase soil microbe activity and consequently increase CO2 emissions that will offset any gains.
I don't know if I have referred to you the paper that Barney is on my website at (second paper about crop):http://eric.com.au/html/microbes_applications.php
The questions I have for you (and largely initiated by the BRS paper on soil carbon that is poor on soil biology, soil carbon sequestration and soil carbon measurement) are:
1. How do you explain (given the comment above) that soil carbon increased by 1.5% in 5 months during the growing period.
2. Why did Phosphorous availability increase by 400%
Also, the BRIX values went from 6 to 12 and production increased (I think) by about 30-40%.

Answer: The standard line, valid particularly for moister cooler regions, is that increasing temperatures will increase microbial respiration of soil OM and thus CO2 emissions. However this needs to be assessed relative to the increased photosynthesis provided there is adequate water and it is not too hot. What most people don't appreciate is that the bio-chemistry of photosynthesis effectively shuts down above 37oC so no growth or bio-activity can be sustained above this threshold which we are already close to.
Thanks for the paper which I will read but in the interim;
1. The increase in soil C levels comes from the stimulated levels and conversion of root

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exudates and fine roots into humates and glomalins. As we address biological growth limitations via sound natural/microbial amendments the quantity of these exudates, microbial activities and their residual humate by-products increases.
2. The exudates feed and enable marked increases in symbiotic microbial activities including by rhizosphere bacteria that fix nitrogen and mycorrhizal fungi that solubilize absorb and recycle key limiting nutrients. As a result nutrient are shifted from unavailable to available organic pools as reflected in the measurements. This increased nutritient availability of course aids plant growth and health as reflected by the Brix measures. Most dont realize that up to 99% of the total soil nutrient content for P for example may not be readily available to non mycorrhizal plants and only available via these processes. Hence the importance of 'microbes' and the risk of nutrient shortages from degrading these processes through excessive fertilizer additions.

Also very important is that it points up to me again the importance of the lack of understanding of stand-alone photosynthetic bacteria whose function was to DO photosynthesis both when things get tough in the soil and when things are going well. **It** would be interesting to hear the comment on how the original photosynthesis of the atmospheric C02 came about in early formative periods of the earths history - when temps were well above the 37 degree mark. The key is: PLANT BASED photosynthesis can shut down at that temp -- NOT because of the heat per se -- but because the plant worries about losing too much water and closes up the stomatal openings which would let in C02 and H2. There is also the point that Photosynthetic bacteria themselves produce exudates and organic substances which can be reduced to humates -- it doesn't have to be just plant roots.... this bit also adds to the material base.

From 3.5 to 2 billion years ago cyanobacteria (Blue green algae in shallow marine structures such as stromatolites) were busy fixing atmospheric CO_2 by photosynthesis into sugars releasing oxygen which turned the atmosphere aerobic since about 2 b years ago. Certainly such bacteria can photosynthesis CO_2 at higher temperatures than the 37oC above which current plant based photosynthesis declines rapidly.
However the big drop in CO_2 levels are likely to have occurred once there was enough oxygen to bioconvert sugars and organic waste into bicarbonate ions which can then be precipitated in mass as calcium carbonates (limestone, chalk etc) with calcium leached into the oceans from the eroding but still bare land surfaces. It was when the rate of calcium and nutrient leaching from the by then weathered land surface declined that there was major competitive advantage for these organisms to colonize the land edges to get more nutrients.
Fungi had major advantages in exploring soils as they were still conected to distant critical water sources. By piggybacking algal cells with them these fungi also had on board factories for producing essential carbon food supplies. We still have these as primary rock colonising systems called lichens. The production of root exudates by even these systems is critical in producing organic acids and enabling the symbiotic fungi to break down rocks and solubilize nutrients from the new mineral surfaces. The same strategies and microbial processes of course still dominate and drive soil and plant relationships.

Of particular note is the comment on the importance of symbiotic fungal/algal relationships -- which are prominent in mineral solubility and critical to

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nutrient transer in crop growth. I am fascinated by the seemingly all-pervasive nature of the symbiosis between phototrophic purple and red bacteria, cyanobacter (which act as algae do in lots of cases) and fungal populations. Autotrophic activity - which is particularly prominent in the litoral zone and which Walter referred to - is also critical element in our formulations, as is the bridging function which is performed by anaerobic yeasts, partially anaerobic purple sulphur bacteria and heterotrophic bacteria (red and purple) which somehow allows aerobic fungal populations to pop out of sealed, anaerobic bottles of our mixtures.
By the way, a key issue in the process described is the ability of those organisms to deal with osmotic pressures (occasioned by exposure to high saline concentrations AND fresh water in close juxtaposition which happens in inter-tidal areas and river flats). This gives a clue as to why we can produce mixtures with potassium concentrations above 5% and still grow live cultures.

The Vanishing Face of Gaia (ISBN: 978-1-84614-241-3)
Question: There was a discussion regarding the role of soil in carbon regulation of the climate, particularly, the role of weathering processes to regulate atmospheric CO2, and cloud formation
Three things jumped out
First, the story goes that the weathering of basalt and granites is the fundamental sink for carbon from the atmosphere to the lithosphere. The weathering process bonds CO2 to produce calcium bicarbonate, which is later converted to calcium carbonate and this is absorbed by marine organisms and eventually sent to the ocean floor. The book states that the weathering of soil particles is accelerated by increased CO2 levels in the soil gas (up to 30 times greater than concentration than in the atmosphere). The increased CO2 is due to organic processes - i.e. soil micro-organisms
Question 1: To what extent does this observation provide an argument for 'permeance' of the Prime Carborn soil carbon process - i.e. the fraction of CO2 absorbed into the soil and bonded with calcium from the calcium silicate rocks and later sent to the deep sea.
Question 2: Does the calcium bicarbonate and the 30 times increase in CO2 in soil air imply a significant additional CO2 sequestration above the standard 55 tons per hectare figure currently quoted. The next point is that the promotion of soil micro-organisms leading to increased calcium bicarbonate /carbonate in the oceans. My understanding is that calcium carbonate provides a buffering effect of the acidification of the ocean associated with the absorption of CO2 and resulting formation of carbonic acid.
Question 3: Is this something that is worth promoting for Prime Carbon as an 'additional benefit'
Of interest, last year I did a 40 ton carbon offset transaction with Janice Lough (climate scientist) at AIMS(using the GGAS carbon credits)These thoughts were prompted from discussions in the book last paragraphpage 108 and page 109.Next thing, there is discussion about the role of biogenic chemicals in 'seeding' cloud formation - particularly dimethyl sulphide and methyl iodide from marine plankton.
Question 4: Does your soil carbon process produce these gases and if so can be this claimed to help promote rain in drought stricken agricultural areas?

Answer: I am at least vaguely aligned with the theory that the eco-system is self-balancing and that as such, there is a system of "demands" and "responses" which appears to be able to manage concentration gradients in any quantum over time. My understanding is that the eco-system has undergone a series of quite radical re-alignments in terms of the location and storage concentrations of several elements and substances, not the least of which are carbon and water over time.
Two key issues hinder human/scientific views on the subject of demand-side

Self-balancing:
a. The time in which scientific records have been taken is immeasurably short in comparison to the time taken for re-balancing events. Not withstanding evidence which would say that the time

between ice-ages and heating events seems to have shortened within living memory; we still only have a few hundred years of stored data which is being used to look at systems which take millions of years to adjust themselves. If I were
a PhD mentor, I would say the sample size appears too small to make the theory stand up.
b. The eco-system is dynamic whereas the scientific method requires an interruption to dynamic systems in order to study individual components. Many things simply cannot be studied when made to stand still. I will attack the last question first:
There is an integral link between water and soil. We have seen for years that soil biology inoculates water bodies... put another way, the same key phototrophic organisms which we focus on in soil are also critical in certain relationships around CO_2 and O_2 ... and more importantly around Hydrogen management in systems... in water. This is actually the premise around which VRM was built.
So, if we are looking for organic processes which effect the nature and distribution of water cycle component bits (i.e. seeding of clouds or manufacture of water from constituents) then we do look at certain biological reactions in the soil. I also use them in water treatment. And it is clear that the
top 100mm or so of the soil profile act as a base for activity which goes deeper in to the soil, through soils to water bodies and from soils to atmosphere and other removal pathways (crops, trees, animals, etc) So these little buggers in the soil converting energy to carbohydrate and nitrogen compounds ... using hydrogen and balancing CO_2 and O_2 in both the soil and super-soil zones (just above the soil) are critical to a lot of things.
And they do effect rainfall without doubt (at least without doubt in my mind)

Chemotrophs RE: Photosynthesis: fixing carbon and making water

Question: It simply outlines one of a large number of bacterial processes collectively known as ‘chemosynthesis’ undertaken by ‘chemotrophs’ in which instead of light being used as the source of energy for metabolic reactions various chemicals are used. Generally the bacteria come from a grouping known as ‘extremophiles’ because they are found in extreme environments such as deep ocean vents, volcanoes, and within geological structures.

Answer: Chemoautotrophs do form part of the groups of organisms performing these vital photosynthetic reactions. However, it is incorrect in suggesting that they only populate extreme environments. While they are found in such extreme environments they also populate virtually all others, and are particularly prevalent in the litoral zones and the interface between soil and water, as well as in most soils.

It also seems to have missed the key point of the article -- being the synthesis of water. Most people readily accept that we need water. Few, if any have previously connected the vital link in the water cycle which is filled by this activity. It is my contention in fact that photsynthesis in green plants, upon which all life depends, is itself fundamentally dependant upon this external bacterial photosynthesis. As such there is very good reason to give this activity a little more generalised attention.

In addition, it is my contention that the quantum of input to the water balance of nature made by these organisms as a group has been fundamentally overlooked. It is my contention that the total mass balance of water inputs as opposed outputs in Australian soils is absolutely dependant upon the hydro-synthesis performed by these organisms. We have evapotranspiration in most catchment areas in Australia which far exceeds precipitation. This has continued for millions of years. Without the contribution to the total water balance made by bacterial photosynthesis there simply would not be vegetation as we know it. What is of interest is that we have learned how to incubate a culture or formulation of these types of organisms so that areas where such activity has declined (often due to

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human activity, land use practice, etc) can be re-inoculated to strengthen this activity.

It also transpires that the use of these cultures or formulations as part of standard composting and recycling processes enables a far less energy intensive reaction and enables control of the limiting factor for such processes in local government and industry -- being H_2S odour.

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