From: david shipway <cortecos@island.net>
Date: 2011.04 .04 4:49:11 PM PDT (CA)
To: andy sinats <andy@sinats.ca>, Richard Balfour <balfourarch@telus.net>
Subject: Re: another green narrative

Andy, there's apparently an active working group of BC folks focussed on evolving biochar issues. I've cc'd Rick so he can let you know who/what/where.

d;)

On 2011/04/04 02:01 PM, andy sinats wrote:

Wednesday, October 29, 2008

Biochar's Fractal Dimension

In early September I traveled to Newcastle, England, to attend the second annual meeting of the International Biochar Initiative.

The conference drew together high ranking officials from the United Nations, international NGOs, appropriate technology experts from the developing world, commercial pyrolysis companies, foresters, agronomists, soil scientists, and others from 31 countries. We learned that you can actually make coal, carry it to Newcastle, and bury it in the ground, reversing the cycle begun by carbon-based capitalism 500 years ago.

Professor Tim Flannery told the gathering that even if we shut down every coal plant and stop all emissions of greenhouse gases from industry worldwide, the dangerous warming of our planet would continue for centuries. "That is the point at which you realize that biochar is really, really important," he said.

Flannery suggested that 8 percent of CO2 is currently going into terrestrial vegetation, but if we could double that, we could buy ourselves time to work on moving away from coal and oil. Flannery said that we have to be mindful of the historic debt incurred by the one billion people whose ancestors made the industrial revolution. "That carbon debt to the other 6 billion could be repaid at 5 percent per year with biochar," he said.

Johannes Lehmann (foreground) Tim Flannery (background) at IBI-2. *Photo by Albert Bates, Farm News Service*

Biochar production systems demonstrated at the conference turned up to half the carbon in biomass or waste product feedstocks into bio-energy — producer gas or wood vinegar — with the remainder captured as a dense, fine-grain, porous char.

This differs from other forms of biofuels in that the carbon is not returned to the atmosphere, either as carbon dioxide from burning, or as methane from decomposition. It is transformed into an inactive form that remains in the soil for thousands of years.

Mixed with compost and/or artificial fertilizer and applied as a soil amendment, biochar improves the tilth, water retention capacity, fertility, and carbon sequestration of degraded soils. Agricultural gains of 880% have been reported, according to Johannes Lehmann, soil scientist at Cornell and chair of IBI.

Scientific understanding of biochar began with the discovery of Terra Preta ("dark earth") soils in Brazil in 1867. Subsequent surveys identified fertile islands of char-containing soils, corresponding to native settlements, dating back thousands of years, throughout the Amazon basin. At IBI-2 we learned that prehistoric Terra Preta has also been discovered in Australia and North America.

The carbon sequestration angle has brought the research effort greater urgency, and the International Biochar Initiative was formed to bring scientists, engineers, farmers, policymakers, funders and advocates into collaboration to speed studies, incentives and applications.

I'll be blogging more about this in coming months, in part because we have been experimenting with biochar at the Institute for Appropriate Technology and are starting to get some interesting results, in part because skepticism is still warranted and biochar alone is not a solution for the existential threats we face, and also in part because we are engaged in a large-scale bamboo-to-biochar initiative that, if successful, will create the first permaculturally-designed biochar-based town -- 4500 completely carbon neutral homes near Chattanooga.

Mantria CEO Troy Wragg and his permaculture design team scout the best parts of a former Bowater pine plantation for places to plant the first bamboo groves. *Photo by Albert Bates, Farm News Service*

In a modern pyrolysis plant, 40% char yield is possible, with energy from the pyrolysis gases refluxed to burn cleanly and produce enough heat to drive the process, dry the feedstock and supply leftover power to a grid-intertie system. This makes about 4 or 5 bottom lines for biochar, and provides the first carbon negative power possibilities, including driving atmospheric carbon levels backwards to pre-Industrial Revolution levels on relatively short time frames. This is the basis of the process we have been advising on near Chattanooga, the small-scale kilns we are constructing at GVI, the subject of my workshop at the Ozark Area Community Conference 2 weeks ago and also one of my presentations at the financial permaculture course that concludes with a Farm tour later today.

What spurred me to pen my thoughts at this point was something Vandana Shiva said at a conference in Italy this past week. Real reform, she insisted, will happen when discussions move from the stratosphere to the soil, and when we find new, non-industrial ways of thinking.

The advantage that biochar offers is something similar to the advantage that fractal geometry conferred upon cell phone users a decade or more ago. The three dimensions of Euclidean space describe how most of us have been looking at the physical world for the past 2300 years. Einstein gave us a forth dimension, time, but it really only reinforced our "normal" way of relating to reality. It was still industrial thinking.

Mathematics has not been that static, and 4-dimensional, 5-dimensional, and even higher-dimensional spaces are now more than the stuff of shamanistic inquiry or surfer meditations. We have discovered fractal geometry in chaotic trajectories (strange attractors) and in natural systems (streambeds). It now seems possible that Euclid's geometry was our limiting factor in understanding both why the polar ice and permafrost is disappearing as fast as it is and how to reverse the process.

Mandelbrot began his seminal treatise on fractal geometry by considering the question: "How long is the coast of Bretagne?" If you lay a ruler along a map of that coast, you get a rough approximation, but to get something more accurate, you have to use several smaller rulers, and as you do, the distance increases. Mandelbrot observed that eventually you will have to concede that if accuracy is your goal, the ruler gets diminishingly small, while the length of the coastline gets infinitely large. At some point even the concept of length becomes problematic.

Here are some graphical examples, all courtesy of Vanderbilt University. If you imagine the simplest ruler as the initiator, a next generation approximation of accuracy, called the generator, makes something mathematicians call the Koch curve.

The Koch curve takes each line and replaces it with four lines, each one-third the length of the original.

Do it again.

We do this iteratively ... without end.

A similar exercise is the Sierpinski Triangle. We start with an equilateral triangle, connect the mid-points of the three sides and remove the resulting inner triangle.

Iterating the first step we get:

The Sierpinski Triangle found its way to cell phones when engineers started experimenting with ways to shrink antenna size while not losing reception. They began with something that looked like a rat maze and before long had progressed into stacked pyramids.

Now they are imbedding fractal antennae into Kevlar helmets.

The advantage is not merely an increasing length for better reception, but the serendipitous discovery that frequency bandwidth is also improved, making many more channels possible. The helmet pattern demonstrates a very high gain antenna with a very small footprint.

Mandelbrot's set is found by iterating
$z_{n+1} = z_n^2 + c$.
where z is a complex number. $z_0=0$. When you do this, it is infinitely complex -- and it looks like mold.

What all this has to do with biochar is in how the Terra preta soils actually work their magic. One gram of biochar has a surface area of 1000 square meters. The way it accomplishes this is through micropores, the crystalline-like surfaces formed, randomly and chaotically, during pyrolysis. Terra preta's carbon sequestration process uses a fractal dimension.

In the soil, biochar's cavities fill up with nutrient foodstocks for microbes, much like a kitchen pantry. The microbes move in, and pretty soon hyphae of fungi appear. The hyphae are a fast road for nutrients and moisture – a trade exchange route to plant and tree roots. Examination of biochar-amended soils a few months after treatment found that vigorous fungal colonization was common.

If you can imagine the char as providing a coral reef-like structure, full of tiny polyps and crevices, it attracts all manner of soil organisms to it. If the pantry is empty, then those microbes will go to work to stock it, which is why biochar denitrifies over-fertilized, burned out farmland and replaces it with slow-release fertility, and also why "charging" the char with compost or urine before applying it is a good idea. I've got a charging station on the balcony just outside my bedroom door.

Urine passes through a spiraling tube from the funnel receptacle on the balcony to the char bin at ground level. *Photos by Albert Bates, Farm News Service.*

Not all char is char, as the saying in the biochar community goes. Imperfectly pyrolyzed, the char contains

“activated” charcoal, that steals oxygen from the soil and releases carbon to fungi, microbes and plant roots and eventually back to the atmosphere, either as carbon dioxide, monoxide or as methane. With more careful pyrolysis, the carbon is locked tight and never leaves the soil. Biochar making, therefore, is not the same as charcoal making, and part of the concern is that if done poorly, the biochar revolution could actually add to our climate crisis.

Done well, the carbon becomes soil structure. The compost in its pantry becomes worm and insect castings, to be taken up by the tertiary decomposers that convert it into plant food. The whole process is supercharged by the fractal geometry, resulting in the observed gains unexplainable by any other means.

All of which is to say, Vandana Shiva is definitely onto something here.
Posted by Peaksurfer at 10:14 AM
Labels: Albert Bates, appropriate technology, biochar, Climate Change, farming, Forests, fractal dimension, mushrooms, Newcastle, Tim Flannery, Tipping Points, Vandana Shiva