

The Civilization of Soils
Hallmarks of the
Unintended & Intended Anthropocene

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Thanks to Bob Wells; "These are Turnips On Biochar.....Any Questions??"



Craig Sam's Char-colate Cacao Trees Bearing fruit in Three years versus Five



Iwamoto Biochar for Aquaculture and Poultry



Iwamoto Biochar for Aquaculture and Poultry



Gasification – Energy-Based Environmental Solutions

Benefits of Gasification

- Meets regulatory requirements with an alternative solution
- Converts waste material into a revenue stream
- Select best use(s) for energy – heat, chilling, steam, or electricity, with the option of varying the use depending on demand
- Eliminates or reduces costs now associated with waste disposal
- Halts the release of non-beneficial nutrients to waterways as a result of runoff from farm fields and storage piles
- Odors are destroyed in the gasification process
- Creates multiple revenue streams – EcoChar, animal bedding, etc.
- Easy to operate – designed to operate unattended and requires little maintenance
- Reduces carbon footprint
- Opportunity for revenue from tipping fees
- When environmental concerns are eliminated, business may be allowed to expand without increased land requirements for permitting
- Final product (EcoChar) is pathogen-free, greatly reduced in volume, and has value in a variety of applications
- Off-site monitoring available

Gasification Produces Heat, Steam, and/or Electricity from a Variety of Biomass and Other Fuels

Coaltec Energy USA, Inc. addresses waste disposal and facility energy needs, allowing business owners to concentrate on their core business expertise. Coaltec's gasification systems can produce heat, steam and/or electricity as desired, as well as EcoChar (Coaltec's trademarked biochar product), and are designed to fit the host site's needs. Depending on the application, a portion of the thermal energy may also be used to dry moisture-laden products (waste grain, vegetable residue, high-moisture manures, etc.), making them easier and less costly to transport or use for fuel. Our gasifiers are extremely versatile, able to operate using a variety of different fuels, while remaining a carbon negative solution for your business.



Completed system in Cordele, Georgia. The fuel is derived from the organic portion of MSW.

Maximizing the value of your waste stream while improving the environment

Coaltec Projects:



Georgia Ethanol Plant, MSW Organic Waste
(active)



Cow Manure Management, Ohio
(Operating since 2012)



Swine Manure Project, Netherlands
(Completed)

Other Current Projects:

Swine and Poultry Manure Project, Indiana
(Fabricated, to be installed August 2016)

Ethanol Plant, Distiller's Grain Project,
Nebraska (Being Fabricated)

Applications

Coaltec's gasification system is well suited to the following fuels:

- Poultry, dairy, and hog manure
- Wet and Dried Distiller Grain
- Food Processing By-Products
- Wood and Construction Waste
- Municipal Waste, Sorted and Unsorted
- Wastewater Treatment Plant Biosolids
- Crops and Crop Residues – corn stover
- Forest Management Wastes and Urban Green Wastes

For additional information – Testing Center –
Michael McGolden
812.455.4568
SAM956@aol.com

Coaltec Energy USA, Inc.
5749 Coal Drive
Carterville, IL 62918
618.453.7324 x 248

EcoChar's characteristics vary with different fuels. Benefits of EcoChar include:

Increased nutrient infiltration, moisture retention, and microbial activity

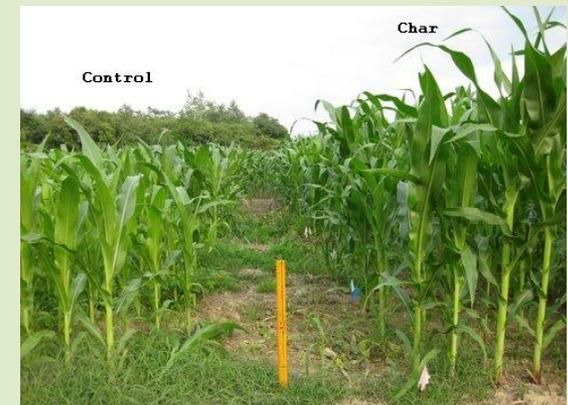
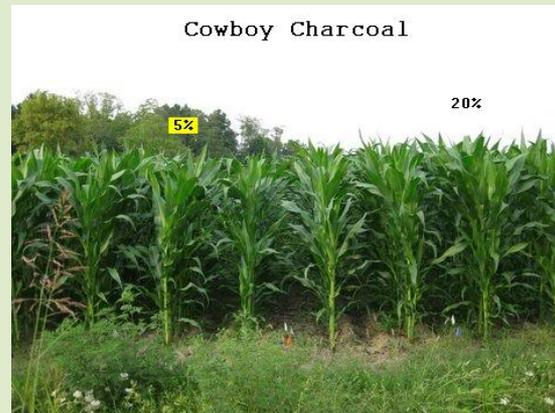
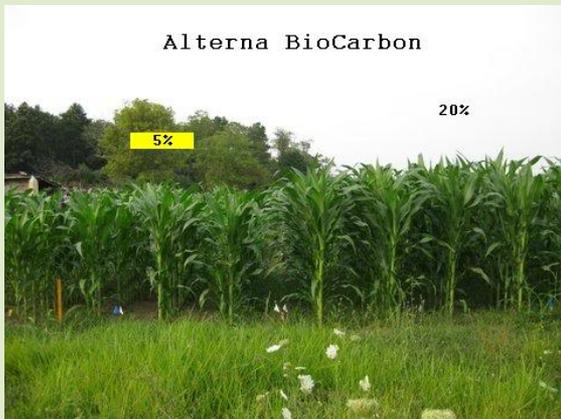
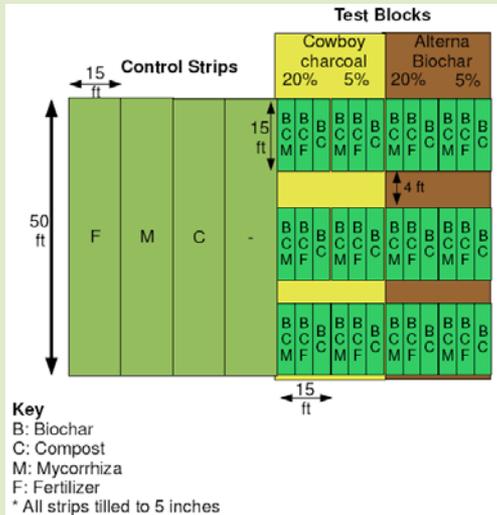
Absorption of nutrients, heavy metals, and hydrocarbons using the enormous surface area of EcoChar

Absorption of moisture, ammonia, and odors in livestock applications

Increased short-term soil organic carbon (1-5 years), as well as long-term soil organic carbon (100s of years)

2009 Virginia Field Trials

20% yield Increase



2010 Soy Yields;

Control Plots;..... 24.8 Bushels/acre

Compost Control Plots; 30.1 Bushels/acre

Biochar Plots;..... 40.8 Bushels/acre



Rizosphere Incorporated

Soil food Web Carbon Sequestration Facility.

Cut away View of a 24 / 7, Automated, solar energy integrated, recalcitrant carbon production unit.

Green Job Creation; Employment of Five million trillion trillion Wee-Beasties Carbon Storage Capacity; 150 Billions Tons of Carbon

Equal to; 550 Billion Ton CO₂
(some Northern Facilities offer winter vacations)



Biochar Cascading Values

Feed Ration for integrated nutrient management & Animal Health & Odor

from Hans-Peter Schmidt

1.

Charging biochar with
malolactic bacteria and
add

1 % BC to silage



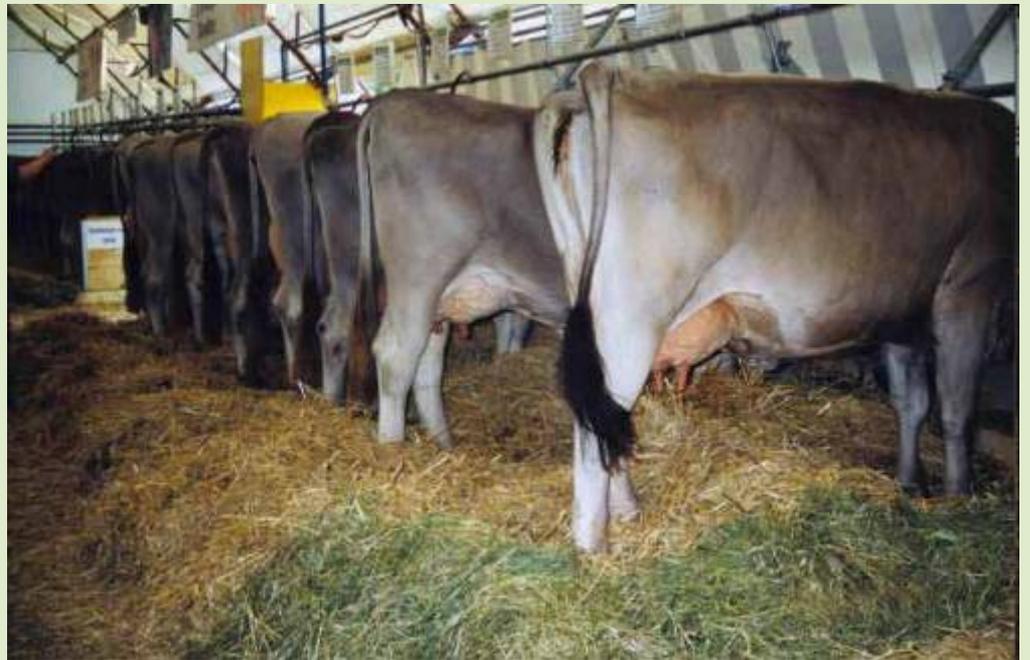
2.

**1 % BC for feeding
Carbon-Feed**



3.

5 - 10 % BC in litter



4.

**1- 1,5 % BC
in liquid manure**



5.

**Composting the carbon
manure + the separated
solids of the liquid manure**

10 – 20% BC



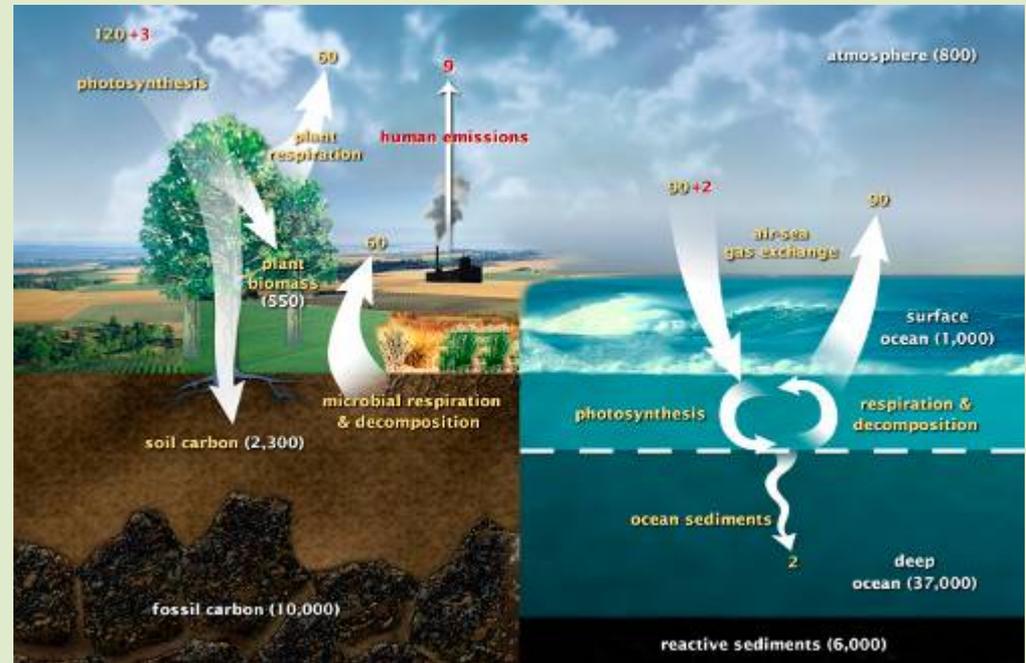
6.

Soil amendment
Fixation of nutrients
Increase of SOM



7.

Carbon sequestration CO₂-certificates?



Control

Biochar



Control

Biochar



Control

Biochar



Calabash Gourd Single Plant Over the Roof



Wee-Beastie Real estate, The Rosiest Scenario;

Total Biomass Harvest in the US; 1.6 Billion Tons

If All was processed by CoolPlanet Biofuels the Yield would be;
120 Billion Gallons of tank ready fuel , (The US uses 150 Billion
gallons per year)

0.3 Billion Tons of Biochar, with a Surface Area of 600 Square
Meters per Gram

One Ton has a surfac area of 148,000 Acres! 148,000 Acres is
equal to 230 square miles!!

300 Million Tons of Biochar equals 69 Billion Square Miles, or
348 times the Entire Surface of the Earth !!!

Biochar Gourds of Damocles, a Grown "Green Roof"



Edible Calabash Gourd is an extremely vigorous climbing vine, growing 1.5 feet per day, I'm planting 6 more next year to cover the entire roof. they average 300 feet of vine (counting tendrils)
My Record Gourd last year was 5.5 feet long and 6 inches in diameter. This stature has been consistent, 20% larger since adopting Biochar.

The Civilization of Soils

Hallmarks of The Unintended & Intended Anthropocene

To me, in the long run, the final arbiter, account and measure of sustainability will be soil carbon content. Once soil based Carbon Markets are in place the true value of Biofuel systems will be realized. Biomass cropping & processing systems can both serve to build soil carbon, (SOC, soil organic content). while making Energy.

As I read the agronomic history of civilization, only the Kayapo Indians and the Egyptians (because of Nile floods, now have forsaken), have maintained fertility for the long haul. millennium scales, 1000 cropping cycles.

We are also in De-nile about our own soil carbon loss over time due to technical mitigations like NPK and the green revolution.

The true "Gold" standard is soil carbon, measurable soon by earth sensing satellites, available for all to see their good, (or bad), works with future Google maps like the Soil Carbon Coalition's "**Atlas of biological work**"; <http://soilcarboncoalition.org/atlas>

The clarity and lack of complexity in this simple perspective has focused my efforts to this goal, my Holy Grail, political & financial recognition of Soil Carbon Content. Every gram of soil-carbon holds & returns eight grams of water. Despite our artistic pretensions, sophistication, and many accomplishments, humans owe existence to a six-inch layer of topsoil and the fact that it rains.

Beyond trope or truism the superlatives fly in soil absolutisms from our political, philosophical, ethical, or Theo-Ecological leadership over millenniums.

"For all things come from earth, and all things end by becoming earth."-----Xenophanes, 2580 B.P.

"We know more about movement of celestial bodies than about the soil underfoot"-- DaVinci, 1500.

"Farmers hold land title it actually belongs to all people because civilization itself rest on soil"--Thomas Jefferson.

"Land, then, is not merely soil; it is a fountain of energy flowing through a circuit of soils, plants, and animals"-- Aldo Leopold,

"The nation that destroys its soil destroys itself."---- F D R.

I favor using a capitalist economic framing, the terms of fiance & banking reflect the exponential growth of biologic systems.

"Soil Carbon is The Asset from which all else we do is Dividend.", and as I end my soil presentations with; "**Carbon to the Soil, the Only Ubiquitous & Economic Place to Put It**".

Dirt, fill dirt, subsoil available at \$4/yd, Top Soil at \$25/yd, most of this price is haulage, is such an under priced commodity. Given this soils' potential to grow with compounding interest. Interest payed in higher crop yields with premiums of lower carbon & management costs, all the while building dividends in ecological & climate services. The Soil Carbon Principal; only built and never mined.

3 Trillion Tons Carbon

This Reappraisal of the Soil Sink Bank, 225 Tons/ha in it's 16-foot deep vaults, Multiplied by 33 billion acres of just biologically productive land branch offices, brings their Total Assets to; **3 Trillion Tons Carbon**.

Now we must cast a proxy vote on how much interest we should pay the farmers for additional deposits. Given that the total Carbon supply in the air & oceans is only 400 GtC, it must be invested wisely in our soils. Long term, the high interest providing our future stable population, when all woman are educated & empowered.

Deep soils store up to five times more carbon than first thought;

The Soil Sink Bank; on average, the soils that were analyzed had;

7 pounds SOC in the top 4 inches per square yard,

12 lbs/sq yd in the top 20 inches of soil

30 lbs/sq yd in the top 16 feet.

That is; 13 tons/acre, 80 tons/ac and 340 tons/ac of soil organic carbon in the top 4", 20" and 16 feet of soil.

USDA projects can lead us to the Royal Road of building soil carbon. As goes California's Air Resources Board, so will go the rest of the States. Agricultural offset protocols are essential for California's mandatory cap-and-trade program for developing infrastructure and encouragement of Ag producers' participation in carbon markets. So Soup to nuts, all Ag producers not only get paid for what they produce, but they get the full value of how they produce it. The USDA projects have enabled adoption in California and in the Voluntary carbon markets. Oz and Canada know that all good things come from building soil carbon; greenhouse gas emissions, nutrient efficiency, and the plethora of ecological services. The farmer has many tools to create efficiency, burning less fossil carbon, emitting less Bio-methane, tight NPK management etc...etc. Good economics, sustainable economics requires that all the cards be on the table, quantifying the values and deficits of Agricultural production is the first step for this recognition and instituting incentive programs.

Soil Biology is our only way to rapidly and massively draw down CO₂ from the air to offset our ongoing and past carbon emissions, It Can safely and naturally restore the hydrological cycles by increasing biogenic aerosols and cloud albedo that can readily cool the planet by the 3 watts/m² needed to offset the now locked in greenhouse warming effects and avoid the Storms of Our Grandchildren.

The French have lead the way recognizing Soil Carbons' value and committing to build Soil Carbon by 0.40% annually. Putting them on the road to Carbon Negativity before any industrialized country. 25 nations have signed on to 4p1000. 100 of the 196 countries in Paris submitted plans to reduce CO₂ via agriculture, forestry and replacing soil carbon into their programmes.

<http://4p1000.org/understand>

A combination of Best Management Practices, (BMPs), for Agriculture, Grazing & Forestry with bioenergy systems which build soil carbon can deliver the giga-tons of carbon necessary into the soil sink bank.

Ag BMPs; 1 GtC, New Forest & BMPs; 1 GtC
Pyrolytic Bioenergy, Cooking Stoves; nearly 1/2 GtC
Industrial Pyrolytic Bioenergy; 2 GtC
Holistic Grazing; 2+ GtC

Over 6 GtC,

So soils & biota can do more than half the 10 GtC reduction job, feeding carbon to life instead of death.

Carbon Sequestration Cascade;

Each Black Carbon gram (biochar & humus) can increase Water Retention by 8 grams, and can support 10 grams of Green Carbon, which each can feed up to 10 more grams of fungal mycelium White Carbon growth

Carbon has been fundamental to life since the birth of our planet. It's the source of all wealth and the conduit of all joy. Carbon cycles among and between billions of interconnected earthlings, whose fates teeter on the element's return trip to the soil. Only the generous reciprocity inherent to life macrocycles can restore abundance and harmony to the planet of the living. May we celebrate a happy Intended Anthropocene, anointed in water & Soil rather than Oil and Blood.

The big problem in tropical soils is with the heat & water inputs microbes break down biomass quickly, compost last in the soils a very short time, so SOC and humus, humic substances, won't build up recalcitrant soil-C.

The Kayapo Indians however found a way around this with their Terra Preta soil protocols.

In Climate Science;

Atmospheric Carbon particles, smoke & soot, that form Carbonaceous aerosols, nucleating 80% of clouds, there for, 80% of our rain, the discovery this year that Carbon aerosols form around a potassium seed, or catalyst, the origins of this atmospheric potassium is fungal life itself. In strong support of the Gaia Hypothesis, life literally calling to the rain. An unaccounted Ecologic Service provided by healthy

Soils. Across disciplines from electronics, agronomy, microbiology and ecology, Spectrographic measurement tools in soil research have reassessed the proportion of Pyrolytic-Carbon that makes up all Soil Organic Carbon, at up to 50%.

[1]

Pleistocene Primary Production;

Reaching into prehistory we have no accounts to rely on. The myths and stories written at the dawn of history, the human record, of being cast from Eden, fending for our selves, then scourged by the great flood of Gilgamesh have been potent lessons for human aspirations & guidance through the millenniums.

More exacting are the geologic records in sediments & ice cores, written on pages of stone, preserved chronologically in layers of ice. These records have no need for myth nor metaphors. Stark truth tellers of what weather & climate was, pollen micro-fossils produced in Stone for billions of years, Sediments for millions and Ice & stalactites for hundreds of thousands of years, Tree rings for 1000s of years

Many Climate researchers look to the Pliocene epoch 2.5 million years ago because it was the last time our world experienced 400 PPM CO₂, to show folks what we are in for now. I feel a greater lesson and model to follow however is to look at the late Pleistocene. Just 12,900 years ago, the dawning of the Ag Revolution, with new findings in Jericho & Turkey setting this revolutions beginnings to Over 12,000 years ago.

The late Pleistocene to Holocene boundary shows a prestigious pedogenesis, the loess–paleosol sequences of the central and northern Great Plains record a broad peak of high effective moisture, a pedogenesis we can emulate with the bio-remediation techniques we advocate as the only economic way to reverse climate change..

The new research concerning the ecologically limiting effects of Phosphorous caused by the loss of the Mega-Fanua means we have never seen the true vigor that forest & grass lands could have. That what we now see as "pristine" systems are but a shadow of their primary production potential. The Pleistocene megafauna extinctions resulted in large and ongoing disruptions to terrestrial biogeochemical cycling at continental scales, switching off this natural nutrient pump by a massive 98%. The megafauna diffused sodium inland and also reduced concentrations in plants near the coast.

[2]

(There is a whole parallel literature developing in the marine literature, with deep diving megafauna playing a key role in nutrient dispersal in the oceans).

Did the Pleistocene extinctions affect land cover reflectivity, (albedo), and climate? Albedo can be more important than carbon, But the increase of cloud forming biogenic aerosols must also be considered.

The origins of the Younger Dryas, (YD), are irrelevant to the climate & food security challenges it presented to mankind.

I however, like throwing a bone to our recalcitrant, "Only God Can Control Climate", Republicans. So, the impact theory of the YD shows a strengthening of God's hand and reduces man's hand in over hunting, as the primary causation of the megafauna extinction.

The YD, 1000 years of -10C Climate Cooling, due mostly to the breakdown of the North Atlantic conveyor current, makes +2C warming look like a walk in the park. The ocean sediments of Canadian carbonate rock, trailing out almost to Ireland, tell a story of massive icebergs across the North Atlantic.

Why did agriculture develop almost simultaneously, across the globe?

A million years of controlling fire, Two hundred thousand years of *homo sapiens*, domestic dogs for 35K years, then in a few thousand years of agriculture, husbandry, special tools, and writing.

We did this to survive and flourish in the face of ecological disaster.

Now we must husband the biosphere to avoid our own AGW disaster. Those who forget history are doomed to repeat it, As far as anthropogenic global warming is concerned, we are doomed if we fail to repeat the ecological profundity of the Pleistocene.

The earliest evidence for agriculture has been pushing beyond 10k BP, the finds in Turkey now at 12K, ever closer to the YD. Just 900 years, a dozen or so lifespans, from such a Biospheric cataclysm, ending this Pleistocene Eden. Those 900 cold & hungry years, the megafauna being taken off the menu 12.9K BP, brings us to the dawn of agriculture.

The surviving bison, elk, and moose to slowly fill a large ecological niche, must have provoked food security issues for the hunters. Even some trees miss the Mammoths, unable to propagate, Untold ecological services reduced; the water tables, the general forest unbound to the detriment of grasslands

If I were H. G. Wells;

One of my fondest dreams has always been to time travel to the triple canopy eastern hard wood forest circa 1491, before invasive English earth worms devoured the 3 foot thick duff, Towering Chestnuts, Oaks as understorey, which I used to consider "Virgin", but now understand as anthropogenic, a selected nut & fruit bearing forest with Fire managed grazing, But Before that native American arboriculture, before the Younger Dryas, an almost unimaginable non-Phosphorous limited forest & grassland ecology created by the Mega-herbivores. What was the extent of the keystone species services of 500 pound Beaver?, Armadillos the size of a Volkswagen?, four species of elephants?, etc...

ADAPTATION, EAST AND WEST;

No Clovis points are found after the YD layer. Paleo-Indian population's reduced mitochondrial DNA diversity have likewise characterized Younger Dryas age climatic deterioration as drastic enough to extinguish northern populations creating a population bottleneck in the peopling of the Americas

To control the forest, optimize grazing for the remaining bison, intensive Fire Management, the only tool as powerful as the forest-stomping megafauna. Smith, Elliot and Lyons (2010), who assume that about 100 million North American herbivores were killed by hunting and claim that the resulting decline in CH₄ emissions could explain the observed decrease of atmospheric CH₄ concentrations dated to the beginning of the Younger Dryas, and that this presumed connection justifies a re-calibration of the onset of the Anthropocene to 13,400 years before the present.

NPP increases CO₂ draw-down, sugar exudates pumped deep into soils, if we make biomass carbon more recalcitrant compost/humus, and really recalcitrant pyrolytic C, biochar, we moderate the Keeling CO₂ curve, More CO₂ inspired, photosynthetic Carbon-Sugars exuded deep into soils, less respired from the breathing biosphere.

Anthropogenic activities led to the stabilization of atmospheric CO₂ concentrations at a level that made the world substantially warmer than it otherwise would be. An unintended consequence of burning forest and opening ground for agriculture. The Soil Carbon built over many millenniums, degraded in 10K years. The 10% C rich mid west soils farmed to 4% in 100 years.

Sustainability is a simple choice really, Live by carbon Or die by the carbon.

The Kayopo Indian people were no carbon Saints in creating high Carbon Terra Preta soils. Lake sediments show us that, with a 5 Gt Carbon draw down with their demise. The "greenest" Empire ever was Genghis Khan's; a 700,000,000 ton draw down. Now disrupting agriculture by rape and pillage may not be a politically correct form of afforestation, but it works.

Dr. Jim Hansen's 100 gigatons of Afforestation will work, as trees have worked time and time again.

The Black Death increased afforestation in Europe by one third, the mass death of farmers is bench marked across the climate record. The Colombian exchange, that Grand reunification of life, was not quite so deliberate, in fact quite unintentional, however the chips of life fell where they may, Losers and winners abound.

Hansen's Afforestation accounting for CO₂ soil & forest sequestration is understated. Not giving full account for new understandings of the ecological services rendered.

Aerosol chemistry is the elephant in the room.

Physicist tend to focus on the carbon, oxygen, and nitrogen contents of the organic materials, Pöhlker et al were surprised finding very high potassium levels, up to 20 percent in the 77 Amazonian carbonaceous aerosol samples, in the form of salts, in all but three of them.

The samples were on the scale of mere millionths or billionths of a meter. The smaller the aerosol, the greater the proportion of potassium – those collected early in the morning were the smallest and richest in potassium. Larger particles contained more organic material but not more potassium. These facts suggest that potassium salts generated during the night acted as seeds for gas-phase products to condense onto, forming aerosols of different kinds.

[3]

Extinction of Life....By Life;

More and more new evidence has been piling up supporting Gaia, Biota influencing even greater aspects of the abiotic world, temperature & atmosphere, Aerosols & Albedo.

An example is how the activity of photosynthetic bacteria during Precambrian times have completely modified the Earth atmosphere to turn it aerobic, and as such supporting evolution of more complex life 2.3 billion years ago, The Great Oxygenation Event (GOE), also called the Oxygen Catastrophe was the biologically induced appearance of dioxygen (O₂) in Earth's atmosphere. Photosynthetic Cyanobacteria were responsible for one of the most significant extinction events in Earth's history. Additionally, the free oxygen reacted with atmospheric methane, a greenhouse gas, greatly reducing its concentration and triggering the Huronian glaciation, possibly the longest snowball Earth episode in the Earth's history

The most severe biotic crisis in the fossil record, the end-Permian Extinction, the big one, 90% of species, now at the doorstep of a very Wee-Beastie. The birth of a new microbial metabolic pathway, methanogenic expansion, highlight the sensitivity of the Earth system to microbial evolution. Microbial innovation leads to exponential growth.

Just as the fossil record reveals the co-evolution of the Pleistocene flora and fauna and the existence of these widespread natural herbivores on each continent; the fossils also record the demise of the mega fauna. In western North America the fossil record indicates that the majority of large herbivores and their associated predators became extinct after 12,900 B.P. This massive extinction over an extremely short time period removed over 70% of the Pleistocene mega fauna in North America. North America lost 33 out of 45 genera of large fauna during this late Pleistocene extinction. Since 12,900 B.P. the depauperate remnants of the Pleistocene mega fauna include bison, elk, moose, deer, antelope, and bighorns. To date neither evolutionary substitution (for which there has been far too little time) nor immigration have filled the empty niches in this natural herbivory.

The implications of the Pleistocene extinctions on current efforts to comprehend our western ecosystems is tremendous, even if not yet recognized. Underlying nearly all aspects of land management is the assumption that the fauna and flora of North America-at the time of European contact was in a pristine natural state of balance.

The big questions of ecological restoration have always been restoring to what?, when? and how? The last "Pristine" ecology, the Pleistocene is my target or model we must emulate with the proxies we have, wise land management, grazing and maybe eventual re-wilding with species now extinct. The Megafauna are most tantalizing and "Dolly" the Mammoth is doable now.

Animal feed supplements,..

Practiced by the European and Japanese, allow this Black Revolution for Agriculture to be fermented by our livestock. In the EU, 90% of the Biochar produced is passed

through livestock before composting and field application. On Swiss & German Farms they have eliminated manure odor and closed the nutrient loop by retaining Nitrogen in Char/Compost. Dr. Ron Leng have shown cattle fed char reduced enteric methane emissions 40%, enhancing feed conversion 20% !, this has to be one the greatest advances in bovine nutrition in the last few decades.

Everything is About Soil Carbon;

The "Founding father" of Terra Preta soil study is Dr. Wim Sombroek, Before Sombroek died in 2003, he called together a team of internationally renowned soil scientists and gave them the challenge of creating a new Terra Preta capable of solving some of the world's most pressing problems. He called this new Terra Preta, "Terra Preta Nova", created using modern thermal conversion technologies; Pyrolysis and Gasification.

If I May be so bold...

As I speak for Biologic Carbon... I speak for the very center of life itself. We have been burning it for well over one million years, exploiting it out of the soils for 12,000 years, combusting fossil carbon for over 150 years. Now, we can grow nano-structured fossil carbons into unprecedented varieties of materials and even human tissues.

The Stone Age did not end for a lack of stones, as well, the Combustion Age will not end for lack of fossil fuels. Nanotechnology and Terra Preta Soil Technology has thrust The Diamond Age upon us, with it, the rectification of the Carbon and Nitrogen Cycles, Restoring Soil Ecology, In turn rectifying the Hydrologic and Climate Cycles.

This train is leaving the station, either get on board or be left in the combusted soot and CO2 pollution of history!
Since we have filled the air, filling the seas to full, Soil is the only Ubiquitous and Economic place to put it!

[1]

Fertile soil doesn't fall from the sky. The contribution of bacterial remnants to soil fertility has been underestimated until now

<http://www.alphagalileo.org/ViewItem.aspx?ItemId=126987&CultureCode=en>

Biologists Unlock 'Black Box' to Underground World: How Tiny Microbes Make Life Easier for Humans,

http://www.sciencedaily.com/releases/2013/01/130103092030.htm?goback=.gde_4767237_member_201276911

Cross-biome metagenomic analyses of soil microbial communities and their functional attributes,

<http://www.pnas.org/content/109/52/21390>

The Hidden Organic Carbon in Deep Mineral Soils;

<http://link.springer.com/article/10.1007%2Fs11104-013-1600-9>

FAO on Conservation Agriculture:

SOIL CARBON SEQUESTRATION IN CONSERVATION AGRICULTURE

"In general, soil carbon sequestration during the first decade of adoption of best conservation agricultural practices is 1.8 tons CO₂ per hectare per year. On 5 billion hectares of agricultural land, this could represent one-third of the current annual global emission of CO₂ from the burning of fossil fuels (i.e., 27 Pg CO₂ per year)."

http://www.fao.org/ag/ca/doc/CA_SSC_Overview.pdf

Greenhouse Gas Mitigation Potential of Agricultural Land Management in the United States:

A Synthesis of the Literature (Third Edition)

"An extensive scientific literature review providing a side-by-side comparison of the biophysical greenhouse gas (GHG) mitigation potential of more than 40 agricultural land management activities in the United States.

<http://nicholasinstitute.duke.edu/ecosystem/land/TAGGDLitRev#.U-GVaGOTItj>

The Coalition on Agricultural Greenhouse Gases, (C-AGG)

<http://www.c-agg.org/>

Re-Building the World's Soil: The Role of Soil Carbon Methodology for U.S. and Global Carbon Offset Projects,

<http://www.prweb.com/releases/2012/12/prweb10185341.htm>

The Final Frontier for Biochar. Carbon Credits;

<http://www.britishbiocharfoundation.org/?p=725>

A copy of the methodology can be found;

http://www.britishbiocharfoundation.org/wp-content/uploads/EB67_repan08_ACM0021_NM0341.pdf

Both the Organic and Agricultural chemical schools of soil science recognize Biochar as a powerful tool to foster biodiversity and nitro efficiency in soils. My hope is that Biochar can form the basis for an uncomfortable marriage between commercial agriculture and organic practice. For him, improved synthetic nitrogen deficiency and livestock manure management, For her, increasingly biodiverse soil

microbiology, forming ever more recalcitrant forms of humic substances.

Work by Christoph Steiner, then at U of GA, showing a **52% reduction of NH₃ loss when char is used as a composting accelerator**. (74% in Oz adding Wood Vinegar). This will have profound value added consequences for the commercial composting industry by reduction of their GHG emissions and the sale

of compost as an organic nitrogen fertilizer.

Biochar effects on soil biota– A review Soil Biology and Biochemistry journal, a review of international work by Lehmann & Janice Thies;

<http://www.biochar-international.org/node/2528>

Soil-C Farming of Oz

"The Cat's Cradle"

Improving Agricultural Productivity and Economic Viability through Improved Understanding of Natural Systems

<http://biochar.us.com/584/cats-cradle>

USA Soil-C Farming

Down The Worm Hole;

<http://www.terra-char.com/uploads/2/3/7/9/23790961/downthewormhole-tc.pdf>

JR Bollinger's first year success with Carbon-Smart Biological Farming ,
by David Yarrow , April 2016

Clean Biomass cooking is no small thing.

The World Bank Study;

Biochar Systems for Smallholders in Developing Countries:

Leveraging Current Knowledge and Exploring Future Potential for Climate-Smart Agriculture

<http://fb.me/38njVu2qz>

has very exacting analysis of biomass usage & sources, energy & emissions.

Also for Onion farmers in Senegal and Peanut farmers in Vietnam.

A simple extrapolation made from the Kenya cook stove study, assuming 250M

TLUDs, (Top-Lite Up Draft) Cook Stoves for the roughly 1 billion folks world wide now using open burning.

A TLUD per Household of 4, producing 0.52 tons char/Household/yr, X 250M = 130 Mt Char/yr

Showing sequestration of 130 Million tons of Biochar per year, could be achieved just from cooking.

In terms of CO₂e, these 250M Households reduce 825M Tons of CO₂e annually.

The cascading pulmonary health benefits for woman & children is the very thick icing on this nearly 1/2 GtC Soil Carbon Cake.

Demonstration, Using quantitative¹³C nuclear magnetic resonance, (NMR), spectroscopy measurements, concluding that both Terra Preta Soils and Midwest dark soils contain 40% to 50%+ of their organic carbon (SOC) as pyrolytic carbon char, that this pyrolytic carbon can account for all CEC

Abundant and Stable Char Residues in Soils: Implications for Soil Fertility and Carbon Sequestration

J.-D. Mao, J. Lehmann,

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<http://pubs.acs.org/doi/abs/10.1021/es301107c>

[2]

As **Vladimir Vernadsky**, (the true father of Gaia in his 1925 book; "**The Biosphere**"), realized about 100 years ago, life (powered by photosynthesis and carbon cycling) is the most potent geologic force. Carbon cycling (which heavily influences water cycling) underlies almost all of our biggest challenges. Many now realize that humans have become a principle influence on carbon and water cycling, but our influence has been largely inadvertent/unintentional and often (e.g. changes in soil carbon in specific places) outside our awareness.

The legacy of the Pleistocene megafauna extinctions on nutrient availability in Amazonia

http://www.nature.com/ngeo/journal/v6/n9/full/ngeo1895.html?WT.ec_id=NGEO-201309

Are Nutrient Limitations a Consequence of the Pleistocene Megafauna Extinctions?

<http://oxfordmegafauna.weebly.com/4/post/2014/03/chris-doughtyare-nutrient-limitations-a-consequence-of-the-pleistocene-megafauna-extinctions.html>

Late-glacial and early Holocene variations in atmospheric CO₂ concentration indicated by high-resolution stomatal index data

<http://www.sciencedirect.com/science/article/pii/S0012821X03003248>

"Atmospheric CO₂ concentrations were found to have decreased rapidly from c. 260 ppmv to 210–215 ppmv within 200 years during the Allerød (GI-1)/Younger Dryas (GS-1) transition. After 100–200 years, CO₂ concentration started to gradually increase to 270–290 ppmv at the end of the Younger Dryas stadial (GS-1)."

Synchronous records of pCO₂ and Δ¹⁴C suggest rapid, ocean-derived pCO₂ fluctuations at the onset of Younger Dryas

<http://www.sciencedirect.com/science/article/pii/S0277379114002509>

Heinrich and Dansgaard-Oeschger events also show how thermohaline circulation plays an important role in transporting heat northward, a slowdown would cause the North Atlantic to cool. Later, as the addition of freshwater decreased, ocean salinity and deepwater formation increased and climate conditions recovered.

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The Role of Ruminants in Reducing Agriculture's Carbon Footprint in North America

<http://www.jswnline.org/content/71/2/156.abstract>

Global Cooling by Grassland Soils of the Geological Past and Near Future

<http://blogs.uoregon.edu/gregr/files/2013/07/Retallack-2013-grassland-cooling-q8ay9r.pdf>

We can mimic the Mega-fauna with cows, making 3.3 tons of Soil-C/Ac/yr, "Most sustainable Ag includes Animals"

This recent University of Georgia grazing study shows a 3.5 tons/ac/yr Soil-C increase.

Emerging land use practices rapidly increase soil organic matter

<http://www.nature.com/ncomms/2015/150430/ncomms7995/abs/ncomms7995.html>

The Trees that Miss the Mammoths

https://fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev7_016050.pdf

Holocene carbon emissions as a result of anthropogenic land cover change

<http://hol.sagepub.com/content/early/2010/12/24/0959683610386983.abstract>

RECONSTRUCTION OF THE MAMMOTH-STEPPE ECOSYSTEM

the transition from steppe to tundra at the end of the Pleistocene. The keystone-herbivore hypothesis

STEPPE-TUNDRA TRANSITION: A HERBIVORE-DRIVEN BIOME SHIFT AT THE END OF THE PLEISTOCENE

<http://www.sysecol2.ethz.ch/refs/entclim/z/zi031.pdf>

The Columbian Encounter and the Little Ice Age: Abrupt Land Use Change, Fire, and Greenhouse Forcing

<http://www.tandfonline.com/doi/abs/10.1080/00045608.2010.502432#.VE21zRY4zHg>

A radical example are what can be achieved with modern Biomass cropping systems. New genetic techniques with Polyploidy trees increase Eco-services by 200%. Innovation in Ag & Agroforest systems usually comes a few percentage points at a time, increasing the yields a bit, shaving off cost of fertilizers etc. Exponential gains are revolutionary and rare, not even biochar feed supplements with >20% Feed conversion increases, 87% reduction of manure odor, through impressive, don't come near the exponential change with Polyploidy trees. Which expands my vision to the possibilities of biomass saving the planet.

Reforestation Carbonwood Panama

<https://www.youtube.com/watch?v=nKbE27uGkYg>

The human microbiome can't be talked of enough. the meta-genomic assays ferreting it out & how soils make

us happy via *Mycobacterium vaccae* bacteria stimulating serotonin.
Smell the Geosmin, and get glued to the Glomalin

Identification of an Immune-Responsive Mesolimbocortical Serotonergic System: Potential Role in Regulation of Emotional Behavior

Christopher Lowry et al., 2007 in *Neuroscience*.

http://www.sage.edu/newsevents/news/?story_id=240785

Getting Stoned on Soil

<http://www.gardenbetty.com/2012/06/getting-stoned-on-soil/>

Geosmin

Brown Chemists Explain the Origin of Soil-Scented Geosmin

<https://news.brown.edu/articles/2007/09/origin-soil-scented-geosmin>

[3]

2016 Billion Ton Report <http://www.biofuelsdigest.com/bdigest/2016/04/03/son-of-billion-ton-the-digests-2016-multi-slide-guide-to-the-usda-billion-ton-report/>

If we could but carbonize it all, all 7.5 Gt of world biomass, (3.75 Gt of carbon), we could sequester about 1.25 GtC of carbon.

Salt Seeds Clouds in the Amazon Rainforest

<http://newscenter.lbl.gov/2012/09/10/amazon-aerosols/>

[4]

Methanogenic burst in the end-Permian carbon cycle

<http://www.pnas.org/content/early/2014/03/26/1318106111>

Archaeageddon: how gas-belching microbes could have caused mass extinction

<http://www.nature.com/news/archaeageddon-how-gas-belching-microbes-could-have-caused-mass-extinction-1.14958>

Great Oxygenation Event

http://en.wikipedia.org/wiki/Great_Oxygenation_Event

Japan Biochar Association;

<http://www.geocities.jp/yasizato/pioneer.htm>

eBRN European Biochar Research Network

<http://cost.european-biochar.org/en>

UK Biochar Research Centre

<http://www.geos.ed.ac.uk/sccs/biochar/>

The Australian and New Zealand Biochar Researchers Network

<http://www.anzbiochar.org/index.html>

Dr. Ron Leng, the first in vivo study;

Biochar reduces enteric methane and improves growth and feed conversion in local "Yellow" cattle fed cassava root chips and fresh cassava foliage

<http://www.lrrd.org/lrrd24/11/leng24199.htm>

The Delinat Institute's Ithaka Journal;

The use of biochar in cattle farming

<http://www.ithaka-journal.net/pflanzenkohle-in-der-rinderhaltung?lang=en>

"90% of the biochar produced in Europe is used in livestock farming." is a pretty powerful statement.

At Delinat they are developing a "Building Division" to exploit char use as a building material; in bricks, wood siding finishes, CharPlasters for solid state moisture control. If high temperature char is used...hold on to your Hats!.....All cellphone signals are Blocked!

Carbon Terra,

<http://www.carbon-terra.eu/en/home>

are offering a full line of Carbon Feeds; CarbonCattle, CarbonDog & CarbonCat food

SupperStoneClean;

In aquaculture a doubling in size of fish, clams & shrimp

<http://superstoneclean.com/video-presentations/>

Biographical Info

An ornamental gardener of 36 years, has spent the last 9 years advocating for thermal conversion of biomass. He has been directly involved in several projects concerning soil carbon at James Madison University, as well as conference planning & presentations at CU Boulder 09, ISU 2010, Sonoma State in 2012 and Umass 2013.

Working to integrate the many applications of Biochar for enteric health as a feedstuff in animal husbandry, for mine scarred lands as an in situ bioremediation for a host of toxic agents, in addition to carbon negative energy and fuels, Erich has networked and collaborated with a host of organizations across the globe. His goal is total symbiotic integration of nutrients, carbon and energy by the husbandry of whole new orders and kingdoms of life. To recruit the Wee-Beasties from numerous biomes allows nature to do the heavy lifting and solve many dilemmas in our macro world. There is Plenty of Room at the Bottom and Biochar has provided the tools to explore this vast realm.

Networking efforts have lead to collaborative field trials with the Rodale Institute , DuPont & ORNL for brownfield remediation trials, and dissemination of char practices to academic & grass-roots organizations. Additionally he has provided editorial assistance on topical articles and the leading books; "The Biochar Solution" & "The Biochar Revolution", also writing the Biochar chapter in "Geotherpy", <https://www.crcpress.com/Geotherapy-Innovative-Methods-of-Soil-Fertility-Restoration-Carbon-Sequestration/Goreau-Larson-Campe/p/book/9781466595392>

Policy & research lobbying efforts with the USDA, USGS, DOE, NOAA, NASA and EPA lead to a briefing of the EPA chiefs of North America at the 2011 Commission for Environmental Cooperation. In 2013 receiving a 4 paragraph "Thank You" snail-mail from Tom Vilsack and Dr. Rattan Lal, also consultative work with Dr. James Hansen and food writer Michael Pollan.

"The Civilization of Soil",

Hallmarks of the Unintended & Intended Anthropocene

abstract

Historic hall marks of Green House Gas, (GHG), emissions are reviewed, providing repeated demonstration of anthropological land use changes on climate forcing.

New Astrophysical and Paleoclimate concordance with extinction events demonstrating climate adaptation by prehistoric man.

The Strata graphic measure of distinctions to the start, and effective end, of the Anthropocene.

A review of new research concerning Soil Carbon, Carboniferous Aerosols and the synergistic ecological services supporting Net Primary Production, (NPP).

The extent of Pyrolytic-Carbon's fraction in soil and the first survey of the extensive deep soil carbon sink.

Review of land use studies on Holistic Grazing, ungulate nutrient & carbon dispersal & climate control.

Implications for Carbon Dioxide Removal, (CDR), when all Best Management Practices, (BMPs), are observed.

How thermal conversion technologies can integrate and optimize the recycling of valuable nutrients while providing energy and building soil carbon.

New discoveries from the Advanced Spectroscopy & Meta-Genomics studies in soil microbiology which demonstrate unaccounted for ecological services provided by a healthy soil. All extremely supportive to Argo-Ecological principles, Carbon & Regenerative Farming initiatives & Soil Carbon Standards and GHG protocols.

Part and parcel to a healthy, high carbon and highly aggregated soil structure.

Integration of Agricultural bio-energy production with nutrient and carbon cycles, enhancing ecological services.

Exploring implications for human and animal health, extrapolating implementation at scale of bio-energy systems that conserve carbon for home health, energy and climate