“Restoring Ecosystems to Reverse Global Warming” ?
A Critique of Biodiversity for a Livable Climate’ claims

By David Schwartzman, dschwartzman@gmail.com
October 4, 2015

Introduction

Efforts to boost sustainable agriculture, specifically with agroecologies and permaculture, are imperative to replace industrial/GMO agriculture, both to confront the challenge of climate change and to eliminate big negatives of the present system of unsustainable agriculture. And yes, these alternatives are very useful in sequestering carbon from the atmosphere, burying it in the soil.

But here is my concern with some of the messaging on the Biodiversity for a Livable Climate (BLC) website and their partnering organizations, in particular the Savory Institute. *We hear the claim that their approach will reverse global warming even while carbon emissions from the energy sector continue. Sometimes the need to reduce these emissions is acknowledged, but often this need is not even mentioned. This is very misleading and a huge exaggeration.*

Even from the BLC's homepage (http://bio4climate.org/):

"We can return to pre-industrial atmospheric carbon levels in a few decades or less, and cool the biosphere even faster than that".

I agree with Pushker Kharecha:

“I think it might detract from the major issues of reducing fossil fuel emissions,” said Pushker Kharecha, a research scientist at Columbia’s Earth Institute, referring to Savory’s approach. “A heavy over-emphasis on land use as a **panacea** [**bold added**] does detract from the more fundamental issue of shifting our energy infrastructure to clean energy.” (https://www.bostonglobe.com/ideas/2014/05/03/how-solve-climate-change-with-cows-maybe/j3c4uoHv4iJqWjHXezlonN/story.html)

Here is the conclusion of this critique: *The critical issue is the potential global sequestration flux assuming a complete transition to this mode of agriculture. The maximum flux is far too small to achieve what is claimed, even if fossil fuel emissions cease immediately! Further, it is possible with a strong wind/solar power transition in a couple of decades to completely eliminate fossil fuel carbon emissions, but sequestration from the atmosphere will be necessary for the rest of this century to bring and keep the* CO_2 *level at 350 ppm (it is now 400 ppm).*

Discussion

The following provides a detailed evaluation of the BLC claims:

1) The claimed potential carbon sequestration fluxes (The Global Opportunity for Capturing Atmospheric Carbon through Soil Regeneration, 2015, “GOCACSR”) appear to be significantly too high, close to an order of magnitude too high.

Total claimed global flux of 28 billion Ton C/year is over 7 times Lal’s (2010) maximum estimated flux for terrestrial ecosystems equal to 3.8 billion Tons C/year.

In a paper not cited by Sacks et al. (2014), Lal (2011), gives a potential carbon sequestration flux from global agroecosystems (croplands, grazing lands, rangelands) equal to 1.2 - 3.1 billion Tons C/year.

There is a glaring lack of actual peer-reviewed literature cited, none given on “GOCACSR”; Sacks et al. (2014) gives one retrievable from literature: Wiley et al. (2013), published as Hasson et al. (2013): 1 Ton C/acre/year, but study on perennial pastures in Australia, based on capacity from 2.75 to 4.75 year duration. To my knowledge no peer-reviewed study has been published demonstrating the high carbon sequestration potential claimed for the Savory approach to restoration of degraded land using cattle.

Research on wetlands is very instructive, since GOCACSR claims this ecosystem has the highest sequestration flux equal to **4 Tons C/acre/year**, compared to 1 and 2 Tons C/acre/year for degraded grasslands and croplands respectively.

Here are estimates from the peer-reviewed literature:
Highest: Tropical riverine wetlands: 3.2 Tons C/acre/year (Adame et al., 2015)
Coastal wetlands (Florida): 0.8 Tons C/acre/year for present; 0.5 Tons C/acre/year for last century, which are likely to represent long-term sequestration flux (Choi and Wang, 2004)
Global wetlands; 0.6 Tons C/acre/year, assuming 7 million square km = 1.73 billion acres (Mitsch et al., 2012)

Temperate freshwater wetlands: 0.73 Tons C/acre/year, highest flux corresponding to forested wetlands (Bernal and Mitsch, 2012)

Conclusion: only tropical riverine wetlands approaches claimed flux, all others are near 1 Ton C/acre/year or less, including the global composite.

2) First already occurring and ongoing impacts of global warming have and will include irreversible effects that should be obvious; hurricanes and temperature extremes cannot be taken back by a time machine, neither can the deaths caused by the main driver of global warming, fossil fuel consumption. To “reverse global warming” with respect to the carbon dioxide level in the atmosphere, sequestration must reach and maintain the pre-industrial 280 ppm level. The calculation “”Doing the arithmetic”, p. 2 “GOCACSR”, is very misleading since it assumes present baseline 400 ppm atmospheric carbon dioxide level for the time computed, as well as *immediate full claimed potential flux* from soil regeneration capture to get “16 years”, as well as a constant anthropogenic carbon flux of 10 billion Tons C/year. The claimed potential land areas subject to soil regeneration, whether is be degraded grasslands, croplands or wetlands, need to be backed up by serious data demonstrating a plausible plan. Even if we take their total areas to be valid as claimed, 15 to 17 billion acres, the time scale for global reconversion should be discussed, assuming a robust program is in place.

Further, ongoing carbon sequestration is imperative even after anthropogenic carbon emissions go to zero, roughly for the rest of this century if such emissions are terminated by 2050, since roughly equal amount of carbon corresponding to the atmospheric carbon dioxide pool resides in ocean/terrestrial biota. There is good reason to conclude that carbon storage in soils using a regenerative approach will saturate on a shorter time scale.

3) Ongoing warmer even with a 2 deg C limit, hence the potential progressive reduction of carbon sequestration potential owing to respiration of soil carbon back into atmosphere must be considered in evaluating the long-term potential of this approach. There is a big research program to evaluate what will happen to this flux as global warming intensifies. For example, there is evidence for an enhanced decomposition rate of soil carbon in temperate forests as temperatures increase, with these forests having a large fraction of global soil carbon (Xu et al., 2014).

4) The Savory restoration of degraded land using cattle as carbon sequestration

I have major concerns with their claims, based on the peer-reviewed literature (see e.g., the critique by Briske et al. (2013, 2014), West and Briske (2013) and Monbiot (2014) with citations which point out gross errors in their estimates of potential fluxes as well as other claims being made). The Savory Institute finally posted a non-peer reviewed white paper on the methane issue which is really problematic, in particular for its downplaying of enteric fermentation methane release, mainly from cows. There is actually evidence that these emissions are greater for grass-fed versus corn-fed cows, but what is imperative, this meat production globally must be radically curbed globally !

The Savory scenario neglects serious consideration of methane/nitrous oxide flux from cattle to atmosphere, particularly methane from cow farts (1.47 billion cows worldwide in 2013; http://www.statista.com/statistics/263979/global-cattle-population-since-1990/). Livestock Greenhouse gas (GHG) emissions were 7.1 billion Tons CO_2-equivalent/year (based on 2005), representing 15% of the total anthropogenic emissions (Gerber et al., 2013); cattle were responsible for 4.6 billion Tons CO_2-equivalent/year (or 65% of the livestock sector), with 44% of the livestock sector emissions coming from methane, 29% from nitrous oxide and 27% from carbon dioxide.

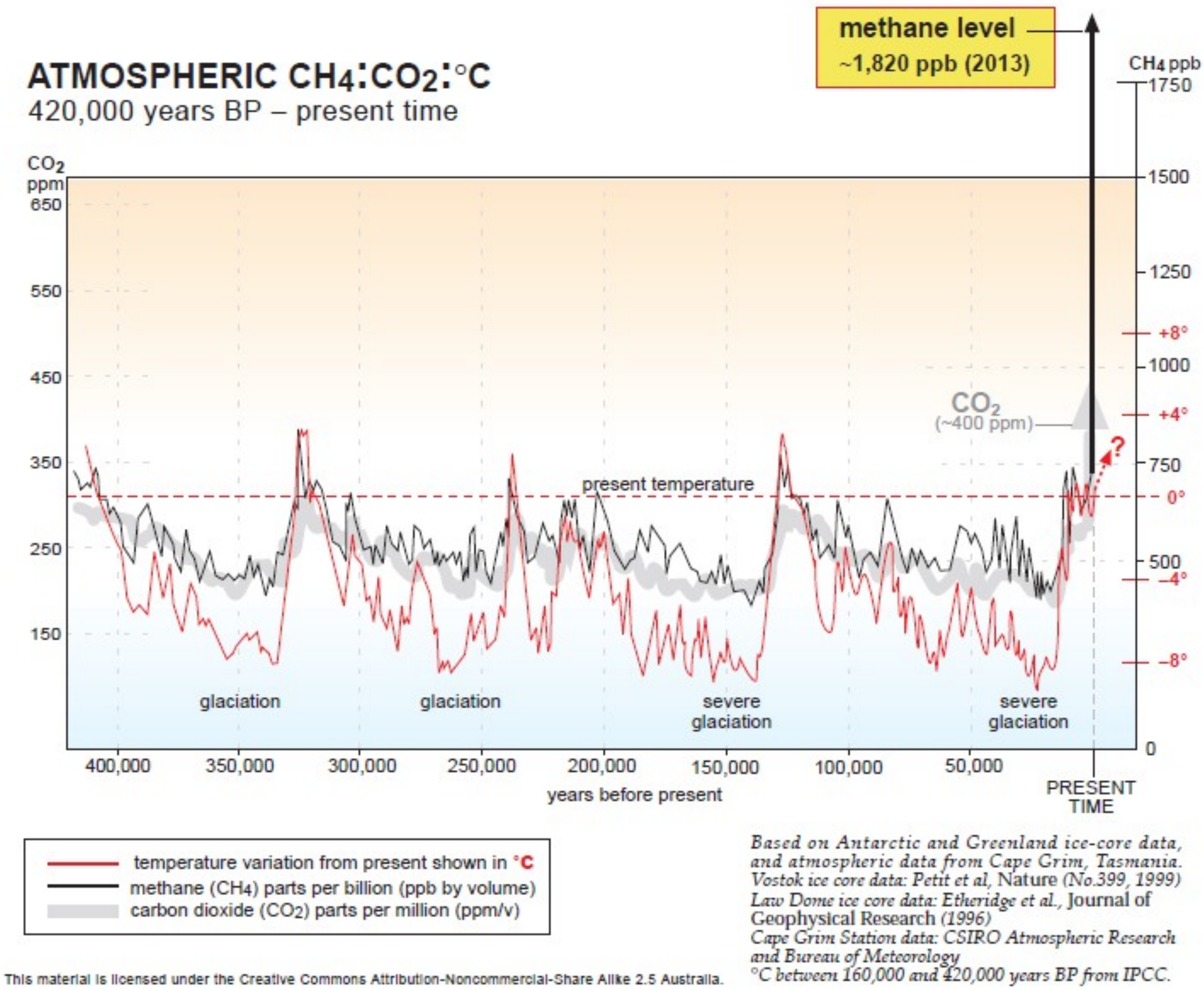
Sacks et al. (2014) recognize that "from a climate change perspective intensively reared livestock are significant contributors to GHG emissions".

But they go on to say "The issue of ruminant methane emissions is frequently raised in discussions about grazing. Methane from livestock has been estimated to be approximately 22% of anthropogenic methane emissions in 2005, or 67.6 million tonnes out of a total 313 Mt (Hoglund-Isaksson 2012). Hristov (2012:2) estimates that historical emissions from wild herds before European settlement in the United States was 86% of current emissions. It is reasonable to infer that this estimate applies more generally across the world. "

No, it is not reasonable to infer that this estimate applies worldwide. First, the cattle population in the U.S. totals 90 million (2015; http://agebb.missouri.edu/mkt/bull12c.htm), but the worldwide total is 1.47 billion (2013), with 213 million in Brazil, 301 million in India and 100 million in China, all with larger numbers than the U.S. (http://beef2live.com/story-world-cattle-inventory-vs-human-population-country-0-111575). There is no evidence that the size of wild ruminants worldwide was close to the size of the global cattle numbers. Hence extrapolating the comparison for the U.S. to the global scale is unwarranted and misleading.

"If such is even close to the case, given that pre- industrial atmospheric methane did not exceed 788 parts per billion by volume (ppbv) for 650,000 years, and were at 600 ppbv or less for most of that period (Spahni:55), we may justifiably conclude that ruminant methane emissions were balanced by natural methane decomposition processes." …" The steady planetary methane levels over the past 650,000 years attest to that, and it is highly unlikely that any significant fraction of the post-industrial methane spike is attributable to livestock. The important understanding here is that intact ecosystems work in ways that we still understand only poorly, and the best we can do to reverse the damage that civilizations have wrought is to regard ecosystems as wholes far greater than the sums of their parts, and proceed accordingly."

"highly unlikely that any significant fraction of the post-industrial methane spike is attributable to livestock" ? The fraction of the present methane/GHG flux from global livestock has previously been cited, and the present methane concentration of the atmosphere is much higher than the last 400,000 years derived from the record recovered from ice cores and present measurements (1.820 ppb in 2013 compared to less one half this level in the going back to 400,000 years B.P.; see Figure below from https://en.wikipedia.org/wiki/Carbon_dioxide_in_Earth%27s_atmosphere).



I was impressed with the presentation of Precious Phiri at the BLC September 26, 2015 event in Washington DC showing significant benefits for rural communities apparently resulting from restorative grazing programs in Zimbabwe. Nevertheless, any claim regarding net carbon sequestration from the apparent increase in grassland productivity, accompanied by the increase in cattle population should be demonstrated by systematic research that quantifies the flux of carbon into the soil and the increase in methane emissions to the atmosphere. If indeed there is a proven benefit from using cattle to restore degraded grasslands, thereby boosting carbon sequestration to the soil, what is the maximum cattle population required for a net carbon sequestration flux taking into account GHG emissions?

Labelling an approach as "holistic" by the Savory Institute doesn't necessarily mean anything other than hype, unless it is backed up by scientific research addressing the actual carbon sequestration flux as a function of time, as well as other claimed benefits.

5) Sacks et al. (2014)* argue “The result is that the emissions-reduction strategy has, to date, been a decisive failure. It is beyond the scope of this paper to investigate the causes of said failure, which are primarily social, political and economic. For present purposes suffice it to say that generally the obstacles to emissions reduction have been a function of political inertia and economic vested interests, as well as difficulties in changing carbon-emitting cultural habits based on the unsustainable use of fossil fuel energy, for example, use of motorized ground and air travel in all aspects of life, and intensive synthetics-based agricultural productivity in all developed parts of the globe. The advancement of energy-conserving practices and suitable technologies would likely have made far more significant progress in the presence of strong political and popular will. .. Since it has become increasingly apparent that emissions reductions will not take place in a reasonable timeframe, there have been alternative proposals for reducing the concentration of atmospheric greenhouse gases (GHGs) by actively removing them from the atmosphere.”

My response: if very robust emissions reductions will not began in the near future, neither will carbon sequestration via regenerative agriculture/soil regeneration, since both are facing the very similar obstacles, in particular the resistance of the fossil fuel, big agribusiness (e.g., Monsanto) corporate sector and their political allies in governments around the world. Overcoming these obstacles by building a powerful transnational movement is the huge challenge humanity faces to have any chance of preventing climate catastrophe (roughly corresponding to keeping the warming below 2 deg C, if not 1.5 deg C, above the pre-industrial level for this century). There is no evidence that implementing regenerative agriculture will be any easier than curbing carbon emissions and replacing our global energy infrastructure with wind/solar power. Any claim that regenerative agriculture can “reverse global warming” without being coupled with radical curbs on fossil fuel carbon emissions is a huge disservice to the climate justice movement. Of course it is important to point out that a robust transition to agroecologies/permacultures replacing industrial/GMO agriculture will reduce GHG emissions from this source, along with curbing fossil fuel consumption. Some 24% of GHG emissions (in 2010) was derived from forestry/land use (including agriculture) with 16% coming from methane, and 6.2% from nitrous oxide emissions (IPCC 2014; pp. 46-47). The total GHG emissions in 2010 was 49 billion Tones CO_2equivalent, in 2012 it grew to 54 billion Tones CO_2equivalent (UNEP 2012, 2014).

Finally, as a climate scientist still doing research (biogeochemistry, energy/climate studies; see my website with my older son Peter: www.solarutopia.org) my understanding of the literature has led me to this conclusion:

Carbon sequestration from the atmosphere is imperative to have any chance of meeting a 2 deg C limit on global warming and will be necessary for the rest of this century because of the re-equilibration of the ocean with the atmosphere with respect to carbon dioxide levels (removing enough atmospheric carbon dioxide to go down below 350 ppm and keeping it there requires continuous sequestration). *But meeting this goal will require very aggressive and complete phase out of fossil fuel consumption in the next few decades*. Regenerative agriculture alone will not likely be sufficient for this task, since at some point the soil carbon pool will become in steady-state with the atmosphere, i.e., saturated. Hence a second technology of carbon sequestration will likely be necessary, chemical reaction of carbon dioxide pumped out of the atmosphere with the crust, focusing on mafic and ultramafic rocks (there is a lot of geochemical research going on wrst this approach).

For example, assuming no phase out of fossil fuels by 2050, with their annual emissions constant (now 36 billion TCO_2/year), 1250 billion Tons CO_2 would be generated by 2050, with roughly one-half remaining in the atmosphere, corresponding to an increase of 313 ppm from the present atmospheric level of 400 ppm, giving a total of 713 ppm. To reduce this level to 350 ppm would require removing 726 billion Tons CO_2. Assuming Lal's (2010) maximum soil carbon sequestration rate of 4 billion Tons C/year equal to 15 billion Tons CO_2 /year, then 48 years would be required, if this sequestration rate was implemented now, an obvious impossibility. Moreover, as a result of re-equilibration from the ocean pool*, soil sequestration must be continued for another 48 years just to keep the atmospheric level below 350 ppm. If soil carbon sequestration at this flux rate were used to "reverse global warming" to the pre-industrial level of 280 ppm, again without radical curbs on fossil fuel emissions, the total time required would be 115 years. Any claim that reversal of global warming is possible on a timescale of a few decades is delusional, even if fossil fuel emissions were completely phased out in the next 35 years.

*E.g., see Cao and Caldeira (2010); their abstract is instructive:
"Carbon capture from ambient air has been proposed as a mitigation strategy to counteract anthropogenic climate change. We use an Earth system model to investigate the response of the coupled climate–carbon system to an instantaneous removal of all anthropogenic CO_2 from the atmosphere. In our extreme and idealized simulations, anthropogenic CO_2 emissions are halted and all anthropogenic CO_2 is removed from the atmosphere at year 2050 under the IPCC A2 CO_2 emission scenario when the model-simulated atmospheric CO_2 reaches 511 ppm and surface temperature reaches 1.8 ◦C above the pre-industrial level. In our simulations a one-time

removal of all anthropogenic CO_2 in the atmosphere reduces surface air temperature by 0.8 ◦C within a few years, but 1◦ C surface warming above pre-industrial levels lasts for several centuries. In other words, a one-time removal of 100% excess CO_2 from the atmosphere offsets less than 50% of the warming experienced at the time of removal. **To maintain atmospheric CO_2 and temperature at low levels, not only does anthropogenic CO_2 in the atmosphere need to be removed, but anthropogenic CO_2 stored in the ocean and land needs to be removed as well when it outgasses to the atmosphere. In our simulation to maintain atmospheric CO_2 concentrations at pre-industrial levels for centuries, an additional amount of CO_2 equal to the original CO_2 captured would need to be removed over the subsequent 80 years." [bold added]**

Conclusion

I like how Ronnie Cummins put it:
"Regenerative Agriculture and Earth Repair practices can not only mitigate, but also, in combination with drastic reductions (80-90 percent) of fossil fuel emissions in our food and farming, transportation, housing, utilities, and industrial sectors, actually reverse global warming."
(https://www.organicconsumers.org/essays/mother-earth-day-2015-regenerating-soil-and-reversing-global-warming)

But I would go further, with an objective of 100% global elimination of all fossil fuels in a couple of decades, starting with the highest carbon footprint ones (coal, natural gas and tar sands oil), coupled with a transition to a full global wind/solar power infrastructure and carbon sequestration from the atmosphere via regenerative agriculture into the soil and chemical reaction of carbon dioxide and water with mafic crust.

References

Adame, M.F., Santini, N.S., Tovilla, C., Vázquez-Lule, A., Castro, L., and Guevara, M. (2015) Carbon stocks and soil sequestration rates of tropical riverine wetlands. *Biogeosciences* 12: 3805–3818.

Bernal, B and Mitsch, W.J. (2012) Comparing carbon sequestration in temperate freshwater wetland communities**.** *Global Change Biology* 18(5): 1636–1647.DOI:10.1111/j.1365-2486.2011.02619.x

Briske, D.D., Bestelmeyer, B.T., Brown, J.R., Fuhlendorf, S.D., and Polley, H.W. (2013) The Savory Method Can Not Green Deserts or Reverse Climate Change, A response to the Allan Savory TED video. *Rangelands* 35(5): 72–74.

Briske, D.D., Bestelmeyer, B.T., and Brown, J.R. (2014) Savory's Unsubstantiated Claims Should Not Be Confused With Multipaddock Grazing. *Rangelands* 36(1): 39-42.

Cao, L. and Caldeira, K. (2010) Atmospheric carbon dioxide removal: long-term consequences and commitment. *Environ. Res. Lett.* 5 024011, doi:10.1088/1748-9326/5/2/024011.

Choi, Y. and Wang, Y. (2004) Dynamics of carbon sequestration in a coastal wetland using radiocarbon measurements. G*lobal Biogeochemical Cycles* 18, GB4016, doi:10.1029/2004GB002261.

Gerber, P.J., Steinfeld, H., Henderson, B., Mottet, A., Opio, C., Dijkman, J., Falcucci, A. and Tempio, G. (2013) *Tackling climate change through livestock – A global assessment of emissions and mitigation opportunities*. Food and Agriculture Organization of the United Nations (FAO), Rome.

Hasson, A., Wiley, T. and Woolston, G. (2013) Whole Soil Sampling to Compare Carbon Sequestration Under Perennial Pastures of Western Australia. *Nature Environment and Pollution Technology* 12 (2): 203-208.

Hristov, A. N. (2012) Historic, pre-European settlement, and present-day contribution of wild ruminants to enteric methane emissions in the United States. *Journal of Animal Science* 90 (4): 1371-1375. (cited by Sacks et al., 2014)

IPCC, 2014: *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

Lal, R. (2010) Managing soils and ecosystems for mitigating anthropogenic carbon emissions and advancing global food security. *BioScience* 60(9): 708-721.

Lal, R. (2011) Sequestering carbon in soils of agro-ecosystems. *Food Policy* 36: S33–S39.

Mitsch, W.J., Bernal, B., Nahlik, A.M., Mander , U, Zhang, L., Anderson, C.J., Jørgensen, S. E., and Brix, H. (2012) Wetlands, carbon, and climate change. *Landscape Ecol*. DOI 10.1007/s10980-012-9758-8.

Monbiot, G. (2014) Eat Meat and Save the World? http://www.monbiot.com/2014/08/04/eat-meat-and-save-the-world/94; published on Guardian website, August 4, 2014.

Sacks, A.D., R. Teague, F. Provenza, S. Itzkan, and Laurie, J. (2014) Reestablishing the Evolutionary Grassland–Grazer Relationship to Restore Atmospheric Carbon Dioxide to

Preindustrial Levels. In *Geotherapy* (Thomas J. Goreau, Ronal W. Larson, Joanna Campe (Editors), pp. 155-194, CRC Press.

"The Global Opportunity for Capturing Atmospheric Carbon through Soil Regeneration", handout at Biodiversity for a Livable Climate Conference, September 26, 2015, Dave A. Clarke School of Law, UDC (Download as "Climate Restoration Solutions Global Opportunity" at: http://www.moralactiononclimate.org/index.php/downloads/biodiversity-for-a-livable-climate; labeled as #3 in as series of Climate Restoration Solutions, Published on 25 September 2015 Modified on 25 September 2015 By Andrea Miller, Produced by the DC chapter of Biodiversity for a Livable Climate (www.bio4climate.org) for the Moral Action on Climate (www.MoralActionOnClimate.org), solutions@bio4climate.org).

UNEP 2012. The Emissions Gap Report 2012. United Nations Environment Programme (UNEP), Nairobi.

UNEP 2014. The Emissions Gap Report 2014. United Nations Environment Programme (UNEP), Nairobi.

Xu, W., Li, W., Jiang, P., Wang, H. and Bai, E. (2014) Distinct temperature sensitivity of soil carbon decomposition in forest organic layer and mineral soil. *SCIENTIFIC REPORTS* 4 : 6512, DOI: 10.1038/srep06512.

West, J. and Briske, D. (2013) Cows, Carbon and the Anthropocene: Commentary on Savory TED Video. http://www.realclimate.org/index.php/archives/2013/11/cows-carbon-and-the-anthropocene-commentary-on-savory-ted-video/

Appendix

Here is my posted comment on Vandana Shiva's article:

In Living Soil Lies the Solution to Climate Change

(http://www.commondreams.org/views/2015/04/23/living-soil-lies-solution-climate-change) Apr 23, 2015

It is an honor to respond to this article from global leader Vandana Shiva. Agroecologies must replace industrial agriculture and GMOs, for the reasons outlined here. I do have a question regarding this section: "On the other hand, organic farming reduces emissions and also makes agriculture more resilient to climate change. Navdanya's research has shown that organic farming has increased carbon absorption by 55 per cent. International studies show that with two tonne per hectare of soil organic carbon, we can remove 10 gigatonne of carbon dioxide

from the atmosphere, which can reduce atmospheric pollution to 350 parts per million."
I assume the removal rate is 10 gigatonnes of carbon dioxide per year. Reduction of the present level of atmospheric carbon dioxide (400 ppm) to 350 ppm corresponds to 370 gigatonnes, but roughly 36 gigatonnes are emitted now from burning fossil fuels and land use. So carbon emissions must be radically reduced and soon, coupled with this approach to have any chance of preventing catastrophic climate change.