Beyond Emissions Reductions

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Introduction

Despite numerous warnings and alarms sounded by climate scientists, today's societies have allowed concentrations of CO_2 in the atmosphere to surpass a level safe for humans and most species alive today. Current climate models indicate that even with a "zero emission" scenario the warming trend may continue before eventually stabilizing decades or centuries from now (Zickfield et al. 2013). NASA now predicts that global temperatures will increase by 9 degrees Fahrenheit by the end of the century (NASA 2014). There is an urgent need for an approach beyond emissions reductions, as necessary as they are, that is more comprehensive and effective than an emissions reduction strategy alone: we must mobilize the biosphere to realize the extraordinary potential for global soil carbon sequestration in order to reverse climate change.

The Problem with "Zero Emissions"

Climate studies that analyze the "zero emissions" scenario, where anthropogenic CO_2 emissions are completely eliminated, demonstrate that the global mean temperature will continue to rise for several decades to even centuries following the elimination of emissions (Matthews 2006; Soloman et al. 2010; Gillett et al. 2011; Matthews and Zickfield 2012; Zickfield et al. 2013). Due to the long residence time of CO_2 in the atmosphere as well as the ocean's vast thermal reserves, global climatic conditions are not projected to stabilize for years following CO_2 elimination strategies (IPCC 2013; Matthews and Caldeira 2008; Zickfield et al. 2013). Some climate experts project that if we succeed in eliminating carbon emissions rapidly and on a global scale, CO_2 levels will peak around 425-450 parts per million (ppm), which is still 100 ppm above the 350 ppm levels proposed as the maximum safe CO_2 concentrations for the survival of humanity (Hansen et al. 2008); other scientists suggest that the safe maximum is significantly less than 350 ppm. The founding director of the Potsdam Institute for Climate Impact Research (PIK), Hans Schellnhuber, has asserted that a safe future would require pre-industrial levels of CO_2--around 280 ppm--saying, "nobody can say for sure that 330 ppm is safe...operating well outside the [historic] realm of carbon dioxide concentrations is risky as long as we have not fully understood the relevant feedback mechanisms" (Adam 2008).

Some climate scientists now warn that to reduce global temperatures to a safe level in a timeframe that allows for the continuation of human societies, a "negative emissions" scenario must ensue (Adam 2008; Matthews and Caldeira 2008; Zickfield et al. 2013). A negative emissions scenario means that not only must humanity cease all carbon emissions, but it must find a way to remove legacy carbon from the atmosphere. According to Alice Bows and Kevin Anderson of the Tyndall Centre for Climate Change Research at the University of Manchester, for atmospheric carbon concentrations to stabilize at 450ppm emissions would have to peak in 2015 and decrease up to 6.5% each year (Adam 2008). Scientists at the U.S. Geological

Survey (USGS) assert that stabilizing atmospheric CO_2 will require an approach that combines reducing emissions with increased carbon storage (USGS 2008). In climate models studied by Zickfield et al. (2013) as well as in previous studies (Gillett et al. 2011), the development of climate change trends, such as sea level rise from thermal expansion and the disintegration of ice sheets, will continue hundreds of years following the cessation of anthropogenic carbon emissions.

These trends are some examples of the byproducts of a positive feedback loop generated in the earth climate system: increased warming (e.g. caused by higher emissions of greenhouse gases (GHG) in the atmosphere) causes ice sheet and glacial melting, which lowers earth's albedo (that is, the degree to which sunlight is reflected and not absorbed as heat) and perpetuates further atmospheric warming, further raising GHG concentrations, and so on. Both positive and negative feedback mechanisms play into the climate equation, but the exact impact of these feedbacks on warming or cooling the climate is largely uncertain due to the complexity of climate system processes. However, the magnitude of the climate's positive feedbacks signals significantly greater warming than many climate models, which exclude uncertain feedback impacts, suggest (Tom and Harte 2006).

In its Fifth Assessment Report on Climate Change (AR5), the IPCC states that "most aspects of climate change will persist for many centuries even if emissions of CO_2 are stopped" (IPCC 2013, pp. 27). Based on years of climate systems research, the IPCC goes on to say that "a large fraction of anthropogenic climate change resulting from CO_2 emissions is irreversible on a multi-century to millennial time scale, except in the case of a large net removal of CO_2 from the atmosphere over a sustained period" (IPCC 2013, pp. 28). Therefore the only hope for reversing the progression of climate change impacts is to go beyond a zero emissions strategy, and focus global efforts on the net removal of carbon from the atmosphere. This urgency is reinforced by the likelihood that significant emissions reductions will not take place any time soon due to the extensive global dependence on fossil fuels in all aspects of modern life.

Vast Potential in Biological Carbon Sequestration

Climate change activists and coalitions such as the Northwest Biocarbon Initiative (Climate Solutions 2010) call for local, regional and global action to remove atmospheric CO_2 through the increased carbon storage in biological systems. The Society for Ecological Restoration asserts that "innovative conservation and restoration projects are perhaps the most potent tools at our disposal to mitigate the adverse impacts of climate change and slow the rate of human-caused extinction of rare, threatened, and endangered plants and animals" (SER 2009). *Scientists and climate experts have definitively stated that eliminating fossil-fuel combustion alone will not reduce atmospheric CO_2 to levels necessary for a habitable planet.* However, there are safe, scientifically validated strategies currently available that can actively remove CO_2 from the atmosphere by way of ecological restoration.

Ecological restoration projects are already advancing on multiple continents around the globe. International efforts have also focused on restoring degraded land and ecosystems to boost the carbon storage capacity of the environment. The World Bank's BioCarbon Fund (BioCF) was the first carbon fund targeted to develop and transform lands for increased carbon sequestration (The World Bank Group 2014). Since 2004, the BioCF has restored 150,000 hectares of degraded lands and decreased deforestation in over 350,000 hectares of land through projects that invest in afforestation, reforestation, and sustainable agriculture (The World Bank Group 2014).

As the largest carbon reservoir in the terrestrial carbon cycle, soils contain roughly three times the carbon of vegetation (FAO 2004). The desertification of drylands is a global predicament that has caused severe soil degradation, and as a result a significant reduction in soil carbon content (FAO 2004). The International Soil Reference and Information Centre (ISRIC) is an international foundation that provides information on the world's soil resources and is engaged in projects that reduce or reverse land degradation, increase water-use efficiency and enhance the food security of climate change-vulnerable populations. In collaboration with other organizations including the FAO and World Resources Institute (WRI), ISRIC has issued multiple technical reports and assessments on land and ecosystem degradation in support of actualizing the benefits of soil and land restoration. As part of the Scientific Committee on Problems of the Environment (SCOPE) network, a Rapid Assessment Project on the Benefits of Soil Carbon (BSC) is underway as an international effort to influence land management policy based on the scientific evidence of enhanced soil carbon stocks (ISRIC 2014).

Domestic efforts on soil carbon sequestration in the U.S. include urban agriculture and rooftop gardens, natural infrastructure projects, wetland restoration, and the reintroduction of grazing livestock properly managed to revive degraded drylands. A Northwest environmental group, Climate Solutions, has spent more than fifteen years examining the potential of natural infrastructure to absorb carbon pollution and mitigate the harmful effects of climate change on the urban environment. Natural infrastructure entails incorporating natural matter such as soil, trees and other vegetation into the man-made, urban landscape (hard infrastructure) to encourage a healthier functioning system. Climate Solutions proposes the use of natural infrastructure in the fight against climate change because "without stabilizing and reducing carbon dioxide concentrations in the air, carbon dioxide levels will climb inexorably toward tipping points where the scale of change will overwhelm our ability to adapt" (Roth 2013).

The climate balancing effects of soil do not end with carbon sequestration. Soil carbon plays a central role in the water cycle, as healthy soils rich in organic carbon content aid the effectiveness of the water cycle to properly operate and keep the land hydrated (Schwartz 2013; Powlson 2011). Soil organic carbon (SOC) that continues to build carbon content over time becomes an atmospheric carbon sink (Powlson 2011; Milne et al. 2007). Soil carbon molecules allow the land to absorb and retain water, which promotes a healthy water-carbon cycle with fewer droughts and wildfires and less runoff (thereby reducing risk of erosion and floods). As a result of improved water cycles, lands that maintain long-term abundant stocks of SOC experience greater climate stability with cooler surface temperatures and are less vulnerable to extreme weather patterns (Schwartz 2013; Powlson 2011; Johnston et al. 2009). Studies have demonstrated that even for non-agricultural soils, small increases in SOC content enhances overall biome stability with increased water infiltration (Powlson 2011).

Examples of Successful Eco-restoration

In the effort to mitigate the many adverse effects of climate change, ecological restoration pioneers are demonstrating the carbon sequestration potential of natural resources around the world. In Portland, Oregon, a study conducted by Ecotrust determined that the city's natural infrastructure (urban forests and other urban ecology) has the potential to double the biocarbon stored to over 485,000 tons of CO2 per year (Roth

2013). As a part of the city's Grey to Green Initiative, 190 ecoroofs and counting have been installed since 2008, spanning 11 acres of rooftops covered in a layer of living vegetation. In addition to decreasing stormwater runoff and saving energy, eco-roofs absorb carbon dioxide and reduce the urban heat island effect of concrete urban architecture. Natural infrastructure projects in Washington and Oregon demonstrate the wide range of human and environmental benefits from urban ecological restoration, including stormwater and flood management, increased biodiversity, cleaner water, cooler urban temperatures and greater overall resilience to climate change.

In 2010, the Oregon-based Soil Carbon Coalition launched the Soil Carbon Challenge as a competition for members to turn their land into an atmospheric carbon sink. Working with the land and the natural processes of photosynthesis and decay, land managers can encourage the development of carbon-rich, water-holding soil organic matter. As of March 2014, 209 baseline plots were planted by Challenge contestants in North America that will be monitored over a 10 year timeframe for SOC content and overall ecological functioning (Soil Carbon Coalition 2014).

One land management technique that is quickly gaining momentum in the international arena of eco-restoration is Holistic Management (HM) and one of its applications known as Holistic Planned Grazing (HPG). Holistic Management projects have already restored millions of acres of grasslands on four continents around the globe, boosting agricultural productivity while revitalizing ecosystems and increasing the CO_2 storage capacity of grassland soils (Savory 2013). Grasslands, LLC is a branch of the Savory Institute that works with ranchers to restore degraded grasslands using planned grazing methods. Following the holistic management approach, ranches in South Dakota have shown substantially improved biomass and biodiversity in 2010 (Capital Institute 2011). Grasslands currently has HPG projects underway on nearly 54,000 acres in the Northern Great Plains with plans to expand HPG to other regions of the U.S. as well as internationally.

Though past and present ecological restoration efforts are not sufficient for mitigating the negative effects of climate change on their own, there are many examples of successful restoration projects that demonstrate an extensive capacity for carbon sequestration. "There are certainly problems with what we've been doing in restoration projects, but it doesn't mean we should stop," says Franco Montalto, a Drexel University environmental engineer who has written about the designed experiment idea. "We should be trying to figure out what doesn't work and stop doing that, and figure out what does work and do more of it. That's what you learn from experiments" (Conniff 2014). Through collaborative efforts at the local, regional, national and global levels there exist monumental possibilities for long-term climate stability.

Ecological restoration as a global practice is not only important for atmospheric carbon levels and climate change mitigation, but has large-scale potential to benefit our economies, food systems, and social communities. Revitalizing degraded lands with techniques such as HPG to increase the SOC levels prepares the land for sustainable agriculture and food production, and can provide work for local residents as well as bolster food security for local and regional communities.

Conclusion

International efforts to reverse or halt the effects of climate change have not only fallen short of achieving short-term emissions-reduction goals, but have failed to propose any alternative attainable strategies for long-term climate stability. Climate experts have informed us that we have surpassed the deadline for emissions reductions as the sole answer to the climate crisis, yet they offer no alternative. The solution is in the soil--we can work collectively to restore livable atmospheric carbon levels, effectively and inexpensively, by maximizing ecosystem health and utilizing photosynthesis and natural resources that are already available to us around the globe.

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