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Annual Review 2015

For Peat's Sake: Hope for a Hot Planet?

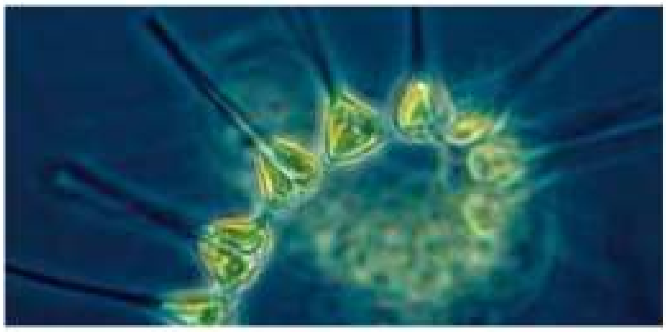
Soil represents a short to long-term carbon storage solution, containing more carbon than all terrestrial vegetation and the atmosphere combined.

For decades, environmentalists have fought to save the oceans and land from the dangers of climate change. All gallant efforts, but some of the best solutions may be in how the land and oceans save the planet.

As countries across the world move towards ratifying the Paris Agreement with a few countries still to sign it, scenarios for keeping global temperature rise to well below 2C and to 'pursue efforts' to keep temperatures to 1.5C above pre-industrial levels, will have to include "negative emissions", i.e. removing carbon dioxide (CO2) from the atmosphere and storing it on land, underground or in the oceans.

Climate change has massive implications for, among other things, phytoplankton - the single-celled organisms that make up the base of the ocean's food web. Not only are phytoplankton sensitive to changes in the climate, they also contribute to those changes, as they can remove carbon from the atmosphere. While controlled iron fertilisation experiments have shown an increase in phytoplankton growth and a temporary increase in drawdown of atmospheric CO_2, it is uncertain whether this would increase carbon transfer into the deep ocean over the longer-term.

FEATURE ARTICLE



Seaweed is one of the fastest growing plants in the world. Kelp, for example, grows up to 9-12 feet long in a mere three months.

The idea is that with access to more iron, plankton would multiply extensively and siphon more CO_2 from the atmosphere.

In 1988, John Martin, an oceanographer at the Moss Landing Marine Observatory, said: 'Give me a half tanker of iron, and I will give you an ice age.' The scientific community has issued a strong call for research to accompany any commercial fertilisation activities, as well as cautionary notes about the risks of iron fertilisation and nitrogen fertilisation.

There is justifiable concern about the risks of ocean fertilisation that include: changes in biological diversity and possible damage to marine ecosystems; changes in dominant phytoplankton species; eutrophication (i.e. growth of unexpected and potentially harmful algal blooms); the creation of anoxic areas in the ocean; the formation of toxic materials; decreasing fish stocks due to nutrient depletion; and the creation and release of greenhouse gases such as nitrous oxide. Ocean fertilisation activity is currently limited, due to resolutions under the Convention for Biological Diversity to small-scale scientific research studies within coastal waters, but more scientific research is likely to both reduce uncertainty regarding the risks, and will also inform development of laws that will likely be needed to mitigate the risks.

Far more scientifically and ethically sound, are plans for seaweed farming on a very large scale. Considered the "tree" of coastal ecosystems, seaweed uses photosynthesis to pull massive amounts of carbon from the atmosphere, with some varieties capable of absorbing five times more carbon dioxide than land-based plants and the high speed growth cycle of seaweed would enable farmers to scale up their carbon sinks quickly.

Interestingly, about 50 percent of seaweed's weight is oil, which can be used to make biodiesel. Scientists at the University of Indiana have worked out how to convert seaweed into biodiesel four times faster than other biofuels, and researchers at the Georgia Institute of Technology have discovered a way to use alginate extracted from kelp to ramp up the storage power of lithium-ion batteries by a factor of ten. Ideal species for such farming and conversion include Laminaria digitata, Fucus serratus and Saccharina latissimi.

Moving with glimmers of hope from the ocean to land, there is growing scientific consensus that land and soil carbon restoration could play a major role in sequestering CO_2 and slowing climate change.

"This land is waiting to be filled up again with carbon if we could manage it sustainably," says Courtney White, author of the book *"Grass, Soil, Hope."*

FEATURE ARTICLE

Soil in a long-term experiment appears red when depleted of carbon (left) and dark brown when carbon content is high (right).

Unsustainable practices such as the overuse of chemicals and fertilizers, excessive ploughing and tilling, crop burning and the use of heavy machinery have disturbed the soil's organic matter leading to soils losing 50 to 70 percent of their original carbon stock. Land-use conversion and soil cultivation is responsible for about one-third of greenhouse gas (GHG) emissions.

According to Rattan Lal, director of Ohio State University's Carbon Management and Sequestration Centre, restoring degraded soils has the potential to store an additional 1 billion to 3 billion tonnes of carbon annually, equivalent to roughly 3.5 billion to 11 billion tonnes of CO2 emissions. According to the IEA, annual CO2 emissions from fossil fuel burning are roughly 32 billion tonnes. In addition to mitigating carbon emissions, soil carbon plays important roles in maintaining soil structure, improving soil water retention, fostering healthy soil microbial communities and providing fertility for crops.

The top priorities, according to Lal, are restoring degraded and eroded lands, as well as avoiding deforestation and the farming of peatlands, which are a major reservoir of carbon and are easily decomposed upon drainage and cultivation.

The buzz around biochar cannot be ignored, produced by burning biomass, such as wood, crop wastes and manure, while cutting off the supply of oxygen. This process is known as pyrolysis and biochar can take the shape of sticks, pellets, or dust that when put in the soil, remove carbon from the atmosphere and store it underground. Despite its promise, the biochar industry remains at an early stage and would need to expand significantly before it was capable of capturing a gigatonne of carbon per year.

"Adding biochar to 10 percent of global cropland could sequester the equivalent of 29 billion tonnes of CO2," says Johannes Lehmann, a professor of agricultural science at Cornell University

Another widely studied agricultural management strategy to increase soil carbon are no-till systems. However, not enough research has been done on lower soil depths where more aggressive tillage systems, such as ploughing, may be relocating carbon. Other studies have found that tilling a previously untilled soil quickly reversed nearly all the previously recorded gains by disrupting aggregates and exposing carbon molecules to microbial attack.

The most famous example of biochar use is the Terra Preta ("black earth") soils in Brazil, which get their name from the charcoal that Native Indians added to the otherwise poor quality soil over 2,500 years ago.

A recent meta-analysis found that more diverse crop rotations consistently produced higher soil carbon, especially when cover crops were included in the rotation. Resistance to this strategy may be due to the dominance of monocultures in agriculture globally and the perceived risk in growing multiple crops.

FEATURE ARTICLE

Grasslands such as the Inner Mongolian grasslands, the Tibetan Steppe, America's Great Plains and the Russian Steppe have received much attention for their substantial potential to act as carbon sinks.

In addition, rotational grazing practices have gained considerable attention for their carbon sequestration potential. When managed correctly, herds of grazing animals can maximise annual pasture biomass production and redistribute carbon throughout pastures.

Similarly, forests represent massive potential to capture carbon. Afforestation and reforestation potentially could achieve large annual carbon sequestration rates in aboveground and below-ground biomass in boreal regions, in temperate regions and in tropical regions.

For the past five years, Australia has had a nationally mandated cap-and-trade programme that enables farmers who adopt carbon-sequestration practices to sell carbon credits to polluting corporations in need of offsetting carbon footprints. The World Bank also has a fund to buy carbon credits from Kenyan farmers as a means to incentivise climate-friendly practices instead of slash-and-burning the land. However, to achieve widespread adoption of anything it needs to be simple and transparent. Farmers in Australia have struggled to meet the stringent and complex demands of a carbon contract and provability is the lynchpin, all of which is challenging for wider implementation.

According to Eric Toensmeier, author of "The Carbon Farming Solution" financial support could come through a higher price charged for foods that encourage sequestration, via a carbon tax or through trading systems in which polluters buy credits to offset their emissions. Programmes such as payment for environmental services, in which governments or others pay farmers for the carbon stewardship of land, is another potential avenue and with the right support things could change quite quickly. In 2015, the French government launched the 4 per 1,000 initiative, the first international effort to restore carbon to the soil. Under the proposal, nations would commit to increasing the carbon in their cultivated lands by 0.4 percent per year.

Although proven soil carbon sequestration practices exist, the science is not yet widely disseminated and there remains uncertainty in how soils are likely to react to a warming world, particularly in areas where water supplies might be at risk.

Climate change isn't a future threat, it's happening now. GHG emissions are breaking records, exceeding even the worst-case scenario envisioned by scientists just a few years ago. In the coming decades, the idea of ocean fertilisation, or there being acres and acres of seaweed farms across the oceans, may not seems so strange or risky. Perhaps, mankind might reside in a world where maximising yield, at the expense of sequestering carbon is shunned, and carbon counting is far more beautiful and worthy than a calorie count.

RECENT EVENTS

4 April 2014

Masai Saigilu Looseyia

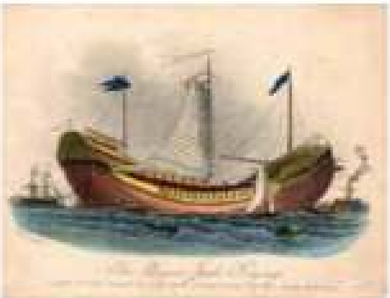
The Big Cats of the BBC's Big Cat Live

Masai Looseyia spoke about the nature and conservation of the Big Cats of Africa, in particular the conservation of lions and leopards. A guide in his native land of the Masai Mara for over 25 years, he provided an overview of Tanzania, the Masai Mara and its people, wildlife, seasons and community-based conservation and guiding.

8 April 2014

Dr Stephen Davies

East Sails West: the Chinese Junk that sailed to London in 1848



Dr Stephen Davies told the extraordinary story of the Chinese junk *Keying* and its journey to Victorian London in 1848. He described the troubled voyage, its diversion to New York, and its arrival in London, where it was exhibited on the River Thames during the Great Exhibition.

24 April 2014

Richard Lancaster

Powering Hong Kong: Are we at a Crossroads

Richard Lancaster discussed the evolving energy world and the potential role that renewable energies are likely to play in the next decade. With reference to Hong Kong, he considered the best long term energy source options to meet the growth in future power needs.

26 April 2014

Field Trip to Mai Po

Members participated in a guided tour of the Mai Po Marshes. The tour glimpsed some of the thousands of migratory birds that visit the marshes before flying north for breeding.

29 April 2014

Jason Wordie

Macau: People and Places, Past and Present

Jason Wordie spoke about the underlying richness, diversity and fascinating history of Macau, which is often overlooked by its more 'obvious attractions'. He highlighted the people who made Macau the uniquely special place that it is today and the unexpected connections between Europe, China and Japan, South East Asia and beyond, which are interwoven in Macau's social and urban fabric.