Natural Resources and Their Ecosystem Services

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NATURAL RESOURCES AND THEIR ECOSYSTEM SERVICES

Webinar proceeding on "Ecosystem Services and United Nations Sustainable Development Goals" Celebrating the 'World Environment Day'
5th June 2020

CHAPTER 1

Regenerating Ecosystem Services to Meet United Nations Sustainable Development Goals

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Abstract

UN Sustainable Development Goals have received severe setbacks from ongoing health, economic, and environmental disasters. Flattening the Covid-19 curve to prevent health system collapse must be immediately followed by flattening the CO2 curve to prevent environmental collapse. We are now on a path towards runaway global warming and sea level rise, with far worse long-term consequences than the public or governments realize, unless we rapidly reduce atmospheric CO2 to pre-industrial levels. Degenerative development, which values Nature only as far as it can be turned into money and CO2 and destroys the future, is rampant. There will be no future sustainable "Blue" or "Green" economies if we don't regenerate the natural ecosystems services we have already destroyed, which control our climate, and the quality and quantity of the air we breathe, water we drink, and food we eat. Regenerative methods have been developed to nurture back the productivity and biodiversity of every ecosystem on land and in the sea but are not being used on the scale needed due to massive failure at policy and funding levels. The sooner they are used the faster will be the benefits and the lower the costs, but the window of opportunity to do so is rapidly closing and will soon become impossible. A global carbon currency is needed for polluters to pay those who remove their CO2. BioGeoTherapy, regenerative development to reverse climate change using nature-based solutions, must become the major task for the rest of this century to ensure our future survival.

Keywords: UN Sustainable Development Goals, Global Warming, Global Sea Level Rise, Regenerative Development, Ecosystem Services, Sustainability, BioGeoTherapy, Carbon currency

Covid Threatens Sustainable Development

Global progress toward the UN Sustainable Development Goals (UNSDG), a comprehensive list of human aspirations for a better future, have taken a very severe blow from the combined medical, economic, and environmental catastrophes caused by the Covid-19 virus. Two thirds of the SDG goals are now unlikely to be met (Naidoo and Fisher, 2020). It is too soon to know how severe and long lasting the impacts will be, but events like this have not been directly experienced for more than a century since the 1918 Flu, and impacts may continue for years.

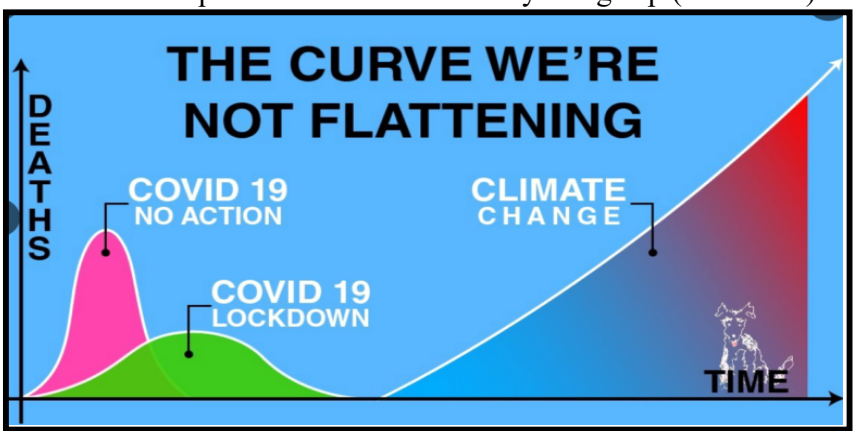
Every serious student of history knew a pandemic like this was inevitable, and could happen at any time, y*et al*most all countries were completely unprepared. By sheer luck this particular virus, extremely transmissible as it is, is not also extremely deadly, but the next one could be!

Human disruption of natural balances has triggered accelerating evolution of pathogens that feast on humans and their livestock, the most abundant prey in the world. Viruses and bacteria not only will

evolve rapidly to meet the opportunities provided by people, cows, pigs, and chickens packed cheek to jowl, they can do so much faster than public health can respond unless the pathogen is stopped near the source before it can spread. Conquering Covid is now the necessary, but not sufficient, first step to conquering climate change.

Flattening the Covid and CO2 curves

Halting transmission at the source, "flattening the Covid curve", to prevent collapse of the medical care system, is now understood by the entire world, except for corrupt politicians bought off by people personally profiteering from planetary plunder. They want no interruption to the "business as usual" making them rich, and have hijacked the world onto a roller coaster ride to hell with runaway global warming and sea level rise consequences far worse than they can grasp (see below).



C: @williamfreimuth *via* twitter

We urgently need to flatten the CO2 curve to prevent our global life support system collapsing. Just as the measure of collapse from Covid is the number of new cases compared to the ability of the health care system to prevent death and promote healing, the measure of environmental collapse is the ratio of new CO2 in the atmosphere versus the ability of the biosphere system to reduce atmospheric CO2 to safe levels (Goreau, 1987). Just as the goal of the health system is minimum death and maximum health, the environmental goal to minimize ecosystem service disruption must be a CO2 level at pre-industrial concentrations in order for global temperature and sea level to remain stable at the levels they have been for more than eleven thousand years (Marcott *et al.*, 2013, Rohling, 2019)

Earth's temperature is at fever level and rapidly rising, to save the planet from heatstroke the causes of this imbalance must be correctly diagnosed and remedied. The conscious evolutionary act of regenerating the planet's life support systems to balance in order to reverse climate change is called Geotherapy (Goreau *et al.*, 2014). Geotherapy methods based on regenerating natural biological regulatory mechanisms are BioGeoTherapy, and those based on artificial means are GeoEngineering.

Climate impacts of degenerative development

Unsustainable development destroys or overexploits resources to maximize monetary profit, causing degeneration of Nature's life support systems, and reducing opportunities for the future. Excess atmospheric CO2 comes primarily from non-renewable fossil fuels and secondarily from destruction of ecosystem services that regulate climate, the quality and quantity of the air we breathe, water we drink, and food we eat.

Regenerative development, or Geotherapy, is the antithesis of degenerative development, it absorbs CO2 from the air by regenerating ecosystems and ecosystem services to become more productive, so is not just sustainable in the weak sense of not being negative, but sustainable in the much stronger sense of creating greater opportunities in the future. It is our only hope for survival, and a healing, life-enhancing gift to future generations whose potential future is now being stolen from them by degenerative development.

We are now hearing a great deal about hopes for Sustainable "Green" and "Blue" Development. At this time every major ecosystem on land and sea is collapsing in area and biodiversity, with destruction, degeneration, or degradation of their ecosystem services. It is clear that we can't have sustainable development in the long run until we regenerate ecosystem biomass carbon storage, which will clean our air, water, and soil. Yet ecosystem and soil regeneration to create new natural carbon sinks is entirely missing from the UN Climate Change Convention (UNCCC), which discusses only

emissions reductions, even though they cannot possibly solve the problem of future climate change caused by the existing excess CO2 that is already in the air! Bringing that dangerous excess CO2 back to the ground it came from is the most cost-effective global solution. Unfortunately, soils are not included in the carbon balances governments must submit to UNCCC, and there is still no mechanism in UNCCC to solve the problem by increasing natural soil sinks. This fundamental flaw prevents the

treaty from reaching its own goals of stabilizing climate at safe levels, which simply can't be achieved by emissions reductions.

GREEN AND BLUE DEVELOPMENT

There will be no sustainable GREEN or BLUE development until we regenerate the ecosystem services that provide our food and regulate our climate, air, and water at safe levels

Global Coral Reef Alliance

ECOSYSTEM SERVICE REGENERATION

Has been developed for every ecosystem

Is being done only on a small scale by individuals

Needs to be done on a planetary scale to reverse runaway climate change

Most important task for this century

Global Coral Reef Alliance

Runaway global warming

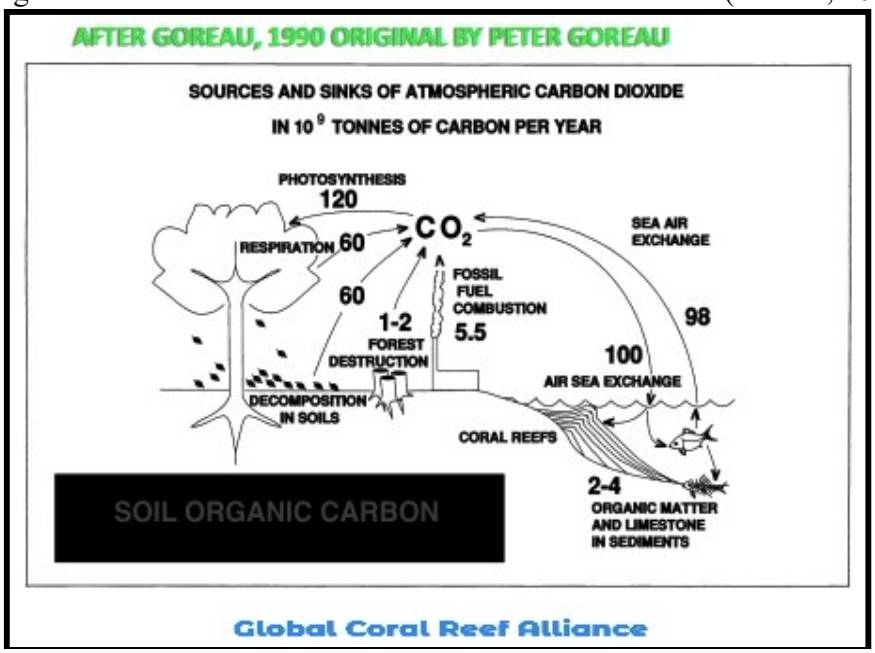
The present UNCCC target of global warming less than 2 degrees C is completely unsustainable even if it were achievable. It condemns coral reefs to death from heat stroke because we passed the temperature tipping point of coral reefs in the 1980s, and it will result in runaway global warming that, based on past climate records, could be up to 13-17 degrees C and 70 meters of sea level rise, once the climate system has responded to increased CO2 (Goreau, 2014, 2018; Rohling, 2019).

You can clearly see the past, present, and future of sea level at this remarkable site on my island, Jamaica. This sea cave formed at sea level 130 to 120 thousand years ago, the last time in world history when it was 1 to 2 degrees C warmer than today (Goreau, 1990). Sea level was around 8 meters higher then, around 26 feet. At that time crocodiles and hippopotamuses lived where London, England now stands. CO2 in the atmosphere was then about 270 ppm, around 40% less than what we now have. When CO2 rises to match TODAY'S CO2, sea level will eventually become around 23 meters, or 75 feet higher than now. And CO2 continues to rise to higher and higher levels, with only a small blip due to Covid, which is too small to change temperatures noticeably. Unless CO2 is urgently reduced to pre-industrial values, the oceans will continue to rise for thousands of years, and billions of people will lose their homes.

Ancient Jamaica cave shows sea level was around 7 m higher when it was 1-2 C warmer and CO2 was 270ppm. For the present CO2 level of 410 ppm sea level will rise around 23 meters. From T. Goreau, 2014

The largest available sink for atmospheric CO2 is soil organic carbon, around 5-12 times more than the atmosphere or living biomass. Wherever we have cut down forests for agriculture, pasture, or towns

we have lost around half the carbon in the soil. Increasing global soil organic carbon by only a few percent could absorb all the dangerous excess CO2 (Goreau, 1987; 2014). About half of soil organic matter is in wetlands, swamps, bogs, and marshes, and about half of that is marine wetlands, mangroves, salt marshes, and sea grasses, which hold more carbon than the atmosphere on less than a percent of the earth's surface. We have destroyed around half of the wetlands, draining the fertile soils, and causing the organic carbon to be oxidized and turned into CO2. Regenerating coastal wetlands could store the largest amount of carbon in the least area at the lowest cost (Goreau, 2017).



Soil carbon is around 5-10 more abundant than CO2 and could store more if we weren't losing it through degenerative land management. From T. Goreau, 2014

Another major carbon sink is soil regeneration using Biochar and basalt rock powders. Biochar, or Terra Preta do Indio (Black Soil of the Indians in Portuguese) was invented thousands of years ago by the Indigenous people of Amazonia. By putting charcoal in soil and adding nutrients they created the most fertile soils in the world in the middle of the least fertile. The carbon is still there 500 years later. By adding basalt powder to replenish missing soil nutrients, these natural materials can accelerate biological productivity for decades and generations, drawing down CO2 from the air and storing it in soil that retains nutrients and water in the ground instead of flushing into the sea. If we applied biochar, made from the harmful invasive weeds smothering the ecosystems we have damaged, with rock powder, to grow food and forests on a large scale, the planetary excess CO2 could be drawn down in as little as a few decades (Goreau 2017).

Indigenous Amazonian biochar technology made the world's richest soils in the middle of the poorest. Photograph of an Amazon soil excavation by James Richardson.

UNSDG, UNCCC, IPCC, and climate targets

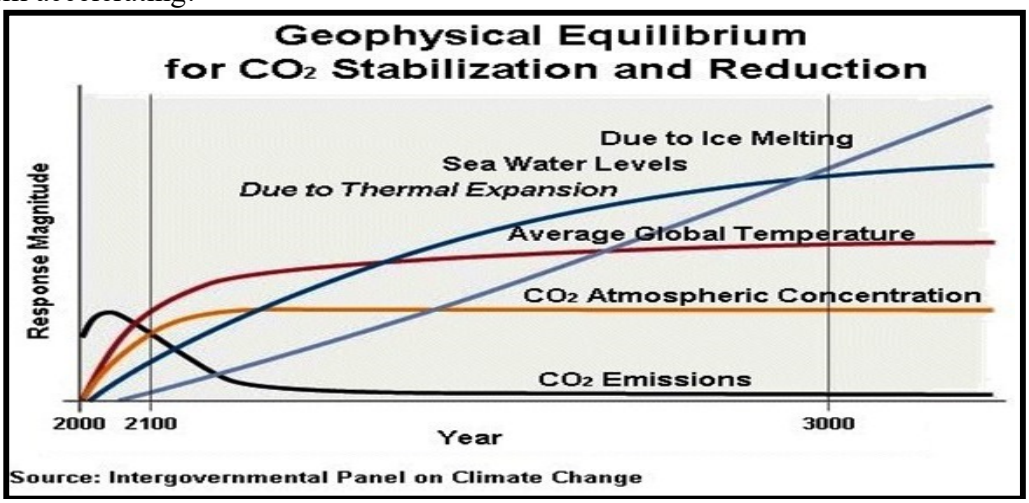
The numbers mentioned above for projected long-term temperature and sea level rise will seem shocking to those lulled into a false sense of security by the Inter-Governmental Panel on Climate Change (IPCC), set up by the world's governments under UNFCCC to advise them on potential effects on future climate, whose projections are far lower!

The reason for this discrepancy is simple, temperature response lags several thousand years behind changes in CO2. Almost all the heat trapped by global warming is vanishing into the deep sea, if it had stayed in the atmosphere the temperature increase would already be around 36 degrees C and humanity would be extinct already! The deep sea has been chilled down to refrigerator temperatures (4 degrees C) by polar ice over the last 3.5 million years. Since it takes 1500 years for the ocean to mix, we won't feel the full response to the CO2 that is in the air TODAY until after SEVERAL THOUSAND YEARS! The IPCC projections are NOT the long-term response, they are only the very first decades of a runaway response that will continue to rise for thousands of years after those who caused it are dead (Rohling, 2019).

The figures I quoted above for the long-term climate responses of temperature and sea level to CO2 over the last million years are based on real data and are much higher and more alarming than IPCC projections, which only represent the very start of a long slippery slope that continues forever for all practical human purposes. That mistake is because Governments gave IPCC a purely POLITICAL mandate, not a scientific one! Governments only wanted to know what might happen while they were in power, not generations afterwards, because they discounted the future to zero! Governments simply did not want to know the long-term consequences of their actions, only what they could be held immediately responsible for, so they gave IPCC orders to estimate impacts only for the next few decades, when climate scientists knew that the responses would barely even start by then!

IPCC climate scientists are not trying to fool anyone, but they have to do what they have been ordered to do: give the right answer to the wrong question! This figure shows the long-term IPCC projections

of a scenario in which all fossil fuel use stops in a century. CO2 and temperature remain high for thousands of years, and a thousand years after fossil fuel emissions stop, sea level rise (light blue curve) is still accelerating!



IPCC is aware of the long-term impacts, but governments don't want to know!

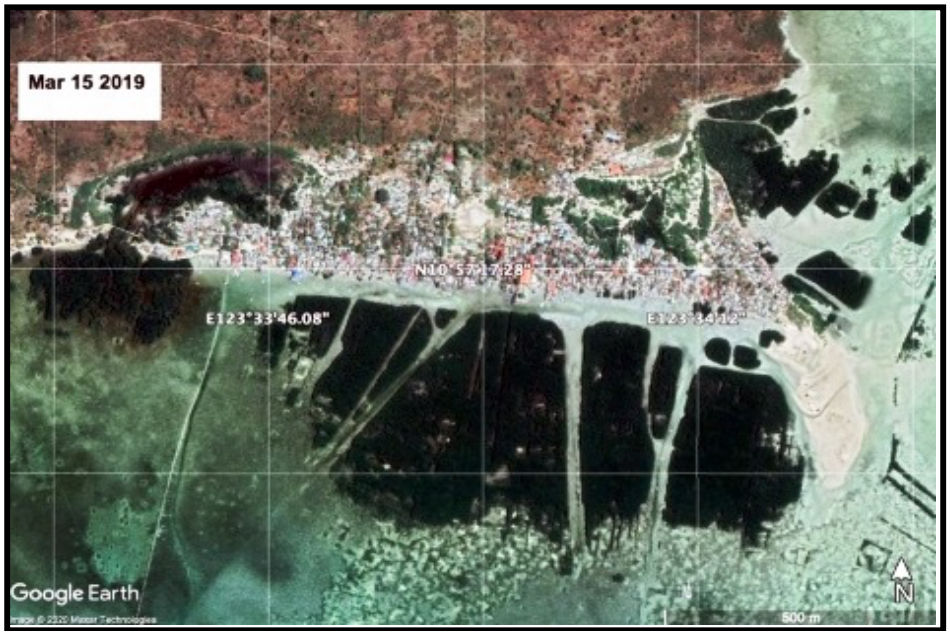
The UNSDGs are a long laundry list of desirable micro-goals, many interdependent, but which provide no integrative target for the entire planet. Atmospheric CO2 is the single best measure of human impact on climate, and carbon is the common currency measuring impacts all use of energy, biological processes, and human economy. A pre-industrial atmospheric CO2 target, now missing from the UNSDGs, is the sadly lacking mega-goal that unites all of the individual micro-goals for true sustainability.

Regenerative development to regenerate ecosystem services and reverse climate change

When Charles Darwin passed through Rio de Janeiro in 1832 there were no trees to be seen. The forested mountain slopes had been entirely cleared for coffee cultivation, the soil had washed away, the springs and rivers dried up, and in the dry season the population had to abandon the city and sail up the coast to any place they could find water to drink. They knew they had caused the problem themselves by deforestation, so the city hired slaves to climb up to the last forested mountain peaks and transplant seedlings. These environmental heroes spent their careers planting a vast forest overlooking Rio de Janeiro, and when the trees came back, the land cooled, springs and rivers returned, and so did the city water supply. A hundred and fifty years later we measured the CO2 coming from the respiration of the soil in this man-made forest, and found it was just as high as we had measured in undisturbed Amazon jungles, demonstrating that ecosystem carbon services were fully recovered.

The Floresta da Tijuca, above Rio de Janeiro, is a man-made forest planted to regenerate the city's lost water supply.

Every ecosystem on Earth can be, and has been, restored, mostly on a small scale by individuals who learned on their own to restore their own surroundings. All of them remembered what they had lost, wanted it back, and realized that the sooner they started planting and the longer they continued the better the results. Each of them discovered independently that you need to add back the missing nutrients and maximize biomass, biodiversity, and internal ecosystem recycling of nutrients, carbon, and water. Doing so not only greatly increases carbon storage, it increases production of useful foods and biological raw materials. The roots of the trees hold the soil in place, replenish groundwater, and cool the entire landscape by transpiration: the water taken up by roots that is evaporated from the leaves carries heat from the ground into the atmosphere, increasing atmospheric circulation and rain.
Anyone can regenerate their own land, like a man in India who planted an entire jungle over 30 years, attracting elephants, tigers, and monkeys. Thousands of people are doing so for their own reasons, but at the same time billions of people are busy destroying nature! Changing their degenerative ways to regenerative ones is the only hope!
The map below shows a vast mangrove forest planted by the villagers of a small island of fishermen, Molocaboc, in the Philippines. Led by a progressive Mayor, Alfredo Marañon, this vast forest protects the islanders from typhoons and tsunamis and is the nursery ground for their fisheries for food and income.



Replanted mangrove forests (dark areas) protect Molocaboc and have caused 300 meters of beach growth (sand spit at lower right).

All marine ecosystems can be regenerated with the Biorock method, which uses safe extremely low voltage currents that greatly increase the settlement, growth rates, survival, and resistance to severe environmental stress like extreme high temperature, mud, and pollution of all marine organisms (Goreau and Trench, 2012). With Biorock, entire coral reefs can be kept alive through severe heat shock bleaching events, and grown back rapidly in places with no natural recovery.

Four year old Biorock reef in Bali, in area that had been barren sand and rubble

By growing Biorock reefs in front of severely eroded beaches we grow the beaches back naturally in months. At present rates of sea level rise most beaches will be gone by the end of this century, with Biorock we can reverse erosion by regenerating coral reefs in warm water, and oyster and mussel reefs

in cold water, that become homes to large schools of fishes, protects beaches from waves, and grows new white sand.

Before and after Biorock reef regeneration. Bleaching killed almost all the corals in 1998

Biorock reefs in front of severely eroded beaches grow back sand naturally in just months. New beach at Pulau Gangga, Indonesia. At start of the project the building on the right was about to collapse into the sea like the tree at left. Photograph by T. Goreau

Half of mangroves, salt marshes, and seagrasses across the globe have been destroyed in the name of development, even though they are our most valuable carbon sinks and fish nurseries. Mangrove, salt marsh, and sea grass are easy to plant, but most planting projects fail because waves wash away the plants before their roots can grow. Biorock greatly increases the growth of marine plants both above and below ground, so we can turn eroding wetlands into growing ones, greatly increasing carbon storage, and fisheries, while protecting coastlines from sea level rise. Normally sea grass needs 5 or 10 cm of sand and mud for the roots to establish, but Biorock is even able to grow sea grass on bare rock because roots grow so fast they attach themselves!

Sea grass grown on bare rock in Mediterranean with Biorock. Photograph by Raffaele Vaccarella

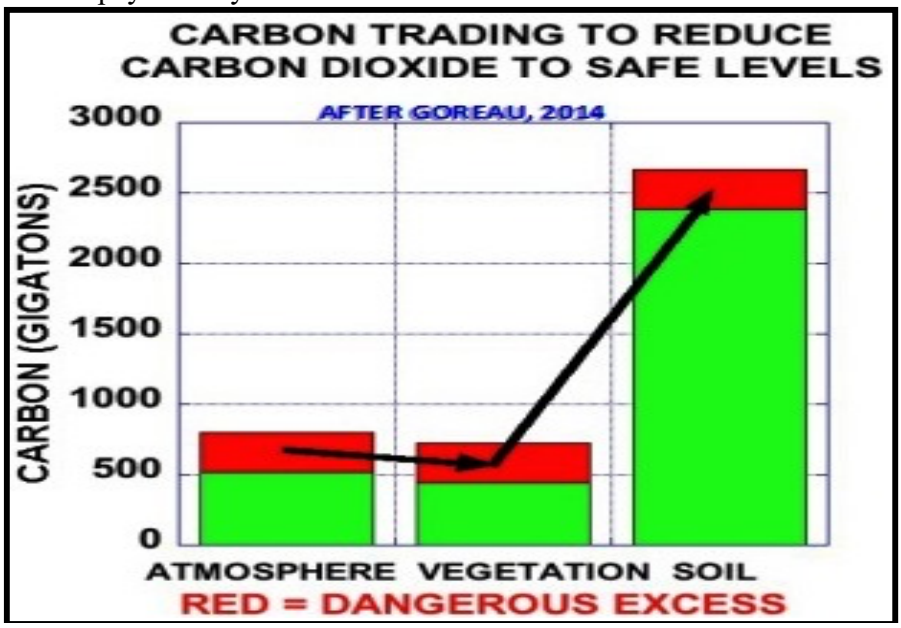
Healthy corals growing with Biorock in severely stressed environments. Photograph by Dr. Chandran Retnaraj

Our goal is to use Biorock on a large scale to regenerate marine coastal wetlands, regenerate sustainable coastal fisheries, and create the world's largest and most cost-effective carbon sinks.

Planned Biorock mangrove regeneration site in Borneo to become an Orang Utan sanctuary, carbon sink, and source of renewable biofuel from Nypa palms

Now or never!

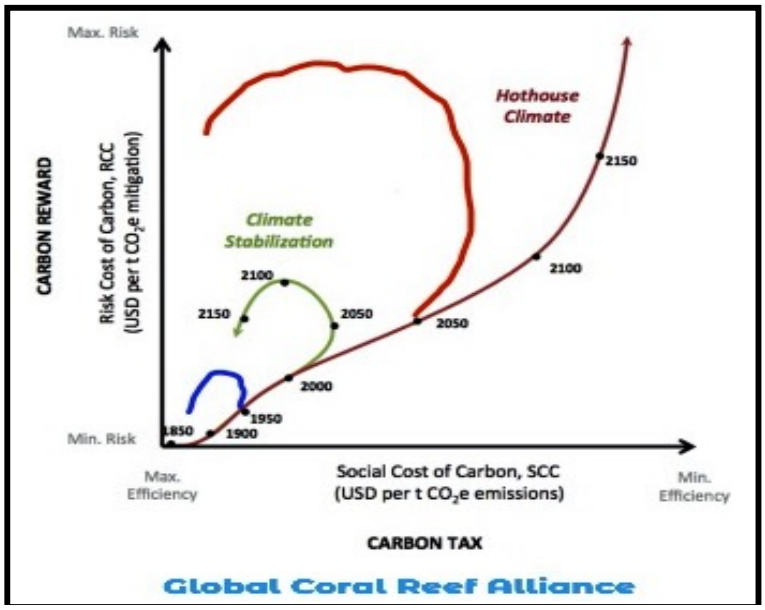
Everyone who has thought seriously about the problem realizes that those who put CO2 into the atmosphere need to pay those who remove it, but the world still lacks any carbon tax capable of paying for carbon removal because most governments are running away and hiding from long term solutions. Since CO2 is a common currency reflecting all environmental, economic, energy, and ecological services it makes sense pay directly for its removal.



Carbon trading is needed to pay to get rid of the dangerous excess CO2 (red part of left column) and store it safely in the soil (right column)

Perhaps the best option is a parallel carbon currency to reward climate mitigation services and to justify the payments by formally pricing the climate risk as the Risk Cost of Carbon (RCC) as proposed in the Holistic Market Hypothesis (Chen *et al.*, 2017, 2019; Chen, 2018). The longer we wait to do so, the more difficult and expensive the task becomes. Had we begun in 1950, the problem would long have been cheaply solved. If we wait much longer the cost becomes larger and larger until it actually becomes physically impossible.

Averting runaway climate change will become the overwhelming task for the rest of this century. Our descendants will be forever grateful if we make BioGeoTherapy our mission. Real leadership is needed, not the infantile squabbling of those whose greed for power prevents collaborating for humanity's common benefit, instead of acting like adults many world "leaders" are just too busy stealing all they can through degenerative development in order to kill each other. We need to reform our political and funding systems to eliminate the deadly degenerates and promote life-restoring planetary regeneration before it is too late!



The Social Cost of Carbon (SCC) and the overlooked Risk Cost of Carbon (RCC) constitute a phase space for managing the costs and risks of climate change (adapted from Chen 2019, unpublished). If we had started in 1950 the problem would have been very cheaply solved. If we wait until 2050 it will become ruinously expensive, or impossible

There are no passengers on spaceship Earth, we are all part of the crew

Buckminster Fuller

Global Coral Reef Alliance

References

1. Chen D.B., van der Beek J., Cloud J. (2019). Hypothesis for a Risk Cost of Carbon: Revising the Externalities and Ethics of Climate Change. In: Doukas H., Flamos A., Lieu J. (eds) Understanding Risks and Uncertainties in Energy and Climate Policy. Springer.
2. Chen, D.B. (2018). Central Banks and Blockchains: The Case for Managing Climate Risk with a Positive Carbon Price. In: Transforming climate finance and green investment with blockchains. Elsevier. A. Marke, Ed., Chapter 15.
3. Chen, D.B., van der Beek, J., Cloud, J. (2017). Climate mitigation policy as a system solution: addressing the risk cost of carbon. Journal of Sustainable Finance and Investment, 7 (3), 1-42.
4. Goreau, T. (2017). Regenerative development to reverse climate change: Quantity and quality of soil carbon sequestration control rates of CO2 and climate stabilization at safe levels, p. 286-291, Proceedings of the FAO Global Symposium on Soil Organic Carbon, Rome.
5. Goreau, T.J. (1987). The other half of the global carbon dioxide problem, NATURE, 328, 581-582
6. Goreau, T.J. (1990). Balancing atmospheric carbon dioxide, AMBIO, 19, 230-236
7. Goreau, T.J., Larson, R.G., Campe, J.A. (Editors). (2014). Geotherapy: Innovative Technologies for Soil Fertility Restoration, Carbon Sequestration, and Reversing Atmospheric CO_2 Increase, CRC Press, 34 chapters, 600 pages.
8. Goreau, T.J., Trench, R.K. (Editors). (2012). Innovative Technologies for Marine Ecosystem Restoration, CRC Press.
9. Goreau, T.J.F., Hayes, R.L., Williams, E. (2018). We Have Already Exceeded the Upper Temperature Limit for Coral Reef Ecosystems, Which are Dying at Today's CO2 Levels, United Nations Convention on Climate Change Talanoa Dialog, GCRA White Papers, http://www.globalcoral.org/we-have-already-exceeded-the-upper-temperature-limit-for-coral-reef-ecosystems-which-are-dying-at-todays-co2-levels/
10. Marcott, S.A., Shakun, J.D., Clark, P.U., Mix, A.C. A reconstruction of regional and global temperatures for the past 11.300 years, Science, 339:1198-1201.
11. Naidoo, R., Fisher, B. (2020), Sustainable Development Goals: Pandemic Reset, Nature, 583,198-201.
12. Rohling, E.J. (2019). The Climate Question: Natural Cycles, Human Impact, Future Outlook, Oxford University Press.