

*"If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted, CO<sub>2</sub> will need to be reduced from its current 385 ppm to at most 350 ppm. An initial 350 ppm CO<sub>2</sub> target may be achievable by phasing out coal use except where CO<sub>2</sub> is captured and adopting agricultural and forestry practices that sequester carbon. ...Biochar, produced in pyrolysis of residues from crops, forestry, and animal wastes, can be used to restore soil fertility while storing carbon for centuries to millennia. More rapid drawdown could be provided by CO<sub>2</sub> capture at power plants fuelled by gas and biofuels."* James Hansen et al.<sup>2</sup>

*"We have already taken more than half of the productive land to grow food for ourselves. How can we expect Gaia to manage the Earth if we try to take the rest of the land for fuel production?"* James Lovelock.<sup>3</sup>

## Executive Summary

***The two bio-geoengineering proposals discussed in this paper are attempts to address one of the greatest threats humankind has ever faced – catastrophic climate change. We attempt to answer the question: Will such global bio-geoengineering 'solutions' help to stabilise climate or could they contribute to wide-scale collapse of our life support systems?***

The evidence presented in **Section 1** makes clear that The UN Framework Convention on Climate Change has failed in its intention. Atmospheric concentrations of greenhouse gases (GHGs) are already at dangerously high levels. James Hansen along with other prominent scientists, environmental campaign groups such as 350.org and Beyond Zero Carbon, as well as the authors of Climate Code Red rightly state that even dramatic reductions in GHG emissions, on their own, are now unlikely to be enough to stabilise climate. Current atmospheric concentrations of 385ppm CO<sub>2</sub>, according to proponents, need to be reduced to 350ppm CO<sub>2</sub> or below.

**Section 2** considers the different proposals for achieving this. We look at the potential for rapidly reducing emissions of short-lived, high-impact greenhouse gases and aerosols which contribute net warming. We then give an overview of the two broad groups of geoengineering proposals for cooling the planet: Making the planet more reflective, and removing CO<sub>2</sub> from the atmosphere. This paper is focused primarily on one aspect of this second grouping; the large-scale use of biomass as a substitute for fossil fuels, whilst simultaneously drawing down atmospheric CO<sub>2</sub> by sequestering some of the carbon in the biomass, either underground or as charcoal to be added to soil.

**Sections 3 and 4** consider in detail the two major proposals promoted by the aforementioned authors for achieving these outcomes. They are; bioenergy with carbon capture and storage (BECS), and bioenergy with biochar, a type of charcoal produced as a by-product of a particular biomass combustion technique. We argue that the development of both BECS and biochar fits very neatly into a wider industry and political strategy to build a broader 'bio-economy'. This would entail the progressive replacement of fossil fuels with industrial biomass under corporate control, linked to a highly centralised energy system and modes of production. From an industry point of view, biochar in particular offers an attractive opportunity to make large, centralised bio-refineries more profitable, and potentially, commercially viable. Both BECS and biochar should therefore be seen as part of a wider corporate strategy for a bio-economy based on industrial monocultures. Corporate patenting,

the scale of biomass use, centralisation and any future inclusion into carbon trading would effectively rule out any different mode of bioenergy use.

The energy balance of producing bioenergy is poor compared to fossil fuels, but significantly more so with BECS or biochar, resulting in a greater land requirement. There are serious doubts about the commercial viability of large-scale carbon capture and storage, and about the safe long-term storage of carbon, making BECS a questionable proposition. The long-term storage of carbon with biochar is of even more serious concern. Biochar is also being promoted as a way of increasing soil fertility, however the science on this is inconclusive and suggests that, in some circumstances biochar can increase plant yields in combination with other synthetic or organic fertilisers while in other cases it may have no effect or even a negative one. Nor are there studies showing how to replicate successful ancient methods of using charcoal to make soil more fertile.

**Section 5** looks at the likely impacts of large-scale 'carbon negative' bioenergy on ecosystems, climate and people. James Hansen and several other proponents advocate large-scale bioenergy production based on low-input, high-biodiversity cultivation methods and on the use of forestry and agricultural 'waste', although Hansen has recently indicated in the media that he may also be looking at tree plantations. We examine those ideas and conclude that the scale and speed of bioenergy expansion required for the purpose of trying to reduce atmospheric carbon dioxide levels is fundamentally incompatible with sustainable production. In particular it will require policies that favour short-term high yields per hectare, which are ecologically the most damaging. We therefore conclude that any policies aimed at the scale of bioenergy use proposed will result in a dramatic expansion of industrial monocultures, even if this is not the intention of those scientists. We note that the key study on which proponents rely for the concept of 'low input, high biodiversity' bioenergy presumes a major intensification of high-input, low-biodiversity industrial agriculture in all other sectors.

We further show that large-scale bioenergy expansion, regardless of the mode of production, will accelerate ecosystem and biodiversity destruction which in turn will accelerate climate change. It will further deplete freshwater and soil and will inevitably compete with food production, threatening the livelihoods of large numbers of people, primarily in the global South.

Bioenergy figures used by proponents of these schemes rely on calculations by other scientists which suggest that at least 500 million hectares worldwide would have to be dedicated to bioenergy production. This represents 1.5 times the entire land area of India, and 20 to 25 times the land area currently used for agrofuel production. Conversely studies show that there is no productive land which is not either natural habitat or already under cultivation. Misleading terms such as 'degraded' and 'marginal' lands are used to describe, for example, semi-arid and community lands slated for conversion to bioenergy.

We also argue that large-scale removal of so-called agricultural and forest residues will deplete soils, greatly speed up soil erosion and soil carbon emissions, as well as trigger chains of biodiversity loss.

We analyse the concept of 'carbon negative' bioenergy and show this to be a misleading term. Industrial agriculture and forestry are already one of the leading causes of climate change, as a result of large-scale ecosystem destruction, soil carbon losses, nitrous oxide emissions from fertiliser use, and high energy inputs. Calling them 'carbon negative' or even 'carbon neutral' is misleading and unjustifiable.

Finally, we argue that indigenous peoples, small-scale farmers and other communities in the global South, including many who practice truly low-carbon and sustainable or

near-sustainable living, are likely to pay the price for any large-scale bioenergy expansion. The number of people who will be displaced could be of an order of magnitude greater than those currently being displaced by agrofuels, given the scale of land-use change advocated by proponents of such policies.

**Section 6** considers the bio-geoengineering proposals in the wider context of our life support systems. We ask whether it is correct to speak about the 'climate crisis' or whether we should be even more concerned about the 'convergence of crises', which include not just climate change, but also species extinctions and ecosystem destruction, soil losses and freshwater depletion, as well as myriad forms of pollution. We argue that it is dangerously reductionist to view those crises in isolation from each other. Not only does each crisis threaten the very foundations of life on earth, but they interact and compound each other. This is illustrated with the wide-scale collapse and extinction of amphibian populations which is currently occurring. Amphibians as a class have survived not just the extinction of the dinosaurs but the end-Permian extinction, the worst ever mass extinction event, yet their complete extinction today is becoming increasingly likely. The causes include the converging impacts of agri-chemical pollution, loss of vegetation cover, ozone depletion, the introduction of invasive species as well as climate change. Reptiles and insect pollinator species (essential for crop production) are also collapsing. Such large biodiversity losses can degrade ecosystems to the point of collapse. Throughout the planet's history, ecosystems have both maintained a stable climate and prevented runaway warming. Their role cannot be measured in terms of carbon storage alone. Natural forests, for example, help to regulate the global carbon and nitrogen cycles, the freshwater cycle and cloud formation, thus increasing the planet's reflectivity. Via the production of the chemical, hydroxyl, they also play an important role in breaking down the powerful greenhouse gas methane. Globally, key ecosystems act as a 'heat pumps' regulating rainfall and storm tracks. Without biodiverse ecosystems, the conditions amenable to life could not be sustained and true runaway warming – a 'Planet Venus' scenario - would be the likely outcome.

**Section 7** discusses adequate responses to the converging crises. The prevailing debate about 'climate targets' and carbon accountancy is seen as a distraction from the more important question of how societies can live without causing more harm to the biosphere, whilst reversing some of the damage already done, and beginning that transition.

We note that responses which address only one aspect of the crisis – for example fossil fuel burning, whilst ignoring or even aggravating others, offer no realistic hope of avoiding runaway warming and a mass extinction event. Such reductionist approaches need to be replaced with a holistic discourse which deals with multiple risk factors interdependently. Such a discourse needs to start from the realisation that we are well beyond safe levels of greenhouse gas concentrations, ecosystem destruction and biodiversity losses. Our hope of survival depends on ending any further destruction and giving the biosphere the best possible chance of maintaining and, if possible, increasing its resilience through ecosystem restoration. Ending further destruction means ending ecosystem destruction, industrial agriculture, industrial forestry and mining, as well as abandoning destructive forms of energy production including fossil fuel burning, industrial bioenergy, and large-scale hydro-electric power. This will inevitably require not just a drastic 'power down' but rapid de-industrialisation. We discuss the complete absence of adequate responses to the current crises in relation to the industrial and free-market paradigm.

In this context we also discuss the need to utilise and harness the ancient knowledge of those indigenous and forest peoples who have managed to live within ecological limits, often for millennia. Diversity of peoples has conferred a diversity of solutions

which aren't even acknowledged by formal bodies like the IPCC as a transferable knowledge source. The quickest way to harness this knowledge is to reinstate land rights along with food and energy sovereignty, particularly in the developing South.

In answer to our opening question;

***Both bio-geoengineering proposals are almost certain to exacerbate biodiversity loss, ecosystem destruction and significantly increase GHG emissions. As such they will accelerate the rate and scale at which our life support systems, including climate, are collapsing.***

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<sup>1</sup> Biochar sequestration in terrestrial ecosystems", Johannes Lehmann et al, Mitigation and Adaptation Strategies for Global Change (2006) 11: 403–427.

<sup>2</sup> James Hansen et al, "Target Atmospheric CO<sub>2</sub>: Where Should Humanity Aim?", 2008, [www.columbia.edu/~jeh1/2008/TargetCO2\\_20080407.pdf](http://www.columbia.edu/~jeh1/2008/TargetCO2_20080407.pdf)

<sup>3</sup> James Lovelock, The Revenge of Gaia, 2006