Land Grabs for Biochar? Narratives and Counter Narratives in Africa's Emerging Biogenic Carbon Sequestration Economy

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Land grabs for biochar?
Narratives and counter-narratives in Africa's emerging biogenic carbon sequestration economy

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Introduction

Biochar refers to the carbon-rich product that results when biomass – from wood or leaves to manure or crop residues – is burned under oxygen-deprived conditions and then buried in the ground.[1] Yet around this apparently simple practice extraordinary levels of technological optimism and debate are emerging amidst the imperatives for global climate change mitigation and associated carbon markets. Burying biochar offers the promise of long-term sequestration of carbon, part of a suite of 'biogenic' approaches to climate geo-engineering that now attract the interest of scientists, policymakers and companies alike. Because its production and burial might also enhance soil fertility and thus food security, and can generate bio-energy and improving women's health through reduced-smoke woodstoves - biochar is rapidly being promoted as a 'multiple win' technology for small farmers in Africa and beyond. Meanwhile, biochar-related businesses are multiplying rapidly, given rich if uncertain rewards promised by emerging global carbon markets. At the same time, critiques are emerging that question this promise and point to the dangers inherent in certain styles of biochar development.

The spectre of land grabs – or 'carbon grabs' - is pivotal to this emerging debate. We define carbon grabs as large scale appropriations of land and resources for global climate change mitigation benefits and profits from carbon markets. As we show, some are arguing for large-scale land deals to produce biochar feedstocks, driven by the impetus to sequester significant quantities of carbon. This threatens a re-run of 'biofuels vs. food' controversies and resource appropriations, yet with a new twist as carbon grabs for biofuels and for biochar feedstocks threaten to compete with each other too. NGO activists and African governments alike have seized on the land grab spectre to mount vociferous critiques of biochar as a whole. On the other hand, many researchers and practitioners insist that land grab possibilities are a red herring, given that carbon sequestration efficiency and effectiveness, let alone small farmers' livelihood needs, are better served by small-scale systems that recycle wastes in ways fully compatible with local farming and resource control. The paper tracks these diverse narratives and counter-narratives, considering which actors are producing them, the assumptions and evidence they draw on, and the ways they are shaped by and play into emerging biochar debates and practices.

The reason for our conceptual focus on narratives is two-fold. First, biochar exemplifies an arena where promise is running far ahead of practice. Schemes on (and in) the ground are only just starting to

[1] This is essentially the same process as used to produce charcoal and the terms are sometimes used interchangeably, although efforts to clarify terminology suggest that biochar is the correct term where charred organic matter is to be applied to soil (the term 'agrichar' is sometimes used for this) (Lehmann and Joseph 2009: 2).

emerge, so there is little empirical evidence of actual resource re-valuations which might be explored empirically. By contrast, the array of narratives circulating around biochar – in published literature, internet and media commentary - offers a rich and provocative research field. Second, narratives undergird and justify future practices and pathways (Leach et al 2010) and speculation in technological development and land acquisition. A focus on biochar narratives enables us to clarify the political, institutional and knowledge relations through which it is being developed and promoted, and which will shape who eventually gains or loses, and how. In particular, we explore the dynamics of polarization that are pervading so much of the current biochar debate – narratives and counter-narratives that the biochar approach is 'good' or 'bad' for the poor, or should be promoted 'at scale' or not - to which arguments about carbon grabs are central. And we show how land and carbon grabs are coming to acquire symbolic power as they are wielded as a dystopic idea in broader activist debates about biochar - and anthropogenic climate change, culpability and responsibility more broadly.

Multiple wins through biochar

To begin with, we need to consider the dominant, overarching narrative about biochar – within which many more nuanced narratives and counter-narratives about its potentials and effects are unfolding – that it offers unprecedented 'multiple wins'. Biochar, its proponents suggest, offers potent ways to meet pressing challenges across agriculture, climate change and energy – and moreover, to address all three domains simultaneously. This is the 'magic' around which biochar's political economy of promise has emerged.

First, biochar is attracting attention as a potentially powerful tool for mitigating anthropogenic climate change. The carbon in biochar, it is claimed, resists degradation and can sequester carbon in soils for hundreds to thousands of years. Offering massive carbon sequestration possibilities, biochar-based strategies are thus being seen by some scientists and policymakers- as we detail later - as a promising route amidst the array of 'biogenic' and geo-engineering options for drawing down and locking up carbon dioxide from the atmosphere – at a time when geo-engineering is itself attracting growing interest and acceptability as a potentially valuable complement to emissions reductions..

Second, in relation to agriculture, it is argued that the burial of biochar provides a potentially powerful method for enhancing soils, helping them to retain nutrients and water, enabling increases in agricultural productivity without, or with much reduced, applications of inorganic fertilizer. Biochar-based strategies are thus being seen to offer valuable routes to building sustainable agricultural futures – not least for resource poor farmers for whom soil fertility and water availability are seen as key constraints on crop production and food security.

Third, in the energy domain, biochar is claimed to offer valuable ways forward in the challenge of building sustainable, low-carbon energy futures. Here the process of producing biochar is the focus, since the required burning of biomass, wastes or other feedstocks in a low- or zero-oxygen environment can, with the right technologies, be tuned also to release bioenergy/ biofuels by-products in the form of syngas and bio-oil.. Of course, the quantity of biofuel so released is significantly less than would be the case if the feedstock could be processed fully for biofuel.

While there is policy and research excitement in each of these domains, it is the promise of biochar to link them in a triple win that makes it extraordinary. As Flannery (2009: xxv) puts it: 'The biochar approach provides a uniquely powerful solution: it allows us to address food security, the fuel crisis and the climate problem, and all in an immensely practical manner'. Unlike other carbon-capture-and-storage techniques being explored to link energy production and climate change mitigation, biochar is not locked-up in a useless way, shoring up storage problems for the future, but harnessed for new productive possibilities in farming. The claim that the carbon buried as biochar stays in the soil through successive agricultural cycles, rather than being mobilized and re-released through crop growth, is key to this. Biochar thus seems to offer a way to mitigate climate change, produce energy and increase agricultural productivity through a single set of practices or technological applications that interact synergistically. Some add further value streams - such as the provision of a means to manage agricultural wastes (Lehmann and Joseph 2009), or even, as we shall see, poverty reduction – multiplying the triple win to quadruple or more. In this way, biochar seems to offer a uniquely powerful pathway to meet multiple sustainability challenges.

In some of the more florid statements and claims, this becomes a pathway to reverse a history of environmental damage, and a magic key to a more sustainable future. For example:

> If you could continually turn a lot of organic material into biochar, you could, over time, reverse the history of the last two hundred years...We can, literally, start sucking some of the carbon that our predecessors have poured into the atmosphere down through our weeds and stalks and stick it back in the ground. We can run the movie backward. We can unmine some of the coal, undrill some of the oil. We can take at least pieces of the Earth and – this is something we haven't done for quite a while – leave them Better Than We Found Them (Bill McKibben, author, climate activist and founder of 350.org; McKibben 2009)

Or in the words of the US-based Huntsville Project:

> Biochar is the only true carbon *reductive* technology that exists… unique in its ability to help humanity solve the climate change problem by taking carbon *out* of the atmosphere. …But this just scratches the surface of what we know about what biochar can do. Biochar is the Swiss Army knife, or the 'killer app' of climate solutions. It is the key to the New Carbon Economy (http://www.newcarboneconomy.info/page6.php)

Biochar for climate change mitigation

In our climate-concerned times, it is not surprising that biochar's most prominent advocates – and the most publicized and heavily-invested narratives about it – emphasise its climatic benefits. Some treat biochar as one of an array of options for geo-engineering the climate (Royal Society 2009); others distinguish it from industrial engineering-based carbon capture and storage approaches, treating biochar instead as a 'biogenic' technique. Nevertheless the overarching argument that biochar buried in soil offers large potential for sequestering carbon, and thus a promising approach to mitigating climate change, has been forwarded by – and has served to draw together – a large array of actors. These range from researchers - mainly in the environment, energy, and earth departments of large universities in the United States (with Cornell University notably prominent), the United Kingdom, and Australia - and governments - mainly in Europe, Australia and the United States - to NGOs, private companies seeking to benefit from carbon markets, and the venture capital, clean energy investment firms and consultancy services that support them.

Several prominent individuals have played key roles in the public promotion of a dramatic pro-biochar for carbon sequestration narrative. Amongst them are James Hansen, head of the NASA Goddard Institute for Space Studies, who has argued that 'Replacing slash-and-burn agriculture with slash-and-char and use of agricultural and forestry wastes for biochar production would provide a CO_2 drawdown of ~8 ppm or more in half a century.'[2]. James Lovelock, originator of the Gaia theory, claims that 'There is one way we could save ourselves and that is through the massive burial of charcoal…. Then you can start shifting really hefty quantities of carbon out of the system and pull the CO_2 down quite fast.' The late Peter Read of the Centre for Energy Research in New Zealand warned of dangerous climatic tipping points so:

> …it is necessary to go beyond what can be achieved through emissions reductions. This entails large-scale carbon removals from the atmosphere and stocking it somewhere safer. Thus… the threat of abrupt climate change thrusts negative emissions systems, including, most promisingly, biochar, into a key role in climate change mitigation (Read 2009: 395).

Tim Lenton, Professor in Earth System Science at University of East Anglia, suggests that biochar is one of the best technological solutions to reducing CO_2 levels,[3] arguing that 'Biochar has the potential to sequester almost 400 billion tonnes of carbon by 2100 and to lower atmospheric carbon dioxide concentrations by 37 parts per million."[4] Johannes Lehmann of Cornell University, a longstanding expert in the field, was in this context named by social enterprise Re:char as the 'biochar hero.'[5] Although often more nuanced and equivocal in their own research and contributions, these – along with a few other – individuals are widely associated by publics, activists, companies and the media with strongly pro-'biochar for climate change mitigation' stances.

In some versions of the narrative, this call to unity is supported by powerful metaphors. Thus the Carbon War Room, a U.S. based organization established by business entrepreneur Richard Branson, to harness 'the power of entrepreneurs to implement market-driven solutions to climate change', enlists biochar as one of its key 'battles' in its 'war' against planet-destroying 'business as usual'. It claims that 'early research has established biochar's potential to scale up to remove several billion tons of CO_2e per year by 2054'. [6]

Tight networks link these actors and institutions. Many university researchers are on the boards of biochar organizations or companies, or offer biochar consulting services. The biochar community is also drawn together around the few large projects, with academics often focusing their research on schemes that companies have instituted for profit. In these ways, it is reasonable to speak of a veritable biochar-for-carbon-sequestration community or 'industry'. Some commentators have gone further to characterise a community of 'biochar worshippers' amongst whom there is corruption and nepotism (Smolker 2010, TNI 2010), suggesting that many researchers also have financial interests in the uptake of biochar – although it is questionable whether there is evidence to support these claims.

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Networks are also facilitated through overarching international organizations and initiatives. Central amongst these is the International Biochar Initiative (IBI) (http://www.biochar-international.org/) established at the first international conference dedicated to biochar in Australia in 2007. The IBI is a

[2] James Hansen, http://www.columbia.edu/~jeh1/.
[3] http://climatechangepsychology.blogspot.com/2009/03/chris-goodall-johannes-lehmann-tim.html
[4] "The Biochar Debate," Physics World, http://environmentalresearchweb.org/blog/2009/10/the-biochar-debate.html.
[5] "Biochar Hero, Johannes Lehmann, Testifies before 111th Congress," 9 July 2009, http://www.re-char.com/2009/07/09/biochar-hero-johannes-lehmann-testifies-before-the-111th-congress/.
[6] http://www.carbonwarroom.com/battle/biochar).

‘non-profit organization that supports researchers, commercial entities, policy makers, development agents, farmers and gardeners, and others committed to sustainable biochar production and use’. Its Board is chaired by Johannes Lehmann, and has members from key research and commercial organizations. Paid subscriptions entitle members to, *inter alia*, ‘contribute to a global community seeking to advance biochar, enhance the earth’s soils, and combat climate change’, and ‘Support IBI’s work to commercialize biochar systems globally at various scales’. The IBI sees itself as ’providing a face for biochar research and outreach efforts as the authoritative organization with respect to information and policy on biochar’ (Lehmann and Joseph 2009: xxiv); not surprisingly given this self-proclaimed leading public face, it is also a key target of biochar’s critics.

Many other smaller pro-biochar networks are also emerging, with diverse interests and emphases within a climate change focus. There are now national and regional ‘biochar networks’ and online discussion fora in China, Mongolia, Hawaii, New Zealand, Japan, and elsewhere. They range from networks such as Biochar Europe, which unites companies and researchers in its aim ‘to promote the development of a large-scale biochar industry within Europe’, through research and development and by seeking carbon offsets through biochar to be recognised in emissions trading (http://www.biochar-europe.org/), to the Indian-based TSBI (The Society of Biochar initiatives) which was founded in 2010, claiming that ‘sustainable biochar is a powerfully simple tool to fight global warming’. The claimed identity of TSBI’s founder, as ‘a passionate earth child and geo-engineering initiator’ exemplifies the bizarre range of subjectivities that the promise of biochar seems able to unite and reconcile (http://www.biocharsoc.org/).

These organisations emphasise agricultural as well as climate change goals – but it is often the latter that are paramount in their optimistic, inclusive statements and climate change mitigation would appear to be a core raison-d’etre; whether agricultural concerns alone would have been sufficient to bring these organisations into being is questionable.

Large-scale carbon sequestration potentials

Key strands within this positive ‘biochar for climate change mitigation’ narrative have focused on exploring and substantiating this claimed potential. Carbon savings potentially come both from carbon sequestered in soils for the long term, and from avoided emissions (from substituting fossil fuels and fertilizer, and through suppression of methane and nitrous oxide emissions that would otherwise occur as biomass decomposes) (Shackley et al 2009, Gaunt and Cowie 2009). First, soil scientists are examining the stability of biochar in soils, finding that pyrolysed organic material has a much greater average stability than uncharred organic matter – suggesting a difference in decomposition rates of at least an order of magnitude, creating a long-term carbon sink that can last from hundreds to thousands of years (Cheng et al 2008, Lehmann et al 2009). Yet uncertainties remain, and long-term stability may depend on the conditions of pyrolysis (e.g. UK Biochar Research Centre 2009), on the nature of ‘background’ soils and other factors (Lehmann et al 2009).

A second, key strand considers the size of contribution to greenhouse gas reductions that carbon sequestered in soils through biochar could make. As Smolker (2010) notes, pro-biochar organizations such as the IBI have created their platforms around highly ambitious-soundbites: that as a ‘climate geoengineering technology’, biochar can sequester ‘gigatons’ of carbon out of the atmosphere, or even ‘absorb all of the carbon emissions from fossil fuel burning that has occurred in the past 50 years’. Researchers have variously substantiated and qualified such claims. Worldwide, total soil organic carbon is about twice the size of the global atmospheric carbon pool (Denman et al 2007). Most soils already contain char generated through vegetation fires and settlement practices during the last few thousand years, and these are estimated to make up several percent of total soil organic carbon worldwide (e.g. Gonzalez-Perez et al 2004). Biochar soil management offers the potential to add significantly to these pre-existing chars. For example Lehmann et al (2006) quote a potential global carbon sink of 5.5 to 9.5 GtC/year by 2100, larger than the annual quantity of carbon currently produced by fossil fuels.

Such figures presuppose an enormous growth in the resources and land areas devoted to the production of biochar feedstocks - as well as that a very large fraction of this carbon would be converted to biochar. Narratives in support of such large-scale carbon capture therefore incorporate propositions about how this might be achieved. For example Goodall (2008), for whom biochar is one of his 'Ten Technologies to Save the Planet', proposes that 200 million hectares of 'forests, savannah and croplands' could be turned into biochar plantations, replacing slow-growing species with fast-growing ones that enable an increased rate of carbon capture. The late economist Peter Read, a high-profile biochar advocate and member of the IBI, advocated establishing up to 1 billion hectares of new tree plantations for biochar (Read 2008). Carbonscape, a company that hopes to be among the first to commercialise the technique, talks of planting 930 million hectares (Monbiot 2009a).

Limits and land grabs

Alongside this positive narrative about the potential of biochar for carbon sequestration are emerging vociferous counter-narratives. These variously identify potentially negative outcomes of biochar investments, as well as trade-offs, which qualify these positive views of biochar's potential to sequester carbon. In a critical commentary in *The Guardian* newspaper in March 2009, the environmental journalist George Monbiot argued that 'the latest miracle mass fuel cure, biochar, does not stand up; yet many who should know better have been suckered into it' (Monbiot 2009a). At the very least, the so-called '"charleaders" need to cool their enthusiasm' (Monbiot 2009b).

The spectre of carbon grabs is central to this critique. To fulfill a 1 GtC/year carbon abatement threshold or beyond – the level that many advocates suggest is the minimum to make a significant contribution - biochar systems would need to be implemented at significant scale, raising questions about competition with land for food production and other uses. A growing body of critical counter-narrative considers biochar, in the words of the Biofuelwatch Declaration (TNI 2010) 'a big new threat to people, land and ecosystems', linking it with land grabs – or carbon grabs - in developing countries.

Concern about biochar carbon-grabbing unites a range of international NGOs, networks and researchers. Prominent amongst these are Biofuelwatch, the Gaia Foundation, the African Biodiversity Network, Friends of the Earth, the Transnational institute (TNI) and GRAIN, who in turn draw on the contributions of a small number of researchers, activists and critical journalists. NGOs such as Biofuelwatch have been raising concerns about biochar since 2009, arguing that 'big new demands for biomass are a threat to farms and forests already suffering from soil degradation and deforestation'. Biochar, in this way, has very rapidly become embroiled in potent discussions about 'green grabbing', where the lands and resources of the poor are seized to assuage the emergent concerns of global environmentalism (Fairhead and Leach 2010).

Thus a report on 'Biochar land grabbing: the impacts on Africa' (African Biodiversity Network, Biofuelwatch and Gaia Foundation 2009) claims that 'the negative impacts of large-scale biochar development in Africa are likely to be dramatic, including exacerbating land-grabbing in Africa'. They point to the claims of some biochar advocates that biochar production on a scale large enough to impact climate will require up to a billion hectares of plantations, and that much of this will be in Africa. This, it is argued, will add to the 'massive land grabbing' that is already taking place for biofuels and foreign agricultural investment geared to food security elsewhere in the world, with major impacts on indigenous communities and their access to land and resources – so exacerbating evictions, food insecurity and conflict. Land grabs in Africa and elsewhere – driven by global food, fuel and financial crises - have already been highlighted including large foreign take-over deals that have been concluded across the continent (Cotula et al 2009). Detailed analysis and documentation of cases of biofuels-related land grabs (e.g. Borras ed 2010) present many nuances and qualifications to this dramatic picture, showing that the extent and ways in which grabs play out, and their impacts, depends greatly on prior institutional and governance, as well as environmental, conditions. Nonetheless, it is the more dramatic instances and threats around food and biofuel land grabs that are called up to warn of the consequences of large scale biochar development. This is coupled with the assumption that biochar production will be on a large scale – drawing on the claims and visions of some of the biochar industry's most extreme advocates.

So, for example, the Biofuelwatch report raises alarm about the proposals of the late Peter Read to establish up to 1 billion hectares of plantations for biochar. Read expected sub-Saharan Africa to contribute 893 million hectares of this land; land which, while he acknowledged is not unoccupied, is not deemed to be under economic activity 'as reported to the FAO'. Lack of formally recorded production is thus seen as justification for taking over lands – regardless of the myriad agricultural, pastoralist, collecting, and other livelihood activities carried out by communities living on and accessing these lands. The journalist Monbiot (2009b), following up his attack on the 'charleaders', puts it thus:

> I wasn't harsh enough about Peter Read. In his response column today he uses the kind of development rhetoric that I thought had died out with the Indonesian transmigration programme. To him, people and land appear to be as fungible as counters in a board game. He makes the extraordinary assertion that "degraded land" - which he wants to cover with plantations - is uninhabited by subsistence farmers, pastoralists or hunters and gatherers. That must be news to all the subsistence farmers, pastoralists and hunters and gatherers I've met in such places (Monbiot 2009b)

In some of his later writings – and presumably in response to critics - Read rephrased his argument as for 'improved' land use over large areas, with this defined as 'sustainable production of the biomass raw material, co-produced with food and fibre' (e.g. 2009: 401). Yet how this balance is to be struck in multi-use lands is not addressed, nor is there any retraction from the assumption that large scale transformations of land use are required – now also justified by the argument that this will be 'good for rural development' by putting unproductive land to productive use. Read draws on the distinction between 'bad' and 'good' biofuels with respect to socio-economic and biodiversity impacts proposed by the Sustainable Biofuels Consensus (Trindade et al, 2008). 'Biochar land-use improvement' is assumed to be 'good', likened to Brazilian sugar cane-ethanol management systems, 'the main good biofuel that is currently available' and where 'sugar cane expansion occurs on *cerrado* land (*miombo* land in sub-Saharan Africa) that is not used for food production and that is plentifully available' (2009: 400). Villagers whose livelihoods depend on miombo woodlands might argue otherwise.

Paul et al (2009) in a report from the NGOs Econexus, Biofuelwatch, Grupo de Reflexion Rural and Friends of the Earth Denmark, raise similar alarm at the 1 billion tonnes of carbon sequestration per year quoted as a lower range to address climate change, arguing that this would make further pressure on ecosystems and land inevitable. They point to a discussion at the 2008 IBI conference in which it was suggested that plantations would be required for scaling-up biochar. For instance the IBI partnered with the Carbon War Room (CWR), to promote 'Operation Black Gold'. Smolker (2010) suggests that the CWR seeks to set up a biochar trade association with the goal of removing a billion tonnes of carbon from the atmosphere – an experiment that, as Biofuelwatch points out, would require much more than a billion tonnes of wood to be used. Biofuelwatch also raise alarm about proposed commercial developments, including proposals included in the US Senate Climate Bill for up to 60 pyrolysis plants producing biochar. They argue that such commercial developments rarely make explicit where their raw materials would come from, and they suggest that land grabs in developing countries might be part of the source.

The relationship between biochar and biofuels drawn in these narratives is highly selective. What is emphasised is biochar feedstocks as a potential equivalent to biofuels as a source of land/carbon grabbing. Thus 'biochar feedstocks vs. food' is discussed in similar terms to the 'biofuels vs. food' trade-offs that became so public and politicized.. What is overlooked in drawing these parallels, however, are the potential trade-offs between biochar feedstocks and biofuels themselves; between the use of land to produce feedstocks that will be pyrolised (yielding a little biofuel along with biochar), vs. turned wholesale into biofuel. These practices are evidently incompatible as uses of the same piece of land. On the one hand, this means that a heavy emphasis on biochar threatens to undermine the biofuel industry. On the other, pursuing both raises the spectre of a 'double whammy' whereby land for biochar feedstocks and land for biofuels are both re-appropriated away from food production.

Re-assessing sustainability, feedstocks and scale

Both in direct response to such critiques and in parallel lines of research and debate, further pro-biochar narratives suggest that land grabbing and trade-offs with food production are not inevitable corollaries of biochar development. Alternative, sustainable approaches exist – and can even be compatible with the livelihood and land tenure needs of resource-poor farmers.

In this vein, one line of research and debate explores the technical feasibility of carbon sequestration while acknowledging the limited availability of biochar feedstocks. The Royal Society (2009) in its report on prospects for 'geo-engineering the climate', informed by expert consultations in the UK and beyond, concluded negatively that sequestration rates sufficient for biochar to make a significant contribution to enhancing the global terrestrial carbon sink would likely be infeasible and unsustainable given competing land uses; at best biochar could make only a small-scale contribution. Yet others - including some of the same researchers who have been associated with an uncritical 'pro-biochar' stance (e.g. Goodall 2009, Lehmann and Joseph 2009) – have built models acknowledging land and biomass constraints with more positive implications. Thus considering only limited biomass feedstock availability, Amonette et al (2007) found biochar able to remove around 1 GtC/year by 2050 (see also Shackley et al 2009). Woolf et al (2010), incorporating a set of aggregate sustainability criteria, estimate the 'maximum sustainable technical potential' of biochar to mitigate climate change as a maximum of 1.8 Gt of CO_2 equivalent (incorporating also methane and nitrous oxide) per year without endangering food security, habitat or soil conservation. This is equivalent to 12% of current anthropogenic CO_2 emissions annually. 1 GtC/year has been deemed a cut-off point for approaches to greenhouse gas abatement to be taken seriously. Biochar methods, as indicated above, are theoretically able to achieve this sustainably – even if they do not offer the overall carbon sequestration potential of some other geo-engineering techniques, such as chemical air capture (Royal Society 2009).

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A second line of argument draws in the soil effects of biochar. In helping plants to grow better, some pro-biochar advocates have made the point that biochar's effects on soils also boost its capacity to contribute to climate change mitigation, making larger-scale systems more feasible. For instance as Goodall (2009) responded to Monbiot's (2009) critique in The Guardian:

> We will have to take the organic outputs of large areas of land in order to achieve this [significant greenhouse gas reductions] and Monbiot is right to express horrified disbelief at some of the figures that we have suggested. Here we depart from the path of agreement. Monbiot mentions but then ignores the other benefits of biochar. These are at least as important as direct climate change mitigation. First, soil dosed with charcoal can substantially improve agricultural productivity. Food crops grow better. Trees planted in biochar often have better root systems. Crop yields are improved. This means that we can provide food supplies for more people from a smaller area of land.

In this view, plantations of biochar feedstocks might remove land from food production but the overall negative effects on food production are compensated by increased production elsewhere.

A third line of research uses modeling to compare different biochar feedstocks and biochar production methods. 'Cradle to grave' lifecycle assessments generally find that biochar results in a net reduction in greenhouse gas emissions, as well as being an energetically-efficient use of biomass (Gaunt and Lehmann 2008, Lehmann and Joseph 2009). However they also underline that the climate change mitigation benefits depend on the specific methods of biochar production and use (Schahczenski 2010, and, crucially, the feedstock. As Gaunt and Cowie (2009) point out, this is a fundamental issue: for additions to the soil carbon pool to result in a net reduction in carbon released to the atmosphere, then the buried organic matter needs to be the result of increased production – otherwise apparent increases in soil carbon stocks might simply reflect the movement of organic matter from one site to another (termed 'leakage' in the language of emissions trading). If the source is virgin material grown for biochar production, this can be less efficient in overall climate change mitigation, as the carbon sequestration capacity of that vegetation is lost when harvested for biochar. Roberts et al (2010) compared biochar systems based on corn stalks, yard waste and a switchgrass biofuel crop, finding that the first two contributed net greenhouse gas emission reductions (of 864 and 885 kg CO_2 equivalent per tonne of dry feedstock respectively, of which 62 – 68% was realized from carbon sequestration in the biochar), but the switchgrass system could be a net greenhouse gas emitter, given indirect land use change impacts. If high carbon-sequestering vegetation such as old-growth forest is cleared to plant biochar feedstock, for instance, then the overall effect on carbon sequestration could be even more negative. In general, the limited range of studies so far seem to point to the advantages of waste-based systems on both technical and sustainability grounds.

A further stream of work assesses the economic potential of climate change mitigation through biochar. Thus Pratt and Moran (2010) use Marginal Abatement Cost Curves in scenarios to 2030 to compare biochar strategies with a range of other carbon abatement strategies, including those based on fossil fuels with carbon capture and storage, renewable energy technologies, and efficiencies in transport and electricity use. They find that even the most expensive biochar projects rival the cost-effectiveness and efficiency of other abatement strategies (although not overall abatement potential). Again, though, economic potential depends on the conditions of biochar production. Comparison of a range of biochar strategies, from small-scale stove and kiln projects in developing countries to large-scale processing plants in Europe and North America, concludes that while most are cost-effective, low-tech projects in developing countries offer the greatest potentials, because a large number can be set up within each region without heavy start-up and running costs. They also note, crucially, that the cost-effectiveness of any of these climate change mitigation projects depends on the price of carbon that can be negotiated through carbon markets – an issue we discuss further below. Assessments of the economic as well as technical potential of biochar to contribute to climate change mitigation thus depend heavily on the way that biochar is produced and used.

These lines of research and argument thus counter the spectre of large scale land grabbing for biochar. Indeed they suggest that small-scale approaches using crop wastes as feedstocks actually perform better for climate mitigation in both technical and economic terms. Indeed from this angle, it can be argued that large scale, monocultural biochar feedstock plantations are a red herring, as they would not be economically viable anyway (David Wayne, pers comm).

Biochar for small farmers

Linking with these narratives about the technical and economic potential of small-scale biochar schemes are further narratives suggesting that biochar is positively good for small farmers. Far from leading to impoverishing carbon grabs, these arguments go, biochar schemes – at least of certain kinds – can help reduce poverty and bring livelihood and health benefits.

A variety of case studies of model, hypothetical biochar systems suited to the conditions of farm households in developing countries have been proposed, and their particular goals, inputs and benefits described and quantified (Lehmann and Joseph 2009, Joseph 2009). These range from a Kenyan household scale bioenergy/biochar system linking crop wastes with improved pyrolising cooking stoves, to a Brazilian system involving the conversion of slash-and-burn farming to slash-and-char, and a model village-level multi-purpose biochar project in an Asian setting. Although the specific benefits vary in these different model scenarios, on balance they are argued to be positive. Hypothetical models (of both small-scale approaches and large scale, industrial ones – see Lehmann and Joseph 2009 and McCarl et al 2009) are an important stock-in-trade of current debate about the socio-economic as well as environmental promises of biochar, given the paucity of 'systems in practice' on the ground.

Nevertheless, there are also a growing number of practical examples of small-scale biochar projects in developing countries. These are all at an early stage, having started in the years since 2005. Most describe themselves as 'trials', illustrating both the novelty/unproven character of biochar applications, and the status of many as simultaneous research sites for the development of biochar science . In African settings, for instance, African Biodiversity Network, Biofuelwatch and Gaia Foundation (2009) list 19 projects. These range from a project by the French Centre for Rural Innovations in Cote d'Ivoire (with an extension to Burkina Faso), involving biofuel (Jatropha, moringa) and biochar trials on 2,500 hectares involving farmers and projects in Cameroon ('field trials' involving 1,500 farmers) and DR Congo (a ten year project in ten villages) run by the Biochar Fund (Belgium); to research projects/trials in Western Kenya linked to Cornell University, targeting 20 households with cookstoves and carrying out biomass assessments on 50 households; small pilot pyrolysis plants and biochar trials in Mali, Niger and Senegal supported by the NGO Pro-Natura, and a study in West-central Ghana aiming to develop 'biochar-based soil management strategies for smallholder agriculture' run by Rothamsted Research (UK) and the Soil Research Institute in Kumasi. In South Africa, several energy and mining companies have started biochar projects: for example Alterna Energy, a subsidiary of a Canadian company, has started a small pyrolysis plant in Mpumalanga Province, with the charcoal sold as fuel and for biochar trials, and Delta Mining is said to be looking for biochar projects. Several of these African projects (including those in Cameroon and Western Kenya) are included amongst the nine country projects worldwide that the IBI selected for evaluation in 2008, partly to 'evaluate cost effective approaches for the widespread introduction of biochar'. The IBI promotes a database and forum for the burgeoning number of small projects and trials around the world to post information and share findings, contributing to a growing global community of experimental practice around biochar.

A number of these projects, as well as the organizations promoting them, claim explicitly to link climate change and energy benefits (and soil benefits, as the next section will explore) with farmers' livelihood needs. Indeed several of the international networks and non-profit organisations discussed above claim to have poverty alleviation and support to small farmers as amongst their goals – although often mixed with potentially contradictory aims geared to large scale commercial biochar systems. Thus for instance the IBI invites members to support its work both to commercialise biochar, and to 'support IBI's work with community-based local and regional biochar groups'.

For organizations with a biochar focus, meeting farmers' needs and priorities is cast as one amongst the multiple 'value streams' generated by biochar projects. Thus the strapline of The Biochar Fund is 'fighting hunger, energy poverty, deforestation and climate change – *simultaneously*' (http://biocharfund.org/index.php?option=com_content&task=view&id=14&Itemid=37). The Fund claims its impact – such as in projects such as those in Cameroon and DR Congo – as in creating 'a synergy that radically changes the livelihoods of some of the world's poorest communities in multiple ways'.

In other cases, organizations with a broader-based development/environment focus take farmers' livelihoods and 'community empowerment' as an entry point, with biochar-related activities cast as a way to address these. An example is Pro-Natura, whose topline concern is 'fighting rural poverty':

> Pro-Natura is tackling the social, economic and environmental problems that face rural communities in the Developing World. The aim is to provide viable economic alternatives to those people struggling to make a living from imperiled environments. This is achieved by building local capacity and establishing participative governance, so that the preservation and restoration of natural resources can be linked to local economic success.

But which has added a series of activities and communications that include biochar, green energy and accessing carbon markets:

> Pro-Natura decided to encourage the use of its green charcoal as a biochar and has launched pilot projects on its intervention sites. The environmental benefits of this innovative application add to the advantages already recognised of the substitution of green charcoal for wood charcoal (deforestation avoided, no methane emissions, etc.). It is thus possible to render the carbon footprint globally negative (by taking more carbon from the atmosphere than is emitted), while fighting effectively against poverty and hunger ….(http://www.pronatura.org/index.php?lang=en&page=biochar)

Similarly, TerrAfrica casts its broad interest as in regional sustainable land management, through an approach emphasizing that 'small-scale subsistence farmers, agro-pastoralists and pastoralists of Sub-Saharan Africa must be acknowledged as important custodians of the environment'. It has joined the biochar movement from this position:

> Biochar technology appears promising, as it connects improving degraded soils, increasing crop yields, energy provision, climate change mitigation and rural development (Woodfine 2009).

In the justifications and descriptions for such rural development-focused projects, global/regional climate change mitigation rarely figures explicitly – not least because it would not be a convincing entry point for local communities faced by more pressing day-to-day challenges. Instead, broader climate concerns are translated into local challenges around deforestation and daily energy needs, as is the case for a variety of projects that link biochar to improved woodstoves. For example,

> The African Christians Organization Network (ACON) has been working in Western Kenya since 2000 to empower villagers by providing opportunities for development that are environmentally sustainable. Since 2004, they have been focusing their work on how to reduce deforestation while improving soils for local farmers in the area. Part of this solution is improved cookstoves and the use of biochar (http://www.biochar-international.org/profile/ACON/Kenya).

Further examples can be found in the work of WorldStove, an NGO 'committed to creating useful and innovative carbon negative products that increase quality of life for individuals and households around the globe' (http://worldstove.org/). They have developed and piloted (in Uganda, Kenya, Haiti, Malawi, Indonesia, Zaire, the Philippines, Burkina Faso, Congo and Niger) pyrolitic cooking stoves that produce biochar:

> ….. many of our intended end users live in extreme poverty and cannot afford the wood it costs to cook a single meal. All of our stoves are designed to function using waste agricultural products that cannot normally be used in a standard stove. Not only does this mean that the fuel cost becomes less, it also means that the end product, biochar, is of commercial value. Our stoves can therefore provide a new way to generate income for the end user in addition to being environmentally friendly on the global level.

What is on offer here is not just a triple win (climate change mitigation, appropriate energy, and agricultural benefits/income), but a fourth: improved health from reduced cooking smoke and indoor air pollution. Indeed as discussed above, the kind of small-scale, slow pyrolysis used in such cooking stoves projects is also being found more efficient and cost-effective for greenhouse gas emissions reductions than the fast pyrolysis that large plants favour (Pratt and Moran 2010).

In these versions of pro-biochar narratives, then, reduced poverty, wellbeing and livelihood benefits to rural people in developing countries go hand in hand with climate change mitigation. The nature of the technology and projects – locally appropriate and small-scale – are core to these co-benefits.

However, it should be noted that if such small-scale schemes are to add up to the aggregate levels of carbon sequestration promised by 'biochar for climate mitigation' narratives, there will have to be a very great many of them. On the one hand, the spectre looms thus not of large-scale land grabs, but of replicated small-scale 'project grabs', which, to be implemented in the number required, will acquire a degree of standardization that rides roughshod over the diversity of local priorities, livelihoods and landscapes. On the other hand, if biochar systems that genuinely work for small farmers emerge, an alternative scenario might see rapid, spontaneous spread from community to community, with farmers adapting technologies and practices to suit their diverse contexts. This would be analogous to the way that other initially marginal innovations – including the System of Rice Intensification (SRI) (Uphoff 2009), and Community-Led Total Sanitation (CLTS) approaches - have spread, now right across the globe (Kar and Pasteur 2005).

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A step towards carbon-grabbing?

Cynical critics dispute this promise of small, pro-poor biochar projects, however, arguing that these are merely the thin end of a wedge that will lead eventually to large-scale carbon grabs. At the moment, they suggest, all biochar projects are small-scale simply because in the virtual absence of subsidies, there has been no opportunity to scale them up (African Biodiversity Network, Biofuelwatch and Gaia Foundation 2009). Indeed this network considers small-scale 'sustainable' biochar to be a 'myth', and current small-scale biochar 'trials', even those with farmer participatory claims and approaches, to be trials for the eventual implementation of schemes at large, commercial scale. Larger-scale deployment is the explicit aim of several projects, they argue, including those run by the Centre for Rural innovations in Cote D'Ivoire with farmers on 2,500 hectares. Moreover, 'emphasis on small-scale biochar appears, at least in some cases, to be part of a marketing strategy to make biochar more politically acceptable' (ibid). They point, for example, to the way that biochar marketing company Genesis Industries openly speaks about its 'guerilla marketing' tactics, in which a focus on small farmers provides a key marketing slogan for the owners of pyrolysis machines. Biofuelwatch similarly suggests that commercial organizations and umbrella initiatives such as the IBI use images of small farmers, their fields and woodstoves to promote a 'humanitarian' image while actually seeking to implement the 'grand visions' and large scale commercial schemes that have been their interest from the outset (Smolker 2010). In this way, and as happened with biofuels, it is argued, small scale participatory schemes are both a smokescreen for and an opening to pave the way for large scale biochar monocultures that displace farmers from their land.

Furthermore they suggest that even when such 'grabs' do not involve land per se – or a transfer of property rights in it – they might be 'biomass grabs'. Thus as Paul et al (2009) argue, if biowaste is removed from a farm to be made into biochar and then not returned to that land, the soil there will be depleted so instead of improving the soil for local farmers, the biochar industry will undermine it. Such arguments suggest that the challenge with large-scale production of biochar – even when the focus is on agriculture - is producing and then distributing it in a way that does not undermine the soils of small farms. For this reason, many argue that small-scale biochar production should be favored. To make biochar most beneficial for small, rural farmers, the production and application of biochar on a small, local scale, from local biowaste, should be encouraged (Pratt and Moran 2010, Roberts et al 2010, Lehmann and Joseph 2009).

Carbon markets and commerce

Key to positive narratives is the idea that biochar projects – whether large or small – can tap into emerging carbon markets. Glover (2009) lists numerous opportunities for 'taking biochar to market', exploiting commercial demands across seemingly disparate areas from urban and rural waste management, agricultural input supply, livestock and industrial sectors, especially as these come under growing pressure from global climate change agendas to internalize environmental costs and use resources sustainably. In particular, it is argued that biochar offers high market potential 'as a long-term and readily measurable sequestration product, [that] will provide additional revenue in any market or jurisdiction where C is traded or C sequestration outcomes are valued' (Glover 2009: 378). Funding from carbon trading is argued to be essential to finance the research and development necessary to discover and exploit the full potential of biochar to contribute to climate change mitigation, and to enable scale-up to sequester carbon at globally-significant levels. At the other end of the spectrum, those emphasizing small farmer livelihoods argue that if farmers receive payments for sequestered carbon, this can provide an income stream and justify the financial and time investment necessary to adopt biochar systems (Palmer 2009) – a model currently being tested by the Biochar Fund in Central Africa (Biochar Fund 2008).

Pro-biochar advocates across the spectrum of scale concerns have therefore been at pains to bring biochar into the UN Framework Convention on Climate Change (UNFCCC) process, and to argue the case for biochar to be included as an offset mechanism in formal carbon trading schemes under the Kyoto Protocol and in its Clean Development Mechanism. At the forefront of this lobbying have been international organizations and networks, notably the International Biochar Initiative, as well as a range of NGOs and of agribusiness and other companies seeking opportunities to invest in the new carbon economy. The Carbon War Room has, through its 'Operation Black Gold', sought to 'apply overwhelming force' to ensure that biochar is included in carbon trading schemes and gains prominence on the agendas of large NGOs (Smolker 2010). But lobbyists also include developing country organizations and governments advocating for small farmer perspectives. Thus in the run-up to the 15th Conference of Parties to the UNFCCC in Copenhagen in December 2009, a group of African governments[7] forwarded a joint submission urging 'the importance and relevance of a decision for including the potential of soils in drylands in sequestering carbon. One such exponent is biochar…' (African Governments 2009). At Copenhagen, a range of specific proposals were made – including that biochar should be included as an allowable method for carbon sequestration within the soil carbon and land use change mitigation and adaptation category, and that biochar should acquire status in the Clean Development Mechanism as a mechanism for carbon offsets. Lal (2010) notes further that payments to land managers for sequestering carbon in agricultural soils was a logical issue for discussions at Copenhagen, not just as sink projects under the CDM but also for enhancing ecosystem services. Through 'farming carbon' – sequestering carbon in soils, including those that are desertified or degraded – and selling carbon credits just like any other farm produced commodity, carbon trading could contribute to poverty reduction.

In the end, these attempts failed. Many scientists, policy makers, NGOs and land managers were disappointed by the discussions at Copenhagen which did not fully address biochar and related land/forest strategies offering multiple benefits (Lal 2010). The post-2012 framework agreement negotiated at Copenhagen included no specific mention of carbon sequestration in soils or of biochar. Yet proponents continue to argue hard for their inclusion as the post-Copenhagen process moves forward. Meanwhile, biochar advocates have achieved notable successes at national policy levels. For instance in the United States, the IBI succeeded in getting biochar R&D included in the 2008 United States Farm Bill while the 2009 US Senate climate bill features biochar prominently. The convincing testimony of prominent scientists and advocates (e.g. Lehmann 2009) has been key in these policy changes, and these advocates continue to argue that at international level, mechanisms for carbon trading that recognize soil carbon sequestration need to be put in place.

At the same time, some advocates recognize that the inclusion of biochar in formal carbon trading will face significant challenges. These echo those common to many CDM/offset mechanisms – they have arisen repeatedly for REDD (Reduced Emissions from Deforestation and Degradation), for instance – but in the case of biochar have a particularly acute complexion. These include establishing a system for

[7] The Gambia, Ghana, Lesotho, Mozambique, Niger, Senegal, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe

quantifying the carbon benefits – a particular challenge given how different these may be for different biochar feedstocks and lifecycle assumptions, and given uncertainties about permanence of sequestration and 'leakage' from projects (Gaunt and Cowie 2009). They also include developing a robust certification system – a particular challenge given that biochar projects are so often small-scale, geographically dispersed, and both difficult and expensive to monitor – not least for small farmers (Palmer 2009). As Lehmann argues, 'the distributed nature of biochar systems and the potential for variability between systems create significant opportunities for sustainability, but also hurdles to widespread adoption, regulation and financial viability' (Lehmann 2009). Such views support arguments for research to explore and establish appropriate regulation for biochar application and crediting (Collison et al 2009, Lal 2010), and to establish whether the monitoring and verification of smaller scale biochar products can be economically feasible (Lehmann 2009). They also highlight potential trade-offs: between large, industrial-scale, uniform biofuel-biochar applications that may be more commercially viable and amenable to the international carbon trade but also more likely to involve land-grabbing, and smaller scale, diverse applications that might deliver greater social and environmental benefits, but are less amenable to carbon trading mechanisms.

For now, such debates rage in an implementation vacuum, while the post-Copenhagen climate change policy machinery rolls slowly on. Nevertheless, even in the absence of this formal carbon market recognition for biochar, opportunities already exist for carbon financing: first through voluntary carbon markets and a variety of available schemes not linked to the Kyoto Protocol and UNFCCC (Gaunt and Cowie 2009) and second through the practice and possibility of aggregating biochar projects with other kinds of small offset project to (legitimately and cost-effectively) sell them in formal global markets (Palmer 2009). These – together with the high promise of big carbon trading gains to come – have been sufficient to entice many small companies and commercial initiatives onto the biochar scene. There they form a subset of the dizzying array of commercial ventures forming around the new carbon economy in general. The website statement of one of the latter, the investment advice firm Green Chip Stocks (strapline: 'a new way of life, a new generation of wealth') encapsulates the immense imagined profits enwrapped with the promise of carbon-trading futures:

> *Carbon Trading: The World's Next Biggest Market. Here's how to get your piece of the profits in the early going.*
>
> The New York Times recently ran an article claiming that "carbon will be the world's biggest commodity market, and it could become the world's biggest market overall". Rest assured, it will be. Currently valued at over $30 billion, the carbon trading market is set to skyrocket to over $1 trillion as the price of carbon becomes more and more valuable. And it's possible to get a piece of this infant industry right now. Early investors can play the burgeoning carbon market by 1. Investing in carbon credits themselves, or 2. Investing in companies that are making extra cash by reducing their emissions. There's no telling just how lucrative this market will become. Why else would huge companies like GE, DuPont, and Johnson and Johnson be racing to reduce their emissions? It's because of the huge profits that stand to be made.

Commercial ventures specializing in or including biochar are many and varied, but are united in the imagined promise of profit- generating technological solutions to a collective global environmental problem. As the venture capital firm VenEarth Group put it:

> Biochar can be produced from agricultural and forest wastes sustainably worldwide. Large scale deployment of biochar in agriculture can deliver gigatons of annual carbon sequestration while improving farm productivity, making us all healthier and wealthier (http://www.venearth.com/).

Among the many companies – and the list is too long to repeat - forming or shaping their activities and claims around the promise of biochar, are first, those producing biochar or biochar technology. These include for example BioChar Products: 'a start up company dedicated to the demonstrating and testing of the fast pyrolysis concept for use in small communities near forested landscapes' (www.biocharproducts.com); Carbon Gold, a UK-based company that manufactures biochar-based products for gardening and has a portfolio of projects in developing countries (http://www.carbongold.com); BiG – Black is Green, an Australian company that designs and produces fast pyrolysis plants (www.bigchar.com), and the aptly-named Dare to Imagine (DTI) Strategy and Marketing Consulting (www.daretoimagine.com/projects.html) that among other activities has a renewable energy project of commercially producing biochar from waste. Another – the Pennsylvania-based Mantria Industries opened the 'world's first commercial scale BioChar facility' in August 2009 to great fanfare but no longer exists, having been charged for fraud by the US government regulators for using 'exaggerated claims and aggressive marketing to con people into investing in biochar sequestration' (Inman 2010). In this fast-moving world of promise, it seems that biochar companies come and go.

Others that have come, for now, include, second, many consultant groups that help firms set up biochar production. For example Biochar Consulting (www.biochar-consulting.com) is a Canadian based company offering 'comprehensive technical services to clients who wish to undertake projects or produce or utilize Biocarbon or Biochar.' CarbonZero (http://www.carbonzero.ch/) focuses specifically on biochar as 'a team of agricultural consultants who can help firms interested in reaping the multiple benefits of utilizing biochar in their operations', and lists seven reasons why biochar is such a good investment/product. A third kind of company are consultancy (or finance) groups offering carbon offsets through biochar, sometimes alongside biochar production. For example Crucible Carbon (http://cruciblecarbon.com/consulting.php) includes biochar amongst the options it advises for how companies can go carbon neutral based on existing technology, while doing research on 'next generation pyrolysis' and regenerative land practices. Outback Biochar (www.outbackbiochar.com) produces biochar mobile technology, sells biochar in small quantities, and provides consultancy services to assess biochar sites, feedstocks, carbon potential, and financing and profit options. Similarly, Re:char: (http://www.re-char.com/about/) is 'part technology company and part information source, providing up-to-date information and commentary on the nascent world of biochar.'

These examples are only a small handful amongst many. In short, there is a vibrant world of 'start-up' commercial activity that seeks to profit from biochar technologies, to profit from helping others set up and manage profit-making initiatives, and to profit from advising others about the potentials. These are layers of hope built upon, and in turn supporting, the narrative of biochar as a solution to climate change. The fragmented nature of this multitude of initiatives reflect the bubble-like character of this investment in promise, as well as the absence of any regulatory framework. Some have questioned whether investment in biochar approaches for the long-term can be sustained through this style of market growth is questionable (Glover 2009).

Questioning carbon market fixes

These pro carbon funding narratives also meet counter-narratives. More nuanced research and commentary casts the future of global carbon markets as more uncertain. It suggests that the future profitability – and economic efficiency – of biochar as a climate change mitigation approach will depend heavily on future carbon prices and the many factors shaping these in a complex global economic system. Others critique carbon trading and geo-engineering together in more general terms. They argue that this represents an economic and techno-fix that distracts from the more pressing need for systemic changes in economies, production systems and lifestyles. As the People's Declaration from Klimaforum09, the large alternative meeting at the Copenhagen Summit, put it:

> Environmental and climate debts must be paid. No false, dangerous, and short term solutions should be promoted and adopted, such as nuclear power, agro-fuels, offsetting, carbon capture and storage (CCS), biochar, geo-engineering and carbon trading…. (Klimaforum 2010)

In this view, biochar is grouped with other geo-engineering methods as part of top-down, centralized approaches promoted by a techno-capitalist industrial complex. This is contrasted with a quite different bottom-up vision in which, as the People's Declaration argues:

> We want to take the future into our own hands by building a strong and popular movement of youth, women, men, workers, peasants, fisher folks, indigenous peoples, people of colour, urban, and rural social groups, which is able to act on and deal with environmental degradation and climate change (ibid).

More specific public and activist concerns turn on whether geo-engineering is a distraction from the more pressing need to cut carbon emissions at source. This is despite the fact that most proponents of carbon sequestration methods and geo-engineering themselves acknowledge that this does not reduce the need for cutting emissions now. As the President of the Royal Society put it in introducing the Society's report, 'nothing should divert us from the main priority of reducing global greenhouse gas emissions. But if such reductions achieve too little, too late, there will surely be pressure to consider a 'plan B' – to seek ways to counteract the climatic effects of greenhouse gas emissions by 'geo-engineering'' (Royal Society 2009: v). Prominent biochar researchers and advocates (e.g. Lehmann and Joseph 2009) also see this as a complement, not a substitute, for emissions reductions through transformations in economies, energy and transport systems. Moreover biochar offers the double prospect both of carbon sequestration and of emissions reductions through pyrolysis-bioenergy production, and the latter's replacement of more carbon-emitting energy sources.

Narratives critical of carbon trading and geo-engineering also invoke global injustice. CDM and carbon offsets, they suggest, offer the developed world an excuse for not cutting their own emissions - rather than as a tool to use in addition to cutting emissions (TNI 2010). This is especially likely for biochar, given that most land for biochar production will be in developing countries. In this way, biochar is symbolically associated with carbon-grabbing on a global scale. Some groups therefore suggest banning any carbon sequestration or geo-engineering options, while others recommend leaving such methods of out the Clean Development Mechanism and carbon trading, in order to reduce the funding towards them (e.g. African Biodiversity Network, Biofuelwatch and The Gaia Foundation 2009).

The governance implications of biochar, along with other forms of geo-engineering the climate, are only just beginning to be raised (Royal Society 2009, Rayner pers. Comm.). Most governments have yet to engage in the debate, let alone establish specific policy positions and frameworks – while global policy frameworks through the UNFCCC are, as we have seen, remarkably non-specific when it comes to biochar. In this governance and policy vacuum, businesses and NGOs alike are pursuing their biochar interests, leaving biochar-for-climate-change-mitigation remarkably vulnerable to the unregulated interplay of private hopes and fears.

Finally, critics of carbon economy-funded approaches argue that these falsely promise a simple solution to far more complex problems. Thus as part of his attack on biochar, Monbiot (2009a) wrote that 'The idea that biochar is a universal solution that can be safely deployed on a vast scale is as misguided as Mao Zedong's Great Leap Backwards… We clutch at straws (and other biomass) in our desperation to believe there is an easy way out.' Biochar and other geo-engineering approaches play into what Hulme (2009) has characterized as a misguided view that 'climate change' is a problem to be solved – rather than a discursive phenomenon that will inevitably be disagreed over and debated, and that implicates multiple smaller, more diverse problems. In this respect, the very 'universal' promise of biochar – its multiple wins – is also its Achilles heel, leaving positive claims and hopes about it very open to accusations and counter-narratives that these claims are over-reaching, over-universalist, and thus hubristic.

Conclusions – Dynamics of polarization – and beyond?

As far as we know, there no large-scale 'land grabs' associated with feedstocks for biochar, yet as we have shown, the spectre of 'land grab' is very much part of the policy debate that is shaping how this potential technology is being developed. In many ways the debates are similar to the biofuel debates, especially if second generation biofuel technologies which use lignin and cellulose become commercial. Indeed, biochar is set to become a competitor for biofuel. It is only likely to be a successful competitor, however, if the hypothesised benefits of biochar for farming are proven. If so, however, the spectre of biochar will add to the pressure that biofuels are placing on land resources.

In many tropical settings smallholder farming is already integrated with practices that involve the clearing and burning of vegetation. If a switch to charring can be seen to improve farmer's yields as well as sequester atmospheric carbon, then enabling farmers to cash in on the carbon sequestration that might incentivise it further presents a clear possibility for a pro-poor, pro-climate solution.

Currently, however, those arguing for biochar as a 'climate solution' are rather dismissive of the kind of indigenous practices which small farmers are likely to use, arguing that these might well liberate other greenhouse gases during pyrolysis, which more than offset the potential carbon locked in the biochar. Technological research is focused on the development of new kiln technologies to generate 'clean char'; technologies which however small scale would still require smallholder agriculture to be integrated with a biochar industry. Under such circumstances, however, the biochar feedstock would become commericalised, and the associated political economic field that shapes the capture of any carbon payments is unlikely to favour farmer. The spectre of 'land grab' and other modes of resource appropriation becomes very real.

In relation to climate change mitigation, biochar has become the subject of a range of competing narratives and counter-narratives. At the extreme, the debate has become highly polarized, with advocates and critics taking pro or anti-biochar stances to which the spectre of carbon grabs is central. Thus one broad narrative centres on the promise of large scale, commercially-viable, biochar production to sequester gigatons of carbon per year and thus contribute significantly to climate change mitigation. It is this large-scale narrative that is the main target of critics, with their counter-narratives that label this as a commercially-driven, infeasible, attempt at a technical fix that will lead to carbon-grabbing, dispossession and poverty. Biochar and its promises are therefore matters for heated debate. This is fast-moving and multi-dimensional, with narratives and counter-narratives swirling amongst and between advocates and critics, researchers and activists, governments and NGOs, businesses and farmers – and those who claim to speak for each. There is truly a politics of biochar at work – and this is, as we have argued, in many respects a politics of promise, around a substance, technology and set of ideas that have yet to make much impact on the ground.

This play of narratives and counter-narratives reveals some strong tensions, dilemmas and trade-offs around biochar. One is around spatial scale, with large scale schemes (promising globally-significant climate change impacts) pitted against small ones (promising more efficient and effective systems, and livelihood gains rather than land grabs and losses). Another is around benefits, and whether these are to accrue in commercial profits or improved small farm livelihoods. A third is around the relationship between biochar and biofuels, and whether these should be seen as complementary or, in fact, competing for land and resources, with biofuels likely to win-out in commercial terms. Narratives and potential biocharred development pathways vary in how they align themselves in relation to these tensions. Meanwhile the more polarized aspects of debate have sometimes involved instances where framings 'speak past' each other, with the spectre of biochar carbon grabs a case in point: accusations target large scale schemes, while defendants retort that (small scale) biochar developments can benefit small farmers.

Amidst such polarization, the myriad more nuanced views and lines of research in the middle can fall out of view. Yet a more qualified, mid-range set of narratives centre on the potential for small scale, diverse, locally appropriate biochar schemes using waste materials to contribute to climate change mitigation more modestly, as part of diverse portfolios of climate change mitigation and adaptation strategies, while generating livelihood benefits at the same time. A key emphasis of these more qualified positions is to portray biochar not as a universalistic silver bullet, but a valuable contributor within necessarily diverse approaches to meeting global challenges – 'an important "wedge", contributing to an overall portfolio of strategies' (Lehmann and Joseph 2009: 9). Rather than turning whole landscapes and livelihoods over to biochar, it might have value for some people and places within diverse, context-specific ways of managing environments and making a living. In this respect, an overarching biochar narrative may be emerging that emphasizes diversity and context specificity. The nascent lines of research that are exploring how biochar performs, according to different criteria and under different agro-ecological and economic conditions, are both justified by such a narrative and likely to generate findings that support it. This in turn justifies research and governance activities to explore and clarify the ecological, technical, social, financial and governance conditions for such promise to be made real. And it justifies further exploration of small farmers' existing practices upon which pro-poor biochar schemes might build.

If questions of biochar governance are only just starting to be addressed (Royal Society 2009), most notably absent from the current biochar field are social science inquiries: both studies of biochar as a phenomenon with social as well as technical meanings, and the interactive social science, with farmers, land users and project implementers, that will be needed to explore its interactions with diverse local social, as well as physical, environments. Opening up a space for such inquiry has been one of the aims of this paper. In a field where the politics of promise are running ahead of practice, there are gaps that research can help to fill, but this will need to be social as much as technical. The exploration of existing narratives around biochar such as we have attempted here is part of this social science inquiry. By clarifying current actors, arguments, assumptions and political interests, along with the emergent pathways they are shaping, we have tried to open up space to consider what narratives would help biochar to become part of pathways to sustainability that also build social justice.

A set of promises that are running ahead of practice and implementation offers the advantage that socio-technical regimes are not yet established and cemented, locked-in through investment and practice. Opportunities to destabilise more problematic narratives – such as those that threaten carbon grabs - may therefore be greater than in more practically-embedded fields of science and technology. Biochar has been deemed a disruptive technology to incumbent political-economic regimes locked into unsustainable pathways – of high carbon emission-fuelled economies and unsustainable, inorganic fertilizer-fuelled agriculture. Perhaps it is time to disrupt the disruptive, and ensure that biocharred pathways themselves do not lock-in to routes and styles that favour scale and profit at the expense of local livelihoods and landscapes.

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