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Conflict of Interest

None.

Abstract

Lay people tend to prefer natural solutions for carbon removal over technological ones. Researchers have argued that all carbon removal methods can be seen as 'natural'. Here I argue that it is also in practice necessary to see all carbon removal methods as 'technological', i.e. standardised, engineered, machine-like, enclosed systems.

Natural carbon removal method are complex socio-natural-technical messy systems that interact in complex ways with their environments. But to work well in practice as an option in climate policy – including in any emissions trading or offsetting schemes – they simultaneously *need to be* framed in much narrower terms, to be accountable (modellable, tradeable). And there will be efforts to not just frame, but physically make natural carbon removal as standardised, engineered, machine-like and enclosed as possible – though doomed to never be fully successful. It is in these senses that all carbon removal is technological.

The ambiguity between an often vague framing as natural, a narrowly technological framing and a wider socio-natural-technical framing, matters for public understanding and acceptance. Would lay publics still prefer natural solutions to carbon removal, if they are informed about the inevitable technological framing and shaping of them? Research is needed about this.

It also matters for the risk of mitigation deterrence. Previous research shows that the narrow framing, of carbon removal methods as technology is implicated in societal processes that deter efforts to reduce greenhouse gas emissions.

Graphical/Visual Abstract and Caption

Nature based solutions have to be standardised and machine-like to work, so there is a tension between seeing them as natural and as technological, which matters for both public acceptance and for the risk that natural carbon removal might deter emissions reduction efforts.

1. INTRODUCTION

There is strong and growing policy interest in removing carbon (and other greenhouse gases) from the atmosphere, in response to the climate crisis and to make climate policy targets more achievable. The public support for natural climate solutions, such as tree planting or peatland restoration, in preference to apparently more technological ways to remove CO_2 from the atmosphere, appears continuously strong (Sweet et al., 2021). But the binary distinction between ‘natural’ and ‘technological’ carbon removal (NCR and TCR) methods is ambiguous, over-simplified and misleading in several ways. Osaka et al. (2021) (see also Bellamy and Osaka, 2020) questioned the suitability of the distinction between natural, or nature-based, and other climate solutions as a basis for policy making, arguing that what counts as natural is in practice socially constructed and variable. They argued that also apparently technological climate solutions can be seen as coming from a universal nature, and that they are only made to be seem natural or unnatural (cultural, artificial, technological) through the particular ways in which they are framed. Here I will argue the complementary point that also apparently natural climate solutions, specifically natural carbon removal methods, need to be seen to be technological in practice. For NCRs to work in the context of climate policy, whether done through top-down regulation or market instruments, their use needs to be made accountable. But, in practice, accountability requires that NCRs are seen and treated as technology (standardised, engineered, machine-like, enclosed systems), in spite of their inescapably open and messy nature. Finally, I will argue that this inevitable ambiguity matters for both public support, and risks that NCRs (and TCRs) might deter emissions reduction efforts (Markusson et al., 2018).

2. UNDERSTANDING NATURAL CARBON REMOVAL AS TECHNOLOGY

So, in what sense is NCRs ’technology’? The prevalent distinction captures the fact that NCRs are not apparently machine-like, but based on biological processes. They are not enclosed systems, but rather open systems (Rayner, 2011) that interact with their environment in complex and not fully controlled ways, whereas TCRs are comparatively enclosed and their interactions with the environment more limited and controlled. But both kinds are in some sense human made. TCR machines obviously so, but NCRs are artificial too. The NCR open systems – for example tree plantations – are artificially modified and governed to fulfil human goals. Such modification, or indeed engineering, includes making the systems more uniform and standardised than nature would spontaneously behave, and so somewhat disconnected from wilder natures. In these ways NCRs can be seen to be technological – they are standardised, engineered, machine-like, enclosed systems. But, both TCRs and NCRs can be seen as complex 'socio-natural-technical' systems. To understand NCRs, the analysis needs to include not just trees, peat bogs etc., but also the people, practices, institutions etc. (Woroniecki et al., 2020) that are required to make them fulfil those human goals, to make them work to the standards set by society. For NCRs to be meaningful parts of climate policy or credible offset markets, it has to be possible to account for their effectiveness. It has to be clear what effects they are expected to produce and how to measure them. There has to be clear and preferably uncontroversial criteria for successful functioning (Sarewitz and Nelson 2008) and metrics for the amount of the effect produced. This is much easier to achieve if their function is seen to be simple and focussed on a few parameters. The NCRs – like any technology – need to be narrowly framed, to be seen to work. And there needs to be a social organisation in place that promotes this framing, defines success criteria, measures functionality etc. It is in this sense that all carbon removal, including ostensibly natural methods, are made to seem technological. And be presented to whoever pays as if they were reliable, efficient machines of carbon removal, with many side-effects forgotten about, not necessarily intentionally.

But since the biological systems of NCRs actually interact with their environments in complex ways, a lot of effort also has to go into engineering the systems. They need to be standardised and homogenised – otherwise it is very hard to measure and know their effect. And cost-effectiveness pressures – arising from policy prudence and/or market competition – means that sites are likely also to be modified for increased productivity, as measured against those few target parameters. Realising and accounting for oft-highlighted co-benefits of NCRs, that would make a virtue of complex interactions of open systems, is easier to say than do in practice. Especially when that practice is based on trading of offsets, and commodification, which thrive on narrower framings.

The open, biological systems of NCRs thus need to be engineered and simplified to work well in practice. In a sense, they have to be treated by the actors involved as if they were encapsulated, and be made to resemble such machine technologies as much as possible. In practice, NCRs have to be both *seen as* technological and modified to *be* as technological as possible.

3. THE MESSY, COMPLEX REALITY

However, the messy, complex reality of socio-natural-technical open systems does not go away, and tends to spill back into the picture (Boyd et al., 2001). There are many problems with carbon accounting in, for example, the NCR-relevant forestry and agricultural domains (Gifford, 2020; Wolf and Ghosh 2020). Data is often lacking in practice. It is hard to establish clear and uncontroversial baselines against which to assess NCRs, and to prove additionality. There is frequently uncertainty about the long-term fate of the sequestered carbon (Hodgson, 2021). And heterogeneity in the open systems is hard to root out, creating measurement problems. There is clearly plenty of scope for contestation. Wolf and Ghosh (2020) studied carbon accounting practices in the agricultural sector and diagnosed them as “provisional, potentially unstable, compromises”.

And many and partly conflicting interests are at play. Many experts and intermediaries have their careers and futures tied up with the production of regulations, standards, and markets. The income and social licence of NCR operators can be threatened. Policy makers may be sensitive to public perceptions of climate policy options like natural carbon removal, as well as to the lobbying of polluters. The fossil fuel industry and others hope that negative emissions can be seen to compensate for their pollution, and secure the legitimacy of what they do. Shell arguing that signing up to buying offsets when using its Shell Card to pay for fuel can make driving petrol-fuelled vehicles carbon neutral is a case in point.

To make matters worse, there are a wide range of possible side-effects that should ideally be accounted for. In terms of indirect impact on carbon emissions, other impacts on the physical environment, and social impacts on local people, their health and livelihoods. There is also a risk that pursuing NCRs (and TCRs) may deter emissions reduction efforts (McLaren, 2020).

In spite of problems like these, there will be temptations to optimise against very small sets of success criteria, and to underplay controversies, indeterminacies and side-effects. As this will make NCRs easier to make machine-like enough to be made viable in policy making, and/or traded as offsets (Lohmann, 2005).

4. AFFORESTATION

That the reality of NCRs is messy and complex may be clearer of we look at an example like afforestation used in offset markets. Such schemes require someone to be the identified owner or manager of the land, which presupposes institutions defining and protecting land ownership rights. The landowner must account somehow for baseline conditions and some form of carbon-related improvement, which presupposes standards of forest carbon accounting such as the Greenhouse Gas Protocol (2021), as well as independent actors monitoring and verifying those accounts. The offset market, in turn, requires rules and organisations governing the trade. Afforestation as useful, knowable carbon removal requires a lot of institutions making both people and trees behave in somewhat predictable ways.

But, there are many conceivable more or less reasonable ways to account for carbon in relation to forestry, to define forms of carbon and carbon flows, baselines and additionalities. Existing standards allow for flexibility and subjectivity (Gifford, 2020) in practice. Which is not to be surprised about; it is clearly no easy task to simplify our understanding of carbon and forests enough to be able to define the entities that can be reliably traded as tonnes of carbon removed through afforestation. And clearly no such standardised metric can reflect the full complexity of forest carbon biogeochemistry, let alone the impacts on people living in and near the forest, or the wider meanings and impacts of forests in society. “Questionable, wonky, and often blatantly dishonest carbon accounting is rampant” (Gifford 2020). There are plenty of ways in which landowners and others can play the system.

To some extent forests themselves can also be standardised. It is much harder and more work is involved in assessing the removal effect of a heterogeneous, biologically diverse site that has been allowed to re-wild, than of a homogeneous, engineered tree plantation. And once standardised, it may be tempting to optimise them to meet simplified performance criteria, for example through genetic modification (Young, 2021). But forests will remain complex socio-techno-natural open systems likely always surpassing our efforts to know and modify them reliably and safely as carbon removal machines.

5. PEAT RESTORATION

To take another example, restoration of peatlands faces some similar problems to afforestation, for example in terms of establishing baselines or longer-term permanence of the carbon storage. Carbon sequestration in peatlands is less well understood than forestry-related methods (Royal Society 2018), compounding the uncertainties involved.

In the UK, the potential for peatland restoration clashes with an established industry based on grouse hunting, which requires regular burning of ground-covering vegetation, and intensive agriculture. The peatland is also concentrated to a small number of large owners, who have considerable influence over policy (Shrubsole 2021). So again, the terrain on which to define baselines, measure permanence etc. is political. Potential risks include underestimates of the potential for carbon sequestration in particular sites to protect grouse hunting, or attempts at claiming restoration credit in spite of continuing to burn, in contrast with neat national accounting of peat restoration’s future sequestration potential.

Peat restoration has also been part of REDD+ policy and associated international payments. Goldstein (2021) studied peatland restoration projects in Indonesia under REDD+, generally involving landowners, consultants, investors and NGOs. She found little accurate carbon flow data from the relevant peatlands. Partly from the simple fact that measurement in swamps is not easy, but also because of mutually reinforcing uncertainties about the funding and the scientific basis. Uncertainty about the funding scheme led to production of more data, but that produced new insights about the complexity of the system studied, and so more scientific uncertainty, which in turn undermined the funding scheme. The political and scientific uncertainties were thus mutually reinforcing, rendering peatland restoration hard to implement in practice, despite it being framed as narrowly technological and governable in the policy.

6. SO WHAT?

All this is not to say that NCRs shouldn’t be used, but rather that an ambiguity, and its precise workings and impacts, has to be reckoned with. Bellamy and Osaka (2020) argued that the boundary between natural and unnatural is ambiguous, and that ultimately all carbon removal methods can be seen as coming from a universal nature, even the apparently technological ones. I here argue the complementary point that in practice they all *need to* be seen to be technological, even the apparently natural ones. The ambiguity between an imprecise and fluffy framing as natural in much public discourse about NCRs, a narrower technological framing in practice, and a wider socio-natural-technical framing takes precise forms that vary by method and context.

NCRs are framed both as primarily natural to lay publics to garner support, and primarily technological to establishment stakeholders to make them work in practice. This ambiguity matters for climate policy. The fact of the ambiguity raises several important questions about public support for NCRs and how that support is known that could usefully be explored through research: How well do lay people know how NCRs would work in practice, and the problems they face? How popular would NCRs be, relative to TCRs, if they knew this? Survey-based studies of public understanding and acceptance (Wolske et al., 2019; Sweet et al. 2021) are useful, but may not be the best methods to explore these questions. What would happen in a focus group setting where people get to think things through in more depth; would they still prefer NCRs?

The ambiguity is also implicated in how the risk of mitigation deterrence from carbon removal arises. Mitigation deterrence is the risk that introduction or consideration of a climate intervention, e.g. carbon removal, results in reduced or delayed climate mitigation (Markusson et al 2018). This can happen intentionally or unintentionally. Unintentional processes include rebounds, or other side-effects. Intentional mitigation deterrence comes about through reducing or delaying mitigation efforts and substituting with NETs. If NETs implementation then fails, atmospheric carbon concentrations remain unmitigated. Some such substitution seems reasonable, but substitution can also be excessive, done with mere reference to the possibility for future NETs and few checks and balances. This latter case is often referred to as moral hazard (McLaren, 2020).

As argued above, framing NCRs as technology entails a reduction in perspective from the socio-natural-technical messy, complex open systems to something more machine-like. And such narrow framing of carbon removal methods, which makes them appear easily substitutable for emissions reductions – with few side-effects, certain outcomes and with knowable overall capacity – is central to how mitigation deterrence comes about, in government or corporate climate budgeting (Markusson et al., 2018).

And, ironically perhaps, the popular framing of NCRs as vaguely ‘natural’ obscures the need to frame them as ‘technological’ in practice, and therefore the problems that arise from framing out some natural, as well as social, side-effects. How framings of CR solutions as natural or technical or socio-natural-technical shape and enhance mitigation deterrence risks, and how that varies across various forms of natural carbon removal, warrant further attention.

Figures, Video, Audio and Tables

None.

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None

Conclusion

In conclusion, I recommend that the need for a technical framing in practice of natural CR technologies should be communicated to and explored with publics, to empower them with this knowledge, and to more robustly assess their understanding and support. In addition, policy makers should take the ambiguities discussed here into account when designing climate policies, which would help alleviate risks of mitigation deterrence from NCRs. This includes when policy makers are tempted to allow NCRs in trading schemes as opposed to setting up separate support, when technical framings have made them seem too readily substitutable for mitigation reductions. Or when policy makers rely overly much on fallible NCRs, after they have been legitimised among lay publics by unproblematised framings of them as natural.

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Notes

None.

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Further Reading

See the report Greenhouse Gas Removal from 2018, published by the Royal Society and the Royal Academy of Engineering for more information about the hoped for potential of negative emissions technologies, including nature based carbon removal.