A Deep Dive into nature-based carbon removal solutions

Across oceans, peatlands, forests and ancient woodlands, our planet quietly sequesters carbon dioxide from the air. Until the eighteenth century, the carbon cycle balanced CO_2 levels in the atmosphere and supported life for over 11,700 years: a period that researchers have named the Holocene.

Temps de lecture : minute

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Enter the Industrial Revolution. Centuries of deforestation followed by the extraction and burning of finite fossil fuels caused a rapid disruption of the earth's ecosystem.

In order to hold the earth to a habitable 1.5℃ and meet the global decarbonisation goals set out by the Paris Agreement, the UN is calling for the rapid, deep, and immediate reduction of greenhouse gas emissions (GHGs), paired with an 'unavoidable' removal of between 10 to 15 gigatons of carbon every year from 2030.

To date, almost 99.9% of carbon removal has been achieved through natural CO_2 removal (CDR) on land – through the creation of new forests, regeneration of previously deforested areas, blue carbon, and more.

In this second half of a two-part series on carbon removal, read on for a deep dive into nature-based solutions (NbS), their potential for carbon sequestration, benefits to biodiversity and local communities, and the ethical challenges of commodifying nature for emerging carbon markets.

The *first half of this two-part series* explored the modern-day mythologies

surrounding carbon removal and the narratives surrounding technological carbon sequestration.

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Despite the chequered past of carbon capture and storage (CCS) and safety concerns, solutions like direct air capture (DAC) have attracted trillions in investment from investors and governments. Nature-based solutions, on the other hand, have taken a financial backseat.

According to Respira, nature-based solutions receive approximately *$133B* of global public and private funding every year (2023), with experts estimating that this needs to increase four-fold by 2050 to meet climate change, biodiversity and land degradation targets.

This lack of funding could be explained by innately long project lifecycles,

where financial returns may not be felt for years, the low availability of high-quality carbon offsets, scepticism towards the voluntary carbon market (VCM), and innate project uncertainty.

The tides may (finally!) be changing

Advances in satellite data and remote sensing technologies have put companies in a far better position to measure, monitor and report (MRV) on NbS solutions. In turn, this means that stakeholders can easily communicate the benefits in the boardroom, quantify the potential economic return, and manage what they can measure.

Furthermore, the UN – a global leader in climate discourse – has thrown its weight behind nature-based approaches as the most credible, long-term carbon removal solution. Earlier this year, *a UN panel* wrote in a scathing supporting panel note that:

> *"Engineering-based removal activities are technologically and economically unproven, especially at scale, and pose unknown environmental and social risks.*
>
> *These activities do not contribute to sustainable development, are not suitable for implementation in developing countries, and do not contribute to reducing the global mitigation costs."*

Moving against political headwinds

Decades of research provide evidence in NbS's long-term efficacy, cost-effectiveness, and local ecological and socio-economic benefits.

Crucially, experts believe that the regeneration of nature will continue to cool the planet long after the peak temperature is reached. For instance, in a 1.5℃ IPCC scenario, *a report by Nature (2021)* suggests that NbS would continue to take a total of 0.4℃ off warming by 2100.

Despite this, NbS still faces resistance and political headwinds.

In September 2023, the government delayed the introduction of the mandate to deliver 10% Biodiversity Net Gain (BNG) on all sites, contained in the 2021 Environment Act, and approved the Rosebank oil and gas field west of the Shetland islands. Both announcements were released in the same week that the State of Nature report reported that *1 in 6 species in the UK are facing extinction*.

Yet, there are some bright spots. Finance Earth launched an accelerator fund for the UK's natural capital market – *the UK Nature Impact Fund* – and the Taskforce on Nature-related Financial Disclosures (TNFD) *published its recommendations on nature-related issues* in September.

Increasingly, companies and communities are following a conviction that NbS is the right way forward, despite the political inaction; and rather than a shortage of enthusiasm, the blocker appears to often be a lack of resources.

NbS from the ground-up

NbS include everything from the restoration of soil and regeneration of landscapes such as lost woodland and peatland to carbon mineralisation, enhanced rock weathering, blue carbon, city greening, and technologies that work at the peripheries of carbon removal.

Biochar and soil

Soils store more carbon than the atmosphere and all plant life put together. When undisturbed, the soil beneath a woodland will typically be damp, earthy and carbon-dense. In temperate regions, ectomycorrhiza will form fungi networks between tree genera (groups of trees, such as pines or oaks) to redistribute the carbon, and enable the trees to act as a collective.

Sensitive regeneration of ancient or lost woodlands, protection of existing forests, and restoration of peatland can help this soil flourish and deepen its natural carbon sequestration abilities. Meanwhile, on arable land, no-till farming (conservation tilling) reduces the re-release of carbon into the atmosphere.

Some D2C brands are already integrating soil carbon sequestration into their value chain. One example is DASH Water, who have partnered with *Respira* to support *Blaston Farm* and offset unavoidable emissions with soil carbon credits.

“The really exciting thing about soil is that you can make a difference between this year and next. It’s immediate. Hylthon’s farm Blaston is one of the first farms in the country to generate the very first measured soil carbon credits in the UK,” says Jack Scott, the cofounder and CMO of *DASH Water*.

Another way to enhance soil's carbon sequestration is through biochar, a charcoal-like substance made from organic material that has been carbonised under extremely high temperatures between 300–1000°C. The Finnish company, *Carbofex*, describes biochar as "black gold" and cites its carbon sequestration potential as every kilogram of biochar binding 3.5kg of CO_2 to the soil.

Carbon mineralisation and enhanced rock weathering

In the case of Edinburgh-based startup *UNDO*, UNDO combines soil carbon sequestration with enhanced rock weathering.

Its technique involves spreading finely crushed basalt rock – one of the most abundant rocks on earth, and a byproduct from quarrying and mining – across agricultural land to accelerate the sequestration timescale from millions of years to mere decades.

Straddling both technological and nature-based carbon removal, one of the most well-funded NbS startups is *Heirloom*.

Heirloom uses limestone – another rock in high supply – to sequester carbon and store in concrete. Its technique is described as one of the world's most cost-effective Direct Air Capture (DAC) technologies in the world. Indeed, after raising $53M in Series A in March 2022, *Heirloom signed one of the largest permanent contracts with Microsoft in September 2023.*

Forestry and landscape regeneration

Over the last 10,000 years, *the world has lost a third of its forests* – an area twice the size of the United States. What's more, in 2022, the UN declared that *upwards of 40% of land worldwide is now classified as degraded*.

Startups like *Zulu Ecosystems* are working to change that. Zulu Ecosystems is working closely with land managers, NGOs and local communities across the UK and the US to co-design landscape-level regeneration projects across lost woodlands and ancient forests, as well as wetland and peatland restoration, in a way that prioritises the needs of nature, land-owners, and local communities.

A technology sitting at the periphery of forestry is being developed by a German-based startup called the *Dryad network*.

Named after the tree nymphs in Greek mythology, these modern-day dryads are wireless sensors trained to detect early signs of wildfire in forests and mitigate the increasing risk of wildfire.

Blue carbon

When entering the water – ideally, the dark, deep and salty kind – the carbon cycle begins to naturally accelerate.

The Guardian describes blue carbon as "a hidden CO_2 sink that could save the planet", yet 'Life Under Water' has been described *as the least funded initiative* of any of the UN Sustainable Development Goals (SDG). However, if the *conversations at the World Economic Forum in January 2023* are anything to go by, that might be changing.

Blue carbon techniques range from the protection, restoration, or enhancement of coastal and marine ecosystems, such as mangroves, seagrasses, and salt marshes, all the way to kelp sinking – a practice that involves growing kelp and sinking it to the bottom of the ocean. *A study by researchers at Conservation International and the University of Western Australia* found that underwater macroalgal forests absorb as much carbon as the Amazon rainforests.

Companies like *Seawood Generation* are using robotics to sink invasive

seaweed species, such as ‘Sargassum’, into the ocean; a technique that makes seaweed production sustainable and commercially viable, while preventing a potential environmental disaster should the Sargassum wash up on shores.

The seawood can then be used as a superfood, biodegradable replacement for packaging, bio-stimulant on cereal crops, and feed supplement to reduce cows’ methane emissions.

Another form of blue carbon lies in biomass. Tel Aviv-based startup *Rewind* aims to take organic material like leaves, branches, and other organic matter to the bottom of the Black Sea, where plants decompose extremely slowly in the oxygen-low anoxic water. The world’s oldest *shipwreck* shares these waters and has been preserved for over 2,400 years.

Putting a price tag on nature

Experts are divided on how to represent nature in the boardroom. Some believe that expressing nature as ‘natural capital’ ’ is the most effective way of advocating for nature in the boardroom. Others are concerned that putting a price tag against nature will further commodify the environment, and make already vulnerable communities even more susceptible to exploitation.

Others believe that the lack of standardisation and governance across the emerging voluntary carbon market could be disastrous – marking the beginning of a new ‘*carbon market gold rush’.*

Over the past few years, carbon credits from REDD+ projects have *come under scrutiny* for exaggerating the risk of deforestation to existing forests and having no positive impact on the climate. Many land-based

carbon sequestration projects have also been widely criticised for focusing solely on carbon as a success metric, rather than the long-term socio-economic and environmental benefits.

> *“Land-based carbon sequestration projects, such as tree planting, are a prominent strategy to offset carbon emissions. However, we risk reducing natural ecosystems to one metric – carbon.”*

– *Valuing the functionality of tropical ecosystems beyond carbon: Trends in Ecology & Evolution*

Indeed, if not correctly managed, landscape-level regeneration could result in land grabbing, the displacement and marginalisation of local communities, and potential compounding of economic inequality.

Against the historical backdrop, what does the future of nature-based carbon sequestration look like?

The future of natural carbon sequestration

Based on its efficacy alone, nature-based carbon removal is the world’s safest bet against climate change and biodiversity loss. Not only will NbS help meet the goals set out by the Paris Agreement, but it will also help protect a world worth living in.

There’s an urgent need to strike a balance between using nature as a resource and valuing its sacredness. Delivering NbS requires an understanding of the interconnectedness and intricacies in an ecosystem and a community’s history.

The benefits of nature-based carbon removal

When done right, the benefits of NbS extend far beyond carbon removal to improved water quality, green job creation, positive impacts on wellbeing, and the joys of nature returning to ecosystems – cuckoos returning to their native woodlands, and wild orchids reappearing in bogs where they once lay dormant. No matter which way you look at it, protecting nature and people is a win-win.

One of the biggest questions moving forwards will be how to make NbS commercially viable and equitable in the long-term. Another will be how to frame natural capital in a way that protects nature and people from further exploitation, and have this reflected in a project's design, implementation, and MRV.

At the upcoming COP28 in Dubai, the UN is set to establish a clearer definition of carbon removal, alongside proposals for stronger governance across carbon removal projects, greater standardisation across methodologies, and additional safeguarding criteria.

The conclusion will have far-reaching implications on the future investment in nature-based solutions, as well as their technological counterparts.

Summary

The task of carbon removal requires both nature-based solutions and technological innovation intertwined, with a focus on indigenous communities and long-term equity.

While there might not be a silver bullet to carbon removal, there is an odyssey in flight – and it's one that includes everything from the direct air capture (DAC) plants of Hengill to underwater seaweed towers, recovery of ancient woodlands, modern-day tree dryads, and more.

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