

What you can measure, you can manage.

How Nature Tech can help us solve
the climate and nature crises



Nature
4Climate

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Foreword

by Heather Clancy, VP, Editorial
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When it comes to sophisticated operating systems, nature trumps all. But a wave of technologies is lending Mother Earth a helping hand when it comes to meeting the climate crisis with nature-based solutions.

Take drones, which can help scale reforestation or ecosystem restoration. There's a crop of players taking flight including [DroneDeploy](#), backed with more than \$142 million, which has an active practice focused on forestry management; [DroneSeed](#), championing "rapid" reforestation; [Dendra Systems](#), focused on managing land and biodiversity restoration; and [Sentra](#), which supports agronomists with decision-making.

Or consider the wave of nature-inspired innovations that aim to address the economy's dependence on petroleum-derived chemicals. One high-profile example is [Evolved By Nature](#), which raised \$120 million in June 2022 to develop ingredients cultivated from silkworms that are replacing petrochemicals in skincare products and protective coatings for leather.

You've heard plenty, I'm sure, about artificial intelligence services sprouting to monitor and manage more precisely the carbon-sequestering services of forests,

agricultural land, wetlands and the like. One startup attracting substantial investments is [Pachama](#), which is developing more discipline around forest carbon marketplaces.

And there are countless other ventures that defy a simple label, like [Terraformation](#), which is using solar panels, desalination and native seeds to reforest desertified microsystems in places like Hawaii.

In most circles, these innovations would be categorised under the broad category of climate tech — the broader ecosystem of biotech, applied and information technologies cropping up to address climate change. Despite global economic turmoil in the first half of 2022, [investments in climate tech ventures reached \\$19 billion](#) — basically even with 2021.

I'd argue that these seedling ventures all fall into the budding category of "Nature Tech," technologies that either mimic the Earth's ecosystems or that are focused explicitly on accelerating nature's natural ability to regenerate. Considering an estimated \$44 trillion of economic value — that's more than half of the world's GDP — relies on nature, investing in Nature Tech is a sound proposition both financially and for the sake of the planet.

Introduction

How to use this document

The purpose of this document is to explain what Nature Tech is and give an overview of its utility in helping us solve the climate and nature crises. We hope to raise interest, inspire action, and ultimately stimulate investment in the sector, as well as highlight the potential pitfalls and how they might be avoided. If you find it useful, please share this paper widely in your network and consider advocating for the guardrails that will be important in scaling these technologies.

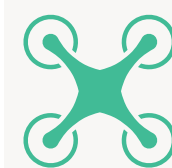
Our human attraction to the new and shiny is universal, perking up the reward system of our brains and initiating our sense of adventure. Technology and technological advances fall squarely into new and shiny. It's no wonder there's a pervasive feeling that "technology will save us" from climate change, especially as it has accelerated such incredible advances over the past few decades.

But will it? Certainly, great strides have been made in clean- and climate- tech, and humankind hopes that work on, for example, direct air capture and storage will be successful at scale. There are huge opportunities for us to use technology for good in many sectors,

and it follows that the application of technology to nature-based solutions (see box below) could be transformational in terms of reaching our global climate and nature targets.

But as ever with tech, we need to mitigate any risks involved when it is not applied for the greater good, ensuring its integrity as it scales. Tech alone won't save us, and of course there is no nature tech without nature. Importantly, we need to realise that our obsession with new and shiny can make tech feel like the end, rather than the means to an end – which in this case is our collective global goal to stabilise the climate and help nature thrive.

What is Nature Tech?



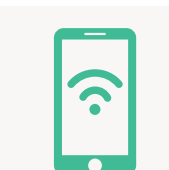
Deployment



MRV



Transparency



Connection

'Nature Tech' describes technologies that can accelerate the implementation of nature-based solutions (NBS) at scale, split into four categories: deployment; monitoring, reporting and verifying (MRV); transparency; and connection.

Drone technology for reforestation or genetic modification for fast growing trees in improved forest management are examples of Nature Tech being used to **deploy** NBS. Technologies such as satellite monitoring, LiDAR, open source

solutions and eDNA testing hold great potential for improving the resolution and reducing the cost of **MRV**, driving greater accountability in NBS. The use of blockchain for carbon transactions and registries could improve **transparency**, trust and efficiency in the voluntary carbon market. Finally, mobile apps can **connect** local communities to sources of information, other people and higher-paying markets for their products, helping to drive the sustainable use of natural ecosystems.

Nature-based solutions for climate

The science is clear: we cannot achieve the Paris Agreement's global climate goals without harnessing the power of nature-based solutions for both climate mitigation and adaptation. We need nature-based solutions to provide at least one third of the mitigation required by 2030 in order to keep our global climate goals in reach.¹ Investing in nature will provide other valuable benefits and resiliency, such as the protection of ecosystems and biodiversity, increased resilience to climate impacts, provision of clean air and water, restoration of degraded lands and importantly, support for sustainable livelihoods. Any discussions about nature must include the local communities whose lives depend on the ecosystems they live in and in many cases protect.

Nature-based solutions (NBS) constitute a range of actions to protect, sustainably manage and restore natural ecosystems to address social, economic and environmental challenges, and provide human and biodiversity benefits. For the purposes of this paper, we are primarily addressing nature-based solutions for climate, and primarily mitigation strategies. However, we have included some adaptation strategies as well as non-climate metrics for nature because the twin crises of nature loss and climate change are so intertwined, and restoring nature is critical to reaching our global goals.

Of course, while technology and its application to these twin crises is the subject of this paper, the scale of the challenge requires a much broader approach and even within just nature-based solutions there are other important applications such as policy, education, capacity-building, community empowerment, and regulation.

¹ <https://www.pnas.org/doi/10.1073/pnas.1710465114>



Why does Nature Tech matter?



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Nature underpins human prosperity and wellbeing by providing economic value and security, supporting human development and equality, and increasing our resilience to climate change. \$44 trillion of economic value generation – over half the world's total GDP – is moderately or highly dependent on nature and its services and, as a result, exposed to risks from nature loss.²

In order to scale NBS, we need Nature Tech alongside other efforts to help us overcome some of its particular challenges. It's hard to demonstrate and monitor the **effectiveness** of NBS such as biodiversity, carbon stocks, climate adaptation and social justice. NBS require a combination of labour, finance, knowledge and

skills. They are challenging to **finance** due to, for example, a lack of clear definitions, the number of indicators, different types of cash flows, taking a longer time to value, having unclear business models, and an uncoordinated capital stack. There are **knowledge and skills gaps** right across the value chain, which is currently underdeveloped in many areas. Current monitoring systems are not capable of measuring the dynamic state of natural ecosystems, and even infrequent measurements are costly and time consuming to obtain.

It's therefore crucial that we keep fostering innovation and finding new ways for technology to support nature. Tech can help with the acceleration, data integration,

augmentation (getting us more information or insights), auditing or accounting (building trust and holding people accountable) and communication of NBS.

Those new and shiny things such as fancy drones or easy-to-use apps that enable local tree-growers to access carbon markets will help activate NBS and move us along the right path, but to really incentivise and scale it, the major role for tech is actually a little less shiny – it's harvesting and making the best use of data for deployment and MRV of NBS, and giving people confidence in how nature can help us deliver on our climate targets. This in large part can be classified as the “measurement” of NBS.

How does Nature Tech help with measurement?

It's widely accepted that we need to get to net zero and nature positive³ at high speed and global scale⁴. If we can measure those myriad benefits nature provides to us effectively, we can then value and manage it like we do other elements of the economy. This is where technology can help.

To date, carbon sequestration and storage is the ecosystem service for which we have the best data that we have been able to measure and track at reasonable precision and scale. By measuring the ability of natural environments to absorb and store carbon, we have a way to value this vital service in the form of carbon credits representing the amount of carbon stored by a forest, for example. These credits can be bought by companies,

governments and individuals wanting to counterbalance their own non-abatable emissions along their pathway to net zero or invest in beyond value chain mitigation. This in turn channels crucial funding into these nature-based solutions that can help us reach our global climate goals. It is crucial that we value rather than commodify nature, and any system should guard against the latter.

Due to limitations in measurement, carbon has often been used as a proxy for the host of biodiversity, ecosystem and community co-benefits that come with, for example, a carbon-dense tropical forest. This is because the actions that deliver measurable climate mitigation, done well, usually also deliver a host of other benefits. These include things

like water quality and increased biodiversity. The metrics for these more complex features of natural systems are either much harder to measure or still being developed, but if we want to integrate nature into global financial models and systems, then we have to be able to measure and monitor what we have, what we're losing, and what we're gaining frequently and at specific locations. An excellent analogy is COVID-19 - when it began, we had no data at all but now we have widespread data collected, synthesised and shared, and it's informing policy and funding decisions in powerful ways. We need the same approach for nature loss and its restoration. This allows us to set meaningful goals and targets, and to hold to account those who don't meet them.



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³ Nature positive is a world where nature – species and ecosystems - is being restored and is regenerating rather than declining

⁴ <https://www.ipcc.ch/report/ar6/wg2/>

² <https://www.weforum.org/press/2020/01/half-of-world-s-gdp-moderately-or-highly-dependent-on-nature-says-new-report/>



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Nature is extremely complex, but modern data science is capable, within the parameters of human knowledge, of dealing with this kind of complexity to give simple, accurate scores and metrics. It can also help with prioritisation - optimising and maximising outcomes of NBS within a finite landscape. We need to start seeing nature as a classic 'big data' problem; we have

billions of living things reacting to lots of different variables in every place – and we need to bring 'big data analytics' to help understand what is happening.

To date, we haven't been able to unlock this 'big data' approach, but we do have exciting tools and technologies that can get us there like bio-acoustics, e-DNA, remote

sensing and monitoring. However, it's critical to understand the relevance, precision, accuracy and feasibility of these tools to effectively evaluate their utility in decision-making, as well as how much data is necessary to take action - and to recognise how, for these technologies to be trustworthy and scalable, transparency and open sharing of data is critical.

Why is transparency and sharing data so crucial?

Transparency for Nature Tech is key - both for the companies themselves and the processes that are put in place. This is partly because of a historic lack of trust in nature-based solutions for climate, but also because the climate and nature crises are huge global problems that requires a coordinated response from multiple stakeholders, many of whom have little or no experience of working together and typically come from very different backgrounds.

Academic science provides established models for collecting and analysing data, with processes such as peer-reviewed publications helping to ensure rigour and transparency. However, historically, the timelines for academic science typically move too slowly to provide solutions for the crisis we face and funding can be inconsistent. Tech, often for-profit tech, can help but it needs to work with science rather than bypassing it.

Enterprise-level solutions of the sort required for the systems change demanded at the current time are not going to be able to be delivered solely by academics or NGOs because of a lack of funding, speed, scalability and resources. Technology companies on the other hand can move fast to develop solutions that are built with the end-user front-of-mind, and they can access other types of funding and investment. But we do need ways of ensuring the solutions delivered for nature are scientifically sound, and that they can be accessed and employed by those who need them in sectors where cost can be a barrier.

The data collected through the measurement of nature needs to be collated and accessed across multiple geographies, languages, landscapes and ecosystem types. Globally, we need to use the same or at least comparable metrics and to a certain extent, transparent workings for how the metrics have been collected and results arrived at.

For corporates and tech companies working in competitive environments, this can be difficult – proprietary data, methodologies, and models are all key to business success. Also, while many of these companies employ scientists to collect and analyse the data they collect (generally known as research and development or R&D), those in-house scientists are not usually publishing their results and therefore it is less easily open to external scrutiny. Tech companies in particular usually come from a culture of "black boxes" which by definition

lack transparency. There are ways to manage this and guardrails that can be put in place to safeguard the growth of these technologies.

Of course while open data is critical to understanding the big picture, not all elements have to be free or with full access for all. As the business and finance world engage with nature and biodiversity it's important to remember that they expect to pay for good quality data and analytics and the income that can be derived from this is vital for long-term upkeep and continued development of solutions. While radical transparency is mostly a good thing, it can have a negative result when used by malevolent actors. Did you know burglars use Google Earth to plan their burglaries? In the same way illegal loggers are using remote sensing data on carbon stocks to find the most valuable part of the forest.



How can Nature Tech help to build trust?

Along with transparency comes trust. Technology will not stop climate change or nature loss, but it can help people trust that investing in a nature-based carbon credit really is reducing or removing material amounts of CO₂ from the atmosphere, or that we have really increased biodiversity in an area by a required amount.

This is well demonstrated by the issue of every project's additionality -as

only reductions in emissions achieved by projects must be "above business as usual" to warrant payments. Using data to better understand the carbon history allows us to work in synergy with the dynamic nature of forests and their carbon storage. With better nature tech, the amount of storage above the project's business as usual baseline can be dynamically monitored, reducing variance and using data to manage risks, similar to managing commodities that

risk deteriorating in transit or in warehouses like corn or wheat but can still be traded on financial markets.

Increased processing power, better algorithms, machine learning and widely available data, make it possible for nature-based carbon projects to be monitored and credited at greater scale. This will increase confidence in the robustness of nature-based solutions.

How can Nature Tech help reduce cost and increase accuracy?

Expanding on the carbon project example, measuring the amount of carbon in ecosystems has historically been a time-intensive and costly process, with the need for teams of people in many locations armed with tape measures or soil sampling kits. While the need for boots-on-the ground will always be important – ground-truthing is essential for modelling the biomass of trees, for example – machine learning combined with remote sensing data

can reduce the costs and increase scalability and validity of NBS – crucial for reaching mid-century climate targets.

Cost is often pitched against accuracy in monitoring, reporting and verifying carbon projects, and it's true that tools such as remote sensing may never be as accurate as direct measurement on the ground. But there are biases, inaccuracies,

and obscurities in both the traditional and new "higher tech" methods of MRV which must be weighed up with the need for cost-effective solutions at scale. For example, human data gathering teams on the ground can never be completely consistent in performance quality, and machine-learning algorithms can, when used inappropriately, generate spurious results that don't match reality.



© Sarah Waiswa/The Nature Conservancy



How is Nature Tech beneficial to local communities?

There is of course a human aspect to Nature Tech. More than 1.6 billion people worldwide rely on forests for their livelihoods⁵. The people who live and work in natural ecosystems are vital to the success or failure of NBS. Indigenous people and local communities are often involved in the implementation of NBS, providing tree measurements through an app, scanning crops using their phones, planting mangroves assisted by satellite data, or protecting forests from migrant farmers or illegal miners using drones, for example.

However, it's crucial to the success of NBS that those people who have to make their living using local resources or depend on ecosystem

resources for subsistence or fuel are integrally involved in the set up and implementations of projects. By having better information and data on agroforestry systems, commodity pricing, or routes to higher-priced markets for crabs harvested from mangrove areas for example, communities can increase income, productivity and quality of life. More and better data also enables communities to engage with their local and national policymakers on important issues.

To be effective and utilised Nature Tech needs to be democratically accessible not only to traditional large-scale commodity markets, but to smallholders and communities too, accompanied by education,

peer-to-peer learning and technical assistance. Where relevant, local communities should have sovereignty over the use of data and information about them or their territories. Equity in how information is generated and collected is important in ensuring poor and marginalised communities are able to access markets and are not left behind. Many of the most vulnerable people in these ecosystems don't necessarily have access to basic technology. Nature Tech is no replacement for meaningful stakeholder engagement and travelling out to local communities to engage with people - in their language - and to understand their needs.

How can Nature Tech help to channel capital into nature-based solutions?

Valuing nature has the potential to help local communities and Indigenous Peoples because it values the service they provide in protecting and restoring local ecosystems. Nearly 50% of the earth's terrestrial biodiversity is found in areas under the stewardship of Indigenous peoples⁶, and recent reports show us that recognising Indigenous land rights leads to lower deforestation rates, higher biodiversity conservation and higher carbon storage⁷. By ensuring that communities are intricately involved in the set up and running of nature-based solutions, we can also ensure they are financially compensated for their contribution to our global goals.

On the other side, it's crucial to get disclosure on nature impacts into company reports and financial systems, so that they can channel money into the nature-based solutions that help to counterbalance their actions elsewhere. This is important alongside substantial and science-based actions to reduce their direct impact on climate and nature. The finance sector has traditionally worked on risk and return but now we have a third dimension – the impact we're having on generating those returns. Until you can measure it, you can't solve it.

Technology enables communication and collaboration between multiple stakeholders who inhabit very different worlds. Indigenous communities and global financial institutions are parts of the same solution but share no common language and operate at very different levels. Tech can connect

local communities via mobile apps on the ground, for example, and blockchain solutions can maintain traceability and transparency of information and finance flows. This enables small communities to tap into globally significant streams of funding and to deliver real outcomes on the ground.



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⁵ <https://news.un.org/en/story/2021/11/1104642>

⁶ <https://www.worldwildlife.org/stories/recognizing-indigenous-peoples-land-interests-is-critical-for-people-and-nature>

⁷ <https://ipbes.net/news/Media-Release-Global-Assessment>

What safeguards do we need to put in place?

As AI, machine learning and other advances in tech and computing power continue to improve our lives and help us solve global challenges, it's worth keeping an eye on how these technologies can harm us and our environments, putting up guardrails to ensure we get the best from technology and its myriad applications.

Transparency and data sharing are hard for profit-based businesses to achieve in any sector. But customers, clients, investors and consumers want to know what type of companies they are dealing with, and increasingly only want to engage with companies contributing to the public good. Funding for non-profit organisations that store public data could be secured through allowing other entities to pay to access certain aspects of the data.

There are a number of initiatives that produce guidance for companies on how to contribute and benchmark

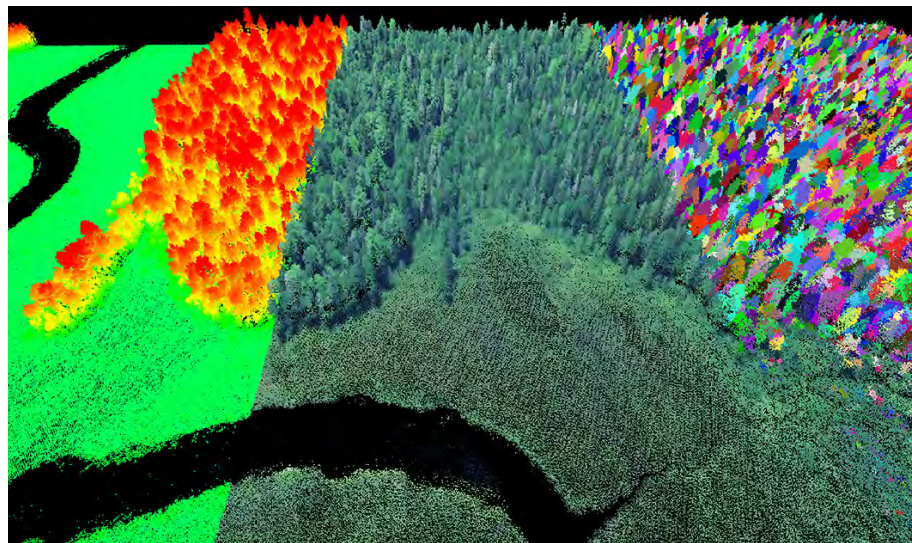
their contribution to global goals, such as the Voluntary Carbon Market Integrity (VCMI) Initiative for the voluntary carbon market, the Science Based Targets Network (SBTN) for nature impacts and the Taskforce on Nature-Related Financial Disclosures (TNFD). If these initiatives were to include a standard for data sharing, data access and data transparency, then companies could easily be judged on and rewarded for how they measure up. Giving data back could provide proof that a company is transformative and sustainable.

One way to encourage transparency by both for-profit companies of all types and non-profit organisations is pre-competitive collaboration, where data and learnings are shared, perhaps even with a non-profit who can coordinate the integration of the data. Another way is having test-beds run by an independent organisation – somewhere tech companies could show that their workings provide a

standardised result, for example for measuring biomass in a forest. This is not dissimilar to the local-authority run testing they do in Bologna of the golden tagliatelle – no need to give away the recipe, but the width must be 7mm uncooked and 8mm cooked. Or similarly, with machine learning the data isn't shared but they could work with local field scientists to check 'piloting'. Finally, if speed has been chosen over accuracy for a particular reason, then this needs to be reflected in the data analysis and explained in the models.

Standards are important and govern most areas of private sector activity. Setting standards for new technology without obstructing innovation is always challenging but engaging innovative nature tech companies in the development of the standards will help navigate this. There are ISO certifications for all sorts of business processes, they even have a guidance document for reaching net zero. Perhaps if there was an ISO certification for some of the processes involved in nature restoration and protection that sit alongside the standards that currently exist and track to SDGs, we would see further standardisation and efficiencies.

Forward-thinking companies of all sectors have been moving from being opportunistic, to compliant, to transparent and finally accountable. There is a recognition that they will be judged by their customer base and shareholders for not contributing to the greater good and by including these guardrails, we can help this judgement take place fairly and accurately.



© Satellite-based or airborne remote sensing data such as optical imagery, lidar and radar, when used together can provide a 3D structure of a landscape. (Visualisation from Pachama)

How can Nature Tech help us with both the nature and climate crises?

Nature Tech can help to address the interrelated challenges of climate change and nature loss, supporting global climate, nature and sustainability goals. Given the point we are at in both these crises, we need all the innovation, speed and scalability of technology that we

can throw at it, working alongside science and with the appropriate guardrails in place.

In the same way that our brains have evolved to get a dopamine kick from the 'new and shiny', we are also hard-wired to feel good when we are

in and around nature. Here's hoping that the combination of both of those tendencies – inherent in Nature Tech – can contribute towards bringing us back on a path towards a stable and nature-abundant planet.



Infographic: Nature Tech map



Nature4Climate is a communications and advocacy platform,
working on behalf of a group of like-minded civil society groups
to promote the role of nature as a climate solution.

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