



The state of nature tech.

Building confidence in a growing market



Nature
4Climate



MRV Collective

MRV Collective is a nonprofit community, intelligence unit, and corporate venture studio on a mission to fast track the adoption of nature tech solutions.

The core members of MRV Collective represent the world's leading nature tech solution providers, nature-focused academics, and mission-aligned NGOs. With a new anchor membership tier to be introduced in 2024, we welcome leaders in the corporate and nature finance community to join our effort, leveraging our bespoke research and matchmaking services to achieve their nature-related goals.

MRV Collective exists to close the nature finance gap.



Serena

Serena is one of Europe's leading venture capital funds, with \$750m under management.

Founded in 2008, Serena finances and supports innovative startups from pre-seed to Series B, with initial checks ranging from \$500k to \$15m. Born of the profound conviction that a venture capital fund should be at the service of its portfolio companies, Serena has set up the largest operational support team in Europe.

Serena has a strong focus on AI, SaaS, Climate Tech and Impact, with several successful portfolio companies such as Dataiku, Electra, Descartes Underwriting, Accenta and Lifem. Protecting biodiversity, combating climate change and promoting sustainable investments are part of the fund's DNA.



Nature4Climate

Nature4Climate (N4C) works to catalyse partnerships between governments, civil society, businesses and investors based on the urgency to protect, restore and fund nature-based solutions to climate change. With 22 member organisations today, N4C champions the deployment of nature-based solutions by raising awareness, campaigning for increased investment, and by creating a broad coalition of partners. N4C's work has helped nature-based solutions go mainstream, leading to action from governments, companies, civil society groups and local communities – and a doubling of public expenditure into this critical area.

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Glossary

Biodiversity credits (bio credits)	A measurable unit of biodiversity and net-positive biodiversity gains that is traded to fund biodiversity conservation.
Blue economy	An economic system or sector that seeks to conserve marine and freshwater environments while using them in a sustainable way to develop economic growth and produce resources such as energy and food.
D-MRV	Digital monitoring, reporting and verification.
FPIC	Free, prior and informed consent. FPIC is a collective human right of IPs and LCs aligned with their universal right to self-determination, which allows them to give or withhold/ withdraw consent, at any point, regarding projects impacting their territories.
IPs and LCs	Indigenous peoples and local communities.
MRV	Monitoring, reporting and verification (MRV) refers to the multi-step process of measuring climate, biodiversity and social impacts resulting from an activity towards achieving environmental, sustainability, and regenerative outcomes.
Nature-based carbon markets	Markets that trade carbon credits generated through the conservation, restoration or sustainable management of a natural ecosystem.
Nature-based solutions (NbS)	Nature-based solutions involve working with nature to address global challenges, providing benefits for both human well-being and biodiversity.
Nature positive	The nature-positive movement is underpinned by naturepositive.org – which complements the global net-zero target – that aims to halt and reverse nature loss (measured from a baseline of 2020) through increasing the health, abundance, diversity and resilience of species, populations and ecosystems, so that by 2030 nature is visibly and measurably on the path of recovery. According to the global goal, by 2050 nature must recover so that thriving ecosystems and nature-based solutions continue to support future generations, the diversity of life, as well as playing a critical role in halting runaway climate change.
Nature tech	A broad set of technologies that can accelerate and scale the implementation of high-quality nature-based solutions (NbS).
Net zero	The IPCC provides a clear definition of global net zero: net-zero emissions are reached when anthropogenic (i.e., human-caused) emissions of greenhouse gases (GHG) to the atmosphere are balanced by anthropogenic removals over a specified period.
REDD+	Reduced Emissions from Deforestation and Forest Degradation. A mechanism for reducing emissions that has additional benefits to biodiversity and local communities.
Spatial finance	The application of geospatial technologies (i.e. remote sensing) to support financial decision making.
Web3	A new iteration of the World Wide Web that is decentralised and uses blockchain technology, cryptocurrencies and NFTs.
VCM	Voluntary Carbon Market. The generation, issuance and buying and selling of carbon credits outside of regulated or compliance markets.

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Examples provided in this report are based on publicly available information on early stage start-ups. Some of the information may vary.

Executive summary

Nature tech's role in accelerating high-quality nature-based solutions

This report considers the current status of the emerging nature tech sector and its future development as a vital tool in supporting nature-based solutions (NbS). NbS are actions that aim to protect, restore and sustainably manage natural and semi-natural ecosystems.

While it is a field that is constantly and rapidly evolving, we define nature tech as a broad set of technologies that can accelerate and scale the implementation of high-quality NbS.

Nature tech is supporting the development of NbS in a vast number of ways – including through the development and implementation of tools and techniques in projects and on the ground, by automating processes and by providing the accurate and reliable data needed to develop the market further. Innovation, market research and the application of nature tech is generating high levels of investor interest and inspiring confidence in the market, making nature-based solutions an increasingly attractive investment option.

Signs of growing maturity in the nature tech market

There has been significant growth in climate tech start-ups, with venture capital (VC) investments having risen sharply over the past decade, and now valued at more than \$40 billion.

To date, nature tech has often been considered a vertical sub-sector

within the climate tech VC market. However, nature tech extends beyond climate tech and can be considered an investment category of its own, albeit nascent. While climate tech focuses primarily on reducing greenhouse gas emissions and mitigating the impacts of climate change, nature tech is more comprehensive, addressing a wider range of environmental challenges, including habitat destruction, deforestation, soil degradation, water pollution and species loss.

The potential for further growth, particularly in opportunities where investment extends beyond climate to tackle other environmental challenges is huge. New products, new companies, new ideas and new markets will emerge and pose a disruptive challenge to incumbents, offering the prospect of positive change in building a decarbonised and nature-positive global economy.

In the last five years, from 2018 to 2022, the accumulated amount of VC investments in nature tech startups amounted to \$7.5 billion. The US market attracted 78% of VC funding between 2018 and 2022, totalling \$5.80 billion. Annual VC investments in nature tech startups increased from \$1 billion in 2018 to \$1.5 billion in 2022, with a peak in 2021 of \$2.39 billion. While the overall VC market declined sharply between 2021 and 2022 (-50% according to Crunchbase), nature tech funding was relatively less affected and fell by just 35%.

There are also several positive signs of the growing maturity of the nature tech industry. For example, early stage investments in nature tech startups increased by +130% in value between

2020 and 2022, from \$0.46 billion in 2020 to \$0.77 billion in 2021 and \$1.06 billion in 2022.

The 'Food and Agriculture' category, which includes regenerative agriculture, biofertilizers, soil health monitoring and sustainable pest and livestock management, has been receiving the largest share of the VC funding in nature tech. The sector attracted \$5.31 billion in VC funding between 2018 and 2022; the equivalent of 71% of the total accumulated over the last 5 years. This is unsurprising as this category is more mature in terms of VC attractiveness.

The next biggest category by total amount invested is 'MRV (monitoring, reporting and verifying) and biodiversity credits' with a total of \$1.23 billion in the last five years. This category has experienced strong momentum, growing from \$120 million in 2018 to \$306 million in 2022 (+155% in five years).

Nature tech market shaped by shift towards nature positive goals

This shift towards nature-positive activity is being reinforced by regulatory developments and the emergence of voluntary frameworks which put nature at the heart of corporate decision-making and disclosure. These include the development of robust science-based targets, and the recommendations of the Taskforce on Nature-related Financial Disclosures (TNFD), which has established a framework for organisations to assess their dependencies, impact, risks and

opportunities relating to nature. For financial institutions and corporations, the drive towards more rigorous analysis of nature-related impacts, and the consistent disclosure of these in a way that is decision-useful for stakeholders, poses a significant challenge. But it also represents a major opportunity for providers of diagnostic, analytical and data-rich tools and techniques.

While these market and regulatory developments put nature firmly at the heart of future corporate and investor interest, many challenges remain in enhancing the desirability of nature tech as an investment sector. These include credibility issues when high expectations for projects are not met, a lack of transparency in the reporting of impact and outcomes, and exaggerated expectations of the power of technology to transform landscapes and livelihoods.

One of the most significant challenges, however, is moving the myriad opportunities to the sufficient scale required, and finding the customers who are willing to invest in and pay for technology solutions to their challenges. Much of this report focuses on the challenges of moving emerging solutions to a much greater scale where their full environmental, social and financial benefits can be realised.

Safeguards are essential in design and application of nature tech

In pursuing the wide range of opportunities in the nature tech market, there is also a need to ensure adequate safeguards are put in place to manage risks and to ensure that environmental and social benefits are spread widely and fairly. This includes incorporating safeguards in the manufacture and

design of nature tech itself, as well as ensuring transparency in the design use and delivery of tech solutions, particularly those that are heavily reliant on data.

Safeguards are required to ensure that all communities are considered and protected, including Indigenous peoples and local communities (IPs and LCs). IPs and LCs play a particularly important role in protecting terrestrial biodiversity, and technology developers and investors need to be mindful of this role when developing technological solutions. This engagement forms part of a broader need to make technology both accessible and affordable, so that it can serve broader community and social goals.

Frameworks are already in place, and are being further developed to support the emergence of high-integrity markets which are governed by clear rules and good practices which instil confidence among market participants, and in the data that underpins market effectiveness.

Advances in digital MRV will drive transparency and data integrity

The field of 'monitoring, reporting and verification' (MRV) is of fundamental importance, as robust MRV provides project developers, investors and financial institutions with confidence that impacts have been properly and rigorously considered. Effective MRV is a vital component of flourishing carbon markets and future biodiversity markets. The development of digital MRV is just one interesting trend which will help to spread recognition of the value and importance of affordable, fast and reliable solutions for monitoring, reporting and verification.

The focus on MRV highlights the criticality of transparency in unlocking future finance for nature. Technology can support automated carbon credit production, deliver accurate data for credit calculations, support certification, and enable ground-level investment through decentralisation and standardisation.

Potential for nature tech to connect communities and accelerate regional innovation

Worldwide, nature tech not only offers the possibility of protecting and enhancing our natural environment, but also has the potential to connect people within and across communities. This is not just in on-the-ground projects, or by connecting landowners, farmers, and smallholders – important though that is. It has potential in much wider contexts such as building public awareness of natural biodiversity and of the importance of conservation, using technology, such as gaming which can mobilise high levels of general public buy-in and education.

Innovation is occurring across the world, tailored to local and regional challenges. This report highlights the diversity and breadth of the initiatives that are underway in the Global South, in Africa, Latin America, Asia, North America, and Europe. It also highlights dozens of examples and case studies of innovations, products and concepts that have been and continue to be developed by emerging companies, eager to contribute to addressing nature loss.



Section 1: Nature tech numbers and insights

1.1 Nature tech and nature-based solutions (NbS)

What is nature tech?

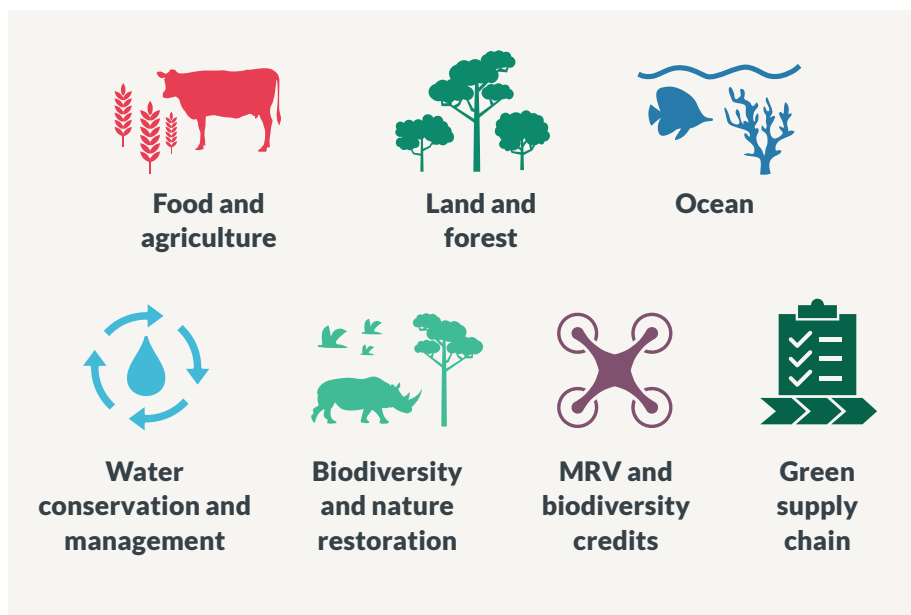
This report defines nature tech as a **broad set of technologies that can accelerate and scale the implementation of high-quality nature-based solutions (NbS).**

Our [first report](#) on this sector characterised nature tech as technology that:

- **Deploys** NbS, such as drone technology for reforestation.
- **Monitors, reports and verifies** (MRV) NbS, such as satellite monitoring.
- Improves **transparency** around NbS, such as blockchain for carbon transactions.
- **Connects** people and projects involved in NbS, such as mobile apps and platforms to connect local communities to higher-paying markets for their products.

However, the definition of nature tech is evolving. The term now addresses an increasing range of environmental challenges including habitat destruction, deforestation, soil degradation, water pollution and species loss. In this report, therefore, we include technologies that support the implementation, acceleration and growth of NbS so that these solutions can deliver the most effective action for nature, climate and people. They include the following areas:

Food and agriculture: regenerative agriculture, precision farming, nutrient management and biofertilizers, soil health monitoring,



integrated pest management, sustainable livestock management, plant biotechnology.

Land and forest: agroforestry, sustainable forest management, precision forestry, bio-geoengineering.

Ocean: sustainable blue economy (fisheries, aquaculture), algae production.

Water conservation and management: smart irrigation systems, wastewater treatment, and water purification technologies.

Biodiversity and nature restoration: protection, restoration and re-wilding of wildlife, forests, grasslands, peatlands, oceans, coastal zones – mangroves, wetlands, seagrasses, coral reefs.

MRV and biodiversity credits: biodiversity data collection and monitoring, digital MRV for carbon and biodiversity, biodiversity credit exchange, digital platforms for onboarding and scaling supply.

Green supply chain: supply chain traceability, land titling management, impact measurement.

The ability of those involved in nature tech to value and report on nature loss or recovery will improve in coming years, providing increasingly bankable benefits for those who protect, restore, and manage natural systems, ecosystems and landscapes.

Nature tech could be even more broadly defined simply as technology that is ‘good’ for nature. This would include all the above, as well as clean tech such as renewable energy generation, which has significant benefits for nature, as well as new generations of capex intensive food system production – through protein enzyme and closed-system farming. We have not included these elements in this report but may do in future iterations, as impacts on nature begin to be measured in more detail.

Why are nature-based solutions important?

Nature is fundamental to our very existence and underpins our global economy. NbS are actions **that aim to protect, restore and sustainably manage natural and semi-natural ecosystems**. NbS can help protect critical biomes such as the Amazon, regenerate mangroves and coral reefs, restore urban green spaces and improve agricultural practices that diversify crops. They can provide long-term positive benefits that flow from healthy ecosystems by providing climate change mitigation, disaster risk reduction, increased climate resilience, food and water security, improved health outcomes and support for local sustainable livelihoods.

We are losing nature at an alarming rate, which is exacerbating and exacerbated by the climate crisis. To meet global biodiversity and climate goals we must invest in activities that protect and restore nature. NbS are essential in supporting the global nature goals that have been developed to halt biodiversity loss, enhance biodiversity and ecosystem functions and services, ecological integrity and connectivity. NbS can provide up to a third of the climate mitigation required by 2030 in order to keep our global climate goals within reach¹.

To meet our climate and nature goals we need to rapidly scale NbS. There are currently four main barriers to scaling:

1. Governments, the private sector and civil society have focused on addressing climate change over the biodiversity crisis, often with a preference for technological solutions. The critical role that NbS play in addressing the dual crises of biodiversity loss and climate change is not yet widely understood. Governments and corporations often favour gray infrastructure to address climate impacts rather than relying on nature to both mitigate climate change and enhance resilience to climate impacts.
2. Limited penetration of generalisable tools (including but not limited to technology solutions) means that implementing NbS remains labour-intensive and bespoke, increasing project complexity and therefore reducing speed of deployment.
3. A lack of trust in NbS due to the complexity of measuring and then evidencing outcomes. A lack of standardised procedures for measuring biodiversity impacts and project outcomes adds to the confusion brought about by knowledge gaps and leads to mistrust.
4. Consequently, there is a financing gap given government and company preference for engineered solutions, and challenges which are i) implementing projects at scale; and ii) evidencing their benefits.

Nature tech is supporting the scaling of NbS by automating processes and providing accurate and reliable data. In addition, nature tech is generating excitement and inspiring confidence in the market, making NbS an investable solution. While tech promises game-changing solutions, we need to be mindful of the unintended risks of tech, develop appropriate safeguards, and include essential stakeholders such as Indigenous peoples and local communities (IPs and LCs) in the deployment of nature tech.

Nearly **50% of the earth's terrestrial** biodiversity is found in areas under the stewardship of Indigenous peoples², with **studies** showing that Indigenous people are some of the most effective stewards of nature. For example, in the Amazon basin, **Indigenous territories account for 28% of the region but only 2.6% of its deforestation**³. Collaboration with IPs and LCs is therefore vital when discussing and implementing NbS, and the technology supporting NbS. We cannot attempt to grow NbS without prioritising the participation of IPs and LCs and ensuring safeguards are in place to protect their rights and ensure equitable benefit sharing. Nature tech is responding to this need and is evolving to uphold procedures such as Free Prior Informed Consent (FPIC) and IP and LC rights, connecting communities and ensuring accessibility.

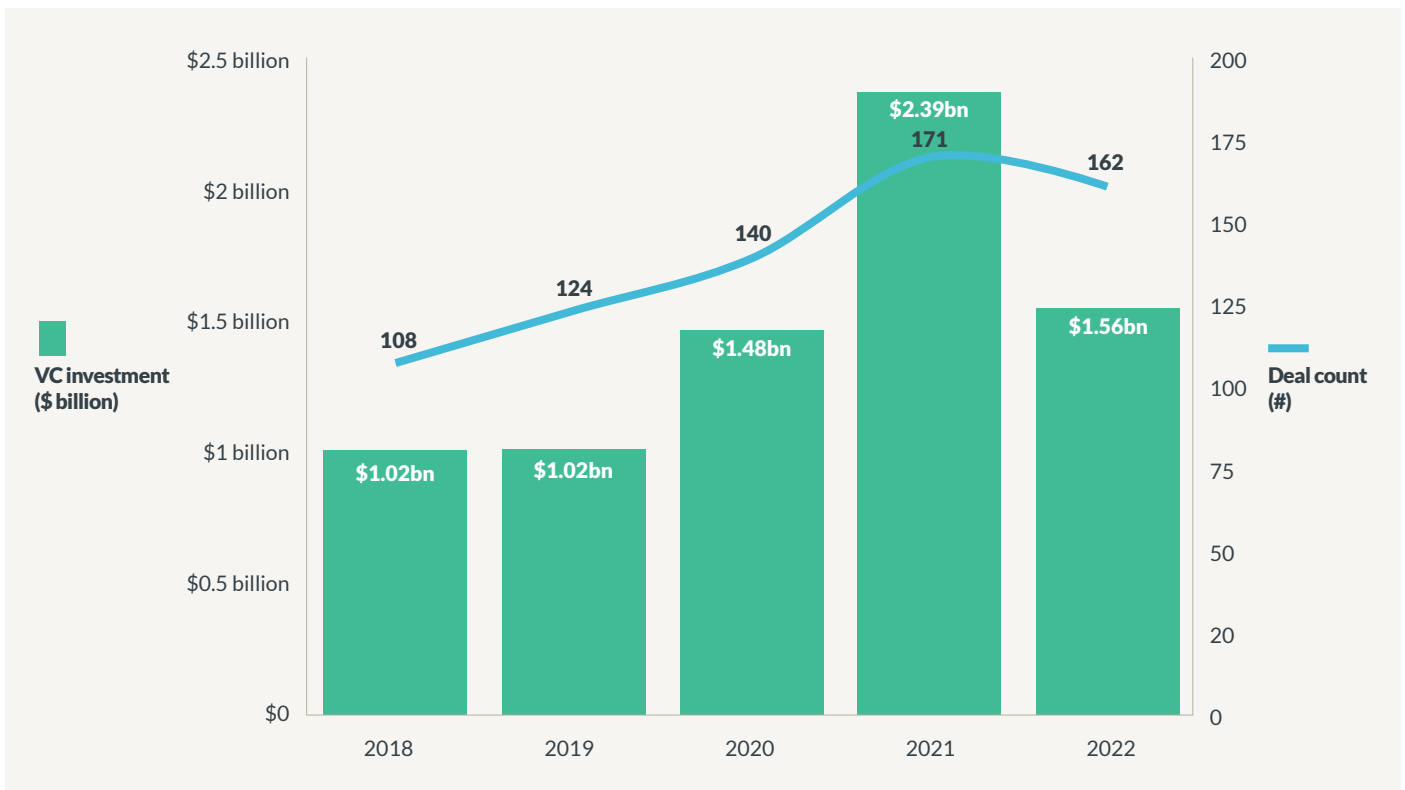
1.2 Venture capital investment in nature tech – signs of growing maturity

Interest in nature tech has surged in recent years, in parallel with an increased awareness of the critical role nature plays in addressing the climate crisis and the need for the global economy to become nature

positive. **An analysis of VC financing for nature tech start-ups estimates that investment in the sector has grown to \$1.5 billion in 2022 from \$1 billion in 2018, with a peak in 2021 of \$2.39 billion.** The fall

in investment between 2021 and 2022 of 35% is a reflection of the downturn experienced by the wider venture capital (VC) market which declined sharply in this period (-50% according to [Crunchbase](#)).

Figure 1. Growth of VC funding in \$ and deal count



Source: Crunchbase and Serena

Venture capital funding in nature tech start-ups

Global climate finance flows averaged \$803 billion per year in 2019-2020⁴. The focus on climate tech start-ups has increased in recent years. VC investments in climate tech have risen sharply over the last decade, reaching more than \$40 billion.

To date, nature tech has often been considered a vertical sub-sector within the climate tech VC market. However, nature tech extends beyond climate tech and can be considered an investment category of its own, albeit nascent. While climate tech focuses primarily on reducing greenhouse gas emissions and mitigating the impacts of climate change, nature tech is more comprehensive, addressing a wider range of environmental challenges, including habitat destruction, deforestation, soil degradation, water pollution and species loss. The same applies to natural capital versus the climate capital stack.

“Nature tech alone will not solve by itself the biodiversity crisis just as climate tech will not solve the climate crisis, but it can be a strong enabler, notably in allowing to better quantify, qualify and report the positive and negative impacts of human activities on natural ecosystems. At Serena, we are convinced that nature tech is the new frontier and will rapidly grow and reach the same level of maturity and scale as climate tech, which has grown from \$413 million in VC investments in 2013 to more than \$41 billion in 2022.

New global actors (in energy, transportation, food, retail etc.) will emerge in a decarbonised and nature-positive economy; they will rely on climate and nature technologies to

disrupt the legacy players, like Tesla disrupting the legacy car manufacturers (the market cap of Tesla is worth hundreds of billions). This is the reason why we call it a massive disruption. And this disruption will be triggered by entrepreneurs who understand they can positively change the world and build global decarbonised and nature-positive businesses. This is where VC money can help.”

Xavier Lorphelin, Managing Partner, Serena.

Analysis conducted by Serena (see appendix A for methodology; source: Crunchbase) reveals that in 2021, VC funding in nature tech start-ups amounted to \$2.39 billion, corresponding to 171 deals, higher than the \$1.56 billion invested in 2022 corresponding to 162 deals. By comparison, climate tech funding amounted to \$41 billion in 2022. For the purposes of this analysis, nature tech start-ups have been classified into the following seven categories:



Food and agriculture: regenerative agriculture, precision farming, nutrient management and biofertilizers, soil health monitoring, integrated pest management, sustainable livestock management, plant biotechnology.



Land and forest: agroforestry, sustainable forest management, precision forestry, bio-geo-engineering.



Ocean: sustainable blue economy (fisheries, aquaculture), algae production.



Water conservation and management: smart irrigation systems, wastewater treatment, water purification technologies.



Biodiversity and nature restoration: protection and restoration of wildlife, forests, grasslands, peatlands, oceans, coastal zones (mangroves, wetlands, seagrasses, coral reefs).



MRV and biodiversity credits: biodiversity data collection and monitoring, digital MRV for carbon and biodiversity, biodiversity credit exchange.



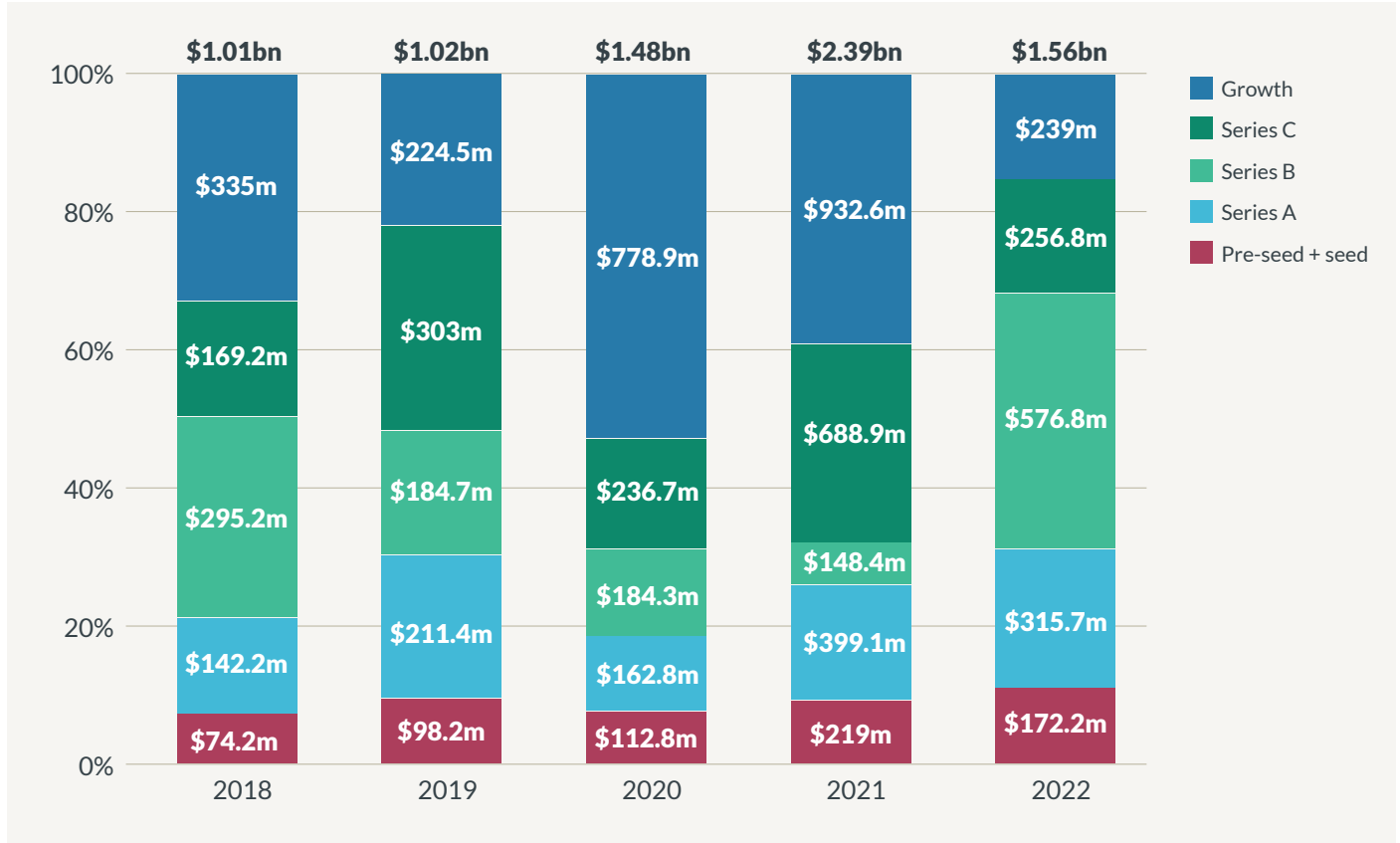
Green supply chain: supply chain traceability, land titling management.

While the overall VC market declined sharply between 2021 and 2022, nature tech funding was relatively less affected and fell by just 35%.

Most of this decrease is related to 'late-stage' deals (series C and beyond) which dropped in value from \$1.62 billion in 2021 to \$0.50 billion

in 2022. Late-stage deals totalled 68% of nature tech VC funding in 2021, but only 32% in 2022.

Figure 2. Investment per funding stage



Source: Crunchbase and Serena

The positive trend of early-stage funding

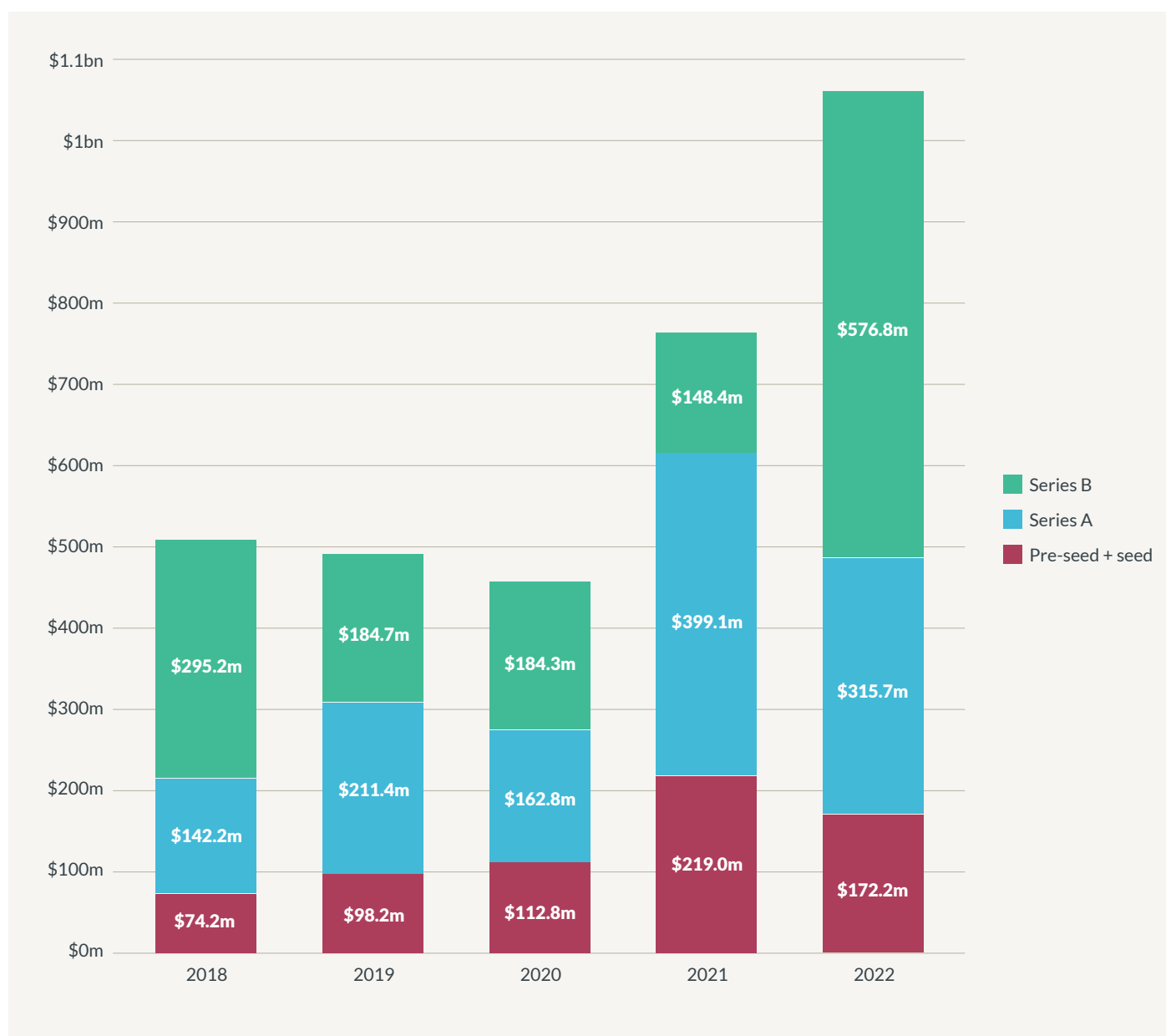
Funding data shows positive signs of the growing maturity of the nature tech industry. Looking at early-stage deals, pre-seed to series B, we see a 38% increase in value from \$0.46 billion in 2020 to \$0.77 billion in

2021 and a further increase to \$1.06 billion in 2022. The overall increase in value is 130% between 2020 and 2022.

The average size of seed, series A and series B rounds has also increased significantly between 2020 and 2022, respectively by:

- 70% (from \$1.52 million to \$2.59 million for seed rounds),
- 63% (from \$6.26 million to \$10.18 million for series A) and
- 71% (from \$15.36 million to \$26.22 million for series B).

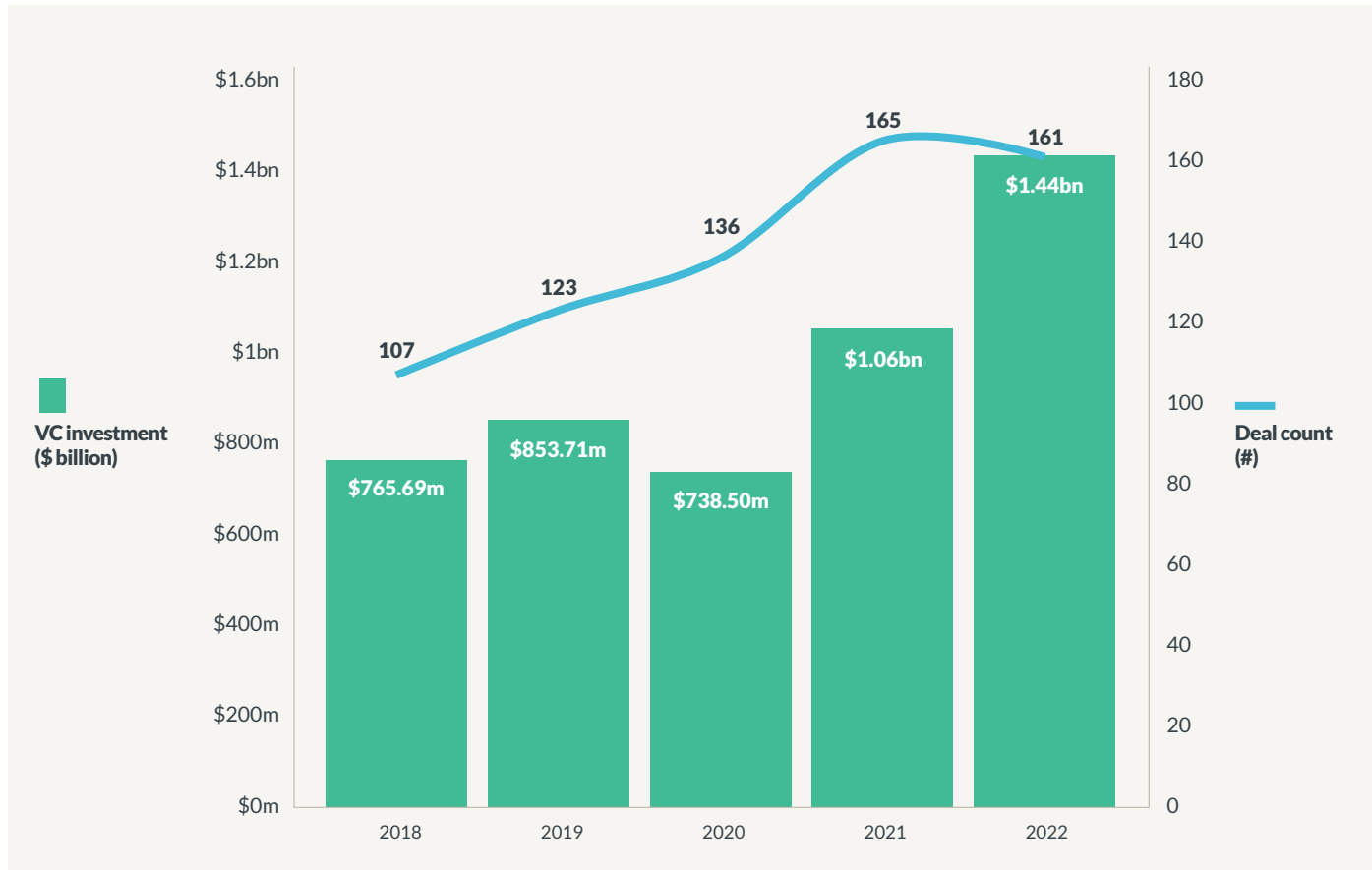
Figure 3. Evolution of pre-seed to series B deals



Source: Crunchbase and Serena

A similar conclusion can be drawn when considering deals with transaction amounts below \$100 million.

Figure 4. Evolution of deals below 100m

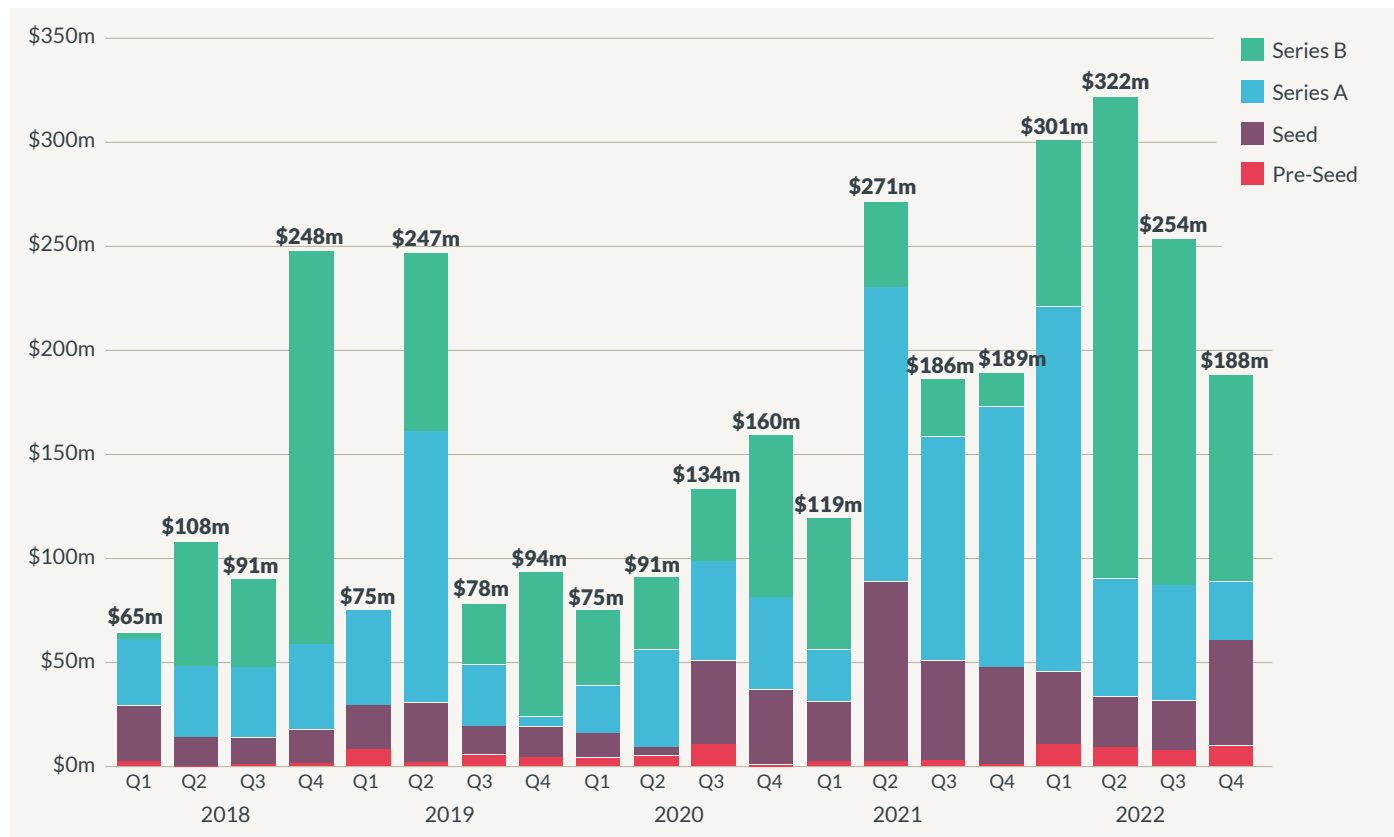


Source: Crunchbase and Serena

The 38% growth of early-stage funding from 2021 to 2022 is encouraging. However, a more detailed quarterly analysis shows that this growth has slowed over the course of 2022, likely due to the overall downturn in the VC market.

A comparison of the first half of 2021 with the first half of 2022 shows there was a significant 60% increase from \$390 million to \$623 million, compared with an 18% increase between the second half of 2021 and 2022, \$375 million and \$442 million respectively.

Figure 5. Quarterly breakdown for early stage deals

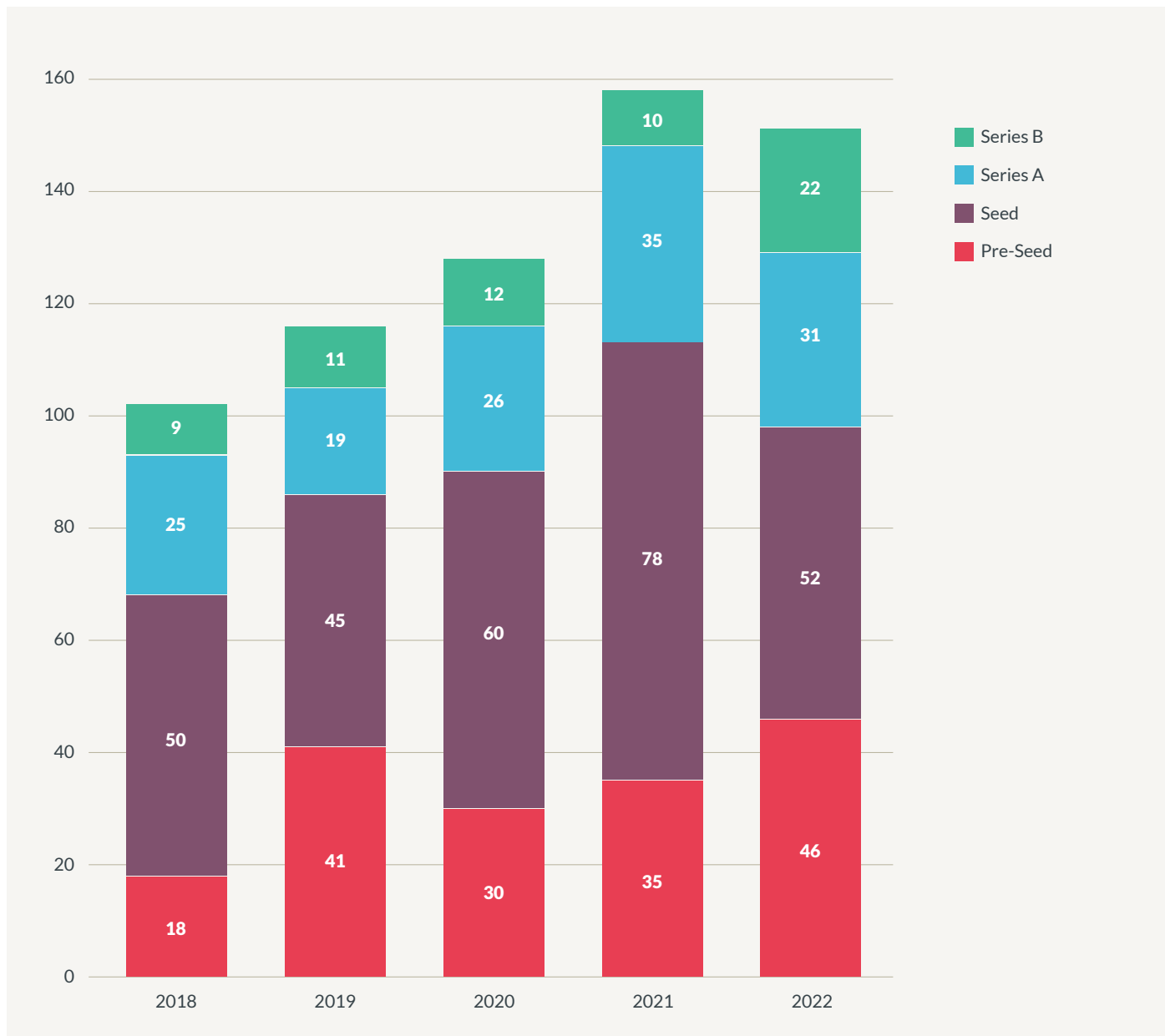


Source: Crunchbase and Serena

Further evidence of a maturing market can be seen when examining the seed/pre-seed to series A/B penetration ratio over the five years from 2018 to 2022. While the combined number of pre-seed and

seed deals has increased a moderate 44%, from 68 deals in 2018 to 98 deals in 2022, the combined total of series A and B deals has risen by 56% from 34 deals to 53 deals.

Figure 6. Deal count pre-seed to series B



Source: Crunchbase and Serena

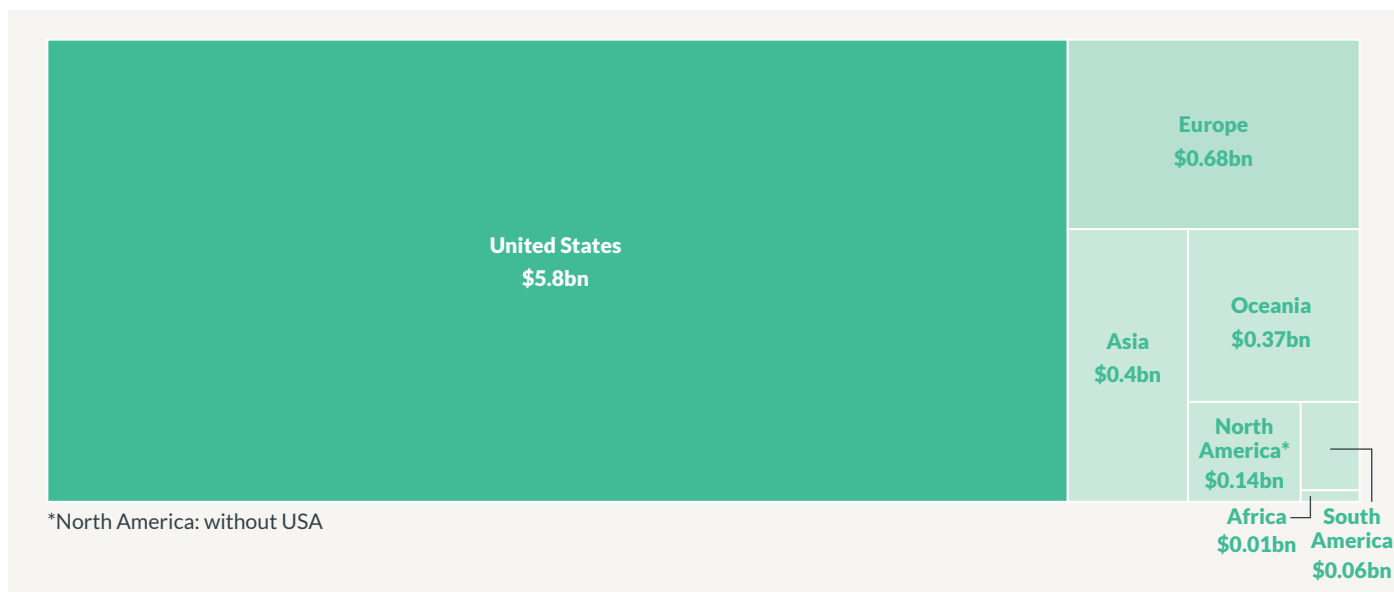
Regional investment

The US market attracted 78% of total VC funding in nature tech between 2018 and 2022, totalling

\$5.80 billion. This originated from just 303 deals, some 43% of the total number of deals. This is likely because the share of the US VC market in nature tech is above what

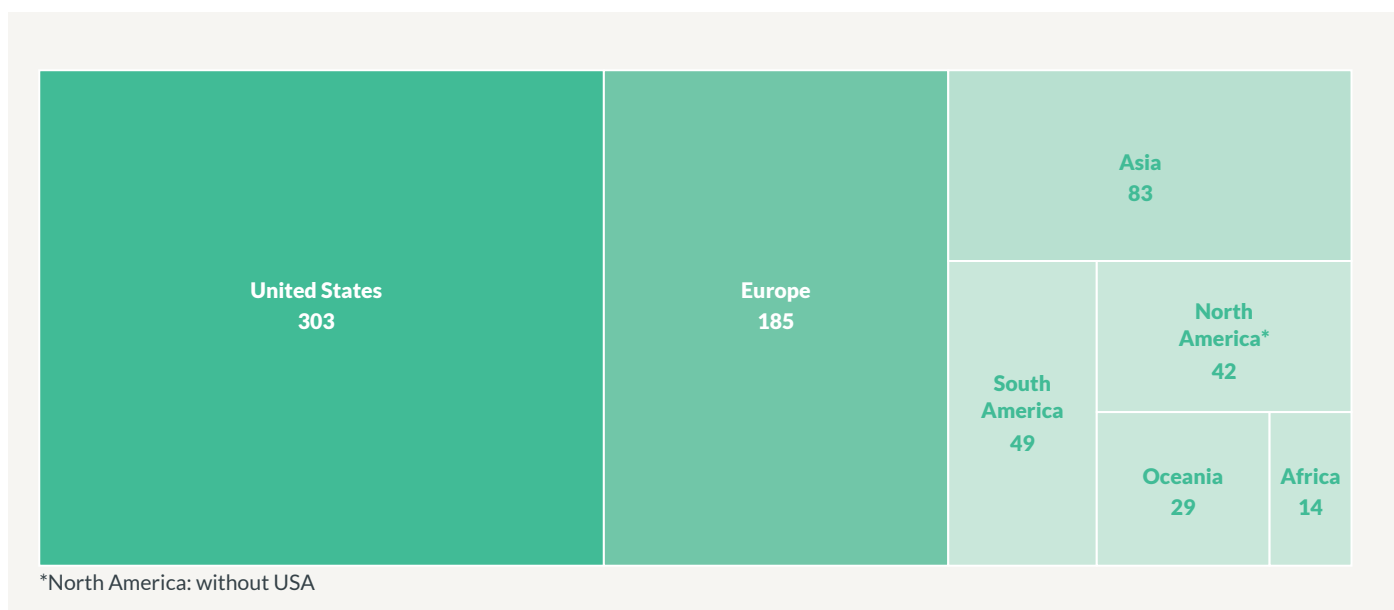
we see in the global VC asset class, which is not surprising since the US VC market tends to be ahead of other markets in terms of new technologies.

Figure 7. Funding per geographical region



Source: Crunchbase and Serena

Figure 8. Number of deals per geographical region



Source: Crunchbase and Serena

When looking at early stage deals from pre-seed to series B, there is a more balanced distribution between geographical regions.

Figure 9. Funding per geographical region pre-seed to series B



Source: Crunchbase and Serena

Which categories of start-ups are attracting VC investment?

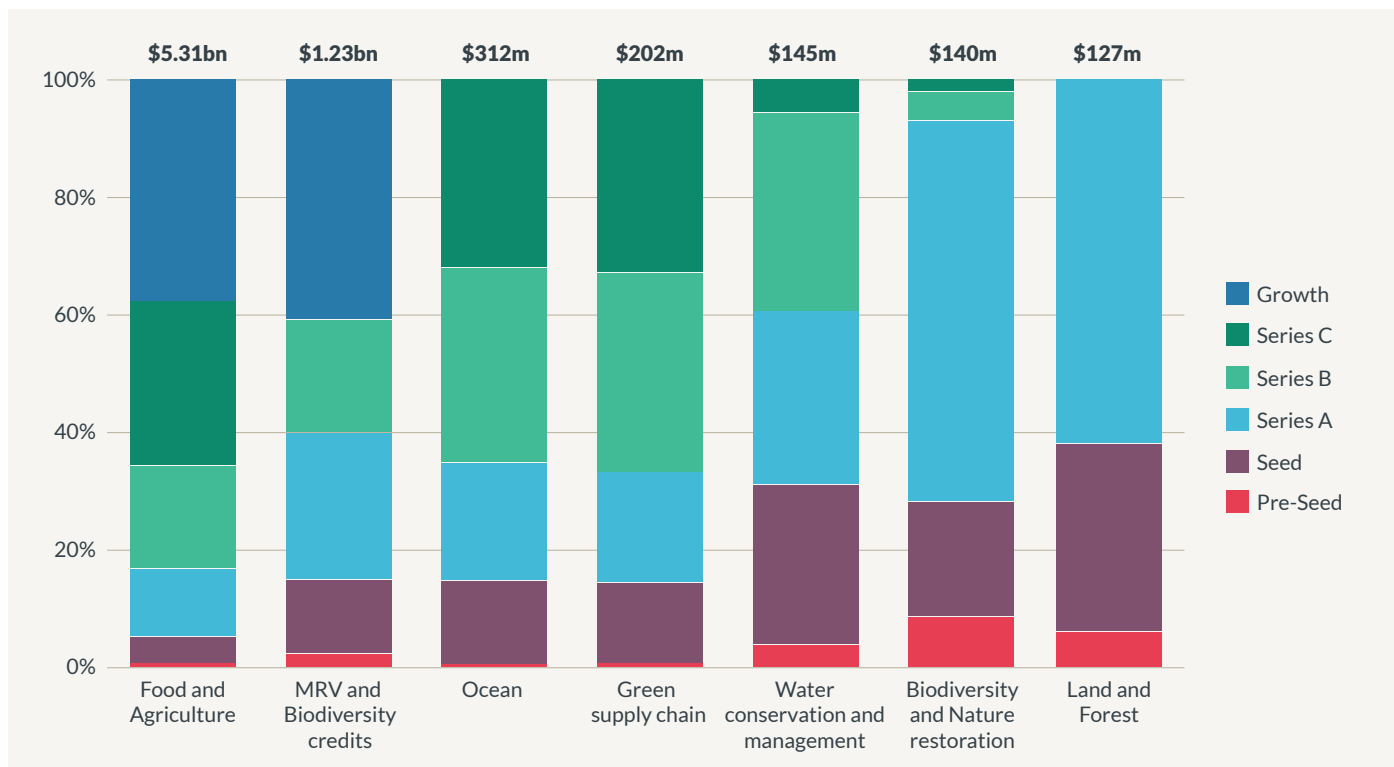
Currently ‘Food and agriculture’ is receiving the largest share of VC funding in nature tech. The sector attracted 71% of the total VC funding in nature tech between 2018 and 2022, a total of \$5.31 billion. While in 2022 alone the sector attracted 63% of all VC funding in nature tech. This is unsurprising as this category is more mature in terms of VC attractiveness.

Agrifood systems are responsible for almost one-third of global GHG emissions, and are increasingly vulnerable to climate change, threatening food security and price stability. A small fraction (4%) of global climate finance is directed towards agrifood systems, suggesting there are significant opportunities for the private sector to increase its financing of this sector⁵.

While a total of \$11.9 billion per year in 2019/20 was invested in project-level finance for agriculture, climate finance for agriculture remains far below the estimated needs of \$30-218 billion per year⁶.

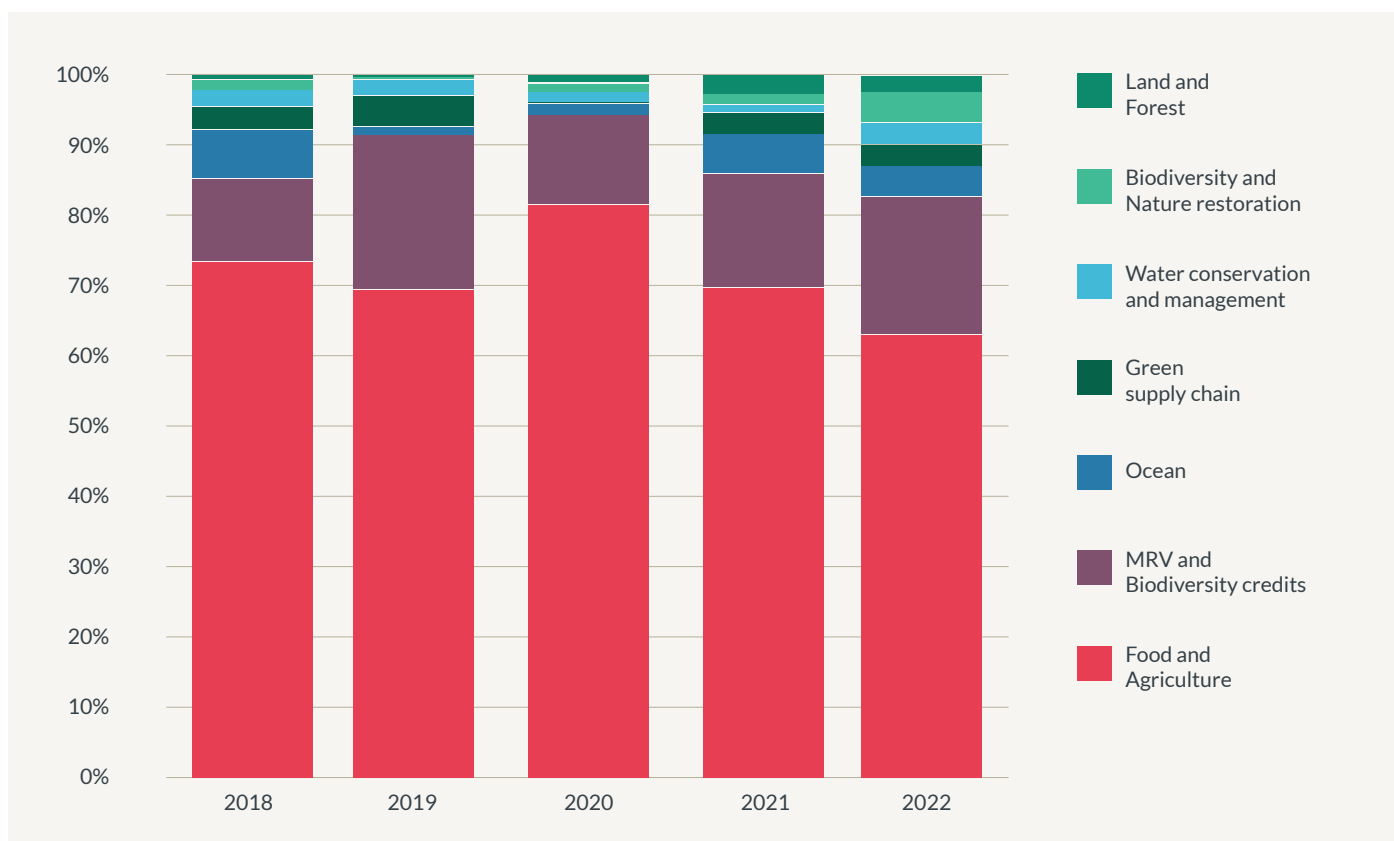
The remaining 29% of investment is split between ‘MRV and biodiversity credits’ with a total of \$1.23 billion in five years and ‘Ocean’ with \$0.31 billion over five years. ‘Water conservation and management’, ‘Biodiversity and nature restoration’ and ‘Land and forest’ remain in earlier stages of development, with no deals above series C.

Figure 10. Funding per category



Source: Crunchbase and Serena

Figure 11. Split per category



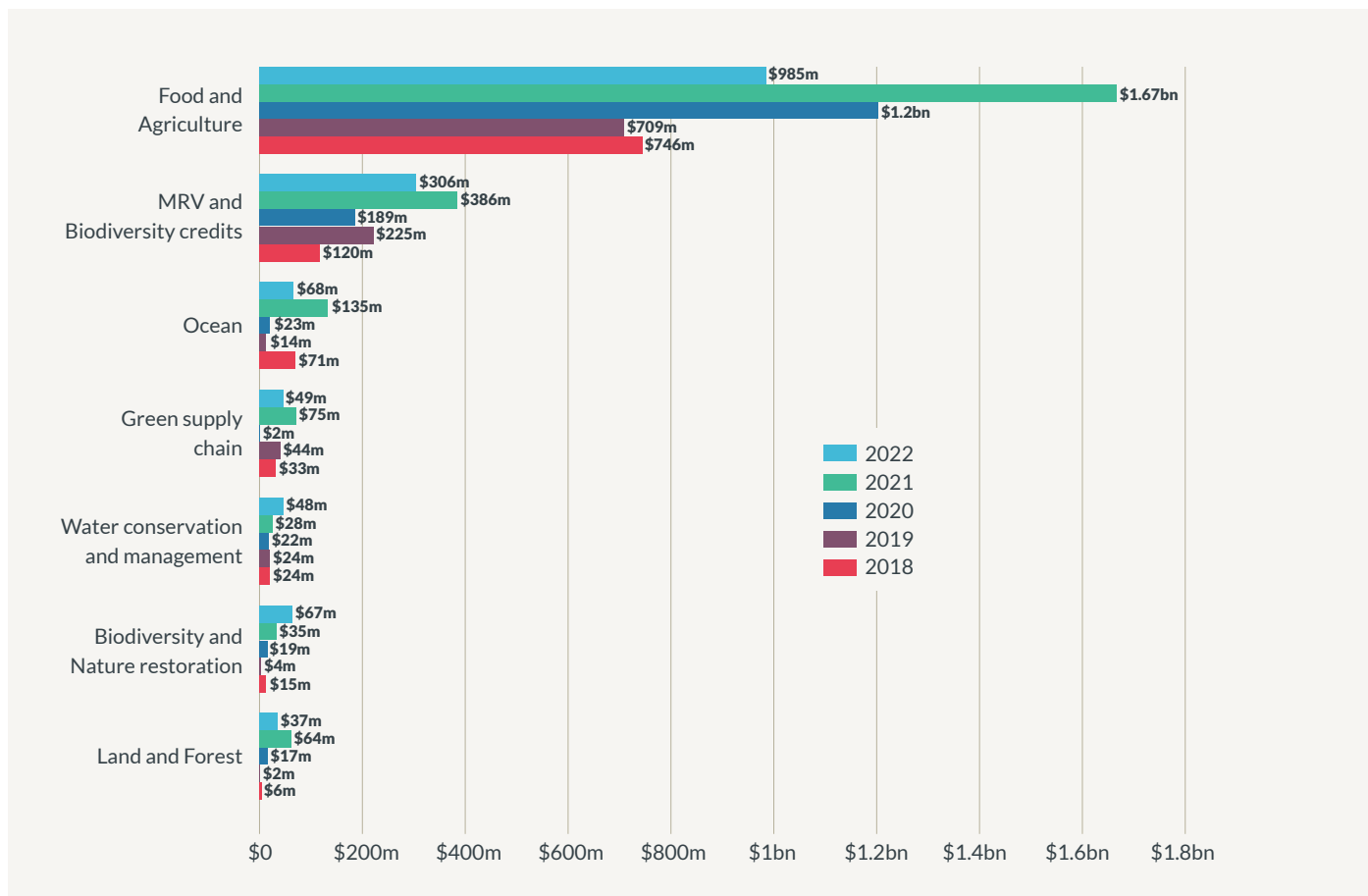
Source: Crunchbase and Serena

The evolution of yearly VC funding for each category and over the five-year period (2018-2022)

demonstrates that the most mature category 'Food and agriculture' experienced the biggest drop in VC

funding between 2021 and 2022, from \$1.67 billion to \$0.99 billion.

Figure 12. Yearly funding per category



Source: Crunchbase and Serena

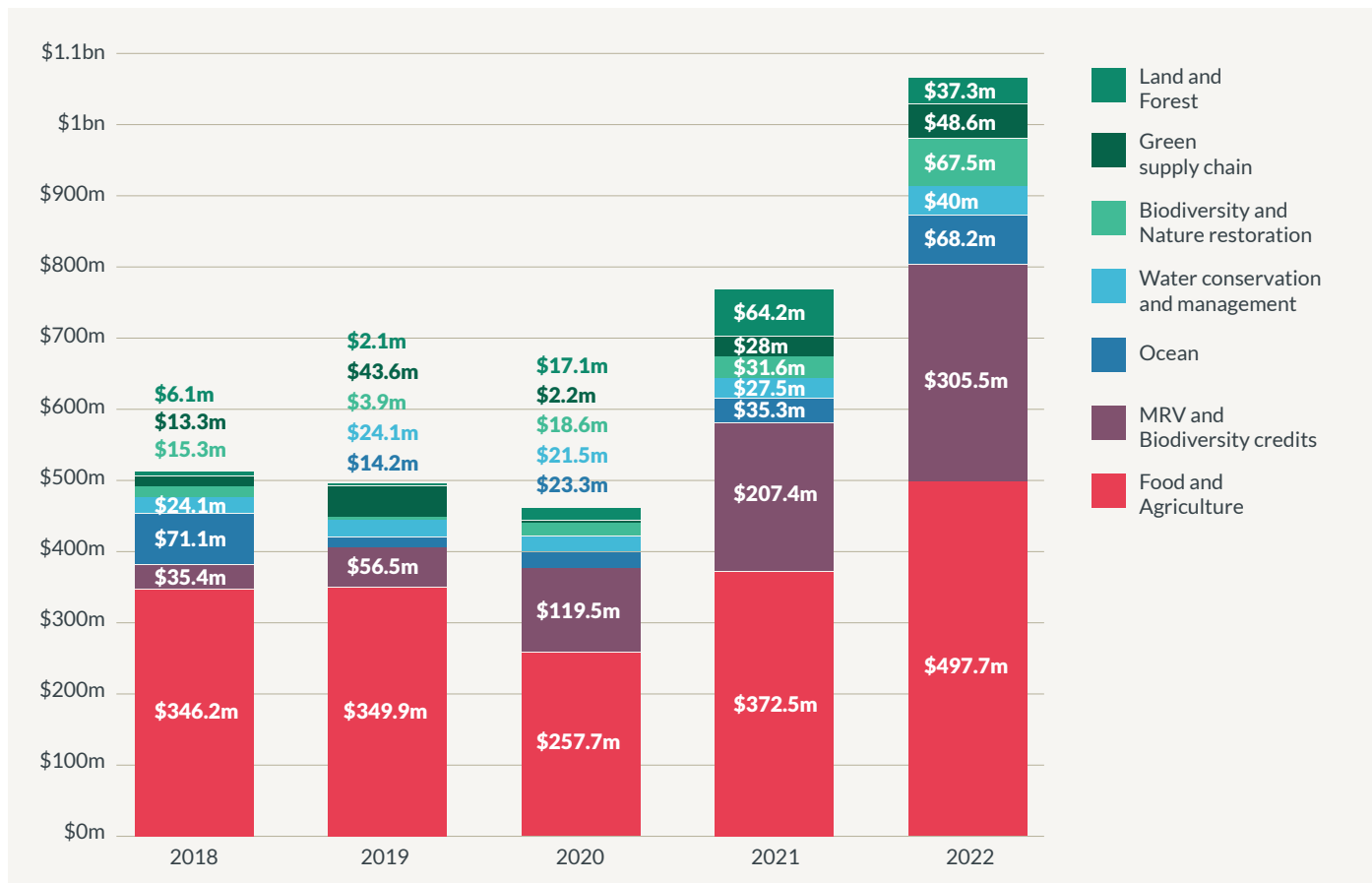
When considering early-stage deals, it is worth noting that all categories except 'Land and forest' have benefitted from the growth of early-stage VC funding from pre-seed to series B between 2021 and 2022. This is a clear indication that the nature tech industry is evolving in a positive, broad-based direction.

An analysis of early-stage fundraising between 2018 and 2022 shows that the three fastest growing categories are (i) 'MRV and biodiversity credits', (ii) 'Land and forest', and (iii) 'Biodiversity and nature restoration'.

1. MRV and biodiversity credits: +763%
2. Land and forest: +511%
3. Biodiversity and nature restoration: +341%
4. Green supply chain: +268%
5. Water conservation and management: +67%
6. Food and agriculture: +44%
7. Ocean: -4%

Of the seven categories, only 'MRV and biodiversity credits' has seen its early-stage fundraising amount increase year after year over the past five years: from \$53.4 million in 2018, to \$56.5 million in 2019, \$119.5 million in 2020, \$207.4 million in 2021, and \$305.5 million in 2022.

Figure 13. Funding per category pre-seed to series B



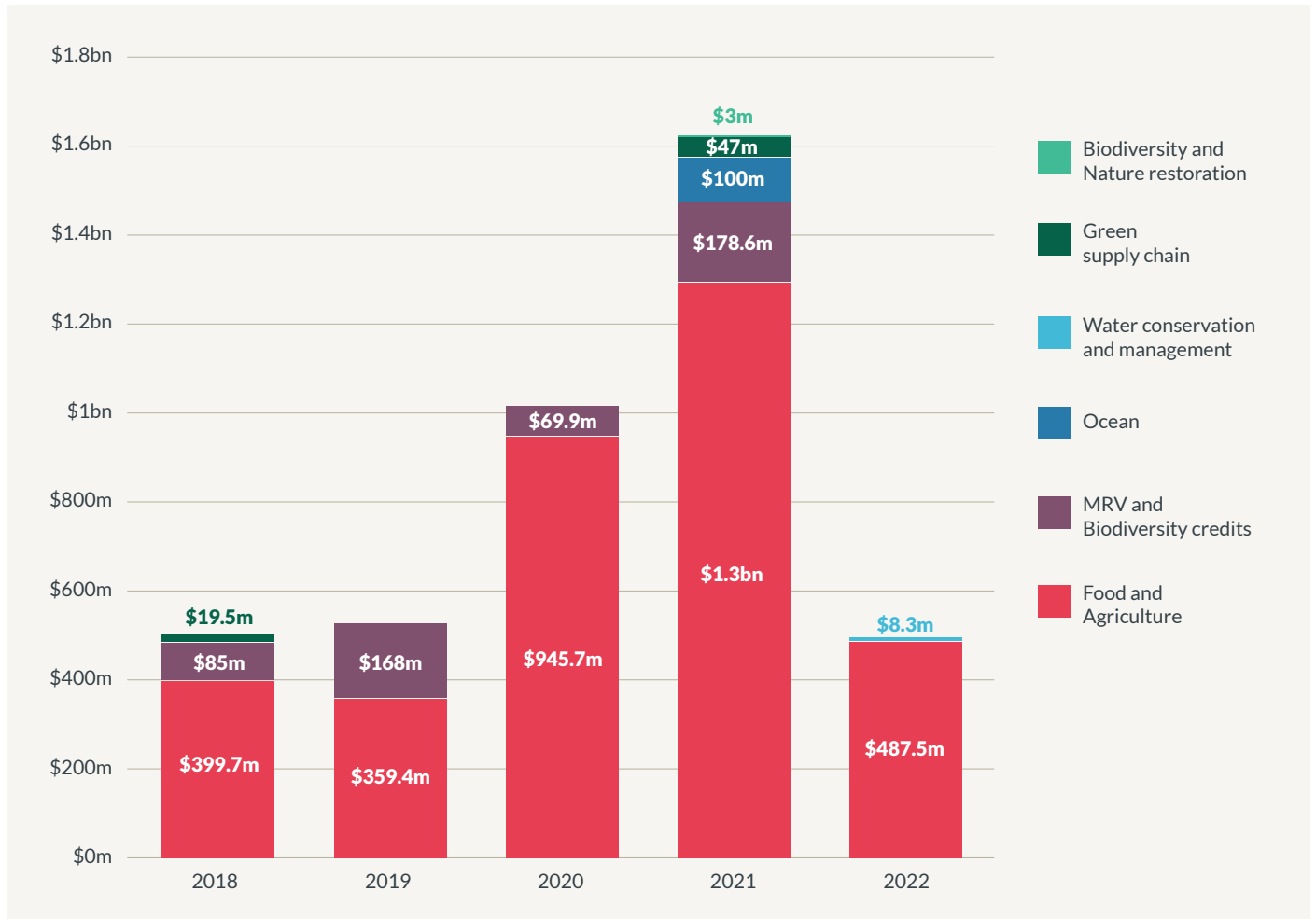
Source: Crunchbase and Serena

The two most mature categories, 'Food and agriculture' and 'MRV and biodiversity credits', have been consistently reaping more than 90%

of the growth funding (series C and above) in nature tech over the past five years. 'Food and agriculture' remains the most mature category,

representing 68% of the growth in funding in 2019 and 98% in 2022.

Figure 14. Funding per category series C and above



Source: Crunchbase and Serena

1.3 Nature-related disclosures – a shift towards nature positive goals

The shift towards nature-positive business activity

Estimates suggest that more than half the world's GDP is highly dependent on nature and the services it provides, while an estimated \$58 trillion is exposed to nature-related risk⁷. As scientific assessments have indicated, our impacts on nature, evident in rapid declines in biodiversity, are profound and global in scale.

Growing recognition of impacts on nature and our dependency on the resources and benefits that natural ecosystems provide has led to the emergence of frameworks and regulations that aim to protect natural resources and mitigate biodiversity loss. Most notably, the [Taskforce on Nature-related Financial Disclosures](#) (TNFD), has brought policy makers, governments, financial institutions, standard-setters, and corporations together to establish a framework for assessing and disclosing dependencies, impacts, risks and opportunities relating to nature. Global frameworks like TNFD have sought to drive greater alignment with other regulatory and emerging frameworks, such as the International Sustainability Standards Board (ISSB) to drive nature-positive action – not only within the direct operations of companies, but also across their value chains.

Building on the approach of the [Taskforce for Climate-related Financial Disclosures](#) (TCFD), which is now widely accepted by investors

and financial regulators globally as a governance and reporting framework for climate reporting, TNFD provides a governance, measurement, and reporting framework for companies to disclose their nature-related financial impacts, dependencies, risks and opportunities in a way that is decision-useful for investors.

“Pivotal Future is a biodiversity data company that produces cost-effective analytics by enabling digital data collection on the ground, anywhere in the world, such that the data is comparable year-on-year, and change over time can be evaluated. Customers are able to disclose the outcomes achieved for nature and biodiversity, across their value chains, backed by auditable data and evidence.”

Zoe Balmforth, Co-Founder,
Pivotal Future

TNFD's role in guiding finance towards a sustainable economy

The initial establishment of TNFD was borne out of the recognition that financial institutions play a critical part in supporting and enabling systemic change. Investors have a vital role in addressing climate change and biodiversity loss, by directing capital to more positive natural outcomes and supporting companies in making investments that deliver positive returns – for the companies themselves and for the natural environment. Efforts to standardise the measurement and reporting within our complicated economic relationship with nature are in their infancy, therefore

decision-useful information is required to enable investors to decide where and how to deploy finance, with an acceptable balance of risk and reward.

A starting point for better decision making about nature is for companies to develop a fuller understanding of their current impacts and dependencies. For many businesses, it is not straightforward to understand how their use of materials has an impact on biodiversity, for example. Identifying and assessing those impacts with suppliers and across their entire value chain can be highly complex, requiring different fields of expertise, collaboration with partners, and extensive data gathering.

Locating impacts, evaluating them, and assessing their consequences are fundamental to this effort – which is reflected in the incorporation of the LEAP methodology within TNFD. The recommended four-phase LEAP approach – (Locate interfaces with nature, Evaluate impacts, Assess risks and opportunities, Prepare to disclose) illustrates both the complexity of understanding nature-related risks and opportunities, and also the need for rigorous analysis and good quality data and information.

The identification of dependency, impact, risk and opportunity is the precursor to action. Many companies are already trying to fill the data gap for investors, by taking a top-down approach to understanding nature risk. It may be that investors can base financing decisions only on third party estimates, or rules of

thumb, but this is no substitute for detailed, reliable, decision-useful information which is independently assured, to provide a sound basis for investment decisions.

The scale of the challenge is enormous, arguably even greater than that of climate change, given the breadth and location-specificity of nature-related challenges. The innovations and solutions needed to enable nature risk reporting to become as common and as systemised financial reporting will generate significant energy, investment and opportunity, especially if this includes risk mitigation and adaptation.

“Dunya Analytics is an emerging innovator in this space, building models and tools that connect the chain links between a company’s plastic use and the impact on biodiversity, to make it easier for companies to report on nature-related risks at scale. Finance must demand transparent and standardised reporting from companies to make informed investment decisions. Companies must pursue solutions and prepare to report on climate and nature risk as they do with financials. Scientists and technologists must collaborate to build the tools and frameworks to ensure all this can be done at scale. We all have a role to play in the transformation to a sustainable economy.”

Megan Pillsbury,
Founder and CEO, Dunya Analytics

Science-based targets on nature

The Science Based Targets Network (SBTN), a global coalition of environmental NGOs and mission-driven organisations, is developing a framework for corporate target setting in line with climate science. Its aim is to enable measurable corporate action on nature across freshwater, land, ocean, biodiversity and climate. In May 2023, SBTN launched the first global science-based targets for nature, focused on freshwater and land. Others, including biodiversity, are to follow.

These targets build on and complement climate science-based targets, which, since 2015 have been set by over 2,000 companies through the Science Based Targets initiative (SBTi). The evidence shows that we cannot achieve climate goals without preventing and reversing nature loss. Both need to be addressed together. Science-based targets for nature are an important mechanism for companies to take action in support of nature’s equivalent to the Paris climate agreement – the [Kunming-Montreal Global Biodiversity Framework](#), signed by nearly 200 countries in 2022.

Focused on the drivers and pressures of nature loss, SBTN is enabling companies to assess their impacts on nature in line with the [mitigation hierarchy](#). In doing so, key drivers of biodiversity loss are addressed with a focus on preserving and restoring ecosystems.

SBTN targets begin with a company’s direct operations but extend across company value chains. They include guidance on local stakeholder engagement to help companies

collaborate with those who may be significantly affected on the ground. This aspect of the guidance focuses on traditionally under-represented groups, such as IPs and LCs, and is an integral part of ensuring a just implementation of targets.

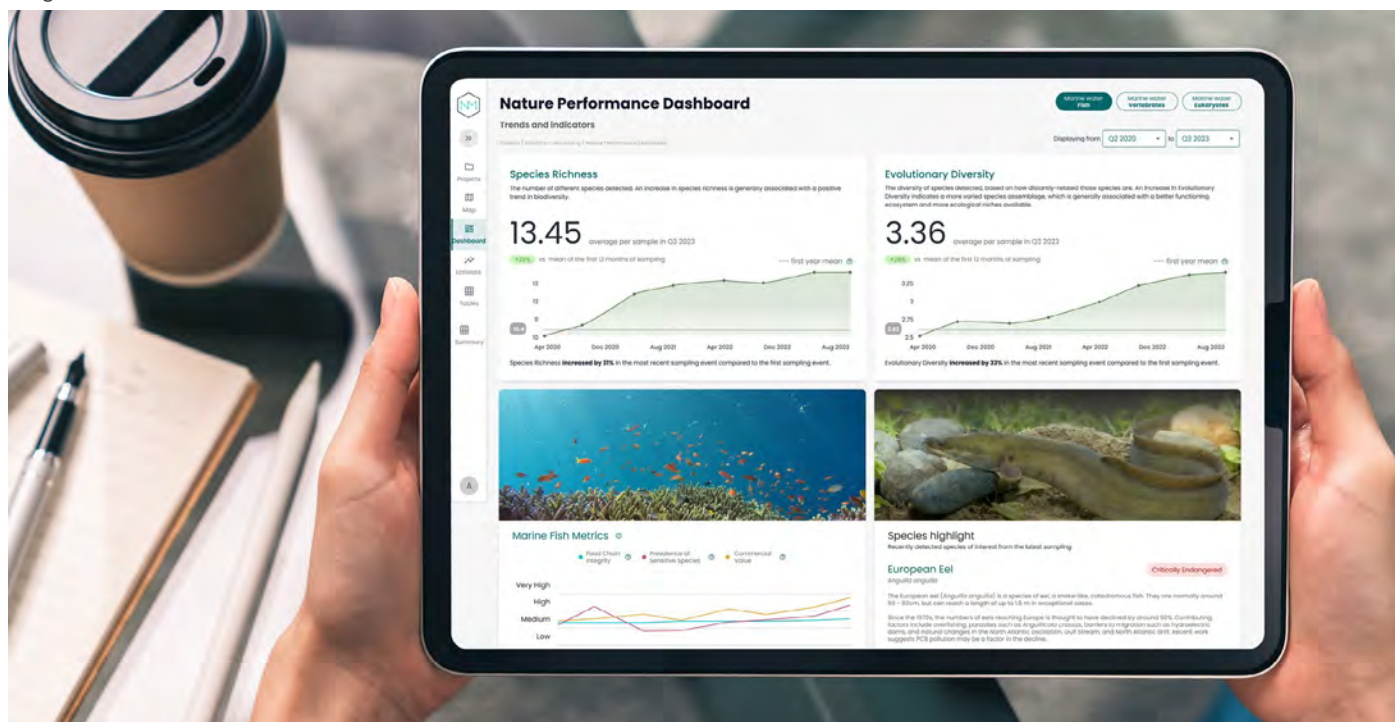
With the initial release of science-based targets for nature, companies can start the target-setting process to assess and prioritise their environmental impacts, and prepare to set freshwater and land targets ahead of validation roll-out projected for early 2024.

The adoption of frameworks such as the TNFD and SBTN is driving value chain transparency, monitoring and modeling. Experts with specialised knowledge are supporting large corporates that have global and diversified activities, in mapping the nature-related risks in their value chain.

“NatureMetrics is one of the major companies working in this field. Operating in 100 countries with over 500 clients, we have helped establish a standardised methodology for collecting and reporting on biodiversity using eDNA. As environmental obligations for businesses grow, NatureMetrics in turn is continuing to develop this area by building and launching the world’s first nature performance monitoring service powered by eDNA technology. This platform makes it as easy as possible for businesses to bring nature-positive discussions to the boardroom level via simple, standardised measurements of biodiversity and impact-on-nature.”

Marta Felton,
Business Development Director,
North America, NatureMetrics

Image credit: NatureMetrics



European and North American trends

In Europe, these frameworks dovetail with the recently passed [Nature Restoration Law](#), which aims to establish protection for 20% of the EU's land and sea by 2030, and the [Biodiversity Net Gain](#) (BNG) initiative in the UK, working to ensure that wildlife habitat is in a better state than it was before development, influencing companies to change the way they assess, monitor and report on their impact on nature.

North American developments are moving in a similar direction. Canada is actively investing in and implementing its 2030 Biodiversity Strategy, engaging members of government, Indigenous groups, stakeholders, non-governmental organisations, academia, women, youth, and local communities in its development process. While the United States government is still coordinating a unified biodiversity strategy, the [Inflation Reduction Act](#) shows the Biden administration's determination to support climate and biodiversity-positive action, with \$369 billion set aside for climate and energy-related funding, much of which is aimed at high-tech solutions.

1.4 Investor insights

For substantial amounts of private and public capital to flow into NbS, investors need to see and understand the impacts, progress and success of any project. Nature tech provides the infrastructure and the tools needed to measure and convey these impacts, and the progress being made by NbS on both terrestrial and aquatic ecosystems.

There are currently four types of investors engaging in nature tech, but the growth of the market is likely to see new entrants in the coming years:

1. The experienced climate tech or **agri-tech** investor who is seeing the growing need and opportunity in the nature tech space and making the pivot.
2. Niche firms with small VC funds who are focused purely on nature tech.
3. Family offices who have an existing relationship with nature and are passionate about nature tech or MRV.
4. Real asset investors who own and manage land and are taking strategic positions in nature tech companies.

It's also interesting to note that large and generalist venture capital firms are beginning to take an interest in the nature tech market and are making their first investments in this space.

Investability of nature tech as a sector

Nature tech has received significant funding in recent years, **primarily from VCs**. While this is clearly a positive trend, it does come with some risks:

- In certain fields, the excitement and hype run ahead of market development. This can lead to credibility issues when project outcomes are later unable to support the original hype. It is important to find ways to ensure that nature tech solutions are scientifically sound before deployment.
- Instances of company's valuations skyrocketing and then coming back to earth (for example, **NCX** and **Earthshot Labs**) may undermine the credibility of other companies in the space.
- Communications around how tech can be deployed, where it can be deployed, the outcomes and how effective it has been is often still a black box. To scale with integrity, there must be greater transparency in the reporting of impact and outcomes and peer-reviewed validations.
- Tech is often presented as a panacea while in reality there are often limitations to deploying tech in various landscapes and contexts. For example, drone seed start-ups that have begun

to get more realistic about where they can actually be deployed and can also impact IPs and LCs. Communication and improved connectivity between stakeholders can mitigate this risk.

Closing the gaps

One of the most significant existing gaps is connecting nature tech companies to real-world opportunities that enable the scaling of a solution, including finding customers who are willing to pay for these solutions at scale. This connectivity is still lacking, and presents itself as companies struggling to scale as rapidly as they had hoped. Changing incentives on the ground is hard, but other stakeholders, including companies, large landowners, non-profits and government entities, have been learning lessons for a long time that can be shared to support connectivity and enhance outcomes.

More productive partnerships between nature tech companies and other stakeholders could potentially unlock scale and impact. Traditional VCs may not be best placed to do this from a skills, networks and return expectation perspective. Alternative or new sources of capital may need to be considered to bridge these two worlds, potentially corporate VCs and impact investors could be an option here. We might also see more and more strategic partnerships and close collaborations between VCs and non-profit organisations to close the gaps.

Case study: Mirova

Mirova is a leading management company that offers investment strategies that provide solutions to sustainable development challenges while pursuing financial performance.

As a responsible impact investor, Mirova directs investments towards companies that contribute towards the sustainable development goals, and has tailored an approach to measuring the environmental, social and governance (ESG) impacts of their real assets and natural capital and private investments. Leaning on advanced understanding and management of ESG risks, Mirova works closely with its investment companies to determine which metrics will accurately measure the strategy being implemented.

It is important to generate an attractive return commensurate with the risk. Mirova's ESG risk management approach in the investment process ensures that productive activities are established on robust and systematic assessment and management of environmental and social risks, underpinned by sound, accountable governance. Excellence in the management of environmental, social and governance (ESG) risks in the companies Mirova supports is also a crucial component of the investment journey.

Site visits play a key role in Mirova's journey with a company throughout the investment life, from the assessment of ESG risks during the due diligence phase to the implementation of an ESAP (environmental and social action plan) to the monitoring of a company's performance. Site visits also reinforce the relationships with management and ESG-dedicated team members on site.

To support companies over the long-term, Mirova report progress against predetermined positive impact indicators that align with the SDGs and the ESAP. The ESAP is designed to embed ESG practices into the core operations of a company, ultimately contributing to a more sustainable global economy.

Investment trends for nature tech

At present, growth is limited as there are few high-quality indicators to determine what investments are going to thrive and achieve impact; technology that supports one solution may succeed in one country or ecosystem but may not work for another. The industry is currently being grown by specialist firms with a passion and drive to find the right tools to address the solutions needed by corporates and project developers.

Corporations are adopting and using nature tech to support their climate and nature commitments but are not currently investing at an early stage. As the industry scales and matures over the coming years, it is likely that corporates will begin to engage beyond the agri-tech vertical that they are currently familiar with, and engage as strategic investors.

Capital formation for nature tech is building from specialised funds launched by large asset managers who have their brand associated with NbS and natural capital or climate and sustainability.

This is an exciting and challenging period for investors pioneering funds into NbS more broadly and into the subset of nature tech. New business models are emerging and it is difficult to predict the outcome. Solution providers are rapidly entering the market – creating competition that will ultimately drive down costs, with some of them showing signs of making a successful franchise.

Opportunities in the blue economy

The ocean plays a critical role in mitigating the climate crisis by acting as both a heat and

carbon sink. They are also vital to improving our resilience to the impacts of a changing climate and support life on Earth with their immense biodiversity.

The ocean is in a critical condition. However, growing awareness of the potential of our ocean to mitigate climate change has led to an explosion of interest in the blue economy – primarily focused on carbon but also on the health of coral reef and coastal ecosystems. Currently, technology is primarily centred around commercial operations improving the sustainability of the fishing industry and remote monitoring of unsustainable or destructive fishing practices. However, tech is emerging to support the restoration of marine ecosystems.

Fund formation around blue economy ventures is happening rapidly,

Image credit: Kasturi Laxmi Mohit/Unsplash



broadly, and much faster than most anticipated. Funds are rising to support sustainable aquaculture, coastal ecosystem management, ocean and coastal carbon, algae management, community-based ventures and alternative proteins. Venture platforms are evolving to address multiple initiatives, such as [Sea Ahead](#) who support an incubator programme that builds the capacity of new founders to scale solutions that enhance ocean health, sustainable ocean industry, and global resilience.

Insurance and permanence in international nature-based solutions

As environmental markets seek more substantial finance, investor confidence is vital. Companies like [Kita](#) and [Carbon Pool](#) are providing insurance for investors that take on the risk of financing upfront, large NbS projects that, if all goes well, will reach breakeven in 10 or more years. While Kita is reimbursing the investor in the case of non-delivery of credits, Carbon

Pool is spreading physical risk by creating a shared pool of credits across various geographies and project types. This minimises the risk of investing in the overall pool, as companies that have invested in a project that has underperformed or failed due to physical risks, will be reimbursed the equivalent number of carbon credits from the shared credit pool.

Governments and international financial organisations are also stepping up their support to protect investors from policy risk by providing insurance for non-delivery due to policy change. This is particularly crucial given that many countries are only now starting to understand how to regulate and tax national and international nature investments and trade, with certain countries stopping projects and exports of carbon credits (e.g. India and Papua New Guinea) and others imposing very significant and sudden taxes for developers (e.g. 50% in the case of Zimbabwe).

Tech companies are doing their part to increase investor confidence by triangulating satellite data, on-the-ground data collection, and

developing academic literature and inventories to estimate and quantify non-permanence risk for projects. This is particularly successful for some risks such as fire, but the predictive capability of these models is evolving, and is likely to improve steadily as nature tech attracts more talent and investment.

The role of spatial finance and climate risk

Spatial finance is the application of geospatial technologies (i.e. remote sensing) to support financial decision making. With more companies setting net-zero targets and sustainability goals in line with the Paris Agreement, there is increased demand for innovative solutions to monitor progress and identify risk and impact. Coupled with a large nature financing gap, more financial institutions are diversifying their portfolios with green products and investing in NbS. However, there is a need to protect investments from greenwashing by providing high-integrity data for

monitoring, reporting and verification (MRV) - to ensure investments are having the intended positive impact on nature. This has led to the growth and innovation of geospatial technologies to bridge the gap with credible data and environmental insight for financial institutions and corporations.

With climate related events such as flooding, droughts and wildfires increasing in frequency and severity, natural disasters are causing significant financial and economic risk. Climate risk is increasingly needing to be incorporated into decision making processes, and with that a growing number of analytics businesses are developing tools to understand and assess natural disasters and their associated risks. Geospatial technologies provide near real-time insight into physical assets, with artificial and machine learning capabilities being developed to stress test locations and model climate-related impacts.

Nature-related investments

In response to the establishment of nature-related commitments, a growing number of carbon offset projects and sustainability-linked instruments are being developed to complement these changing practices. More companies are turning to natural climate solutions (e.g. projects that protect, manage and restore nature to reduce greenhouse gas emissions and sequester carbon) as a component of their net-zero commitments. Service providers specialising in remote sensing for MRV are working with corporates and investors to provide the insights necessary for undertaking due diligence on carbon project performance and integrity prior to investment.

Nature tech companies also work with project developers to provide

information on changing land cover and carbon stock, which supports project development and provides the necessary tools for ongoing MRV over the project lifetime. Similarly with sustainability-linked instruments, financial institutions and governments are linking their nationally determined contribution (NDC) commitments under the Paris Agreement to sustainability-linked performance indicators, using remote sensing data to ensure that environmental outcomes are achieved (e.g. the protection of native forest).

“Spatial finance is a growing industry focused on providing objective insight to help inform financial theory and decision making. With climate change and nature loss providing increasing risk to assets and investments, geospatial technologies are increasingly being used to accurately assess, monitor and report on nature.”

Heather Shepherd, Business Development Representative, Space Intelligence

Biodiversity monitoring and measuring impacts

Along with understanding and modelling the risk created by climate change, there is a growing push from regulatory bodies to report on how a company is impacting nature. [The TNFD](#), [SBTN](#) and the new regulation from the [EU on zero deforestation](#) within supply chains has motivated companies to prioritise locating their land-based supply chain assets, directly feeding into the market of geospatial technologies for this insight. However, the large blocker for supply chain assessment is obtaining location specific information i.e. boundaries of operations associated with a company. Without this level

of transparency, it is difficult to associate nature impact directly to a company, another area where tech may be able to help.

“Restor is a spin-off from Crowther Lab at ETH Zurich. We use geospatial technology to support organisations in transparently mapping their land based assets, and then analyse these locations using the very latest biodiversity science (see [Case study - SEED](#)).”

Thomas Elliott, CEO, Restor

Measuring the impact of NbS is challenging. The range of potential impacts – financial, environmental and community-based – are diverse but inter-connected. Biodiversity impacts are typically highly localised, and do not lend themselves to financial consolidation. Putting a financial value on activities such as restoration and regeneration is not straightforward.

Many investors currently focus solely on carbon, and do so for a variety of reasons; it is easier to measure, it is fungible, and it presents a more mature framework. However, investors are seeing opportunities in the wider NbS market and are diversifying their portfolios. Some nature tech, namely that which deals primarily with protection and restoration of biodiversity, has a unique set of stakeholders. If investors want to make investments into companies that deliver enduring outcomes for biodiversity, they will need to consider a specific set of additional considerations in their investment processes.

Real asset investors who own land might be best placed to start and run pilots and report on metrics, as they have direct influence over their land. Reporting on these metrics could yield product premiums and evidence for interventions they may be undertaking already (e.g., regenerative agriculture, agroforestry).

At the capital markets and public equities level, applications such as **NatureAlpha** can address these challenges in the near term, by providing insights on nature and biodiversity footprint, risks, and impacts of asset-level investment decisions.

A range of biodiversity assessment tools and methodologies are evolving, and will continue to evolve, to provide accurate data on the extent of company and supply chains impact, including the **Integrated Biodiversity Assessment Tool** (IBAT) and the **Living Planet Index** (LPI) in addition

to the the **Global Biodiversity Score** (GBS) and the **Biodiversity Intactness Index** (BII), both of which are recommended by the TNFD as tools that can guide companies adopting the LEAP approach.

Case study - SEED

The **Crowther Lab** in ETH Zurich is developing **SEED** to overcome the challenge of measuring complex biodiversity. SEED is the world’s first biodiversity index that accounts for all scales of life’s complexity at a genetic, species and ecosystem level, for every location on the planet and its change over time. Rather than measuring a few reductionist aspects of nature, SEED integrates multiple datasets across all levels of diversity and taxonomic groups into a single comprehensive and standardised measure designed to convey the underlying state of biodiversity.

By correlating this with remote-sensing and ground-truth site data, assessments can show how biological complexity (“biocomplexity”) is changing in any site over time, and benchmark with other sites in the same ecoregion. SEED rates the state of that ecosystem relative to its natural state. Therefore, a rating of 1 means that ecosystem is in a natural state, and zero would be the equivalent of a completely degraded ecosystem. The closer a site is to 1, the more regenerative and resilient it is likely to be. In addition to supporting corporations in assessing the state of an ecosystem they are investing in, SEED will also be used to support the measurement of an organisation’s impact on the ecosystem over time.

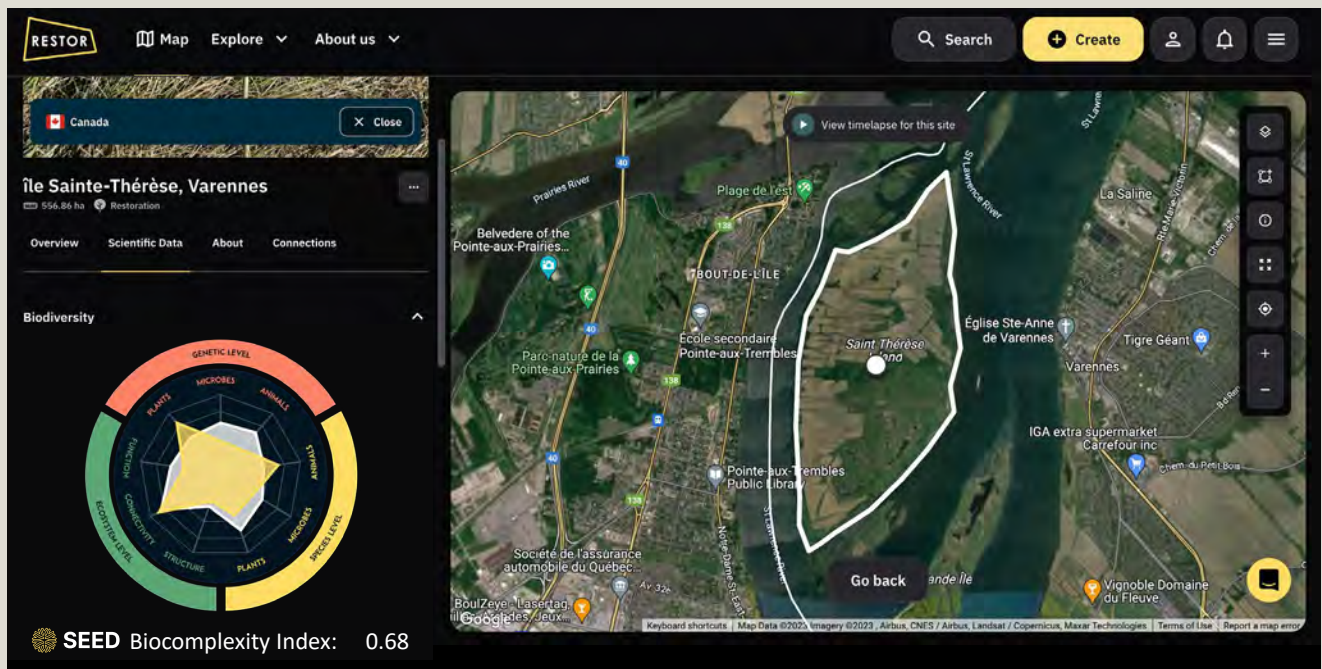


Image credit: Land Life



Demand

Often, even where there may be a great idea and application of nature tech, buyer interest has been limited to a few small transactions and can hold back market progress. There are various reasons for this, such as the lack of a high-quality, independently certified credits available for buyers to purchase.

As VC investment into nature tech grows, customer demand must be strong enough to support ongoing startup growth, especially in a bearish economic and fundraising environment. Demand for nature tech may come from groups like corporate enterprises, governments or municipalities, individuals, or NbS project developers. Origins of this demand may be found in various motivations:

- **Desire for high quality offsets:** groups may want to avoid negative press associated with cheaper offsets, and want to meet their climate or net-zero goals while having defensible social and

environmental aspects impacts. It is worth noting here that recent negative press on avoided deforestation credits may soften this demand in the short term, or move towards reforestation or restoration type credits.

- **Interest in inseting:** corporate groups are increasingly interested in meeting their climate goals while also creating value in their own value chains, or 'insetting'. Many fashion, food and agriculture corporates have opportunities to apply NbS via inseting.
- **Value creation:** reducing pain points or creating benefits for groups while simultaneously achieving biodiversity goals. New tech advances can achieve significant bottom-line wins for companies, allowing them to scale rapidly through existing markets, while also reducing pollution, land conversion, or improving habitat.
- **Compliance:** incoming regulations like the Corporate Sustainability Reporting Directive in the EU will require

corporates to report on their impacts on nature. This will drive demand across a number of nature tech opportunities across understanding and mitigating impact.

- **Brand benefits:** as nature rises up the international agenda, many groups will want to differentiate their brand by being on the frontline of nature progress.
- **Ethical motivations:** groups driven by the emotional or ethical imperative to protect nature.

These demand signals will involve many industries, market sizes, sales cycles, and regulatory constraints. It is critical to consider the size and growth of markets when considering the trajectory of an individual company, or the nature tech space as a whole.

“Buyers need to step up. Many nature tech models rely on underlying demand from corporates, but without forward offtake or revenue certainty, investors are naturally hesitant to step in.”

Siddarth Shrikanth, Just Climate

1.5 Safeguards for people and ecosystems

Safeguards are measures taken to help reduce the risks related to implementing and scaling nature tech, while achieving environmental and social benefits. While supporting and scaling NbS is the end goal, the social and environmental risks of the tech itself need to be considered, as well as the use of the tech and the sharing of the resulting data. Data safety, transparency, gender and how tech may impact IPs and LCs are all considerations for evaluating potential risks and designing associated safeguards.

Technology can be a powerful enabler of inclusivity and engagement with IPs and LCs who have historically been left out of critical decisions regarding the environment they live in, and very often steward. However, to be that enabler, tech must be used, designed, and deployed with an understanding of and sensitivity to the local culture, language, and a host of other human contexts specific to the location of the tech being deployed

Tech design requires a precautionary principle

The manufacturing and design of nature tech has direct impacts on the environment that need to be considered. For example, the mining of materials to meet demand can significantly impact a local environment and disrupt entire ecosystems, while the failure to recycle electronic components properly can contaminate soil and pollute ground water. For the

sector to flourish, unintended environmental risks and application of the necessary safeguards needs to be anticipated and acted on. Through building circularity into the **design** and manufacturing process of nature tech, we can create regenerative business models that contribute to **establishing a circular economy**.

Critically, nature tech design needs to take a precautionary principle, given the uniquely complex natural systems it interacts with, and needs to be backed by science. There are novel solutions that may have great positive potential, such as cloud seeding, advanced weathering and sinking kelp into the deep sea. But for many of these new approaches, the broader environmental outcomes remain largely untested and unknown, and there are serious risks of negative consequences if they are deployed at scale. Of course there is always tension between a precautionary principle and the need to move quickly due to the scale of the nature and climate crises. Investors in nature tech should always challenge the science of any tech solution under consideration for investment, in addition to a comprehensive risk and impact assessment.

The design of tech can also have unintended impacts on the end user. Too often there is a lack of gender, racial, and ethnic diversity in the design of technology, which can have an effect on the use of the tech and the resulting quality and integrity of the data being collected. Safety gear that doesn't fit the female form, sensors that only pick up white skin or AI that picks up on racial bias from the datasets fed into it are some

examples of tech that does not work for women or people of colour. To scale tech solutions, the tech needs to be designed with inputs from the user or with the end user in mind. For example, **Cyber Tracker** mobile phone tools for local expert trackers with extensive Indigenous knowledge can have tailored features such as icons throughout the interface to overcome language and literacy barriers, in order to ensure the user is able to gather detailed biodiversity data. App design also needs to consider that offline access is crucial for field-based users in remote locations where they may not be able to upload data or access cloud-based data.

When tech is designed with an end user in mind, it can also have the power to build a more inclusive economy. For example, **Koltiva's mobile tech solutions** aims to provide agriculture communities with enhanced access to information and resources offering user-friendly mobile applications tailored to the specific needs of individual supply chain actors.

"Our web and mobile tech application is pivotal in fostering digital and financial inclusion among rural farmers. By integrating a secure digital finance feature called 'KoltiPay' in our applications, we facilitate access to financial services such as mobile banking, microcredits and insurance. This enables farmers to manage their finances, access loans and receive premium payments. These financial inclusion initiatives empower rural farmers to break free from traditional barriers and gain economic independence."

Manfred Borer, CEO, Koltiva



Transparency, integrity and data security

Transparency in the origination, collection and use of data is critical to generating a coordinated response to the climate and nature crises from multiple stakeholders from differing countries, languages and ecosystems. Safeguards are designed to improve transparency in the delivery and use of tech solutions and can support data integrity and instill confidence in its use. Transparency can support integrity at multiple levels, from the origination of the data to ensuring its accuracy, by adhering to frequent updates, ensuring that the appropriate spatial scale is used, and to help understand spatial bias. However, significant risks may arise when transparency is prioritised over the security of the collected data.

While open data is critical to understanding the complete picture, not all elements have to be free or with full access to all. If data is not secure throughout its entire lifecycle then the information is open to corruption, theft, or unauthorised access with potentially dire consequences. For example, endangered species can become more vulnerable to poaching and harvesting when their location is publicly disclosed. The citizen science system [iNaturalist](#) tackles this by generalising the locations of observations of endangered species. These security concerns also extend to environmental defenders. With 1,730 environmental defenders murdered in the last decade⁸, it is crucial that safeguards are developed to keep personal and location data secure.

Indigenous peoples and local communities

Of the global area covered by Key Biodiversity Areas (KBA), 36% is found within IP and LC lands, and over half of that area is not protected by other means⁹. Indigenous peoples' knowledge of natural processes and their ability to manage their land sustainably has shown typically lower deforestation rates in their lands being typically lower than in adjacent areas outside of IP and LC stewardship¹⁰. In the Amazon basin, for example, Indigenous territories account for 28% of the region but only 2.6% of its deforestation¹¹, supporting the crucial role forests play in mitigating the worst effects of climate change.

Studies frequently confirm that IPs and LCs are the best conservationists of our natural world¹² because they have very strong connections to nature with valuable traditional knowledge about their environment. When developing and investing in a tech solution, tech developers and investors therefore need to be mindful of the leading role that IPs and LCs play in conservation. Rather than simply incorporating a cursory consultation with IPs and LCs, tech developers can and must incorporate IPs and LCs into the design and the deployment of tech.

A wide range of external **factors currently challenge IPs and LCs**, their rights and their livelihoods, including climate change impacts, insecure land tenure, and economic drivers such as deforestation, illegal cattle ranching and mining, and sometimes even conservation solutions. Nevertheless, partnerships are being developed to support NbS coming from deep within the forests, rivers, mangroves, savannahs, and most importantly from the knowledge of the communities.

Inclusion of IPs and LCs

Tech can effectively facilitate the inclusion of IPs and LCs and encourage engagement. While the application of tech can bring important opportunities to Indigenous peoples and local communities, it can also bring risk to their rights. For example, the use of drones to plant trees in restoration projects can take jobs from IPs and LCs. By combining IP and LC knowledge to collect ground-level biodiversity data on birds or plants with drone technology, it is possible to achieve positive social impact in addition to improvements in biodiversity. For example, **Flying**

Forests has developed ecosystem restoration drone technology and a global distribution network that equips local communities with the technology to scale up their restoration efforts, with fair revenue sharing.

For tech to be the enabler of inclusivity, tech has to be designed, deployed and used with an understanding and sensitivity of the local culture and language. Apps that monitor biodiversity or illegal activity, for example, should be developed to enable the participation of IPs and LCs that speak languages that differ from the tech developer. Training needs to also be designed to support the end users' customs, literacy levels and language to ensure inclusivity and result in the effective use of the tech being deployed.

While not specific to technology, it's still worth mentioning that engagement with IPs and LCs should always be fair, equitable and follow free, prior and informed consent (FPIC) procedures. FPIC needs to be at the core of every NbS project that involves or could potentially affect IPs and LCs. FPIC procedures attempt to ensure community engagement extends beyond sensitisation meetings that introduce the project in order to gain an in-depth understanding of IP and LC concerns about the project more broadly, in addition to the data being collected, and to ensure their specific needs are met. The **Shipibo REDD+** is one example of an NbS project that is actively trying to overcome these challenges by working collaboratively with IPs and LCs throughout project development and implementation.

In Tanzania, project developer **Carbon Tanzania** and tech company **Sensing Clues**, are working together to transform a traditional app that monitors wildlife and illegal activity into **an app that monitors**

and captures evidence of FPIC procedures and community-based activities. The app is available in different languages, and despite being available for use globally, it can be tailored to meet the requirements of different communities in varied landscapes. In Tanzania, the app is currently used by village game scouts with no formal education who speak Swahili or other Indigenous languages.

Making technology accessible

In addition to incorporating a participatory approach to designing and deploying nature tech to ensure IP and LC needs are met, it is imperative that technology is affordable and accessible to IPs and LCs. Promoting a community-led approach recognises the critical role IPs and LCs play in protecting their environment and incorporates them as strategic partners in delivering effective natural climate solutions.

Technology is a tool that can serve community purposes, their priorities and life plans. For example, the **Norwegian Ministry of Climate and Environment through NICFI** (Norway's Climate and Forest Initiative) spearheaded and funded a programme to make unprecedented access to high-resolution satellite data for everyone over the tropical forest region. The NICFI Satellite Data Program has been designed with the specific purpose of reducing and reversing tropical forest deforestation, but more importantly, reducing traditional barriers to access such as cost and arduous licensing, internet connectivity, training and language. Indigenous communities are consulted in developing new use cases and use the base-maps to plan their forest protection patrols.



An initiative such as this has a positive impacts because it supports community planning, land management, decision making and improves the security of forest patrols, as well as facilitating measurement of compliance with family conservation agreements.

In Indonesia, satellite imagery is supporting Indonesia's government [Peatland Restoration Agency](#) to map and monitor peatlands to prevent a reoccurrence of the 2015 fires, by empowering local communities to assess and guide peatland management approaches.

Combining tech and IP and LC knowledge

While the latest technology can enhance ecosystem monitoring, it is essential to deploy it alongside the unparalleled local knowledge of IPs and LCs. Community-based and Indigenous knowledge is a critical tool in understanding ecosystem health and, crucially, in planning and implementing the actions that will ultimately improve it. When local knowledge is combined with results of tech-enabled monitoring, it is possible to put those results into social and environmental context and to develop much more effective actions. In Peru, Indigenous forest monitoring initiatives, supported by [UN-REDD](#), generate useful data and information for the management of natural resources and empower local and Indigenous communities to monitor and measure their forests. Forest monitoring units are equipped with Indigenous knowledge while

computers, drones and GPS devices provide technical support to the project's communities.

Technology can also play an important role in documenting and monitoring the contributions made by IPs and LCs on the ground. It can provide information to help make informed decisions regarding partnerships, market access, benefit sharing, financial transparency and community investment.

By embracing technology as a support tool, IP and LC voices enter the global arena, enabling them to demonstrate their leadership in conservation and to become active participants in decision-making processes. The nature tech industry must endeavour to go beyond 'doing no harm' to make a positive contribution to the lives of IPs and LCs through genuinely inclusive and participatory programmes that ensure beneficiaries receive get the full benefits of these technological solutions.

Image credit: Land Life



Safeguarding frameworks for high-integrity NbS

While tech can help to build trust in NbS more broadly, we also need safeguards for the broader NbS sector that are important to be aware of when implementing or investing in nature tech.

Existing guidance can help with the development of safeguards for a project or programme:

1. Resolution 5 of the fifth UN Environment Assembly ([UNEA 5.2](#)), recognises that NbS need to respect social and environmental safeguards (including for IPs and LCs) in line with the three Rio Conventions.
2. The [IUCN global standard for NbS](#) provides guidelines for a self assessment that addresses the pillars of sustainable development (biodiversity, economy and society) and resilient project management. The global standard supports inclusive and transparent governance processes and the engagement with and empowerment of local people. The criteria ensure clear and measurable biodiversity outcomes are periodically assessed and that any unintended consequences of nature-based solutions on nature are assessed periodically.
3. The [Voluntary Carbon Market Initiative \(VCMI\)](#) supports the development of a high-integrity voluntary carbon market that contributes to the goal of the Paris Agreement. The VCMI's Claims Code of Practice provides a rulebook on how companies can make voluntary use of carbon credits as part of credible, science-aligned, decarbonisation pathways.
4. The [Integrity Council for the Voluntary Carbon Market's \(ICVCM\)](#) Core Carbon Principles Assessment Framework guides the creation of high-quality carbon credits that deliver finance to communities and project proponents deploying carbon projects.

However, these frameworks don't necessarily require the data themselves to be freely accessible, and inequity in access can lead to a power imbalance between data holders and other stakeholders such as IPs and LCs. This inequity has the potential to render the implementation of Free, Prior and Informed consent (FPIC) procedures meaningless unless expectations on data sharing can be incorporated.

Section 2: Emerging trends in nature tech

Tech solutions that support the origination of NbS projects, in addition to the multitude of tools that improve the efficiency and accuracy of MRV, are evolving.

This growing array of tools is bolstering trust and confidence in NbS by providing much needed transparency and data integrity. This section describes emerging trends in the nascent but growing nature tech market.

2.1 NbS origination

A number of macro trends are converging to create a strong market pull to develop innovative and creative NbS projects that regenerate nature at speed and at scale.

Many of these are relevant to land. Land degradation is increasing. According to the UN, up to 40% of our world's land is degraded¹³, and more than 400m hectares of land is being degraded and desertified every year through activities such as deforestation, overgrazing and mining. It is clear that land regeneration and restoration must happen at a planetary scale, and urgently.

Increased focus on removal credits

According to an analysis by BCG in January 2023, 80% of voluntary carbon market (VCM) credits are currently avoidance-based¹⁴. However, more than half of the companies surveyed indicate that over 65% of their portfolio is to be made up of removals credits by 2030, with 7% of companies saying it will make up 100% of their portfolio. As a Director of Energy Project and Strategy said in the survey, "We prefer removal credits because it's easier to verify the impact – we're very sure what's happening". Analysis from Cultivo shows that 950 million hectares of land will need to be restored by 2030 just to meet this demand for nature-based removal credits¹⁵.

Despite this increase in investment in removal credits, it is important to remain focused on the "NCS Hierarchy" of protect, manage and restore. We need to protect

biodiversity to avoid further damage, manage lands more sustainably, and restore degraded land. These three imperatives are not mutually exclusive and should form part of a wider portfolio of projects.

Increased focus on nature-positive goals, nature risks and reporting

With \$45 trillion of financial risk exposed through nature related risk¹⁶, financial institutions are increasing their focus on nature reporting and disclosures, accelerated by initiatives such as TNFD.

Similarly, progressive corporations are increasingly seeing nature-positive goals as of equal importance to their net-zero goals, and are actively exploring how nature-based solutions can help them meet both sets of goals. This is driving an increased demand for more holistic natural capital and social impact data, beyond just carbon data.

Shift to advanced market commitments

Financial institutions and corporations are realising that in order to secure a future supply of high-quality nature-based removal credits to achieve their net-zero emissions commitments, and have the data to report against their nature goals, they need to become active in unlocking the supply of land and helping to originate projects that regenerate nature in their early stages. This realisation is translating to a surge in advanced market

commitments in terms of pre-financing mechanisms that provide early stage catalytic capital, and forward credit purchase agreements.

Increased demand for enriched data

Understanding the biodiversity, carbon and water gains of a tract of land is just a fraction of the analysis that is needed to invest in its regeneration. Scientific knowledge of NbS potential for carbon mitigation, biodiversity protection and recovery, along with its impacts on people's livelihoods, health and well-being, have expanded dramatically since the 2017 Griscom *et al* paper¹⁷ that calculated that nature could provide up to one-third of the emissions reductions needed to meet climate targets. However, we still need to tackle the challenge of data integration and accessibility.

In this context, the industry is moving at pace beyond project design documents and into a data-rich environment that provides a fast and deep understanding of ecosystem's protection, management and regeneration projects. Nature4Climate, for example, is this year launching a free, online tool which maps opportunities across more than 20 natural climate solutions' pathways to indicate where, why and how we can unlock nature's potential to meet climate and biodiversity targets and commitments.

The platform, called [naturebase](#), integrates thousands of data points collected via different technologies such as AI, machine learning and satellite, to collate and verify existing knowledge based on peer-reviewed science. It displays available information on carbon mitigation, ecosystem and biodiversity benefits and human well-being impacts, enabling policies and case studies to support decision-making on NbS implementation in every country, state and city in the world, down to a one kilometre resolution. This can help to build trust among all the stakeholders involved, from landowners to investors and offtakers.

The role of nature tech in NbS origination

Nature tech can play a critical role in helping originate projects that regenerate nature at speed and scale.

For example, [Cultivo's](#) platform uses geospatial analysis and AI to screen large areas of land and identify where to start projects that have the highest regeneration potential. It also uses digital tools and generative AI to streamline the due diligence and project design process for origination, dramatically reducing time and increasing confidence to unlock advanced market commitments.

For example, digital tools can help project developers and experts co-design PDDs (project design documents). Greater clarity on policy, trade agreements and tax treatments, for example, can be provided by enriched data for investment decisions.

Digital tools can also enhance collaboration between the network of partners involved in regenerating a project. For example, local communities and land stewards can be given the tools and knowhow to carry out ground truth measurements.

Nature tech can also provide the data to authenticate the claims for a project in a transparent and observable way. This is not just related to carbon capture claims, but also to claims on biodiversity gain, water gain, and social impact. This not only provides the information that underwrites forward purchase credit agreements, but also provides the data for corporate disclosures and reporting.

“Nature tech should be used to scale origination and mobilise finance into projects to get them off the ground. Cultivo has developed a platform that delivers on both the scaling of origination and mobilising finance. Ultimately, technology is a tool with a primary role of removing friction and creating efficiency, so the experts on the ground can actually spend more time regenerating nature, than planning to do so.”

Manuel Piñuela, Co-Founder and CEO, Cultivo



Image credit: Roshni Lodhia/Carbon Tanzania

2.2 Advances in monitoring, report and verification (MRV) – driving transparency and data integrity

Why do we need MRV?

‘MRV’ refers to the monitoring, reporting and verification of nature-based solutions.

MRV enables the monitoring, reporting and verification of the many different mechanisms that are being applied to determine progress towards global biodiversity goals. MRV helps to measure the impacts that interventions are having on nature. Once data is reported, it can help to replicate successful pilots in other geographical settings and the verification of data gives confidence to make data-driven decisions that help manage risk, highlight opportunity, and close the nature-finance gap.

MRV is essential to a functioning NbS market and gives the confidence to scale nature-based decision making. NbS project developers use MRV to demonstrate their impact, and ratings agencies need MRV to verify project activities. Corporates needing to demonstrate compliance with regulatory frameworks or voluntary initiatives such as TNFD will also become increasingly reliant on MRV.

“We cannot treasure what we cannot measure”

Raviv Turner, Founder, MRV Collective

MRV in the voluntary carbon market

With the exponential growth of the voluntary carbon market (VCM) in recent years, there has been renewed focus on the quality and integrity of the claims being made by companies, as well as on the credits generated by project developers. The quality and integrity of credits has recently been called into question, resulting in many doubting the ability of the VCM to deliver in the public interest.

A high-integrity VCM has the potential to mobilise, at speed and scale, billions of dollars a year in additional climate finance that removes carbon or cuts emissions, often with additional benefits to nature. However, the VCM can only deliver outcomes that address both climate and biodiversity goals if there is sufficient trust in the market. MRV can help build and sustain that trust by measuring and reporting on whether an intervention both mitigates climate change and improves or worsens an ecosystem. Once we can see what intervention is working, we can use the data to set effective project parameters.

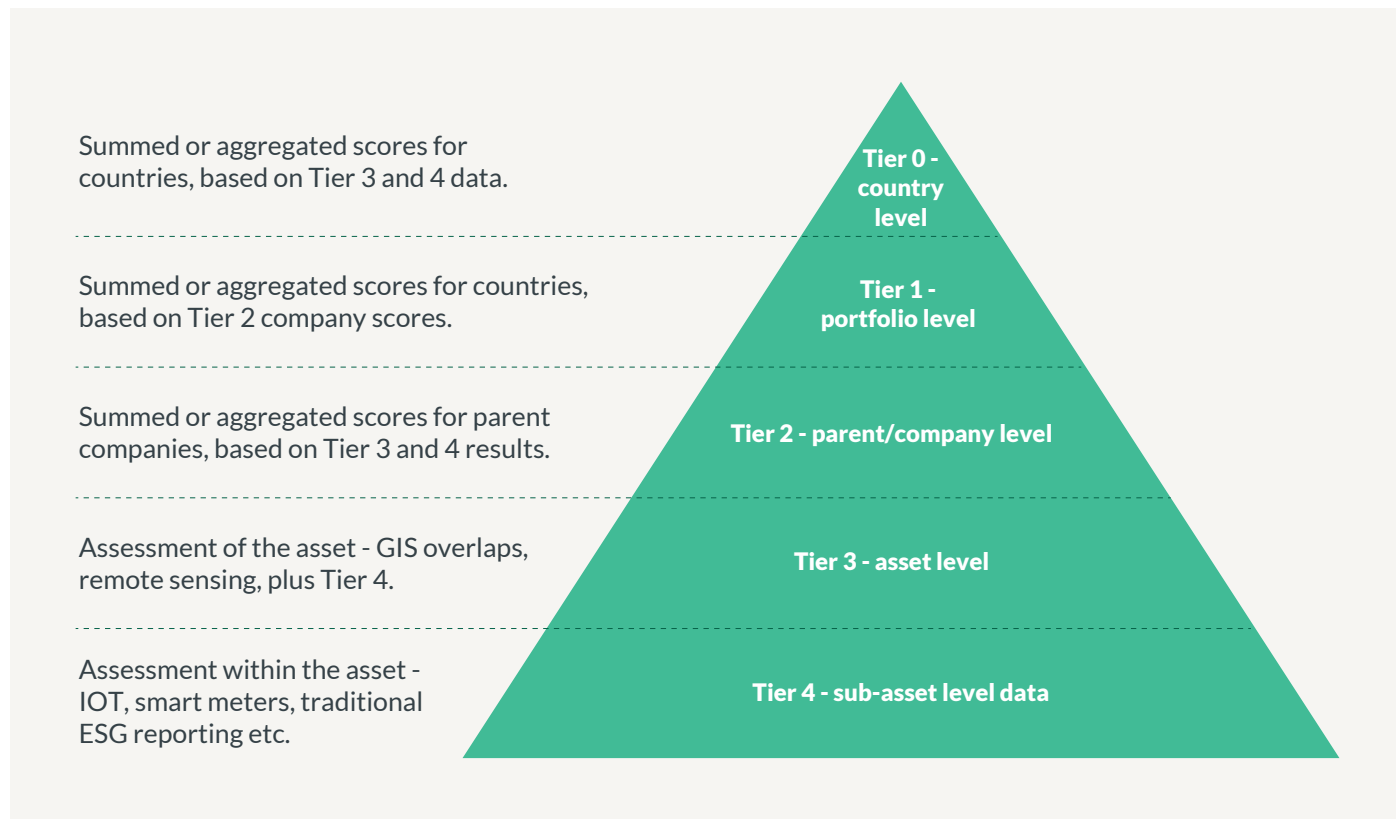
MRV for biodiversity markets

To support and protect the nascent biodiversity market, it is important that lessons are learned from experience of the carbon market, including the need for transparency and confidence building – so that any accusations of ‘greenwashing’ are dispelled.

MRV is currently used for measuring data that helps to determine a broad overview of our impact on biodiversity. However, to understand the true extent of impact, a deeper understanding is needed of supply chain impacts on biodiversity, not only at a site level but across a company’s upstream and downstream activities.

A study by Iceberg Data Lab reveals that 90% of an agricultural company’s impact on biodiversity was found in its non-operated activities¹⁸, emphasising the need for rigorous and accurate localised data in addition to data that measures the impact of an entire value chain. Currently, not enough sites have been required to conduct MRV and those that do have MRV processes in place have often relied on manual MRV, which is time and resource intensive, expensive and difficult to verify. Without rigorous and consistent use of MRV across all levels we cannot understand the full impact a supply chain has on biodiversity.

Figure 15. Going forward: ongoing value chain and location data management



Source WWF, MAXAR

MRV is also critical in supporting financial markets to close the biodiversity funding gap, currently estimated to be \$230 billion per year¹⁹. Robust and accurate data assures investors that their investments are demonstrating the environmental impact promised, and that they will ultimately lead to an increase in investment.



Image credit: Land Life

Categories of MRV

To tackle some of the challenges inherent in MRV, it is becoming increasingly helpful to digitise the MRV process in order to scale NbS. ‘D-MRV’ – the automation of

processes that allows the collection of data more quickly, on a more consistent and regular basis, and with improved data integrity – can provide greater transparency, efficiency, and accountability. High-integrity and transparent

data are essential for achieving the climate and nature transition and D-MRV is a more efficient and effective form of monitoring, reporting and verification that will help to drive progress.

Table 1. Traditional vs digital MRV

	Traditional MRV	Digital MRV
Verification cost	Average \$50K	Consumption based
Verification methods	Direct measurements	Hybrid: Sampling + Modelling + Remote Sensing
Verification entities	1	Multiple (On The Ground + Remote Sensing)
Min project size	1,200 ha +	Varies based on method
Time to verification	2+ years	< 30 days
Land owner equity	Bottom of the waterfall	Receives majority of credits
Project verification	Every 3-4 years	MRV on-demand
Governance	Off-chain registries	Off-chain + On-chain

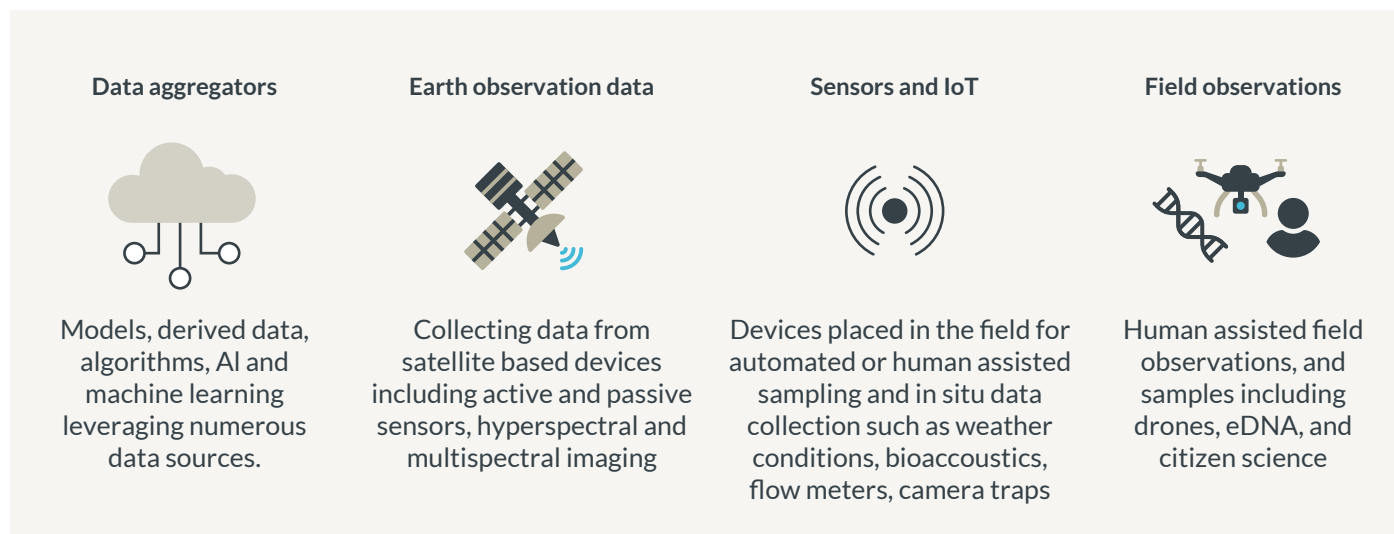
Source: MRV Collective

Providers of D-MRV are evolving their products to address solutions for different ecosystems in addition to providing tailored solutions for different credit classes, from biochar to ocean conservation and afforestation / reforestation.

D-MRV encompasses a range of technologies that can be grouped into four categories:

1. Data aggregators, developing technology that analyses data and the patterns in the data including AI, machine learning in addition to remote sensing technology including camera and hyper-spectral imaging.
2. Satellite data, collecting data through remote-sensing technology including camera and hyper-spectral imaging.
3. Internet of Things (IoT) data: sensors and devices that collect data on weather and biodiversity.
4. ‘Boots on the ground’ uses technology that collects raw data at the ground level such as bioacoustics instruments or eDNA.

Figure 16. Categories of D-MRV



Source: MRV Collective

While satellites are able to increase the understanding of a landscape, we cannot assess an ecosystem using satellites alone. Remote sensing can improve understanding of a forest by assessing tree height, tree species, diversity and land cover. However, remote sensing is not without its challenges and limits our ability to

understand what is happening below the tree canopy in order to gain a full picture of a complex ecosystem.

To understand the full extent of biodiversity within an ecosystem, remote sensing data has to be layered upon with ground-truth data that is collected using drones, acoustics, tree inventories,

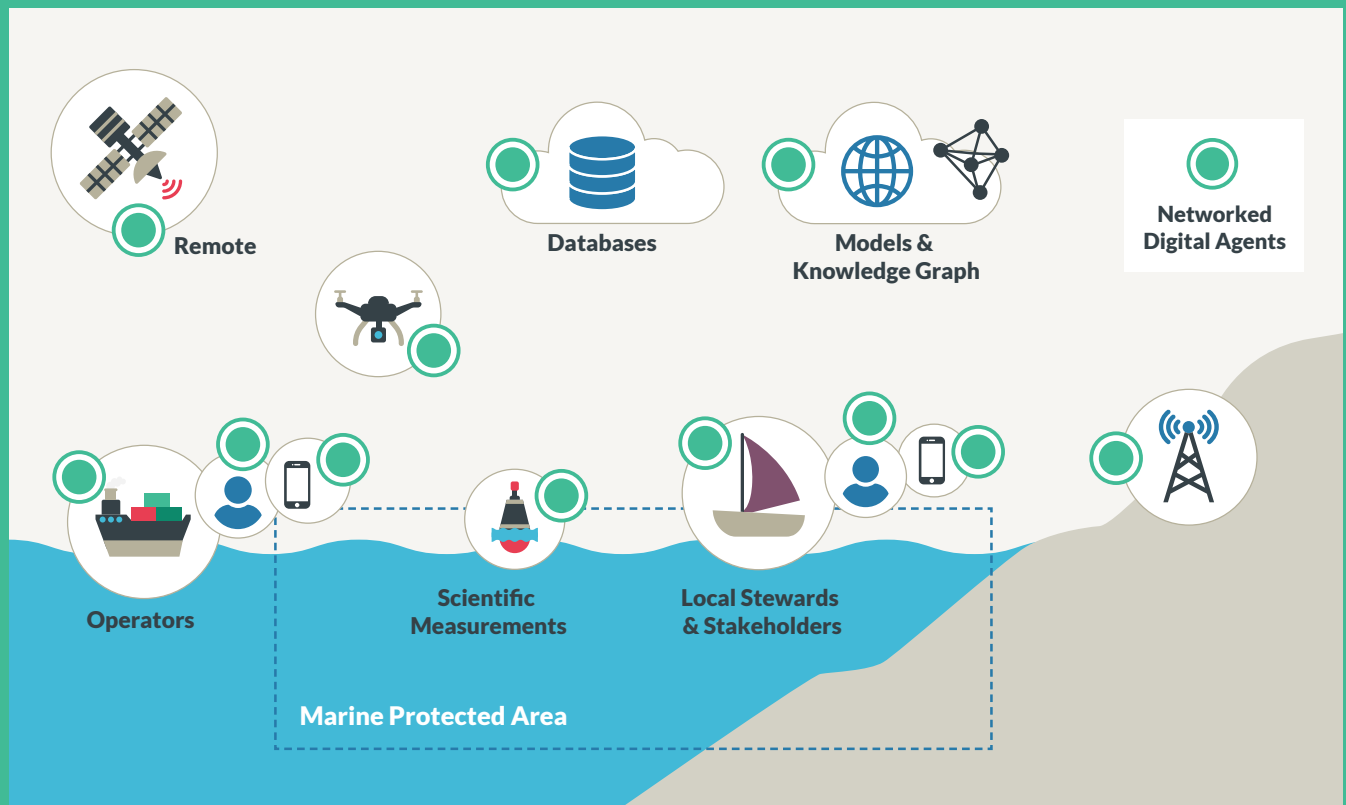
environmental DNA and camera traps for terrestrial ecosystems and thermal infrared scanners, radar imagers and scatterometers for aquatic ecosystems. There is an emerging wave of ground sensing technologies that need to be used and which can link to remote sensing to advance the effectiveness of MRV.



Image credit: Sylvera

OpenEarth Foundation white paper describes a ‘digital agent architecture for robust MRV in ocean conservation.’ Design concepts leveraging numerous source points of data are increasingly being envisioned however data integration solutions are still evolving and nascent.

Figure 17. Numerous source points of data



Source: OpenEarth

Trends in D-MRV

As is the case with nature tech more broadly, D-MRV is subject to similar emerging trends, including in the following areas:

1. **Indigenous peoples and local communities:** Recognition of the critical role that IPs and LCs play in protecting biodiversity²⁰ is better understood and companies can be expected to act on this understanding in the future. Rainforest Labs is a project which combines Indigenous knowledge, technology, and training to uphold Indigenous land rights to

monitor and protect the Peruvian Amazon. However, recognition alone of IP and LC rights and their role in protecting biodiversity is not enough. Cultural diversity is highly correlated with place and biodiversity²¹ and it is anticipated that more companies and organisations will start inviting and centering IP and LC knowledge keepers, and their ecosystem management practices to guide the use of nature tech and the collection of nature data. This is increasingly important as nature data must be collected via *in-situ* methods on an ongoing basis. Thus, a paradigm shift may

be underway from viewing data as an asset to be extracted and monetized towards data as a collaborative asset, upon which many can benefit and come to rely upon. Furthermore, IPs and LCs are critical in ensuring nature data is of high quality, high integrity, and is consistent. They are important partners who can ensure improvements over time and often have the greatest agency in protecting fragile ecosystems when cultural practices and economic benefits are aligned.

2. **Improvements:** MRV technologies, from bioacoustics to remote sensing and artificial intelligence, are rapidly improving and becoming more accurate, more reliable and less expensive. Increased investment in MRV facilitates the advancement of technology and prices will continue to fall as adoption rates increase.

Table 2. Potential benefits of technological advances to measure ecosystem condition

Benefits	Examples
Quality - Improved quality and accessibility of data from established approaches	Remote sensing data, including the resolution of satellite imagery, are rapidly advancing, improving the availability and accuracy of maps of, for example, ecosystem extent, threatening processes (e.g. deforestation and infrastructure) and structure (e.g. biomass and vegetation height).
Types - Availability of new types of data that were previously difficult or impossible to collect	Advances in acoustic monitoring technology and data analysis approaches allow ecosystem condition indicators to be derived from the complexity, and species present, in the recordings. Similarly, advances in eDNA can provide information on the health and composition of communities.
Scale - Large volumes of data available for extensive geographic areas	Biodiversity data platforms, such as eBird and GBIF, are enabling compilation of large quantities of data on species' presence and trends over time, for increasingly large parts of the globe, which could inform measures of ecosystem condition.
Cost-effective - Efficiencies in data collection make new data collection and analyses feasible	New or enhanced existing technologies, including UAVs, remote sensing, camera trapping, acoustic monitoring and eDNA can obtain large amounts of data quickly and cost-effectively compared to traditional field methods.
Analytical power - Advances in data processing analysis can generate new insights into ecosystem condition	Machine learning and computer vision are quickly advancing with high potential for improving conservation monitoring. For example, advances in data analysis are allowing the automated detection of species' presence, or near real-time monitoring of threatening processes and condition.

Source: TNFD - Guidance on the identification and assessment of nature-related issues: The TNFD LEAP approach

3. **Disclosure:** TNFD's recent publication of a [high-level scoping study](#) has confirmed that demand for nature-related data is growing quickly and that a global nature-related public data facility is needed. A global nature-related public data facility could scale the availability, quality and maintenance of nature data with significant benefits for public, private and civil society stakeholders globally.
- "Underpinned by the right scope, governance, financing and incentive structures, and enabled by globally consistent methods and standards for nature-related data, a global nature-related public data facility would be a game-changer for better risk management and enabling new nature markets to emerge."*
Simon Zadek, Executive Director, Nature Finance
- MRV is critical for corporations and financial institutions reporting against the disclosure metrics within TNFD. Following the release and adoption of TNFD's disclosure recommendations, there is the possibility of a surge in the purchase of MRV technologies as companies move forward with disclosures on their nature impacts, dependencies, risks and opportunities – including their location, evaluation and assessment of nature related issues, within the LEAP approach.

MRV challenges and future developments

“MRV is essential to building trust and confidence in nature markets, which will ultimately help close the nature finance gap. Once trust has been established and maintained, NbS will truly be able to scale and support global progress on our shared climate and biodiversity goals.”

Raviv Turner, Founder, MRV Collective

While MRV is critical in unlocking international finance for climate and biodiversity, the sector itself is currently underfunded. While early stage funding in MRV has been growing steadily every year from \$53.4 million in 2018 to \$305.5 million in 2022, more investment is needed to scale MRV and close the finance gap for nature.

Challenges still need to be overcome in the following areas:

- 1. Increase capital:** To encourage investment and increase capital flows, the process for financial institutions measuring biodiversity impacts in supply chains needs to be simplified.
- 2. Greater understanding of supply chain impacts:** To deploy the right MRV solutions, a detailed understanding is needed of supply chains. Currently, traceability within supply chains is poor, limiting the ability to measure the impacts of a supply chain on biodiversity accurately. This is beginning to change with the enforcement of mandatory regulations such as the [EU Deforestation Regulation](#)

mandating companies importing commodities into the EU to provide evidence that their supply chains are free of deforestation. The [FAO](#) is also working with governments, businesses and other stakeholders in agri-food supply chains to educate and raise awareness of global sourcing impacts. As a result of these mechanisms, frameworks, and a rise in [platforms tracking land-use change using satellite imagery](#), companies are beginning to close the knowledge gap in their supply chains as they develop or extend their reporting on nature-related topics. For example, [Meridia Verify](#) is Meridia's Automated Field Data Quality Verification Solution helping companies to reach full traceability and due diligence compliance. Meridia's solution supports comprehensive assessments of supply chain datasets and data management practices, and then tests the field data quality of the supply chain to segregate compliant and non-compliant datasets for verification and assurance.

“For corporates to scale their use of MRV technology providers to assess NBS success within and outside their supply chains, we need to move towards standardised and open source NBS MRV models. Consultants will continue to win as long as MRV models remain in a black box, making real transparency very difficult (and auditing a massive pain).”

George Darrah, Director, Systemiq

- 3. Data integrity:** For companies to report accurately on nature disclosures, traceability within supply chains needs to improve. Blockchains are [popular for increasing supply chain transparency](#) and they are being used to trace supply chains to ensure environmental integrity. [Crystalchain](#) has developed a traceability tool and a method to trace entire supply chains to the batch, while [Verity Tracking](#) is a platform to track, verify, and empirically value carbon intensity across the full carbon lifecycle.

At present, the quality of MRV data being entered onto the blockchain in a bid to improve transparency is poor and not delivering the intended results. Root cause analysis on the fundamental problems in the science and traceability of MRV needs to be undertaken before bringing more MRV data onto the blockchain. Once scientific gaps in what to measure and how to measure it have been addressed and data integrity and quality has been improved, these type of solutions will be able to scale and deliver on their promises.

- 4. Adjust incentive structure:** Validation and verification bodies (VVB) need to be decoupled from the issuing of standards to create appropriate checks and balances in the system. Project developers, corporates and financial institutions need to look at setting aside 10-25% of their budget for independent MRV to ensure data integrity.

2.3 Building the market

Building market-based approaches to finance NbS, such as biodiversity and carbon markets, is an important way to fund NbS and to help close the existing financing gap. Government finance, development assistance and conservation and philanthropic funding are not going to be sufficient on their own to fund the protection and restoration of nature. Nature tech is playing, and will continue to play, a critical role in building and scaling these markets.

Biodiversity markets

Biodiversity credits have the potential to provide a significant contribution to funding the fight against nature loss. They offer a source of real, scalable financing that could flip incentives so that it is possible for people to be better off restoring and conserving nature than destroying it.

But biodiversity credits markets are not without risk. If credit markets are not founded on principles of high integrity, there is potential for missed opportunity or even real harm. The market needs to have space to emerge and scale, while at the same time ensuring its impacts are positive and the risks of harm are avoided.

“Voluntary biodiversity credits markets are on the horizon. There have been some early ‘pre-market’ credit trades, and there is rapid work underway by several groups around the world to design the standards that will govern what a certified biodiversity credit means to the wider, global market. It is very likely that the first biodiversity credits standards will be launched in 2023 and there is huge excitement around what comes next, with some expecting rapid market growth as those seeking to invest in nature positive outcomes are provided with a simple means to do so.”

Zoe Balmforth,
Co-founder, Pivotal Future

How can nature tech help?

High-integrity biodiversity markets need to depend on minimum standards of proof, so that those making claims can be sure they are telling the truth about the outcomes they have funded, and so that financing is directed to where it is proven to achieve positive change. Most buyers, especially those with brands to protect and corporate targets to meet, will want to know what they are buying and to see evidence for it. That burden of proof in turn depends on high-quality,

ground-level biodiversity data that can be stress-tested and audited.

Nature itself is beautifully complex – a system and vast web of other interconnecting systems – and this complexity makes the task of defining a biodiversity credit fiendishly difficult, and the role of measurement especially important. If a credit is to represent protection or restoration of ecological health, it will not be sufficient to measure actions taken, threats avoided, or the status of one species. Multi-dimensional, on-the-ground data on the state of biodiversity, across many different aspects of its complexity, will be required if buyers are to be able to tell the truth about outcomes achieved.

Technology is a powerful enabler here because if it is developed and deployed in a robust, science-led way, it will ensure that it is possible to produce a high-quality credit, backed with data and evidence of real, on-the-ground outcomes, without prohibitive costs. Technology means it is no longer true that scalability is the enemy of fidelity in biodiversity data, and that matters for biodiversity markets because it makes it possible to scale the market without risking trust and confidence in the product.

A global roadmap for harnessing biodiversity credit markets for people and the planet

A Global Roadmap for Harnessing Biodiversity Credit Markets for People and the Planet was launched by France and the UK at the 'Summit for a New Global Financial Pact' held in Paris in June 2023²². The development of this roadmap was supported by NatureFinance as part of the Taskforce on Nature Markets's initiative-based approach.

To build equitable, nature-positive biodiversity markets, and broader nature credit markets, the roadmap highlights five key design challenges to address:

1. Providing credible, timely, and affordable measurement and monitoring of the state, improvement and/or maintenance of biodiversity.
2. Scaling sustained, and high-integrity demand for credits and associated financing.
3. Ensuring sufficient, high-integrity supply of credits offering nature positive outcomes.
4. Securing adequate price and equitable distribution of rewards to project developers, sovereigns, and Indigenous peoples and local communities.
5. Establishing robust governance and broader, transparent institutional arrangements.

These five challenges are inter-linked and should be brought together as part of one integrated governance design effort to shape biodiversity credit markets. For example, scaling demand will require substantial policy direction, whether compliance-based or through upside incentives. An equitable distribution of economic rewards certainly will not be delivered automatically by free market dynamics alone, given the asymmetries in information and negotiation capabilities, especially for many (not all) local communities and Indigenous peoples. High integrity supply, likewise, will almost certainly need more than the combined efforts of project developers and private certification bodies.

The role of digital tools in modernising carbon markets

Over the past 15 years, carbon markets have served as an effective, global instrument to move funding from one part of the world to another. Billions of dollars have been mobilized and thousands of projects have been funded²³. But the first generation of these markets was built on manual practices, subjective calculations, and a complex infrastructure of players. To achieve the scale, speed and integrity required of these markets, they need an update. Digital tools will play a critical role, particularly in **MRV**.

D-MRV platforms offer solutions to remove bias, increase transparency, and rapidly scale high-integrity investments in activities that reduce

emissions. These platforms are in development for a range of different carbon project types. For the sake of specificity, the following focus is on the sector currently in the spotlight: forest carbon credits. It focuses on four ways in which credit issuances are being modernised.

1. Shift from manual data collection to satellite observation

Despite remarkable advances in satellites and machine learning, many credit calculations today still rely on costly, labor-intensive methods. Field crews measure individual trees by hand to inventory carbon stocks over a small sample of a project's area. These inventories occur every 5-10 years and cost tens to hundreds of thousands of dollars and can take months or even years to complete.

Satellite-based carbon mapping offers a scalable, cost-efficient approach to crediting. Satellites are also essential to enhancing credit quality, because they can observe forest change both within a project *and* the surrounding region, enabling a **data-driven approach** to computing a project's emissions impact. Without a satellite view of the landscape, status quo crediting can rely on assumptions that can lead to accusations of over-crediting²⁴.

For a detailed understanding of the complete ecosystem, from both **above the canopy and below**, we need to combine both remote sensing technology with ground-truthing data.

2. Shift from inconsistent, manual calculation to uniform, automated calculation

Today, project developers run credit calculations in spreadsheets, which auditors then review line-by-line. Though rules vary by registry, nearly all allow significant room to adjust calculations on a project-by-project basis. Crediting volumes can vary widely for the same project depending on who performs the calculations. With digital platforms, credit calculations would be automated, standardising crediting across projects and eliminating opportunities to manipulate crediting.

3. Shift from auditing projects to certifying platforms

With a shift to automated credit calculation, platform certification would replace project-by-project spreadsheet audits, speeding up time to issuance. Periodic platform certification would verify the accuracy of all calculations before a platform can participate in the market²⁵.

4. Shift from static documents to interactive, digital visualisation

To understand how credits are calculated for a project today, it would be necessary to read through hundreds of pages of registry documents and trace calculations through enormous spreadsheets. Satellite

observations hosted on a user-friendly platform with interactive data visualisations would allow buyers, landowners, and the public to 'see' the impact of carbon projects for themselves.

"By auditing systems rather than individual projects, we can dramatically reduce the time and costs associated to bringing new projects to market. This standardisation is critical to scale high-quality carbon projects."

Dick Cameron, VP of Science, Pachama

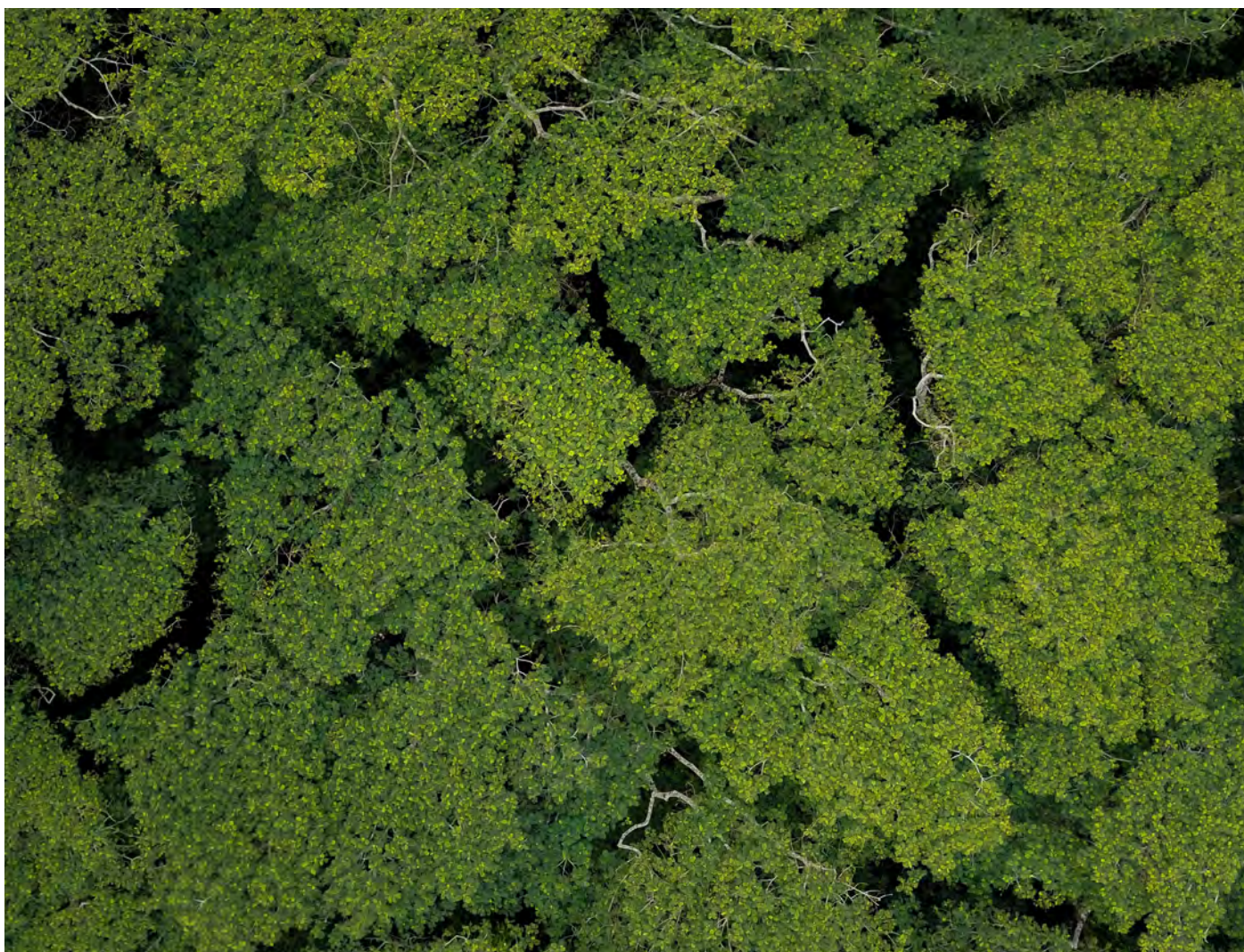


Image credit: Michael Olsen/Unsplash

2.4 Connecting communities and the market

A report by the UN estimates that nearly 75 million people are currently employed across various NbS that protect, manage and restore nature. This number is expected to increase by an additional 20 million people by 2030 if investment in NbS is tripled²⁶. For NbS to scale, communication and connectivity between entrepreneurs, tech providers, project developers, IPs and LCs and investors is key. Nature tech plays a critical role in creating connectivity and building links between IPs and LCs and smallholders to market and learning resources, between tech providers, project developers and IPs and LCs to measure impact, and between communities of people to support and promote nature and NbS.

Technology that connects has to build trust, which is often achieved through increasing transparency throughout the implementation process, operation and management of an NbS, the measuring of impact, financial transactions and benefit sharing.

Human-centred technology to unlock nature-based solutions

Land owned or managed by local communities is often ideal for the implementation of NbS. If NbS are to succeed and grow in scale, the

solutions must be owned, managed by and benefit the local stewards of the land. Yet historically, it has been too complicated and costly to make it worthwhile for local land-managers and communities to access the NbS market. If NbS are made economically attractive and straightforward for local communities to adopt, they would have the incentive and the tools to implement and manage NbS on a scale that the climate and ecological crises demand.

This is where technology comes into play. A human-centred approach to nature tech will unlock local capacity to implement NbS and connect impacts and the communities to the market. To be effective, the following three trends must be realised:

- 1. Technology that connects and enables local implementers and land managers:** One of the critical aspects of making NbS scalable is to ensure that initiatives are accessible and managed by local communities. This necessitates the development of technology that streamlines project implementation, automates reporting, and connects local actors and enables them to share knowledge. This will support local communities deploying NbS to generate the necessary data and reports that will unlock financing opportunities.

- 2. Focus on performance management:** Achieving long-term success with NbS requires a focus on measuring and reporting on progress and impact. This entails tracking leading indicators that enable targeted interventions to achieve desired outcomes over time. For example, while impacts like carbon sequestration might be the end goal, they will not be achieved if an intervention, such as growing trees, does not succeed. Tracking leading indicators ensures that action can be taken ahead of time to give investments in NbS the best possible chance of success.

- 3. Greater transparency of impact:** Transparency is fundamental to garner trust for NbS and tech can support the enhancement of transparency. NbS needs reporting that demonstrates to standards and investors how impacts such as carbon removal and equity sharing amongst local communities are achieved. It also requires clarity about the methodologies used to measure and calculate those impacts. The industry is already moving toward greater transparency, but it must be further advanced if NbS are to gain the support needed for wide-scale ecosystem restoration. Technology can propel the market toward heightened transparency.

Image credit: Taking Root



Taking Root, for example, is a company that is using technology to facilitate the creation of impacts that benefit smallholder land stewards, the climate, and nature. Its technology platform is used by project implementers to enable the management of forest carbon removal projects at scale while connecting thousands of smallholder farmers to the carbon market.

“Taking Root has always been focused on building for livelihoods through forest restoration. Human-centred technology is fundamental to achieving that goal. The industry needs technology which enables better knowledge sharing, capability building, and transparent reporting so locally owned NbS can successfully scale. The investments into tech-enabled NbS which will succeed are those that are in service of the people and communities who own and manage the land.”

Will Sheldon, Commercial Director, Taking Root

How does web3 support nature-related investments?

The fragmentation of digital infrastructure hampers nature monitoring progress. However, digitising sustainability data presents a chance to redefine our digital systems. NFTs, blockchains, and similar technologies empower users to control their data instead of relying on centralised entities. By shifting the data ownership paradigm, blockchains and digital ledgers can expedite global biodiversity goals. Web3’s emergence also facilitates coordination, accountability, and financing mechanisms for nature action.

Data and protocols that enable clear data provenance allow for publicly available data to be used

for baselining and information exchange, **particularly as AI grows in use**. This enhanced transparency has the potential to increase trust in data and in **NbS carbon credits** more broadly. A range of different solutions are being developed to increase transparency and enhance connectivity. For example **dClimate** is a chain-agnostic, decentralised climate and land data explorer and marketplace, featuring datasets as APIs that simply integrate into smart contracts enabling machine readable agreements. **SimplexDNA** is an environmental-DNA-based biodiversity monitoring system that uses blockchain to connect local communities, large corporations, and governments to generate a biodiversity baseline layer. **Open Forest Protocol** is a protocol that incentivises accurate monitoring of ecological assets, then monetizes verified climate projects through a transparent marketplace.

Web3's role in nature-based carbon markets

Platforms that reward regenerative land stewardship are **trending in the web3** sector. These platforms connect rural farmers to international climate finance and reduce inequalities between countries and regions. **ReSeed** is a platform that brings carbon credits directly from farmers to the market by financing and incentivising farmers to steward carbon through regenerative farming practices.

Regen is a platform that supports origination and investment in ecological credits, which include but are not limited to carbon. A blue economy developer, **Vlinder**, is piloting a forward-funded project on-chain with Senken and **Kolektivo** is piloting food forests in Curacao tied to digital assets in the form of 'GeoNFTs'.

Blockchain and finance platforms

Blockchain-based payment systems can enable the **deployment of payments for ecosystem services**. These systems aim to reduce the costs of implementing nature-based carbon credit projects and increase confidence in financial transactions through the transparent nature of blockchain technology. **Good Dollar** is a non-profit protocol enabling widespread access and use of digital currency through cell phone crypto wallets. **Symplifi** is a blockchain credit platform for underbanked businesses, eliminating friction and enabling affordable access to credit in emerging markets.

There are emerging technologies that enable de-risked institutional investment (i.e. green bonds) to **reduce the finance gap** for nature-based climate solutions. Several

financing platforms are evolving to provide liquidity and track value. **Solid World** is a financial service that aims to de-risk institutional investment into nature-based climate solutions for stewards by providing liquidity. **Mento** is a financial service that issues stable-value digital assets, which aims to track the value of an existing real-world asset. **Spirals** is a blockchain protocol that funds high-impact climate projects through redirecting yield earned by providing liquidity.

Gaming's untapped potential for nature and climate

July 2023's **Games for Change Festival** in New York City brought global representatives from the gaming industry together to discuss positive impact delivered through game play, including engagement with the UN Sustainable Development Goals. The global conservation community, including governments and environmental non-profits, is missing an opportunity to leverage the gaming industry and its communities to achieve our 2030 global biodiversity and climate goals in two important ways.

Connecting the general public

First, solutions to these crises demand mobilisation of the general public – at present, an unrealised aspiration. Games generate billions of engagement hours daily. They have great potential to foster change because they empower players to step into diverse roles, confront challenges, make choices, fail safely, receive feedback and explore consequences in a highly

engaging context. They give players *agency* – the ability to make a difference in virtual *and* real-world environments. Whether building awareness, providing visions for preferred futures or inspiring action through donations, activations for conservation causes and calls-to-action, there are growing proof points that games can inspire a generation to engage in shaping their future. There is untapped potential for the three billion gamers globally to participate in a meaningful way with biodiversity and climate action²⁷.

Mobilising finance

Second, the 2030 Global Biodiversity Framework aims to mobilise and diversify financing towards a \$200 billion annual goal (UN CBD). Gaming industry projections rise towards \$533 billion annually by 2027²⁸, after doubling annual revenue in the past five years. Initiatives like 'Humble Bundle' (which raised \$240 million for charities) and 'Playing for the Planet' have shown that industry alliances generate significant funding when gamer values align. Exciting potential also exists to bridge gameplay with real-world outcomes; a model which could democratise investing in nature, carbon and nature markets, and conservation projects. Take for example, Untamed Planet's Roblox game 'Untamed Animals', where over 10,000 players raised \$10,000 in two and a half weeks through in-game activities to adopt and name a rhinoceros and support wildlife conservancies in Kenya's rangelands. Strategic partnerships which can link insights from conservation technology such as wildlife monitoring, bioacoustics, and earth observations into virtual worlds will allow gamers not just to consume or design digital worlds, but advocate and invest in the living one.

Case study: Games for wildlife and storytelling

While games have always told stories, their use as a storytelling channel is gaining in popularity. Many games have even been the sources for very popular TV shows and movies. Some games, such as E-Line Media's "Never Alone" were created entirely to tell a story, in this case, the traditional stories of the Iñuipat Alaskan native people.

Being much more reliant on documentary film, the wildlife and nature sector has not yet embraced games as a storytelling medium. This is a significant, missed opportunity to tell the stories of wildlife, its habitats, the conservation of those habitats, and the people on the front lines of that conservation work.

In the past few years, however, examples have emerged that can provide the inspiration for more investment and experimentation in this field. **Internet of Elephants**, a company dedicated to wildlife storytelling through games, has released a number of products, including "Wildeverse" – a location-based AR game for mobile, which lets players recreate the jungles of Borneo and Congo in their own backyard while searching for Fio the orangutan. "Alba", a game by **UsTwo Games**, tells the story of a girl visiting her family in the Mediterranean, but ultimately transforms her summer holiday to that of saving local wildlife.

Each of these games takes a completely different approach to telling the stories of wildlife, nature, and conservation, proving that games offer endless opportunities to tell powerful stories and have the potential to engage audiences more deeply and longer than traditional mediums.



2.5 Transparency

By tracing global supply chains and measuring and verifying the development and impact of NbS, tech can make global impacts on nature visible, hold environmental markets accountable and increase trust in NbS.

Developing and sharing carbon, social and biodiversity data

Carbon markets operate by establishing a financial value for the sequestration, reduction or avoidance of carbon emissions. But many projects generating carbon credits are also nature-based solutions (NbS) that provide other services that benefit people and nature – for example, biodiversity uplifts, or improved health and livelihoods for communities. Businesses are increasingly recognising these values beyond carbon, and want to understand not only how their investments lead to credible carbon outcomes, but how they have a positive impact on biodiversity and people.

Many platforms use satellites and remote-sensing technology to generate the desired data, which can offer valuable insights into the impact and effectiveness of NbS interventions. Examples include estimating impacts such as soil health and biomass changes (**Loamin**), modelling tree canopies (**Genvision**), and measuring a variety of carbon, social and biodiversity indicators (**Chloris**). This follows a

trend towards increased reliance on satellite reporting. However, for many indicators the data gaps and uncertainty levels remain high. It is anticipated that in the future, increased investment in private data providers, such as **Planet Labs**, can fill these gaps, while complementary investment in on-the-ground data collection and national inventories is also needed to improve the accuracy of estimations across different regions and ecosystems. This is a complex area where building trust is critical and so moving away from on-the-ground data collection should be done at a pace which takes into account confidence hand-in-hand with developments in science and technology.

To enable businesses to make credible claims about impact, systems that can aggregate, dis-aggregate, and communicate a wide range of impact data from NbS will be essential. In the VCM, credit ratings agencies support this by bringing together data from multiple sources to analyse and rate projects, validating their quality. Often, the ratings give businesses an understanding of how likely a project is to generate the carbon impact they seek, or claim. For example, both **Renoster** and **Sylvera** focus on developing advanced carbon models. **Calyx Global** supports both greenhouse gas integrity and SDG impact ratings, and **BeZero** combines a wide variety of data from project documents, peer-reviewed literature, conservation databases, and remote-sensed sources. To date, these ratings have been focused on carbon, with limited information on the delivery of wider ecosystem services.

Intermediaries in environmental markets can also play a role in helping businesses understand and communicate project impacts. Platforms are emerging that develop and connect businesses to NbS projects, as well as generate project scores. For example, **Earthly's** platform features a project assessment framework that analyses 106 indicators across carbon, biodiversity and people to give a more holistic view of project integrity and impact.

Carbon, biodiversity and social data allows businesses to explore opportunities to integrate their NbS investments within their wider ESG strategy. For example, by focusing investments on a small number of high-quality projects, businesses can meet multiple ESG targets simultaneously – such as land area restored and lives improved. This also helps to tell a more coherent impact story to employees, customers and shareholders.

“Whilst much of this reporting is done outside standardised frameworks today, we expect this will improve as businesses start to follow new guidance, setting science-based targets for land. Hopefully, this will help to increase ambition to tackle nature loss and climate change together, and ensure corporate investments in nature are proportional to, and even go beyond, their negative impacts on the planet.”

Oliver Bolton, CEO and Co-founder, Earthly

Transparency and technology: the way forward for environmental assets

Technology is a critical tool for enhancing transparency and unlocking much needed finance to:

1. Accelerate project workflow and drive down the costs of manual mapping, satellite analysis and data collection, thereby shortening the time it takes for environmental assets to generate revenue.
2. Produce audit-ready emissions calculations for each carbon credit, to be verified by international standards and carbon credit ratings companies using software developed in-house.
3. Deliver community benefits, supported by blockchain data, which records community consent and tracks the flow of funding to indigenous and local communities.

Technology infrastructure for scale: automating carbon credit production

Carbon credit production is vital for generating revenue from protecting threatened forests. Reducing the time it takes to generate cash flow from each project can encourage more participants into the market. Software can reduce the time and effort required at the initial assessment stage, as well as the credit calculation and documentation stages of carbon credit production. With the automation of maps, tables and most importantly, emissions calculations for new projects, the time required to generate cash flow can be cut. The key is to design the software

from the ground up so that the data and calculations produced are audit ready – meeting or exceeding current industry standards.

Accurate data for credit calculations

Following an initial project feasibility study, gigabytes of complex data are analysed in the cloud. Months of work from PhD-level technical experts can be reduced to minutes by using technology. But what about the data itself? Can that be verified and streamlined for transparency? The short answer is yes.

For example, AI can model peatland hydrology to allow the tracking of water flow around a site according to the elevation and distribution of waterways. This data is essential in helping to raise water levels to their original state. Understanding the path and level of water is crucial, as it has a direct correlation to tropical forest health and regrowth. With this level of detailed analysis, the placement of peat compaction dams in the logging canals that dried out the land can be optimised, resulting in measurable rises in water levels. This creates the right conditions for assisted regeneration of the forest, which begins to return naturally.

By using satellite analysis, high-resolution maps of the forest can be developed showing increases in forest cover, increasing trust in this approach to assist regeneration.

The production of extensive scientific documents required for verification represents a significant human resource cost for project developers. Specialised software that permits real-time collaborative writing on the same document with review, tracking and stylistic capabilities will ensure all documents are formatted according to the

requirements of each verification standard. Taken to scale, using this software cuts down the time required for experts to perform necessary reporting and ensures that company systems are ready to use large language models and other forms of AI support.

Transparency at the source: creating a value-based carbon credit through technology

Showcasing the impact of monitoring technology, while demonstrating the impact of climate finance on local communities, will bring accountability to the sector. Web3 can bring all this data on-chain, increasing transparency and starting the process of decentralising verification.

Web3 transparency also offers buyers the choice to fund smaller, locally-managed projects in addition to premium carbon credits from larger scale, commercial projects. For community forestry, all finance is 100% reported and audited externally, adding a critical element of financial transparency. These projects are a vehicle for delivering community funding and project revenue sharing.

The way forward: ground up investment, decentralisation and standardisation

Greater transparency will increase accessibility, equity and the quality of carbon credits. Innovative technology and increased social impact should play equal roles in the next generation of carbon markets. Decentralising validation and credit issuance can bring buyers and sellers together more directly.

Case study - Forest Carbon

Forest Carbon, backed by AXA Investment Managers and PT Saratoga Investama Sedaya Tbk (Saratoga), is building technology infrastructure for scale from the ground up. Managing and restoring over 22,000 hectares of Indonesian peatlands through the **Sumatra Merang Peatland Project**, Forest Carbon is at the forefront of forest and biodiversity monitoring. Tested in harsh tropical environs, the company's technology has been validated and is now being deployed.

Since its inception in 2016, the Sumatra Merang project has successfully restored forest cover from 1% to 36%. In addition, the project invests back in the local community to provide health and education services. The project also creates jobs and programmes that bring additional areas under protection through community-led forestry.

"We stand alongside Forest Carbon in their ground-breaking efforts to fuse technology with environmental conservation. Together, we believe in a future where innovation leads us towards more sustainable growth."

Devin Wirawan, Investment Director, Saratoga

Through the development of proprietary software, Forest Carbon is reducing the time and effort required at the initial assessment, as well as the credit calculation and documentation stages of carbon credit production. By automating the maps, tables and most importantly, emissions calculations for new projects, the company is reducing the time it takes to generate cash flow from each project.

"Forest Carbon believes it can improve the quality of carbon credits by offering more granular and robust impact data. Together with investors, Forest Carbon is confident that technology-based solutions hold the key to addressing current bottlenecks in capital for nature-based projects, while driving down the high cost and barrier-to-entry for smaller land stewards."

Devan Wardwell, Chief Operating Officer, Forest Carbon

Forest Carbon's proprietary assessment tool has increased the number of new project opportunities assessed, increased the quality of the assessments, decreased decision making time and increased competitiveness by offering the capability to act immediately on new opportunities. The software presents data in a custom project dashboard, incorporating data from Internet of Things (IoT) sensors to track and monitor weather, biodiversity and rainfall data. Camera traps and bio-acoustic sensors have been able to track the return of various endangered species at the site such as Sumatran tigers, gibbons and sun bears.

Forest Carbon is exploring partnerships with companies like **Meridia** to incorporate digital land rights certificates in its work, increasing the strength of social safeguards, and documenting historical land rights for local populations.

"We are excited to see technology solutions road tested by Forest Carbon in the field, and believe their systems have the possibility to increase their speed of growth and deliver more transparency to the market."

Adam Gibbon, AXA Investment Managers Natural Capital Lead

Section 3: Nature tech in action

3.1 Regional spotlights – accelerating regional innovation

A just and equitable transition to a nature-positive and net-zero future requires a coordinated global response. Every region of the world is developing solutions to address the global challenges of biodiversity loss and climate change. This chapter looks at important trends occurring around the world.

Innovation from the global south

Written by Alex Comminos, NatureHub

It is anticipated that some of the most important innovations in nature tech will come from the Global South, where innovators are actively catering to the needs of local smallholders in ways that may disrupt incumbents in OECD markets. In Brazil, for example, there is evidence of the emergence of innovative solutions to address local problems that have global consequences.

Over the last two years, investments in and commitments to restore extensive landscapes across Brazil are generating an exciting wave of nature-based innovation and impact. Solutions that address the acquisition and use of land, and build a bio-economy are evolving and showing great potential.

Land acquisition - In Brazil, solutions are emerging to replicate and adapt the digital services of the real estate industry to nature-based solutions in support of stakeholders expanding into new territories. Start-ups are centralising disparate data sources to enable faster and better decision making, seamlessly aggregating environmental, economic, and legal data inputs.

Land preparation - New nature tech innovations are working hard to make restoration efforts more efficient and economically viable. Companies are emerging that enable mass reforestation at speed and scale by using technology to plant in hard to access locations. In addition, solution providers are developing innovative services that address

critical operational bottlenecks related to seed supply and seedling production.

Bio-economy - New solutions are helping to create infrastructure that aims to build the capacity of local communities. For example, converting nuts and fruits into food, oils or cosmetic products. These traditionally offline communities are also benefitting from fintech services that connect them to purchasers and buyers, offering low cost and convenient access to essential financial services. Platforms, such as [NatureHub](#), are arising to connect the diverse NbS community and to share and exchange knowledge.

Africa

Written by Caitin Wale, Founder and CEO, Kinjani

Africa's nature tech revolution: building the silicon savannah

Africa is in the midst of a transformative journey, in which the burgeoning field of nature tech is playing a central role, offering sustainable solutions. These trends are not mere theoretical concepts; they are backed by compelling data that illustrates Africa's evolving landscape.

Green credits: The Africa Carbon Markets Initiative (ACMI) aims to invest up to \$1 billion in high-integrity African credits²⁹. These credits focus on diesel replacement and biodiversity, reshaping sustainable development in Africa.

Carbon removal: Africa is a significant player in climate change mitigation, with the potential to help remove billions of tonnes of CO₂ annually. This contribution is bolstered by Africa's rich resources, including energy, biomass, rocks, soils, oceans, and a growing population.

Renewable potential: Some African regions are blessed with abundant renewable energy sources: solar, wind, geothermal, and hydroelectric power. Ethiopia³⁰ and Kenya³¹ already boast grids powered by 93-99% renewable energy, and untapped hydro energy potential remains.

Rural empowerment: Nature tech innovations are transforming rural Africa, creating income opportunities and improving lives. Innovations like

solar irrigation, biodigesters, and clean cooking solutions empower communities and fuel industries like biogas and hydrogen, thanks to financing through carbon credits.

Carbon storage potential: Africa holds significant geological storage capacity, about 20% of global capacity, ranging from 1,500 to 55,600 GtCO₂³². This underscores Africa's integral role in carbon capture and storage.

Expansive land and oceans: Africa's vast landmass, surpassing the area of China, Japan, India, the US, the UK, and Europe combined, offers ample opportunities for sustainable agriculture, biodiversity conservation, and marine protection.

A resilient and growing population: With a projected population doubling by 2050, Africa faces severe climate-related challenges. About 45% of the population is expected to be affected, driving industries to adopt climate-smart solutions³³.

Enhancing food and water access: Innovations like biochar and enhanced rock weathering improve soil quality, water retention, and crop yields. Decentralised agriculture practices like intercropping, fungi cultivation, and agroforestry boost resilience and agricultural productivity.

Future agriculture: Precision agriculture, aided by satellite technology and drones, enables data-driven sustainable practices. Bio-

based fertilisers and insect farming reduce agriculture's environmental impact, while cold chain storage technologies mitigate food losses and waste, enhancing food security.

A sustainable approach to building and mining: African nations are increasingly integrating nature and biodiversity into urban planning. With more than 30% of the world's mineral reserves, Africa plays a significant role³⁴. Nature tech innovations, such as using invasive plants for biochar production and mine waste rehabilitation, decarbonize industries and promote nature-based solutions.

Africa's embrace of nature tech trends, supported by compelling data, reflects a continent committed to sustainable development, with global benefits. Leveraging its abundant resources, Africa charts a technologically advanced path toward a brighter future, benefiting not only itself but also the global community.

"Kinjani's venture building programme aims to foster a bustling climate tech ecosystem in Africa, leveraging its talented and growing workforce, abundant natural resources and the power of technological innovations. Our focus is to inspire local entrepreneurs and cultivate innovations that enhance climate resilience, implement a circular economy, and promote carbon removal in supply chains."

Caitin Wale, Founder and CEO, Kinjani

Latin America

Written by Naomie Lecard, Albo Climate

Digitise to scale: Albo Climate's D-MRV technology for nature-based climate solutions in South America

Scaling nature-based solutions is critical in meeting climate targets and protecting vulnerable natural ecosystems – from mangroves in Asia to rainforests in South America. Albo Climate is an Israel-based start-up that developed a novel remote sensing platform, powered by AI and satellite technology, to quantify and monitor environmental metrics in nature-based climate solutions across ecosystems worldwide. By applying proprietary AI models to myriad high-resolution satellite data, Albo Climate's environmental intelligence platform delivers transparent pixel-level data, insights, and forecasts on carbon dynamics, land use and deforestation, biodiversity, and climate risks.

Earth Observation technologies, such as those pioneered by **Albo Climate**, are emerging as crucial tools in driving the transition towards sustainable land use and scaling nature-based climate solutions across South America. Digital MRV (D-MRV) technologies are catalysing the preservation and restoration of some of the most fragile ecosystems and unique biodiversity hotspots, such as the Amazon region, which provide the world with invaluable ecosystem services, including carbon sequestration, biodiversity conservation, and climate regulation.

Scalability is paramount in maximizing the environmental benefits of nature-based climate solutions and unlocking their full mitigation potential to keep temperature increase below 2°C.

However, scalability introduces some critical technological challenges: data collection, processing, and transparency.

“By harnessing the power of AI and novel modeling techniques, Albo enables the comprehensive analysis of carbon stocks and biodiversity at scale. Furthermore, we provide environmental insights to implement financial incentives and strategic action plans. Albo Climate's primary focus is on large-scale forest conservation and regeneration, as well as natural habitat preservation projects in South America.”

Dr. Marco Calderón-Loor,
CTO, Albo Climate.

For instance, Albo Climate has partnered with an Environmental Conservation NGO *Fundación Futuro*, and *Universidad de las Américas (UDLA)* to deploy its novel D-MRV technology in one of the last tropical mountain forests – the Chocó Andino Biosphere – a UNESCO Natural Heritage Biosphere Reserve located in Ecuador and extending over 286,805 hectares. Albo Climate developed a **robust AI model specifically trained for this ecosystem** with local and regional data, which produced a series of yearly carbon stocks maps at a 10-meter-per-pixel resolution. This model is used to support an innovative financial climate mechanism aimed at protecting this vital ecosystem.

“The Chocó Andino is a challenging landscape mosaic encompassing a wide range of forest types, along environmental gradients over short distances. Nevertheless, our above-ground carbon monitoring model succeeded in capturing the complexities of these ecosystems and delivering the improved accuracy and resolution we had aimed for, thanks to

our ongoing research programme on mountain forest dynamics supported by permanent sampling plots.”

Francisco Cuesta, Deputy Scientific Director, UDLA and Albo's Scientific Advisor.

AI-powered remote sensing technologies are also increasingly used to observe and track temporal and spatial changes in biodiversity health, which can be of utmost importance to monitoring the co-benefits of nature-based solutions. Whether to quantify and map at the pixel-level floral species abundance in a given project, ecosystem, or at the landscape level, or to monitor and map habitat suitability and connectivity, Albo Climate is providing actionable biodiversity data, used by various stakeholders to implement conservation policies and action plans. For instance, Albo has collaborated with *Universidad de las Américas (UDLA)* and WWF-Ecuador to develop a **habitat connectivity model** and provide high-resolution mapping of rivers, wetlands, and seasonally flooded habitats for the entire Ecuadorian Amazon region³⁵. This data will subsequently be used to implement conservation planning by WWF-Ecuador, which aims to locate key conservation areas to maintain habitat connectivity for threatened river fishes migrating from the Peruvian and Colombian Amazon towards the heads of river watersheds in the Ecuadorian Amazon.

With the health of our planet at stake and with the effects of climate change already being experienced, leveraging Earth Observation and AI to digitise MRV methods represents a one-of-a-kind opportunity to comprehend the environmental impacts of nature-based solutions in South America and beyond, comprehensively and at scale.

Asia

Written by Vega Welingutami and Kristýna Vydrová, Koltiva

Nature-based solution trends in Asia: leading the way towards climate resilience and sustainable supply chains

Climate change has profound implications for agriculture, with increased temperature, changing rainfall patterns, and extreme weather events affecting crop productivity and food security.

The expanse and geographical diversity of Asia-Pacific means that the region encompasses a diverse range of geographies and climates. Together with its growing population, this diversity brings a broad spectrum of challenges and hazards. Disasters (as a GDP%) cause more damage in Asia-Pacific than anywhere else in the world. The primary cause of the high rates of GDP loss is the heavy reliance of over 60% of the region's workforce on sectors highly prone to climate change. The main sector is agriculture, providing livelihoods to more than 2.2 billion people³⁶.

At the same time, agricultural activities release significant amounts of greenhouse gases (GHG) and are one of the main drivers of climate change. Asia and the Pacific account for 37% of the world's total emissions

from agricultural production, and the People's Republic of China (PRC) alone accounts for more than 18% of the total³⁷.

Consequently, NbS trends in Asia are closely linked to the region's vulnerability to climate change impacts, particularly in the agriculture sector. The solutions focus on climate-resilient agriculture, emphasising techniques such as agroforestry, regenerative agriculture, and precision farming. These approaches aim to enhance the adaptive capacity of farmers, improve water conservation and carbon sequestration, increase agricultural productivity, and mitigate greenhouse gas emissions.

Moreover, in response to growing consumer demands for traceability, ethical sourcing, and reduced environmental impact, Asian countries are implementing NbS practices throughout the whole supply chain. This includes promoting sustainable land management practices among both large-scale plantations and smallholder farmers, adopting green logistics and transportation systems, and implementing circular economy principles in food processing and packaging.

By embracing nature-based solutions and actively participating in global initiatives, Asia is playing a crucial role in shaping the global response to climate change and advancing sustainable supply chains for a more resilient future.

Koltiva supports agribusinesses with solutions and services to address the environmental impacts of their operations and reduce carbon footprints across their global supply chains. Together with enterprise clients, Koltiva is attempting to solve the triple challenge to increase smallholder farm productivity while enforcing environmental protection and promoting trade transparency.

"Koltiva's software ecosystem, KoltiTrace MIS, plays an important role in addressing climate change by enabling companies to track and monitor their supply chains for sustainability and climate-related issues. Key features of this end-to-end application ecosystem include farm management, geo-location mapping, supply chain GHG assessment, land use tracker, and de-carbonization ranking."
Manfred Borer, CEO, Koltiva

North America

Written by Renée Vassilos, The Nature Conservancy

The changing landscape of agri-tech

Agriculture can play a critical role in mitigating climate change and biodiversity loss. The way to realise the potential of agriculture is to support the scaling of regenerative agriculture production systems. The agriculture industry is a lucrative market for incumbents dominating the sector but that is changing with new companies developing solutions that are creating competitive pressure and revealing new market opportunities. Some of these new solutions will be critical for supporting the transition towards regenerative production systems. Regenerative practices that are critical for farm and ranch operations to adopt to rebuild soil health and thereby realise positive planetary-scale outcomes from agriculture production are increasing acres under cover crop, increasing crop rotations, increasing acres under minimum till or no till, input optimisation and scaling rotational grazing management plans. However, it is often the case that adopting these practices that improve soil health also increases the complexity of a farm or ranch operation and highlights several obstacles to adoption, including labour shortages and the risk of increasing costs in a low margin business.

The Nature Conservancy (TNC) is using investment as one tool to support the adoption of these practices. TNC is supporting solutions that show potential to scale one or more of the regenerative practices that rebuild soil health. The goal is to make these regenerative practices not only the right decision from a conservation perspective but also the right business decision for farm and ranch operations.

As awareness that we need to change the way we produce food is growing, the investment landscape is starting to change. There is an emergence of an early stage technology ecosystem where venture dollars are starting to flow and more companies are being formed, creating an interesting and engaging space to be investing in.

Conservation

Healthy soils deliver climate and nature benefits. To achieve its health building goals, TNC supports solutions that provide conservation benefits and allow producers to implement practices in a profitable way. For the delivery of conservation outcomes, conservation goals and business objectives should be intricately linked from the beginning and at every stage of the business lifecycle.

“If we are not supporting solutions that provide conservation benefits and ensure that the practices can be implemented in a profitable way, then we will not be able to achieve our soil health goals.”

Renée Vassilos, Director of Agricultural Innovation, TNC

Case studies

VENCE is a virtual herd management solution start-up. The regenerative grazing lands team within TNC believes that virtual herd management is a critical tool required to scale the adoption of regenerative grazing management plans. Fixed fence, one critical component of traditional herd management, is a barrier. TNC invested in Vence in 2021 and they were acquired by Merck Animal Health in 2022, demonstrating that some of the incumbents in the sector are investing outside their historic business lanes.

Growers Edge is a financial technology company, invested in by TNC, that created a tool to support the adoption of regenerative practices. One of the barriers to large-scale adoption of regenerative practices is the financial risk a farm or ranch takes on by introducing a new practice. Growers Edge developed a warranty that enables farm operations to de-risk the adoption of cover crops. In addition, a warranty to support the adoption of nutrient management practices is being piloted in 2023.

Image credit: Tim Calver / The Nature Conservancy



Focus on conservation

TNC's investment process is focused on identifying companies that can support our conservation outcomes. Conservation, rather than returns, guides our decision making. To that end, TNC uses the following safeguards in assessing potential investments:

1. When an investment has a scientific component, the TNC science team reviews the solution, ensuring there is scientific evidence demonstrating the conservation value of the company's product.
2. TNC's internal team working in the agriculture sector assess whether a solution has the promise of circumventing, mitigating or disrupting a known

challenge or roadblock to scaling the adoption of regenerative agriculture practices on farm.

3. Diversity screening is conducted by TNC's Director of Agriculture Innovation.
4. Unintended consequences and reputation risk for TNC are also considered.
5. TNC maintains a narrow, tactical investment thesis. The solutions must support the scaling of one or more of the practices scientific research has confirmed rebuild soil health.

Challenges

TNC sees this investment strategy as a complement to the work of core teams and partners. The investments are intended to support the core teams delivering results on farm and

on ranch. When feasible, TNC works collaboratively to test promising solutions and share knowledge gained both internally and externally. The goal is to support faster market transformation and realise the role agriculture can play in climate change mitigation and halting and reversing biodiversity loss.

Through their seat at the investor table, TNC is seeking to support the innovation and technology needed to support the profitable adoption of regenerative practices on farm and on ranch. Rebuilding soil health is the critical component to building more resilient agriculture production systems that benefit climate, biodiversity and support the well-being of farm and ranch operations and rural communities.

Europe

Written by **Oliver Bolton, Earthly**

How Europe is innovating and diversifying the market

In Europe, there are an increasing number of independent platforms filling the gaps in international carbon crediting systems, enabling farmers and foresters to benefit from increasing corporate investment in landscape recovery and regeneration.

For example, **Pina Earth** has developed AI technology that can model forests under climate change to support decision-making in forest management. Europe has a history of monoculture forests, in which 33% are dominated by single tree species. Pina has the potential to help reverse this trend by allowing businesses to make contributions to climate adaptation in the forestry sector. Another example is **Climate Farmers**, who are working with farmers across western Europe to quantify the carbon, biodiversity, soil health, and water impacts of holistic grazing management, generating contribution credits that can help finance the costly transition to regenerative practices.

Farmers are innovating in the marine as well as land sectors, and while accounting methodologies for

impacts like carbon are lacking, an increasing opportunity for seaweed is being realised. Seaweed not only sequesters carbon, but also has positive impacts on biodiversity and water quality, which may complement the income from the wide range of seaweed-derived products that are possible. For example, **Biome Algae** in the UK Southwest is working with leading universities to explore the impacts of leaving seaweed on lines outside harvesting cycles. The project has already demonstrated an increase in biodiversity around the farm, and has designed a scalable wind/solar powered processing facility and biorefinery, to power the processing for seaweed-derived products while minimising carbon emissions.

In the UK, the **Woodland and Peatland Carbon Codes** can be used to generate credits for offsetting. However, there has been a gap in the quantification of co-benefits for people and biodiversity, as the methodologies do not have detailed requirements for positive impacts beyond carbon. We expect this to change as businesses use UK carbon credits towards their CSR goals as well as (or instead of) carbon offsetting. The pricing, slower time frames for delivery

of verified carbon units, and the smaller scale of the projects make them ideal to top up international portfolios of carbon credits so that UK/European businesses can have a local impact while remaining on a pathway to net zero.

The UK government has facilitated the development of an increasingly wide range of national environmental markets, spanning biodiversity, nutrients and carbon. This is giving land developers the opportunity to differentiate segments of their land to monetise different ecosystem services – for example, focusing on nutrients near water, biodiversity in grasslands, and carbon in woodlands and farms. More experimentation is needed to explore the pricing and stacking of these impacts outside compliance markets, as it is expected that demand for voluntary credits linked to biodiversity will grow as frameworks like TNFD are more widely adopted. Project developers, like **Creating Tomorrow's Forests** and **the Future Forest Company**, are already making use of DEFRA guidance, on-the-ground surveys and new technology like eDNA to quantify baselines, anticipating these opportunities.

3.2 Case studies

Koltiva

Written by Vega Welingutam and Kristýna Vydrová, Koltiva

Empowering Indigenous peoples and local communities (IPs and LCs) in sustainable agriculture through mobile technology

Mobile technology, including smartphones, has become increasingly accessible and affordable, even in remote areas. Up to 32% of producers Koltiva works with have access to mobile phones with the numbers growing rapidly, especially in Asia.

Koltiva recognises this transformative trend and strives to use it to bridge the digital divide and drive financial inclusion for rural communities. By leveraging human-centred technology, backed by boots-on-the-ground support, all supply chain actors are empowered to actively participate in sustainable farming practices while increasing their digital literacy and financial access.

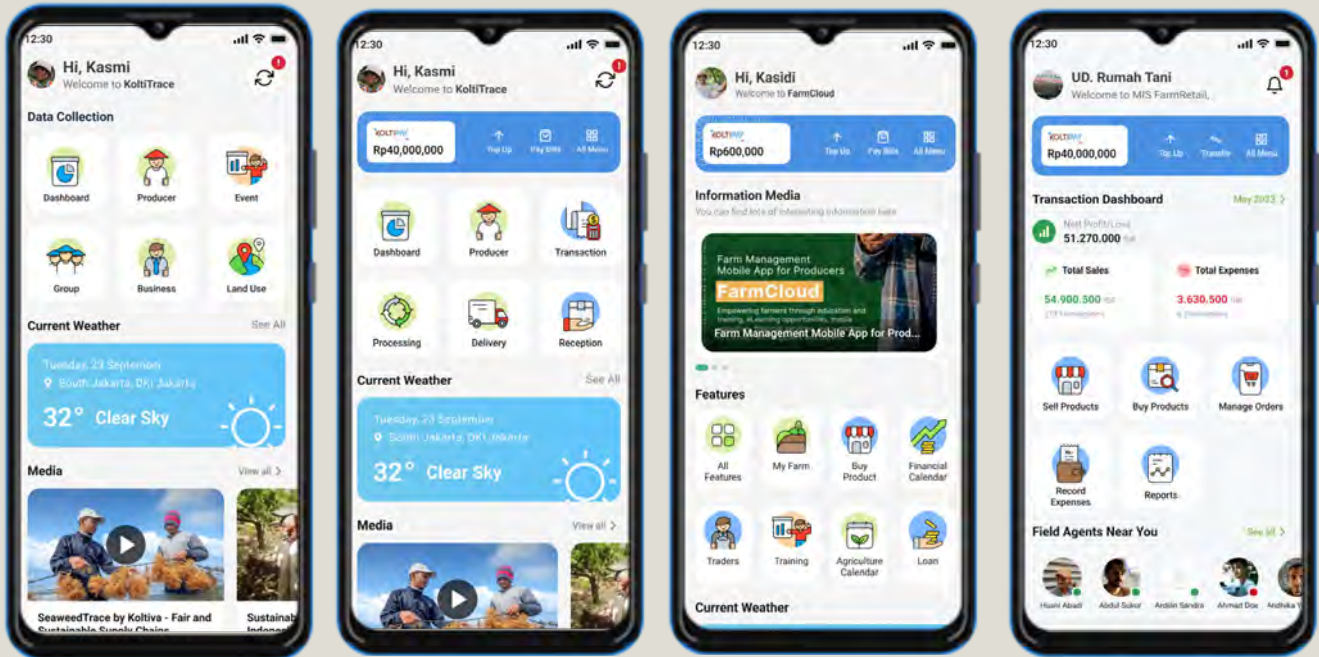
At the core of Koltiva's mobile tech solutions is the aim to provide agriculture communities with enhanced access to information and resources, offering the following user-friendly mobile applications tailored to the specific needs of individual supply chain actors:

FarmCloud: Farm management mobile app for producers. Providing access to personal and supply chain data, eLearning, media, and interaction with input suppliers and crop buyers. Access to eWallet feature KoltiPay for savings, loans, PPOB transactions, crop procurement, agri-inputs purchase, and premium payment.

FarmRetail: An e-commerce mobile app for agri-inputs shops and distributors improves market access to sell high-quality inputs, manage sales, and ensure seed-to-farm traceability. Integrated with KoltiPay for cashless payments.

FarmGate: Designed for various parties involved in the purchasing and handling of crops. This app allows for the traceability and segregation of produce from the farm to the factory.

FarmXtension: Used by field agents, agronomists, or extension officers to collect and verify producer data, map farm polygons and record training, and coaching activities.



By using the mobile applications, producers gain access to information on best agricultural practices, market insights, weather updates, relevant educational resources, as well as verified data about their farms. Farmers can use this data to support the land legalisation process, or as a proof of compliance with buyer’s requirements or third-party certification standards. Producers are empowered to make informed decisions, optimise their crop production, and adapt to changing market dynamics.

Koltiva’s mobile tech application is also pivotal in fostering digital and financial inclusion among rural farmers. By integrating a secure digital finance feature (KoltiPay) in the applications, access to financial services such as mobile banking, microcredits and insurance is simplified. These financial inclusion initiatives empower rural farmers to break free from traditional barriers, unlock economic opportunities and gain economic independence.

Through the integration of technology, we can pave the way for a more inclusive and prosperous future for rural communities.

Flying Forests International

Written by Dr Lauren Fletcher, Beta Earth Global

Flying Forests has developed ecosystem restoration drone technology and a global distribution network that equips and empowers local communities to become long-term environmental stewards, with fair revenue sharing.

Emerging drone-based technologies invented in 2009 by Dr. Lauren Fletcher are allowing the automation of ecosystem restoration.

Private forested landownership is highly fragmented. It is estimated that this fragmented ownership of private forested lands climbs to as much as 80% owning less than 10 hectares on a global basis³⁸. However, Flying Forests say that 80% of private forested land-holders around the world do not have enough land to scale up to a single day's worth of drone-based restoration operations with the current drone-companies. This locks them out of access to the technology and excludes them from the direct financial and social benefits. Flying Forests address this social and environmental gap.

A core objective at Flying Forests is to provide a technology layer in partnership with existing, local organisations that already have active ecosystem restoration activities, greenhouses, and seed collection. By creating locally co-owned business units that employ local pilots and members of the local community for seed collection and seedball manufacturing, they are able to reduce the cost of access *and* provide local social uplift with fair revenue sharing throughout the value chain.

The **Lucha Startup Studio**, a key partner, was founded to close social and environmental gaps in Peru. One project in Piura, northern Peru, trains and employs local community members to grow sustainable agroforestry products, and to monitor and manage the forest with satellite and drone data. Restoration has typically been through hand-planting, but with the partnership with Flying Forests, they are integrating the drone restoration platform and scaling up to countrywide operations.

Drones and satellites first make detailed maps of the terrain, nutrients, and biodiversity – which is combined with information from local ecologists who identify the correct mix of native local species appropriate to protect and expand local biodiversity, as part of the ecosystem restoration plan. The data is passed through machine learning algorithms to generate geo-referenced planting maps. Local ecologists match tree and other species with the correct soil conditions to ensure the highest yields and biodiversity. Mapping provides important data for the planning of restoration, conservation and certification of restored environments. Regular project monitoring is conducted, both with drone surveys on a quarterly basis, and a social audit on an annual basis.

One planting team is able to plant 100,000 seedballs/day. A country business unit can plant 40 million/year and just 25 countries will be able to scale to one billion planted each year.



Flying Forests is improving livelihoods and reducing poverty among vulnerable communities by introducing a number of livelihood interventions. A local stakeholder economy develops around seed collection, nurseries, and regenerative agroforestry. Additionally, carbon revenue released annually helps to sustain community engagement over time. These restoration activities not only mitigate climate change and improve food security for rural populations, but also promote community education and upskilling. By building lasting relationships sustainability is guaranteed.

Meridia Verify

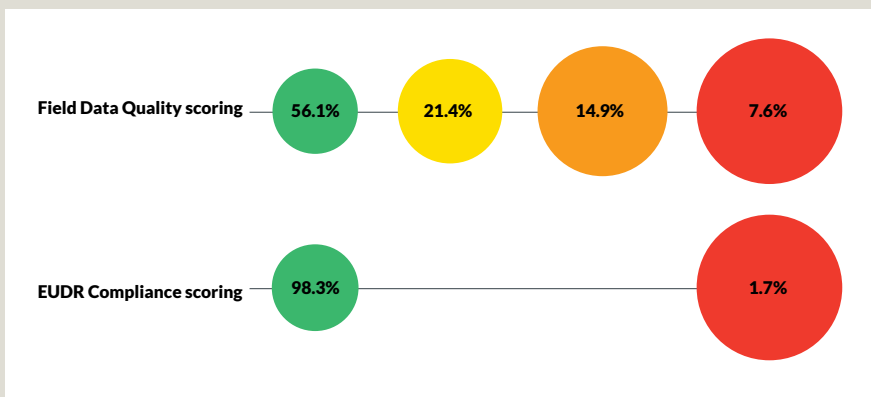
Written by Manon Michelle Monhemius, Meridia

Due to the European Union’s Deforestation Regulation (EUDR), companies are forced to comply with mandatory actions requiring rigorous data collection at the farm level, including geographic coordinates. Given that a significant share of tropical commodities are currently insufficiently traceable, this can be challenging.

This lack of traceability poses a growing risk for companies, which can result in supply chain disruptions, hefty penalties, and reputational damage. It can also exclude smallholders from supply chains. To address these issues, compromising field data quality is no longer acceptable.

However, field data collection is complex. Extensive data quality analyses show that a significant portion of farmer data is faulty. For many farms in remote areas, there is no data at all.

Meridia Verify ensures high-quality data for both buyers and sellers. This proven methodology, endorsed by industry experts, continuously improves data collection and management. ‘Stress-testing,’ with currently over 40 field-calibrated tests, creates a scoring profile that identifies the trustworthiness level, potential fraud risks, compliance and non-compliance to regulation, major risk drivers, and recommendations for improvement.



An instance of Meridia Verify’s automated field data quality verification and compliance test results indicates that data quality is often overlooked. Even though only 1.7% of the farms in this dataset are marked as non-compliant due to on-farm deforestation, a much larger segment of the dataset (7.6%) has a critical data quality score due to a variety of issues such as overlaps, duplications, farms

located in villages or water bodies and such, rendering it unqualified for inclusion in a EUDR Due Diligence Statement and requiring a significant set of farms to be remapped to avoid the risk of penalties for noncompliance, as “truthfulness and precision of geolocal data” is explicitly mentioned in the EUDR legislation.

The aim is for Meridia Verify to become a quality seal or standard for data quality and compliance, internalised in daily procurement processes, for commodity traders, manufacturers, and service providers (e.g. in climate and carbon) to gain visibility, trust and assurance to meet due diligence regulations and other objectives.

Meridia is collaborating with ICE Benchmark Administration (IBA) to launch the ICE Commodity Traceability Service or ICE CoT. IBA is part of Intercontinental Exchange, home to the world’s largest soft commodity futures and options markets.

ICE CoT is a technology platform designed to maintain the frictionless trade of physical cocoa and coffee by supporting these industries’ compliance with the EUDR. Meridia’s methodologies and technology will be embedded within ICE CoT to provide robust validation for farm and traceability data provided by cocoa and coffee traders and operators.

Launching in 2024 ahead of the EUDR entering into application in December 2024, ICE CoT is designed to provide continuous and independent validation of the traceability data from the initial parcel to its ultimate use or export, giving confidence to operators and traders of the quality and compliance of the data underlying the product.

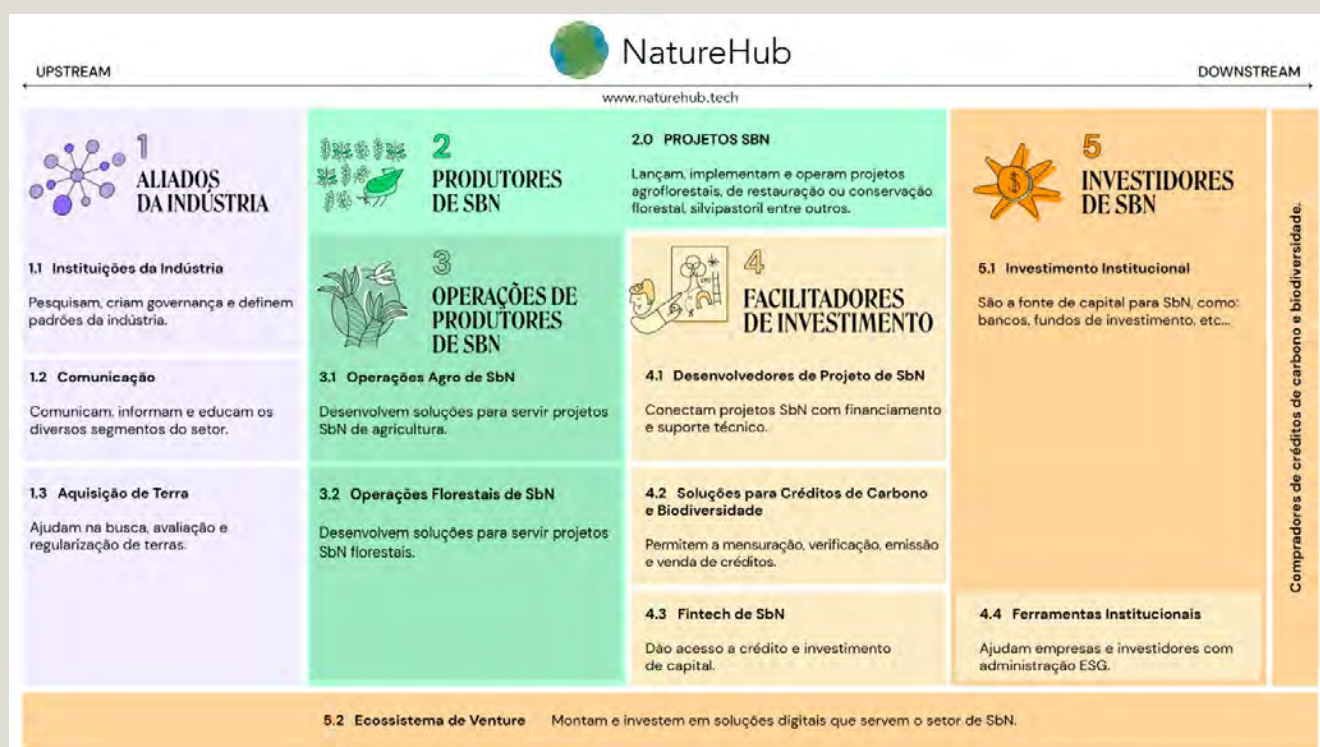
NatureHub

Written by Alex Comninos, NatureHub

NatureHub Brasil is a non-profit organisation whose mission is to strengthen the awareness and understanding of nature-based solutions (NbS) and their role in mitigating the risks of climate change.

The platform combines a free database of over 400 global NbS organisations with expert interviews to mobilise and inspire a diverse community. This includes reforestation CEOs, start-up founders, investors, forest engineers, as well as those wanting to learn more.

The NatureHub Brasil's mission is to strengthen visibility and understanding for the nature-based solutions market in Brazil, and this includes highlighting important efforts to build stronger bridges between the broader value chain and IPs and LCs. The NatureHub database provides access to market stakeholders seeking to support and engage efforts that strengthen indigenous rights, alongside supporting IPs and LCs to discover solutions that can provide access to information and commercial opportunities. In addition the NatureHub platform invites experts to share their experiences and insights, disseminating important information that includes best practices and case studies of local community engagement.



Kanop

Written by Louis de Vitry, CTO and Co-founder, Kanop

Remote sensing imagery has the potential to play a critical role in expanding carbon markets and fostering trust. However, measuring the impact of nature-based solutions using this technology presents significant challenges.

The first complexity lies in the sources of input imagery provided to the models. Choices must be made to leverage the vast amount of remote sensing imagery available, particularly with the advancements in new space technologies. The diversity and richness of input imagery calls for the development of models that fuse the processing of time series of multispectral and Synthetic Aperture Radar (SAR) imagery. Such models would gather information related to seasons and phenologies through multi-temporality, while at the same time gather rich spectral (multispectral imagery) and structural information through multi-modality.

A second complexity relates to the ground-truth data bottleneck. The performance of AI models is dependent on the abundance and quality of the available ground-truth data. For forest indicators such as canopy height and tree height, large LiDAR surveys are becoming increasingly available on a per-country basis. The challenge in using these surveys lies in the statistical extrapolation from a few training countries to a potentially global coverage. For end-use forest indicators such as above ground biomass or carbon, the difficulty is even starker, with a dilemma often posed between data quantity and quality. On the one hand, some datasets provided by ESA or NASA are extensive but only derived from indirect modelling with respect to remote sensing data. On the other hand, smaller and localised datasets constituted from ground data are typically of higher quality but difficult to scale in size.

To overcome this bottleneck, there is a need for innovative learning paradigms. One highly promising line of exploration lies in generative AI approaches, which can reduce the dependence on ground truth data.

Generative AI models undergo a two-step training process. They start by learning on very large datasets of input imagery without using associated ground truth data. During this stage, the models extract meaningful patterns and representations from the input data itself. Subsequently, the models progress to a supervised learning phase, where they undergo 'fine-tuning' using smaller datasets that contain both input imagery and corresponding ground truth data.

The fine-tuning step of generative AI training could be further divided into several sub-steps. For example, the model could undergo an initial fine-tuning on a large dataset with low-quality ground truth data, followed by a second fine-tuning on a smaller dataset with high-quality ground truth data. Taking the refinement process even further, the models could be fine-tuned using high-quality ground truth data specific to the region or area of interest. This localised fine-tuning would be best achieved through few-shot learning, which is closely related to generative AI.

"Innovative solutions can be found to effectively and accurately measure the impact of nature-based solutions with remote sensing imagery. Accurate and meaningful measurements will play a pivotal role in unlocking the full potential of nature in the future."

Louis de Vitry, CTO and Co-founder, Kanop.

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mapbox
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Dynamic Plot

📍 Brazil
🌿 Climate 🗺️ 4 polygons 📏 1190.81 ha

⚙️ Configure
🗺️ View map

📄 Request measurement
Standard
Date
➤ Submit

Time series

Indicator

Living aboveground

Level

Polygons

Filter

Polygon all

Living aboveground biomass per ha evolution

Date: July 2019
Living aboveground biomass per ha: 122.5 t / ha
Upper confidence interval limit (95%): 141.6 t / ha
Lower confidence interval limit (95%): 114.4 t / ha

Living aboveground biomass per ha variation

- 2022
Standard measurement Completed
- 2021
Standard measurement Completed
- 2020
Standard measurement Completed
- 2019
Standard measurement Completed
- 2018
Standard measurement Completed
- 2017
Standard measurement Completed

91 %

forest cover

12 m

canopy height mean

14 m

tree height mean

226k t DM

of living biomass

109k t

of carbon

399k t

of CO₂ eq.

Overview

Indicator

Level

Living aboveground biomass per ha

Polygons

An app that supports Indigenous peoples and local communities (IPs and LCs) rights and knowledge

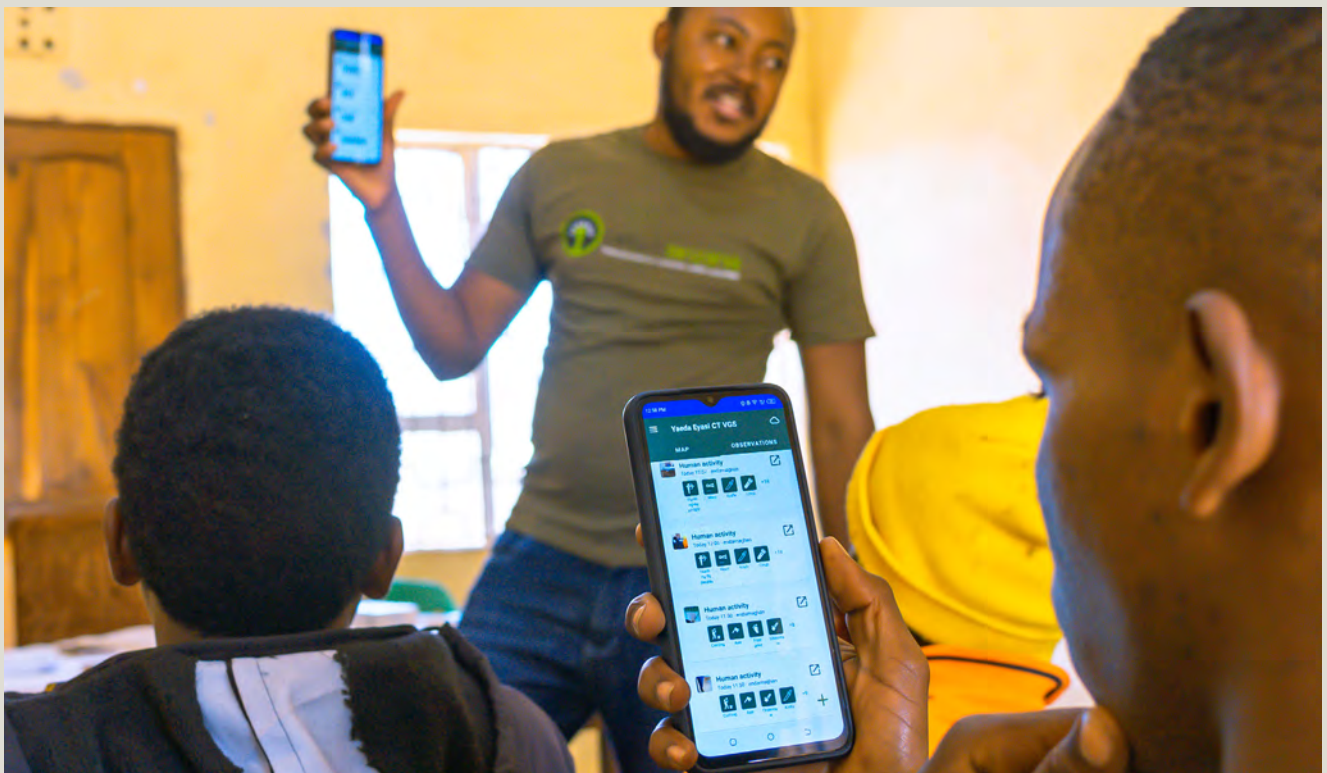
Written by Peadar Brehony, Carbon Tanzania

In Tanzania, project developer Carbon Tanzania and tech company Sensing Clues, are working together to improve integrity in NbS by providing transparent monitoring data, enhancing governance transparency and accountability, ensuring change to IPs' and LCs' rights to resources. A traditional app that monitors wildlife and illegal activity has been transformed into an app that also monitors and captures evidence of free prior and informed consent (FPIC) procedures and community-based activities.

Through the Sensing Clues' "Cluey" app, Carbon Tanzania is enhancing transparency throughout the project development process, from introductory meetings with local communities right through to the implementation of project operations. Cluey is capturing evidence of FPIC meetings, training sessions and benefit sharing meetings in real time, and is backed up on the cloud to be shared for validation and verification. Securing evidence of community activities has the potential to strengthen indigenous rights and hold project developers to account, ensuring local communities have the knowledge to make informed decisions about the use of their natural resources.

Carbon Tanzania's projects are located in remote ecosystems with limited connectivity. To overcome the challenge of limited connectivity, Cluey can be used offline in the field by IP's, LC's and field staff, and then uploaded to the cloud making it viewable on a dashboard by any user with permission. Users can view evidence of illegal activity, land incursions or conflicts and minutes of community meetings, over time scales of their choosing. This data can then be used to settle disputes, strengthen governance and eventually reduce the number of conflicts that occur.

Cluey is also transforming wildlife monitoring processes. The app is able to capture the exceptional and ancient tracking abilities of the Hadza hunter-gatherers, to monitor wildlife with a form of evidence that is then accessible to validators and scientists in other parts of the world, who often speak a different language to the data collectors. The transparency Cluey brings to project development has the potential to increase integrity in NbS and improve trust, allowing investors to make informed decisions and ensuring indigenous rights are upheld.



The NICFI Satellite Data Program

Written by Charlotte Bishop and Laura Abuja Conde, KSAT

Introduction and uses within Indigenous communities

Public satellite data sources such as Landsat and Sentinel have allowed for growth in the use of remote sensing information across a wide range of applications. For forestry and land changes, for example, they are the most used satellite datasets in the world.

However, they are at a medium to low spatial resolution of 10-30m. Higher spatial resolution data therefore brings opportunities to provide more detail, which in turn improves reporting, monitoring, and detecting smaller changes than before, as well as providing baseline data to support progress towards sustainable development and climate change mitigation goals. However, traditionally such data has often come at a significant cost.

It was for this reason that in September 2020, the Norwegian Ministry of Climate and Environment through NICFI (Norway's International Climate and Forest Initiative), funded the **NICFI Satellite Data Program**. For the first time ever, access to high resolution data (<5m, updated monthly) across an unprecedented, continuous area of 45M sq km between 30 degrees north and south has been facilitated.

By reducing the typical barriers to access, such as cost and arduous licensing, the program has the opportunity to empower more users to benefit from it regardless of their experience with satellite imagery.

KSAT, together with its partners **Planet** and **Airbus**, provide this service to ensure that users can not only find this data within the tools they are familiar with (e.g. Global Forest Watch (GFW), Google Earth Engine (GEE) and ArcGIS/QGIS) but can also use the existing functionality provided by Planet's own platforms and integrations for detailed or visual analyses.

Image credit: Renting C / Unsplash



Planet's medium resolution (PlanetScope) archive and new collection data forms the core products offered whilst Airbus provides access to its historical SPOT-5, 6, 7 datasets for strategic partners. The programme runs until September 2024 and the data released as part of the programme remains accessible in perpetuity.

A key goal of this programme is to enable all users – from local to regional to global – to scale, and reduce barriers to access. Indigenous communities – the stewards of their land for generations, hold immense understanding and knowledge of their lands, making them important users for the programme, directly or indirectly.

Yet internet connectivity, language and specialised knowledge are still barriers to Indigenous communities wishing to explore how earth observation, or geospatial information in general, can support their activities. Public sources such as Sentinel-2 are increasingly used, but with the availability of the NICFI Satellite Data Program there is growing interest, and use, to see how the higher spatial and temporal resolution data can supplement and grow existing analysis practices. Exposing the data to different users within the Indigenous community can also help identify different and more diverse use cases, and by working with Indigenous communities there is an opportunity to empower them to see and realise the benefit that such data can bring.

Rainforest Foundation US facilitates training in the use of the NICFI Satellite Data Program data to five Indigenous organisations and 33 Amazonian native communities of the Kichwa, **Shipibo** and Ticuna people. The images are downloaded in satellite information hubs and transformed into android format where they are then transferred to the native communities as offline images. Community patrols use the basemaps on their smartphones to plan patrols to validate early deforestation alerts. The impact this has on the local communities is that it helps improve planning and security of forest patrols and facilitates measurement of compliance with family conservation agreements.

Shipibo REDD+ Case study

Written by Olivia Palma

The Shipibo community in the Eastern Peruvian Amazon are increasingly facing deforestation threats from logging, palm oil companies, agricultural expansion, and Mennonite invasions across 2.8 million hectares. The Shipibo REDD+ Project, currently in the feasibility study phase, is being co-led by the Shipibo cooperative, Koshicoop, and Earthshot Labs, with community members driving the initiative alongside trusted technical support.

The project aims to address the threats of deforestation in the Shipibo community's territory while promoting sustainable development, preserving biodiversity, enhancing adaptation, and mitigating climate change.

To begin, technical teams used various data sets and inputs to analyse only eligible communities with georeferenced and legally recognised land titles. By including the deforestation rate and the number of hectares per number of families, the team further filtered to identify where they could have the most economic impact, ensuring their ability to be successful.

In addition to co-designing a project that maps the drivers of deforestation and creates tangible territorial solutions to combat invasions, the project aims to build sustainable chains that support families, reducing community-driven deforestation. Community members have also put forth a set of 'social solutions' to incorporate the social context in which they work and provide communities with the chance to organise themselves. Social solutions and true community engagement are essential to ensure that all project activities align with ancestral practices, recapture cultural and family values, and reflect the community's views for the future.

Appendix

VC funding analysis and methodology

Nature tech start-ups were classified into seven categories:

- **Food and agriculture:** regenerative agriculture, precision farming, nutrient management and biofertilizers, soil health monitoring, integrated pest management, sustainable livestock management, plant biotechnology.
- **Land and forest:** agroforestry, sustainable forest management, precision forestry, bio-geoengineering.
- **Ocean:** sustainable blue economy (fisheries, aquaculture, etc.), algae production.
- **Water conservation and management:** smart irrigation systems, wastewater treatment, and water purification technologies.
- **Biodiversity and nature restoration:** protection and restoration of wildlife, forests, grasslands, peatlands, oceans, coastal zones – mangroves, wetlands, seagrasses, coral reefs.
- **MRV and biodiversity credits:** biodiversity data collection and monitoring, digital MRV for carbon and biodiversity, biodiversity credit exchange.
- **Green supply chain:** supply chain traceability, land titling management.

The objective is to quantify and analyse venture capital (VC) funding in nature tech start-ups since 2018. A database of 705 venture capital transactions in nature tech startups (excluding grant and debt financing) was extracted from Crunchbase using keywords specific to the seven nature tech categories. These deals represent total VC funding equal to \$7.46 billion for the five-year period 2018-2022.

Each transaction includes the following information:

- Name, location and description of the company.
- Transaction date and amount.
- Stage of investment (pre-seed, seed, series A, series B, series C).
- Nature tech category.

It should be noted that the current database does not take into account impact-related criteria related to biodiversity, climate change or societal, because these criteria are not yet explicitly measured, assessed and reported by nature tech start-ups or investors.

Endnotes

- 1 <https://www.nature.org/en-us/what-we-do/our-insights/perspectives/how-nature-can-get-us-37-percent-of-the-way-to-the-paris-climate-target/>
- 2 <https://www.worldwildlife.org/stories/recognizing-indigenous-peoples-land-interests-is-critical-for-people-and-nature>
- 3 New UN report shows evidence that Indigenous and Tribal Peoples are the best guardians of the forests of Latin America and the Caribbean | FAO | <https://www.fao.org/americas/noticias/ver/en/c/1380819>
- 4 <https://www.lse.ac.uk/granthaminstitute/explainers/what-is-climate-finance-and-where-will-it-come-from/>
- 5 <https://www.climatepolicyinitiative.org/publication/landscape-of-climate-finance-for-agrifood-systems/>
- 6 <https://www.climatepolicyinitiative.org/publication/landscape-of-climate-finance-for-agrifood-systems/>
- 7 <https://www.pwc.com/gx/en/news-room/press-releases/2023/pwboosts-global-nature-and-biodiversity-capabilities.html>
- 8 <https://www.globalwitness.org/en/campaigns/environmental-activists/decade-defiance/>
- 9 https://wwflac.awsassets.panda.org/downloads/report_the_state_of_the_indigenous_peoples_and_local_communities_lands_and_territories_1.pdf
- 10 <https://www.nature.com/articles/s41893-021-00815-2>
- 11 <https://www.fao.org/3/cb2953en/online/src/html/deforestation-and-forest-degradation-in-indigenous-and-tribal-territories.html>
- 12 <https://www.scientificamerican.com/article/what-conservation-efforts-can-learn-from-indigenous-communities/>
- 13 UNCCD Global Land Outlook 2022
- 14 Voluntary Carbon Market Insights Report, BCG and Shell, Jan 2023
- 15 Berkeley Voluntary Registry Offsets Database – v5 (as of 31st March, 2022) and World Economic Forum Nature and Net Zero - May 2021
- 16 PWC Managing Nature Risks, April 2023
- 17 <https://www.pnas.org/doi/full/10.1073/pnas.1710465114>
- 18 TNFD pilot Agrifood Industry; March 2023 by Iceberg Data Lab and I Care by Bearing Point.
- 19 <https://www.unep.org/resources/state-finance-nature-2022>
- 20 <https://www.wri.org/research/securing-rights-combating-climate-change>
- 21 UNESCO “Making Peace with Nature” CBD contribution
- 22 NatureFinance and Carbone4. (2023). Harnessing Biodiversity Credits for People and Planet: A Roadmap, NatureFinance. Retrieved from <https://www.naturemarkets.net/publications/harnessing-biodiversity-credits-for-people-and-planet>
- 23 <https://www.ecosystemmarketplace.com/carbon-markets/>
- 24 <https://www.sylvera.com/blog/guardian-offsets-response>
- 25 Platform certification could also include random in-depth, manual audits of individual projects.
- 26 <https://www.unep.org/news-and-stories/press-release/nature-based-solutions-can-generate-20-million-new-jobs-just>.
- 27 UNEP. 2022. Playing for the Planet Annual Impact Report.
- 28 Statista; Statista Advertising & Media Insights. Video game market revenue worldwide from 2017 to 2027 (in billion U.S. dollars). June 2023.
- 29 <https://africacarbonmarkets.org/action-programs/>
- 30 https://www.irena.org/-/media/Files/IRENA/Agency/Statistics/Statistical_Profiles/Africa/Ethiopia_Africa_RE_SP.pdf
- 31 RMI Third Derivative: <https://www.knbs.or.ke/wp-content/uploads/2021/09/Economic-Survey-2021.pdf> Exhibit 8
- 32 <https://www.knbs.or.ke/wp-content/uploads/2021/09/Economic-Survey-2021.pdf>
- 33 https://au.int/sites/default/files/documents/42276-doc-CC_Strategy_and_Action_Plan_2022-2032_23_06_22_ENGLISH-compressed.pdf
- 34 <https://saiia.org.za/research/africas-mineral-resources-are-critical-for-the-green-energy-transition/>
- 35 <https://www.mdpi.com/1999-4907/14/9/1903>
- 36 ESCAP, 2023; WMO, 2022
- 37 Source: Asian Development Bank
- 38 White et. al. and FAO report

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